The WINAND STARING CENTRE for Integrated Land, Soil and Water Research

Landforms and soils of Baringo District, Kenya

A site evaluation for rangeland use

L. Touber

Report 20

Wageningen (The Netherlands), 1989

Landforms and Soils of Baringo District, Kenya

Survey carried out for:

The Range Management Handbook Project (RMHP), G.T.Z. Nairobi, Kenya.

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ABSTRACT

Touber, L., 1989. Landforms and Soils of Baringo District, Kenya; A site evaluation for rangeland use. Wageningen (The Netherlands), The Winand Staring Centre. Report 20. 57 p.; 6 fig.; 3 tables; 1 map; 1 legend sheet, 3 Annexes.

Within the framework of the Range Management Handbook Project, Kenya, an inventory has been carried out of landorms and soils of Baringo District at a 1 : 500 000 scale. It concerns a site evaluation for rangeland use, which is based on a limited amount of field observations, and relies heavily on visual interpretation of satellite imagery. The physical data of landforms and soils are interpreted for aspects of primary production (fertility and soil-water relationships) and for management aspects (erosion status and hazard; accessibility for livestock; flooding hazard; possibilities for the construction of dams and waterpans).
Annex I deals with the organizational and logistic aspects.

Keywords: Kenya, Baringo District, Landforms, Soils, Range Management, Satellite Image Interpretation

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The WINAND STARING CENTRE is continuing the research of: Institute for Land and Water Management Research (ICW), Institute for Pesticide Research, Environment Division (IOB), Dorschkamp Research Institute for Forestry and Landscape Planning, Division of Landscape Planning (LB), and Soil Survey Institute (STIBOKA).

Project nr. 8556

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CONTENTS

IN FOLDER:
Map and legend sheet: "Landforms and Soils of Baringo District"
at scale 1 : 500 000

1 INTRODUCTION

The Range Management Handbook Project is a collaboration project between the Ministry of Livestock Development of Kenya and the German Organisation for Technical Cooperation (GTZ). It aims at the inventory of the potential for extensive rangeland use of the dry Northern and Northeastern regions of Kenya, through studies on climate, landforms, vegetation, soils and hydrological and socio-economic aspects.

It is the purpose to present the results of these inventories per District in the form of 1 : 1 million scale maps and their interpretation. Maps and reports should be easily intelligable to staff of the extension services and planning division of the Ministry of Livestock Development.

The Winand Staring Centre for Integrated Land, Soil and Water Research*) already participated in the inventory of landforms and soils of Marsabit, Wajir, Mandera and Samburu Districts. The present report deals with the landforms and soils of Baringo District. As was the case with former district surveys, the present one is based on satellite image interpretation and a restricted amount of field observations. The relatively small size of the Baringo District called for the production of a 1 : 500 000 scale map. This is for presentation purposes only. The survey intensity does not justify a publication scale, larger than 1 : 1 000 000. Field checks were directed towards the assessment of range potential rather than towards the execution of a conventional "multi-purpose" soil survey. Hence it is preferred to use the term "Site evaluation for rangeland use" as subtitle for these land inventories.

Acknowledgements are contained in the mission report, Annex I.

*) Continuing the research of the former Soil Survey Institute (STIBOKA).

2 METHODS

2.1 General

Survey methods have been described in a separate volume, dealing with the general approach to small-scale inventories of soil and vegetation resources in the context of the Range Management Handbook Project (Touber, 1988). Aspects of this methodology, as far as specific for the present survey, will only be dealt with here.

2.2 Materials

All existing previous studies concerning the area were consulted as much as possible during the interpretation of satellite imagery. These comprise mainly the Exploratory Soil Map of Kenya (Sombroek et al., 1982) and all available geological maps and reports. Due to the planning and execution of numerous projects in the field of irrigation and range land rehabilitation, a fair amount of other publications on parts of the District is available. The literature list contains these publications.

During preparation of the field survey, much emphasis was given to interpretation of remote sensing material. Use was made of 1 : 500 000 scale prints of Landsat images taken during the dry season of 1976.

2.3 Survey activities

Field survey was conducted from September 26th to October 20th 1989.
The number of actual field survey days that were spent on field data gathering amounts to twenty six. A total of 110 observation points were established, at which points both the soil surveyor and the vegetation scientist recorded their data simultaneously. Apart from recording field data at these points, vegetation and soils were viewed while travelling between points. Fig. 1 gives the locations and reliability diagram.

It may be clear that not all landform/soil/vegetation types have been covered by field visits as one would judge necessary for a 100% reliable description. This is however inherent to the scale at which the Project operates, and not in conflict with the planned projects output, which calls for a general overview of the natural resources of each District.

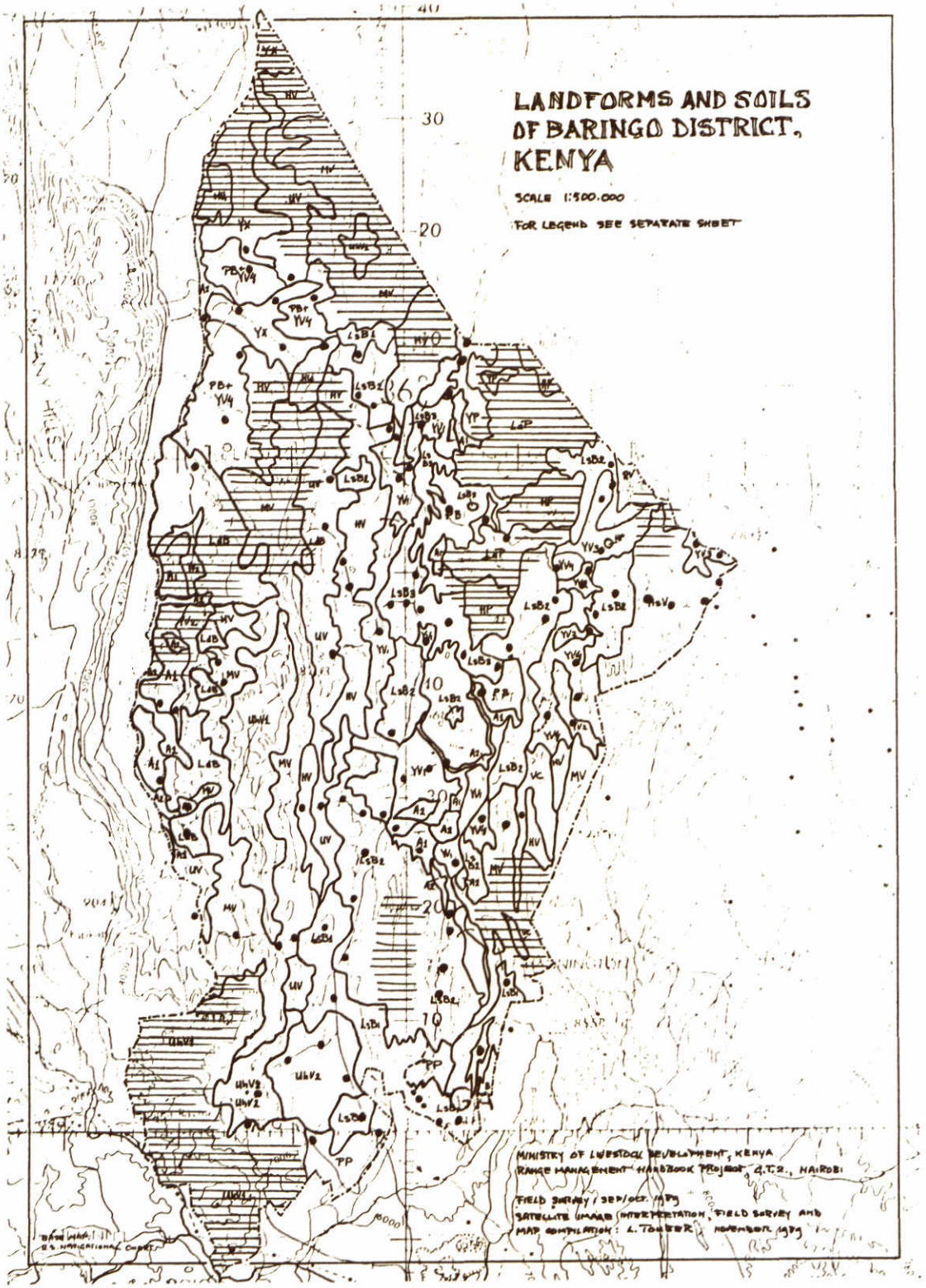

fig. 1 LOCATION OF OBSERVATION POINTS, AND DISTRIBUTION OF RELIABILITY

• OBSERVATION POINT

AREA WITH COMPARATIVELY LOW DENSITY OF FIELD DATA

The vegetation scientist initiated interviews with local people, knowledgeable as to the performance of the habitat as rangeland, and as to plant species.

2.4 Map and report preparation

Map and legend have been prepared according to the standard procedure as described in volume I of the Range Management Handbook (Touber, 1988). The 1 : 500 000 scale satellite image interpretation map has been corrected and amended according to the field data. The final basic document is a landforms and soils map at scale 1 : 500 000. All further information contained in the present report is based on this map. Ozalith prints of this map are available on request from the Kenya Soil Survey at NAL and/or the Range Management Handbook Project, GTZ, Nairobi.

In contrast to previous surveys, attention is paid here to the obvious and omnipresent "status of erosion", more than the rather speculative landquality "erosion hazard".

3 SURVEY RESULTS

3.1 Summary of landforms, rocktypes and soils

Baringo District offers good examples of landforms, typical of the Eastern Rift Valley. The rift faulting has resulted in large altitude differences of the land, accompanied by often mountainous escarpments. A wide range in climate-, soil- and vegetation types goes along with these height differences; hence contrasting potential and use of the land is a result. Here an attempt is made to give a brief description on the distribution of major land forms. Figure 2 refers, and represents a rigorously simplified version of the landforms and soils map of Annex 1.

Most prominent are the mountainous slopes of the Tugen hills and the escarpment of the Eastern Rift Valley flanks towards the Lherogi/Laikipia plateau (unit MV). Soils are formed on mostly older (Pliocene) volcanic rocks, and, due to the prevailing very steep and long slopes, are shallow and very stony.

Above and outside these rift valley flanks the more humid and cooler highlands of the Tugen hills, Eldama Ravine area (unit UhV) at altitudes over 2200 m) and the Lherogi/Laikipia Plateau (unit HsV at an altitude of 1800 m) are found. Also here older volcanic rocks prevail, that mostly bear a combination of shallow soils over rock and deeper red clays (Tugen hills, Eldama Ravine area) or shallow gravelly clay loams and some deeper grey clays at the Laikipia side.

The major part of the District is occupied by the Rift Valley floor, highlighted by the lakes Bogoria and Baringo, and to the west by the Kerio River. The deepest central part of both valleys descend gradually to well under the 900 m (3000 ft) contours in the North, near to the district boundary with Turkana.

At the base of the Tugen hills, a zone of badly eroded Uplands and minor Hills are found, developed on largely unconsolidated and highly erodible material (HV and UV). Apart from these, the majority of the arid low lands is occupied by basalt Plateaus that are broken and tilted by faulting in more recent geological times. Numerous rocky cliffs alternate with gently undulating, but mostly very shallow and stony clay loam soils of the step-faulted basalt Plateaus (unit LsB).

The latter and lower parts of the step faulted rift valley floor are the areas where sedimentation takes place. The geological erosion that has been active since the beginning of the crustal movements has detached large quantities of materials from both flanks of the Rift valley. These sediments have settled in Piedmont Plain - like low slopes (e.g. the Njemps flats; the Mukutan area), often with promising irrigation potential (unit YV). Soils are mostly well drained deep friable silty loams, or heavy cracking clays. These piedmont plains are (partly) due to

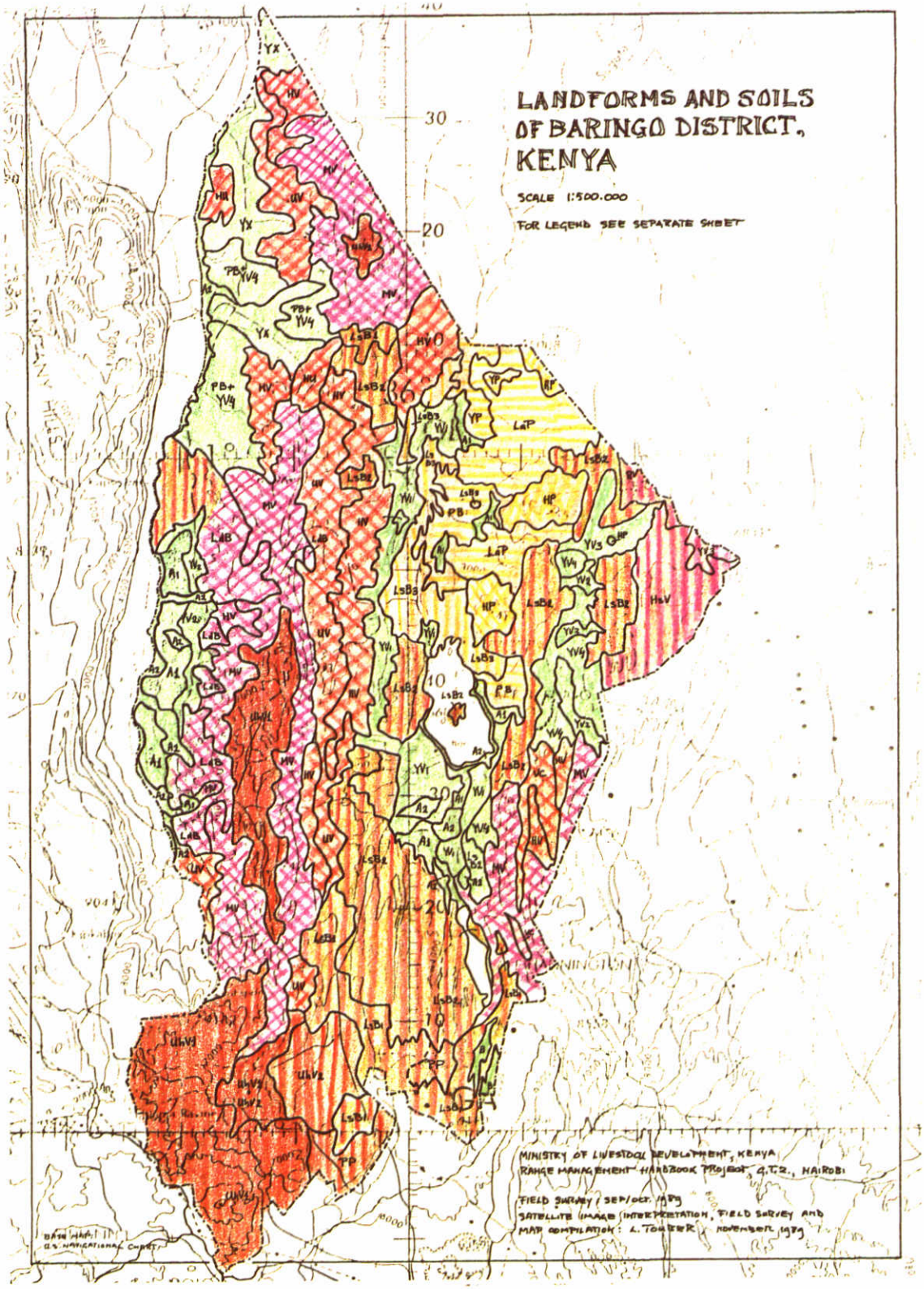

Fig. 2 SUMMARY OF LANDFORMS

- MOUNTAINS, MOUNTAIN SLOPES, MAJOR RIFT VALLEY ESCARPMENTS
- HIGH LEVEL UPLANDS
- STEP FAULTED HILLS
- HILLS AND UPLANDS AT THE FOOT OF THE TUGEN HILLS
- STEP- AND GRID- FAULTED BASALT PLATEAUS OF THE RIFT VALLEY FLOOR
- SUB RECENT VOLCANIC HILLS, AND LAVAFLOWS, PARTLY COVERED BY ASHES
- SEDIMENTARY PLAINS AND PIEDMONT PLAINS

recent crustal movements, partly due to overutilisation) themselves subject to erosion, especially towards the north, and as a result, often bear a dense gravel layer at the surface, or are transformed into a badland topography due to gully erosion.

In the center of the Rift Valley, north of Lake Baringo, relatively recent vulcanicity has produced some Hills (HP) and the more recent basalt flows, that are partly covered by a blanket of ash and fine gravel (LaP).

3.2 Evaluation of soil properties relevant to primary production and range management aspects

3.2.1 General

Methods of data gathering and interpretation is contained in volume I of the Range Management Handbook (Touber, 1988). The system followed is based on the Framework for Land Evaluation (FAO, 1976). This Framework is elaborated for the present topic into "Guidelines: Land Evaluation for extensive grazing" (FAO, 1987).

Within a given climatic zone, the availability of soil moisture and of nutrients are the land qualities that have a prevailing influence on the primary production of rangelands. Land qualities that are related to aspects of management, are erosion hazard, accessibility for livestock and possibilities for the construction of pans and dams.

In reality more parameters are of influence of course, but data on these were not obtainable in the context of the present site evaluation, or are judged of less importance.

The landqualities are rated in the following sections, in order to establish a comparison among the various mapping units identified. The figures given do not pretend to have any absolute value or quantitative connotation.

3.2.2 Soil moisture availability

Soil moisture availability depends on the course of the rainfall/evaporation ratio through the seasons; the infiltration capacity of the surface soil; the water holding capacity of the soil material and the depth of the rooting zone.

Infiltration capacity depends on the porosity of the surface soil, which in turn is influenced by such parameters as vegetation cover, soil texture, soil structure and organic matter content. Important is that the surface soil is not "sealed". This is the case on "overutilized" soils, where due to too frequent grazing and trampling the vegetation cover, the organic matter

content and hence structure stability and porosity have diminished. A low infiltration capacity causes (part of) the rainwater to run off along the surface. This water will not become available to the vegetation on the soil where the rain falls.

Water holding capacity is estimated according to its connection with the soil texture (see separate volume on methodology). The depth of the rooting zone may be limited by shallow rocks or an abrupt change in texture or a change in chemical composition, such as a strong increase with depth in salinity or sodicity.

Table 1 gives a comparison among the mapping units concerning effective soil depth, available water capacity and eventual run-off losses. A combination of these is given as "final rating", of soil moisture availability in a separate column. These ratings are expressed on the map of figure 3.

Constraints to the production of standing crop in grazing land due to limited potential soil moisture availability are found in the major part of the District.
This is due to the prevailing shallow and stony soils and/or erosional processes (run-off losses).

Good moisture storage is found in the sedimentary areas of the Piedmont plains and Alluvial plains; partly also in the high level Uplands.

3.2.3 Chemical soil fertility

In addition to rainfall and water holding capacity, the productivity of soils depends on their chemical richness.

Table 1 Ratings of soil characteristics, relevant to productive capacity of rangelands.

Unit No.	Mapping Unit	Effective soil depth 1: v. deep 5: v. shallow	Available water capacity 1: v. high 5: v. low	Run-off losses 1: negligible 5: v. high	Final rating potential soil moisture availability 1: high 5: low	Rating relative chemical fertility 1: v. high 5: v. low
1	MV	5	2	3	4	2
2	RV	3/5	3	4	4	3
3	HU	4	3	4	4	4
4	HV	4	4	4-5	5	3
5	HsV	3/5	3/3	3/5	3/4	3
6	HP	5/2	3/2	5/3	4/2	2
7	LsB1	5	3	3	4	2
8	LsB2	5	4	3	4	2
9	LsB3	5/4	4/3	3/2	4/3	1
10	LdB	5	3	5	5	3
11	LaP	5/2	3/2	5/2	4/2	2
12	UhV1	4/1	3/1	3/1	3/1	3
13	UhV2	3/4	2	2	3	4
14	UV	4	4	5	5	4
15	YV1	1/3	1	3/5	2/3	2
16	YV2	2	3	4	3	3
17	YV3	2	3	2	2	2
18	YV4	3	4	3	3	2
19	YP	2	2	3	2	3
20	YX	3/4	4/2	3/4	3	3
21	PB	4	3	3-4	3	1
22	PP	2	2	3	2	3
23	A1	2	1	3	2	3
24	A2	1	1	1	1	1
25	B	3	4	1	4	3
26	VC	3	3	4	4	2

Note [1] If the ratings for effective soil depth and run-off losses both score unfavourable, i.e. 4 or 5, the final rating is downgraded. Loss of rain-water due to run-off has been given most weight in the final rating; the Available Water Capacity has been given least weight.

[2] Potential Soil moisture availability: i.e. Soil moisture availability according to soil properties only. Climate is not taken into account.

The mapping units are rated according to the content of "dark minerals" (ferromagnesian minerals) of the rock type on which the soils have developed, as well as to the amount of "primary weatherable minerals" observed in the soil profile*).

*) Laboratory analyses of top soil fertility samples were not yet available at the time of report writing.

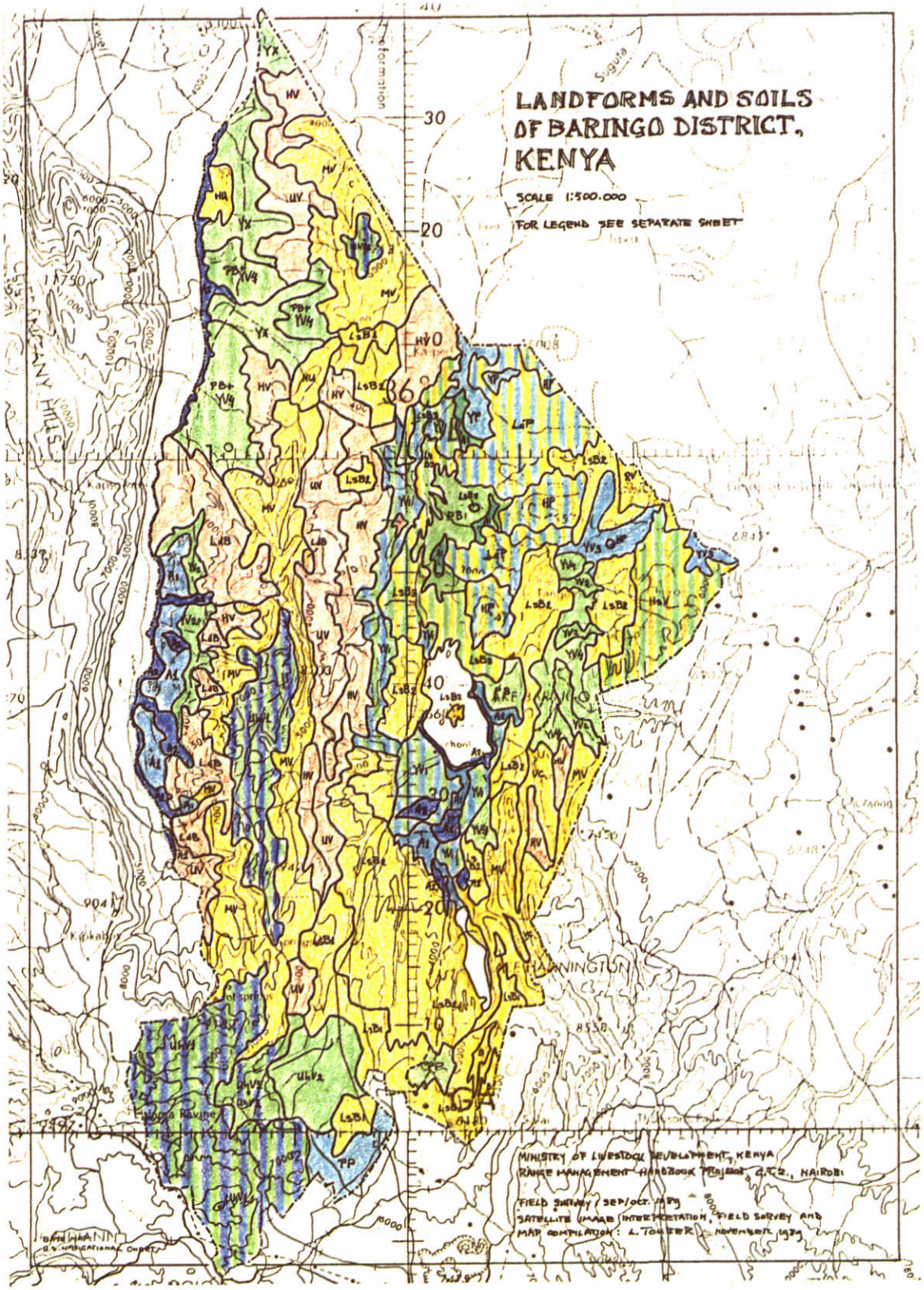

fig. 3 : SOIL WATER HOLDING CAPACITY

DISTRIBUTION OF MAP UNIT RATINGS — SEE TABLE 1

The latter parameter depends on the "age" of the soil mantle, i.e. on how intensive or for how long minerals have been weathered and leached out of the soil.

Table 1, last coloumn, lists the ratings of chemical fertility. Generally speaking, the more shallow soils in "younger" relief-rich landforms have a higher amount of weatherable primary minerals. Also volcanic rocks have, as a rule of thumb, a moderate to high amount of ferromagnesian minerals.
As almost the entire Distinct consists of volcanic rocks, in combination with "young", relief-rich landforms, it is expected that lack of chemical soil fertility is not a limiting factor to the primary productivity of rangelands in Baringo District.

Chemical toxicities are not expected to play a significant role. Salinity and sodicity is occasionally found in sedimentary areas, such as the Piedmont Plains, Alluvial Plains and Bottomlands (units YV, A and B), but only at greater soil depths.

3.2.4 Erosion

The volume on methodologies gives an explanation of types of erosion, the factors involved and of the performance of certain soil types in general. Erosion is a widespread and very prominent feature in Baringo District. Therefore it is preferable to report on the status of accelerated soil erosion as presently found in the field, rather than giving the more theoretical prognosis of "erosion hazard" in case of (future) overutilization of the rangeland.
Table 2 summarizes the map unit ratings of erosion status. The erosion observed is proof of an alarming degradation of the rangelands of rather large parts of the district.

The table includes an estimation of the possibilities for recuperation. The ratings of these possibilities are largely based on the factors of infiltration capacity (or degree of sealing of the surface soil) and soil fertility, assuming a proper management and sufficient rainfall (i.e. no "failing" rainy seasons). These ratings could be considered indicating an amount of time needed for the land to recuperate (e.g. 1: two or three seasons; 4: eight to ten years).

Worst affected are the volcanic Uplands (mapping unit 14: UV); the dissected basalt Plateaus (mapping unit 10: LdB) and the valley Complex of the Ol Arabel area (mapping unit 25: VC).
In the case of the Uplands, erosion is largely due to the soft, detachable character of the (soil) material, in combination with the slope/landform and position in the landscape. It is thus a "natural" situation that these unstable areas are vulnerable to erosion, and little or no pressure on the land is needed to start the development of a badland topography.
In case of mapping unit 25: VC accelerated erosion is obviously

human induced. The presence of permanent water (Ol Arabel river) causes intensified use of the land.

Less severe, but also strongly eroded are the soils on steep land (mapping units 1, 2 and 4: MV, RV and HV). This can be regarded as a "natural" situation rather than a consequence of overutilisation of the range. Soils are shallow, rocky and stony. Bush-fallow cultivation (finger millet, with a rotation frequency of three to five years) is practiced at higher elevations in these units. Advanced sheet erosion is associated with this practice. Soils of the step faulted basalt Plateau of the Rift valley floor (mapping unit 8: LsB2) are equally stony and shallow. These have been rated as "strongly eroded". Moderately and slightly affected are the sedimentary areas of the Piedmont Plains (mapping units 15-20: YV, YP, YX) and Alluvial Plains (mapping unit: 23, A1). Mapping unit 15: YV is locally severely affected by gully erosion, especially towards the north, mainly due to nearness to watercourses.
Frequently desert pavements are encountered where these sedimentary areas are subject to sheet erosion. In these cases a rapid recuperation is hindered due to unfavourable germination conditions.
Also, where erosion cuts into the deeper subsoil, saline-sodic layers come to the surface or in nearer contact with the rooting zone, and thus causing an extra type of soil degradation.

Least affected by erosion are the high-level Uplands (mapping unit 12: UhV1) mainly due to a good vegetation cover in connection with favourable climatic conditions. Least eroded are also the lower-level alluvial areas (mapping unit 24: A2) and mapping unit 17: YV3.

Figure 4 gives the distribution of the ratings contained in Table 2.

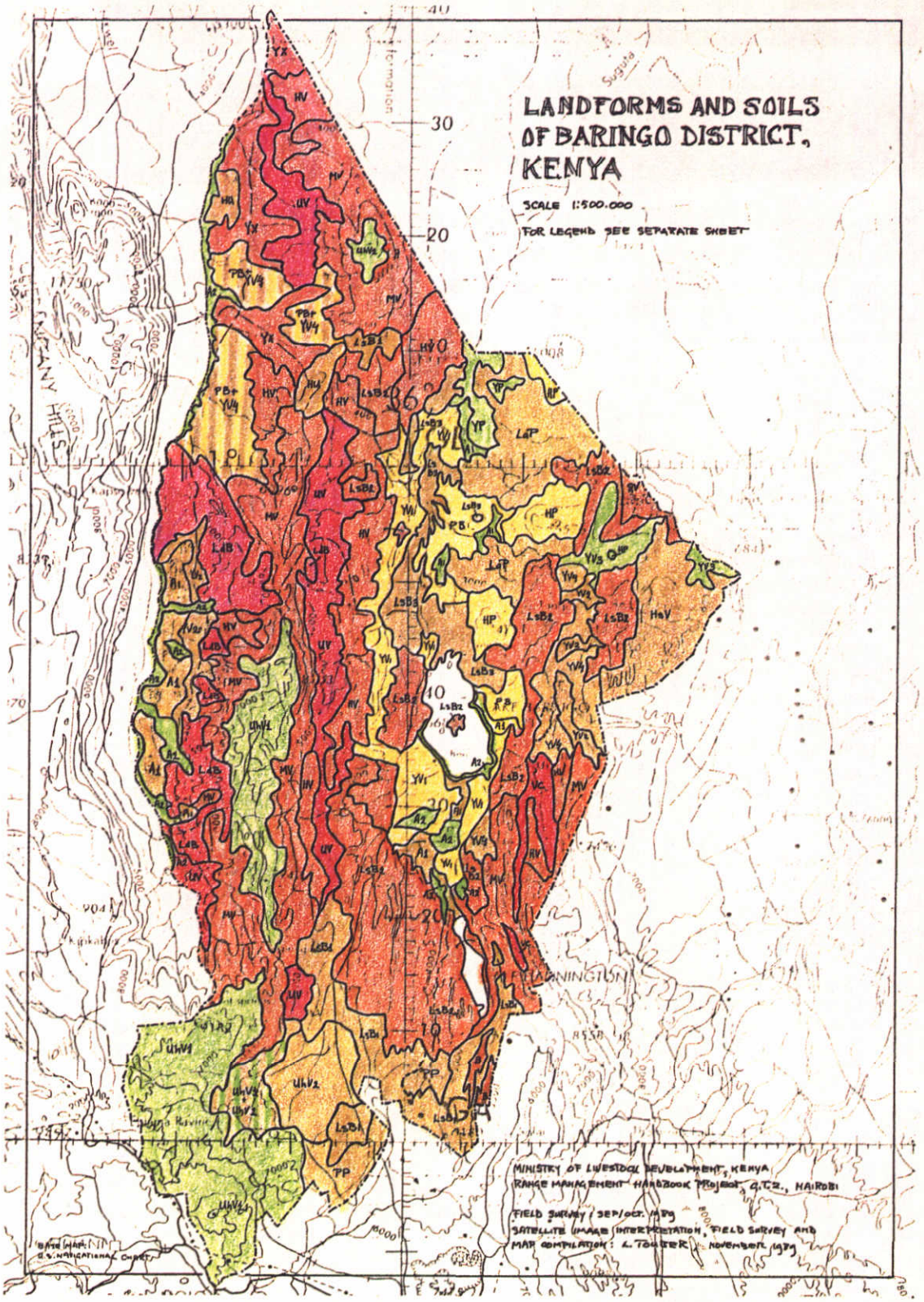

fig 4: STATUS OF EROSION

DISTRIBUTION OF MAP UNIT RATINGS - SEE TABLE 2

- SEVERELY ERODED
- STRONGLY ERODED
- MODERATELY ERODED
- SLIGHTLY - MODERATELY ERODED
- NO EROSION, SLIGHTLY ERODED

Table 2 Ratings of erosion, and possibilities for recuperation of the natural vegetation towards productive grazing.

Unit No.	Mapping Unit	Status of erosion 1: none; 5: extreme		Possibilities for recuperation 1: good; 5: none	Final Rating Present Degradation 1: none, slight; 5: severe
		Sheet	Gully		
1	MV	4	2	3/4	4
2	RV	-	-	-	(4)
3	HU	4	1	2	3
4	HV	4	2	4	4
5	HsV	3/4	1/1	4/3	3/4
6	HP	-	-	-	(2)
7	LsB1	3	1	3	3
8	LsB2	3/3	1/4	4/1	4
9	LsB3	3	1	3	3
10	LdB	5	4	5	5
11	LaP	3/2	1/2	3/2	3/2
12	UhV1	3/1	1/2	1/1	2/1
13	UhV2	3	3	2	3
14	UV	3	5	4	5
15	YV1	3	2/5	2	2/5
16	YV2	4	2	2	3
17	YV3	1	1	2	1
18	YV4	1	3	3	3
19	YP	2	1/4	1	1/3
20	YX	3	4	3	4
21	PB	3	1	2	2
22	PP	4	2	2	3
23	A1	4	2	3	4
24	A2	1	2	1	1
25	B	2	4	4	4
26	VC	4	5	4	5

3.2.5 Accessibility

Limitations in accessibility are determined by steepness of terrain forms and surface ruggedness, due to gullies and/or stones and boulders. Such conditions restrict livestock movements, limiting the daily "action radius" of herds and thus the actually available rangeland.

Apart from such permanent, year round restrictions additional limitations to accessibility are posed during the wet season by flooding/ponding of areas and/or stickiness/muddiness of the surface in certain areas. The ratings for these land characteristics are specified in the volume on methodology.

Results for Baringo District are summarized in Table 3. The first two columns give subratings for steepness and terrain ruggedness. The final ratings express a combination of these, and are specified according to animal type.

Table 3 Map unit ratings of limitations to accessibility.

Unit No.	Mapping Unit	Subrating Constraints due to slope, topography 1: none, slight 5: severe	Subrating Constraints due to surface rocks, stoniness etc. 1: none, slight 5: severe	Final rating Permanent, year round constraints: 1: none, slight 5: severe			Additional wet season constraints -: none 5: severe
				sheep goats	camel	cattle	
1	MV	5	3	3	4	5	-
2	RV	5	4	4	5	5	-
3	HU	3	4	2	3	4	-
4	HV	4	3	2	3	5	-
5	HsV	1/4	2/4	1/2	1/3	2/5	2/-
6	HP	3/1	4/1	3/1	4/1	5/2	-
7	LsB1	1/5	2/4	1/4	1/5	2/5	-
8	LsB2	1/5	2/4	1/4	1/5	2/5	-
9	LsB3	1/3	4	2	3	4	-
10	LdB	2	3	1	2	3	-
11	LaP	4/1	5/1	3/1	4/1	5/1	-
12	UhV1	4/1	3/1	NA	NA	NA	NA
13	UhV2	2	2	NA	NA	NA	NA
14	UV	4	2	2	3	4	-
15	YV1	2	1/2	1	2	2	-
16	YV2	1	1/2	1	1	2	-
17	YV3	1	1	1	1	1	3
18	YV4	1	1	1	1	1	4
19	YP	1/4	1	1	1	1/4	-
20	YX	1/4	1	1	1	2	2/-
21	PB	1	1/4	1	2	2	2/-
22	PP	1	1	1	1	1	-
23	A1	1	1	1	1	1	2
24	A2	1	1	1	1	1	4
25	B	1	1	1	1	1	2
26	VC	4	2	2	3	4	-

Obviously the areas of high relief energy such as mountains, hills and the rift valley escarpment, pose strong restrictions.

To a lesser extent also the uplands are of a limited accessibility. Figure 5 gives these ratings in map form, expressing accessibility for cattle in dry season conditions.

Ratings for additional wet season constraints are contained in the last column of Table 3. Only some units with relative flat topography and heavy clay soils are expected to be inaccessible during the rains. These concern mainly the Piedmont Plains of mapping unit 18: YV4 and alluvial areas with high watertable (mapping unit 24: A2).

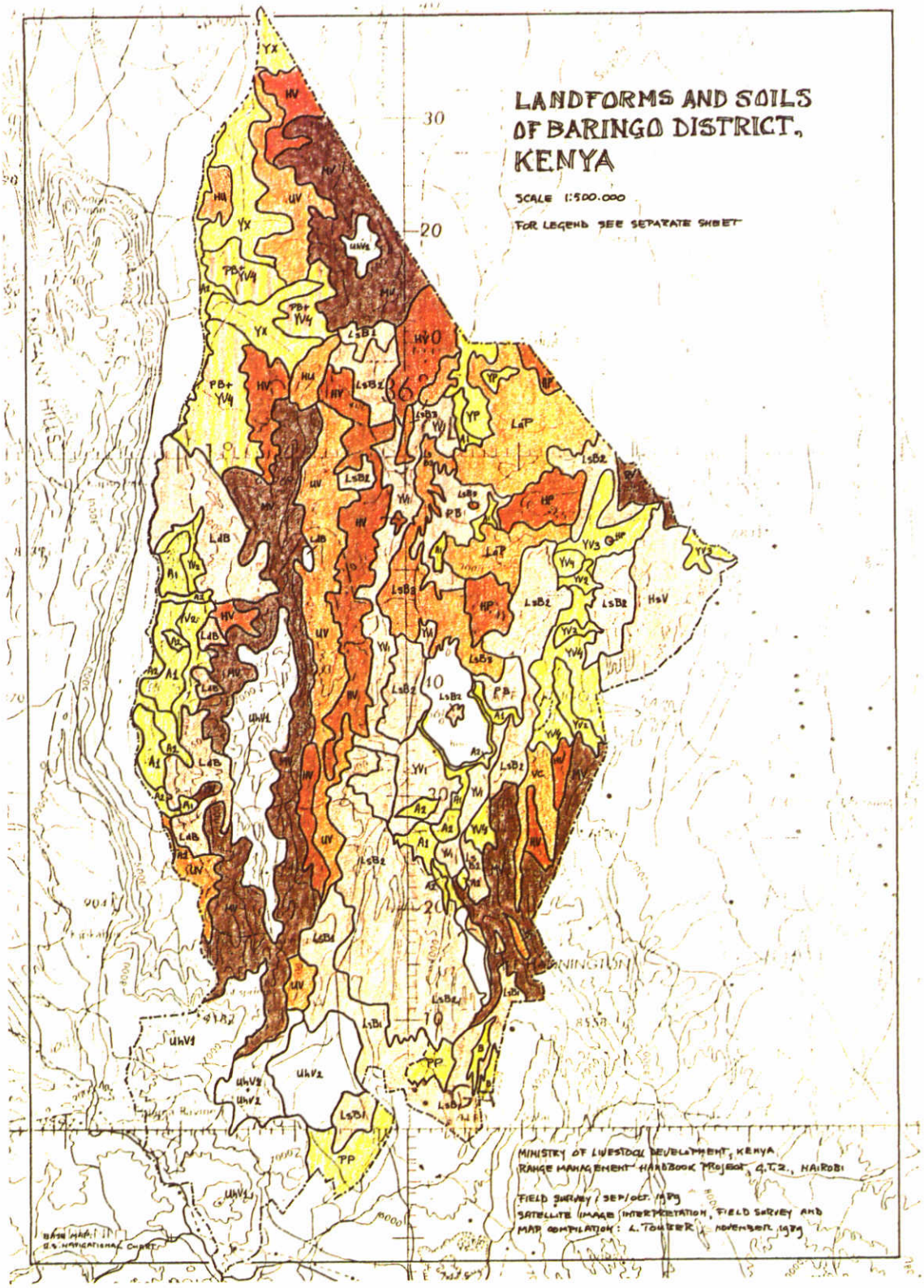

Fig. 5 LIMITATIONS TO ACCESSIBILITY : YEAR-ROUND CONSTRAINTS

DISTRIBUTION OF MAP UNIT RATINGS - SEE TABLE 3

- NO, SLIGHT LIMITATIONS
- SLIGHT LIMITATIONS
- MODERATE LIMITATIONS
- MODERATE-SEVERE LIMITATIONS
- SEVERE LIMITATIONS

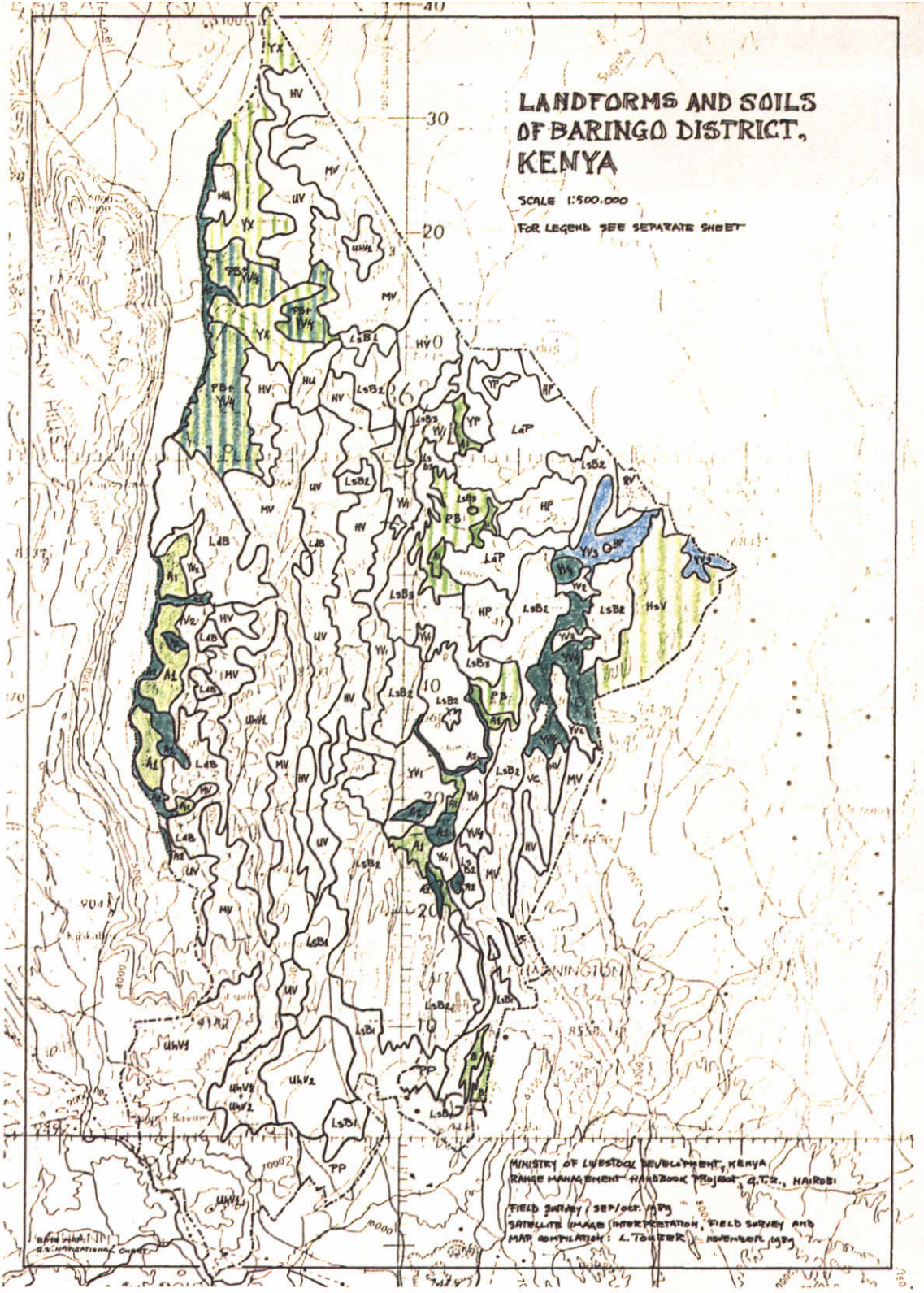

FIG. 6 LIMITATIONS TO ACCESSIBILITY : TEMPORARY WET SEASON CONSTRAINTS IN ADDITION TO PERMANENT, YEAR-ROUND LIMITATIONS - SEE ALSO FIG 5
DISTRIBUTION OF MAP UNIT RATINGS - SEE TABLE 3

NO ADDITIONAL LIMITATIONS

SLIGHT ADDITIONAL LIMITATIONS

MODERATE ADDITIONAL LIMITATIONS

MODERATE - SEVERE ADDITIONAL LIMITATIONS

3.2.6 Possibilities for the construction of dams and waterpans

Landforms and soils are compared in respect of the opportunity for the collection of surface water in pans and dams. Such possibilities are largely contained in the landcharacteristics slope length and steepness, the density of the drainage network and permeability of the subsoil. Factors as rainfall evaporation, availability of construction material and the abilities of the local people to maintain these constructions, are not considered here.

Unfavourable conditions for such constructions prevail in mapping units 1-3: MV, RV and HV, due to steepness of the terrain. Permeability of the subsoil is probably a limitation in units 4: HV and 14: UV. In the case of dark coloured heavy cracking clay soils, such as prevail in units 17 and 18: YV3 and YV4 construction of dams and pans may not be feasible due to swell-shrink properties of the clay. Strong sodicity of the deeper subsoil, as is suspected in the units 15: YV1 (locally) and 23 and 24: A1 and A2, will render such constructions very unstable.
All other units seem to have no major constraints, except that in most cases only a very thin soil mantle is present. This may digging impossible and/or the transport of materials from elsewhere necessary.

4 MAPPING UNIT DESCRIPTIONS

Mapping Unit 1: **MV**

Surface area:
Landform, relief: Mountains and major escarpments; very steep, regular and irregular very long slopes.
Altitude range: approx. 1200-2200 m (4000-7000 ft).
Rock type, soil parent material: Older volcanic rocks; basalts, ashes, tuffs.
Soils: Well drained, very shallow, friable clay loam of varying colour, over deeply weathered rock. Generally very gravelly and stony at the surface; in places humic topsoil.
Productive capacity: (given the climatic zone) low, due to general shallowness and gravelliness of the soil. Locally high, where humic topsoils prevail.
Erosion status and hazard: Sheet erosion and to a certain extent gully erosion has resulted in the widespread densely packed gravelly surface layer over weathered rock (associated with bush-fallow cultivation). Extreme gully erosion is locally found on the lower slopes.
Erosion hazard is high, mainly due to the prevailing steep to very steep slopes.
Accessibility: Strongly reduced due to slope steepness.
Observations: 25, 26, 33, 38, 39, 48.

Mapping Unit 2: **RV**

Landform, relief: Footridges of Llerogi plateau, Loros plateau. Steep V formed valleys, with slopes of over 50%, and numerous small, broken and tilted plateau remnants.
Rock type, soil parent material: Mainly volcanic rocks, undifferentiated.
Soils: Shallow bouldery and stony soils.
Productive capacity: Soils with moderate mineral reserve, and good soil-water relationships, where original forest soil is present.
Status of erosion: No clear signs of accelerated erosion. Top soil degradation is obvious where original forest disappeared.
Erosion hazard: Severe erosion is inevitable after removal of the original vegetation.
Accessibility: Severe restrictions for all stock in the majority of the unit.

Mapping Unit 3: **HU**

Surface area:
Landform, relief: Hills of moderate to steep, irregular and straight slopes.
Altitude range: Approx. 1100-1300 m (3500-4500 ft).
Rocktype, soil parent material: Undifferentiated Basement System rocks, predominantly gneisses.
Soils: Well drained, shallow, rocky and stony sandy clay loams of various colour and consistence; locally over deeply weathered rock; locally with humus-rich topsoils.
Productive capacity: Moderate to low, due to low moisture storage capacity and low do moderate chemical soil fertility.
Status of erosion: (no observations).
Erosion hazard: The steep topography makes this land vulnerable for erosion.
Accessibility: Moderate to low, due to steepness of topography, and local rockiness of the surface.
Observations: None; information inferred from similar landforms elsewhere.

Mapping Unit 4: **HV**

Surface area:
Landform, relief: Hills and hill ranges of steep, straight, moderately long slopes. The area is characterized by a dense drainage network.
Altitude range:appr. 1100-1400 m (3500-4500 ft).
Rock type, soil parent material: mainly ashes, tuffs and other half- or unconsolidated volcanic materials, interbedded with thin basalt layers.
Soils: well drained, very shallow, friable, yellowish brown to yellow red stony and gravelly loam or silty clay loam and rock outcrops.
Productive capacity: Low, due to the generally very thin and stony soil mantle.
Erosion status/hazard: Moderate to severe sheet erosion and locally in downslope position gully erosion. This erosion status is inherent to both relief (steepness) and soil parent material (unconsidered rock type).
Accessibility: Moderate to severe restrictions due to steepness of the relief.
Observations: 44, 51, 63.

Mapping Unit 5: **HsV**

Surface area:
Landform, relief: Step-faulted hill ranges. Steep, convex slopes alternating with (gently) undulating "steps" in a N-S oriented pattern (Rift faulting).

Altitude range: Approx. 1500-1900 m (5000-6500 ft).
Rock type, soil parent material: Undifferentiated volcanic rocks, mainly basaltic.
Soils: Association of:

1. moderately well drained, shallow to moderately deep, friable, yellowish brown, gravelly light clay to gravelly, fine sandy clay loam, locally with a humus-rich topsoil (on gently undulating "steps").
2. well drained, exceedingly stony and rocky areas with pockets of shallow, yellowish brown, loamy soils (on steep, convex slopes).

Productive capacity: Moderate on the gently undulating areas, due to mainly shallowness and gravellyness of the soils. Locally, productive capacity is high where soils are deeper, contain more humus and are less well drained. The steeper slopes have a naturally low vegetation cover due to the stony and bouldery character of the area.
Erosion status, hazard: The end-stage of erosion has been reached over most of the steeper areas, as a natural consequence of the relief. The well drained gently sloping parts of the "steps" suffer a widespread sheet erosion that has resulted in the present gravelly shallow soils. The fragile friable soil material seems easily detachable by rain splash impact.
Accessibility: Moderate to severe constraints in the steeper parts of this unit.
Observations: 86, 87, 88, 89.

Note: There is a noticeable gradient in climate and hence soil quality, travelling in a West-East direction: the soils tend to be richer in humus content in each higher "step". At the highest level pockets of colluviated areas can be found with less well drained, clayey soils (Acacia gerardii wooded grassland) of high productive capacity.

Mapping Unit 6: **HP**

Surface area:
Landform, relief: Volcanoes, cone shaped hills; overall slope moderate, locally step-faulted; locally terraced due to lavaflow sequences; locally smooth slopes of ash deposits.
Altitude range: Approx. 900-1500 m (3000-5000 ft).
Rock type, soil parent material: Recent basalts (lavaflows), partly covered by pyroclastic material and ashes.
Soils: Complex of rock outcrops and somewhat exessively drained fine-gravelly sandy clay loams: soils comparable to those of mapping unit 11: LaP, except for a higher humus content in the topsoils.

Productive capacity: Within this climatic zone these soils are (apart from the rock outcrops) of a comparatively high productivity due to fair soil moisture storage, good infiltration capacity and high soil fertility.
Erosion status and hazard: (no observations). Along major tracks soils may be deeply gullied. Erosion hazard depends largely on the soil texture (coarseness of pyroclastic material) and slope, but is estimated as generally low.
Accessibility: Moderate restrictions due to local steep slopes and rugged rocky terrain.
Observations: None. Information inferred from Satellite Image Interpretation and knowledge of similar landforms elsewhere.

Mapping Unit 7: **LsB1**

Surface area:
Landform, relief: Step-faulted plateau of gentle, straight slopes and gently undulating relief, alternating with steep short slopes and minor escarpments, in a N-S-oriented pattern (Rift faulting).
Altitude range: Approx. 1500-1800 m (5000-6000 ft).
Rock type, soil parent material: Older volcanic rocks, mainly Basalts and Phonolites.
Soils: Association of:

1. Well drained, very shallow, friable, yellowish red and yellowish brown, very to extremely gravelly and stony clay loam.
2. Well to moderately well drained, deep, friable, yellowish red clay loam (depressional areas; approx. 15-20% of the unit area).
3. Rock outcrops (escarpments).

Productive capacity: Low, on all three components, either due to rockiness, stoniness and shallowness or, in case of the deeper colluviated soils, because of erosion.
Erosion status/hazard: The shallow soils of the 1st component offer little soil material to be eroded. The deeper soils of the depressional areas (in fact tilted, formerly flat, bottomlands) are generally under attack of sheet erosion, depending on the slope %, and suffer heavy gully erosion in some places. The capacity of the vegetation to recover is high, however. Reseading and conservation practices tend to be successful in these deeper soils of the depressional areas.
Accessibility: Locally severe restrictions due to the rocky cliffs of the faultlines.
Observations: 10, 11, 12, 13A, 13B, 15, 22, 23, 54, 109.

Mapping Unit 8: **LsB2**

Surface area:
Landform, relief: Step-faulted Plateau of gently undulating relief, broken by minor escarpments and cliffs (Rift faulting) in a N-S oriented pattern.
Altitude range: 1000-1500 m (3500-5000 ft).
Rock type, soil parent material: (older) volcanic rocks, mainly basalts and phonolites.
Soils: Association of:

1. Well drained extremely shallow, exceedlingly stony and rocky soils
2. Well drained, very deep, friable, dark reddish brown clay loam to clay, locally slightly saline.
   The surface with shallow rocky soil exceeds the area of deep soils at an approximate rate of 85-15%.

Productive capacity: Low to very low due to the prevailing rockiness and stoniness of the area. The "bottomlands" with deep soils are potentially productive.
Erosion status/hazard: The major part of the area consists of surface rocks, stones and gravel from which there is little to be eroded.
In the bottomlands sheet erosion is an imminent process, while locally severe gully erosion removes the soils at a fast rate.
Accessibility: Moderate restrictions due to local minor escarpments and stoniness of the surface.
Observations: 18, 19, 20, 21, 30, 31, (45), 52, 53, 84, 85, 91, 98, 99, 107, 108.

Mapping Unit 9: **LsB3**

Surface area:
Landform, relief: Step-faulted basalt plateau; escarpments of faultlines and irregularly indulating mesotopography of sub-recent lavaflows.
Altitude range: 800-1000 m (200-3200 ft).
Rock type, soil parent material: Quaternary, (sub-recent) basalts.
Soils: Association of:

1. Rock outcrops and very shallow extremely gravelly, stony and bouldery clay loam;
2. Local depressions with moderately well drained, shallow, gravelly clay loam soils, that are locally saline and sodic.

Productive capacity: Very low water holding capacity due to shallowness and gravelliness; moderate chemical fertility; local salinity. The 2nd component has a degraded topsoil.
Erosion status: By its nature and origin these "young" areas have very shallow soils. On the rocky component there is little to be eroded. The local depressions show signs of slight sheet erosion.

Accessibility: Moderate, to locally severe restrictions, due to the ruggedness of the stony and rocky surface.
Observations: 41, 42, 79, 80, 81, 82, (84), (85).

Mapping Unit 10: **LdB**

Surface area:
Landform, relief: Sloping (tilted) plateau, dissected by steep, ravine-like valleys. Overall slope 5-12%.
Altitude range: Approx 1250-2000 m (4000-6500 ft).
Rock type, soil parent material: Older volcanic rocks; basalts.
Soils: Rock outcrops and patchy shallow remnants of a well drained (once deep?) friable, dark reddish brown, clay loam.
Productive capacity: Extremely low, due to prevailing denuded rock.
Erosion status/hazard: End-stage of sheet and gully erosion: the probably once deep and productive soil has been eroded away almost completely.
Accessibility: Moderate restrictions for cattle due to roughness of the surface.
Observations: 28, (34), 76.

Mapping Unit 11: **LaP**

Surface area:
Landform, relief: Lavaflows of locally extremely irregular mesotopography, or with "terraced" topography due to infills of volcanic ashes.
Altitude range: 750-1000 m (2500-3200 ft).
Rock type, soil parent material: Recent basalts, partly covered by volcanic ashes and pyroclistic rocks.
Soils: Association of [1] rock outcrops and [2] well drained fine gravelly ash soils of varying depth (soils as in mapping unit 18: YP).
Productive capacity: Very low (on rock outcrops) and moderate to high (on volcanic ash soils), due to moderate to high waterholding capacity, high soil chemical fertility and fair topsoil conditions.
Erosion status/hazard: Probably locally gully development, to a limited extent. In general soils of high infiltration capacity and resistance to erosion.
Accessibility: Moderate to severe restrictions locally, due to lava outcrops.
Observations: None, information inferred from satellite image interpretation.

Mapping Unit 12: **UhV1**

Surface area:
Landform, relief: High level Uplands. Undulating and locally hilly relief; short to moderately long slopes of varying steepness.
Altitude range: 1750-2500 m (5500-8500 ft).
Rock type, soil parent material: Tertiary volcanic rocks, mainly Basalts.
Soils: Complex of:

1. Shallow gravelly soils of varying texture, over rock, or over deeply weathered material (on steeper slopes).
2. Friable, dark reddish brown to dusky red, light clay, of varying drainage and depth, with a topsoil, rich in organic matter.

Productive capacity: High, mainly du to climatic conditions. As to the livestock sector, this land is suited for dairy cattle in mixed farming systems.
Erosion status/hazard: Very low due to good infiltration capacity, as a consequence of good vegetation cover and high organic matter content, as well as the stable character of the soil material.
Accessibility: N.A.
Observations: (6), (7).

Mapping Unit 13: **UhV2**

Surface area:
Landform, relief: High level uplands, gently undulating, slopes of various steepness and length.
Altitude range: 1500-1800 m (5000-6000 ft).
Rock type, soil parent material: Tertiary volcanic rocks, mainly basalts.
Soils: Complex of soils of various depth, colour, rockiness and stoniness, mainly moderately deep, friable, dark red clay to clay loam.
Productive capacity: Due to climatic conditions agriculturally marginal land, but high potential for livestock where erosion has not degraded the land severely.
Erosion status/hazard: Much sheet and gully erosion has been observed locally. The shallow gravelly soils and rock outcrops are the result of on-going erosion. However, the rather fragile soil material allows a fast recuperation of the vegetation cover.
Accessibility: N.A.
Observations: 4, 5, (6), (7), 109.

Mapping Unit 14: **UV**

Surface area:
Landform, relief: Undulating Uplands at the base of the Tugen hills. Intricately dissected with short steep slopes. Locally badland topography.
Altitude range: 1000-1400 m (3200-4500 ft).
Rock type, soil parent material: Tertiary ash deposits, lake bed deposits, pyroclastic rocks and thin basalt flows.
Soils: Well drained, very shallow, very gravelly clay loam. Locally remnants of dark toned, stony clay.
Productive capacity: The majority of the land surface consists of unconsolidated gravelly, ashy and stony material of very low productive capacity.
Erosion status/hazard: Very badly to extremely eroded land, especially in the southern region of the unit.
Accessibility: Moderate restrictions, due to gullied topography.
Observations: 24, 27, 32, 44, 64, 65.

Mapping Unit 15: **YV1**

Surface area:
Landform, topography: Piedmont Plain: gently sloping to almost flat overall topography. In many areas undulating mesotopography or badland due to gullying.
Altitude range: 900-1200 m (3000-4000 ft).
Rock type, soil parent material: Alluvial deposits, coarse and fine, derived from volcanic rocks (basalts, ashes, older lake bed deposits: mainly units HV and UV).
Soils: Well drained, very deep, very friable, calcareous, very fine sandy loam to silty clay; in places gravelly; in places saline in the deeper subsoil.
Productive capacity: Moderate to high, due to good soil-water storage and infiltration capacity and high soil fertility.
Erosion status/hazard: Sheet and gully erosion is widespread and imminent. The loose, friable soil material is susceptible to rainsplash impact. On the other hand vegetation can recuperate fast on these soils, as long as a gravel pavement has not formed yet.
Accessibility: Moderate restrictions in badly gullied areas.
Observations: 1, 3, 16, (29), 43, 46, 50, (55), 56, 57, (58).

Mapping Unit 16: **YV2**

Surface area:
Landform, topography: Piedmont Plain: long, gentle slopes, locally undulating mesotopography due to erosional processes.

Altitude range: 1000-1200 m (3200-4000 ft).
Rock type, soil parent material: Alluvial sediments, derived from volcanic rocks.
Soils: Well drained to moderately well drained very deep, friable, yellowish brown to strong brown, gravelly clay to clay loam; in (eroded) places exceedingly gravelly and stony.
Productive capacity: High, due to good moisture storage properties and humic topsoil conditions. However, a large part of the unit suffers bad sheet erosion, and has a concentrated layer of stones and gravel at or near the surface.
Erosion status/hazard: Soils are susceptible to rainsplash impact. Sheet erosion is widespread and in many places advanced. Around Mukutan strong gully erosion.
Accessibility: No restrictions.
Observations: 97, (100), 102, (104), 105.

Mapping Unit 17: **YV3**

Surface area:
Landform, topography: Piedmont Plain: long gentle slopes.
Altitude range: 1400-1800 m (4500-6000 ft).
Rock type, soil parent material: Alluvial and colluvial sediments, derived from undifferentiated volcanic rocks.
Soils: imperfectly drained, very deep, very firm, very dark greyish brown, calcareous cracking clay, locally calcareous in the deeper subsoil.
Productive capacity: High, due to good soil moisture storage capacity and soil fertility.
Erosion status/hazard: Locally bad gully erosion (in Amayo-neighbourhood). This soil type is sensitive to gully development.
Accessibility: Moderate restrictions in the wet season due to stickiness of the surface.
Observations: 90, 90A, 92, 95, 96.

Mapping Unit 18: **YV4**

Surface area:
Landform, topography: Piedmont Plain: long gentle slopes; locally incised river courses.
Altitude range: 1000-1400 m (3200-4500 ft).
Rock type, soil parent material: Alluvial and colluvial sediments derived from undifferentiated volcanic rocks.
Soils: Complex of:

1. Imperfectly drained, deep, very firm, dark greyish brown and dark reddish brown, calcareous, (cracking) clay, locally saline in the deeper subsoil.

2. Moderately well drained, moderately deep shallow, friable, greyish brown to yellowish brown calcareous clay to clay loam, mostly saline and sodic.

Productive capacity: Moderate to low, due to problematic soil-water relationships and saline-sodic conditions.

Erosion status/hazard: Locally deep gully erosion, especially in zones bordering stream courses. The second soil component is derived from the first as a result of erosion.

Accessibility: Moderate to severe restrictions in the wet season due to stickyness of the surface.

Observations: 74, 77, 103, (104).

Mapping Unit 19: **YP**

Surface area:

Landform, topography: Piedmont Plain. Long gentle slopes, partly terraced due to underlying lavaflows. Locally badland topography.

Altitude range: 800-900 m (2500-3000 ft).

Rock type, soil parent material: Subrecent volcanic ashes, partly redeposited by alluvial processes

Soils: Well drained, very deep, very friable, strong brown (calcareous) fine-gravelly coarse sandy clay loam.

Productive capacity: High, due to favourable infiltration, moisture storage and high chemical fertility.

Erosion status/hazard: Locally the area shows a badland topography. However, these concern stabilized gullies. Sheetwash erosion is widespread, in spite of the good infiltration.

Accessibility: No restrictions.

Observations:(58), 59, 60.

Mapping Unit 20: **YX**

Surface area:

Landform, relief: Piedmont Plain, partly dissected peneplain: Long, gentle slopes and gently undulating topography.

Altitude range: 900-1100 m (3000-3500 ft).

Rock type, soil parent material: Basement System rocks and colluvium and alluvium derived from both Basement System rocks and volcanic rocks, and sandstones (Turkana grit).

Soils: Moderately well drained, deep, friable to firm, dark greyish brown calcareous, saline and sodic; clay loam to clay and well drained, shallow, yellowish red, coarse sandy clay loam (over Basement System rock and sandstone).

Productive capacity: Low, on the first component due to salinity/sodicity; on the second component due to shallowness of the soil.

Erosion status/hazard: The unit is largely affected by moderate to severe gully erosion especially in the neighbourhood of river incisions.

Accessibility: Slight restrictions due to gullying. Locally restrictions in the wet season due to stickyness of the surface.
Observations: 69, 71, 73, (77).

Mapping Unit 21: **PB**

Surface area:
Landform, topography: Volcanic Plain, almost flat, with locally irregular mesotopography of (sub)recent Basalt flow structures.
Altitude range:800-900 m (2500-3000 ft).
Rock type, soil parent material:
Soils: Association of:
1. (mod) well drained, shallow to moderately deep, friable, yellowish red to yellowish brown clay loam to clay, in places gravelly and stony.
2. shallow rock outcrops and very stony shallow soils.

Productive capacity: Low. The somewhat deeper clay loam soils have a higher waterholding capacity. Management practices (reseeding) are only viable on this component of the association.
Erosion status/hazard: Slight to moderate sheet erosion is observed. Due to the generally flat or slightly terraced topography, erosion hazard is low.
Accessibility: Locally slight constraints on rocky areas. In the wet season restrictions of short duration.
Observations: 62, (79).

Mapping Unit 22: **PP**

Surface area:
Landform, topography: Almost flat to gently undulating Volcanic Plain; locally deeply incised river courses.
Altitude range: 1500-1700 m (5000-5500 ft).
Rock type, soil parent material: Bedded volcanic ash deposits.
Soils: Well drained, deep, friable, (dark) greyish brown, stratified fine gravelly sandy loam.
Productive capacity: High (if in non-degraded condition), due to good infiltration and waterholding capacity and high natural fertility level.
Erosion status/hazard: Overutilisation has led to strong sealing and sheetwash, especially along river courses (Molo river). It is espected that the vegetation cover on these soils can recuperate rather easily.
Accessibility: No constraints.

Mapping Unit 23: **A1**

Surface area:
Landform, topography: Almost flat alluvial plain, locally undulating mesotopography due to erosion.
Altitude range: 900-1000 m (3000-3200 m).
Rock type, soil parent material: Subrecent alluvium derived from volcanic rocks.
Soils: Well-moderately well drained very deep friable and compact locally stratified soils of various texture and degrees of salinity and sodicity.
Productive capacity: High, as far as the soils are not heavily eroded.
Erosion status/hazard: Over considerable areas sheet wash has eroded over 50 cm of soil, locally leaving previously deep salinity at or near to the surfrace.
Accessibility: Restrictions only temporary during heavy rainfall.
Observations: 17, 83.

Mapping Unit 24: **A2**

Surface area:
Landform, relief: Alluvial plain of almost flat topography.
Altitude range: 900-1000 m (3000-3200 ft).
Rock type, soil parent material: Alluvial sediments derived from volcanic rocks.
Soils: Very deep stratified soils of various drainage, condition, colour and texture, mainly with relatively high organic matter content. In places saline and sodic.
Productive capacity: High, due to generally good topsoil conditions: high organic matter content, and chemically rich parent material (recent alluvial sediments).
Erosion status/hazard: Locally some sheet and gully erosion. No high hazard due to generally flat relief.
Accessibility: Restrictions may locally occur in the wet season. Along the Kerio river some flooding hazard is reported.
Observations: 2, 35, (37), 72.

Mapping Unit 25: **B**

Surface area:
Landform, topography: Almost flat Bottomland, locally terraced by erosional processes.
Altitude range: 1500 m (5000 ft).
Rock type, soil parent material: Sediments derived from volcanic ashes and other volcanic material.
Soils: Moderately well drained, very deep, friable and "smeary" clay loam.

Productive capacity: Salinity and poor physical properties make these soil of very low waterholding capacity: the vegetation is reportedly drying out very soon after the rains.
Erosion status/hazard: Locally badly affected by sheetwash and gully erosion.
Accessibility: No restrictions.
Observations: 14.

Mapping Unit 26: **VC**

Surface area:
Landform, topography: Valley complex of various small Upland- and Footslope-like landforms. Mostly short slopes of various steepness. On many places badland topography in former footslopes.
Altitude range: 1200-1600 m (4000-5200 ft).
Rock type, soil parent material: Undifferentiated volcanic rocks and sediments derived from these.
Soils: Association complex of:

1. Dark toned clay soils of varying depth, stoniness and salinity (on the Upland-like component).
2. Deep reddish brown silty clay loam and deep dark greyish brown cracking clay, mostly strongly gullied, transported and redeposited (in the Footslope - like component).

Productive capacity: Moderate to high (as far as erosion has not destroyed the area). Soils that are less affected by erosion have generally good physical and chemical properties.
Erosion status/hazard: An estimated 50% of the area is moderately to extremely affected by gully erosion, by sheet erosion, and by redeposition of soil material eroded up-slope.
Accessibility: Restrictions are moderate to severe, due to deeply entrenched erosion gullies.
Observations: 49.

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ANNEX I

Mission Report

CONTENTS OF ANNEX I

ACKNOWLEDGEMENTS

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Of great assistance was the Catholic Mission in Kositei, notably Father Seán McGovern, for providing much appreciated hospitality; for lending us the latest updated 1 : 50.000 scale topographic maps; and for providing us with general information on the area.

We are equally grateful for hospitality received from the Catholic Mission in Parbelo.

Finally I want to thank also Mr. Baraza, Regional Centre for Mapping, Surveying and Remote Sensing, Nairobi, for his swift action taken in the provision of satellite imagery for our survey.

1 INTRODUCTION

The GTZ-funded Range Management Handbook Project aims at the inventory of the natural resources of the arid and semi-arid lands of Kenya, and the interpretation of these data in terms of recommendations for sustained forms of range land use. Results will be presented in the form of reports and maps at a 1:1M scale for each district separately. These are to be used by the Ministry of Livestock Development for both planning at ministerial level, as well as a first orientation for extension officers at district location or grazing block level.

The study is essentially a multidisciplinary one, in which are engaged a climatologist; a vegetation/range ecologist; a landforms/soils specialist; a hydrologist and a livestock agronomist.

The project started in 1986 and will be on-going to at least December 1991. Of the nine districts concerned, so far the surveys of Marsabit, Wajir, Mandera and Samburu Districts, have been completed.

The Winand Staring Centre participates in the project by providing the expertise for the landforms and soils inventory and for its interpretation in terms of productive capacity of rangelands and limitations to range land use.

The consultant travelled to Kenya on 15 September 1989. Initially it was intended to start the survey of Garissa District. However, due to logistical problems connected with security hazards, it was decided to postpone the Garissa survey and proceed to implement the Baringo and West-Pokot Districts surveys. Actual fieldwork in Baringo took place between September 25th and October 20th, 1989. The West-Pokot District appeared to be twice the size as it is indicated on available topographic maps, so that this areas merits a separate survey mission.

Due to the relative small size of Baringo District, the Ministry of Livestock Development opted for the presentation at a 1 : 500.000 scale. Technically speaking, this implies a fourfold intensity of survey work compared to the 1 : 1.000.000 scale presentation. In the case of Baringo District, this is all the more necessary due to its intricate pattern of highly variable landforms, rock types, soils and vegetation.

The present report covers the fourth consultancy to the Range Management Handbook Project. Annex II contains the Itinerary; Annex III the Terms of Reference.

2 ACHIEVEMENTS AND CONSTRAINTS OF THE WAJIR DISTRICT SURVEY

2.1 Survey preparation

In field surveys of lare areas for which only a short time period is available (15.000 km² in four weeks time in the present case), the interpretation of remote sensing material is of crucial importance. Prior to field survey, a few days were spent on the production of an interpretation map at scale 1 : 500.000 of the whole District. Twenty different interpretation mapping units were identified with the help of 1 : 500.000 scale Landsat Images (1976). A base map was kindly provided by the Kenya Soil Survey. The whole area is geologically surveyed. These surveys provide very valuable information in addition to the Exploratory Soil Map of Kenya at scale 1 : 1.000.000 by Sombroek et al. (1982). Further, a number of detailed surveys, mainly for irrigation schemes in the "Njemps Flats" area is available. The district is, and has been, the area of a number of projects dealing with rehabilitation of rangeland. All relevant literature is listed in Volume II, last pages.

A copy of the Satellite Image Interpretation Map was provided to each of the participating consultants prior to the field survey.

In view of the envisaged output, being a landforms and soils map at a scale of 1 : 500.000, some drawbacks were experienced. It is generally recommendable to work at a preliminary "field-work" scale that is twice the final scale of publication. Thus, in the case of the present survey, it is preferred to work at a scale of 1 : 250.000 in the preparatory stage. However, the necessary materials (transparant topographic base maps at 1 : 250.000 scale) were not available within the consultancy time, due to the hasty improvised change of survey area (see Introduction).

The planning and plotting of observation points along roads and motorable tracks in areas representative of satellite image interpretation units, is another essential part of fieldwork preparation. For this, one obviously needs up to date topographic maps in combination with recent and sufficiently detailed satellite imagery, especially in the case of Baringo District. The available set of 1 : 250.000 scale topographic maps are largely outdated and show unreliable relief data. The incidental provision by the Catholic Mission of Kositei of 1 : 50.000 scale topographic sheets (1983) came as a god-send. The satellite imagery available (landsat MSS, January 1976, at scale 1 : 500.000) is in its sort of excellent quality, but for the present purposes does not have sufficient detail, and is outdated in view of

the highly intensified road network in recent years.
It is regrettable that Landsat Thematic Mapper images, which provide an image resolution that makes them suitable for scales of 1 : 250.000 and larger, seem to be available only in the near future at the Regional Centre for Mapping Surveying and Remote Sensing in Nairobi. These images provide also more up to date information on the accessibility of the survey area.

2.2 Field survey

During the field visit, the survey team consisted of the vegetation/range ecologist (Dr. Herlocker), the landform/soils specialist (Touber) and the hydrologist (Dr. Bake).

Field checks were located at points identified beforehand as representative according to the satellite image interpretation map. The vegetation scientist and soil surveyor conducted their observations simultaneously at the same sites. Soil and landform characteristics that play a role in the performance of rangeland were recorded, i.e. topography, steepness, drainage condition, soil moisture availability, rooting space, degree of surface sealing, signs of rainwater run-off, flooding, ponding, humus content of the top soil, calcareousness, salinity (at three standard depths), soil consistence and texture. At most of the sites soil fertility samples were taken. These were delivered at the N.A.L. for "Mehlig" analysis, i.e. major nutrients, carbon content, pH and salinity.

The cooperation with the vegetation surveyor proved very fruitful. A good correlation between the landforms/soils map and the vegetation map was ensured.

Field survey took place from September 25th to October 20th.

Some areas in the North of the District are not covered sufficiently by field survey, due to a limited accessibility. In spite of the rainy season, road conditions did not hinder the progress of the survey, mainly due to the areas conditions of rapid drainage.

2.3 Map and report preparation

During the last days of October all field data were put together on the basis of which twenty five units were identified. These have been presented on a 1 : 500.000 scale map with legend for publication in the handbook.

The rather intricate pattern of land elements within major landforms in Baringo District are the cause that mapping units

are of a complex nature at this small scale. As it is hard to distill a major component within these complex units, reliability is at stake. Thus, the need of more detailed fieldwork is felt (for publication at 1 : 500.000), or, alternatively, publication at a 1 : 1.000.000 scale, as this allows for broader generalisations.

Finalisation of the complete technical report materialized in November 1989, Wageningen. This report is contained as Volume II of the present publication.

ANNEX II Itinerary

14 September	Departure Amsterdam-Frankfurt-Nairobi via LH3207 and LH588.
15 September	Arrival Nairobi. Meeting with Kenya Soil Survey. Obtain equipment and transparent base map Garissa District. Purchase supplies.
16-17 September	Interpretation sattelite imagery Garissa District. Complement Topographic maps with Amoco exploration lines. Load vehicle.
18 September	Meeting with GTZ administration. Visit KSS library. Obtain prints of interpretation map Garissa District.
19 September	Travel Nairobi-Garissa by plane. Survey flight over Southern Garissa.
20 September	Meeting with District Livestock development officer, Mr. A. Tifow. Meeting with Mr. Murage, Ministry of Transport and Communication. Meeting with District Officer, Garissa, called off. Decision to postpone Garissa District survey.
21 September	Travel Garissa-Nairobi by road. Visit Regional Centre for Mapping, Surveying and Remote Sensing ("Remote Sensing Centre") to obtain satellite images, for Baringo and W. Pokot Districts. Report to GTZ office.
22 September	Meeting with RMHP team members and team coordinator Mr. Shabaani, Min. of Livestock Dev. HQ. on arrangements for Baringo and W. Pokot districts surveys. Brief Mr. Wokabi, acting head, Kenya Soil Survey, on situation. Obtain transparent topographic base map for Baringo and W. Pokot districts from KSS cartography dept. Collect soil survey reports on survey area. Start satellite image interpretation.
23-24 September	Satellite image interpretation Baringo and W. Pokot districts.
25 September	Obtain ozalith prints of interpretation map at KSS. Meeting with RMHP team at Min. of Livestock Development HQ. Visit Remote Sensing Centre. Meeting with GTZ administration. Load vehicles.
26 September	Purchase satellite imagery at Remote Sensing Centre. Travel Nairobi-Nakuru-Kabarnet. Meeting with Mr. Obiero, Deputy Livestock Dev. Officer.
27 September	Meet Mr. P.P. Olando, D.O.1, Kabarnet. Meet Messr. Lagat and Labat, assistant range officers in Marigat. Start field observations.
28 September-5 October	Conduct fieldtrips from Marigat base camp, Southern Baringo District.

6-7 October	Travel to Kapenguria, West-Pokot. Discover that size of W. Pokot District is twice as indicated on topomaps. Decision to finalize Baringo District Survey. Return to Marigat.
8 October	Resume field survey from Marigat base camp.
9 October	Shift base camp from Marigat to Chemolingos. Meet Dr. Ngugi, veterenary officer. Settle at Catholic Mission, Kositei. Meet Mr. Wesley Tomno, District Officer, Nginyang Division.
10-15 October	Conduct field checks from Kositei base camp, to cover Northwestern Baringo District.
16 October	Shift base camp from Kositei to Tangulbei. Conduct field checks along Loruk-Tangulbei road. Meet D.O. Tangulbei Division Mr. Joseph Imbwaga.
17-19 October	Conduct field checks from Tangulbei base camp; travel to Marigat.
20 October	Conduct field checks from Marigat; travel to Nairobi.
21-22 October	Sort out equipment and samples - start re-interpretation of satellite images.
23 October	Return soil survey equipment to Kenya Soil Survey. Deliver soil samples to laboratory. Meet Mr. Wokabi. Meet team members at GTZ office.
24 October	Accounts petty cash at GTZ office. Map and legend preparation.
25 October-1 November	Map and legend preparation; map unit descriptions. Visit library KSS and WRAP.
30 October	Discussions with Mr. Wokabi, acting head, KSS and Mr. Olulo, head, cartography KSS. Meet Dr. Walther on future programme; on conditions renewal contract.
31 October	Visit Netherlands embassy, ABN Bank, for payment diplomatic pouch KSS-STIBOKA. Visit to UNEP: meet Mr. A. Ayoub, Desertification Control Programme; Mrs. Schomakers, J.P.O., D.C. PAK; and Mr. Drammeh, Regional Office for Africa.
1 November	Travel Nairobi-Zürich SR283.
2 November	Travel Zürich-Amsterdam SR790.

ANNEX III: Terms of reference

1. The area investigation includes the Districts Wajir, Mandera and Garissa.
2. Field work will be complemented by desk work on soils.
3. Field work will include certified spatial occurance of generalized soil types in more than one land unit.
4. To point out erodibility or performance to erodibility and erosion hazards by wind/water. This is necessary for the number of stock which might be considered to use one specific area.
5. To improve knowledge on soils during field work, whenever possible, especially in respect to soil fertility, which might effect growing performance of forage plants.
6. Information on the performance (soil fertility etc.) of eroded soils should be given.
7. Recommendations should be given where to protect the soil (i.e. which soil type and Range unit).
8. Geomorphological occurrence of the major units such as slope gradients and exposure should be included.
9. To assist in mapping Range units (vegetation included).
10. To cooperate with the other scientists expecially during field work.
11. Results:

11.1 Generalized draft maps (as produced for Marsabit District) of related soils of the indicated areas.

11.2 Description of the newly grouped soils which is easily understandable and usable by related (non-soil trained) personnel.

11.3 Description of soil fertility - if possible with the present informations available and the informations collected during field work and its consequences for the use of a particular Range.

11.4 Generalized maps of the Districts Wajir, Mandera and Garissa.

11.5 Concise descriptions on the grouped soils of the above districts.

11.6 Suggestions for further work/research.

Note:
If it is necessary to get analysis of soils - esp. soil fertility-arrangements with N.A.L. and KSS will be done.