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SOILS AND VEGETATION OF MLUNGUI PROPOSED FOREST RESERVE MARAMBA DIVISION, MUHEZA DISTRICT, TANGA.

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Min. of Agriculture, National Soil Service
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East Usambara Catchment Forest Project Technical Paper 24

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TABLE OF CONTENTS

LIST OT TABLES

Page

LIST OF FIGURES

SUMMARY

The East Usambara Catchment Forestry Project (EUCFP) requested the National Soil Service (NSS) to carry out soils and vegetation survey of Mlungui forest reserve. The objectives of the study were to give general soils distribution, assess the fertility and to map out forest in terms of density and dominant tree species.

Mlungui Proposed Forest Reserve covers an area of about 200 ha and is located on Mlungui hill, Maramba division, in Muheza District. The climate is characterised by bi-modal rainfall pattern with long and short rain seasons from March to May and October to December respectively.

The forest is proposed by East Usambara Catchment Forest Project to be gazetted as a forest reserve. Mlungui hill is divided into three major physiographic units summit and upper slope, mid-slope and lower slopes. Slope gradient of the study area ranges from 16 to 40 % at an elevation between 200 to 450 m above sea level. The soils are formed from metamorphic rocks of the Usagaran system. The rocks are dominantly gneiss.

The soils in the study area are shallow to very deep, moderately to well drained, clay loam or sand clay loam to clay, dark reddish brown to dark red or red or yellowish red. In places the soils have rock outcrops or even rocky without surface stoniness.

The density of the forest in the study area is variable. It ranges from dense to highly disturbed forest. The commom and faithful tree species include *Scorodophloeus fischeri, Manilkara sulcata, Craibia brevicaudata, Lecaniodiscus fraxinifolius, Haplocoelopsis africana, Cola microcarpa, Marhamia lutea, Ludia mauritiana, Commiphora eminii, Teclea simplicifolia and Lettourianthus stellatus.* common lianes and climbers include *Commiphora pteleifolia, Dictoyophleba lucida, Cissus sylvicola, Psilotrichum scleranthum and Landolphia spp.*

The eastern slopes contain vegetation types different from the western slopes. Outstanding trees on the eastern slopes are *Adansonia digitata* a coastal or inland species left behind after forest disturbance, *Cussonia zimmermanii* (abundant in area of high disturbances), *Dichapetalum stuhlmanii, Zizphus mucronata,* and *Lecaniodiscus fraxinifolius.*

The western slopes have moist evergreen forests characterized by population pockets of *Pandanus rabaiensis* in a protected middle zones of valleys usually with rocky blocks, emergent isolated tall trees of *Sterculia appendiculata, Scorodophloeus fischeri, Afrosersalicia ceracifera, Julbernadia magnistipulata, Ludia madagascariensis, Combretum shumannii, Diospyros kabuyeana, Alchornea hirtella* and *Ricinodendron haudelotii.*

The summit and upper slopes have somewhat mixed vegetation. Common and faithful species include *Afrosersalicia ceracifera, Aflezia quanzensis, Bombax rhodognaphalon, Haplocoelopsis africana, Haplocoelum inopleum, Julbernardia mgnistipulata, Lecaniodiscus fraxinifolius, Ludia mauritiana, Manilkara sulcata, Cola microcarpa, Caltis philippensis, Scrodophleus fischeri* and *Zizphus mucronata*

1. INTRODUCTION

This report presents the results of detailed soil and vegetation survey at a scale of 1:10,000 of Mlungui Proposed Forest Reserve (200 ha) located at Maramba Division, Muheza District, in Tanga Region. It is found within coordinates 38°45'E and 38°50'E and 4°55' and 5°00'S about 10 km from Mtapwa village along Tanga-Maramba road (Figure 1). Mlungui Poroposed Forest Reserve is part of the East Usambara forests and it is proposed to be gazetted as a forest reserve to be managed as a catchment forest.

The survey was carried out by the National Soil Service (NSS) at the request of East Usambara Catchment Forest Project (EUCFP).

The objectives of the study were:

1. To give general soils distribution and assess the fertility status; and
2. To map out forest in terms of density and dominant tree species.

The fieldwork was carried out from 8th to 9th September 1995 by two NSS Soil Surveyors messrs J.M. Shaka and H. Mwanga. Vegetation classification is based on vegetation survey conducted by Leonard Mwasumbi and fieldwork assisted by Philip Clarke from Frontier Tanzania .

Messrs Shaka and Mwanga were also responsible for the production of the final report and map.

Soil samples collected during fieldwork were analyzed by the NSS Central Laboratory under supervision of Mr. C.T. Shawa. Soils and vegetation map of the Forest Reserve were traced by Mr M.I. Maro, NSS draughtsman.

ORIGINAL HARDCOPY &
SOFTCOPY MISSING IMAGE

Figure 1. Location of Mlungui proposed Forest Reserve.

2 THE ENVIRONMENT

2.1 Climate

Climate is one of the prime determinants that affect a type of vegetation to be found in a given area. However, only rainfall data is available and relevant for Mlungui Proposed Forest Reserve. Table 1 provides a summary of the rainfall data from Lugongo Sisal Estate, which is the nearest climatic recording station.

Table 1. Mean monthly rainfall (mm) at Lugongo Sisal Estate and mean monthly temperatures (^{o}C) at Mlingano Agricultural Research Institute (1949 - 1979).

Months	Mean monthly rainfall (mm)	Mean min. temp. (^{o}C)	Mean max. temp. (^{o}C)
Jan	64	21.6	32.5
Feb	59	21.7	33.1
Mar	156	21.9	33.0
Apr	159	21.9	30.6
may	161	21.7	29.2
Jun	46	19.5	28.2
Jul	51	18.6	27.6
Aug	50	18.4	28.1
Sep	66	18.8	28.6
Oct	125	19.7	29.8
Nov	156	20.7	30.7
Dec	147	21.6	32.1

The rainfall pattern in the study area is bi-modal with long (masika) and short (vuli) rainy seasons from March to May and October to December respectively. The main dry months are from June to September and January to February.

The data on temperature (Table 1) are those recorded at Mlingano Agricultural Research Institute located at Muheza District on the edge of East Usambara mountains. Air temperatures and relative humidity have small yearly variations . The coolest month is July with mean minimum temperatures of 27.6^{o}C and the warmest one is February with mean maximum temperatures of 33.1^{o}C.

2.2 Landform and Geology

Mlungui Proposed Forest Reserve is situated on Mlungui hill which is surrounded by wide valley bottom that are used for the cultivation of variety of crops. The hill itself can be divided into units based mainly on the slope gradient.

Major physiographic units include summit and upper slopes, mid-slopes and lower slopes. Summits and upper slopes are relatively elevated part of the hill with dominant slope ranging from 35 to 40 %. Elevation ranges from 400 m to 450 m above sea level.

Mid-slopes are found at an elevation between 300 - 400 m above sea level with dominant slope of 20 to 35 %. Lower slopes on the other hand occupy areas that are highly disturbed either by logging or former cultivation for food production. The area is found within 200 m to 300 m above sea level with dominant slope of 16 to 20 %.

The East Usambara in general and Mlungui hill in particular is characterised by Metamorphic rocks of the Usagaran system (Precambian Basement). The rocks are dominantly gneiss with intermediate mineralogical composition. The rocks have approximately equal quantities of light minerals (quartz and feldspar) and dark minerals (pyroxene and hornblende). Locally amphibolites occur (Geological Survey of Tanzania, 1965).

2.3 Land-use and vegetation

A large part of Mlungui Proposed Forest Reserve is natural forest. The forest in the area can be categorised according to density, and the degree of human involvements. `Dense forest` include uneven aged more or less disturbed natural forest which has species composition characteristic to the original forest type and has an unbroken crown cover. This type of forest covers mainly the summits and upper slopes.

On the other hand `poorly stocked forest` are those with variety of pioneer or secondary forest species which are poorly stocked because of various natural or manmade reasons. They are forest with low density, fairly open crown cover, modest volume and dominant height less than in dense forest belonging to the same forest type. This part of the forest shows some human influence especially logging. This type of forest is found mainly in the mid-slopes.

Other parts of the forests are `highly disturbed` such that often the natural vegetation types are absent. These are forests that are regenerated from the formerly cultivated lands. Very few trees are present. The area is dominated mainly by short and dense grasses. Evidence shows that some parts within the lower slopes has been under human inhabitation. Charcoal and some pottery remnants are seen in some places. Cutting trees for timber (logging) has for the past years been practised in Mlungui Proposed Forest Reserve especially in the lower slopes. These are indicated by the trunks which are still seen in the lower slopes.

3 STUDY APPROACH

Prior to the commencement of the fieldwork, all relevant and available sources of information were studied. These include topographical and geological maps and all other relevant literatures for the study area.

A detailed soil study for the area included auger hole observations in each of the established sample plots. A total of 10 auger hole observations were made to a depth of 150 cm where possible. The augerings were described according to FAO (1977) guidelines for soil profile descriptions. Soil colours were named according to the Munsell notation (Munsell colour Charts Inc., 1973).

The augering and vegetation identification followed a grid approach, with observation sites spaced at standard intervals. The overall observation density was one observation point per 20 ha, corresponding to a nominal 450 m x 450 m grid system. In each grid square there was a 20 m x 50 m vegetation plot, in which samples were taken.

For vegetation identification and classification, in each of the sample plot all trees with DBH greater than 10 cm were counted followed by individual tree identification and botanical classification. Using information from aerial photography the forests were also categorised based on the density of the forests trees and the degree of the human involvement in the study area.

Soil samples for standard soil fertility analysis were collected from two depths 0-25 cm and 25-50 cm. The soils were then analyzed according to the Internationally accepted method in use at NSS. The parameters studied include texture by hydrometer, pH, total N, organic C, available P, and Exchengeable calcium, potassium, magnessium and sodium.

The information gathered during the fieldwork and that from the chemical analyses was used in conjunction with recent aerial photography (1994) of scale 1:25,000 for East Usambara and Landsat Imagery to produce soil and vegetation map at a scale of 1:10,000.

4. SOILS AND VEGETATION

4.1 Soils and vegetation map and legend

Based on the slope gradient the study area has been divided into three major physiographic units which are presented by capital letters.

S- summits and upper slopes
M- mid-slopes
L- lower slopes

These major units are sub divided based on the soils characteristics. Further subdivision is based mainly on the dominant tree species that are found in the area.

4.2 General soils and vegetation conditions

The soils in the study area are generally shallow to very deep, moderately to well drained, sand clay loam to clay, dark reddish brown to dark red or red or yellowish red. In places the soils have rock outcrops or even rocky without surface stoniness. The slopes are very steep ranging from 16-40 % and the soils are very prone to severe erosion if vegetation cover is removed.

The chemical data presented in Table 2 shows that generally the soils in the area are very strongly acid to mildly alkaline. The soils are non-saline. Organic carbon and total nitrogen are variable in the study area. In some of the mapping units the level of organic carbon and total nitrogen varies from low to high. This clearly show that the amount of organic matter in the soils within the study area is high and the organic matter is of good quality as indicated by the C/N ratio.

Available phosphorus is low while exchangeable bases vary from low to high. The level of exchangeable calcium is very high. It seems that the parent material from which the soils are formed is rich in this element.

For the whole area dominant tree species are found in association with other tree species.
The dominant tree species which are found in most of the mapping units in the study area include *Scorodophloeus fischeri, Manilkara sulcata, Craibia brevicaudata, Lecaniodiscus fraxinifolious, Haplocoelopsis africana, Cola microcarpa, Marhamia lutea, Ludia mauritiana, Commiphora eminii, Teclea simplicifolia and Lettourianthus stellatus.* common lianes and climbers include *Commiphora pteleifolia, Dictoyophleba lucida, Cissus sylvicola, Psilotrichum scleranthum and Landolphia spp.*

The occurrence of these tree species is found to be largely associated with slope gradient and human influence either by timber logging or cultivation especially in the lower slopes. Tree species found in the summit and upper slopes are characteristically different from those found in the mid-slope and that of the lower slope.

Table 3. Analytical data for Mlungui Proposed Forest Reserve.

Location and sample depth	Texture class	pH 1:2.5 H^2O	pH 1:2.5 KCl	0rg C %	Total N %	C/N	Avail.P mg/kg	Exchangeable bases Ca	Mg	K	Na	Ec mS/cm
								------ Cmol(+)/kg-------				
Plot												I
0 -25 cm	CL	5.4	4.7	1.9	0.19	10	3.17	5.97	1.92	0.31	0.05	0.03
25-50 cm	C	5.0	3.9	1.0	0.11	9	0.85	3.08	1.95	0.12	0.07	0.02
Plot												2
0 -25 cm	SCL	6.9	6.2	3.3	0.30	11	2.35	13.92	5.80	1.84	0.07	0.07
25-50 cm	SCL	6.7	5.5	1.1	0.12	9	2.30	8.08	4.50	0.15	0.05	0.05
Plot 3												
0 -25 cm	CL	5.4	4.7	2.0	0.19	10	3.18	5.96	1.92	0.32	0.05	0.03
25-50 cm	C	5.0	3.9	1.0	0.11	9	0.85	3.07	1.96	0.12	0.07	0.02
Plot												4
0 -25 cm	C	7.5	7.0	3.3	0.27	12	3.57	15.65	5.17	1.65	0.04	0.11

25-50 cm	C	6.0	5.1	1.6	0.13	12	0.55	3.64	1.09	1.46	0.04
0.08											
Plot											5
0 -25 cm	SCL	6.8	6.2	3.2	0.31	11	2.35	13.80	5.81	1.87	0.07
0.07											
25-50 cm	SCL	6.7	5.5	1.1	0.11	9	2.31	8.10	4.46	0.16	0.05
0.06											

Table 3. (continued)

Location and sample	Texture class	pH 1:2.5 H^2O	pH 1:2.5 KCl	Org C %	Total N %	C/N	Avail.P mg/kg	Exchangeable bases Ca	Mg	K	Na	Ec mS/cm
								------ Cmol(+)/kg-------				
depth												
Plot												6
0 -25 cm	CL	6.6	6.2	6.2	0.58	11	0.86	32.38	10.69	1.12	0.07	0.10
25-50 cm	C	6.8	6.1	2.3	0.20	12	0.76	15.66	5.18	1.07	0.06	0.06
Plot												7
0 -25 cm	CL		6.6	6.0	0.53		0.86	32.38	10.65	0.10	0.07	0.10
25-50 cm	C		6.8	2.0	0.14		0.75	15.50	5.20	1.00	0.06	0.06
Plot												8
0 -25 cm	SCL	6.2	5.6	3.0	0.28	11	2.06	12.75	3.01	0.66	0.11	0.06
25-50 cm	SC	6.3	5.0	1.1	0.12	9	1.00	7.41	4.75	0.21	0.13	0.02
Plot												9
0 -25 cm	SCL	6.8	6.1	3.2	0.30	11	2.36	13.92	5.79	1.84	0.07	0.07

25-50 cm	SCL	6.7	5.5	1.1	0.12	9	2.29	8.08	4.48	0.14	0.05
0.05											
Plot											10
0 -25 cm	SCL	6.5	5.8	2.0	0.20	10	7.93	10.92	2.52	0.86	0.05
0.04											
25-50 cm	SCL	6.6	6.0	1.0	0.10	10	5.33	8.04	2.66	0.53	0.03
0.03											

4.3 Description of the mapping units

4.3.1 Mapping unit, S1.1 (30 ha)

This unit covers the summit of Mlungui hill at altitude 400-450 m above sea level. Dominant slope is 35-40 %. The soils in this mapping unit are deep, well drained, dark reddish brown topsoil to red subsoil. The texture of the soils varies from clay loam in the topsoil to dominantly clay in the subsoil.

The soil reaction of the soils as indicated by the pH of the soil is very strongly acid to strongly acid with pH values that ranges from 5.4 in the topsoil and decreases to 5.0 in the subsoil. Total nitrogen on the otherhand are low in this mapping unit with levels varies from 0.19 in the topsoil to 0.11 % in the subsoil. The organic carbon are medium in the topsoil with values of about 1.9 % and decreases to low levels in the subsoil. The carbon to nitrogen ratio show that the organic matter are of good quality. The available phosphorus in this soil is low with levels generally less than 7 mgP/kg.

The exchangeable calcium in this mapping unit is medium in the topsoil and decreases to low levels in the subsoils with values 5.97 and 3.08 Cmolc//kg respectively. On the otherhand the soils in the mapping unit has medium levels of magnesium while potassium levels are low to very low with values ranging from 0.31 Cmolc/kg in the topsoil to 0.12 Cmolc/kg in the subsoil. The exchangeable sodium are generally very low with values dominantly less than 0.1 Cmolc/kg.

The dominant vegetation types here are dense forest which are less disturbed natural forest. The influence of man is very little and if at all it has been there then prohibition from getting into the forests has left the forest intact and alot of forest regeneration has occurred. They are dominated by trees species that have unbroken crown cover. The dominant tree species in the sample plot comprise of mainly *Angylocalyx braunii, Craibia zimmermannii, Cussonia zimmermannii, Cynometra webgeri, Scorodophloeus fischeri, Garcinia volkansii, Julbernardia magnistipulata, Milletia usaramensis, Pandanus rabaiensis, Manilkara spp., Blighia unijugata* and *Baphia kirkii*. Common shrub layer includes *Dracaena deremensis, Dracaene usambarensis, Encephalartos hildebrandtii, Erythroxylum imarginatum, Sclerochitoa boivinii, Ochna macrocalyx, Asparagus falcatus, Erythrococca spp.,* and *Euphorbia nyikae*

This mapping unit is represented by Plot 1.

4.3.2 Mapping unit S1.2 (42 ha)

This unit covers the same topographical position and soils characteristics are similar to that of mapping unit S1. The difference is that this mapping unit is mainly dominated by *Pandanus rabaiensis and Scorodophloeus fisheri, Markhamia lutea, Manilkara sulcata, Julbernardia magnistipulata, Afrosercalicia celacilifera, Alchornea hirtella, Bombax rhodognaphalon and Teclea simplicifolia*. Shrubs include *Garcinia spp., Rinorea sp.,* and the regenerating trees include *Dracaena deremensis, Euphorbia nyikae* and *Encephalartos hildebrandtii.* This mapping unit is represented by Plot 3.

4.3.3 Mapping unit M1.1 (34 ha)

This mapping unit covers the mid-slope of Mlungui forest reserve. With dominant slope of 20 % and occurs at altitude 350-400 m above sea level. The unit is characterized by the presence of rock outcrop in most part of the unit. The soils in this mapping unit are shallow to moderately deep, moderately well drained, dark brown and sand clay loam in texture. The soils have stoneline dominated by quartz at variable depth and within the soils matrix mica flakes are present.

The soil reaction of the soils is neutral with pH values that ranges from 6.7 to 6.8. It is almost constant within 50 cm from the surface. The total nitrogen in the topsoil is medium with levels around 0.30 % but it decreases to low levels in the subsoil with values of about 0.12 %. The organic carbon of the soils found in this mapping unit is high (3.2 %) in the topsoil and decreases to low levels (1.1 %) in the subsoils. The C/N ratio which gives more information on the availability of the nitrogen and hence showing the quality of the organic matter are of good quality. The levels ranges from 9 to 11.

The available phosphorus are low with levels ranging from 2.36 to 2.29 mgP/kg. The exchangeable calcium on the other hand are very high with levels that varies from 13.92 in the topsoil to 8.08 Cmolc/kg. Exchangeable magnesium are dominantly high ranging from 5.79 in the topsoil to 4.48 Cmolc/kg in the subsoil. Potassium levels are high in the topsoil (1.84 Cmolc/kg) and decreases to very low levels in the subsoil. The exchangeable sodium are generally very low with levels less than 0.1 Cmolc/kg.

The mapping unit shows signs of pole cutting and logging. It seems the unit was for some years ago before the area was strictly prohibited was used for tree logging and other uses. After prohibition the unit is with slightly dense natural vegetation cover with dominant tree species in sample plots comprising of *Lecaniodiscus, fraxinifolious, Manilkala Sulcata, Ludia mauritania, Mimusops sp., and Dorstenia*. Common climbers include *Dichapetalum mossanbicense, Cissus rotundifolia, Monanthotaxis buchananii, Hugonia castaneifolia, Artabotrys modestus, Schlechterina mitostemmatoides* and *Salacia leptoclada.* The common shrubs are *Teclea sp., Brachylaena huilensis, Zanthoxylum* and *Ricinodendron heudelotii.* Plot 9 represent this mapping unit.

4.3.4 Mapping unit M1.2 (15 ha)

This unit covers the same setting and have similar soils characteristics except that the dominant tree species in the mapping unit include *Lecaniodiscus fraxinifolious, Dombeya spp* and *Gronia spp*. The unit is represented by Plot 8**.**

4.3.5 Mapping unit M1.3 (8 ha)

The position to which this mapping unit occurs in the study area is similar to that of M1.1 and the soils characteristics are similar as well. However the difference between this unit with others is that the dominant tree species include *Cola spp, Ludia mauritiana,* and *Lecaniodiscus fraxinifolious.* Common grasses include *Oplismenus hirtellus and Leptaspis cochleata and a sedge Cyperus cyperoides.* The common herbs and shrubs seedlings include *Asteranthe asterias, Synaptolepsis kirkii, Dichpetalum stuhlmanii, Monanthotaxix buchanannii, Scorodophloeus fischeri, Salacia leptoclada, Aningeria ceracifera and Teclea*

spp., The regenerating trees include *Ludia mauritiana, Manilkara sulcata* and *Diosppyros kabuyeana.* The mapping unit is represented by Plot 2.

4.3.6 Mapping unit M2 (26 ha)

The unit occurs in the mid-slope of Mlungui hill at an altitude 300 m above sea level. Dominant slope at the site is 38 %.

The soils are moderately deep, well drained, rocky in places, without surface stoniness. The soils are very dark brown to brown. The texture in the topsoil is clay loam that changes to gravelly or slightly gravelly in the subsoil.

The unit is still under sparse vegetation and dominant trees species include *Aningeria spp*. and *Scorodophloeus fisheri*. Plot 5 represents this mapping unit.

4.3.7 Mapping unit L1 (17 ha)

The mapping unit covers lower slopes at an altitude of 250 m above sea level. Dominant slope is 20 %. The soils are moderately deep to deep, well drained, clay loam to clay, dark reddish brown soils. No rock outcrops are observed in this unit.

The pH of the soils indicates that the soil reaction of the soil is neutral with values that ranges from 6.6 in the topsoil to 6.8 in the subsoil. Here the tendency is that the pH increases slightly with soil depths. That is the topsoil have lower pH values as compared to the subsoil. Total nitrogen on the otherhand are medium to high in the topsoil with values of about 0.58 % but the levels decreases to low levels in the subsoil with levels of about 0.2 %. The organic carbon is very high to high with levels that varies from 6.2 to 2.3 % respectively. However the C/N ratio indicates that the organic matter are generally of good quality.

The available phosphorus are low with values ranging from 0.86 to 0.76 mgP/kg. The exchangeable calcium on the otherhand are very high with values dominantly greater than 5 Cmolc/kg. The levels of magnesium are very high as well and decreases to high levels in the subsoil. The values are 10.69 and 5.18 Cmolc/kg for the topsoil and subsoil respectively. Potassium levels are medium while the sodium levels are generally very low in these soils.

The unit has sparse forests that are surrounded by fallow cultivation. Within a sample plot dominant tree species are *Ludia mauritania, Cola microcarpa, Drypetes usambarica and Dichapetalum stuhlmannii.* The regenerating tree are *Encephalartos hildebrandtii*. The herb layers are presented by *Landolphia kirkii* and *Lecaniodiscus fraxinifolius*. On the other hand the dominant shrubs include *Tarenna pavettoides, Suregada zanzibarense,* and *Leptactina platyphylla.* This mapping unit is best represented by Plot 6.

4.3.8 Mapping unit L2 (9 ha)

The unit covers lower slope of Mlungui hill. Dominant slope is 18 % at altitude 230m above sea level. No rock outcrop and surface stoniness. The soils of this mapping unit are

moderately deep, well drained, dark brown to brown, clay loam or clay topsoil to gravelly or slightly gravelly clay subsoils.

The mapping unit has forest that probably formerly was disturbed. The unit shows some evidence of logging. However the only tree species remaining in the sample plot include *Millettia spp; Lecaniodiscus fraxinifolious* and *Cola spp*. Common seedlings, herbs and shrubs include *Asteranthe asterias, Bequaertiodendron natalense, Clerodendrum spp., Ommiphora spp., Justticia spp., Haplocoelum inopleum, Oxyyanthes sppeciosus, Scorodophloeus fischeri, Diospyros kabuyeana, Erythrina sacleuxii,* and *Suregada zanzibarense.* The mapping unit is represented by Plot 7.

4.3.9 Mapping unit L3 (11 ha)

This mapping unit occupies the lowest altitude at about 220 m above sea level and has slope gradient of 16 %. The soils are very deep, well drained, dark brown or very dark brown, sand clay loam .

The soil found in this mapping unit have slight acid to neutral reaction. The pH levels varies from 5.8 to 6.0. The levels of the total N are low with levels less or equal to 0.2 %. The organic carbon in the soils are medium (2.0 %) and decreases down the soils to low levels (1.0 %) but the ratio between carbon to nitrogen lies between 8 and 13 which indicate good quality of the organic matter and entails good mineralisation of nitrogen.

The available phosphorus in the soils are medium in the topsoil and decreases to low levels in the subsoils with levels that ranges from 17. 93 and 5.33 mgP/kg in the topsoil and subsoil respectively. The exchangeable calcium are very high in the topsoil but decreasing with soil depth. The levels are 10.92 and 8.04 Cmolc/kg respectively. The magnesium levels are generally medium (2.52 to 2.66 Cmolc/kg) while the potassium levels are medium (0.86 Cmolc/kg in the topsoil and 0.53 Cmolc/kg in the subsoils respectively. Sodium levels are as well very low with values less then 0.1 Cmolc/kg.

The mapping unit shows presence of charcoal at 20-30 cm depth. The unit has been under cultivation for some years back as still coconut and mangoes plants are observed. Within a sample plot, 2 trees > DBH were counted and could not be classified. The unit is represented by Plot 10.

4.3.10 Mapping unit L4 (8 ha)

The mapping unit L4 covers the lower slope of Mlungui hill. Dominant slope gradient is 25 %. The soils in this unit is shallow, well drained, dark reddish brown to dark red clayey soils. The unit is rocky as in most parts of the unit rock outcrops can be observed.

The soil reaction of the soils found in this mapping unit are mildly alkaline (7.5)in the topsoil to slightly acid in the subsoils (6.0). Total nitrogen is medium in the topsoil (0.27 %) but decreases to low levels in the subsoil (0.13 %). The organic carbon in this soil type found within this mapping unit is high in the topsoil but decreases to medium levels in the subsoils. The levels are 3.3 and 1.6 % respectively. The C/N ratio shows that the organic matter are of good quality.

The available phosphorus is generally low with levels around 3.57 mgP/kg in the topsoil that decreases to 0.55 mgP/kg in the subsoil. The exchangeable bases are high in the topsoil and decreases to medium and low levels in the subsoils. The levels of calcium within the soils are 15.65 and 3.64 Cmolc/kg respectively. The levels of magnesium are high in the topsoil (5.17 Cmolc/kg) and becomes medium in the subsoil (1.09 Cmolc/kg). Potassium levels in the soils are high with levels that varies between 1.2 to 2.0 Cmolc/kg. The levels of sodium in the soils are very low with values less than 0.1 Cmolc/kg.

The mapping unit shows evidence of high degree of forest degradation due to disturbances resulting from abandoned cultivation and frequent dry summer fires. Secondary vegetation development with dominant mat forming grass of Panicum trichocladum, Trema orientalis are dominant pioneer tree species where forests ahve been destroyed. Within a sample plot, dominant and common tree species, many of which are indicators of disturbances include *Solanum incanum, Lantara camara, Harungana madagascariensis,* and *Panicum maximum.* Other species are common and faithful coastal bushland elements. These include *Carpodiptera africana, Cissus rotundifolia, Dichapetalum mossambicense, Hoslundia opposita, Millettia sacleuxii, Dichapetalum stuhlmannii, Cyphostemma spp., Phyllanthus reticulatus, Phyllanthus spp., Lecaniodiscus fraxinifolius, Sterculia appendiculata, Dombeya torrida* and *Grewia conocarpa.* The unit is represented by Plot 4.

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ANNEX 1: GUIDE TO SOIL FERTILITY EVALUATION

Organic matter and total nitrogen

	very low	low	medium	high	very high
Organic matter %	<1.0	1.00-2.0	2.10-4.20	4.30-6.0	>6.0
Organic C %	<0.60	0.60-1.25	1.26-2.50	2.51-3.50	>3.50
Total N %	<0.10	0.10-0.20	0.21-0.50	>0.50	

C/N ratios give more information about the availability of nitrogen than total N levels only. C/N ratios indicate the quality of the organic matter:
C/N 8-13: good quality
C/N 14-20: moderate quality
C/N >20 : poor quality

Soil reaction

Soil reaction (pH H_20) is classified as follows:

Reaction	pH
extremely acid	below 4.5
very strongly acid	4.5 to 5.0
strongly acid	5.1 to 5.5
medium acid	5.6 to 6.0
slightly acid	6.1 to 6.5
neutral	6.6 to 7.3
mildly alkaline	7.4 to 7.8
moderately alkaline	7.9 to 8.4
strongly alkaline	8.5 to 9.0
very strongly alkaline	above 9.0

Available phosphorus

	low	**medium**	**high**
Avail. P (Kurtz-Bray I) mg/kg Avail. P (Olsen) mg/kg	<7 <5	7-20 5-10	>20 >10

Available phosphorus is determined by the Kurtz-Bray I method if the pH H_20 of the soil is less than 7.0. In soils with a pH H_20 of more than 7.0 the Olsen method is used.

Exchangeable calcium

	very low	low	medium	high	very high
Ca (clayey soils rich in 2:1 clays) Cmolc/kg	<2.0	2.0-5.0	5.1-10.0	10.1-20.0	>20.0
Ca (loamy soils) Cmolc/kg	<0.5	0.5-2.0	2.1-4.0	4.1- 6.0	> 6.0
Ca (kaolinitic and sandy soils) Cmolc/kg	<0.2	0.2-0.5	0.6-2.5	2.6- 5.0	> 5.0

Exchangeable magnesium

	very low	low	medium	high	very high
Mg (clayey soils) Cmolc/kg	<0-3	0.3-1.0	1.1-3.0	3.1-6.0	>6.0
Mg (sandy soils Cmolc/kg	<0.2	0.2-0.5	0.5-1.0	1.1-2.0	>2.0

For loamy soils a classification has to be used with figures in between the two sets presented for clayey and sandy soils.
The desired saturation level of exchangeable Mg is 10 to 15 percent; for sandy and kaolinitic soils 6 to 8 percent Mg saturation is still sufficient.
Ca/Mg ratios of 2 to 4 are favourable.

Exchangeable potassium

	very low	low	medium	high	very high
K (clayey soils) Cmolc/kg	<0.20	0.20-0.40	0.41-1.20	1.21-2.00	>2.00
K (loamy soils) Cmolc/kg	<0.13	0.13-0.25	0.26-0.80	0.81-1.35	>1.35
K (sandy soils) Cmolc/kg	<0.05	0.05-1.10	0.11-0.40	0.41-0.70	>0.70

The desired saturation level of exchangeable K is 2 to 7 percent.
Favourable Mg/K ratios for most crops are in the range of 1 to 4.

Exchangeable sodium

	very low	low	medium	high	very high
Na (Cmolc/kg)	<0.10	0.10-0.30	0.31-0.70	0.71-2.00	>2.00

ANNEX 2. GUIDE TO SOIL DEPTH CLASSIFICATION

Very shallow	: <20 cm
Shallow	: 20-40 cm
Moderately deep	: 40-80 cm
Deep	: 80-120 cm
Very deep	: >120cm

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