NA

MBULU DISTRICT COUNCIL

AGRICULTURE and LIVESTOCK DEVELOPMENT DEPARTMENT

FIELD GUIDE TO LAND AND SOIL RESOURCES

OF

MBULU DISTRICT

Mbulu District Council

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FOREWORD

This field guide brings together knowledge and experience of farmers, extension workers, administrators and scientists on nature and use of land and soil resources in Mbulu District. It has been prepared with the aim to facilitate the development and diversification of agriculture extension messages.

A major step towards the compilation of this booklet was made during a one week workshop in May 1995. In a joint effort of district staff, divisional extension officers and agricultural research officers from institutes in Arusha (ARI-SELIAN), Tanga (ARI-MLINGANO) and Wageningen (SC-DLO), information from earlier studies on land and soil resources and farming systems was put together. A simplified zonation of major land units was made and combined with the current agro-climatic zonation into a new agro-ecological framework.

In a first attempt to use the framework, farmers practices and experiences were listed per agro-climatic zone and compared with current extension messages. The overviews produced are included in this field guide. The messages they contain are provisional and need to be discussed thoroughly with farmers.

It must be concluded that important steps towards the diversification of extension messages have been made. However, more work is needed to incorporate specific information on Land and Soil resources. May the content of this field guide stimulate extension workers and farmers alike in doing so.

Dr G.A. Tigwela
District Agriculture and Livestock Development Officer
Mbulu, December 1995

HOW TO USE THIS GUIDE

This field guide contains five sections with information on land and soil resources of Mbulu District.

To know more about:

I * Landscape formation
* Technical words
* Earlier studies
----------> SECTION ONE (yellow tab)

II * Land systems
* Agro-climatic zones
* Agro-ecological framework
* Agro-ecological zones
----------> SECTION TWO (green tab)

III * Soil groups
* Soil types
* Soil fertility
----------> SECTION THREE (red tab)

IV * Farmers practice
* Extension messages
----------> SECTION FOUR (blue tab)

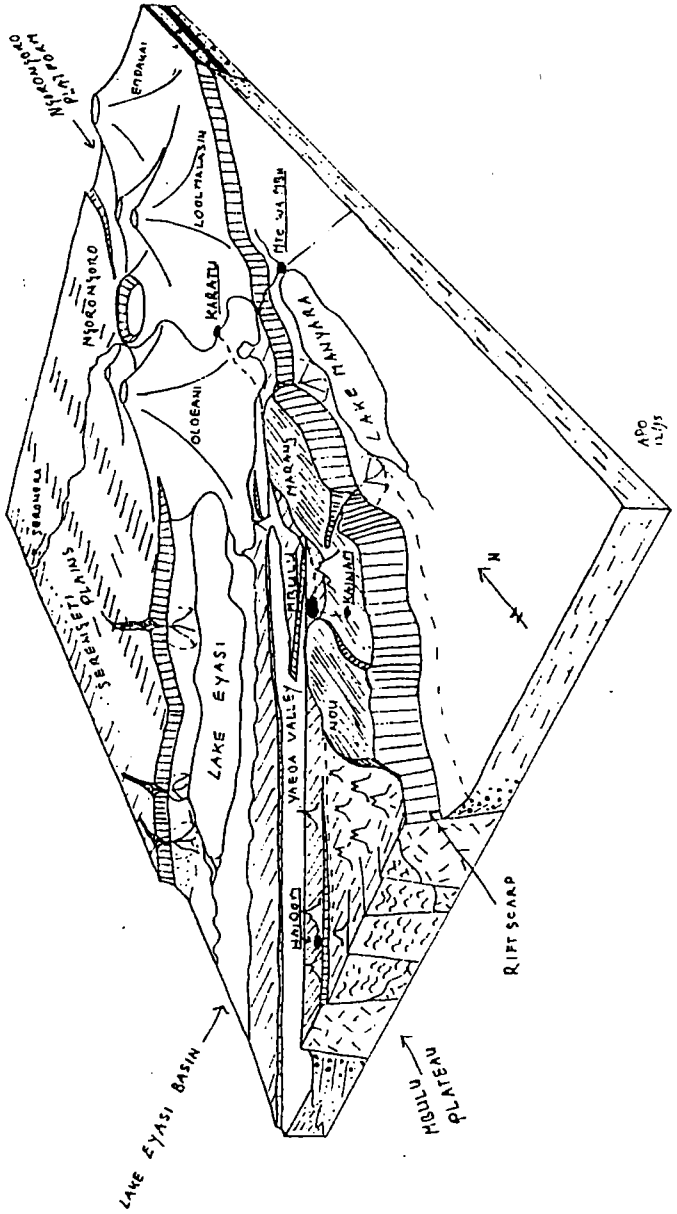
V * Land system map
* Cross sections
----------> SECTION FIVE (grey tab)

SECTION ONE

BACKGROUND INFORMATION

If you are looking for:

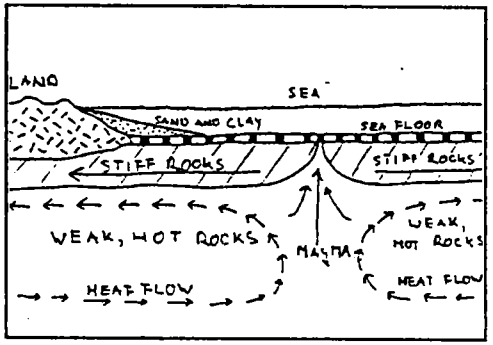
MBULU LANDSCAPE



A. HOW THE LANDSCAPE OF MBULU WAS FORMED

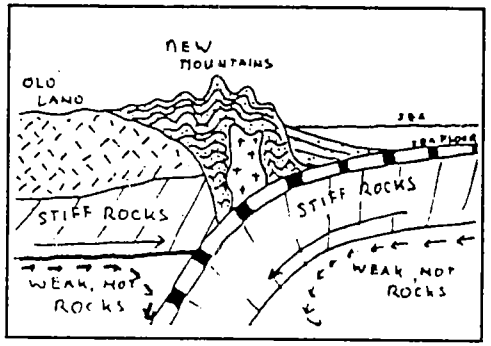
Basement

Long ago, when the foundations of the Earth were laid, a wide sea covered the place where Mbulu district is found now. At the bottom of that sea layers of sand and clay were laid down.



Deeper down, beneath the seafloor, it was hot. So hot that rocks become weak and slowly churn like water being heated. These movements made the outer layers of the Earth to be carried from one place to another like large plates of stiff rock.

Where pieces of the Earth's crust drifted apart, the layers from deep down started to rise toward the seafloor. As a result of the changes, the hot rocks partly melted into more movable, liquid rock material called **magma**. Through cracks in the seafloor some of it reached the surface, where it solidified into new rocks upon contact with the cold water.



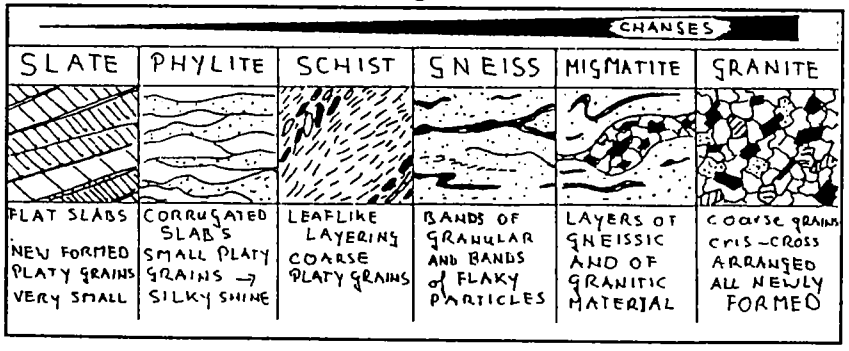
However, there were also places where drifting plates collided with each other. Here rock layers of the seafloor were pushed up and folded into high mountains rising above the sea. It was in the heart of these mountains that Mbulu's basement was laid down.

Basement rocks

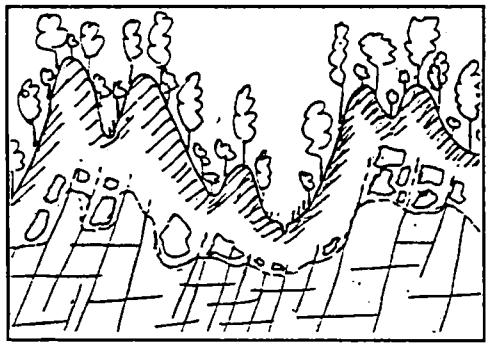
The forces involved in mountain formation caused rocks to change in nature. Rock grains were broken down and out of them new ones were made.

In clayey rocks shiny flakes were formed. Where changes were slight, the new platy grains remained so small that they cannot be seen by the naked eye. Their presence makes rocks split easily into flat slabs. Such a rock is called **slate**. Where changes were more outspoken, the shiny flakes grew bigger. The grains can just be seen by the naked eye and give the rocks a silky shine. Rocks of this type split into corrugated slabs and are called **phyllite**. In clayey rocks which were strongly modified, newly formed grains are medium to coarse in size. As the particles are all flattish and most of them were put in the same direction, the rock has a leaflike layering and can easily be split into small flakes or slabs. The name for the rock is **Schist**. Where changes were strongest, bands of more granular and bands of more flaky new rock particles were formed. The name for such a rock is **gneiss**.

In sandy rocks most grains only changed their form and were glued together. They have a sugary outlook and are called **Quartzite**. In some places, the pressure and temperature became so high that certain grains in the rocks melted and were moved from one place to another in liquid form. Upon cooling down the liquids slowly became hard again and well-shaped grains grew out of them. The name of such a mixed rock with old and new layers is **migmatite**. Where pressure and temperature became very high indeed, all original rock particles melted. Upon becoming hard, a completely new rock was formed consisting of coarse white, grey, reddish and blackish grains lying cris-cross in the rock. Such a coarse grained is called **'Granite'**.

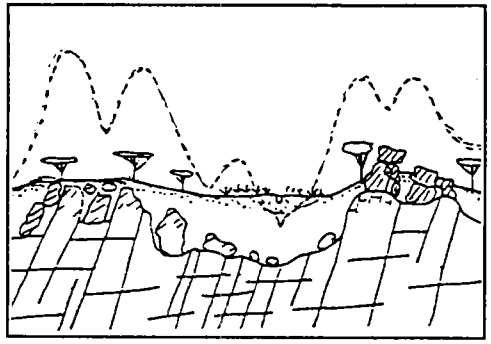


Land surface



Although by now its rocks had been formed, the present land of Mbulu was still hidden in the heart of the mountains. However, the heat of the sun made the overlying rocks to crack. Rain water entered into cracks and started to make the rocks soft, so that plants and trees could grow in them.

During long wet periods green vegetation covered all the land. Rain water went down through the soil into the rocks. Where this ground water reached the surface again springs started to flow. The power of this running water cut valleys into the soft rock.

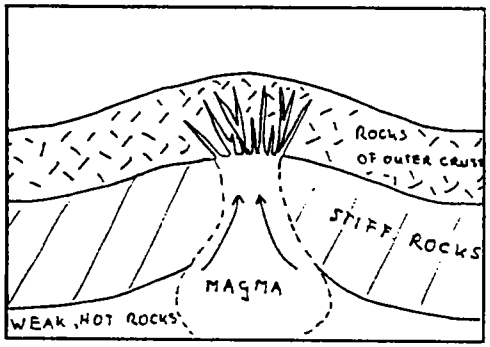


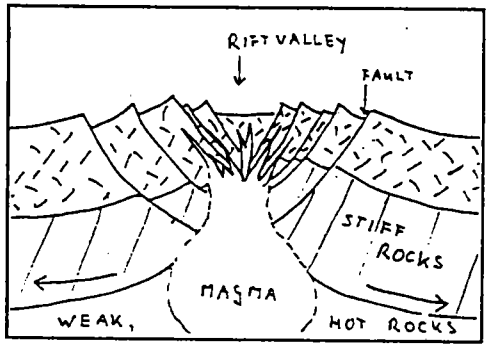
However, there were also long dry periods during which green vegetation became scarce. Rains started to wash away bare soils and soft rock alike. However, the rivers could not carry off so much sand and clay, so they dropped their load in their stream bed. As a result mountain ridges were made low, valleys were filled up and wide flat areas were formed. Only where rocks were strong and massive, remnants of high ground were left behind. These leftovers of former land surfaces are known as **residual hills**. The work of making rock particles less tight and carrying them off is called **erosion**. Erosion whereby the land surface is made flat by planing it down, is called **planation**. The level land surface is also called an **erosion plain** or **erosion surface**.

In Mbulu district several erosion surface are found. The highest and oldest is at the Nou Plateau. The land surface is strongly dissected by deep valleys. Only the highest summits of the ridges between the valleys (also called **interfluves)** represent the original plain level. The ridge summits of the Mama Isara area and Marang Forest represent remnants of another. The two old land surfaces are separated from each other by a steep slope (also called **escarpment)**. The youngest plain level is found south, west and north of the older two.

Earth movements

Local earth movements played an important role in shaping Mbulu's landscape. They occurred as a result of magma rising upward. It caused basement rocks in the crust to heat and expand. As a result the land surface cracked and was lifted-up. The action of fracturing and displacement of parts of the Earth's crust is called **faulting**, while fractures along which displacements took place are **faults**. At the surface faults are often marked by more or less steep cliffs, also called **fault scarps**.



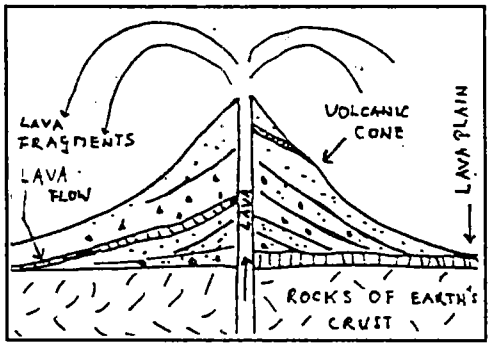


Continued crustal expansion and partial melting of the lower layers of the basement rocks caused the land surface to rupture and collapse. This breaking up as result of extension of the crust of the Earth is also know as **rifting**. The long, narrow depressions bounded by faults are called **rift valleys**. The two major land units in the district which resulted from rifting are known as: **Mbulu Plateau** and **Lake Eyasi Basin**.

As a result of these crustal movements rivercourses on the newly formed plateau were interrupted or reversed and their power to cut valleys was increased. In the basins, fan-like land forms developed at places where rivers deposited their erosion material from the plateaus. They are known as **alluvial fans**. During wet periods, water started to pond and large lakes were formed in the rift depressions. Once more drier conditions prevailed, the lake dried up. The dry bottoms of former lakes are known as **lake plains**.

Volcanoes

In the north of the district, basement rocks were overlain by rocks resulting from volcanic action. The activity was related to the process of rifting and involved the outpouring of magma through the air and over land. Magma that has been pushed out of the Earth's crust and poured out onto the land surface is also called **lava**. The lava found in Mbulu is fine grained and dark coloured. It is called **basalt**. Early lava flows filled valleys in the basement rocks and eventually formed the widespread **lava plains** found south of Karatu. Around the opening through which the materials reached the surface a steep round **cone** was formed by the accumulation of lava flows and fragmented products ejected through the air. Such a conical hill is called a **volcano**. Later dissection of the slopes at the foot of the cone led to the formation of **foot ridges**. The northern boundary of the district is found on them. The foot ridges are part of tree major volcanic cones known as Oldeani, Ngorongoro and Loolmalasin. In Mbulu many low conical hills are found on the footridges and the plains. It are small volcanoes made up of mainly fragmented basaltic rock.



B. EXPLANATION OF WORDS

alluvial Belonging to a stream or running water.
alluvial fan A low, outspread, flat to gently sloping mass of loose rock material, shaped like an open fan, deposited by a stream at the place where it issues from a narrow *valley* upon a *plain*.
basalt A general term for a very fine grained, dark colored rock that solidified from molten or partly molten material at or near the surface.
basement The complex of rocks that underlies the materials near the surface in an area.
basin (a) A depressed area with no surface outlet. (b) A low lying area in the Earth's crust, made by earthmovements, in which loose rock material have been laid down.
clay A loose, earthy, extremely fine-grained rock particles.
cliff Any high, very steep or overhanging face of rock.
cone *volcanic cone*.
crust The outermost layer of the Earth.
erosion The general process whereby materials of the Earth's *crust* are loosened, disolved or worn away and moved from one place to another.
erosion plain A general term for any plain produced by *erosion*.
erosion scarp A *scarp* produced by *erosion*.
erosion surface A land surface shaped by the action of *erosion*.
escarpment A long, more or less continuous *cliff* or relatively steep slope facing in one general direction, breaking the continuity of the land by separating two level or gently sloping surfaces and produced by *erosion* or *faulting*.
fan *alluvial fan*.
fault A fracture or zone of fractures in the Earth's *crust* along which there has been displacement of the sides parallel to the fracture.
fault scarp A steep slope or *cliff* formed directly by earth movement along a *fault*.
faulting The process of fracturing and displacement that produces a *fault*.
flood plain The surface or strip of relatively smooth land adjacent to a river channel, covered with water when the river overflows its banks.
foot slope A general term for the lower, gently sloping hillside surface that includes all the slopes of deminishing gradient.
foot ridge A general term for a gently sloping *interfluve* at the foot of a *volcanic cone*.
gneiss A medium to coarse grained rock in which bands of granular rock particles alternate with bands of flaky ones.
granite A light coloured, coarse grained rock formed by solidification from *magma*.
hill A natural elevation of the land surface, rising rather prominently above the surrounding land.
interfluve The relatively undissected ridge between two adjacent valleys flowing in the same general direction.
lake Any inland body of standing water occupying a depression in the Earth's surface.
lake plain (a) The nearly level surface marking the floor of an extinct lake, filled in by well-sorted loose rock fragments from inflowing streams. (b) A flat lowland bordering an existing lake.
land That part of the Earth's surface that stands above mean sea level.
landform Any recognizable form or feature of the Earth's surface having a characteristic shap

and produced by natural causes.

landscape The distinct association of *landforms* that can be seen in a single vieuw.

lava A general term for *magma* which was poored out onto the surface of the Earth; also a term for the rock that solidified from it.

lava flow A surficial outpouring of magma from a central opening or an elongated fracture in the Earth's surface.

lava plain A broad stretch of level or nearly level land, underlain by a relatively thin succession of lava flows.

magma Naturally occuring molten or partly molten rock material within the Earth.

migmatite A composite rock consiting of materials that changed their form and outlook and of materials that melted completely and solidified again.

phylite Fine grained rock with newly formed fine flaky particles, charcterised by a silky shine and a corrugated cleavage.

pipe A vertical conduit through the Earth's crust below a volcano through which magma has passed.

plain Any flat area at a low elevation.

planation The process of erosion whereby the surface of the earth is reduced to an even, flat or level surface.

planation surface *erosion surface*.

plateau Any comparatively flat area of great extend and elevated above the adjacent country.

residual hill A isolated hill surrounded by an extensive erosion plain.

rifting The process of rupturing of the land surface as a result of extension of the Earth's crust.

rift A long, narrow continental depression that is bounded by *faults*.

rift valley A *valley* that has developed along a *rift*.

river bed The channel containing or formerly containing the water of a river.

sand loose, medium to coarse grained rock particles.

scarp a line of cliffs produced by faulting or erosion.

schist A rock with medium to coarse grained, flattish, newly formed rock particles, which is charcterised by a leaflike layering and which can be easily split into small flakes or slabs.

slate A fine grained rock that can be easily split in flat slabs

soil (a) all unconsolidated materials above hard rock. (b) The natural medium for growth of plant.

summit plain A high-level plain formed by a series of summits of the same nature.

quartzite A sandstone in which grains changed their shap and were glued together.

valley Any low-lying land bordered by higher ground.

volcanic Belonging to the activities, structures or rock types of a volcano.

volcanic vent The opening at the Earth's surface through which *volcanic* materials are forced out.

volcanic cone A conical hill of lava and/or lava fragments that is built up around a volcanic vent.

volcano A vent in the surface of the Earth through which magma and assoiciated gasses and ash is forced into the open; also, the usually conical form that is produced by the thrown out material.

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SECTION TWO

LAND INFORMATION

More about:

(major land system map)

A. MAJOR LAND SYSTEMS

The land surface of Mbulu district can be divided into six units with similar rock type and a common landscape history. These large groupings of related areas are called **major land systems.** Four of them represent areas where basement rocks are found, while the other two comprise volcanic and sedimentary areas respectively. The major land units have been given the name of the localities where they typically are present. Their distribution is shown on page II-2 and a short description of the units is given below.

Basement areas

Major land systems characterised by gneiss are:

* **Kainam - Kansay system.** The area covers 115,000 ha (15 %) of the district and embraces the high elevated land of Nou Plateau, Mama Isara area and Marang Forest. It is characterised by deeply weathered rock. Most of the land surface is strongly dissected into steep interfluve ridges and narrow valley bottoms. The area forms part of an old erosion plain which developed before rifting disrupted the land surface. Remnants of the old landscape are characterised by strongly leached reddish clay soils.

* **Waama - Endalah system.** The area covers 120,000 ha (17 %) of the district and is situated to the northwest of the Kansay-Kainam land system. It is mainly composed of flat-topped to rounded interfluves ridges and partly infilled valleys. The area forms part of an erosion plain which developed after that of the Nou plateau and Mama Isara area. The residual hills rising above the general surroundings are remnants of these older landscapes. The process of rifting has sliced the plain into several segments with different elevation. Renewed stream erosion has removed most of the valley fills in reaction to these earth movements and the latest changes to the relative wet present-day climatic conditions. Agriculture use of the land is now accelerating this natural erosion process.

The major land system characterised by granite is:

* **Maghang - Harsha system.** The area covers 180,000 ha (25 %) of the district and is west and south west of the Nou Plateau. It is composed of flat to gently undulating interfluve ridges and wide infilled valleys and forms part of the same erosion plain which makes up the Waama-Endalah

land system. Where stream erosion has dissected the plains, the area consists of steep interfluve and narrow valleys. The many steep uprising, residual hills near Ensdamasakt are remnants of the same erosion surface found on the plateau of Nou and Bashanet. Being derived from coarse grained granites, the soils of the area are sandy and have a low to very low soil fertility.

The major land system characterised by schist is:

* **Haydom - Hayderer system.** The area covers 32,000 ha (5 %) of the district and is found in the south. It is composed of wide flat topped interfluve ridges and filled-in valleys. The land surface forms are part of the erosion plain which developed west and south west of the Kainam - Kansay land system. Dissection by stream erosion has been limited to areas nearby escarpments. Ash deposits from the Hanang volcano are found immediately south and east of the Mbulu district. They are likely to have contributed to the relatively high nutrient content of the red clays soils in the area.

Volcanic areas

The land system characterised by volcanic rocks is:

* **Ngorongoro system.** The area covers 110,000 ha (15 %) of the district and is found in the north. It is composed of flat to gently sloping lava plains and sloping to moderately steep foot ridges of tree major volcanoes known as Loolmalasin, Ngorongoro and Oldeani. Locally steep fault scarps and small volcanic cone are found. The area forms part of a landscape which developed on the Ngorongoro platform after the first phase of rifting. The major basin-like depression, known as Ngorongoro crater, is situated just outside the district. It developed after collapse of the rocks above the place where the lava came from. Subsequent stream erosion dissected the slopes of the Ngorongoro and led to the development of the foot ridges. In the plains at the base of the Ngorongoro volcano wide valleys formed. In a later stage those valleys were filled in again with cracking clays with a relative high sodium content. The combination of these two characteristics makes that the land in the infilled valleys is highly erodible.

Sedimentary areas

The major land system characterised by clays and sands is:

* **Yaida - Eyasi system.** The area covers 140,000 ha (20 %) of the district and is found in the Lake Eyasi basin. It is composed of flat lake plains and of gently sloping foot slopes at the lower end of hill and scarp slopes. The gently sloping land surfaces have been formed by the deposition of loose rock fragments and soil particles transported from higher situated areas by run-off water. The composition of the material reflects the nature of the rock from which the material has been derived. They comprise mainly sand and clays derived from basement gneiss and granite. The material in the flat areas were laid down in swamps or former lakes, where, due to later evaporation of the water, sodium and calcium salts have accumulated.

(Agro-climatic zone map)

B. AGRO-CLIMATIC ZONES

Rainfall

Three different air streams determine rainfall patterns in Mbulu. The first is a high southwesterly wind which reaches the district in October/November. It results in erratic showers caused by thunderstorms. The second rain bringing wind come from northerly directions and influences the weather in November/January. It also causes local thunderstorms making the rains to be unreliable. The third rain-bringing air stream is an east to southeasterly wind. It effects the weather from February/March to September/October. The rains fall along widespread fronts and have a relative high reliability.

Temperature

Seasonal fluctuation in temperature reflects a similar trend as the rainfall. The two hottest periods are November/December and February/March, separated by a slightly cooler period in December/January. The coldest period is July/ August (Tsaqutumo). It is preceded by a period of fog (Quu'a) in June/July and followed by a period of strong wind (Tlambo'ama) in August/September.

Agro-climatic zones

Based on differences in land use type and planting time, Mbulu District can be subdivided in five agro-climatic zones. They have been named according to their regional distribution. Determining factors behind the division are differences in rainfall distribution, related to altitude and topographic position.

* **Western Zone.** It is situated in Lake Eyasi basin between 1000 and 1500 meter above sea level.
  Mean annual rainfall varies from 370 in Mang'ola to 570 in Yaeda Chini with less then 40 rainy days. Reason for its aridity is its situation in the rain shadow of the Eyasi escarpment (westerly rains), the Ngorongoro platform (northerly rains) and of the Mbulu Plateau (easterly rains).
  Main production system is livestock keeping. Rain-fed agriculture is minimal. Irrigated agriculture is practised around Mang'ola. Main crops are: onions, maize, paddy and coconut.

* **Southern Zone.** It is situated on the southern half of the Mbulu Plateau at 1500-2100 meter above mean sea level.

Mean annual rainfall varies from 760 near Haydom to 790 near Dongobesh with about 45 rainy days. The October/November and November/December rains reach about 50% of total. This due to its position on the Mbulu plateau, west and southwest of the topographic barrier formed by the Nou plateau. The March/april rains are highest near the Manyara Rift scarp and decreases to wards the west.
Major production system is mixed livestock keeping and rain-fed agriculture. Crop areas varies between 1 to 12 acre per household. The cropping season starts with the coming of the October/ November rains, which suffice to keep crops going until the coming of the later rains. Main cropping systems are maize intercropped with beans, sorghum and sunflower. Wheat and pigeon peas are upcoming. Cattle is kept at free range grazing. Manure and traction is used in support of crop production. Irrigated agriculture is practised near Dongobesh, Bashay, Diyomat and Mangisa. Main crops are: maize/beans and vegetable.

* **Central Zone**. It is situated on the northern half of the Mbulu plateau at 1500-2100 m. above mean sea level.
Mean annual rainfall is about 830 mm near Mbulu with about 80 rainy days. Major difference with rainfall pattern of most of the Southern Zone is that the October/November rains are minimal. However the November-/December and March/April rains are almost twice as big. This is mainly due to its position north of the Nou plateau and its higher elevation.
Major production system is mixed livestock keeping and rain-fed agriculture. Crop areas varies between 1 to 10 acre per household. The cropping season starts with November/December rains, which suffice to bridge the dry spell in January and keep crops going until the coming of the later rains. Main cropping system is maize intercropped with beans (planted in January/February). A second bean intercrop is planted after maize has reached physiological maturity (in April/May). Sole beans, vegetables and sugarcane are planted in valleys using residual moisture. Sorghum is planted towards the Western Zone. Cattle is kept at free range grazing. Introduction of improved dairy cattle is upcoming. Manure and animal traction is used in support of crop production.

* **Northern Zone**. It is situated on the transition from the Mbulu plateau to the Ngorongoro platform at 1200-1800 meter above mean sea level.
Mean annual rainfall varies between 940 at Mbulumbulu and about 800

near Karatu. It further decreases to about 600 mm towards the western zone. There are about 75 rainy days. Major difference with the Southern Zone is that the October/November rains are negligible. This is because the west to southwestern winds do not meet a topographic barrier towards the east. The November/December rains in the zone are light due to its position in the rain shadow of the volcanic cones on the Ngorongoro platform. The later March/April rains however are heavier than elsewhere in the District. This is because the east to southeasterly rain-bringing winds meet the high topographic barrier on the Ngorongoro platform.
Major production system is mixed livestock keeping and rain-fed agriculture. Cropping areas varies between 3 to 50 acre per household. Land preparation takes place in November/December and planting starts with the onset of the March/April rains. Main cropping system are maize intercropped with beans or pigeon peas and wheat or barley (planted in April). Sole maize also is found. There is more mechanization, more attention for crop management and farming is more commercialised than in the other zones. Estate farming dominates the wettest northwestern part of the zone with coffee and wheat as main crops. Cattle is kept at free range and zero grazing. The herds are shifted to Mang'ola at the end of dry season to overcome shortage of grazing areas. On few farms improved dairy cattle is being introduced.

* **Eastern Zone**. The Eastern zone is situated on the eastern edge of the Mbulu Plateau at 2000 - 2300 m. above mean sea level.
Mean annual rainfall varies from about 1000 at the Nou Plateau to 1220 mm near Kansay in the Mama Isara area. The early November/December rains as well as the later March/April rains are well distributed and reliable with more than 90 rainy days. The high rainfall is mainly due to its high elevation and position northeast of the Nou plateau.
Major production system is mixed livestock keeping and rain-fed agriculture. Crop areas varies between 0.5 to 4 acre per household. Maize and beans are planted twice a year. The first crop is planted in the valley bottoms in June/July. The second crop is planted on hill slopes in November/December with the coming of first rains. Perennial cropping systems are coffee intercropped with bananas and a wide variety of fruit trees (Peach, Apple, Orange, Guava, Avocado, Lemon, Palm and Tangerine). Cattle is kept at free range and zero grazing. Manure and animal traction is used in support of crop production.

AGRO-ECOLOGICAL FRAMEWORK MBULU DISTRICT

MAJOR LAND SYSTEMS				AGRO-CLIMATIC ZONES				
ROCK TYPE	CLASS NAME			WEST	SOUTH	CENTRAL	NORTH	EAST
		ADDITIONAL INFORMATION	RAINFALL (mm)	530	760	830	900	1070
		ALTITUDE (m)	SYMBOL (area ha)	W (273,600)	S (157,000)	C (109,500)	N (89,900)	E (51,200)
Clay/sand	Yaeda-Eyasi	1000 - 1500	Y (133,600)	YW (133,600)				
Basalt	Ngorongoro	1200 - 1800	N (111,100)	NW (40,700)			NN (70,400)	
Gneiss	Wasma- Endalah	1200 - 1800	W (119,000)	WW (40,800)	WS (13,200)	WC (45,500)	WN (19,500)	
	Kainam-Kansay	1500 - 2300	K (115,200)			KC (64,000)		KE (51,200)
Granite	Maghang-Haraba	1700 - 2100	M (165,500)	MW (54,500)	MS (111,000)			
Schist	Haydom-Hayderer	1600 - 1800	H (36,800)	HW (4000)	HS (32,800)			

C. AGRO-ECOLOGICAL FRAMEWORK

Combination of agro-climatic zones with major land systems results in a logical framework for Mbulu's land resources. As can be seen on the facing page only 13 out of the 30 possible combinations exist. Each combination has a typical set of land / agro-climatic characteristics and therewith its own potential and limitations.

(agro-ecological zone map)

D. AGRO-ECOLOGICAL ZONES

Areas with a typical combination of land / agro-climatic characteristics make up an agro-ecological zone. On page II-12 the distribution of Mbulu's 13 agro-ecological zones is shown.

SECTION THREE

SOILS INFORMATION

More about:

SOIL GROUPS MBULU DISTRICT

MAJOR LAND SYSTEM				SOILS					
ROCK TYPE	CLASS NAME			Deep (>50cm)					Shallow (<50cm)
		ADDITIONAL INFORMATION	DRAINAGE	Free (no mottling)			Impeded (mottling)		
			TEXTURE/ POSITION	Clayey	Loamy	Sandy	on slopes	in depressions	over rock /hard pan
		ALTITUDE (M)	SYMBOL (area ha)	C (278,600)	L (57,900)	S (35,400)	I (23,200)	B (63,700)	R (211,600)
Clay/sand	Yaeda-Eyasi	1000 - 1500	Y (133,600)	YC (55,700)	YL (16,300)	YS (21,900)		YB (37,700)	
Basalt	Ngorongoro	1200 - 1800	N (111,100)	NC (59,100)	NL (6,200)		NI (100)	NB (5,000)	NR (40,500)
Gneiss	Waama-Endalah	1200 - 1800	W (119,000)	WC (29,300)	WL (4,900)	WS (900)		WB (2,600)	WR (81,300)
	Kainam-Kansay	1500 - 2300	K (115,200)	KC (80,800)	KL (3,000)			KB (2,400)	KR (29,000)
Granite	Maghang-Harsha	1700 - 2100	M (165,500)	MC (32,400)	ML (27,600)	MS (10,700)	MI (23,100)	MB (7,300)	MR (64,200)
Schist	Haydom-Hayderer	1600 - 1800	H (36,800)	HC (21,400)		HS (1,900)		HB (6,900)	HR (6,600)

A. SOIL GROUPS

Earthy materials supporting plant growth are called soils. The soils of the district can be divided into 6 major groups. They aggregate at higher level into three categories: (i) shallow soils, (ii) deep soils with free drainage and (iii) deep soils with impeded drainage.

Shallow soils

All soils with a depth of less then 40-50 cm fall into this category. Their potential for annual crops production is low as water storing capacity and total volumetric nutrient content are low. Shallow soils over hard rock are found on the steep hill sides of isolated residual hills in the basement areas and on the very steep slopes of the volcanic cones. Shallow soils over soft (rotten) rock are found along the eastern part of the Mbulu Plateau. Limitations are similar as for soils on hard rock but less severe as substratum is often rootable and able to store moisture.

Deep soils with impeded drainage

All soils with depth of more than 40-50 cm and having excess of water (as evidenced by mottling within one meter of the surface) in some parts of the year fall into this category. Major limitation for crop production is low oxygen availability for plant growth during wet season. Two soil groups have been distinguished.

* **Impeded drained soils on slopes.** These soils are commonly found at the lower end of footslopes or alluvial fans. Low nutrient content as a result of leaching of nutrients is an extra limitation.
* **Impeded drained soil in depressions.** These soils are found in valley bottoms and in low lying, often enclosed positions on erosion or lava plains. Extra limitation is flooding hazard during wet season. However during the dry season the surplus water adds to the potential of the soils. Volumetric nutrient content of these soils is normally high. However excess of sodium is often an extra limitation which enhances soil erosion and reduces crop yields when soils are being used for crop production.

Deep soils with free drainage

All soils with depth of more than 40-50 cm which show no signs of excess of water (evidenced by mottling within one meter of the surface) fall into this category. Three soils groups have been distinguished based on textural differences of the subsoil:

* **Deep, freely drained clayey soils.** Soils of this group have clay percentages of more than 40. They are found throughout the district and are developed over gneiss and basalt. The natural fertility of the soils is moderate to high. Those developed over gneiss tend to a surface seal which make the soils vulnerable to water erosion.
* **Deep, freely drained loamy soils.** Soils of this group have clay percentages of less then 40. Where the sand content is more than 70 clay percentage is more than 15. They are found on plains and on long slopes at the foot of escarpments and isolated hills of basement areas. Erodibility of loamy soils is a potential limitation when soils are being used for crop production.
* **Deep, freely drained sandy soils.** Soils of this group have more than 70% sand while the clay content is less than 15%. Major limitation is low water storage capacity. Soils are found mainly along active stream beds, near the base of granite outcrops and at the end of long foot slopes where washed out erosion products accumulate.

B. SOIL TYPES

More about soil types per land system:

YAEDA - EYASI LAND SYSTEM (Y)

TERRAIN INFORMATION				SOIL INFORMATION						
	TOPOGRAPHY				DEEP SOILS (>50cm)					SHALLOW SOILS
					WITH FREE DRAINAGE			WITH IMPEDED DRAINAGE		(<50 cm)
MAP CODE	CLASS NAME	LAND FORM	SLOPE (%)	SOIL TYPE	CLAYEY TEXTURE C	LOAMY TEXTURE L	SANDY TEXTURE S	ON SLOPES I	IN DEPRESSIONS B	OVER ROCK R
Y11	flat	lake plains	0-2	1	SSC: brown ASF: low (9) NPK: 322 ELF: salinity EXT: 4,200 ha				SSC: brown ASF: mod. (14) NPK: 312 ELF: salinity EXT: 31,300 ha	
Y12	gently sloping	alluvial fans	2-8	2	SSC: red/brown ASF: low (9) NPK: 322 EXT: 51,500 ha	SSC: brown ASF: low (9) NPK: 322 EXT: 16,300 ha	SSC: brown ASF: mod.(14) NPK: 312 EXT: 21,900 ha		SSC: brown/gray ASF: high (16) NPK: 311 ELF: sodicity EXT: 6,600 ha	
				total	55,700 ha	16,300 ha	21,900 ha	-	37,900 ha	

SSC=SubSoil Colour; ASF=Actual Soil Fertility (with indicative maize yield in bags per acre); NPK=Nutrient availability of Nitrogen (N), Phosphorus (P) and Potassium (K) respectively: 1=adequate, 2=moderate, 3=low; ELF=Extra Limiting Factors; EXT=extent in hectares

Analytical data topsoils (0-20cm)

SOIL TYPE	REFERENCE	%SAND				%SILT		%CLAY	pH	Ec	Tot.N	Org.C	Available P		Exch. cations				CEC	Tot.P	Tot.K	B.DENS
		Coarse	Medium	Fine	Very fine	Coarse	Fine		1:2.5 H2O	1:2.5 mS/cm	g/kg	g/kg	Brayl --mg/kg--	Olsen	Ca	Mg	K	Na	cmol /kg	mg/kg	mg/kg	g/cm3
C1	NSS/MC174	----------60----------				4	4	32	9.0	4.2	0.9	9		4	485	34	11	59	161			
C2	NSS/MC97	----------58----------				10	2	30	7.3	0.06	1.3	8		9	59	22	11	4	85			
L2	NSS/MC531	----------70----------				12	6	12	8.5	0.13	0.6	7		12	179	15	14	0.5	186			
S2	NSS/MP88	29	22	23	9	12	4	1	8.5	0.05	0.4	4		16	90	11	6	0.1	83			
B1	NSS/MP93	5	14	21	2	22	2	34	9.4	2.4	0.6	5		18	325	31	13	183	260			
B2	NSS/MP92	2	5	11	8	21	4	49	8.2	0.12	1.1	11		24	257	65	32	32	266			

NGORONGORO LAND SYSTEM (N)

TERRAIN INFORMATION				SOIL INFORMATION						
	TOPOGRAPHY				DEEP SOILS (>50cm)					SHALLOW SOILS
					WITH FREE DRAINAGE			WITH IMPEDED DRAINAGE		(<50 cm)
MAP CODE	CLASS NAME	LAND FORM	SLOPE (%)	SOIL TYPE	CLAYEY TEXTURE C	LOAMY TEXTURE L	SANDY TEXTURE S	ON SLOPES I	IN DEPRESSIONS B	OVER ROCK R
Nv2	undulating	lava plain with broad interfluves	2-8	1	SSC: brown ASF: high (16) NPK: 311 ELF: stoniness EXT: 900 ha					as C1 but shallow EXT: 17,300 ha
Nv3	rolling	lava plain with rounded and isolated bottom lands	8-16	2	SSC: red/brown ASF: high (16) NPK: 311 EXT: 22,400 ha				SSC: grey ASF: high (16) NPK: 311 ELF: sodicity EXT: 3,300 ha	as C2 but shallow EXT: 8,200 ha
Nr3	sloping	volcanic cone with broad flat topped foot ridges	8-16	3	SSC: red/brown ASF: high (18) NPK: 211 EXT: 20,900 ha					as C3 but shallow ELF: stoniness EXT: 4,300 ha
Nr4	moderately steep	volcanic cone with narrow flat topped foot ridges	8-16	4	as C3 EXT: 5,800 ha				as B3 EXT: 400 ha	as R3 EXT: 300 ha
Isolated Terrain Features										
Mp1	flat	flood plains	0-2	5	SSC: red/brown ASF: high (16) NPK: 311 EXT: 700 ha	SSC: red/brown ASF: high (16) NPK: 311 ELF: sodicity EXT: 6,200 ha			SSC: red/brown ASF: high (18) NPK: 112 ELF: flooding EXT: 2,300 ha	
Mf2	gently sloping	alluvial fans /foot slopes	2-8	6	SSC: red/brown ASF: high (16) NPK: 311 EXT: 4,300 ha			SSC: brown ASF: mod. (14) NPK: 312 EXT: 100 ha		
Mh5	steep	cliffed valleys	30-55	7	as C3 ELF: stoniness EXT: 2,800 ha					as R3 EXT: 8,300 ha
Ms8	steep	scoria cones	30-55	8	SSC: red ASF: high (16) NPK: 311 EXT: 600 ha					as C8 but shallow EXT: 1,400 ha
Ms6	very steep	scarp slopes	>55	9						as R3 ELF: rockiness EXT: 3,900 ha
				total	58,400 ha	6,200 ha		100 ha	5,000 ha	40,500 ha

SSC=SubSoil Colour; ASF=Actual Soil Fertility (with indicative maize yield in bags per acre); NPK=Nutrient availability of Nitrogen (N), Phosphorus (P) and Potassium (K) respectively: 1=adequate, 2=moderate, 3=low; ELF=Extra Limiting Factors; EXT=extent in hectares

Analytical data topsoils (0-20cm)

SOIL TYPE	REFERENCE	%SAND				%SILT		%CLAY	pH	Ec	Tot.N	Org.C	Available P		Exch. cations				CEC	Tot.P	Tot.K	B.DENS
		Coarse	Medium	Fine	Very fine	Coarse	Fine		1:2.5 H2O	1:2.5 mS/cm	g/kg	g/kg	Brayl --mg/kg--	Olsen	Ca	Mg	K	Na	cmol /kg	mg/kg	mg/kg	g/cm3
C1	NSS/MP82	4	5	6	1	19	11	53	7.0	0.10	1.1	15		39	158	53	41	1.8	312			
C2	NSS/MP65	7	5	4	2	8	13	64	6.8	0.09	1.8	21	21		116	39	33	1.8	261			
C3	NSS/MP71	0	0	1	2	14	11	70	8.1	0.31	1.9	33	16		166	44	30	0.5	273			
C5	NSS/MP83	2	2	4	4	16	17	55	7.0	0.13	1.6	11		39	168	53	30	4.6	272			
C6	NSS/MC435	----------20----------				14	18	48	6.3	0.11	1.3	17	14		92	53	31	3.9	194			
C8	NSS/KLP4	0	1	2	3	13	23	59	6.5	0.10	1.9	31	30		185	55	30	3	367			
L5	NSS/MP90	1	1	2	4	47	28	17	8.2	0.15	1.4	17		19	392	80	43	7.4	399			
I6	NSS/MP67	1	0	1	1	3	26	68	7.4	0.1	1.0	13		25	202	62	13	21	242			
B2	NSS/MP68	0	0	1	1	3	14	82	8.7	0.34	1.1	18	8		563	101	8.2	43	744			
B5	NSS/MAP12	4	3	3	1	31	9	60	7.8	0.3	3.2	47		41	209	96	4	43	341			

WAAMA - ENDALAH LAND SYSTEM (W)

TERRAIN INFORMATION				SOIL INFORMATION							
	TOPOGRAPHY				DEEP SOILS (>50cm)						SHALLOW SOILS (<50 cm)
					WITH FREE DRAINAGE			WITH IMPEDED DRAINAGE			
MAP CODE	CLASS NAME	LAND FORM	SLOPE (%)	SOIL TYPE	CLAYEY TEXTURE C	LOAMY TEXTURE L	SANDY TEXTURE S	ON SLOPES I	IN DEPRESSIONS B		OVER ROCK R
We2	undulating	erosion plain with flat interfluves and narrow bottom lands	2-8	1	SSC: red ASF: low (11) NPK: 321 EXT: 4,600 ha				SSC: grey ASF: low (9) NPK: 322 ELF: sodicity EXT: 500 ha		
We3	rolling	dissected erosion plain with rounded interfluves and broad valleys	8-16	2	SSC: red ASF: mod. (13) NPK: 221 EXT: 7,400 ha				SSC: grey ASF: v.low (4) NPK: 332 EXT: 1,700 ha		as C1 but shallow EXT: 2,000 ha
We4	hilly	dissected erosion plain with rounded interfluves and V-shaped valleys	16-30	3	SSC: red ASF: low. (11) NPK: 322 EXT: 3,000 ha						as C3 but shallow ELF: stoniness EXT: 17,600 ha
We5	steep	dissected erosion plain with narrow interfluves and V-shaped valleys	30-55	4	as C3 EXT: 1,400 ha						SSC: brown ASF: v.low NPK: 322 ELF: rockiness EXT: 51,600 ha
Isolated features											
Wp2	flat	flood plains	0-2	5	SSC: red/brown ASF: low (9) NPK: 322 ELF: EXT: 2,100 ha	SSC: red/brown ASF: low (9) NPK: 322 ELF: compaction EXT: 2,600 ha	SSC: grey ASP: v.low NPK: 323 ELF: flooding EXT: 900 ha		SSC: grey ASF: v.low (7) NPK: 323 ELF: flooding EXT: 500 ha		
Wf2	Gently sloping	alluvial fans /foot slopes	2-8	6	SSC: red/brown ASF: low (9) NPK: 321 ELF: sealing EXT: 9,200 ha	SSC: red/brown ASF: low (9) NPK: 322 ELF: sealing EXT: 2,300 ha					
Ws4	Steep	residual hills	16-30	7	as C3 EXT: 400 ha						as R5 EXT: 2,400 ha
Ws5	Steep	residual hills	30-55	8	as C3 EXT: 1,200 ha						as R5, but very shallow EXT: 6,000 ha
Ws6	Very steep	scarp slopes	>55	9							as R8 EXT: 1,600 ha
				total	29,300 ha	4,900 ha	900 ha	-	2,600 ha		81,300 ha

SSC=SubSoil Colour; ASF=Actual Soil Fertility (with indicative maize yield in bags per acre); NPK=nutrient availability of Nitrogen (N), Phosphorus (P) and Potassium (K) respectively: 1=adequate, 2=moderate, 3=low; ELF=extra limiting factors; EXT=extent in hectares

Analytical data topsoils (0-20cm)

SOIL TYPE	REFERENCE	%SAND				%SILT		%CLAY	pH	Ec	Tot.N	Org.C	Available P		Exch. cations				CEC	Tot.P	Tot.K	B.DENS
		Coarse	Medium	Fine	Very fine	Coarse	Fine		1:2.5 H2O	1:2.5 mS/cm	g/kg	g/kg	Brayl --mg/kg--	Olsen	Ca	Mg	K	Na	cmol /kg	mg/kg	mg/kg	g/cm3
															---cmol/kg---							
C1	NSS/MP49	14	9	8	3	12	9	45	6.3	0.05	1.3	18	4		90	32	23	1	179			
C2	NSS/MP37	10	17	15	4	3	5	46	6.7	0.04	2.1	22	7		82	26	19	1	168			
C3	NSS/MP94	16	22	21	8	----?	----	28	6.9	0.07	0.9	12	7		73	19	14	5	140			
C5	NSS/MP45	10	22	23	6	9	0	30	6.7	0.04	1.3	8	5		43	15	9	0.4	85			
C6	NSS/GuP2	14	18	21	8	12	5	22	6.1	0.03	0.9	14	5		59	20	5	1.7	113			
L5	NSS/MP50	30	26	17	5	5	2	15	6.7	0.05	0.7	7	6		63	27	14	1	122			
L6	NSS/MP35	17	22	25	9	4	7	16	6.4	0.02	0.8	10	5		19	12	6	0.3	40			
S5	NSS/MP10R	52	27	7	1	3	0	7	6.8	0.03	0.4	5	2		15	5	0.9	4	45			
B1	NSS/MP93	28	11	5	2	8	4	42	6.9	0.05	1.4	22	3		137	53	7	11	189			
B2	NSS/GuP6	18	30	21	4	6	4	17	6.3	0.03	0.9	10	4		18	12	5	1	71			
B5	NSS/MP108	55	27	7	1	3	0	7	6.8	0.03	0.4	5	2		15	5	0.9	4	45			
R4	NSS/MP32	11	20	32	11	12	3	11	6.5	0.02	1.0	8	4		14	7	4	0.2	38			

KAINAN-KANSAY LAND SYSTEM (K)

TERRAIN INFORMATION				SOIL INFORMATION							
	TOPOGRAPHY				DEEP SOILS (>50cm)						SHALLOW SOILS (<50 cm)
					WITH FREE DRAINAGE			WITH IMPEDED DRAINAGE			
MAP CODE	CLASS NAME	LAND FORM	SLOPE (%)	SOIL TYPE	CLAYEY TEXTURE C	LOAMY TEXTURE L	SANDY TEXTURE S	ON SLOPES I	IN DEPRESSIONS B		OVER ROCK R
Ke3	rolling	dissected erosion plain with rounded interfluves and wide valleys	8-16	1	SSC: red ASF: mod. (13) NPK: 221 SER: ELF: EXT: 4,500 ha				SSC: grey ASF: low (4) NPK: 332 SER: ELF: EXT: 200 ha		
Ke4	hilly	dissected erosion plain with rounded interfluves and U-shaped valleys	16-30	2	SSC: red ASF: low (9) NPK: 223 SER: ELF: EXT: 9,400 ha				as B1 EXT: 1,600		as C2 but shallow EXT: 3,300 ha
Ke5	steep	dissected erosion plain with narrow interfluves and U-shaped valleys	30-55	3	SSC: red/brown ASF: low (9) NPK: 322 SER: ELF: EXT: 57,900				SSC: grey ASF: v.low (9) NPK: 322 SER: ELF: sodicity EXT: 600 ha		as C3 but shallow EXT: 1,100 ha
Ke6	very steep	dissected erosion plain with narrow interfluves and V-shaped valleys	>55	4	as C3 EXT: 2,900 ha	SSC: brown ASF: v.low (7) NPK: 323 SER: ELF: EXT: 3,000 ha					as L4 but shallow EXT: 11,000 ha
Isolated features											
Ks5	steep	residual hills and scarp slopes	30-55	5	as C3 EXT: 6,000 ha						as L4 but very shallow EXT: 3,000 ha
Ks6	very steep	residual hills and scarp slopes	>55	6							as L4 but shallow EXT: 10,500 ha
				total	80,800 ha	3,000 ha	-	-	2,400 ha		28,900 ha

SSC=SubSoil Colour; ASF=Actual Soil Fertility (with indicative maize yield in bags per acre); NPK=Nutrient availability of Nitrogen (N), Phosphorus (P) and Potassium (K) respectively: 1=adequate, 2=moderate, 3=low; ELF=Extra Limiting factors; EXT=Extent in hectares

Analytical data topsoils (0-20cm)

SOIL TYPE	REFERENCE	%SAND				%SILT		%CLAY	pH	Ec	Tot.N	Org.C	Available P		Exch. cations				CEC	Tot.P	Tot.K	B.DENS
		Coarse	Medium	Fine	Very fine	Coarse	Fine		1:2.5 H2O	1:2.5 mS/cm	g/kg	g/kg	Brayl --mg/kg--	Olsen	Ca	Mg	K	Na	cmol /kg	mg/kg	mg/kg	g/cm3
															---cmol/kg---							
C1	NSS/MP101	16	12	8	2	3	15	44	6.4	0.08	1.9	26	6		88	31	26	1.1	210			
C2	NSS/MP59	18	8	4	2	21	14	33	5.5	0.08	2.3	37	6		25	19	1.5	0.6	159			
C3	NSS/MP56	11	12	12	6	20	10	29	7.0	0.03	1.7	23	4		72	35	4.4	1.4	125			
L4	NSS/MP42	22	21	14	3	5	10	25	6.6	0.02	1.3	20	8		38	10	2.3	0.4	54			
B1	NSS/GuP6	18	30	21	4	6	4	17	6.3	0.03	0.9	10	4		18	12	5	1	71			
B3	NSS/MP113	3	5	9	5	11	15	52	7.5	0.25	1.6	18		4	192	88	6.6	24	360			

MAGHANG-MARSHA LAND SYSTEM (M)

TERRAIN INFORMATION				SOILS INFORMATION						
	TOPOGRAPHY				DEEP SOILS (>50cm)					SHALLOW SOILS
					WITH FREE DRAINAGE			WITH IMPEDED DRAINAGE		(<50 cm)
MAP CODE	CLASS NAME	LAND FORM	SLOPE (%)	SOIL TYPE	CLAYEY TEXTURE C	LOAMY TEXTURE L	SANDY TEXTURE S	ON HILL SLOPES I	IN DEPRESSIONS B	OVER ROCK R
Ma1	flat	erosion plain with flat interfluves and broad bottomlands	0-2	1	SSC: red ASF: low. (9) NPK: 322 EXT: 5,000 ha				SSC: black ASF: mod. (13) NPK: 221 EXT: 2,600 ha	
Ma2	undulating	erosion plain with flat interfluves and small bottomlands	2-8	2	SSC: red/brown ASF: v.low (7) NPK: 323 EXT: 19,000 ha	SSC: brown ASF: v.low (7) NPK: 323 EXT: 16,000 ha	SSC: brown ASF: v.low (7) NPK: 323 EXT: 6,400 ha	SSC: brown ASF: v.low (7) NPK: 323 EXT: 17,400	as B1 EXT: 4,700 ha	SSC: brown ASF: v.low (7) NPK: 323 EXT: 3,500 ha
Ma3	rolling	dissected erosion plain with rounded interfluves and broad valleys	8-16	3	SSC: red (7) ASF: v.low NPK: 323 EXT: 1,200 ha	as L2 EXT: 1,300 ha				as R2 EXT: 1,300 ha
Ma4	hilly	dissected erosion plain with rounded interfluves and V-shaped valleys	16-30	4	as C3 EXT: 2,000 ha	as L2 EXT: 3,200 ha				as R2 EXT: 4,400 ha
Ma5	steep	dissected erosion plain with sharp interfluves and V-shaped valleys	30-55	5						as R2, but very shallow EXT: 41,900 ha
Isolated Terrain Features										
Mf2	gently sloping	foot slopes	2-8	6	SSC: red/yellow ASF: low (9) NPK: 322 EXT: 5,000 ha	SSC: brown ASF: v.low (7) NPK: 323 EXT: 7,400 ha	SSC: brown ASF: v.low (2) NPK: 333 EXT: 4,300 ha	SSC: brown ASF: v.low (7) NPK: 323 EXT: 5,700		
Ms4	moderately steep	residual hills	16-30	7	as C3 EXT: 200 ha	as L2 EXT: 200 ha				as R2 EXT: 300 ha
Ms5	steep	residual hills	30-55	8						as R5 EXT: 10,300 ha
Ms6	very steep	scarp slopes	>55	9						as R5 ELF: rockiness EXT: 2,500 ha
			total		32,400 ha	27,600 ha	10,700 ha	23,100 ha	7,300 ha	64,200 ha

SSC=SubSoil Colour; ASF=Actual Soil Fertility (with indicative maize yield in bags per acre); NPK=Nutrient availability of Nitrogen (N), Phosphorus (P) and Potassium (K) respectively: 1=adequate, 2=moderate, 3=low; ELF=Extra Limiting factors; EXT=Extent in hectares

Analytical data topsoils (0-20cm)

SOIL TYPE	REFERENCE	%SAND				%SILT		%CLAY	pH	Ec	Tot.N	Org.C	Available P		Exch. cations				CEC	Tot.P	Tot.K	B.DENS
		Coarse	Medium	Fine	Very fine	Coarse	Fine		1:2.5 H2O	1:2.5 mS/cm	g/kg	g/kg	Brayl --mg/kg--	Olsen	Ca ---cmo	Mg	K /kg---	Na	cmol /kg	mg/kg	mg/kg	g/cm3
C1	MSS/MP22	26	15	14	7	11	4	23	6.2	0.11	1.0	12	3		35	15	12	9.2	85			
C2	MSS/MC175	---------- 74 ----------				4	2	20	7.0	0.04	0.9	9		4	54	20	3.8	3.1	97			
C3	MSS/MP54	11	22	33	11	10	3	10	6.3	0.02	0.8	9	6		20	6	3.1	0.4	55			
C6	MSS/MP24	17	13	20	9	10	3	28	5.2	0.06	1.1	12	7		24	20	7.6	124	103			
L2	MSS/MP28	16	18	25	11	14	5	11	5.8	0.07	0.8	8	6		32	11	3.3	1.7	63			
L6	MSS/MP15	25	22	18	6	8	6	15	5.6	0.05	1.0	10	7		12	10	1.1	1.1	59			
S2	MSS/FJ2	29	22	28	8	6	3	4	6.5	0.05	0.4	3	4		7	2	0.8	0.5	16			
S6	MSS/MP25	31	20	21	10	8	4	6	5.1	0.05	0.6	5	1		5	3	1.8	1.0	27			
I2	MSS/MP5	22	17	16	4	12	6	23	6.0	0.03	1.0	13	1		42	20	3.2	1.8	99			
I6	MSS/MP12	18	20	26	9	10	4	13	6.0	0.06	0.9	11	4		22	10	3.0	1.0	65			
B1	MSS/MC29	---------- 26 ----------				8	14	52	6.4	3.2	2.4	30	2		224	56	14	41	291			
R2	MSS/MP4	31	22	22	1	11	6	7	6.3	0.05	0.6	7	1		17	6	2.2	1.8	37			

HAYDON - HAYDERER LAND SYSTEM (H)

TERRAIN INFORMATION				SOILS INFORMATION						
	TOPOGRAPHY				DEEP SOILS (>50cm)					SHALLOW SOILS
					WITH FREE DRAINAGE			WITH IMPEDED DRAINAGE		(<50 cm)
MAP CODE	CLASS NAME	LAND FORM	SLOPE (%)	SOIL TYPE	CLAYEY TEXTURE C	LOAMY TEXTURE L	SANDY TEXTURE S	ON HILL SLOPES I	IN DEPRESSIONS B	OVER ROCK R
Ha1	Flat	erosion plain with broad, interfluves and large bottom lands	0-2	1	SSC: red ASF: mod. (14) NPK: 312 EXT: 6,000 ha		SSC: gray/brown ASF: mod. (14) NPK: 312 EXT: 1,800 ha		SSC: black ASF: mod. (13) NPK: 221 EXT: 5,100 ha	
Ha2	Undulating	erosion plain with broad interfluves and small bottom lands	2-8	2	as C1 but with ASF: low (9) NPK: 322 EXT: 13,400				as B1 EXT: 1,900 ha	
Ha3	Rolling	dissected erosion plain with rounded interfluves and wide valleys	8-16	3	as C2 but gravelly EXT: 700 ha					as C2 but gravelly with stoney surface +rock outcrops EXT: 700 ha
Ha4	Hilly	dissected erosion plain with rounded interfluves and V-shaped valleys	16-30	4						as R3 but very shallow EXT: 1,200 ha
Isolated Terrain Features										
Hf2	gently sloping	foot slopes	2-8	6	as C2 but with gravelly layers EXT: 1,200 ha					
Hs5	steep	residual hills and scarp slopes	30-55	7						as R3 but very shallow EXT: 4,700 ha
			total		21,400 ha	-	1,900 ha	-	6,900 ha	6,600 ha

SSC=SubSoil Colour; ASF=Actual Soil Fertility (with indicative maize yield in bags per acre); NPK=Nutrient availability of Nitrogen (N), Phosphorus (P) and Potassium (K) respectively: 1=adequate, 2=moderate, 3=low; ELF=Extra Limiting Factors; EXT=Extent in hectares

Analytical data topsoils (0-20cm)

SOIL TYPE	REFERENCE	%SAND				%SILT		%CLAY	pH	Ec	Tot.N	Org.C	Available P		Exch. cations				CEC	Tot.P	Tot.K	B.DENS
		Coarse	Medium	Fine	Very fine	Coarse	Fine		1:2.5 H2O	1:2.5 mS/cm	g/kg	g/kg	Brayl --mg/kg--	Olsen	Ca ---cmo	Mg	K /kg---	Na	cmol /kg	mg/kg	mg/kg	g/cm3
C1	MSS/MP16	5	7	18	12	14	8	36	6.4	0.05	1.3	23	15		41	21	13	0.7	113			
C2	MSS/MP7	4	6	12	1	28	11	38	5.8	0.04	1.4	22	6		85	48	4.8	0.6	185			
S1	MSS/MP17	13	12	17	8	16	11	22	5.7	0.08	1.6	12	11		49	20	4.2	0.6	122			
B1	TCMP/M5	------ 7 ------			6	--- 21 --		66	6.7	0.47	2.4	28	--		374	226	368	3.6	716			

ACTUAL SOIL FERTILITY MBULU DISTRICT

MAJOR LAND SYSTEM					SOILS																																	
ROCK TYPE	CLASS NAME	TOPOGRAPHY		ZONE	WEST					SOUTH					CENTRAL					NORTH					EAST				
				DEPTH	Deep				Sh	Deep				Sh	Deep				Sh	Deep				Sh	Deep				Sh
				DRAI-NAGE	Free			Im		Free			Im		Free			Im		Free			Im		Free			Im	
		LAND FORM	RELIEF CLASS	CODE	C	L	S	B	R	C	L	S	I	B	R	C	L	S	B	R	C	L	S	I	B	R	C	L	S	B	R
Clay/ sand	Yaeda-Eyasi	Lake plain	Flat	Yl1	3			2																							
		Alluvial fans	Gently sloping	Yf2	3	3	2	1																							
Basalt	Ngorongoro	Lava plain	Undulating	Nv2	1				1												1					1					
			Rolling	Nv3																	1				1	1					
		Volcanic cone	Sloping	Nr3	1				1												1										
			Moderately steep	Nr4	1																1				1						
		Flood plains	Flat	Np1	1	1		1													1										
		Alluvial fans	Gently sloping	Nf2	1																1			2							
		Cliffed valleys	Steep	Nb5	1				1												1					1					
		Scoria cones	Steep	Ns5	1				1												1					1					
		Scarp slopes	Very steep	Ns6																						1					
Gneiss	Waama-Endalah	Erosion plain	Undulating	We2																	3				3						
			Rolling	We3											2			4	3							3					
			Hilly	We4											3				3	3						3					
			Steep	We5	3				4					4						3						4					
		Flood plains	Flat	Wp1						3	3	4		4	3	3	4		4	3	3	4		4							
		Footslopes	Gently sloping	Wf2	3					3	3				3	3				3	3										
		Residual hills	Moderately steep	Ws4					4					4	3				4												
			Steep	Ws5	3				4						3				4						4						
		Scarp slopes	Very steep	Ws6					4																4						
	Kainam-Kansay	Erosion plain	Rolling	Ke3											2			3													
		Hilly	Hilly	Ke4											3			3	3						3			3	3	
		Steep	Steep	Ke5											3				3						3			3		
		Very steep	Very steep	Ke6											3	4			4						3	4			4	
		Residual hills/ scarp slopes	Steep	Ks5																											
			Very steep	Ks6											3	4			4						3	4			4	
Granite	Maghang-Harsha	Erosion plain	Flat	Me1						3				2																	
			Undulating	Me2	4	4				4		4	4	4	4																
			Rolling	Me3						4	4				4																
			Hilly	Me4	4				4	4	4				4																
			Steep	Me5					4						4																
		Gently sloping	Footslopes	Mf2						3	4	4	4																		
		Residual hills	Moderately steep	Ms4						4	4			4																	
			Steep	Ms5					4					4																	
		Scarp slopes	Very steep	Ms6										4																	
Schist	Haydom-Hayderer	Erosion plain	Flat	He1						2		2		2																	
			Undulating	He2						3				2																	
			Rolling	He3						3				3																	
			Hilly	He4					3					3																	
		Foot slopes	Gently sloping	Hf2						3																					
		Hill/scarp slopes	Steep	Hs5										3																	

Soil depth: Sh=Shallow
Soil drainage: Im=Impeded
Soil code: C=Clayey; L=Loamy; S=Sandy; I=on Interfluves; B=in Depressions; R=over rock
Soil fertility classe (of upper 20cm): 1=high; 2=moderate; 3=low and 4=very low

C. SOIL FERTILITY

How to find your way:

1. Turn to table on facing page.

2. If you want information per climatic zone, go down in the column of your choice until you reach the land unit of interest you are and read the fertility data.

3. If you want information per land unit, look for the correct line and read the information in the column of interest.

4. For explanation of the soil fertility class codes see information below table.

SECTION FOUR

EXTENSION MESSAGES

More about:

FARMERS PRACTICE

LIVESTOCK SYSTEM	DISEASE		FEEDING	BREEDING
	TYPE	CONTROL		
Zebu cattle / Sheep / Goats / Donkeys	Worms Tick born diseases	Dewormed when animal is emaciated Dipped or sprayed when ticks are seen on body i.e. threshold Ticks removed by hand	Grazed on grassland and fed with farm residues	Breeding bull selected from same herd
Pigs	Worms	Dewormed when animal is emaciated	Grazed like ruminants and fed with ungrounded maize	No selection of males for breeding
Dairy cattle	Worms Tick born diseases	Dewormed once a year Dipped or sprayed once a week with Supadip or Steladone	Fed on the ground with unchopped (often stemmy) grass, stover and ungrounded maize Concentrates and common salts used when available Watered when fed	Serviced soon after onset of heat Delayed heat not stimulated

A. LIVESTOCK PRODUCTION - ANIMAL HUSBANDRY

EXTENSION MESSAGE

LIVESTOCK SYSTEM	DISEASE		FEEDING	BREEDING
	TYPE	CONTROL		
Zebu cattle / Sheep / Goats / Donkeys	Worms Tick born diseases	Deworm at beginning and end of rains Dip or spray once a week with acaricide e.g. Supadip	Graze on grassland and feed crop residues outside farm	Import selected bull from another herd
Pigs	Worms	Deworm four times a year	House and feed with maize flour	Select breeding males from another farm
Dairy cattle	Worms Tick born diseases	Deworm four times a year Dip or spray twice a week with acaricide e.g. Supradip, Steladone or Bacdip	Chop grass and stover before feeding Use farm mixed concentrates Make common salt (e.g. super maclick) available for use without limited Feed lush elephant grass (2-3 ft tall) Use a trough for feeding Grained maize before feeding Make water available for drinking without limited	Feed enough minerals to stimulate heat Service animals 9-12 hours after onset of heat

FARMERS PRACTICE

FODDER TYPE	LAND MANAGEMENT		HARVESTING / STORAGE	UTILIZATION
	SOIL FERTILITY	WEEDING		
Elephant grass (In Southern, Northern and Eastern zone)	Little or no FYM applied	Done once a year or less	Commonly harvested when matured too much (stemy fodder)	Fed unchopped
Rhodes grass (In Northern zone)	Some FYM applied during planting		Grazed when green or left as standing hay	Standing hay grazed in dry season
Desmodium (In Dongobesh, Tumati and Karatu)	-		Harvested green	Fed in mixture with elephant grass
Maize stover	see crop production		Collected after harvest of maize cops Stored on the ground in heaps	Fed unchopped and untreated in dry season
Bean residues			Collected after removal of seeds Stored on the ground in heaps	Fed untreated in dry season
Pigeon pea residues				

EXTENSION MESSAGE

FODDER TYPE	LAND MANAGEMENT		HARVESTING / STORAGE	UTILIZATION
	SOIL FERTILITY	WEEDING		
Elephant grass Recommended for Southern, Northern and Eastern zone	FYM: 500-700 lq/a/3yrs	Weed area harvested on same day	Harvested at height of 2-3 ft	Feed chopped
Rhodes grass Recommended for dry areas of Northern and Southern zone	Confine grazing on pasture plot to keep dung dropping in field	-	Graze on plot Harvest at flowering and preserve as hay	Feed hay grazed in dry season
Desmodium Recommended for Southern, Central, Northern and Eastern Zone	-		Harvested together with elephant grass to prepare mixture	Feed in mixture with elephant grass
Maize stover	see crop production		Remove first leaves when maize cobs and continue as it matures Dry stover and store in raised and thatched barn to protect fodder from direct rain and sun	Feed in dry season treated with molasses water and salt to increase nutrient value and palatability
Bean residues			Collected soon removal of seeds and store as described for maize stover	Feed in dry season Moisture before feeding to make them become soft and palatable
Pigeon pea residues				

FARMERS PRACTICE

CROPPING SYSTEM	VARIETY	SPACING (cm*seed)	YIELD (b/a)	PEST/DISEASE		LAND MANAGEMENT		
				TYPE	CONTROL	SOIL FERTILITY	LAND PREPARATION	SOIL CONSERVATION
Maize	CG 4141 H 622/32 Kilima	90x50*2	20	Stalk borers	Thiodan 5% EC/Decis	UREA, SA or CAN: 50-100 kg/a	Ploughing/harrowing Making lateral irrigation furrows Making strip borders	
Onions	Red Bombay	10x5	120	Onion thrips		UREA: 350 kg/a		
Paddy	Taiwan Kula na Bwana Super	10-12 random planted	35 25 25	Birds	Scaring off	Nil	As above plus: Making permanent basins	
Coconut	E.A.	500x800		Rhinoceros		1 lq FYM/plant hole	Digging plant holes 60x60x60cm	

cm=centimeter; b/a=bag per acre; FYM=farmyard manure; SA=suphate of ammonia; CAN=calcium ammonium nitrate; lq=laqwanti (c. 20kg)

EXTENSION MESSAGES

CROPPING SYSTEM	VARIETY	SPACING (cm*seed)	YIELD (b/a)	PEST/DISEASE		LAND MANAGEMENT		
				TYPE	CONTROL	SOIL FERTILITY	LAND PREPARATION	SOIL CONSERVATION
Maize	CG 4141/42 H 622/32 Kilima	90x50*2	20 20 15	Stalk borers A. bollworm	Endosulfan Decis 50EC	FYM: 500 lq/a/3yrs UREA: 1-2 b/a/yr	Good seedbed to facilitate irrigation	-
				Maize streak	Early planting Resistant varieties			
Onions	Red Bombay	10x5*1	120	Onion thrips	Decis, Dursban, Thiodan	UREA: 6-8 b/a/yr		
				Tuber rot Rust	Resistant varieties Field hygiene			
Paddy	Taiwan Kula na Bwana Super Japan	20-25 random or 30x30 in poor soils	25-35	Birds Stem borer Cutworm Armyworm	Scaring off Malation Decis Endosulfan	-		
				Rice blast Brown spot	Use clean seed Resistant varieties Good crop mgt			
Coconut	E.A. Local	500x800	-	Rhinoceros beetle	Remove with sharp wire	FYM: 2 lq/hole	Plant holes 60x60x60cm	

cm=centimeter; b/a=bag per acre; FYM=farmyard manure; SA=suphate of ammonia; CAN=calcium ammonium nitrate; lq=laqwanti (c. 20kg); yr(s)=year(s)

FARMERS PRACTICE

CROPPING SYSTEM	VARIETY	SPACING (cm*seed)	YIELD (b/a)	PEST/DISEASE TYPE	PEST/DISEASE CONTROL	LAND MANAGEMENT SOIL FERTILITY	LAND MANAGEMENT LAND PREPARATION	LAND MANAGEMENT SOIL CONSERVATION
Maize / Beans	Mehh Kilima CG 4141/42	90x50*2	10-12	Stalk borers	Endosulfan 5% plus ash 1:1	Manure: 500-700lq/a/3yrs shallow soils 500-700lq/a/4yrs deep soils	At onset first rains: -tractor ploughing -oxen ploughing	Reducing run-off by: -making cut off drains Others: -preserve trees -preserve pastures
	Karanga Losi booh Qangar Red Masai	90x30*3	2-3	Beanfly	-			
Sorgum	Mangure Tegemeo	90x30 60x30	4-5	Sorgum rust	?	Manure: 500-700lq/a/3yrs	At onset first rains: -oxen ploughing	
Sunflower	S 400/430	90x30	7-10	Birds	Scaring off	Manure: 500-700lq/a/3yrs	Before onset 2nd rains: - ploughing	
Wheat	Mbuni Tausi	Broad cast	8-12	-	-	Manure: 300-500lq/q/4yrs		
Chickpeas	-	-	-	-	-	Nil		

cm=centimeter; b/a=bag per acre; FYM=farmyard manure; SA=suphate of ammonia; CAN=calcium ammonium nitrate; lq=laqwanti (c. 20kg); yr(s)=year(s)

EXTENSION MESSAGES

CROPPING SYSTEM	VARIETY	SPACING (cm*seed)	YIELD (b/a)	PEST/DISEASE TYPE	PEST/DISEASE CONTROL	LAND MANAGEMENT SOIL FERTILITY	LAND MANAGEMENT LAND PREPARATION	LAND MANAGEMENT SOIL CONSERVATION
Maize / Beans	Kilima CG 4141/42 H 622/32 TMU Local	90x50*2	15-20 15-20 20-25 10 10	Stalk borers Armyworms A. bollworm -/- Maize streak Head smut Cob rot	Apply: -Endosulfan 4kg/a -/- Resistant varieties Early planting Crop rotation	FYM: 500-700lq/a/3yrs UREA: 1-2 b/a/yr	Plough at onset first rains (tractor or oxen)	Contour steep slopes
	Karanga Red Masai Lyamungu 85/90	90x15*2	4	Beanfly Beetles Aphids Pod borers -/- Anthracnose Rust Hallo blight	Spray with: -Rogor -Karate -Endosulfan -/- Field sanitation Crop rotation Spray with: -Decesol -Dithan -Brestan			
Maize	as above	80x50*2	15-25	as above	as above			
Sorgum	Local (Mangure) Tegemeo Serena	90x10*2 90x30*3	8-10	Birds Stem borers S.shootfly -/- Leaf rust Head smut Blight	Scaring Early planting Spray with: -Endosulfan -Malation Crop rotation -/- Resistant varieties Seed dressing with: -Fernasan D Crop rotation Field sanitation	FYM: 500-700lq/a/3y		
Sunflower	Local S 400/30 Record	90x30*2	10-14	Birds A. bollworm Termites -/- Head rot Stem rot Root rot	Scaring Spray with: -Endosulfan -Rogor -/- Observe season (dry weather maturing) Destroy crop residues Crop rotation	FYM: 300lq/a/3yrs	Before onset 2nd rains	
Wheat	Mbuni Tausi Mbaywayu	Broad cast 60 kg/a	8-12	Birds Armyworm Aphids A.bollworm -/- Stem rust Leaf rust	Scaring Spray with: -Tenitrothion -Malation -/- Resistant varieties Crop rotation Field danitation Seed dressing with: -Fernasan D	FYM: 300-500lq/q/4yrs UREA: 1 b/a/yr	Early and proper	

cm=centimeter; b/a=bag per acre; FYM=farmyard manure; SA=suphate of ammonia; CAN=calcium ammonium nitrate; lq=laqwanti (c. 20kg); yr(s)=year(s)

FARMERS PRACTICE

CROPPING SYSTEM	VARIETY	SPACING (cm*seed)	YIELD (b/a)	PEST/DISEASE		LAND MANAGEMENT		
				TYPE	CONTROL	SOIL FERTILITY	LAND PREPARATION	SOIL CONSERVATION
Maize/	CG 4141 H 632/22 Kilima Mehh	90x50*2	5-10	Stalk borers	Endosulfan 5% - 4kg/acre	FYM: 4-5 t/a/3yr shallow soil 4-5 t/a/4yr deep soil	Before onset first rains -ploughing by tractor -hand hoe digging After onset first rains: - animal draft ploughing	Contouring by: - using grasses - using crop residues - ploughing across slope Terracing
Beans	Kachumba Karanga Kachumba Red Masai	-	3-5					
Maize	as above	80x50*2	15-25	Stalk borers	as above	as above		
Sorgum	Mangure Tegemeo	90x30*2	-	Sorgum rust	-	nil		
Beans	as above	-	3-5			nil	Onset dry season: - hand hoe digging - ground water drainage	
Vegetable/ fruit: Tomatoes Onions Egg plant Okra Spinace Amaranthaus	-	-	-	-		FYM: 1 lq/ seedbed of 1x2m		
Sugar cane	TPC- nyausi -nguuu Madarusha -ndefu	-	-			Nil	Year round: - hand hoe digging - ground water drainage	

cm=centimeter; b/a=bag per acre; FYM=farmyard manure; SA=suphate of ammonia; CAN=calcium ammonium nitrate; lq=laqwanti (c. 20kg); yr(s)=year(s)

EXTENSION MESSAGES

CROPPING SYSTEM	VARIETY	SPACING (cm*seed)	YIELD (b/a)	PEST/DISEASE		LAND MANAGEMENT		
				TYPE	CONTROL	SOIL FERTILITY	LAND PREPARATION	SOIL CONSERVATION
Maize/	H 622/32 Kilima CG 4141/42 Local	90x50*2	20 15 20 10	Stalk borers Army worms Cutworms A. bollworm -/- Maize streak Head smut Cob rot	Apply: -Endosulphan 4kg/a -Fenitrothion -/- Crop rotation Early planting Field sanitation Resistant varieties	FYM: 200-700 lq/a/3yrs UREA: 1-2 bg/a/yr	Before onset rains	Contouring steep slopes
Beans	Red Masai Lyamungu 85/90 Karanga Kachumba Canadian Wonder Local	90x15*2	4	Beanfly Beetles Aphids Pod borers -/- Anthracnose Rust White mold Hallo blight	Spray with: -Rogor -Karate -Endosulfan -/- Field sanitation Crop rotation Spray with: -Dithane -Deresol -Brestan			
Maize (sole)	as above	80x50*2	25	as above	as above			
Beans (sole)	as above	50x20*2	8	as above	as above	FYM: 300 lq/a/3yrs		
Sorgum	Local (Mangure) Tegemeo Lulu Serema	90x10*2 90x30*3	8-10	Birds Stem borers Sorgum shootfly -/- Leaf rust Head smut Blight	Scaring Early planting Spray with: -Endosulfan -Malathion Crop rotation -/- Resistant varieties Seed dressing with: -Fernasan D Crop rotation Field sanitation	FYM: 300 lq/a/3yrs UREA: 1 b/a/yr (top dressing)		

cm=centimeter; b/a=bag per acre; FYM=farmyard manure; SA=suphate of ammonia; CAN=calcium ammonium nitrate; lq=laqwanti (c. 20kg); yr(s)=year(s)

FARMERS PRACTICE

CROPPING SYSTEM	VARIETY	SPACING (cm*seed)	YIELD (b/a)	PEST/DISEASE		LAND MANAGEMENT		
				TYPE	CONTROL	SOIL FERTILITY	LAND PREPARATION	SOIL CONSERVATION
Maize /	CG 4141/42 Fresh H 632/23 Kilima Mehh Recky	90x50*2	10-12	Stalk borers	Thiodan dust: -4 kg/a	FYM: 500-700lq/a/3yr shallow soils 500-700lq/a/4yr deep soils	At onset first rains: -ploughing by tractor/ oxen	Contouring
Beans /	C.Wonder Red Masai	90x30*3	2-3	Beanfly	Applying ULV -Sumicidin -Decis			
Pigeon peas	-	-	4-5	-	-			
Barley	Kibo	75-85 kg/a	4-6	-	-	FYM: 200 tin/a/y Urea: 1-2 b/a	Before onset 2nd rains: - ploughing/harrowing by tractor/oxen	
Wheat	Joli Tausi	90-100 kg/a	4-6	-	-			

cm = centimeter; b/a = bag per acre; FYM = farmyard manure; SA = suphate of ammonia; CAN = calcium ammonium nitrate; lq = laqwanti (c. 20kg); yr(s) = year(s)

EXTENSION MESSAGES

CROPPING SYSTEM	VARIETY	SPACING (cm*seed)	YIELD (b/a)	PEST/DISEASE		LAND MANAGEMENT		
				TYPE	CONTROL	SOIL FERTILITY	LAND PREPARATION	SOIL CONSERVATION
Maize /	CG 4141/42 H 622/32 Kilima Local	90x50*2	15-20	Stalk borers A. bollworm Armyworm -/- Maize streak Leaf rust Cob rot	Apply: -Thiodan dust Spray with: -Malathion -Fenitrothion -/- Early planting Resistance variety Seed dressing	FYM: 500-700 lq/a/3yrs UREA: 1-2 b/a/yr	Plough at onset first rains Use chisel after 3 years to break plough pan	Contouring at 4-55% slope Restrict grazing on cropland Use improved stoves Use biogas Construct bio- latrines
Beans /	Canadian Wonder Red Masai Lyamunga 85/90 Local	90x15*2	2-3	Beanfly Beetles Aphids Pod borers -/- Anthracnose White mold Rust Blight Angular leaf spot	Use pesticides: -Rogor 50 -Karate -Thiodan -/- Resistant varieties Crop rotation Clean seeds Spray fungicides: -Dithane -Brestan -Deresol			
Pigeon peas	Blue Babati Local	90x100*2	4-5	A. bollworm Root mealbug -/- Fosarium wilt	Clean fields Crop rotation -/- Crop rotation			
Maize (sole)	as above	80x50*2	20-25	as above	as above			
Beans (sole)	as above	50x20*2	8-10	as above	as above			
Barley	Kibo	broadcast 50 kg/a	10-15	Birds Aphids -/- Stem rust Leaf rust	Spray with: -Fenitrothion -/- Resistant varieties Crop rotation Field sanitation	UREA: 1 b/a/yr	Early and proper	
Wheat	Joli Tausi	broadcast 60 kg/a	10-15	A. bollworm Armyworms -/- Stem rust Leaf rust	Spray with: -Malathion -/- Resistant varieties Crop rotation Field sanitation			

cm=centimeter; b/a=bag per acre; FYM=farmyard manure; SA=suphate of ammonia; CAN=calcium ammonium nitrate; lq=laqwanti (c. 20kg); yr(s)=year(s)

FARMERS PRACTICE

CROPPING SYSTEM	VARIETY	SPACING (cm*seed)	YIELD (b/a)	PEST/DISEASE		LAND MANAGEMENT		
				TYPE	CONTROL	SOIL FERTILITY	LAND PREPARATION	SOIL CONSERVATION
Maize/	Mehh Ukiriguru	90x50*5	5	Cutworms	-extra seeds -irrigation -planting during rains	FYM: - 300 lq/a/3yr	- hand hoe digging - burning	Contouring by: - using grasses Terracing - cutting benches Tree planting
Beans	Mehh booh Daaten Uren Karanga. Quangar	90x30*3	3-5	Beanfly	-			
Coffee/	Arabica	300x250	5-10	Leave miners CBD Leaf rust	-	FYM: - 1 lq/a/hole		
Banana	Kijivu Kimalindi Kikojozi	-	-	-	-			
Beans	as above	30x30*3	3-5			nil		-
Vegetable/ fruit: - Pear - Apple - Orange - Guava - Avocado - Lemon - Palm - Tangerine	-	-	-	-		FYM: - 300 lq/a/3yr		

cm=centimeter; b/a=bag per acre; FYM=farmyard manure; SA=suphate of ammonia; CAN=calcium ammonium nitrate; lq=laqwanti (c. 20kg); yr(s)=year(s)

EXTENSION MESSAGES

CROPPING SYSTEM	VARIETY	SPACING (cm)	YIELD (b/a)	PEST/DISEASE		LAND MANAGEMENT		
				TYPE	CONTROL	SOIL FERTILITY	LAND PREPARATION	SOIL CONSERVATION
Maize/ Beans	H 622/32 Kilima Local	90x50*2	15 15 8	Cutworms Stalkborers -/- Maize streak Head smut	Rotation Early planting Use pesticides -/- Early planting Crop rotation Field sanitation Resistant varieties	FYM: 500 lq/a/3yrs UREA: 1-2 b/a/yr (top dressing)	Before onset of rain	Contouring on steep slopes
	Lyamungu 85/90 Local	90x15*2	4	Beanfly Beetles Aphids Pod borers -/- Anthracnose White mold Rust Blight Angular leafspot	Use pesticides: -Rogor 50 -Karate -Thiodan -/- Resistant varieties Crop rotations Use fungicides: -Dithane M45 -Brestan -Daresol Field sanitation			
Maize (sole)	as above	90x50*2	10-20	as above	as above			
Beans (sole)	as above	50x20*2	8	as above	as above	FYM: 500 lq/a/3yrs		
Sweet potatoes	Local	ridges 30-60cm apart 25-30 cuttings	8-10 (ton/a)	Leafminers Weevils Beetles -/- Stem blight Tuber rot	Crop rotation - Resistant varieties -/- Crop rotation Resistant varieties Roguing	FYM: 200 lq/a/3yrs		
Coffee/	Arabica	300x300 or 270x270 (pure stand)	10	Leafminers Coffee-berryborers Coffee-stemborers -/- Leafrust CBD	-Dursban -Selecron -Thiodan -Dieldrex Field sanitation -/- -Blue copper -Nordox -Bravo 500	FYM and Compost 20 kg N/a FYM: 2lq/hole (1 month before planting)	Dig plant holes 3 months before onset of rains	
Banana	Kisukari Paz'kihaya Kitivi Kimalindi	500x400 or 300x300 (pure stand)	1 (t/a)	Nematodes -/- Panama disease	Field sanitation Use Furadan -/- Field sanitation Roguing			
Tobacco	Local (fire cured)	90x30	300 (kg/a)	Cutworms Aphids Stemborers A. bollworm -/- Anthracnose Leafspot Frog eye	Apply: -Endosulfan -Rogor -Dielrin -/- Field sanitation Spray fungicide (Dithane/copper)	FYM: 500 lq/a/3yrs	Before onset of rains	

cm=centimeter; b/a=bag per acre; FYM=farmyard manure; SA=suphate of ammonia; CAN=calcium ammonium nitrate; lq=laqwanti (c. 20kg); yr(s)=year(s)

SECTION FIVE

MAP INFORMATION

More about:

(index map)

A. LAND SYSTEM MAP

How to find your way.

1. Locate approximately the area of interest on the index map and read the number of the grid cell in which the area is situated.

2. Turn to the map which has the same number as the grid cell in which your area of interest is located.

3. Find the exact location of your area of interest and read the mapping codes for land system unit (black characters) and agro-climatological zone (green characters).

4. To know more about:
   - **mapping code for land system**: turn to page V-4, look-up concerned map symbol and read description of mapping unit;
   - **description major land system unit**: turn to page II-3, look-up name of concerned land system and read text;
   - **mapping code for agro-climatological zone**: turn to page II-6, find name of agro-climatologic zone in legend of map;
   - **description agro-climatologic zone**: turn to page II-7, look-up name of zone of interest and read text;
   - **soils in area of interest**: turn to page III-5, look-up concerned major land system and read information under corresponding mapping code;
   - **soils at site**: turn to page V-17, look-up concerned major land system, find your position on the detailed cross sections and read the soil type code(s) of the nearest soil unit(s), turn to page III-5, look-up major land system and read information under corresponding soil type;
   - **farmers practice/extension messages**: turn to page IV-3, look-up concerned agro-climatic zone and read text.

replace by coloured one

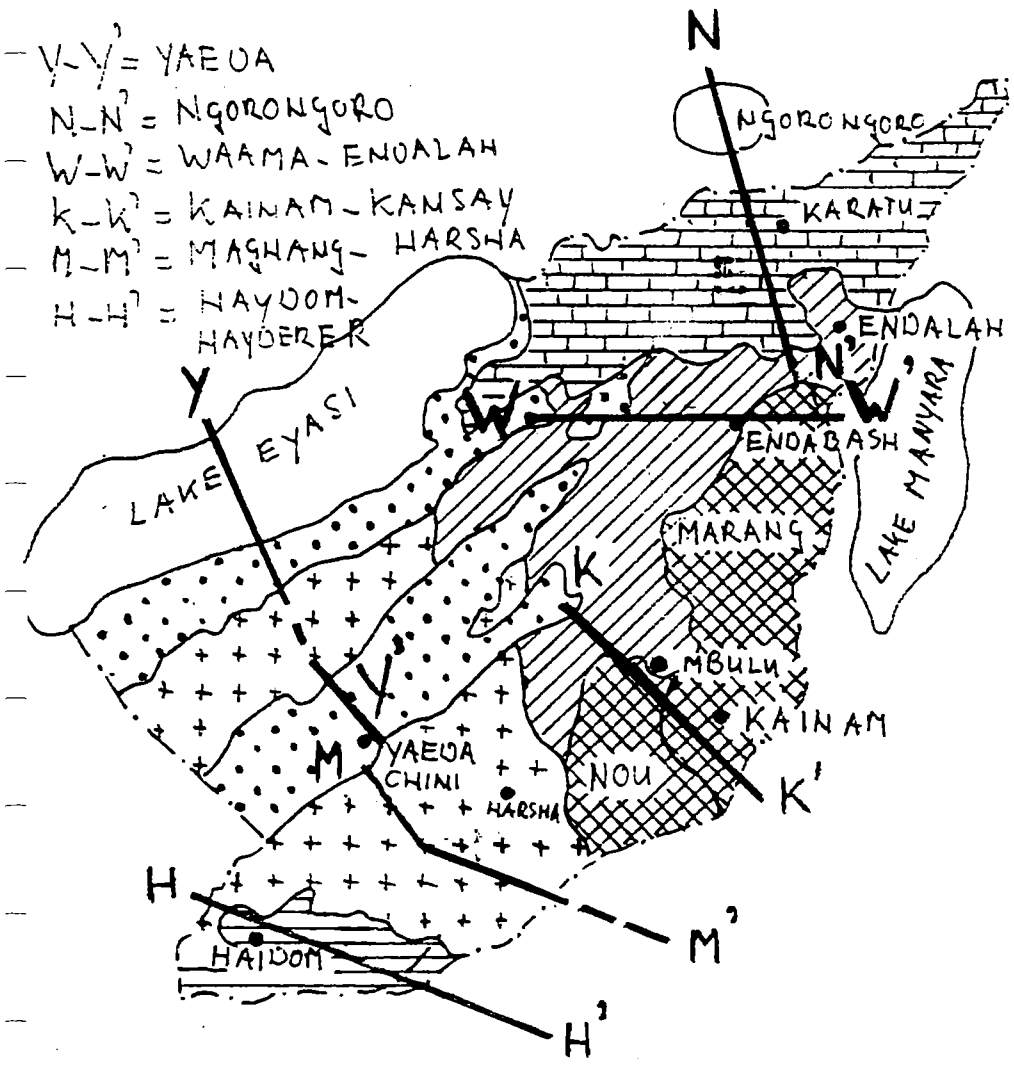
map 01.

LEGEND

LAND SYSTEM MAP MBULU DISTRICT

MAJOR LAND SYSTEM				TOPOGRAPHY					
ROCK TYPE	CLASS NAME			Flat	Gently sloping	Sloping	Mod. steep	Steep	Very steep
		ADDITIONAL INFORMATION	STEEPEST SLOPE (%)	0-2	2-8	8-16	16-30	30-55	>55
		LAND FORM	MAP SYMBOL	1	2	3	4	5	6
Clay/mud	Yaeda-Eyasi	Lake plains	Yl	Yl1					
		Alluvial fans	Yf		Yf2				
Basalt	Ngorongoro	Lava plains	Nv		Nv2	Nv3			
		Flood plains	Np	Np1					
		Alluvial fans	Nf		Nf2				
		Foot ridges	Nr			Nr3	Nr4		
		Valleys	Nb					Nb5	
		Hills/scarps	Ns					Ns5	Ns6
Gneiss	Wasmo- Endalah	Erosion plains	We		We2	We3	We4	We5	
		Flood plains	Wp	Wp1					
		Foot slopes	Wf		Wf2				
		Hills/scarps	Ws				Ws4	Ws5	Ws6
	Kainam-Kanamy	Erosion plains	Ke			Ke3	Ke4	Ke5	Ke6
		Hills/scarps	Ks						Ks6
Granite	Maghang-Harsha	Erosion plains	Mc	Mc1	Mc2	Mc3	Mc4		
		Foot slopes	Mf		Mf2				
		Hills/scarps	Ms				Ms4	Ms5	Ms6
Schist	Haydom-Haydever	Erosion plains	He	He1	He2	He3	He4		
		Foot slopes	Hf		Hf2				
		Hills/scarps	Hs					Hs5	

(map 02 — 11 on next page



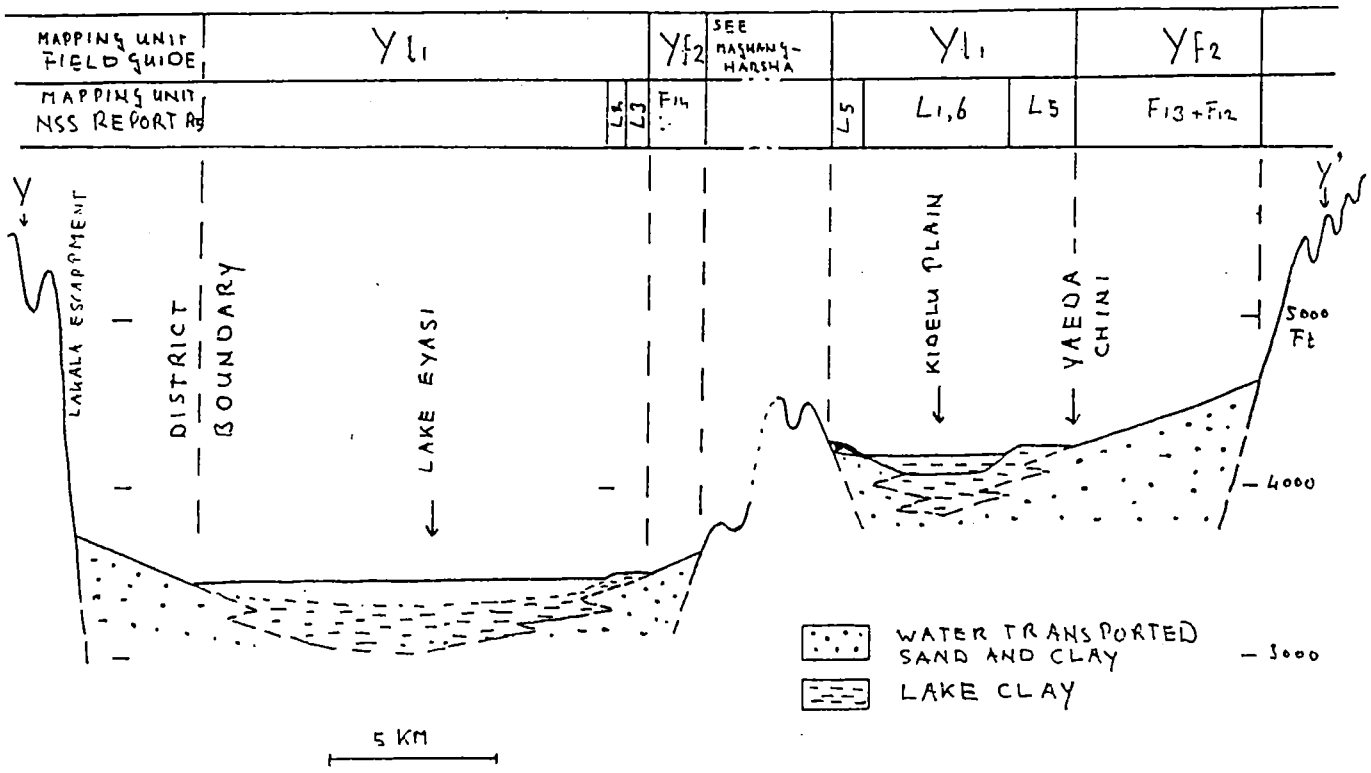
B. CROSS SECTIONS

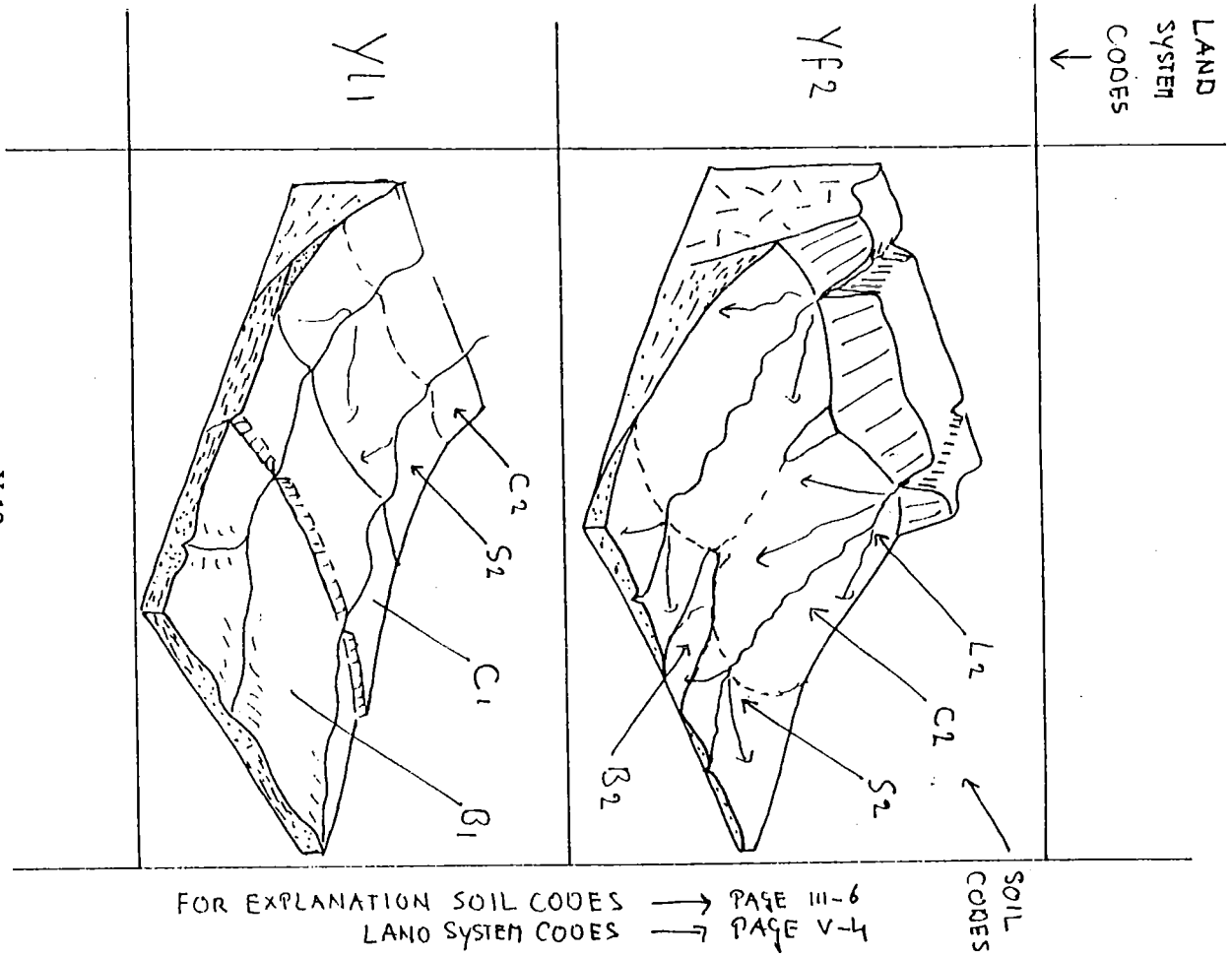
How to find your way.

1. Locate your approximate position on the cross section location map on page V-16
2. Turn to cross section of interest.
3. Locate your position and read land system and soil codes.
4. Turn to page V-4 to find the explanation of the land system code and continue on page II-3 for a general description of the unit.
5. Turn to page IV-5 to find the explanation of the soil codes.

Where to find the cross sections of major land systems

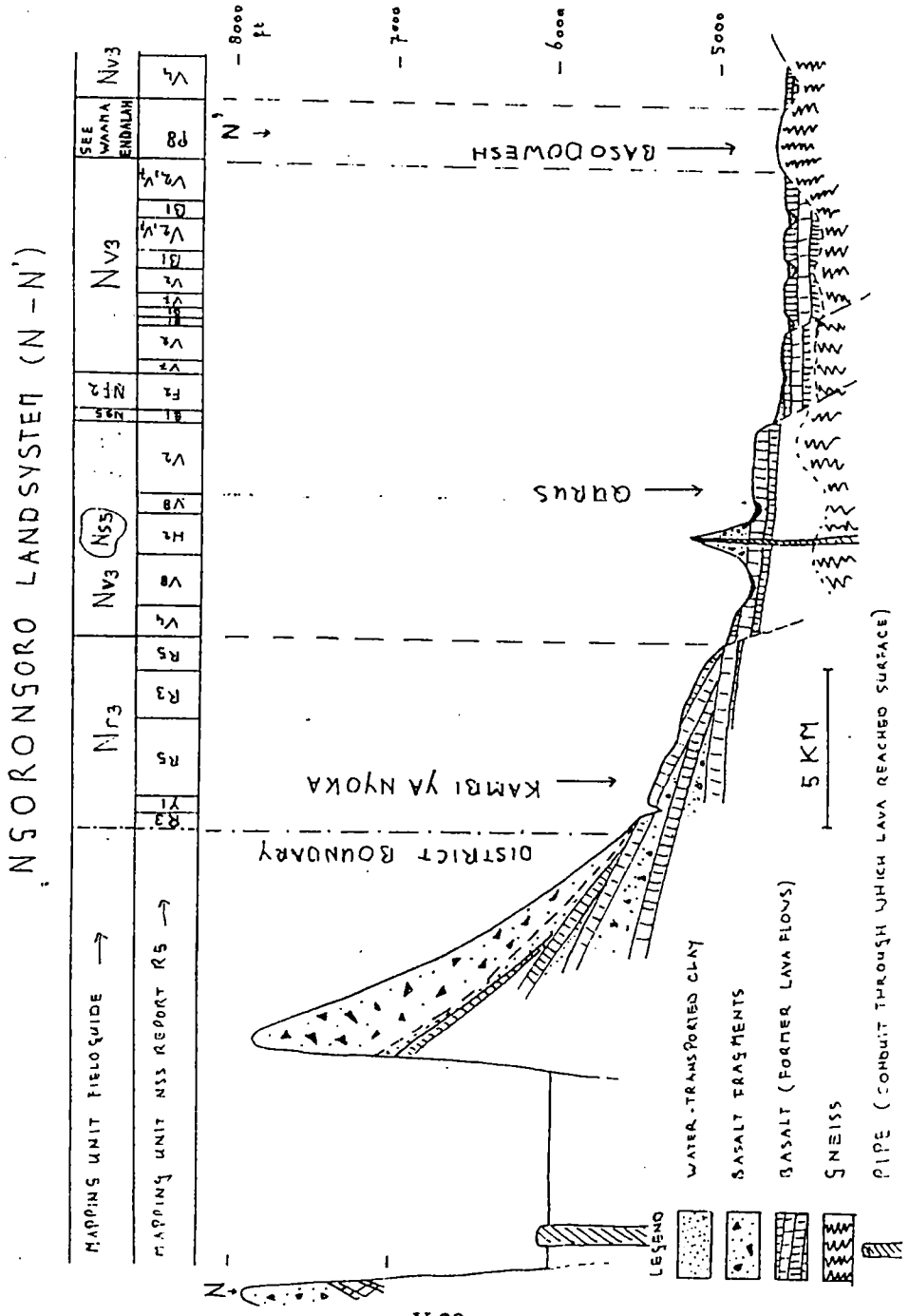
YAIDA - EYASI LAND SYSTEM (Y-Y')





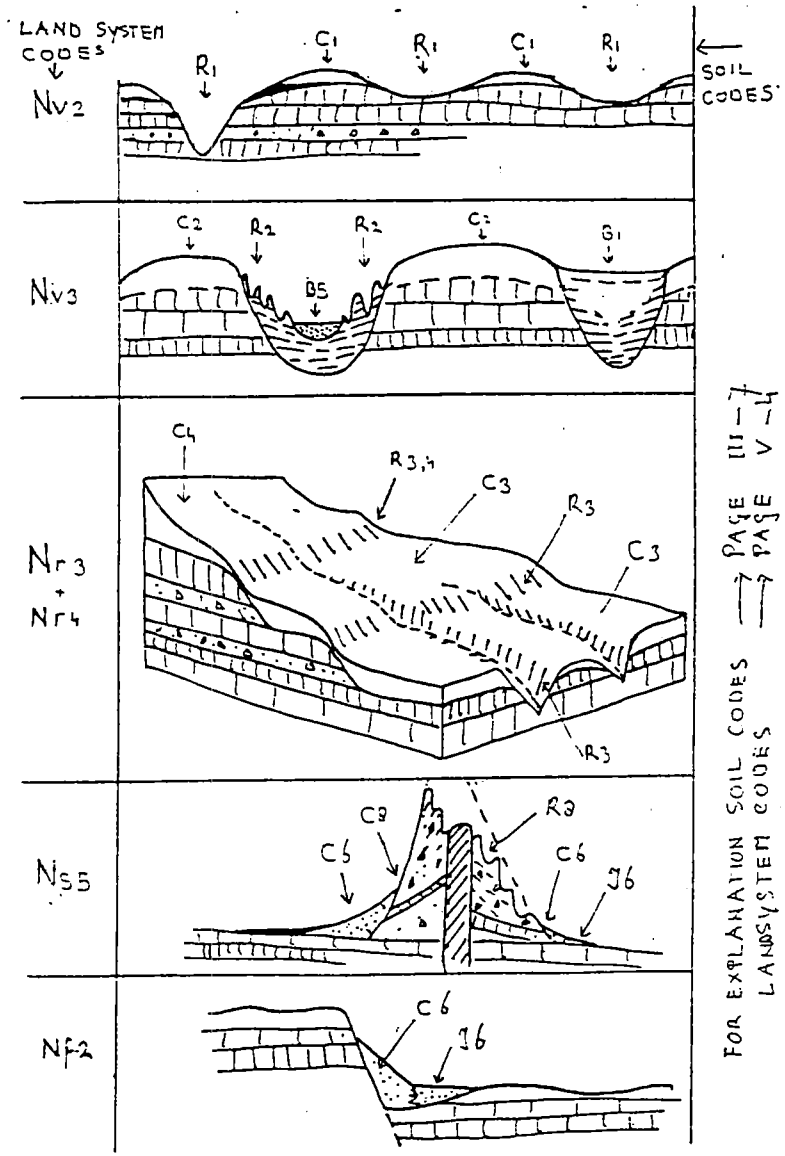
FOR EXPLANATION SOIL CODES → PAGE III-6
LAND SYSTEM CODES → PAGE V-4

YAEDA-EYASI LAND SYSTEM

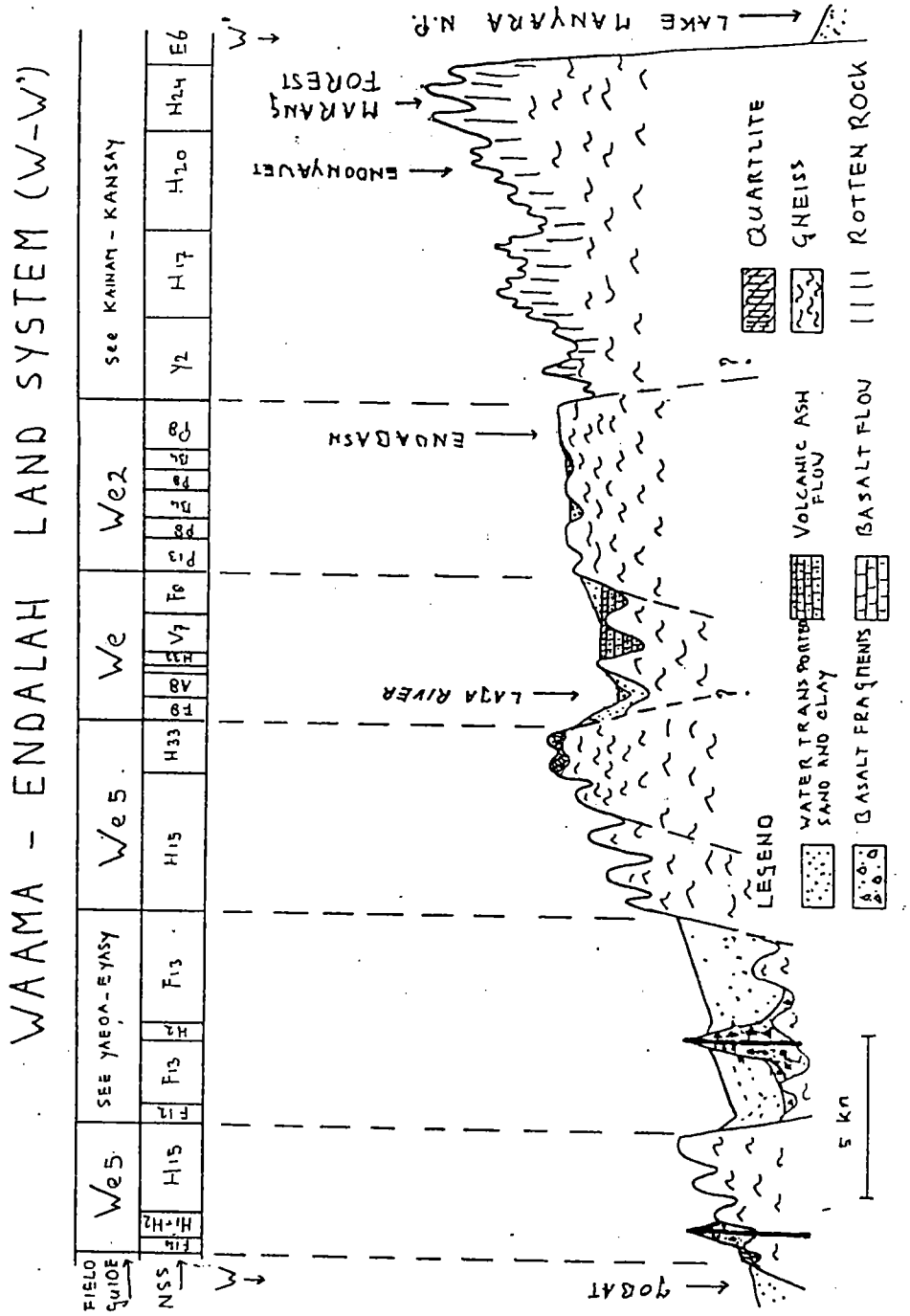


V-20

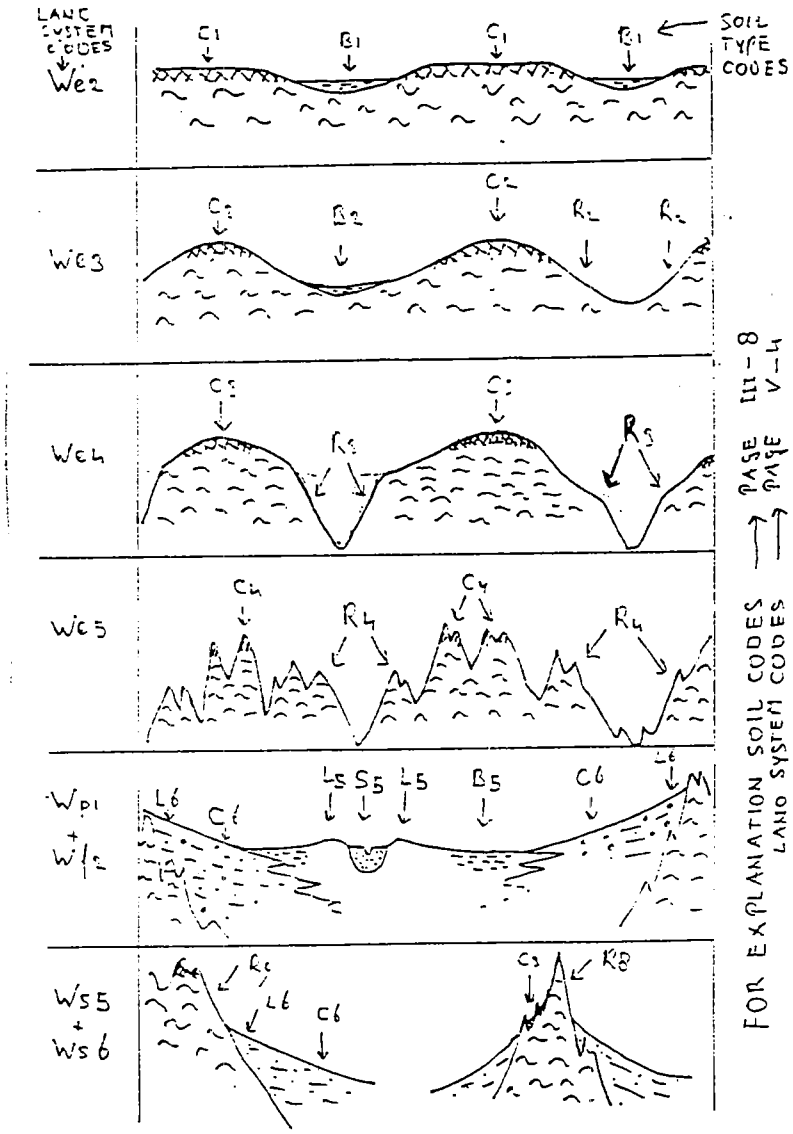
NGORONGORO LAND SYSTEM



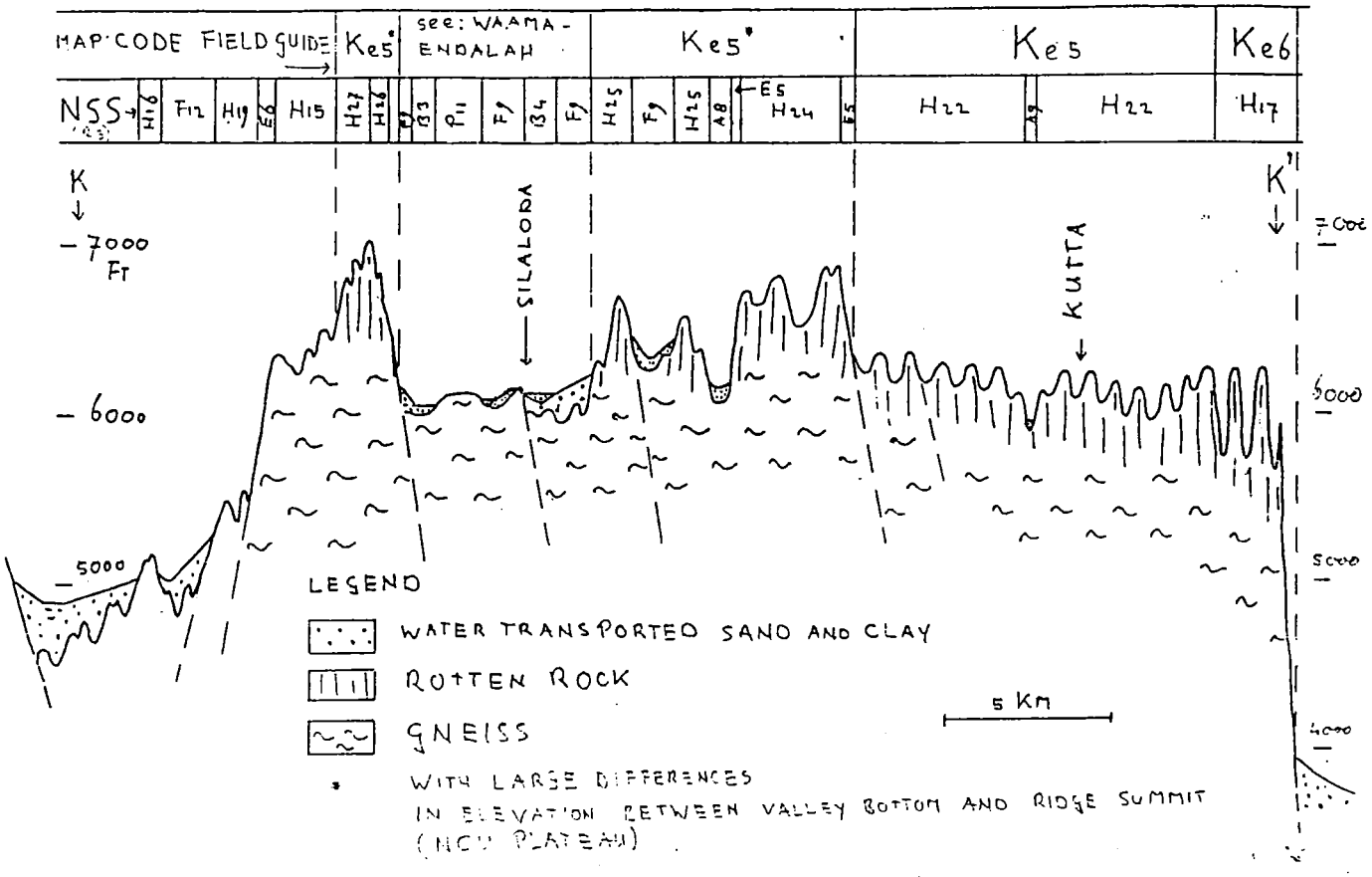
V-21

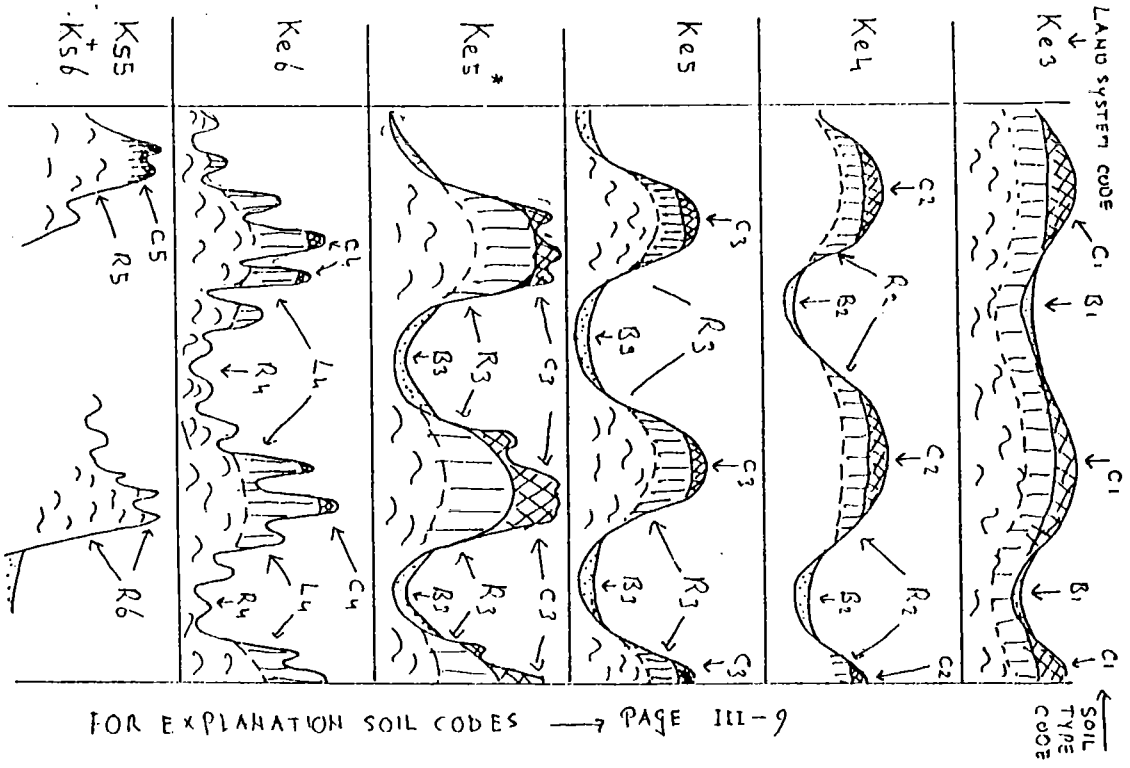


WAAMA-ENDALAH LAND SYSTEM

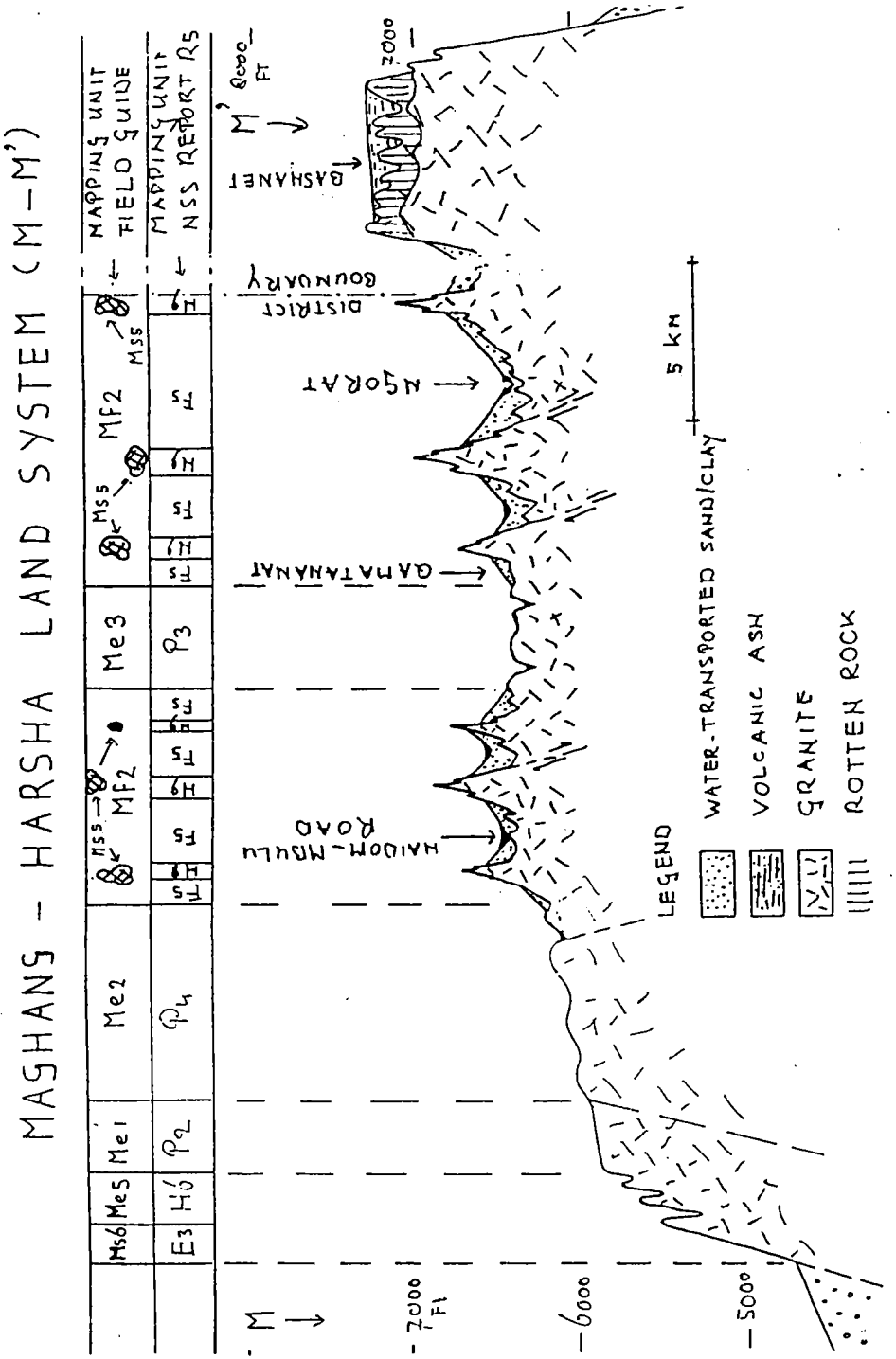


KAINAM - KANSAY LAND SYSTEM (K–K')

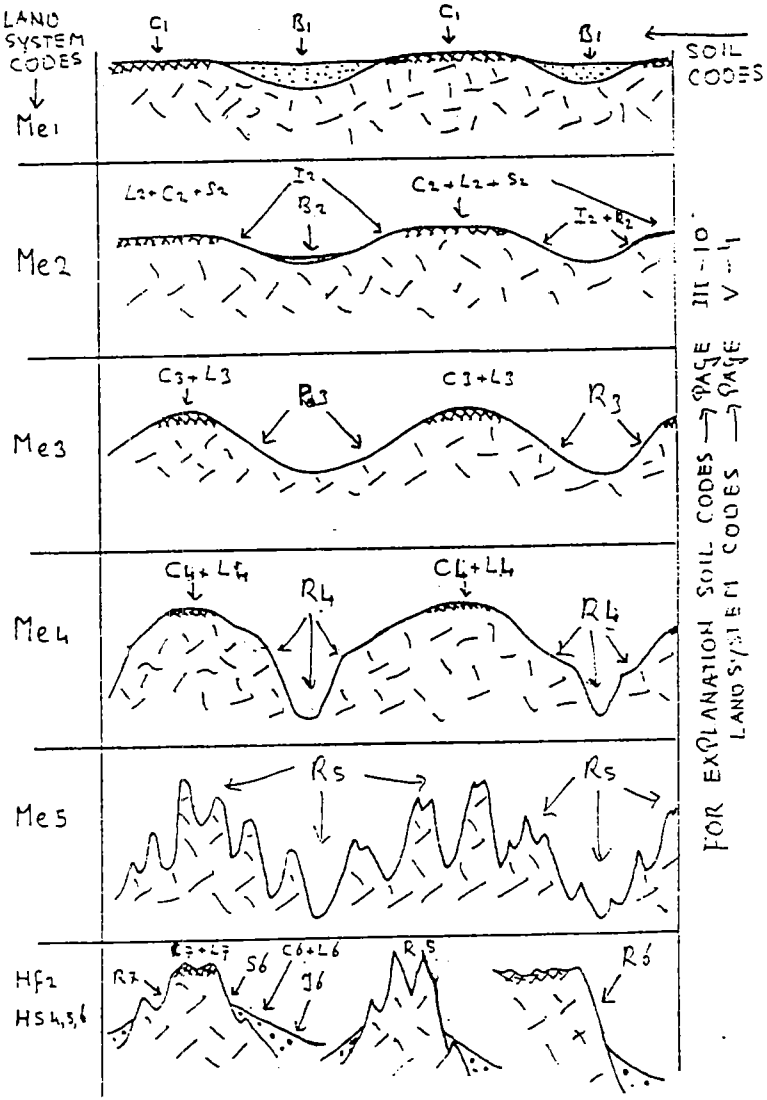


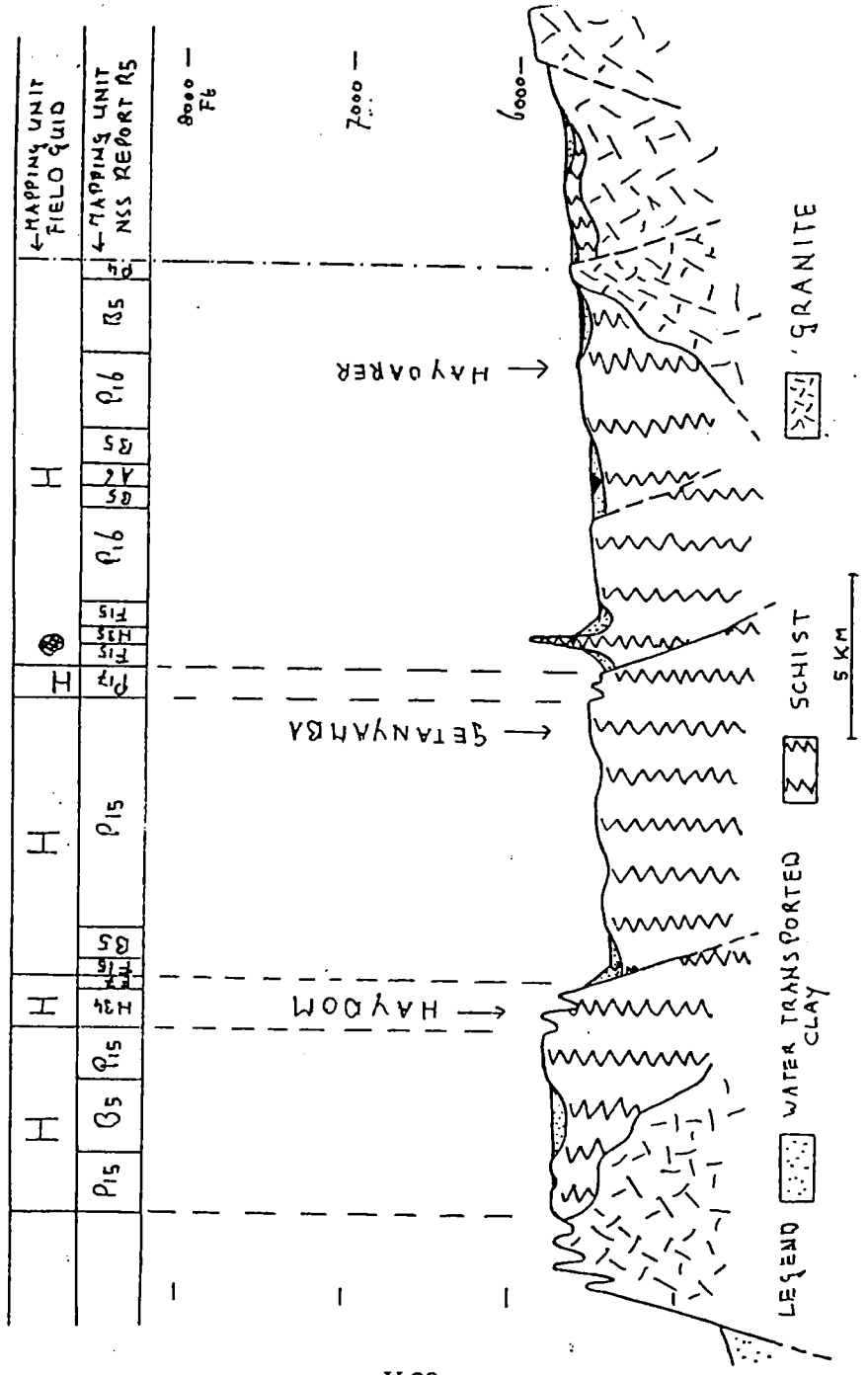


KAINAM-KANSAY LAND SYSTEM

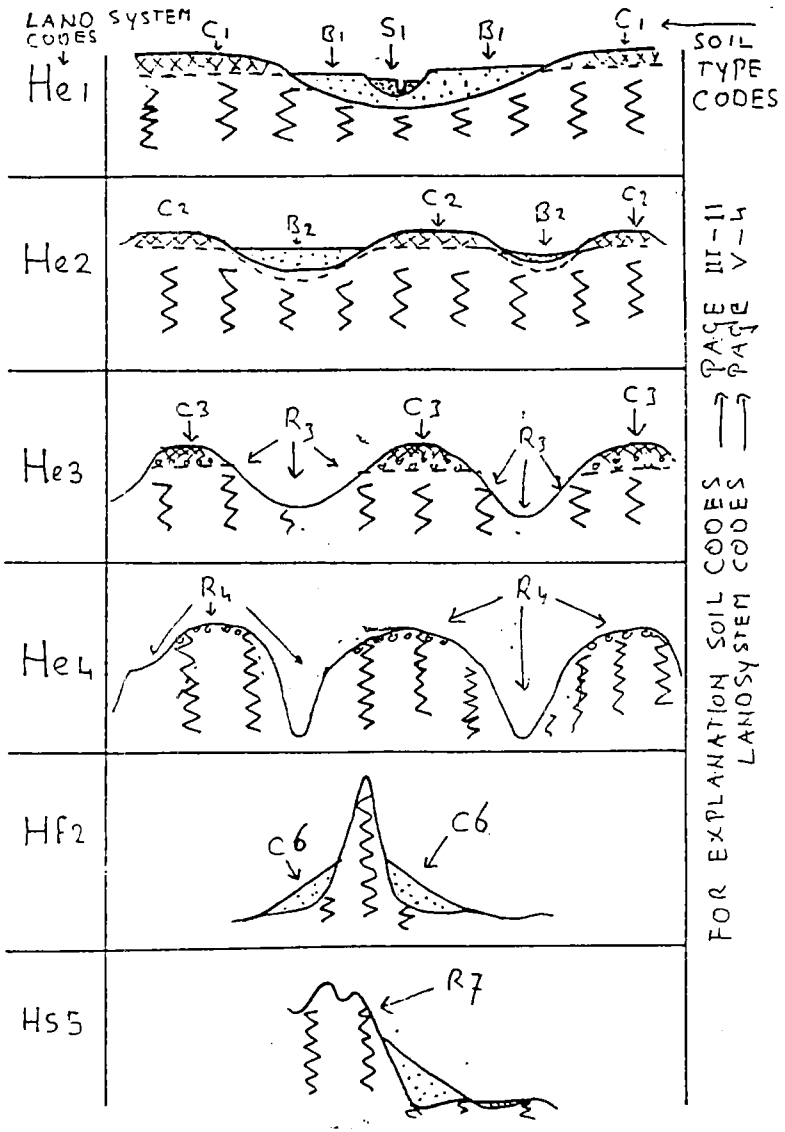


MAGHANG-HARSHA LAND SYSTEM

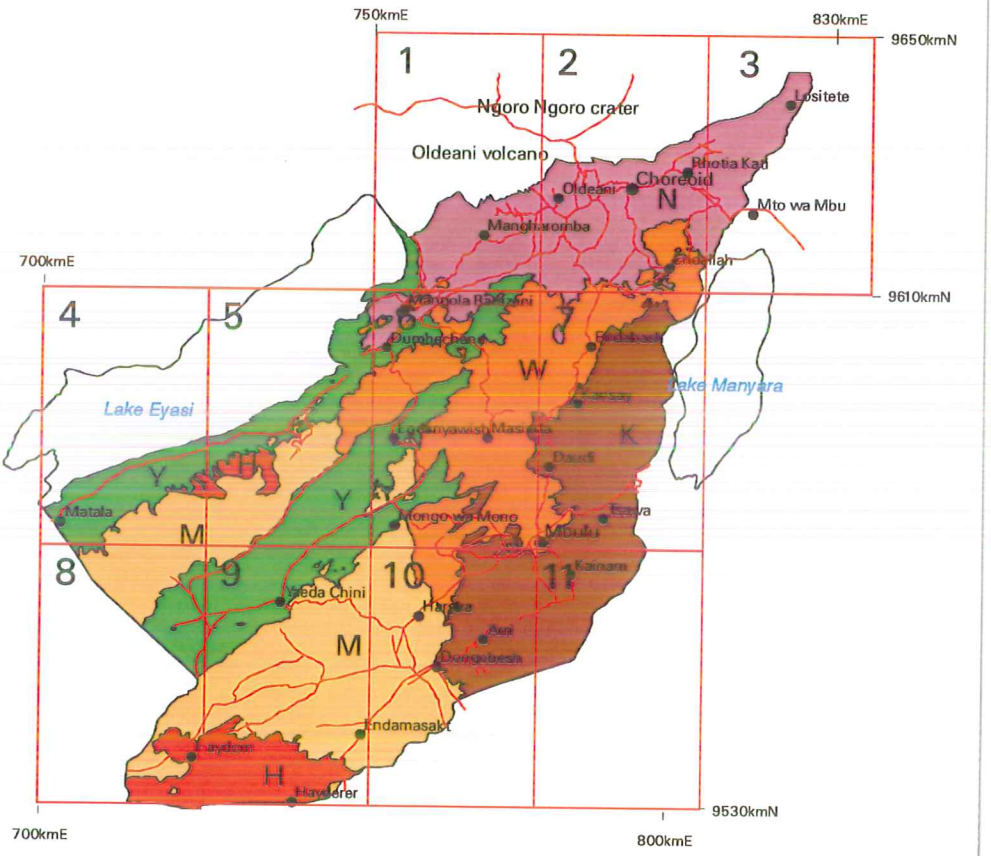




HAYDOM-HAYDERER LAND SYSTEM



MAJOR LAND SYSTEMS
MBULU DISTRICT
MAP INDEX
Scale 1:1,250,000



* FOR DETAILED INFORMATION TURN TO

MAP SHEET OF YOUR CHOICE

* EXPLANATION MAP SYMBOLS SEE LEGEND ON PAGE V– 4

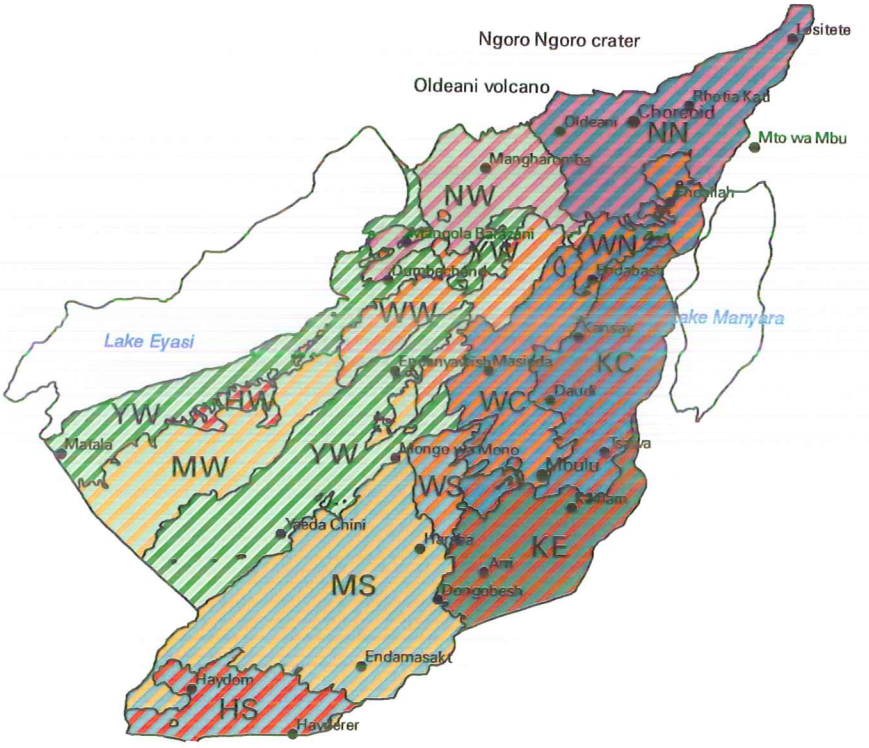
LEGEND
LAND SYSTEM MAP MBULU DISTRICT

MAJOR LAND SYSTEM				TOPOGRAPHY					
ROCK TYPE	CLASS NAME			Flat	Gently sloping	Sloping	Mod. steep	Steep	Very steep
		ADDITIONAL INFORMATION	STEEPEST SLOPE (%)	0-2	2-8	8-16	16-30	30-55	> 55
		LAND FORM	MAP SYMBOL	1	2	3	4	5	6
Clay/sand	Yaeda-Eyasi	Lake plains	Yl	Yl1					
		Alluvial fans	Yf		Yf2				
Basalt	Ngorongoro	Lava plains	Nv		Nv2	Nv3			
		Flood plains	Np	Np1					
		Alluvial fans	Nf		Nf2				
		Foot ridges	Nr			Nr3	Nr4		
		Valleys	Nl					Nl5	
		Hills/scarps	Nh					Nh5	Nh6
Gneiss	Waama-Endalah	Erosion plains	We		We2	We3	We4	We5	
		Flood plains	Wp	Wp1					
		Foot slopes	Wf		Wf2				
		Hills/scarps	Ws				We4	We5	We6
	Kainam-Kansay	Erosion plains	Ke			Ke3	Ke4	Ke5	Ke6
		Hills/scarps	Kc						Kc6
Granite	Maghang-Harsha	Erosion plains	Me	Me1	Me2	Me3	Me4		
		Foot slopes	Mf		Mf2				
		Hills/scarps	Ms				Ms4	Ms5	Ms6
Schist	Haydom-Hayderer	Erosion plains	He	He1	He2	He3	He4		
		Foot slopes	Hf		Hf2				
		Hills/scarps	Hs					Hs5	

AGRO– ECOLOGICAL ZONES

MBULU DISTRICT

Scale 1:1,250,000



* FOR EXPLANATION MAP SYMBOLS SEE PAGE II–10

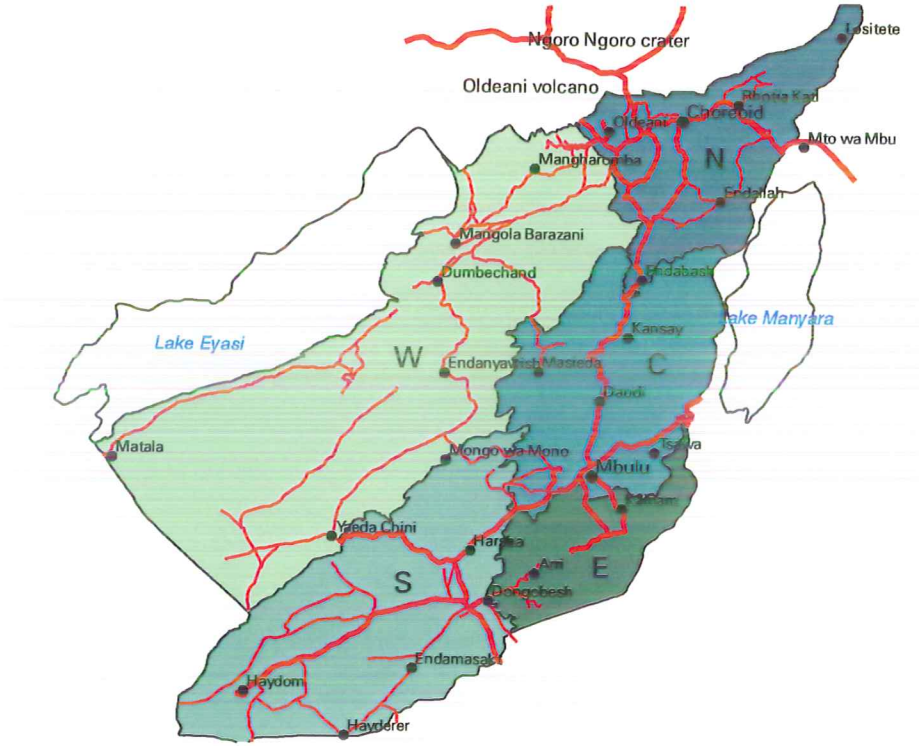
AGRO– ECOLOGICAL FRAMEWORK MBULU DISTRICT

MAJOR LAND SYSTEM				AGRO– CLIMATIC ZONE				
ROCK TYPE	CLASS NAME			WEST	SOUTH	CENTRAL	NORTH	EAST
		ADDITIONAL INFORMATION	RAINFALL (mm)	530	760	830	900	1070
		ALTITUDE (m)	SYMBOL (area ha)	W (273600)	S (157000)	C (109500)	N (83900)	E (51200)
Clay/sand	Yaeda– Eyasi	1000–1500	Y (133600)	YW (133600)				
Basalt	Ngorongoro	1200–1800	N (111100)	NW (40700)			NN (70400)	
Gneiss	Waama– Endalah	1200–1800	W (119000)	WW (40800)	WS (13200)	WC (45500)	WN (19500)	
	Kainam– Kansay	1500– 2300	K (115200)			KC (64000)		KE (51200)
Granite	Maghang– Harsha	1700– 2100	M (165500)	MW (54500)	MS (111000)			
Schist	Haydom– Hayderer	1600–1800	H (36800)	HW (4000)	HS (32800)			

AGRO– CLIMATIC ZONES

MBULU DISTRICT

Scale 1:1,250,000

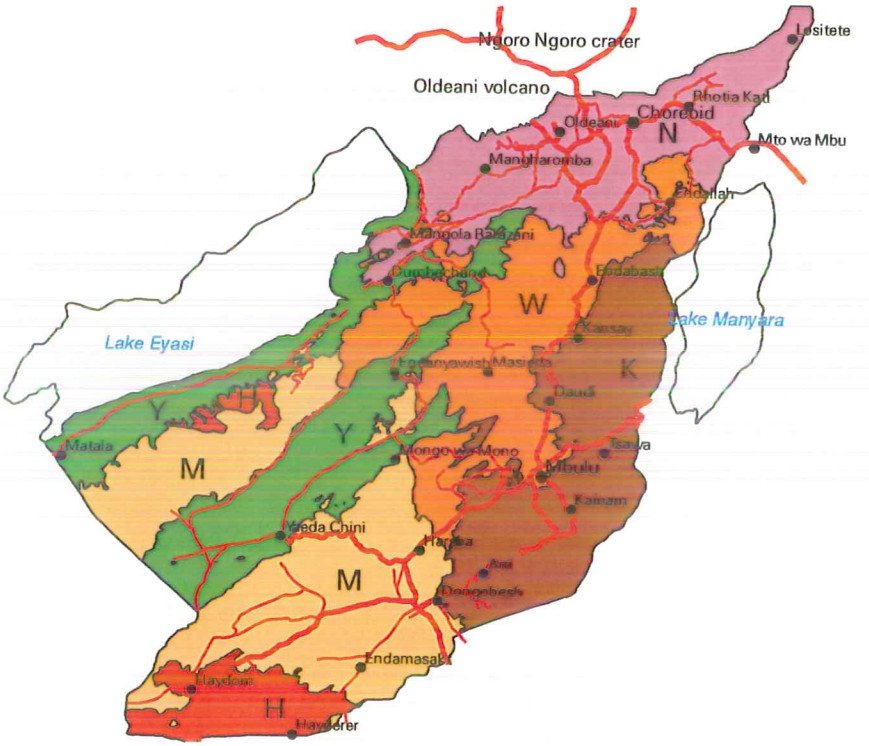


W	S	C	N	E
WEST	SOUTH	CENTRAL	NORTH	EAST

MAJOR LAND SYSTEMS

MBULU DISTRICT

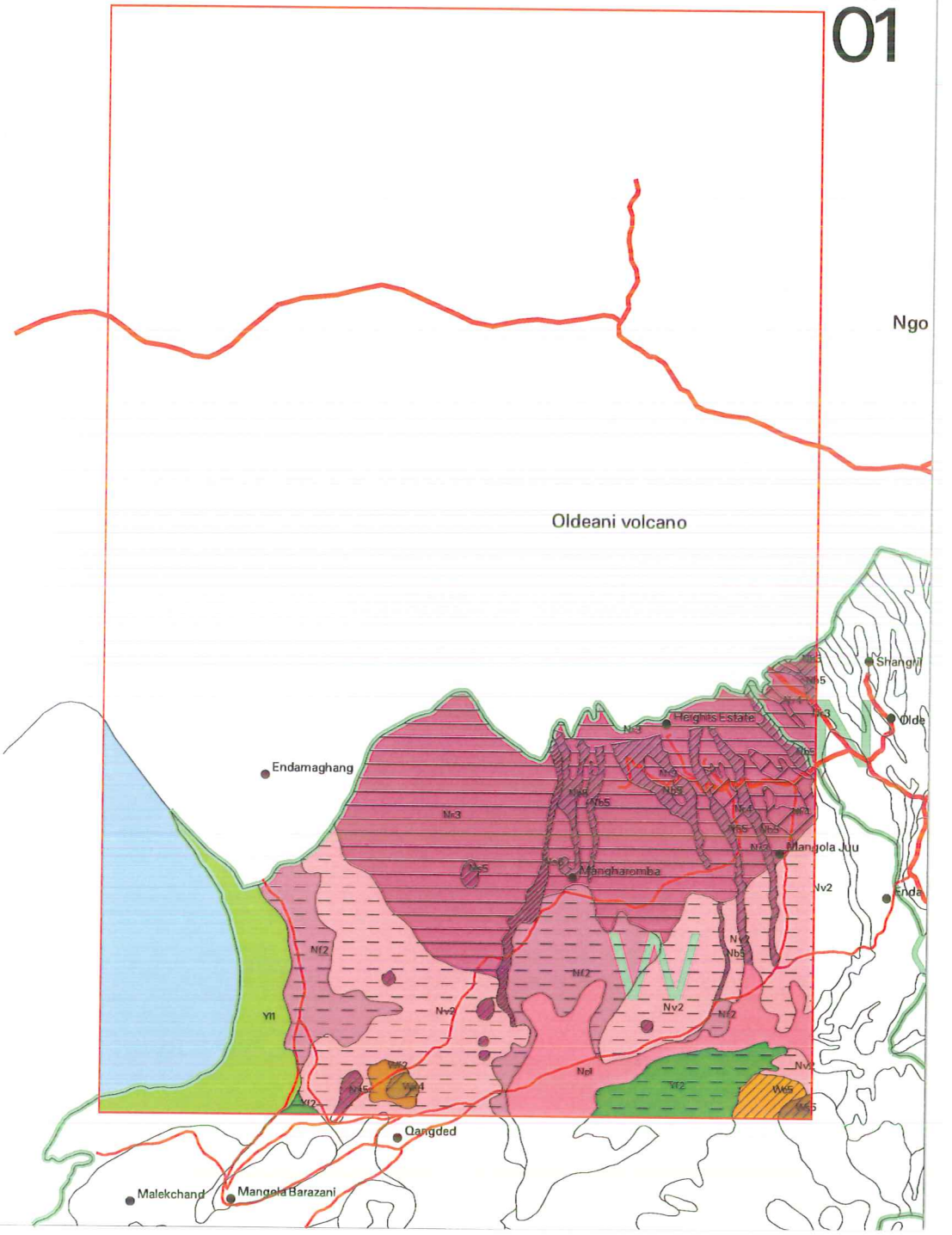
Scale 1:1,250,000



K	W	M	H	N	Y
KAINAM–KANSAY	WAAMA–ENDALLAH	MAGHANG–HARSHA	HAYDOM–HAYDERER	NGORONGORO	YAEDA–EYASI

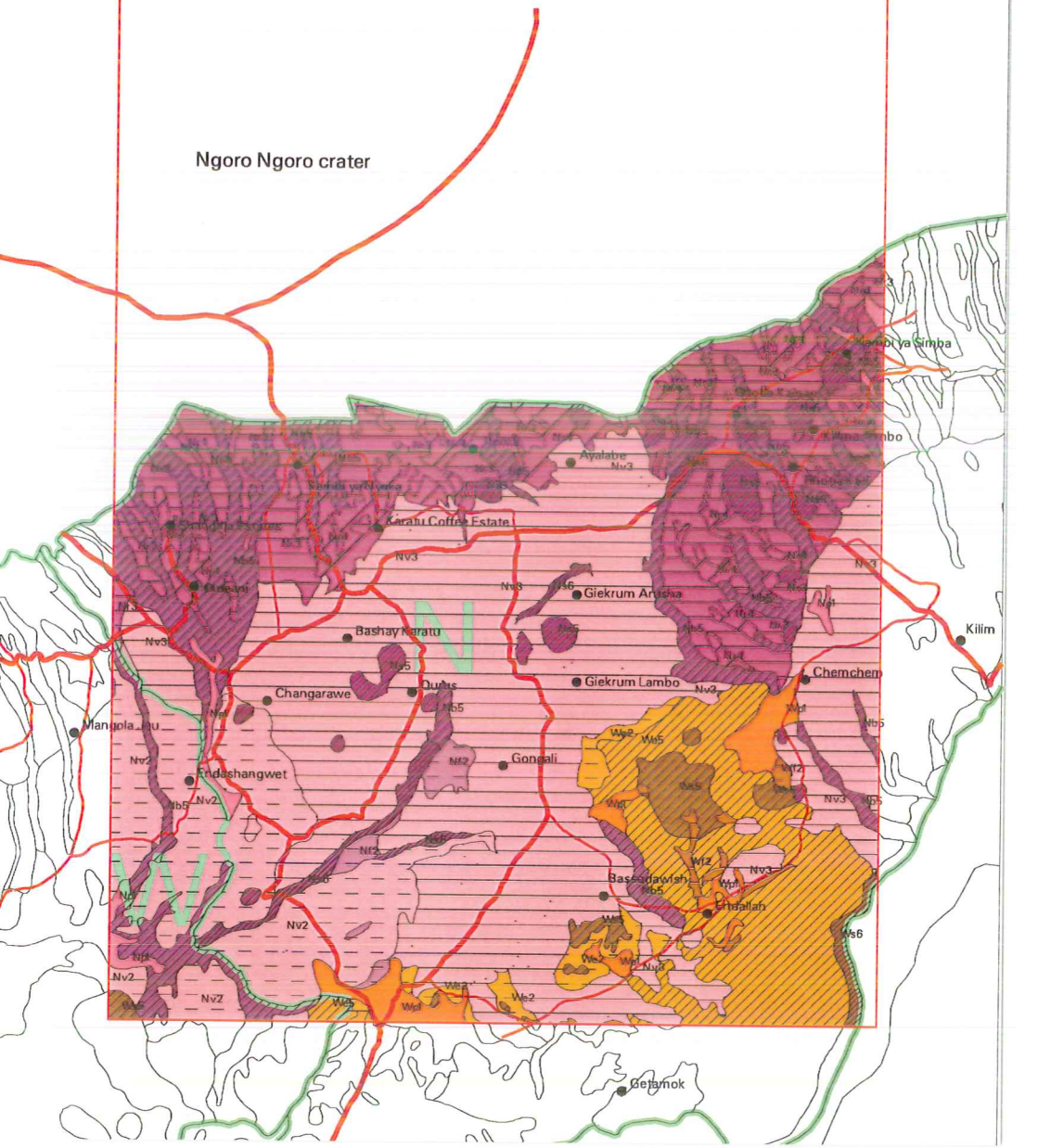
LAND SYSTEMS MBULU DISTRICT

MAP
01



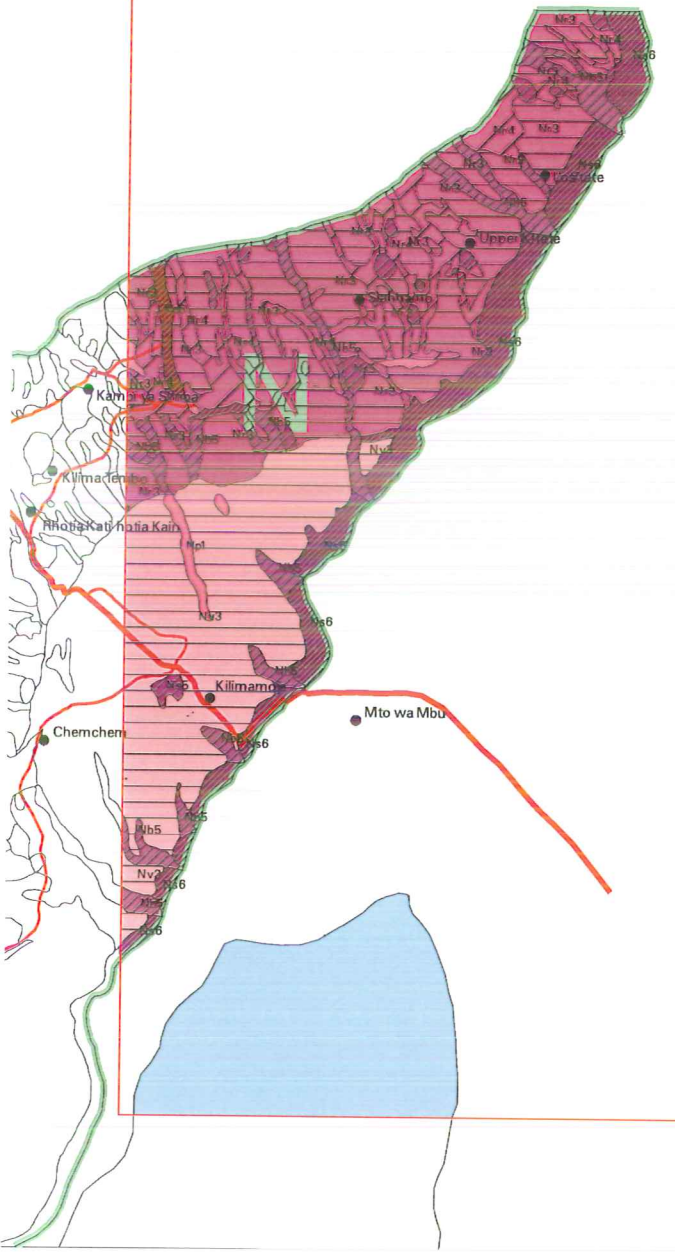
LAND SYSTEMS MBULU DISTRICT

MAP 02



LAND SYSTEMS MBULU DISTRICT

MAP
03

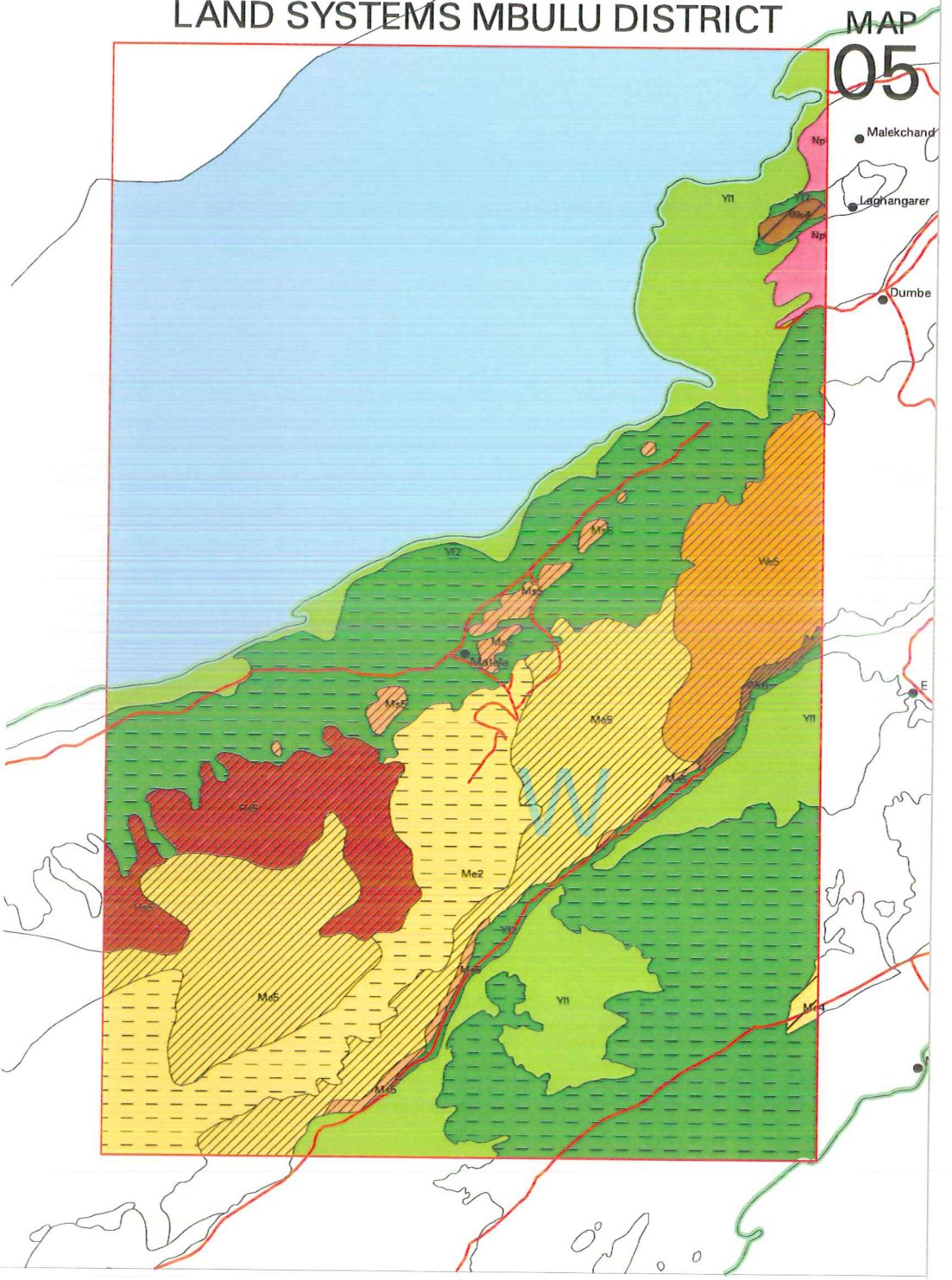


LAND SYSTEMS MBULU DISTRICT

MAP
04

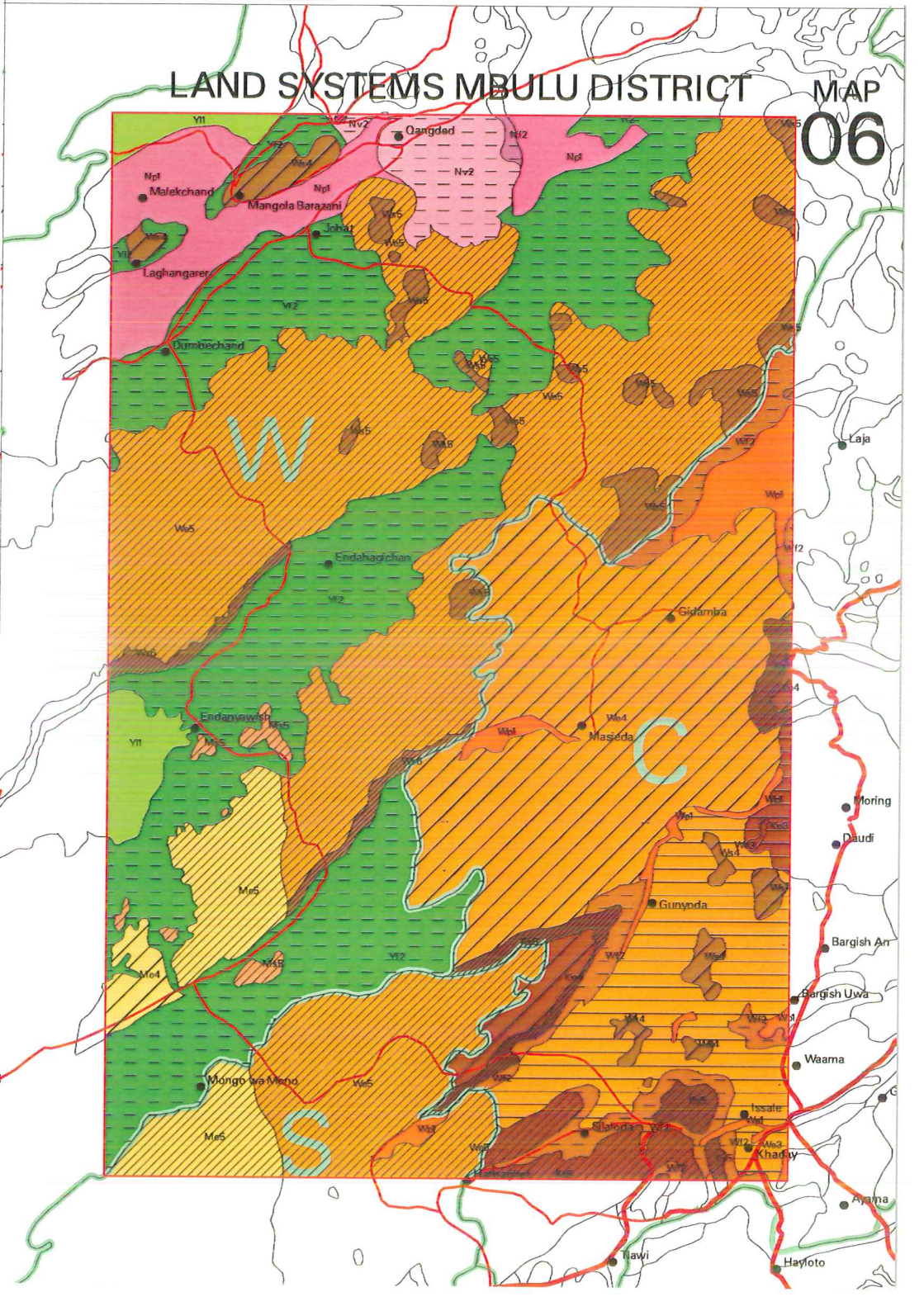
LAND SYSTEMS MBULU DISTRICT

MAP 05



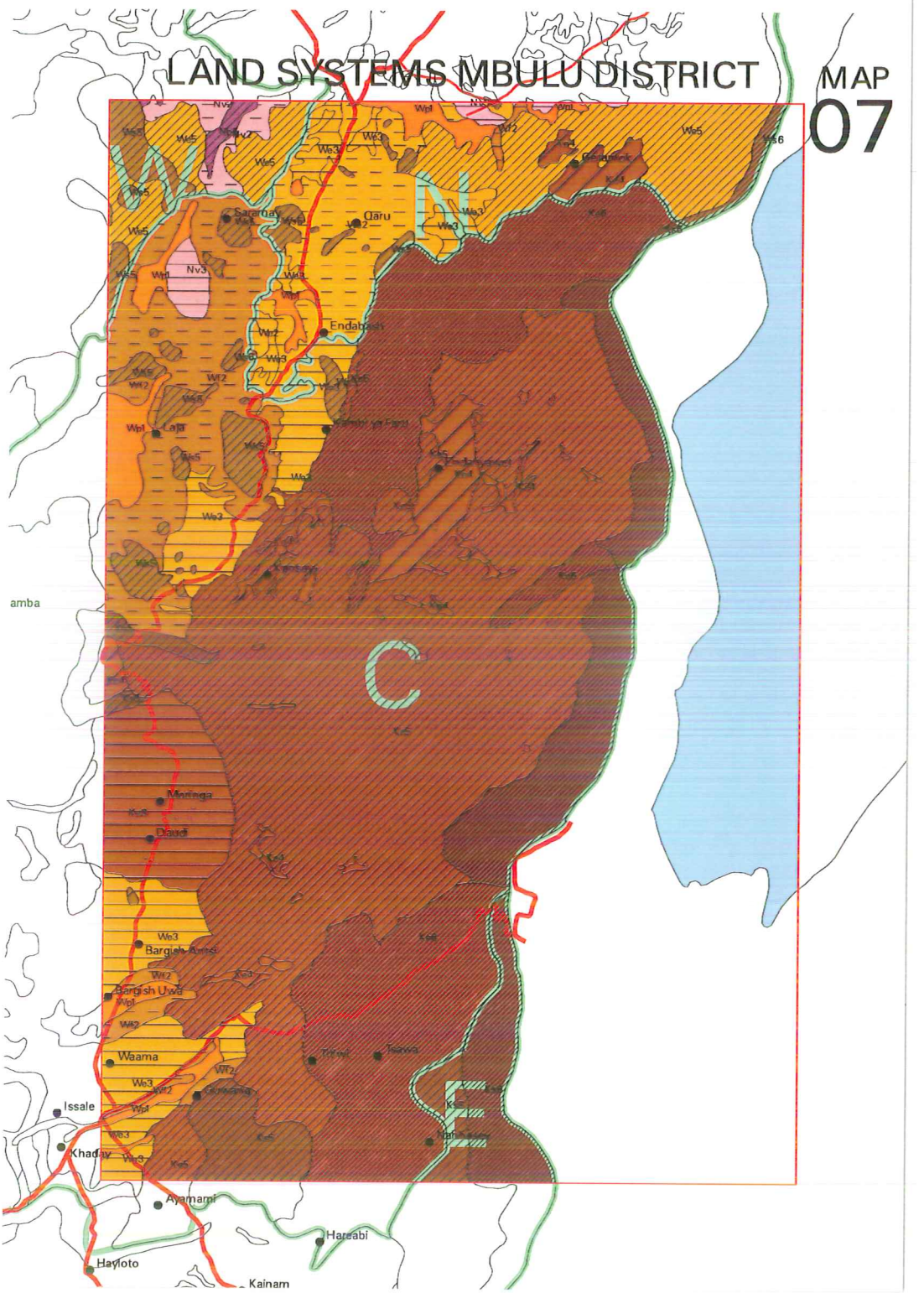
LAND SYSTEMS MBULU DISTRICT

MAP 06



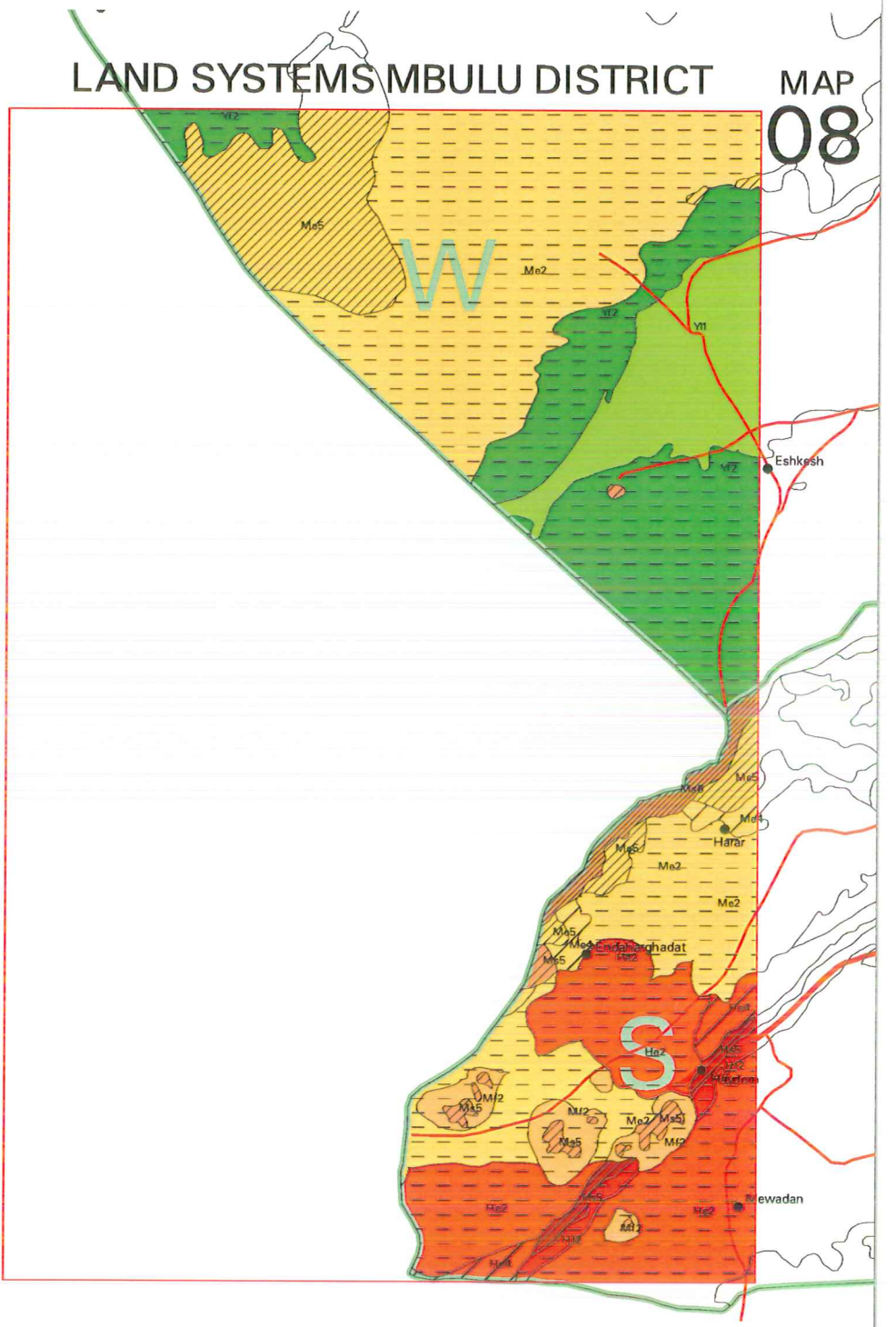
LAND SYSTEMS MBULU DISTRICT

MAP 07



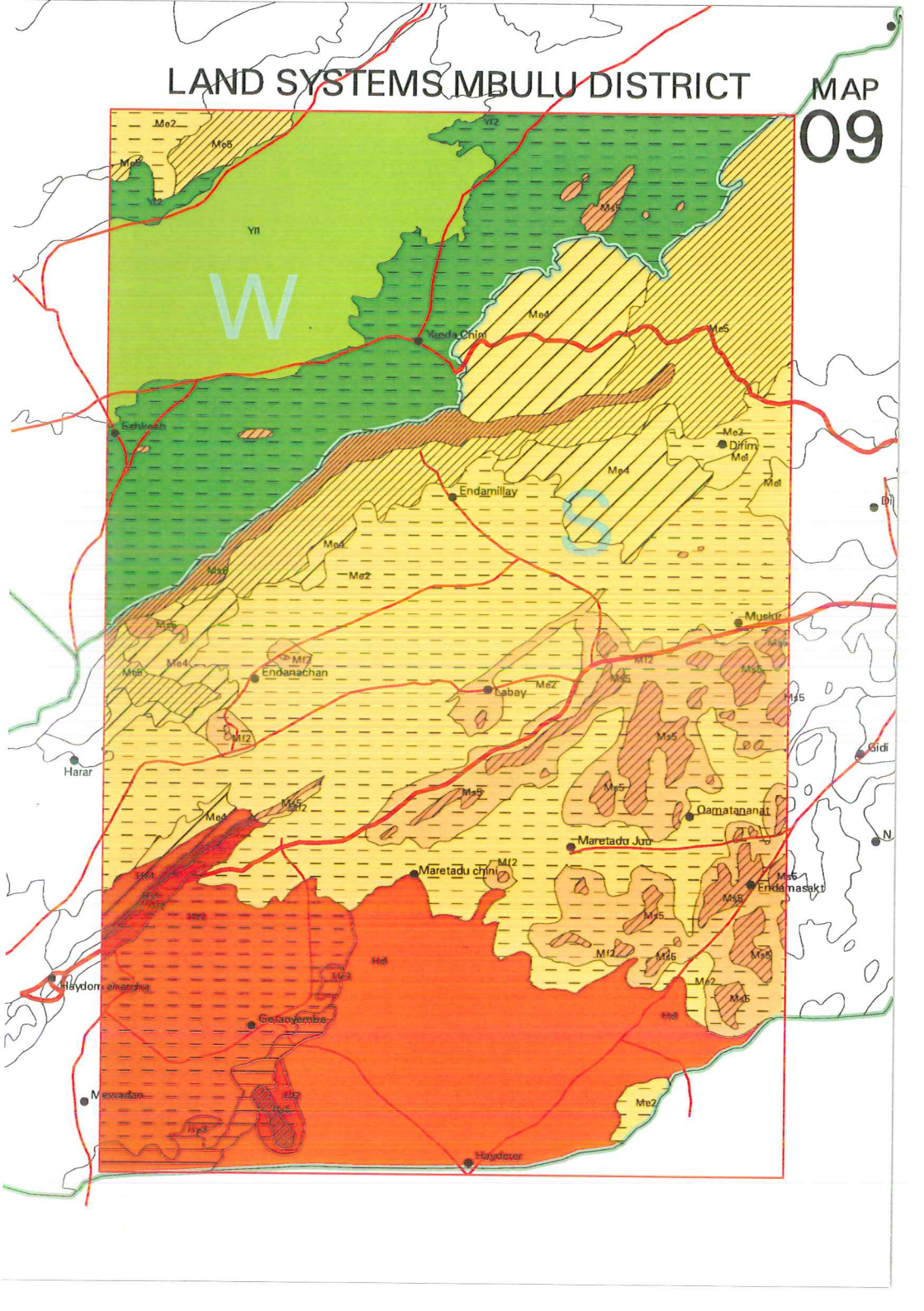
LAND SYSTEMS MBULU DISTRICT

MAP 08

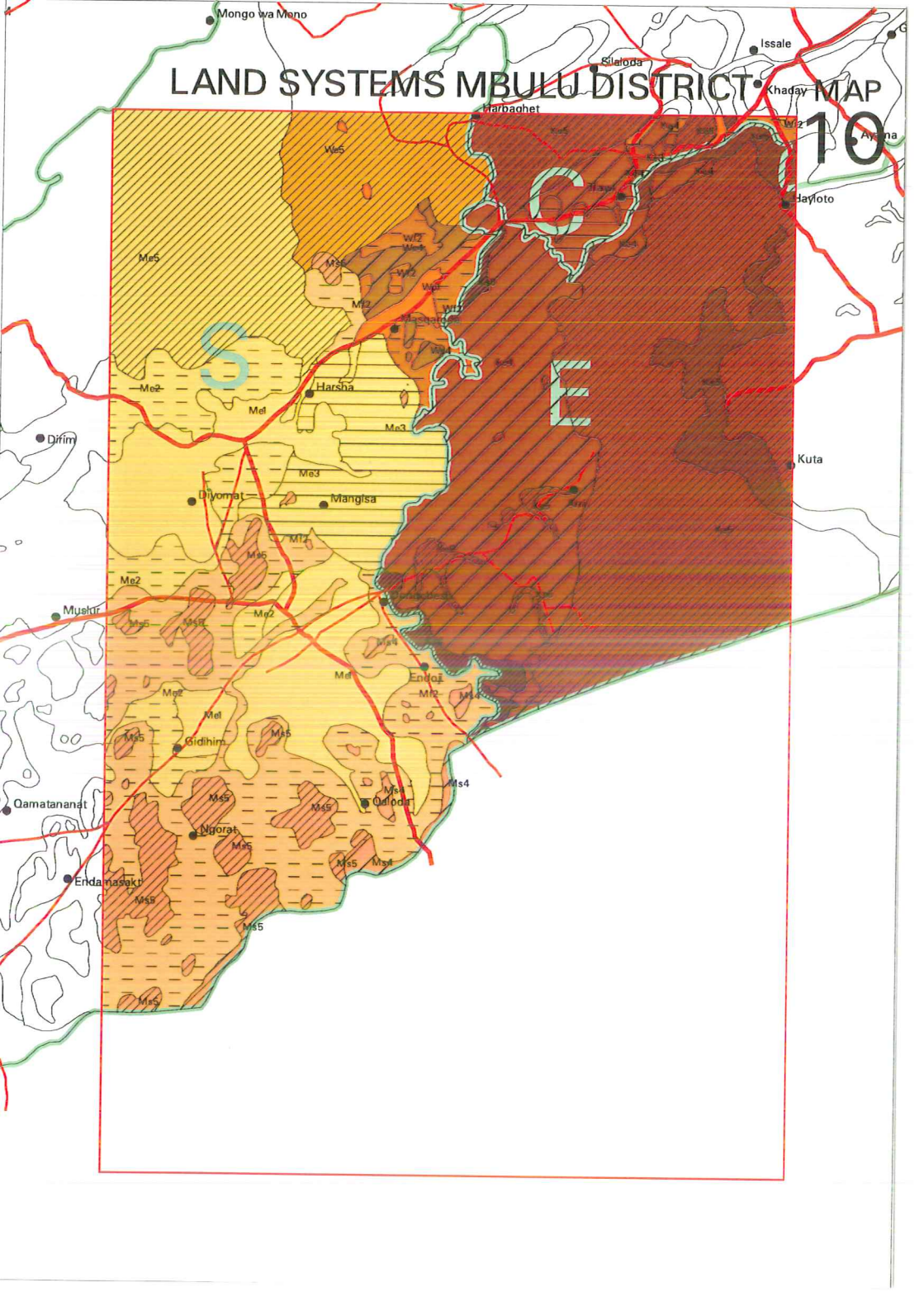


LAND SYSTEMS MBULU DISTRICT

MAP 09



LAND SYSTEMS MBULU DISTRICT MAP 10



LAND SYSTEMS MBULU DISTRICT

MAP
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