Republic of Kenya
Ministry of Livestock Development (MOLD)

Range Management Handbook of Kenya
Volume II, 1

Marsabit District

Nairobi 1991

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Editors: H.J.Schwartz*, Salim Shaabani**, Dierk Walther***

*Department of Animal Production, Technical University Berlin
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PREFACE

A precondition for sound planning is a reliable database. A lot of information about the natural resources of this country have been collected over a very long time. Unfortunately most of this information is scattered and is mainly found in form of scientific publications, academic theses and consultancy reports. Thus it is either not available in the districts where it could form a district data base, or it is in a form that can not readily be used for planning purposes.

The District Focus for Rural Development Policy introduced in the country in 1984 identifies the districts as centres for planning and decision making. The implementation of this policy requires detailed information about the situation at district and locational level for planning purposes because the few available resources have to be appropriately utilized for maximum benefits.

With the increasing human population in the country, the arid lands are playing an important role of producing red meat and other products to feed a growing population, and also ensure food security for the nation. This calls for an accurate and up to date data base to facilitate proper planning of the utilisation of natural resources to ensure an optimum and sustainable production.

The Ministry of Livestock Development (Range Management Division) and the Federal Republic of Germany through the German Agency for Technical Cooperation (GTZ) have taken a first step in the right direction in compiling the available data on Marsabit District in form of a handbook which is accurate, up to date and easy to use for planning and advisory purposes. This is the first volume of the total of 10 intended for all the arid district in the country.

The data included in this handbook is intended to be used by planning division, of various ministries, training and research institutions, donor agencies and non governmental organisations. Since this handbook includes diversified information about the district it will serve as an important reference material for schools in Marsabit in particular and other schools in the country in general. It will be useful in the recently established 8-4-4 system of education which emphasizes amongst other subject knowledge of the local environment.

This handbook is intended to improve the production and utilisation of natural resources of Marsabit District in particular and those of the nation in general and assist the Nation to reach the goal of economic management for renewed growth as explained in the Sessional Paper No 1 of 1986.

A.M.Mutai
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The compilation of the Marsabit Range Management Handbook volume would not have been possible without the efforts and dedication of very many people and organizations. Unfortunately there are too many to allow us to mention all of them individually and point out their individual contributions. Therefore we take this opportunity to thank all the people who in one way or another have contributed to the preparation of this volume. This includes the many herdsmen who willingly gave us information about their range lands, as well as their expectations and frustrations. Such information formed the core of the Handbook.

We would like to give special thanks to the District Commissioner and the District Executive Committee of Marsabit, who encouraged us to proceed with the work; willingly shared information from their offices and spent many hours with us in discussing the various issues included in the Handbook. We also thank the District Officers (D. O.'s) who arranged for our field surveys; the chiefs and assistant chiefs, who organized our meetings with the elders; and the herdsmen who contributed very valuable information unavailable from anywhere else. Many Primary School teachers acted as interpreters in addition to being sources of information themselves, their contribution is highly appreciated.

Ministry of Livestock Development personnel acted as the co-ordinators of information gathering in the district. They also reviewed the reports. The efforts of Mr. Mwangi, the District Livestock Production Officer, and Mr. Halakhe, District Range Officer, are highly appreciated as are those of other M.O.L.D. district staff.

The following government departments and institutions gave invaluable support: Meteorological Department, Survey of Kenya, Kenya Soil Survey, National Agricultural Laboratories, Remote Sensing Facility, and the University of Nairobi.

Other institutions which gave support to the preparation of the Handbook include: Total Oil (Kenya); Stiboka, Wageningen, (The Netherlands); Technical University Berlin (Germany); the Universities of Giessen and Trier (Germany).

Planning and organization of the Range Management Handbook (R.M.H.) was done by the R.M.H. Steering Committee under the chairmanship of the Chief of Range Management, Mr. Arthur Chege. The members of the committee reviewed the manuscripts and gave invaluable suggestions thereby making the Handbook easier to understand and use. The contribution of the Steering Committee is highly appreciated.

Funding for the Handbook was obtained from the Federal Republic of Germany through the German Agency for Technical Cooperation (GTZ). The project was begun by the former German Agricultural Team (G.A.T.) under the leadership of Dr. Jörn Fitter. The efforts of all G.A.T. personal and of Dr.Fitter who was instrumental in starting and shaping the project and are hereby appreciated and acknowledged.

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Technical Adviser R.M.H.

Salim B. Shaabani (MOLD)
Project Co-ordinator R.M.H.

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INTRODUCTION

SALIM B. SHAABANI AND DIERK WALTHER

In 1982 the Ministry of Agriculture published the "Farm Management Handbook of Kenya" which now provides a sound reference on those natural conditions and management requirements which are determining successful farming. It serves as a source of baseline information for individuals and groups of people working in the area of rural development. The "Farm Management Handbook of Kenya" focussed on the high and medium rainfall districts where natural conditions are conducive to commercial and peasant farming. The "Range Management Handbook of Kenya" represents a corresponding effort aimed at the arid and semi-arid areas of the country. In the recent past, much information has been generated which is relevant for land use planning and management of these areas, primarily for livestock production. Most of the information available is in the form of scientific papers and not always readily applicable for practical use in development planning, administration and political decision making.

In view of this, an attempt was made to compile all available information with particular emphasis on immediate applicability for the development of Kenya's arid and semi-arid lands. To allow sufficient detail in the presentation a district-by-district treatment of the subject was chosen. This resulted in a series of reports under the common title "Range Management Handbook of Kenya, Volume II". This report (Volume II.1), presenting information on Marsabit District, is the first in the series to be published. It consists of a collection of 20 maps on a scale of 1:1,000,000 and the accompanying text which is to be considered as an extended legend to the maps.

Since all information presented is based on a mapping scale of 1:1,000,000 million detailed information on specific small areas can not be given. This volume is the first attempt to point out the natural potential and the ecological and economic constraints governing land use in the district on a very broad scale. If more information on a specific area is required for detailed planning, this should be mapped in the appropriate scale. The methods used in collecting and processing of the required data are described in the text below and in greater detail in Volume I of the Handbook.

Marsabit District covers an approximate area of 75,000 km2. It is the largest district in Kenya. It is larger than the Western, Central and Eastern provinces. The district borders the Republic of Ethiopia in the North, Wajir District in the East, Isiolo District in the South East, Samburu District in the South West and Turkana District in the West.

Natural conditions in Marsabit District differ widely. Vast lowlands ranging from 400 to 700 m a.s.l. are interspersed with several mountain ranges reaching altitudes of more than 2,700 m a.s.l. Correspondingly mean annual rainfall varies from less than 200 mm to over 1000 mm. A complex geology has led to the development of numerous soil types differing in depth, texture, water holding capacity, salinity and fertility. Consequently vegetation types found vary from barren land due to high salinity, various grass- and bushlands to evergreen tropical mountain forest, each with it's own characteristic support capacity for farming and pastoral production.

Administratively the district is divided into six divisions, namely: Laisamis, Loiyangalani, North Horr, South Horr, Sololo, Moyale and Central Division. About 80% of the people of Marsabit District are pastoralists, obtaining their livelihood from livestock and livestock based industries, about 10% of the total population are agriculturists and reside mainly around the Marsabit mountain and other areas which receive comparatively high and reliable rainfall. About 5% are in commerce trade and the rest are on salaried employment.

This part of the Handbook is prepared essentially as a common reference for planning of livestock and livestock related projects in the district. However, the background information included will certainly also be useful for general planning purposes. Volume II.1, Marsabit District, covers the following subject matters:

1 Climate (Map Nos 2 through 11)

Climatic factors such as rainfall, temperature and radiation determine to a large extent the ecological potential and the resulting productive capacity for primary biomass of any area of land. In Marsabit District climatic conditions vary considerably between lowlands and highlands, but also within these regions, leading to great differences in primary biomass production and the resulting carrying capacity for livestock populations. Rainfall as the single most important climatic factor effecting biomass production has been described in considerable detail in a series of 7 maps (Map Nos 3 through 9) with information on annual rainfall, seasonal rainfall, reliability of rainfall, median annual rainfall, median seasonal rainfall, reliability of annual and seasonal rainfall. An additional map of the production risk due to lack of rainfall (Map No 10) with special reference to forage production highlights this important aspect. The available meteorological data have been summarised in a map of eco-climatic zones (Map No 11) for the district, which are different from the ecological zones defined by Pratt and Gwynne (1977).

In Marsabit District there are relatively few meteorological stations with rainfall records exceeding 20 years. In Map No 2 all meteorological stations and their respective representative areas in the district are given. Due to editorial considerations Volume II.1 contains no chapter relating to the climate in the district and the rainfall maps. This will be covered in a separate report covering several districts together. General aspects pertaining to the climate of Kenya's arid and semi-arid areas are covered in Volume I.

2 Landforms and Soils (Chapter I, Map Nos 12 through 16)

For the purposes of the Handbook, landform and soil mapping units were defined and delineated based on the predominant geology and parent material, which support specific soil types. Special attention was given to:

- productive capacity for purposes of forage production,
- ratings of soil erosion hazards,
- rating of permanent and seasonal restrictions to accessibility for livestock.

3 Vegetation Types (Chapter II, Map No 17)

The classification of vegetation types by Pratt and Gwynne (1966) was modified slightly to fit the purposes of the Handbook. Each vegetation type found and mapped is described in general botanical terms, regarding it's occurrence and special features in Marsabit District, as well as the dominant species and their respective maximum frequency and/or cover. Special attention was given to the mapping of the present range condition to point out areas where degradation is occurring. When interpreting the vegetation maps special consideration should be given to the fact that absence of perennial grasses in many places in the district may not indicate over use because there are some areas due to climatic and soil factors which cannot support perennial grasslands.

4 Water Sources (Chapter III, Map Nos 18 and 19)

Drinking water was always rated as the most limiting factor for livestock production in the arid and semi-arid areas. Therefore most of the livestock development and improvement efforts in the district and elswhere have been centred around development and improvement of permanent and seasonal water sources. However, recent experiences have shown that isolated development of more water sources alone cannot solve the problems of livestock industry in the arid and semi-arid areas. There are examples where development of water, such as the installation ofmotorised deep boreholes, have led to severe degradation of vegetation and soils in the vicinity of such boreholes by attraction too many herds. The Handbook emphasizes balanced development of water giving consideration to the ecological potential of the adjacent pastures. An inventory of water sources by type, location, yield or capacity and quality is provided as well as water availability within normal daily travelling distances of different livestock species.

5 Range Unit Inventory (Chapter IV, Map No 20, text maps IV.1 through IV.4)

Range units are defined as areas of reasonably uniform ecological potential for their use as pastures, i. e. areas at similar altitudes, with similar precipitation and soils which usually results in a similar vegetation. Range units can be delineated at a very small and accurate scale of a few hundred square meters. This however would defeat the purpose of the concept, i. e. to provide a range management tool for practical application. A unit size of between 2,000 and 3,000 sqkm was considered to give sufficient differentiation and resolution under the conditions in Marsabit District and at the same time keep the number of units small enough for management purposes.

The range units were delineated on the basis of the major landforms (Map No 12) and the primary vegetation types (Map No 17).Range unit boundaries must not be understood as administrative boundaries like those of National Parks and Reserves, Forest Reserves, Grazing Blocks or District boundaries. They are merely ecological boundaries and a matter of convenience for land evaluation and resource management planning. Marsabit District was divided into 23 range units with an average size of approximately 2,400 sqkm, with 980 and 6,035 sqkm as the smallest and the largest unit respectively. A comprehensive inventory drawing on all information compiled was prepared for each range unit leading to recommendations on land use and development altenatives.

6 Livestock Marketing (Chapter V, text map V.1)

Since the Livestock Marketing Division (LMD) for a long time has held a monopoly for livestock marketing in all those districts which formerly constituted the Northern Frontier District , marketing infrastructures for private commercial activities are still underdeveloped. Heavy emphasis needs to be placed on a livestock marketing programme in the near future to amend this situation. To assist in this effort the Handbook includes an inventory of all existing marketing facilities, including existing and proposed holding grounds and buying centres. Informal marketing networks with their linkages to formal markets are explored, transportation modes, marketing and utilization of other livestock products are discussed. Constraints to marketing of livestock are analyzed and suggestions to improvement are made.

7 Traditional Pastoralists: Land Use Strategies (Chapter VI, text maps VI.1 through VI,7)

Human resources are just as important to consider for land use planning as are physical and natural resources. An attempt has been made in the handbook to describe the pastoral peoples of Marsabit District and their traditions, beliefs and taboos as far as they affect livestock production and range land utilisation. Particular emphasis has been placed on the description of traditional migration patterns of herds and settlements and the factors determining these migrations.

Application of the Handbook's Information to Planning Purposes and other than Livestock Related Activities:

As earlier stated, the Handbook provides background information for general as well as specific planning pruposes in the district. Some examples are given below.

1 Infrastructure (District Planning Officer)

Information is given on physical infrastructure. This was obtained primarily from field surveys as almost no data were available from the district office. As no comprehensive district maps exist, Map 1 is the first effort to provide district authorities with useful infrastructure information, such as location of villages and the road network. Map 1 should be revised by the District Planning Officer whenever possible. Recorded inaccuracies can easily be corrected.

2 Water (District Water Engineer)

All available data on existing water points, such as boreholes, dams, pans, piped water yields and water quality were collected at the district, provincial and headquarter levels and presented on a map (Map 18). This provides an easily used reference on the distribution of various types of water sources. The includes a superimposed grid system to aid in locating water sources recorded in the Handbook. Circles drawn around water sources on the map show the maximum distance most livestock will graze or browse from water. Other handbook maps should be consulted when planning additional water supplies. This insures that they are put in the most effective locations and that they do not endanger surrounding rangelands by promoting overutilisation. Some useful maps in this context are those on vegetation (Map 17), range condition (Map 2) and on accessability to livestock (Maps 15 & 16).

For instance, it will be noted that some parts of Marsabit District have no developed water sources. Consultation of Map 17 and the text maps IV,1 to IV,4 on the potential for grazing livestock will show most of these areas either to be barren lands with a very poor vegetation cover or annual grass/ dwarf shrub lands with only low potential for regular grazing. This information suggests that it would be wrong to recommend water development in such areas as funds will be wasted on an area where animals have an inadequate forage supply. In addition maps can be consulted regarding soil water holding capacity, accessability of the proposed water site and the surrounding rangelands and soil erodability. Soil erosion caused by trampling will quickly cause siltation of dams or pans.

It is understood, of course, that planning requires consultations and cooperation with other district staff, particularly MOLD staff. Updating of the information given on the maps is easily done. Therefore district authorities will always have updated information on water sources (e.g. borehole not operational any more; dam silted/half silted; new water sources developed etc.)

3 Agriculture (District Agricultural Officer)

There is a largely unproven assumption that most ASAL districts have a potential for expansion of either rainfed or irrigated agriculture. To verify this assumption one has to consult the existing information. Consultation of Maps 4 and 5 (median rainfall of the two annual rainy seasons) will narrow down the choice of potential gricultural areas. Recourse can then be taken to the maps on soils (Maps 12 to 16 but specifically to Map 13 on soil fertility. The maps showing the probability that a given area will receive rainfall (Maps 6 and 7) and those indicating the probability of the length of the growth period of forage, mainly perennial grasses (Maps 8 and 9) indicate that only very few and small areas in Marsabit District have some potential for rainfed agriculture. Map 10 gives an overall account of production risk.

Potential irrigation areas can be determined by analysis of Map 18 regarding the kown potential of permanent water sources. The soil report and soil map (Map 12) provide information about constraints due to plant nutrient availability in the soil.

Experience in the district indicates that irrigation can only be established with heavy financing and in very small areas. However, the map scale (1:1,000,000) does not allow the accurate determination of small pockets of potential irrigation areas. In consideration of the primarily pastoral economy of the majority of the districts population, a balanced view should prevail as to whether agricultural activities should deprive pastoralists of their essential dry season ranges. Barred from these areas stock will be forced to concentrate on less productive wet season ranges causing malnutrition, death and financial losses. Close cooperation with MOLD officers is needed to avoid such situation.

4 Education (District Education Officer)

District maps will be provided to all learning instutions. This will make knowledge of the district's resources available to decision makers at all levels. Thus, knowledge of the district's environment can be more clearly geared to the Government's effort for a more balanced use of the environment. Living conditions will be more clearly understood.

Map 1 (physical information) can be updated according to the needs of each school. Maps 2 to 20 and the accompanying reports will describe each student's district environment thereby preparing them to live within the district and to assist in conserving it's fragile ecology.

CHAPTER I
LANDFORMS AND SOILS
LUC TOUBER

INTRODUCTION

The present survey report deals with the physical environment of Marsabit District. This inventory is part of the range potential assessment of the arid and semi-arid lands of Kenya, in the context of the production of a Range Management Handbook (RMH) for the Ministry of Livestock Development.

Time constraints have necessarily restricted the amount and intensity of the field observations. Satellite image interpretation plays an important role. Field checks were limited in number and directed towards the assessment of range potential, rather than towards the execution of a conventional "multi purpose" soil survey. Hence it is preferable to use the term "Site evaluation for rangeland use". The RMH project document calls for information that is accessible to professionally non-related staff of the Range Division of the Ministry. As much as possible therefore this report avoids technical/pedological terminology.

Survey results present the major limitations of the abiotic environment to range potential and their distribution in Marsabit District. These data will have to be merged with climate and vegetation data to arrive at the estimation of sustainable stocking rates and range management units.

METHODOLOGY OF DATA GATHERING AND RESULTS

The gathering of soil data in a natural resources inventory exercise comprises routine-wise the following three steps

- collection of existing data in literature and the interpretation of available remote-sensing material
- field survey work
- elaboration of data; production of maps, legends and report.

The way these three phases, and especially the field work, are implemented, depends wholly on time and manpower available.The present survey was scheduled to be finalized in three months time out of which four weeks were available for field checks. For an area as vast as Marsabit District a field survey will be necessarily of a very low intensity, i.e. only a limited number of field observations per unit area can be made.

Also, the kind of observations are geared towards evaluation for extensive range, rather than to the compilation on a comprehensive multi-purpose reconnaissance soil survey.

Previous surveys and remote sensing data

Of existing data use has been made of the 1:1 scale Exploratory Soil Map of Kenya (Sombroek, 1982). Of the southern part of the District a lot of data exist due to the Unesco's IPAL project, of which readily available are a soil map at 1 : 250.000 (Van Kekem, 1986); a 1 : 500.000 scale soil erosion map (Bake, 1983) and a range type map (Lusigi et al., 1983). Sombroeks and Van Kekems publications proved most useful.

Crucial for the implementation of small scale inventories, is the use of aerial photographs or satellite imagery. Soil inventories of large areas that are presented on very small scale maps, such as 1 : 1 Million have necessarily to rely heavily on the interpretation of remote sensing data. Time constraints and difficulties in accessibility make it impossible, even in surveys of a much larger scale (eg. 1 : 100.000) to visit for instance all points of a regular grid system, and make a soil observation every 100 and 1000 meters.

The interpretation of aerial photographs or satellite images provides the opportunity to select a limited number of points in the field in a strategical way, such that the data of these field observation points are representative for large tracts of land.

In the present survey, of which the area covers about 200 x 300 km, the use of aerial photographs is too costly and too time consuming. (Existing photographs are at scale of 1 : 60.000, which means a coverage of 1000 photographs). Therefore use was made of 1 : 500.000 scale prints of Landsat Images.

Field survey work

Fieldwork was conducted in four weeks time, by a team consisting of a range specialist/team leader; a vegetation consultant and a soil survey consultant. As many as possible representative points were visited by travelling along all existing motorable tracks. In some cases the oil-drilling companies cutlines were followed, using compass and car mileage counter. Use was made of 1 : 250.000 scale topographic sheets (Survey of Kenya) together with the landsat images for orientation.

At each observation point was recorded: landform, geology, slope, stoniness/rockiness, apparent soil degradation and topsoil quality (grass cover, organic matter content, "sealing" of the surface), status of erosion (sheet erosion, overwash, gully erosion, tunnel erosion, wind erosion, wind deposition). Further soil depth, soil texture, soil colour, consistence and calcareousness. In a number of cases topsoil samples were taken for fertility analysis and soil salinity.

It was considered too time consuming and not altogether relevant to make soil profile pits. Soil augering were made in a limited number of cases, most soils being too stony.

Elaboration of data

Elaboration of field data was initiated by drawing final landforms/soils boundaries on a 1 : 500.000 scale mosaic of landsat images, together with the preparation of a legend. The legend follows the set-up in use by the Kenya Soil Survey, i.e. an entry of Major landforms (Mountains; Footslopes; Plains, etc.) and at second level Geology (Basement system Rocks, Volcanic Rocks, Lake bed deposits, etc.). At the third level these units are divided again according to the local topographic conditions and prevailing soil qualities as observed in the field.

The units are described in terms of predominant slope steepness; erosion hazard; accessibility to livestock, flooding hazard, soil drainage, -depth, -colour, salinity/sodicity, rockiness and stoniness, texture, infiltration capacity and topsoil organic matter content.

Map compilation was accomplished by the production of a provisional 1 : 500.000 scale soil map, traced from the Landsat Mosaic on to a transparent 1 : 500.000 scale copy of a USA "operational navigation chart", available at KSS. This 1 : 500.000 scale soil map was simplified and reduced by means of an optical pantograph to the present 1 : 1 Million scale version. The provisional 1 : 500.000 scale map with legend and description of its 58 units, is available at GAT as mimeographed international document. The final 1 : 1 Million map shows 36 units and serves as the basis for further data interpretation and rangeland evaluation.

GENERAL INTRODUCTION TO THE ENVIRONMENT

Major landforms and geology

Oldest features of the landforms in Marsabit District are the hill masses (mapping unit HU) at the SW border of the district. They have an average height of 2000-2500 m above sea level and 1500-2000 m above the general level of the surrounding plains. Similar hills of the same age occur to the north-eastern part, along the Ethiopian border, although of lesser elevation above the general landscape. They consist of Precambrian Basement System Rocks. These hill masses are not important in terms of surface extent. They are important water catchment areas, however, and are the source of the sediments of which their surrounding footslopes are built (mapping unit 10: FU) and of most of the extensive sedimentary plains in the southern part of the district (mapping unit 26: PSU3 and 27: PSU4).

More important hill masses are formed by the Kulal, Asie, Marsabit and Hurri (mapping units 1 and 2: MV and 4 and 5: HP) and their surrounding slopes and lavaflows or "Footridges" (mapping units 7:FrV1, 8: FrV2, 9: FrV3). These volcanic hill masses are of Pleistocene age and consist mainly of basalts.

Hurri, Asie and Marsabit show in their topregion a NNW-SSE stretching zone of volcanic ash cones (mapping units 4 and 5: HP). At the general level of elevation most of the rest of the district is occupied by basalt flows of Tertiary and Quaternary age. They form a vast and almost flat to very gently undulating landscape (mapping unit 15: LV3). Towards the West these flows are broken and partly broken by N-S stretching rift faults, causing an undulating and step-faulted topography (mapping units 13: LV1 and 14: LV2).

Between this faulted area and Lake Turkana, alluvial fans have developed, that, in the process of uplift, themselves have been eroded by deep and broad gullies or "lagas". As a consequence an number of terrace levels can be discerned, separated by strongly gullied and steep "badland" topography (mapping units 17: UP, 18: YP and 31: P1X).

Extensive lavaflows of more recent age stretch NE of Marsabit towards the Eastern border. It features as an inhospitable, rugged and very rocky landscape (mapping unit 36: LA). The central part of Marsabit district is formed by the Chalbi Desert, a dried-out lake bed: a flat, salt crusted surface, devoid of vegetation (mapping unit 30: P13).

Distribution of soil properties

The main factors that determine the formation and distribution of soils are climate, rocktype, topography, time, vegetation and human influence. In order to explain the distribution of various soil types and their properties, these factors will be dealt with briefly as they are found in Marsabit district.

Climate

The amount of plant growth is largely a function of climatic conditions, and with this "phytobiomass", the formation of organic matter in the top soil is strongly related. The more moist the climate, the more organic matter in the soil. Organic matter is very beneficial to the quality of the soil, especially in respect to resistance to erosion and to infiltration and water storage capacity.

Areas of higher rainfall like the top regions of Kulal, Marsabit and Hurri hill masses show an organic matter content in their top soils of 1.5 to over 2%. The very dry major part of the district however, has an organic matter content of less than o.5% in the topsoil.

Where rainfall dominates evaporation, like in tropic forests such as Marsabit National Park and Mt. Kulal, there is a leaching of mineral salts from the soils with the surplus rainwater. Where evaporation is predominant over rainfall, mineral salts are not washed from the soil but may be even residually enriched. This is especially the case in areas that receive floodwaters, usually originating from rainfall elsewhere, carrying amounts of salts and sediments. Especially the lowest parts, of the landscape where the water stagnates, evaporation leaves the salts behind. The Chalbi Desert (mapping unit 30: P13) is the result of such a process: a saline area where plant growth is virtually absent due to toxic quantities of salt in the soil.

Apart from these areas where floodwater assemble (mapping units 30: P13 and 32: AA), the major part of the district has, due to its hot and semi-arid conditions, soils that are rich in mineral salts; of basic reaction (pH 7-8.5) and are in general strongly calcareous.

Geology

Rocktype or geological composition determines the so-called parent material from which the soils develop. On the landforms and soils map, the legend mentions mainly three types of rock:

1. Undifferentiated volcanic rocks, mainly basalts. These are a fine-grained rock type, relative poor in quartz and rock in ferro-magnesian minerals, so that the weathering products (soils and sediments derived from these rocks) are mainly red or reddish coloured clays and clay loams. Further, most units on undifferentiated volcanic rocks show to a lesser or stronger degree stoniness of boulders at the surface, a typical feature for these geological formations. All these units on undifferentiated volcanic rocks are indicated with a V as second capital letter in the unit symbol.

2. Another important volcanic rocktype are the Pyroclastic rocks (all P-units). These are volcanic ashes, usually producing coarse grained, fine gravelly soils of high permeability and infiltration rates.

3. The Basement System rocks and sediments derived from these (all U-units) contain more sand particles and are poorer in ferromagnesian minerals. The soils developed on this parent material are more brownish coloured coarse sandy loams and coarse sandy clay loams.

The division of the Marsabit soils according to parent material is very important as they show marked differences in textural composition, clay mineralogy and chemical properties, as well as in behaviour to erosional processes .

Time

Time, in the geological order of magnitude, determines the duration of processes of weathering and soil formation. This is illustrated in Marsabit district by the lava-basalt flows that range in age from early-tertiary to sub-recent. The youngest ones show the little or no weathering and soil formation and feature as inaccessible rock and boulder fields (mapping unit 36: La) while the oldest ones have a very deep cracking clay soil, with only locally stones and boulders (mapping unit 15: LV3).

Topography

Topography exerts its influence through slope steepness, whereby erosion through runoff of rainwater can gain momentum. Higher and steeper parts of the landforms have often shallow rocks soils (mapping units 3: HU, 7: FrV1, 8: FrV2, 16: UU, 17: UP, 14: LV2) while the extensive flat and very gently undulating land tends to have a much deeper soil mantle (mapping units 15: LV3 and 22: PV1).At the foot of steep hills and scarps eroded material may accumulate and form the substratum for a deep thick soil (mapping unit 10: FU). Also this eroded material has been transported and sedimented into larger, almost flat areas, depressions or bottomlands, where consequently as well deep soils are found, free of rocks or stones (mapping units 19-20: YV; 24-30: PsU- and P1-units; and 32: AA and 33:, BV).

Topography has its influence also on drainage of soils: the possibility for water to flow off or seep through in the more elevated parts, where consequently also dissolved weathering products (nutrients) are leached. In downslope positions, where flooding or ponding may occur, there is an accumulation of sediments and plant nutrients (see also climate and salinity/sodicity).

Vegetation

Plant growth and litter production has an important influence on the top soil and soil surface qualities by the supply of organic matter. The humus content determines largely the capacity of the soil to allow overgrazed areas to recuperate within a foreseeable future.

Human influence on soil in Marsabit District is manifest only locally by the effects of accelerated erosion. The concentrated presence of livestock around permanent watering points is an obvious example. Various forms, degrees and the consequences of human-induced erosion will be dealt with below.

DESCRIPTION OF MAPPING UNITS

Introduction to the map legend symbols

The mapping unit symbols are built up of two capital characters, the first one indicative of the major landform it represents; the second denominating the geology or parent material. A third digit (number) simply differentiates within a landform/ geology unit according to local topography and/or soil type.

The sequence of units is chosen according to topographic position: from high (mountains) to low (alluvial plains) in landforms; and from old to young (as far as known) in geology.

The system is adapted from the one in use by the Kenya Soil Survey (KSS, 1987).Symbols denominate the following:

M	Mountains
H	Hills
Fr	Footridges of major volcanoes
F	Footslopes
L	Plateaus
U	Uplands
Y	Piedmont plains
P	Plains, undifferentiated
Ps	Sedimentary plains
Pl	Lacustrine plains
A	Alluvial plains
B	Bottomlands
VC	Valley complex
D	Dunes
La	Recent Lavaflows
U	Basement system rocks, undifferentiated
V	Volcanic rocks, undifferentiated
P	Pyroclastic rocks, volcanic ashes
A	Alluvial deposits, undifferentiated
X	Material of various origin

The Mapping Units

Mapping unit 1: MV1

Surface area: 142 km ; O.2% of total district area

Geology: Undifferentiated tertiary volcanic rocks-mainly basalts and pyroclastic rocks

Relief, Topography: Hilly to rolling topography. Slopes over 30% common. Relief intensity locally over 300 m.

Vegetation; landuse: Forest, partly National Park

Soils: Well drained, very deep to shallow dusky red to dark reddish brown friable clay loam to clay, in steep places mostly bouldery and stony

Condition of topsoil: Thick, humus rich, well structured top soil with good vegetative cover. High infiltration capacity of surface soil, high resistance to erosion

Erosion hazard: Potential hazard of gully development after clearing of vegetation, especially at steeper slope parts

Accessibility to livestock: Locally severe restrictions for cattle, mainly due to slope steepness

Mapping unit 2: MV2

Surface area: 995 km ;1.5% of total district area

Geology: Undifferentiated tertiary volcanic rocks-mainly basalts, conglomerates and some ash deposits

Relief, Topography: Rolling to undulating "highlands", occasional river courses deeply entrenched.

Vegetation, landuse: Croton woodland and Combretum bushland. Themeda and Chrysopogon grassland. Intense cultivation, rainfed, smallholders
Soils: Well drained, very deep, dusky red to dark reddish brown friable clay loam to clay, in places bouldery and stony.
Condition of topsoil: High organic matter content under uncultivated conditions. High infiltration capacity. High "recuperation" capacity after over grazing.
Erosion hazard: Low sheet erosion hazard. Gully development imminent along cattle tracks. Moderate winderosion hazard under high grazing pressure.
Accessibility to livestock: No restrictions.

Mapping unit 3: HU

Surface area: 813 km ;1.2% of total district area
Geology:Precambrian Gneisses, undifferentiated Basement System Rocks
Relief, Topography: Hilly to mountainous topography. Irregular, in many places precipitous slopes and giant rock outcrops.
Vegetation, landuse: Nil (rock outcrops) or bushland
Soils: Rock outcrops and well drained, shallow dark reddish brown, friable, rocky and stony sandy loam to sandy clay loam
Condition of topsoil: Where present, moderate rich in organic matter and primary weatherable minerals
Erosion hazard: Sensitive to sheet and gully erosion after removal of vegetation, mainly due to slope steepness and shallowness of soils
Accessibility to livestock: Severe constraints. Accessible only locally to goats.

Mapping unit 4: HP1

Surface area: 141 km ;0.2% of total district area
Geology: Relatively fine-grained pyroclastic material: volcanic ash of fine-gravel sizeRelief
Topography: Many isolated small volcanic cones, among gently undulating "highlands"
Vegetation, landuse: Erithrina and Acacia wooded grassland of Themeda, Pennisetum, and Chrysopogon species
Soils: Well to somewhat excessively drained, moderately deep, dark brown fine gravelly sandy clay loam, in places stony and gravelly
Condition of topsoil: Relatively rich in organic matter, well structured surface soil with high infiltration capacity. Rapid regrowth of vegetation after over-utilisation
Erosion hazard: Slight to moderate wind erosion hazard
Accessibility to livestock: Steepness of volcanic cones poses some constraint to the accessibility for cattle and camel

Mapping unit 5: HP2

Surface area: 1756 km ; 2.6% of total district area
Geology: Volcanic ashes and fine-grained pyroclastic material
Relief, Topography: Gently undulating highland, with numerous small straight sloped hills (ash cones)
Vegetation, landuse: Bushed grass of Acacia, Mellifera and Acacia tortilis over mainly Chrysopogon
Soils: Well to somewhat excessively drained moderately deep, brown, locally stony, fine gravelly sandy clay loam
Condition of topsoil: Moderately high in organic matter. High infiltration rate
Erosion hazard: Low sheet and moderate gully erosion hazard under high grazing pressure. Good possibilities for recuperation of vegetation. Locally strong sheet erosion over shallow calcrete formation
Accessibility to livestock: Moderate restrictions to cattle due to stoniness and steepness of terrain

Mapping unit 6: HV

Surface area: 518 km ; 0.8% of total district area
Geology: Undifferentiated volcanic rocks, mainly basalts
Relief, Topography: Hilly and rolling topography, locally stepfaulted. Scarps and precipitous slopes common
Vegetation, landuse: Mainly sparse annual grassland with locally scattered bush
Soils: Well to somewhat excessively drained, shallow, dark reddish brown calcareous, extremely stony, bouldery and rocky clayloam
Condition of topsoil: In the drier zones degraded to mere boulder mantle. In the semi-arid zones (Sabarei) low in organic matter and sensitive to degradation
Erosion hazard: Already degraded areas carry a protective stone mantle. Otherwise con-

siderable sheet and gully erosion hazard
Accessibility to livestock: Only for goats there may be some possibilities to enter into the area

Mapping unit 7: FrV1

Surface area: 514 km ; 0.8% of total district area
Geology: Undifferentiated volcanic rocks; mainly basalts with locally admixture of pyroclastic material
Relief, Topography: Slopes of Mt. Kulal: gentle to irregular slopes of up to 8%, intersected by numerous steeply incised river gorges (slopes over 30%)
Vegetation; landuse: Deciduous woodland with dwarfshrub understory of Duosperma eremophilum
Soils: Well drained shallow to moderately deep dark reddish brown, friable, locally calcareous, stony to very bouldery clay loam to clay
Condition of topsoil: Moderate amount of organic matter content and moderately rich in nutrients. Soils with capacity to regenerate vegetation after overgrazing
Erosion hazard: Strongly gully development possible upon eventually overutilized areas
Accessibility to livestock: Severely limited by the numerous steeply incised river courses. Along the relatively smooth crests, stoniness and boulders reduce the accessibility for cattle.

Mapping unit 8: FrV2

Surface area: 1612 km ; 2.4% of total district area
Geology: Undifferentiated volcanic rocks, mainly basalts
Relief, Topography: Lower slopes of Marsabit, Asie and Hurri hill masses. Overall slopes from 5% uphill to less than 2% at outer edges. Steeply incised stream-courses
Vegetation, landuse: Deciduous shrubland and bushed grassland of Acacia mellifera, Acacia reficiens over annual and perennial grasses
Soils: Imperfectly to moderately well drained deep, dark brown, locally saline and sodic, locally stony and bouldery, cracking clay
Condition of topsoil: Well structured top soil, low in organic matter content
Erosion hazard: Possibly severe gully erosion and tunnel erosion hazard. Presently at over utilized areas slight sheet erosion and wind erosion. In the neighbourhood of steeply dissected stream courses stronger erosion features
Accessibility to livestock: Slight to moderate restrictions to camel and cattle due to local stoniness, surface boulders and deeply entrenched rivers

Mapping unit 9: FrV3

Surface area: 8955 km ; 13.3% of total district area
Geology: Tertiary lavaflows. Lower volcanic slopes of Marsabit, Kulal Asie and Hurri hill masses: mainly basalts
Relief, Topography: Overall slopes from 5% uphill to less than 2% at lower edges. Complex of steeper and flatter local topography due to irregular lavaflow morphology
Vegetation, landuse: Deciduous shrubland of Acacia mellifera and A. reficiens, depending on altitude, with Chrysopogon or annual grassland of mainly Tetrapogon and Aristida species
Soils: Complex of well to imperfectly drained shallow to deep dark reddish brown calcareous locally saline, locally very stony bouldery and rocky clay loam to clay with many rock outcrops and in many places an extremely stony and bouldery surface.
Condition of topsoil: The surface soil is generally low (at higher elevation) to very low (in hotter parts) in organic matter content
Erosion hazard: Soil is mainly found as level-colluviated pockets in the depressions of the irregular rock and boulder topography. Sheet and gully erosion will therefore develop only at a scale depending on local situation. Wind erosion causes the formation of a desert pavement easily at heavily frequented areas (e.g. north of Kalacha), as the loose layer of very fine and light soil material is easily picked up by the wind
Accessibility to livestock: Moderate to severe restrictions for cattle and to a lesser extent to camels, due to the often rugged rocky topography and surface stones and boulders

Mapping unit 10: FU

Surface area: 1821 km ; 2.7% of total district area
Geology: Colluvium derived from undifferentiated Basement System rock
Relief, Topography: Gentle, concave to straight, long slopes of 8-2%

Vegetation, landuse: Mostly deciduous bushland, or bushed grassland of Commiphora Delonix sp. and Acacia mellifera over annual and perennial grasses
Soils: Well drained, very deep, dark reddish brown friable to firm sandy clay loam to sandy loam
Condition of topsoil: Undisturbed soils have a moderate to high infiltration capacity. Soils tend to be sensitive to over utilization, where sealing of the surface prevents a rapid recuperation of the vegetation cover
Erosion hazard: Soils sealing means a strong reduction in infiltration capacity and hence a rapid increase of sheet erosion. Also ravine-like gully development is not uncommon on these footslopes, due to vegetation disturbance uphill
Accessibility to livestock: There are restrictions to accessibility for cattle and camel only, due to locally dense shrub cover

Mapping unit 11: FP

Surface area: 293 km ; 0.4% total district area
Geology: Volcanic ash deposits and fine pyroclastic material, partly colluviated
Relief, Topography: (Due to mapping scale also the volcanic cones, with which these footslopes are associated are included) concave regular slopes of 5-1%
Vegetation; landuse: Annual sparse grassland and dwarfshrubs
Soils: Well to somewhat excessively drained, moderately deep to shallow, brown, very friable, strongly calcareous, fine gravelly clay loam, with calcrete formations at various depths
Condition of topsoil: Under the given extremely dry conditions these soils have moderately high organic matter content and a reasonable infiltration capacity
Erosion hazard: Due to the high amount of fine volcanic ash the area is however sensitive to wind erosion, when under heavy grazing pressure. Presently there is evidence of slight sheet erosion and some accumulation of windblown deposits around dwarf shrubs.
Accessibility to livestock: No restrictions

Mapping unit 12: FV

Surface area: 585 km ; 0.9% of total district area
Geology: Colluviated deposits of volcanic origin, locally Basement System material present (Sabarei, area)
Relief, Topography: Gentle overall slope of 8-2% in many places gullied
Vegetation, landuse: Mainly deciduous bushland of Acacia species
Soils: Well drained, very deep dark reddish brown calcareous, very gravelly and stony sandy loam, with a very stony surface
Condition of topsoil and Erosion hazard: The stone concentration and sealing at the soil surface, the frequently gullies and the development of bushland thicket in many places are all signs of soil degradation and accelerated erosion.
Accessibility to livestock: Moderate restrictions to camel and cattle due to surface stoniness, gullied topography and dense bush

Mapping unit 13: LV1

Surface area: 310 km ; 0.5% of total district area
Geology: Basalts
Relief, Topography: Plateau; i.e. an almost flat elevated area, bordered by an escarpment
Vegetation; landuse: Probably bushed grassland
Soils: Most probably similar to those of mapping unit 15: LV3: i.e. moderately well drained very deep reddish brown cracking clay
Condition of topsoil: The relatively elevated position and from aircraft observed dense pattern of cattle tracks suggest a fairly productive soil in good condition
Erosion hazard: Low, mainly due to almost flat topography and favourable vegetation cover. Possibly moderately sensitive to wind erosion
Accessibility to livestock: Locally slight restrictions to cattle, due to surface stoniness.The surrounding escarpment is a prohibitive barrier to movements beyond the area

Mapping unit 14: LV2

Surface area: 4380 km ; 6.5% of total district area
Geology: Basalt
Relief, Topography: Partly stepfaulted basalt plateau:i.e. due to geological faultlines an undulating topography of north-south stretching ridges and depressions
Vegetation, landuse: Mainly deciduous bushland of Acacia mellifera, A. reficiens and Boswellia Sp.
Soils: Well drained soils of various depths, with frequent rock outcrops. Mainly very stony and bouldery, clay loam to cracking

clay

Condition of topsoil: Mainly low in organic matter content; loose and friable consistence

Erosion hazard: In connection with the topography the locally cracking clay may give rise to tunnel erosion development, and eventual gullies

Accessibility to livestock: Stones and boulders and terrain steepness will locally strongly hamper the accessibility for cattle, and to a lesser extent for camels

Mapping unit 15: LV3

Surface area: 7531 km ; 11.2% of total district area

Geology: Basalts

Relief, Topography: Very gently undulating to almost flat, slopes not exceeding 2%

Vegetation, landuse: Annual grassland of Tetrapogon and Aristida (locally in moister climate reach: Lintonia) and Bushland, associated with bouldery soils

Soils: Moderately well drained, very deep, dark reddish brown, calcareous, locally cracking clay to clay loam, with a stony surface, locally very stony and bouldery

Condition of topsoil: Due to climate conditions a low organic matter content of the top soil. Loose and very friable consistence

Erosion hazard: Loose surface soil is sensitive to wind erosion.The process of deflation under heavy livestock traffic has led to 100% bare stone cover in a wide area around Balesa waterhole.

Accessibility to livestock: Where surface boulders and stones occur, there is a moderate restriction to cattle

Mapping unit 16: UU

Surface area: 282 km ;1.9% of total district area

Geology: Undifferentiated Basement System rock, mainly Precambrian Gneisses. In places rich in ferromagnesian minerals

Relief, Topography: Undulating to gently undulating, with regular convex-concave slopes of up to 5%

Vegetation, landuse: Deciduous bushland of Acacia reficiens, Commiphora and Duosperma. Areas of Illaut. Laisamis, Korr almost devoid of vegetation

Soils: Welldrained shallow to moderately deep dark reddish brown gravelly sandy clay loam to sandy loam

Condition of topsoil and Erosion: Over large areas in the surroundings of the permanent waterholes of Illaut, Laisamis and Korr, sheet-wash erosion has removed the topsoil and part of the subsoil. The bare surface is characterised by a strong sealing that prevents a major part of the scant precipitation to infiltrate into the soil, and that forms a severe limitation to the restoration of the vegetation cover.

Accessibility to livestock: No limitations

Mapping unit 17: UP

Surface area: 4375 km ; 6.5% of total district area

Geology: Mainly coarse pyroclastic rocks and volcanic conglomerates

Relief, Topography: very gently undulating to rolling topography, with short convex slopes. Dense network of V-sharped drainage lines

Vegetation, landuse: Shrub vegetation mainly in drainage lines only. Elsewhere practically bare desert pavement, in places sparsely populated by annual grasses.

Soils: Well drained moderately deep to shallow, brown, strongly calcareous very gravelly clay loam, with a desert pavement at the surface, and calcrete layers at shallow depths

Condition of topsoil: The area is in very poor condition. Soils moisture storage is very low due to gravel content and shallow calcrete formation. Area of very low potential

Erosion hazard: Water and wind erosion have hardly any impact due to the omnipresent gravelly surface layer

Accessibility to livestock: The undulating topography is a moderate restriction

Mapping unit 18: YP

Surface area: 1515 km ; 2.3% of total district area

Geology: Alluvial deposits, largely derived from pyroclastic rock

Relief, Topography: Almost flat, very gentle slopes at three levels of elevation, steeply dissected by many broad, flat-bottomed "lagas"

Vegetation, landuse: Deciduous shrubland and sparse annual grassland. In lagas Acacia tortilis and Salvadora persica are common. Locally perennial grasses

Soils: 1 (on undissected), almost flat & very gentle slopes. Moderately well drained, very deep, dark reddish brown gravelly clay loam, in places with an exceedingly gravelling or stony surface

2 (in the deeply entrenched broad "Lagas").

Exceedingly gravelly soils of various drainage condition, depth, colour and texture; mainly strongly calcareous and saline, and frequent calcrete layers near to the surface
Erosion hazard: In terms of geological erosion, the area is of a very unstable nature, whether "overutilized" or not
Accessibility to livestock: Limited, due to the frequent steep banks between lagas and terrace remnants

Mapping unit 19: YV1

Surface area: 724 km ; 1.1% of total district area
Geology:
Alluvium derived from volcanic rocks
Relief, Topography: Almost flat to very gently sloping, locally gullied
Vegetation, landuse: Various, mainly Acacia mellifera and A. reficiens bushland or bushed grassland
Soils: Moderately well to imperfectly drained, very deep, reddish brown to grayish brown, calcareous, locally saline and sodic clay loam to cracking clay, in many places gravelly and/or with an exceedingly gravelly surface
Erosion hazard: Strong wind erosion hazard wherever livestock is concentrated. In places gully development
Accessibility to livestock: Occasional flooding may occur, which makes the area partly and temporary inaccessible. Also stickiness of the surface may restrict the accessibility in the rainy season

Mapping unit 20: YV2

Surface area: 270 km ; 0.4% of total district area
Geology: Colluviated and windblown deposits, mainly derived from pyroclastic rocks
Relief, Topography: Almost flat
Vegetation, landuse: Almost exclusively Indigofera dwarf shrub
Soils: Well to somewhat excessively drained, moderately deep, yellowish brown, very friable, strongly calcareous fine gravelly loam to loamy sand
Condition of topsoil: Topsoils show low organic matter content, have a relative high infiltration capacity, so that run-off is limited to a minimum. No signs of sheet or gully erosion
Erosion hazard: The deposits being partly of a wind blown origin, are sensitive to wind erosion, when too frequently trampled by livestock
Accessibility to livestock: No restrictions

Mapping unit 21: YC

Surface area: 956 km ; 1.4% of total district area
Geology: Alluvium derived from pyroclastic rocks and lake bed deposits, partly redeposited by wind erosion
Relief, Topography: Very gently undulating slopes less than 2%
Vegetation, landuse: Pattern of bare-gravelly surface and Indigofera dwarfshrub; scattered Euphorbia cuneata, locally also Maerua crassifolia and Cadaba mirabilis
Soils: Complex of: (1) Well drained, deep, pale brown, strongly calcareous gravelly clay loam, with an exceedingly gravelly surface (2) Somewhat excessively drained, moderately deep, yellowish brown, strongly calcareous, saline, fine gravelly stratified sandy loam
Condition of topsoil: The first component is a degraded soil with desert pavement, devoid of vegetation. The second component consists largely of mobile windblown deposits
Erosion hazard: Wind erosion is active in especially the second component. Here also, due to its topographic position, occasional run-on occurs, accompanied by sheet wash erosion. Fresh windblown deposits (small dune formations) are readily populated by Indigofera dwarf-shrubs
Accessibility: No restrictions; occasionally in wet season due to (very short lived) flooding

Mapping unit 22: PV1

Surface area: 1865 km ; 2.8% of total district area
Geology: Basalt
Relief, Topography: Almost flat, slopes 2%
Vegetation, landuse: Deciduous bushland, alternating with perennial grassland (Lintonia nutans, Sorghum purpureum, Aspilia, Abutilon)
Soils: Imperfectly drained, very deep, dark brown, firm, calcareous cracking clay, locally stony
Condition of topsoil: Soils of relatively high production, fertility and organic matter content
Erosion hazard: Under heavy grazing pressure sensitive to wind erosion. Strong gully

development hazard in neighbourhood of river system (mapping unit 34: VC), due to topography, sub-surface cracks and possible sodicity in deeper subsoil
Accessibility to livestock: Limitations for cattle and camel in the wet season, due to stickiness of the clay soil

Mapping unit 23: PV2

Surface area: 2395 km ; 3.6% of total district area
Geology: Basalt
Relief, Topography: General slope is almost flat. Irregular mesotopography due to many low rock outcrop ridges (Lavaflow morphology)
Vegetation, landuse: Bushed grasslandSoils: Probably similar to those of unit PV1, only with rock outcrops and surface stoniness
Erosion hazard: Probably low sheet and gully erosion hazard due to topography
Accessibility to livestock: Moderate restrictions for cattle due to rock outcrops

Mapping unit 24: PsU1

Surface area: 528 km ; 0.8% of total district area
Geology: "Red Sandy Plain" deposits. Tertiary sediments of Basement System origin
Relief, Topography: Sedimentary plain, very gently undulating, slopes 2%
Vegetation; landuse: Bushland
Soils: Well drained very deep, dark red, sandy clay loam to sandy loam
Condition of topsoil: Rather low in organic matter content, but relatively high infiltration capacity, due to porous and well structured soil. Risk of top soil sealing in heavily utilized areas
Erosion hazard: Low erosion hazard, due to almost flat topography
Accessibility to livestock: No limitations except locally due to dense bush

Mapping unit 25: PsU2

Surface area: 2500 km ; 3.7% of total district area
Geology: Undifferentiated sediments, mainly from Basement System rocks
Relief, Topography: Almost flat topography, slopes 2%
Vegetation; landuse: Partly dense bushland, and bushed grassland. Species composition dependent on drainage condition and salinity
Soils: Complex of among others: (1) Moderately well drained, very deep, dark brown soils of varying texture and consistence (2) Imperfectly drained shallow, grayish brown, very firm sodic sandy clay
Condition of topsoil: Widely varied: locally rich in organic matter (component 1) locally strongly sealed (component 2); also in places cracking clay with thick, loose, dusty surface layer
Erosion hazard: Low in soil component 1; high sheet erosion hazard at strongly sealed surfaces. Wind erosion hazard on cracking clay soils with loose surface layer
Accessibility to livestock: Mainly restricted due to dense bush, and in wet season due to local flooding

Mapping unit 26: PsU3

Surface area: 2590 km ;3.9% of total district area
Geology: Undifferentiated sediments, derived mainly from Basement System rocks
Relief, Topography: Very gently undulating plains; overall slopes less than 2%. In many places with undulating mesotopography, caused by numerous shallow drainage lines and/or subrecent formation
Soils: Association of: (1) The elevated parts of the gently undulating mesorelief: - Somewhat excessively drained, very deep, reddish brown loamy sand (2) The depressional areas between the sub recent dunes: - Moderately well drained, very deep, brown, calcareous sandy clay loam, locally saline and sodic
Condition of soil and erosion hazard: In the neighbourhood of Illaut, Korr and Laisamis the stabilized dunes have been reactivated due to over utilization of the rangeland. Elsewhere the "dune component" has a good infiltration capacity and bears at least a reasonable cover of vegetation (Indigofera and Blepharis a.o.). The depressions are mainly affected by sealing, low infiltration and sheet erosion
Accessibility to livestock: Only due to locally dense bush there may be some restrictions to cattle and camels

Mapping unit 27: PsU4

Surface area: 4500 km; 6.7% of total district area
Geology: Undifferentiated alluvial sediments, largely derived from Basement System rocks
Relief, Topography: Almost flat extensive

plains, with gently undulating mesorelief, due to numerous shallow drainage lines and subrecent dune formation
Vegetation, landuse: Bushland and bushed grassland
Soils: Association of: (1) at the relatively elevated parts (subrecent dunes): - Somewhat excessively drained, very deep, dark reddish brown, soft to loose calcareous sand to sandy loam. (2) In the depressional areas: - Imperfectly drained, very deep, dark reddish brown to brown sandy clay loam, in many places with a soft sandy loam top soil
Condition of top soilsand erosion hazard: The higher parts (component 1) are sensitive to wind erosion. The vegetation cover is easily damaged by trampling of the surface. In the depressions (component 2) either the soil is strongly sealed (degraded and sheet-washed until natric-B horizon) and/or covered by wind deposits deflated from the subrecent dunes. This process is strongly represented in the heavily damaged areas between Kargi, Korr, Illaut, Laisamis and Loglogo. The loose surface material is however readily (a time-span of several years) re-occupied by Indigofera and/or other dwarf shrubs, and may stabilise after a number of seasons
Accessibility to livestock: The lower parts are locally temporarily inaccessible due to flooding during the wet season

Mapping unit 28: Pl1

Surface area: 400 km; 0.6% of total district area
Geology: Lake bed deposits, derived from various parent rock
Relief, Topography: Almost flat and very gently undulating topography
Vegetation, landuse: Indigofera dwarf shrub
Soils: Well drained, very deep, pale brown, very friable, strongly calcareous, saline, fine gravelly stratified sandy loam
Topsoil condition and erosion hazard: The surface soil is very low in organic matter content, but due to texture and consistency, has a fairly high infiltration capacity. The topsoil is unstable in respect to wind action; deflation and accumulation of soil material seems a continuous process. The area is sensitive to overutilization however: deflation can easily lead to the formation of unproductive desert pavements

Mapping unit 29: Pl2

Surface area: 495 km; 0.7% of the total area
All features as unit 28, but with frequent table-land-like calcrete outcrops. Formerly common Acacia tortilis woodland, of which nowadays some scattered remnants are left
Mapping unit 30: Pl3
Surface area: 1225 km; 1.8% of total district area
Geology: Lake bed deposits, from various sources
Relief, Topography: Flat to almost flat floor of former lake, presently forming the Chalbi desert
Vegetation, landuse: Nil
Soils: Imperfectly to poorly drained, very deep, brown to olive grey, strongly calcareous, strongly saline and sodic soils of varying, mostly fine, textures
Condition: Seasonally flooded, highly saline soil with extensive salt crusts at surface. The area is of no value to rangeland use

Mapping unit 31: P1X

Surface area: 1695 km; 2.55 % of total district area
Geology: Sandy and calcareous lake bed (?) sediments derived from various sources, mainly non-volcanic (a.o. Turkana grits?)
Relief, Topography: Very gentle to almost flat terrace remnants at three main topographic levels, separated by rather extensive badland topography, i.e. intricately dissected, very steep, short slopes
Vegetation, landuse: bushland and bushed grassland
Soils: (1) at terrace remnants; - Somewhat excessively drained, deep, pale brown, friable, calcareous loamy sand (high and middle level) - Well to imperfectly drained, very deep, pale brown, friable and loose, calcareous and saline stratified soils of mostly coarse sandy textures (lowest level) (2) in badland topography: - excessively drained sandy soils of varying depth
Condition of topsoil and erosion hazard: At the terrace remnants the soils have a high infiltration rate due to coarse sandy textures and a low erosion hazard. However on the lowest level of the terrace remnants the soils are sensitive to wind erosion. The badland topography is considered a result of subrecent geomorphic processes, and not due to man-induced accelerated erosion
Accessibility to livestock: The lowest level

of the terraces is in the wet season temporary and locally inaccessible due to flooding. The badlands are inaccessible

Mapping unit 32: AA

Surface area: 1165 km; 1.7% of the total district area
Geology: Undifferentiated, predominantly recent alluvial deposits
Relief, Topography: Almost flat, 1%
Vegetation, landuse: Locally perennial grassland; locally woodland and bushland of Acacia seyal
Soils: Seasonally flooded, imperfectly drained, very deep, firm, dark reddish brown, calcareous, cracking clay, or stratified sandy clay loam to sandy loam, locally saline and sodic
Condition of topsoil and erosion hazard: The area is a productive one, mainly due to the seasonal floodwaters that it may receive. Locally the situation is taken advantage of by the cultivation of sorghum. Perennial grassland is not uncommon. In prolonged drought periods the soils develop a thick loose layer over a hard, deeply cracking subsoil. Along stream courses a network of gullies tend to develop during the periods of flooding (streambank erosion), with the sub-surface cracks as a starting point
Accessibility to livestock: In the wet season the accessibility may be severely limited due to flooding and/or sticky and muddy soil consistence. Locally also dense Acacia bush poses restrictions

Mapping unit 33: BV

Surface area: 595 km; 0.9% of total district area
Geology: Sediments derived from undifferentiated volcanic rocks, including pyroclastics and ashes
Relief, Topography: Almost flat to very gently sloping
Vegetation, landuse: Mainly dwarf shrubland of Indigofera with sparsely scattered Acacia reficiens, Euphorbia cuneata
Soils: Well drained, deep, very friable, yellowish brown strongly calcareous, fine gravelly sandy loam, locally with calcrete gravel or layers at shallow depth
Condition of topsoil: Rather good to moderate infiltration rates, although also signs of runoff at lower slope parts and valley centre has been observed
Erosion hazard: Low sheet erosion hazard; no gully development; moderate wind erosion hazard
Accessibility to livestock: No restrictions

Mapping unit 34: VC

Surface area: 1386 km ; 2.1% of total district area
Geology: Partly basalts, and alluvium derived from various rocks
Relief, Topography: Valley complex of riverine plateau incision and areas of badland topography associated with these
Vegetation, landuse: Various. Dense bushland and annual grassland
Soils: Complex of various, mainly bouldery, dark clay soil
Condition of topsoil and erosion hazard: Unstable area, largely badly eroded and being eroded, probably due to overutilization (north of Turbi; Ethiopian border).The badland areas and valley incision are of low accessibility, also due to dense bushland

Mapping unit 35: DX

Surface area: 615 km; 0.9% of total district area
Geology: Windblown sands and sandy loams of various origin
Relief, Topography: Dunes; rolling mesotopography of short convex slopes
Vegetation: Euphorbia cuneata over Indigofera dwarf shrubland
Soils:Association of: (1) on the dunes: - Excessively drained, very deep, reddish yellow, very friable calcareous and sodic sand (2) in between the dunes: - poorly drained, very deep (locally shallow), dark brown, firm, calcareous saline and sodic, sandy clay loam with locally calcrete gravel or - layers at shallow depth
Erosion hazard: The dunes are very sensitive to overutilization, so that "reactivation" of these dunes takes place under moderate grazing pressure

Mapping unit 36: La

Surface area: 5625 km; 8.4% of total district area
Geology: Basalt flows of recent and subrecent origin
Relief, Topography: Overall landform almost flat, but rugged meso topography of numerous ridges of rock outcrops, with pockets of soil in between

Vegetation: Mainly bushland and annual grasses
Soils: Extremely rocky, bouldery and stony area with a restricted amount of well drained clay to clay loam soils of varying depth
Accessibility to livestock: The area is virtually inaccessible to livestock

SOIL PROPERTIES OF RELEVANCE TO THE QUALITY OF RANGELAND

This chapter will deal with soil properties that influence the performance of rangeland. Firstly those characteristics will be presented that determine the primary production of forage and browse (Water availability, effective surface area, fertility);Secondly those that are of importance to management aspects of rangeland, like accessibility and erosion hazard.

Water availability

The availability of moisture for the growth of natural vegetation and agricultural crops is dependent on rainfall, moisture storage capacity of the soil, eventual salinity, and (very important in arid/semi-arid areas) the infiltration capacity of the surface soil.

Soil moisture storage capacity (SMSC) depends mainly on the depthof the soil (effective soil depth, rooting space) together with the available water capacity of each soil horizon (AWC). The AWC is expressed in % or in mm water per m. soil, and depends on in a number of physical soil properties that will not be dealt with here, as collection of these data was not possible in the context of this survey work. As a rule of thumb, however, the order of magnitude of AWC is related to the soil texture. Approximate values are given below for homogeneous soils of one meter deep, that have no stones, boulders, gravel or hardpans of any kind. (After Bookers Soil Manual):

High AWC: >180 mm.m Very fine sandy and silty textures
Moderate AWC: 120-180 mm.m clayey soils, silty clay loams, sandy loams
Low AWC: <120 mm.m Sands, loamy sands, coarse sandy loams

The depth of soil, from surface to rock or impenetrable layer, together with the volume of coarse fragments, as stones, boulders, gravel, determines the rooting space.

Soils are considered deep and very deep when they have a depth of over 80 cm. Moderately deep soils are between 40 and 80 cm deep; shallow soils 20-40 cm, and very shallow soils less than 20 cm.

The amount of moisture in the soil is not only dependent on the amount of rain and the SMSC. Of crucial importance, especially in arid and semi-arid conditions, is the infiltration capacity of the surface soil. Infiltration determines what percentage of the already scarce rainfall actually penetrates into the soil and becomes available to plant growth. No measurements of infiltration capacity have been made, as this was not feasible in the context of the present study (Infiltration tests are time consuming, logistically difficult, and reliable only if many replica's are made). It is sufficiently known from other areas in Kenya how one can expect the surface soil to behave in heavy showers of short duration. It is also predictable from surface features whether high or low infiltration rates are likely. In this context soil degradation plays an important role, i.e. the status of over-utilization of the rangeland, and consequently its top soil conditions, (organic matter content; structure) and basal vegetative cover.

For soils developed on Basement System Rocks and derived sediments the degree of top soil sealing is an adequate parameter or "quick look method" for estimating infiltration: A strongly sealed surface hardly allows any rainwater to enter the soil. Soils developed on volcanic ashes or soils with volcanic ash admixture usually have high infiltration rates. Also, generally speaking, better infiltration rates are found on well vegetated areas, i.e. those with higher rainfall, vegetation and organic matter in the topsoil.

An estimate for all units is given in table I.1, where 1 denominates high infiltration; 2 moderate, and 3 low rates.Results of these three components of soil moisture availability, and a final classification is given in the same table.

The ratings for effective soil depth taken into account also stoniness. The AWC according to texture, receives an "upgrading" in case of high organic matter content in the soil. The final ratings range from 1 = very high soil moisture storage capacity to 5 = very low SMSC.

A good performance in respect of water availability (apart from climate) is offered by mountains and hills on volcanic and pyroclastic rocks high-level volcanic foot-ridges: the almost flat volcanic plateaus, plains and piedmont plains the high lying component (windblown deposits) of sedimentary areas (mapping units 1 and 2: MV; 4 and 5: HP; 7: FrV1; 13: LV1; 15: LV3; 20: YV2; 22: PV1; 25: PsU2; 26: PsU3; 27: PsU4).

A poor performance offer the basement system and volcanic hills, the step faulted volcanic plateau the uplands in basement system rocks and on pyroclastic rocks the more recent lavaflows and the low lying components of various sedimentary areas (mapping units 3: HU; 6: HV; 14: LV2; UU; 17: UP; 23: PV2; 25: PsU2; 26: PsU3; 27: PsU4; 36: La).

Effective surface area

Stones, gravel and boulders on the soil surface pose a reduction of these effective surface area. A good, productive soil that is covered for 40% by stones for example, is only covered by vegetation for the remaining 60%, so only 60% of the units surface area can be considered as grazing area.

Table I.1, last column, gives the estimated "effective grazing surface percentage" in classes; 1 means over 80%; 2 : 60-80%; 4: 20-40% and 5 means less than 20% effective surface area.

Nutrient, availability, toxicity

Fertility of the soil is in agricultural production important, and equally in rangelands a fertile soil tends to produce more vegetation than a soil with nutrient deficiencies. It has been argued that in areas of less than 500 mm of rainfall per year the soil fertility is not an important limitation to productivity.

It has been observed in this study that in general the soils in Marsabit District, being under semi-arid to arid climate, show high amounts of calcium, that the pH ranges from 7.0 to 8.5 and that the soils are not likely to be deficient in P and K.

Of these dry areas the topsoils are very low in organic carbon however (<0.55) and probably also in Nitrogen (not determined).The tentative conclusion is that natural fertility is not a major factor in the rangelands of Marsabit District.

Salinity reaches toxic levels in a number of places, such as the Chalbi Desert (mapping unit 30: P13) and locally in alluvial deposits of mapping units 29: P12; 33: BV, 32: AA and 19: YV1, where the soil is practically devoid of vegetation.

It is not known whether sodicity reaches toxic levels in Marsabit District. High sodicity is found in most sedimentary plains: mapping units 25: PsU2 (partly) and 27: PsU4 (lower level). This has an adverse effect on soil structure, infiltration and erodibility, rather than a direct influence on plant growth.

Erosion Hazard

Soils influence the production of rangelands indirectly by their resistance or sensibility to overgrazing. Areas from where more vegetation is grazed (removed) than yearly is produced, the vegetation cover changes its composition, tends to diminish and disappear gradually. When the cover of natural vegetation disappears, soil degradation of some form is sure to take place, the most well known being soil erosion.

It depends on the type of soil how this degeneration will proceed, and in what form, and to what extent the degrading soil has a capacity to allow the vegetation cover to recuperate when grazing pressure is relieved.

The removal of vegetation and exposure of bare soil to the atmosphere has an adverse effect through a change in soil temperature regime: the humus of the top soil tends to disappear (oxidation), while the impact of raindrops and treading of livestock is much stronger on the bare soil surface. The result is a surface layer of structureless soil particles that have either a loose (very : "friable" or "fluffy") or a highly compacted concrete-like (soil "sealing") character. The former, loose, very dusty, degraded soil surface is common on soils of volcanic origin /especially ashes or ash-enriched soils) or on sediments derived from volcanics. The latter, sealed surface, commonly develop on soils derived from Basement System rocks.

The three main forms of erosion: sheet, gully and wind erosion are active in Marsabit District. The term sheet erosion is an incorrect but (formerly) widely used term referring to the result of rill or rill wash erosion meaning that surface soil is removed sheet-wise by run off water over large tracts of land. This in contrast to the situation indicated by gully erosion where run off water is concentrated in narrow channels or gullies. It is often implied that gully erosion is a deteriorated further stage of sheet erosion.Both forms of erosion occur in Marsabit on rather different soils however. Wind erosion is the removal of loosened soil particles by wind action, a feature also strongly represented in Marsabit District.

Forms of erosion and possibilities for recuperation

Sheet erosion.

A common feature on overutilized soils of Basement System areas (all -U units) is sheet erosion in various stages of progress. This is associated with a lesser or stronger sealing of the surface, in a hard and compacted soil surface, that has a strong negative influence on the possibilities for the recuperation of the vegetative cover. A strongly sealed surface causes a low infiltration rate and higher percentage of already scarce to runoff. The hard surface is a strong limitation for seeds to germinate and creepers (stolons) to root. Reseeding, if ever planned, will fail if these soils are not plowed in advance - in the context of extensive rangeland use a too costly exercise. Strong forms of sheet erosion and sealing are observed at mapping unit 16: UU between Illaut and Korr. Recuperation of the natural vegetation will take probably a period of time in the order of magnitude of 10-20 years. Less severe forms of sheet erosion and surface sealing are locally observed in mapping unit 10: FU, and also rather widespread in the low-lying component of the sedimentary plains (mapping units 26: PsU3 and 27: PsU4).

Gully erosion

Sealing of the surface soil is usually not, or to a far lesser extent, observed on soils in the volcanic areas. In the for Marsabit District higher rainfall areas, on the volcanic slopes of Marsabit, Hurri and Kulal, some gully erosion is observed (not meaning the gullies in mapping units 7: FrV1 and 8: FrV2, as those ravine-like drainage are considered results of a natural geological/morphological process).Subsurface cracks in the mainly clayey soils in volcanic areas are thought to be the starting point for gully development, and also for the rather common "sinkholes", "tunnelerosion" or "piping" that occur also in the drier volcanic regions. On some sloping areas of the mentioned hill masses (especially Hurri Hills), gullies have been observed that are nowadays completely recovered by grass vegetation. The rather favourable physical and chemical properties of these red clays are apparently allowing a rather fast recuperation of the natural vegetation on a bare surface of this soil type. Yet the development of erosion gullies, especially on the grazing areas of the Hurri Hills, Marsabit, Kulal and Asie are a cause for concern, as these areas are classified as high potential (cattle) grazing areas, a comparative rare feature representing a good deal of the total production of the district.

A serious form of accelerated gully development is observed north of Turbi (mapping unit 34: VC) in dark coloured cracking clay soils, that probably are sodic (unstable clays) in the deeper subsoil.

An altogether different type of erosion gullies are the activated lines of drainage in the footslopes (mapping unit 10: FU) of the Basement System Hills /e.g. Ndoto Mountains). This gully development is not so much the result of over grazing on the footslopes itself, but rather due to removal of protective vegetation in the hills, causing a different hydrological regime in the catchment region above the footslopes.

The badland topography of mapping unit 31: P1X is considered (like the ravines of units FrV1, FrV2), the result of a recent geomorphological condition rather than man-induced erosion.

Wind erosion and deposition

A less conspicuous, but widespread feature is wind erosion, especially in the dry volcanic areas and on the sedimentary plains. It is largely the trampling of livestock that looseness the soil surface particles, which are picked up by the constantly strong and dry southwesterly wind.

Soils that are sensitive in this respect are those that exist of the volcanic ash deposits and/or that are ash-enriched mapping units 17: UP; 21: YC; 18: YP; 11: FP; 20: YV2; 28: Pl1; 29: Pl2; 30: Pl3 and locally 9: FrV3; 14: LV2 and 15: LV3). Also prone to wind erosion are those soils that exist of subrecent windblown deposits such as dune formations (mapping units 35: DX, high level component of mapping units 26: PsU3 and 27: PsU4).

The ultimate stage of wind erosion in many areas of volcanic origin is the so-called desert pavement, i.e. areas where the surface is covered by a residually enriched layer of gravel. Unit UP and parts of YC are notorious in this respect; the only vegetation left being some shrubs in the lines of drainage. Also the areas around Balesa (mapping unit 15: LV3). Kalacha and Maikona (mapping unit 9: FrV3) show the same kind of deterioration. Obviously the restoration of a vegetation cover in areas with a top soil that exists of pure gravel, will be a long term process.

Wind erosion on areas that exist of originally windblown material forms a less conspicuously dramatic rangeland deterioration, while a positive aspect in these areas is the distant neighbourhood.These recent windblown deposits / especially in mapping unit 27: PsU4) have one favourable characteristic, which is a high infiltration capacity for rain and apparently are readily repopulated by Indigofera spinosa dwarf shrubs.(mapping units 26: PsU3; 27: PsU4; 35: DX; 28: Pl1; 29: Pl2 and 21: YC).

Actual and potential erosion

On the map legend a column is reserved for "Erosion hazard after removal of vegetation". The actual erosion or top soil degradation is not evenly distributed over the various soil mapping units, but mainly concentrated around permanent water holes. This actual situation is not expressed in the map legend under the column erosion hazard. The legend indicates only a comparison between units in the respect of sensitivity to erosion that will take place if the area is under too high grazing pressure.

Table I.2 presents ratings for potential erosion (1: slight, 2: moderate, 3: strong) or erosion hazard, whereby the fourth column gives an estimation as to the possibility for the recuperation of the vegetation, (1: <5 years, 2: 5-10 years, 3: >10 years).

A fifth column gives the final ratings for sensitivity to erosion/degradation hazard, ranging from 1: slightly sensitive to 4: highly sensitive. Distribution of these final ratings are presented in figure 5.2.

Areas in drier climate zone are naturally more sensitive to erosion than in areas of higher rainfall - mainly due to less natural vegetation and a consequently weaker coherence of the top soil structure. Unfortunately it is not possible in the context of this study to reach to a more quantitative erosion hazard determination for the purpose of range evaluation and carrying capacity.

Constraints to the accessibility for livestock

Livestock has to travel daily, or almost daily, between boma, grazing area and watering point. The greater this action radius (with mostly the watering point as focus) the more pasture available.

Where the easy progress of the daily movement is hampered, the action radius, and thus are grazing, is reduced. A notorious obstacle in this respect, especially for cattle, are surface stones and boulders. In the wet season not only flooded areas are inaccessible, but also muddiness or stickiness of clay soils are, temporarily, a constraint.

The following land characteristics have been taken into account for the evaluation of accessibility for livestock (see table I.3):

- stoniness-rockiness at the surface (1: no stones; 3: very rocky);
- steepness of the terrain (1: flat, gently undulating; 3: steep);
- flooding, ponding, stickiness, muddiness in wet season only (- = no additional constraints; 5 = inaccessible)

Especially goats are more adapted to rough terrain conditions, and can reach areas that are otherwise inaccessible to cows. Camels are assumed to take an intermediate position in this respect. Table I.3 gives ratings of the land for goats, camels and cattle separately, whereas rating 1 stands for "no restrictions" and 5 for "virtually inaccessible". Additional wet season constraints-ratings indicated between brackets reflect only temporary or localized situations.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

As part of data gathering for the compilation of the Range Management Handbook (RMH), a survey was conducted in Marsabit District on landforms and soils Satellite image interpretation and field checks have led to the production of a 1:1 million scale landforms and soil map, of which the units are described in terms of topography, rock type, soil properties and land qualities pertaining to rangeland potential. These land qualities are rated and presented in tabular form and in maps.

It can be concluded that in view of available moisture storage capacity, infiltration capacity, surface stoniness and soil fertility, the rated levels of productivity (not including climate) are distributed as follows:

- High level of productivity: 30% of the District area.
- Moderate level of productivity: 39% of the District area.
- Low level of productivity: 31% of the District area.

Ratings of soil erosion hazard are distributed as follows: 11% of the District area is rated non-slightly sensitive to erosion, and has good possibilities for the recuperation of the vegetation; 31% of the area is rated slightly to moderately sensitive to erosion; 47% of the area is rated moderately to severely sensitive to erosion; 11% of the district is highly sensitive to erosion, where recuperation of the vegetation cover will be a long term process.

Serious actual soil degradation is only observed in the vicinity of waterholes, where also the settlement of pastoralists becomes permanent (Kargi, Korr, Illaut, Laisamis, Loglogo, Balesa, Kalacha, Maikona and recently also Guz and Dukana).

In a number of cases a return of the original vegetation cover seems possible in the near foreseeable future. In others the area seems beyond repair. The type of soil plays a crucial role in the degradation process and in the possibilities for the recuperation of the vegetative cover.

A general tendency can be observed that areas of low productivity due to climate, are more sensitive to erosion, especially wind erosion.

Restrictions in accessibility for livestock, due to rockiness, stoniness and/or steepness of the terrain are distributed as follows:

- no restrictions in 37%,
- slight restrictions in 17%,
- moderate restrictions in 33% and
- severe restrictions in 12% of the District.

An additional 13% of the survey area is in the wet season temporarily inaccessible due to flooding; a further 33% of the District poses possibly in the wet season due to stickiness or muddiness of the terrain.

During the survey it has been observed that highest grazing pressure is found on the areas of relative high potential. These are the marginal areas around the agriculturally suitable land of the Marsabit, Hurri, and Kulal hill masses, where livestock of mixed farming systems meets with pastoralist grazing. It is recommended to start more detailed reconnaissance studies into the potential of these areas, in order to come to balanced controlled stocking rates, as these areas are of crucial value to pastoralists, and in the present circumstances subject to degradation.

In order to overcome the lack of quantifiable data, studies should be conducted that lead to the knowledge of maximum sustainable carrying capacity. These studies should be carried out on a restricted number of sites that are representative in climate, soil type and vegetation for large tracts of the ASAL areas, and should be chosen on the basic of the present RMH inventories. The development of mathematical models could play a role in attaining the desired results.

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Table I.1: Ratings of primary production related soil factors listed by mapping unit

Unit no.	Mapping unit symbol	Effective soil depth	Available water capacity	Infiltration capacity	Final rating water availability	Effect. surface area
1	MV1	1(3)	1	1	1	1-2
2	MV2	1	1	1	1	1
3	HU	3	3	2	4	3-4
4	HP1	2	1	1	2	2
5	HP2	2	2	1	2	2-3
6	HV	3	3	2	4	4
7	FrV1	2-3	1	2	2	3
8	FrV2	2-3	2-1	3	3	3
9	FrV3	2-3	2	2-3	3	3(4)
10	FU	1	2-3	2	2-3	1
11	FP	2-3	2-3	2	3	2
12	FV	1-2	2	2-3	3	2-3
13	LV1	1	2	2	2	2(4)
14	LV2	3-2	2	2	4	4
15	LV3	1	2	2	2	2(4)
16	UU	3-2	2-3	3	4	1
17	UP	2-3	3	3	5	(4)5
18	YP	3	2-3	2-3	4	4
19	YV1	1	2	2-3	3	3
20	YV2	2	1-2	1	2	1
21	YC	2	2	2	3	52
		2	1-2	1	3	1
22	PV1	1	2	2	2	1-2
23	PV2	1	2	2	2	3-4
		4		3	5	
24	PsU1	1	1-2	1-2	2	1
25	PsU2	1	2	2	2	1
		3	2	4	5	
26	PsU3	1	2-3	1	3	
		1	2	3	3	
27	PsU4	1	2-3	1	2	1
		3	2	4	5	
28	Pl1	2	2	2	3	1
29	Pl2	3-2	2	2	3-4	1(4)
30	Pl3	4	1-2	3-2	5	1
31	P1X	1	3	1	2	1
		3	2-3	3	5	
32	AA	1	2-1	2	2	1
33	BV	1-2	2	2	2-3	1
34	VC	2(?)	2(?)	2(?)	3(?)	2(?)
35	DX	1	2-3	1	2	1
		3	2	3	4	
36	La	4(1)	2	2	5(2)	5

Table I.2: Ratings of forms of erosion hazard and possibilities for recuperation of the natural vegetation listed by mapping unit

Unit no.	Mapping unit symbol	Sheet erosion hazard	Gully erosion hazard	Wind erosion hazard	Possibilities for recuperation	Final rating
1	MV1	1	2-3	1	1	2-4
2	MV2	1	1-3	2	1	1-4
3	HU	3	3	1	3	4
4	HP1	1	1	1-2	1	1
5	HP2	1	2	2	1	1
6	HV	2	2	2	2	3
7	FrV1	1	3	1	1-3	2-4
8	FrV2	1	3	1-2	2	3-4
9	FrV3	1	2	2-3	2	3
10	FU	3	2	1	2	3
11	FP	2	1	2	2	2
12	FV	2	3	2	2	4
13	LV1	1	1	2	1	1
14	LV2	1	1	2	1	1
15	LV3	1	2	2	2	2
16	UU	3	2	2	3	4
17	UP	1	1	2	3	3
18	YP	2	2	3	3	4
19	YV1	2	2	3	2	4
20	YV2	1	1	2	1	1
21	YC	1	1	2	3	2
		1	1	3	2	2
22	PV1	1	2-3	2	2	3
23	PV2	1	1	2	2	2
24	PsU1	2	1	1	2	2
25	PsU2	1	2	3	2	3
		3	2	2	3	4
26	PsU3	1	1	3	1	2
		3	1	2	3	4
27	PSU4	1	1	3	1	2
		3	1	2	3	4
28	Pl1	1-2	1	3	2	2-3
29	Pl2	2	1	3	2	3
30	Pl3	1	1	2	3	2
31	P1X	1	1	2	1	2
		2	3	1	3	4
32	AA	1	2-3	2	2	3
33	BV	1	1	2	1	2
34	VC	2	3	2	2	4
35	DX	1	1	3	1	2
		1	1	2	3	3
36	LA	1	1	1	1	1

Table I.3: Ratings of constraints to accessibility for livestock listed by mapping unit

Unit no.	Mapping unit symbol	Constraints due to slope, topography	Constraints due to surface rocks,stones	Constraints in dry season for: sheep & goats	camels	cattle	Additional wet season constraints
1	MV1	2	2	1	3	3	-
2	MV2	1-2	1	1	1	1	-
3	HU3	3	3	4	5	5	-
4	HP1	1	1	1	1	2	-
5	HP2	1-3	1-2	1	2	3	-
6	HV	3	2	3	5	5	-
7	FrV1	1-3	2	3	5	5	-
8	FrV2	2	2	1	2	3	3
9	FrV3	2	1-3	2	3	4	2
10	FU	1	1	1	1	1	-
11	FP	1	1	1	1	2	-
12	FV	1	2	1	2	3	-
13	LV1	1	1	1	1	2	-
14	LV2	2-3	2-3	2	3	5	-
15	LV3	1	1-2	1	2	3	2
16	UU	1	1	1	1	2	-
17	UP	2	1-2	1	3	4	-
18	YP	2-3	1-2	1	1	2	-
				2	3	5	5
19	YV1	1	2	1	1	1	(5)
20	YV2	1	1	1	1	1	-
21	YC	1	1	1	1	1	-
							3
22	PV1	1	1	1	1	2	3
23	PV2	1	2	1	3	4	(3)
24	PsU1	1	1	1	1	1	-
25	PsU2	1	1	1	1	1	-
							5
26	PsU3	1	1	1	1	1	-
							2
27	PsU4	1	1	1	1	1	-
							5
28	Pl1	1	1	1	1	1	(3)
29	Pl2	1	1	1	1	1	(5)
30	Pl						
3	1	1	1	1	1	5	
31	P1X	1	1	1	1	1	-
		5		5	5	5	
32	AA	1	1	1	1	1	5
33	BV	1	1	1	1	1	(5)
34	VC	1	1	1	3	4	4
		3	3				
35	DX	3	1	1	1	3	-
							3
36	La	3	3	3	5	5	-

CHAPTER II
VEGETATION TYPES

Wolfgang Schultka

Vegetation type 1: Forest (see Plate II.1)

Trees form dense stands over large areas with closed canopies and possess their own bioclimates. In the survey area, forests are generally montane and evergreen, with trees up to 40 meters high. Some areas may have been partially cleared and replacement populations are mosaics of evergreen bushes and montane grassess and, therefore, can be utilised for grazing. In general, these are not grazing areas. That is, they have been declared National Parks or Reserves.

Occurrence in Marsabit District: Kulal (7)*, Marsabit National Park, Marsabit National Reserve
Comments: Species composition and frequencies highly variable. No grazing, protected areas. On Mt. Marsabit partially semi-deciduous forest with *Croton megalocarpus*.

Growth form:	Most common species:	Frequency:	Range unit:
Trees:	*Juniperus procera*	up to 65%	(7)*
	Cassipourea malosana	40%	
	Diospyros abyssinica	40%	
	Teclea nobilis	30%	
	Olea hochstetteri	25%	
	Olea africana	25%	
	Teclea simplicifolia	20%	
	Apodytes dimidiata	10%	
	Croton megalocarpus	frequencies	Marsabit Park
	Strombosia scheffleri	not	
	Ekebergia capensis	available	
	Premna maxima		
Shrubs and bushes:	*Rytigynia neglecta*	up to 35%	
	Psychotria kirkii	20%	
	Clausena anisata	10%	
	Erythrococca bongensis	10%	
	Allophylus abyssinicus	10%	
Grasses:	*Oplismenus hirtellus*	up to 25%	
	Schoenoxiphium lehmannii	10%	
Dwarfshrubs and herbs:	*Impatiens meruensis ssp. teptentr.*	up to 30%	
	Dicliptera colorata	20%	
	Desmodium repandum	10%	
	Pentas lanceolata	5%	
	Achyranthers aspera	5%	

* Figures in Brackets refer to Range Unit numbers as in Chapter IV

Vegetation type 2: Woodland (see Plates II.2 & II.3)

In contrast to forest, woodland stands either do not form closed canopies, or the tree covered areas are too small for the development of an individual bioclimate (eg. this applies to the riverine woodland). At higher altitudes, woodland stands are small groups, or loosely associated trees that may be forest remnants. At high altitudes these may be evergreen trees (eg. *Olea africana*); whereas, at median and lower altitudes these are generally deciduous trees (eg. *Erythrina burtii*, *Acacia-* and *Combretum sp.*). Ground cover is montane grassland with dominating *Themeda triandra* (to a lesser degree *Bothriochloa insculpta*) and *Chrysopogon plumolosus*. At lower altitudes, the loosly associated trees may still be over 10m in height. Crown areas are over 20% of ground cover and shrub is frequently found in between trees but usually covers less than 10% of the overallcrown area. As a rule, a well developed herblayer consisting of grasses, herbs and dwarfshrubs exists. In the survey area, *Acacia tortilis* woodland is commonly found.

Occurrence in Marsabit District: South Horr (4)*, Kulal (7), Huri Hills (13), Marsabit East(18), Rusa-rus(20), Marsabit National Reserve, Losai National Reserve
Comments: Usually consists of loosely associated stands of variable density and composition, crown cover areas of up to 10%, *Acacia tortilis* stands of up to 30%. **Herblayer** usually consists of species comparable to those of perennial grasslands at higher altitudes (see vegetation type no.3).

Growth form:	Most common species:	Frequency:		Range unit:
Trees:	*Juniperus procera*	frequencies		(7)*
	Olea africana	not		
	Erythrina burtii	available		(7,13)
	Acacia nilotica ssp. subalata			(13)
	Acacia drepanolobium			(7)
	Acacia etbaica			(7)
	Combretum molle			(13,18)
	Acacia tortilis ssp. spirocarpa			(20)
Dwarfshrubs:	*Duosperma eremophilum*	up to	80%	esp. in A. tortilis woodland(4)

Vegetation type 3: Perennial grassland at higher altitudes (see Plate II.4)

Perennial grasses dominate; though, intermittened groups of trees and shrubs with crown cover of the less than 2% may also be found. Types may be differentiated according to height:

"giant"	over 3m in height (eg. stands of *Penisetum purpureum*; not found in the survey area).
"tall"	1.5 -3m in height (eg. *Themeda* grassland).
"short"	below 0.25m in height (eg. *Cynodon macrostachyus*).
"dwarf"	below 0.10m in height (eg. *Enneapogon*, *Oropetium*).

Occurrence in Marsabit District: Kulal (7)*, Huri Hills(13), Mt Marsabit (18)
Comments: The productivity of these areas may be endangered by fire and/or overgrazing.

Growth form:	Most common species:	Frequency:		Range unit:
Grasses:	*Themeda triandra*	up to	70%	18
	Chrysopogon plumolosus		60%	
	Bothriochloa insculpta		20%	
	Setaria incrassata		5%	

Vegetation type 4: Evergreen to semi-deciduous bushland with perennial grassland (see Plate II.5 & II.6)

This vegetation type is defined to consist of montane bushes with *Euclea schimperi*, *Euclea divinorum*, *Carissa edulis*, *Grewia similis* a.o.. At higher altitudes they project from *Juniperus procera/Olea africana* montane forests. In between groups of bushes lawns of perennial grasses with *Bothriochloa insculpta*, *Eragrostis braunii*, *Digitaria scalarum* and/or *Themeda triandra* may be found. Due to high grazing pressure these populations have been strongly disturbed (ie. erosion and over-grazing indicators esp. *Solanum incanum* exist). At lower altitudes, but generally over 900m a.s.l, deciduous bushes (eg. *Acacia etbaica*, *Acacia nilotica* and *Commiphora* sp.) dominate. *Chrysopogon plumolosus* is the dominant grass-type found.

Occurrence in Marsabit District: Kulal (7)*, Mt. Marsabit (18)

Comments: Usually strongly differentiated, separate woody stands which cover up to 20% of ground area; frequency estimates refer only to within stands. In between grassland (see vegetation type 3), at approximately 1600 m a.s.l. different species composition.

Growth form:	**Most common species:**	**Frequency**:		**Range unit:**
Trees:	*Juniperus procera*	up to	60%	(7)
Bushes:	*Rhamnus prinoides*	up to	40%	
	Euclea schimperi		30%	
	Carissa edulis		10%	
	Turraea mombassana		5%	
	Rhus natalensis		5%	
	Jasminum floribundum		5%	
	Cussonia holstii		5%	
Grasses:	*Digitaria scalarum*	up to	30%	alt. 1,600m
	Setaria sphacelata		15%	a.s.l
	Eragrostis braunii		10%	
	Cyperus obtusiflorus		5%	
Disturbance indicators:	*Solanum incanum*	up to	80%	
	Conyza pyrrhopappa		80%	

Vegetation type 5: Deciduous bushland (Plate II.7)

By definition, the terms "bush" and "shrub" both connotate a woody plant with a multiple number of separate stems; so that, "bushland" and "shrubland" could be termed synonimous. In East Africa, however, "bushland" refers to a vegetation type in which beside high bushes occasional trees may be found. "Shrubland", in all associations, is smaller and usually without trees. As a rule, deciduous bushland refers to a vegetation type consisting of fairly dense stands of trees (distinctly differentiated into trunk and crown) and bushes which are usually not higher than 10m and have a crown cover of 20%. The development of thickets is common with overall crown cover of at least 60% and frequently over 90%. Penetration of grazing animals into these structures may become nearly impossible. The understory herblayer is normally weakly developed. Livestock often only graze on way- or roadsides, or other open areas.

Occurrence in Marsabit District: Kulal (7)*, Kalacha (10), Maikona (14), Marsabit W. (15), Sololo (16), Marsabit E. (18), Mado Kelu (23), Marsabit National Reserve

Comments: Highly variable species composition, up to 30% of crown covered area, frequent thicket formation with up to 90% cover. Grazing only in open areas or on the edges of copses.

Growth form:	Most common species:	Frequency:		Range unit:
Trees:	*Commiphora (div. spp.)*	frequencies		
	Erythrina melanocantha	not		(16)
	Delonix elata	available		
	Boswellia rivae			(21)
	Delonix baccal			(21)
	Acacia zanzibarica ssp. microphylla			(16)
Bushes:	*Acacia mellifera*			
	Acacia nubica			
	Croton dichogamus			
Grasses:	*Chrysopogon plumolosus*	up to	15%	Marsabit Natl.
	Setaria verticillata		15%	Reserve
	Urochloa panicoides		10%	
	Echinochloa stagnina		5%	
	Aristida adscensionis		5%	
	Themeda triandra		5%	
	Pennisetum mezianum		5%	
Dwarfshrubs:	*Duosperma eremophilum*	up to	60%	

Vegetation type 6: Deciduous shrubland (see Plates II.8, II.9, II.10 & II.11)

Shrubs are less than 6m in height with overall crown cover of maximally 20% of ground cover. Should occasional trees exist, they form less than 10% of the overall crown cover. The herblayer is only weakly developed. Thicket development is common.

Occurrence in Marsabit District: Ileret (1)*, Hurran Hurra (5), Mt. Kulal (7), Hedad (8), Koroli (11), Maikona (14), Sololo (16), Marsabit East (18), Sibiso Malbebale (21), Marsabit National Reserve
Comments: The cover by woody species is usually around 20%; ocassional thicket formation with ground covers up to 90%. In all layers variable species frequencies.

Growth form:	**Most common species:**	**Frequency:**		**Range unit:**
Shrubs:	*Acacia zanzibarica ssp. microphylla*	up to	40%	(16,21)
	Acacia mellifera		20%	
	Acacia nubica		20%	
	Acacia reficiens		10%	
	Acacia paolii		5%	
	Acacia tortilis ssp. spirocarpa		5%	
	Balanites obicularis		5%	
	Commiphora (div. spp.)		5%	
	Cordia sinensis		3%	
	Cadaba farinosa		2%	
Grasses:	*Setaria acromelaena*	up to	30%	(16)
	Aristida adscensionis		20%	
	Lintonia nutans		20%	(16)
	Sporobolus pellucidus		20%	(16)
	Leptothrium senegalense		10%	
	Sorghum purpureo sericeum		10%	(16)
Dwarfshrubs and herbs:	*Duosperma eremophilum*	up to	60%	
	Blepharis linariifolia		40%	
	Sericocomopsis hildebrandtii		20%	
	Aspilia mossambicensis		10%	
	Heliotropium albo hispidum		10%	
	Indigofera spinosa		10%	

Vegetation type no 7: Shrub-grassland (see Plate II.12)

This vegetation type consists of occasional bushes or shrubs or groups of both. Bushes always persist but have crown cover areas of less than 10%, frequently less than 5%. Bushes and shrubs may be found in varying combinations with annual or perennial grasses and herbs. Common examples of Kenyan shrub-grasslands are: *Commiphora/Acacia* shrub-grasslands with dwarfshrubs, annual and perennial grasses, *Acacia mellifera/Acacia reficiens* shrub-grassland with dwarfshrubs, annual grasses and herbs, shrub-grassland with *Acacia* species and *Capparaceae* or shrub-grasslands with predominantly perennial grasses.

Vegetation type 7.1: *Commiphora-Acacia* shrub-grassland.

Occurrence in Marsabit District: Overall distribution: Ileret (1)*, Hurran Hurra (5), N. Horr (6), Hedad (8), Dukana (9), Kalacha (10), Koroli (11), Marsabit W. (15), Marsabit E. (18), Milgis (19), Rusarus (20), Sibiso Malbebale (21), Galba (22), Sibiloi National Park

Growth form:	Most common species:	Frequency:		Range unit:
Shrubs:	*Commiphora (div. spp.)*	frequent.		
	Commiphora flaviflora	frequent.		
	Acacia reficiens	up to	5%	
	Acacia senegal ssp. kerensis		5%	
	Euphorbia cuneata		5%	
	Acacia mellifera		3%	
	Jatropha parvifolia		3%	
	Acacia tortilis ssp. spirocarpa		2%	
Grasses:	*Aristida adscensionis*	up to	60%	
	Tetrapogon cenchriformis		50%	
	Enneapogon spec.		5%	
	Leptothrium senegalense		5%	
	Chrysopogon plumolosus	up to	40%	(15,18)
Dwarfshrubs and herbs:	*Blepharis linariifolia*	up to	40%	
	Duosperma eremophilum		30%	(15,18,19)
	Sericocomopsis hildebrandtii		20%	(18)
	Indigofera cliffordiana		10%	
	Indigofera spinosa		10%	
	Barleria acanthoides		5%	
	Heliotropium spec.		5%	

Vegetation type 7.2: *Acacia mellifera/Acacia reficiens*-Shrub-grassland (see Plate II.12)
Occurrence in Marsabit District: Moiti (2)*, Hurran Hurra (5), Mt. Kulal (7), Kalacha (10), Maikona (14), Marsabit West (15), Milgis (19).

Growth form:	Most common species:	Frequency:		Range unit:
Shrubs:	*Acacia reficiens*	up to	10%	
	Acacia mellifera		5%	
	Euphorbia cuneata		5%	
	Acacia senegal ssp. kerensis		3%	
	Acacia paolii		2%	
	Acacia tortilis		2%	
	Commiphora (div. spp.)		2%	
Grasses:	*Tetrapogon cenchriformis*	up to	50%	
	Aristida adscensionis		30%	
	Aristida mutabilis		5%	
	Leptothrium senegalense		5%	
Dwarfshrubs and herbs:	*Blepharis linariifolia*	up to	40%	
	Duosperma eremophilum		10%	
	Indigofera cliffordiana		10%	
	Indigofera spinosa		10%	
	Heliotropium spec.		5%	

Vegetation type 7.3: Shrub-grassland with *Acacia sp.* and *Capparaceae*

Occurrence in Marsabit District: Hurran Hurra (5)*, North Horr (6), Mt. Kulal (7), Hedad (8), Kalacha (10), Koroli (11), Maikona (14), Marsabit West (15), Dida Galgalu (17), Milgis (19), Galba (22).

Comments: Ground cover of woody species usually below 15%. In the herblayer variable species composition and frequency.

Growth form:	Most common species:	Frequency:		Range unit:
Shrubs:	*Acacia reficiens*	up to	5%	
	Commiphora (div. spp.; often Commiphora flaviflora)		5%	
	Acacia mellifera		5%	
	Euphorbia cuneata		5%	
	Acacia paolii		3%	
	Acacia nubica		3%	
	Cadaba farinosa		2%	
	Cordia sinensis		2%	
	Grewia tenax		2%	
	Maerua endlichii		2%	
	Cadaba mirabilis		1%	
	Salvadora persica		1%	
Grasses:	*Leptothrium senegalense*	up to	10%	
	Aristida adscensionis		5%	
	Aristida mutabilis		5%	
	Dactyloctenium aegyptium		5%	
	Sporobolus spec. (near sp. pellucidus)		5%	
	Tetrapogon cenchriformis		5%	
Dwarfshrubs and herbs:	*Duosperma eremophilum*	up to	40%	
	Blepharis linariifolia		20%	
	Indigofera spinosa		20%	
	Heliotropium albo hispidum		5%	
	Indigofera cliffordiana		5%	
	Sericocomopsis hildebrandtii		5%	

Vegetation type 7.4: Shrub-grassland with predominantly perennial grasses

Occurrence in Marsabit District: Hurran Hurra (5)*, Kalacha (10), Maikona (14), Sololo (16), Dida Galgalu (17), Milgis (19), Mado Kelu (23).

Comments: Particularly in range units (16) and (17) this veg. type is present as *Lintonia-Acacia mellifera* seasonally waterlogged shrub-grassland.

Growth form:	Most common species:	Frequency:		Range unit:
Shrubs:	*Acacia mellifera*	up to	15%	
	Acacia reficiens		5%	
	Acacia seyal		5%	
	Commiphora (div. spp.)		5%	
Grasses:	*Chrysopogon plumolosus*	up to	40%	(10)
	Lintonia nutans		30%	
	Leptothrium senegalense		10%	
	Setaria acromelaena		10%	
	Sorghum purpureo sericeum		10%	
	Sporobolus nervosus		10%	
	Sporobolus spec. (near pell.)		10%	
	Aristida adscensionis		5%	
	Enteropogon macrostachyus		5%	
	Oropetium minimum		5%	
	Sporobolus helvolus		5%	
Dwarfshrubs:	*Aspilia mossambicensis*	up to	10%	
	Barleria proxima		5%	

Vegetation type 8: Dwarfshrub-grassland (see Plates II.13 & II.14)

This vegetation type consists of grassland, frequently patchy, with dwarfshrubs. In this context the term dwarfshrub includes *Chamaephyta frutescentia* (stems completely lignified and under 70 cm in height) and *Chamaephyta suffrutescentia* (stems only partially lignified). Dwarfshrub-grassland is the characteristic vegetation type of the semi-desert zone.

Occurrence in Marsabit District: Ileret (1)*, Moiti (2), Loyengalani (3), S. Horr (4), Hurran Hurra (5), N. Horr (6), Mt. Kulal (7), Hedad (8), Dukana (9), Kalacha (10), Koroli (11), Kaisut (12), Marsabit W. (15), Dida Galgalu (17), Milgis (19), Mado Kelu (23), Marsabit National Reserve
Comments: In all layers variable species frequencies; total cover by woody species usually less than 2%.

Growth form:	Most common species:	Frequency:		Range unit:
Shrubs:	*Acacia senegal ssp. kerensis*	up to	2%	
	Balanites orbicularis		2%	
	Euphorbia cuneata		2%	
	Salvadora persica		2%	
	Acacia tortilis ssp. spirocarpa		1%	
	Cadaba mirabilis		1%	
	Commiphora (div. spp.)		1%	
	Cordia sinensis		1%	
	Maerua crassifolia		1%	
Grasses:	*Aristida adscensionis*	up to	30%	
	Tetrapogon cenchriformis		30%	
	Aristida mutabilis		5%	
	Cenchrus pennisetiformis		5%	
	Dactyloctenium aegyptium		5%	
	Oropetium minimum		5%	
	Sporobolus nervosus		5%	
Dwarfshrubs and herbs:	*Blepharis linariifolia*	up to	40%	
	Duosperma eremophilum		40%	
	Indigofera spinosa		30%	
	Indigofera cliffordiana		15%	
	Sericocomopsis hildebrandtii		10%	
	Barleria acanthoides		5%	
	Heliotropium albohispidum		5%	

Vegetation type 9: Barrenland

In these areas, vegetation is quite sparse and frequently occurs in strips. In years with extremely low precipitation, these localities may be characterized as deserts. After rainfall, these regions green-up, particularly with annual grasses. In Kenya, two main subtypes may be differentiated.

Vegetation type 9.1: Sparse grassland, sparse dwarfshrubland on drainage lines (see Plates II.15, II.16 & II.17)

Barrenland with dwarfshrubs on drainage lines on which vegetation cover, as viewed over large areas, is below 2%. In regions with precipitation of below 100mm, it should be noticed that water is unevenly distributed throughout the soil, and influences vegetation growth accordingly. The absence of a closed vegetation cover induces high surface run-off. On raised surfaces or hills relatively amounts of water penetrate the soil than may be exspected from precipitation figures; the opposite is true for drainage lines and basins. Thus, vegetation, in these areas, is also not distributed evenly but is concentrated where water reserves exist in the soil. Whereby, in higher rainfall zones the vegetation is spread diffusely over the whole area, and in the more arid zones vacillates toward concentrated patches (eg. along drainage lines).

Occurrence in Marsabit District: North Horr (6)*, Kalacha (10), Kaisut (12).
Comments: References to frequencies are restricted to the vegetation within drainage lines only; overall vegetative cover less than 2%.

Growth form:	Most common species:	Frequency:		Range unit:
Grasses:	*Tetrapogon cenchriformis*	up to	60%	
	Aristida adscensionis		20%	
	Cenchrus pennisetiformis		5%	
Dwarfshrub	*Indigofera spinosa*	up to	70%	
	Blepharis linariifolia		10%	

Vegetation type 9.2: Annual grasses of the *Aristida/Tetrapogon* -complex (see Plates II.18, II.19 &II.20)

This sub-type consists of extensive, nearly pure ranges of annual grasses on which usually one specie dominates.

Occurrence in Marsabit District: Ileret (1)*, Hurran Hurra (5), N. Horr (6), Mt. Kulal (7), Dukana (9), Kalacha (10), Marsabit W. (15), Dida Galgalu (17), Galba (22), Mado Kelu (23).
Comments: Frequently pure stands of either *Tetrapogon cenchriformis* or *Aristida adscensionis* and highly variable species frequencies.

Growth form:	Most common species:	Frequency:		Range unit:
Grasses:	*Tetrapogon cenchriformis*	up to	70%	
	Aristida adscensionis		60%	
	Cenchrus pennisetiformis		5%	
	Leptothrium senegalensis		5%	
Dwarfshrub and herbs:	*Barleria proxima*	up to	10%	
	Blepharis linariifolia		5%	
	Indigofera spinosa		5%	

Vegetation type 10: Riparine Woodland (see Plate II.21)

Riparine woodlands are relatively narrow (often less than 20m wide), dense to loosely associated vegetation strips along seasonal watercourses (Luggas). The most commonly occurring species are *Acacia tortilis, Delonix elata* and locally *Acacia albida, Acacia elatior* ssp. *turkanae*; *Acacia xanthphloea* may be found in moist locations. On the edges of these coppices, bush and shrub, whose browse is eaten by goats and camels is usually found (esp. *Grewia, Cordia* and *Cadaba* species). The understory herblayer is only weakly developed.

Occurrence in Marsabit District: Distributed throughout the whole District along seasonal watercourses and drainage lines.
Comments: Tree cover ca. 30%; along wider luggas up to 80%, then relatively little understory vegetation; in the herblayer highly variable species composition with covers ranging from 5-70%.

Growth form:	Most common species:	Frequency:		Range unit:
Trees:	*Acacia albida*	up to	80%	(1)
	Acacia elatior ssp. turkanae		80%	(1)
	Acacia tortilis ssp. spirocarpa		60%	
	Diospyros scabra		5%	(4,12)
	Delonix elata		3%	
Shrubs:	*Salvadora persica*	up to	60%	
	Cadaba farinosa		5%	
	Cordia sinensis		5%	
	Grewia (div. spp.)		5%	
Grasses:	*Cenchrus ciliaris*			
	Dactyloctenium aegyptium			
	Enteropogon macrostachyus			
	Eragrostis (div. spp.)			
	Panicum maximum			
	Pennisetum mezianum			
Dwarfshrubs and herbs:	*Barleria eranthemoides*			
	Duosperma eremophilum			
	Sericocomopsis hildebrandtii			

Vegetation type 11: Woodland to grassland on seasonally waterlogged soils (see Plate II.22)

Soils within these locations often have high clay content (ie. stable clay/humus complexes, "black cotton soil"). Complete waterlogging during wet seasons with frequent standing surface-water is common. These soils dry out rapidly during the dry season and develop numerous deep fissures. In the survey area common trees/bushes are *Acacia seyal* var. *fistula* and *Acacia drepanolobium* at higher elevations. The herblayer contains perennial grasses, mainly *Pennisetum mezianum* and Ephemera such as *Setaria sphacelata, Blepharis linariifolia, Tribulus cistoides, Cyperus ghiolii* a.o. The development of substantial standing biomass is unreliable!

Overall distribution: Hurran Hurra (5)*, N. Horr (6), Marsabit W. (15), Sololo (16), Dida Galgalu (17), Marsabit E. (18), Milgis (19), Rusarus (20).
Comments: In the herblayer highly variable species composition and cover.

Growth form:	Most common species:	Frequency:		Range unit:
Trees:	*Acacia seyal var. fistula*	up to	60%	
Shrubs:	*Salvadora persica*	up to	5%	
Grasses:	*Pennisetum mezianum*	up to	40%	
	Lintonia nutans		30%	
	Setaria acromelaena		20%	
	Enteropogon macrostachyus		10%	
	Cyperus ghiolii		5%	
	(Cynodon plectostachyus)	up to (frequently much less).	60%	
Dwarfshrubs and herbs:	*Duosperma eremophilum*	up to	30%	
	Aspilia mossambiciensis		10%	
	Tribulus cistoides		10%	
	Barleria acanthoides		5%	
	Blepharis linariifolia		5%	

Vegetation type 12: Shrubland to grassland on saline soils (see Plates II.23 & II.24)

These are various vegetation types on saline soils. In the survey area they occur along the fringes of the Chalbi desert and along the shores of Lake Turkana. Here they are usually dense stands of *Sporobolus spicatus*. On small dunes, thickets or shrubland with *Sueda monoica* and *Lagenantha nogalensis* dominate. A typical dwarfshrub is *Dasysphaera prostrata*. .These regions are of little importance as pastures.

Occurrence in Marsabit District: Particularly along the shores of Lake Turkana and on the edges of the Chalbi Desert. Ileret (1)*, Moiti (2), Loyengalani (3), Hurran Hurra (5), N. Horr (6), Mt. Kulal (7), Kalacha (10), Koroli (11), Marsabit West (15), Sibiloi National Park
Comments: Woody species particularly in range unit Ileret (1) and on the edges of the Chalbi Desert.

Growth form	Most common species:	Frequency:		Range unit
Shrubs:	*Suaeda monoica*	up to	40%	
	Lagenantha nogalensis		20%	
	Salsola dendroides		20%	
Grasses:	*Sporobolus spicatus*	up to	70%	
	Drake-Brockmannia somalensis		5%	
Dwarfshrub	*Dasysphaera prostrata*	up to	5%	

Composite vegetation types:

In certain areas, different vegetation types grow in conglomeration and frequently only cover relatively small sections of land; so that, separate vegetation types cannot be outlined at the given cartographic scale. In this case, a broad lineation, alternating in the colours of the separate vegetation types will be utilized (see map).

Plate II.1: Montane forest (vegetation type 1) in the background, in the foreground perennial grassland (vegetation type 3) generated through clearing, probably burning, with replacement populations of *Themeda triandra* and *Bothriochloa insculpta*.. Beginning erosion.

Plate II.2: Woodland (vegetation type 2) at higher altitudes, group of trees with *Erythrina burtii* in the Huri Hills. In between trees, grassland (vegetation type 3)of *Themeda triandra* and *Chrysopogon plumulosus*.

Plate II.3: *Acacia tortilis* woodland (vegetation type 2) at lower altitudes. In between trees large areas covered by the dwarfshrub *Duosperma eremophilum*.

Plate II.4: Perennial grassland (vegetation type 3) in the Huri Hills. In the background (right) small woodland complexes with *Acacia nilotica* spp. *subalata* and *Erythrina burtii*.

Plate II.5: Evergreen to semi-deciduuos bushland with perennial grassland (vegetation type 4) on Mt. Kulal with bush groups; areas with *Digitaria scalarum* (right); deep erosion gullies due to livestock tracking; over-grazing indicator species *Conyza pyrrhopappa* (left).

Plate II.6: Evergreen to semi-deciduuos bushland with perennial grassland (vegetation type 4) at lower altitudes, *Acacia etbaica* is the dominant bush, in the middle the over-grazing indicator *Plectranthus igniarius*. The dominant grass-type is *Chrysopogon plumolosus*.

Plate II.7: Deciduous bushland (vegetation type 5) with *Acacia*, *Boswellia* and *Commiphora* species, beginning thicket formation, the flowering tree in the centre is *Delonix baccal* .

Plate II.8: Deciduous shrubland (vegetation type 6), dominantly *Acacia reficiens* with grasses and dwarfshrubs; crown cover of approximately 10%.

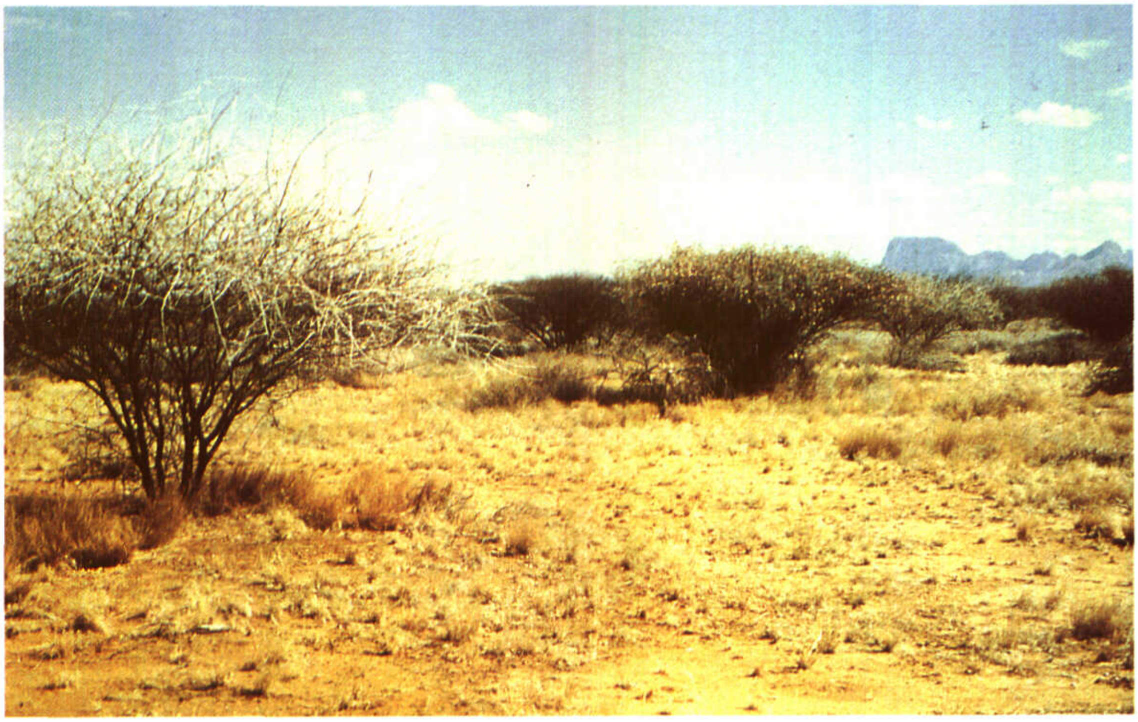

Plate II.9: Deciduous shrubland (vegetation type 6), *Acacia reficiens, Acacia mellifera, Acacia tortilis, Boscia coriacea*; total crown cover of approximately 20%.

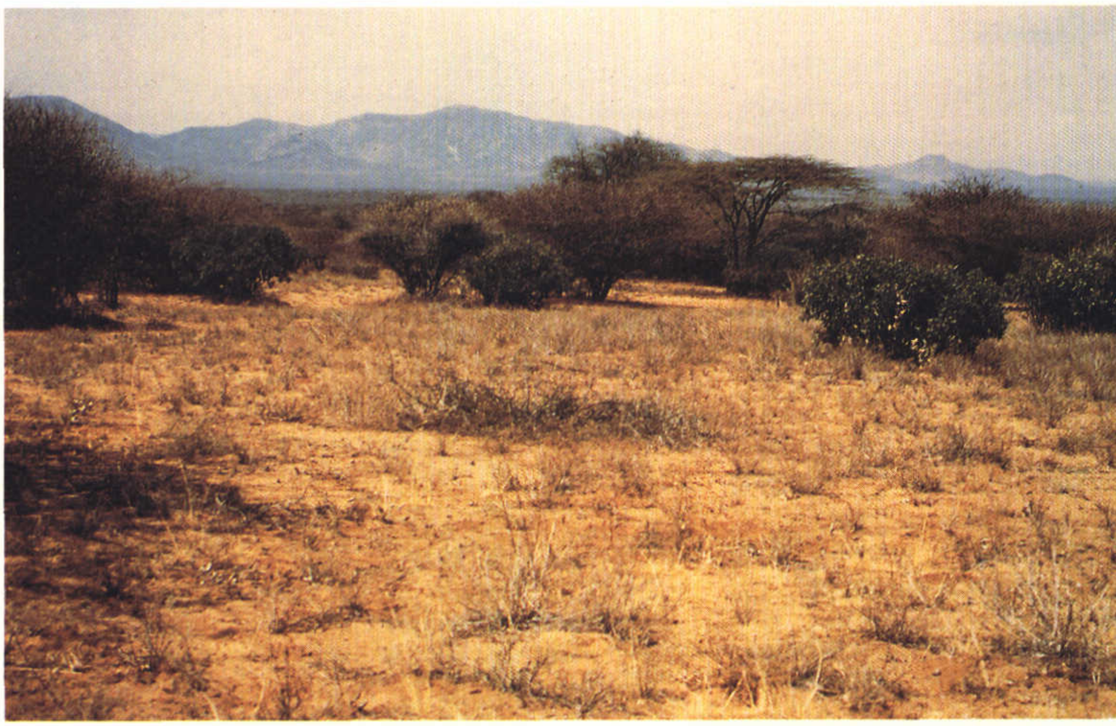

Plate II.10: Deciduous shrubland (vegetation type 6), thicket development, primarily *Commiphora* species and *Acacia mellifera*; total crown cover of approximately 90%.

Plate II.11: Deciduous shrubland (vegetation type 6), thicket development (centre) through *Acacia reficiens*,; total crown cover of over 90%.

Plate II.12: Shrub-grassland (vegetation type 7), *Acacia reficiens, Acacia mellifera*. crown cover of less than 5%, interspersed with dwarfshrubs (*Duosperma eremophilum*), crown covers of approximately 15%, understory of grasses, with high precipitation abundant growth of ephemera.

Plate II.13: Dwarfshrub-grassland (vegetation type 8), occasional *Acacia reficiens* bushes, crown cover of less than 2%, dwarfshrubs (*Indigofera spinosa*) dominate with interspersed annual grasses.

Plate II.14: Dwarfshrub-grassland (vegetation type 8), occasional *Commiphora flaviflora* bushes, crown covers of less than 2%, in the foreground perennial and annual grasses as well as dwarfshrubs. With high precipitation abundant growth of ephemera.

Plate II.15: Barrenland (vegetation type 9.1), concentrated patches of vegetation along drainage lines (esp. *Indigofera spinosa*; on hill footslopes *Aristida adscensionis*.

Plate II.16: Barrenland (vegetation type 9.1), on slopes annual grasses (*Aristida adscensionis* and *Tetrapogon cenchriformis*), in basins small trees (*Acacia tortilis*) bushes (*Grewia* sp., *Boscia coriacea* and *Cadaba farinosa*) and dwarfshrubs (*Indigofera spinosa*).

Plate II.17: Barrenland (vegetation type 9.1), in basins dense stands of dwarfshrubs (esp. *Indigofera spinosa*).

Plate II.18: Barrenland (vegetation type 9.2), full cover stand of the annual grass *Tetrapogon cenchriformis*.

Plate II.19: Barrenland (vegetation type 9.2), open cover stand of the annual grass *Tetrapogon cenchriformis.*

Plate II.20: Barrenland (vegetation type 9.2), concentrated patches in basins of the annual grass *Tetrapogon cenchriformis.*

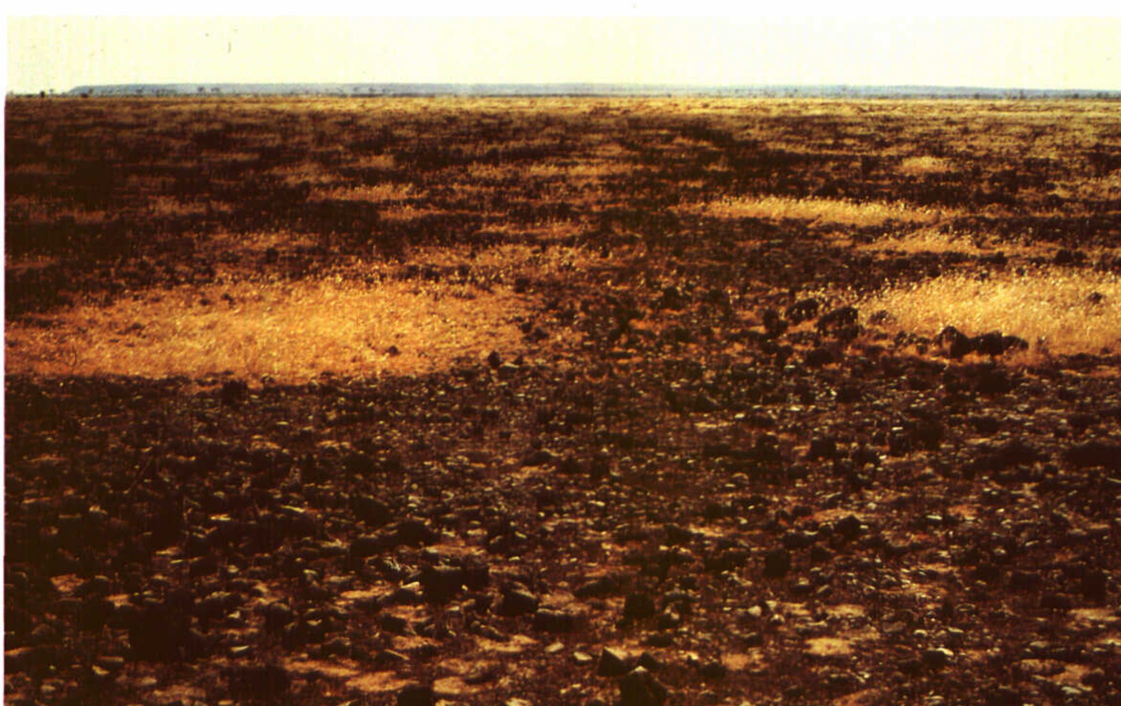

Plate II.21: Riparine Woodland (vegetation type 10), *Acacia tortilis* riparine woodland along a seasonal watercourse.

Plate II.22: Woodland to grassland on seasonally waterlogged soils (vegetation type 11) with *Acacia seyal* var. *fistula*; after rainfall, sparse groundcover are mainly ephemera.

Plate II.23: Shrubland to grassland on saline soils (vegetation type 12), dunes along the edge of the Chalbi desert with *Suaeda monoica*.

Plate II.24: Shrubland to grassland on saline soils (vegetation type 12), *Sporobolus spicatus* grassland near Lake Turkana.

ADDENDUM

Condition of Marsabit District Range Lands (refers to Map No 2)
by Dennis Herlocker and Dierk Walther

Good condition

Most (80%) of the district's rangelands are in good condition. In the case of Marsabit District, however, this primarily means that the rangelands are not degraded. It does not mean that they have a high productive potential which can be realized by, for instance, the provision of additional water supplies. Over all, the rangelands of the district are low in potential productivity. Rainfall is generally low and highly variable. Soils are often shallow and/or stony. The vegetation is dominated by deciduous shrubs and annual grasses or, over large areas, there is no vegetation at all. Such rangeland produce only low amounts of forage. Some limited improvement in rangeland productivity may be locally possible through improvement of stockwater supplies, but the potential for significantly increasing livestock production in this manner is severely constrained by the prevailing adverse environment of the district.

Fair condition

Fair range conditions shows the impact of use by livestock but there has been no serious impairment yet of rangeland productivity. Approximately 14% of the district's rangelands are in fair condition. Most fair condition rangeland in the district occurs at higher elevations in the northeast (Sololo-Moyale, Marsabit and Kulal Mtns) and at lower elevations south of the Hedad Plain and between Loyangalani and the west end of the Chalbi Desert. Stockwater is more available in these areas and the soils tend to be less rocky and both more accessible and erodible.

Around Maikona and Loyangalani heavy use of Indigofera spinosa dwarf shrubs on desert pavement soils (soils with a surface layer of rocks/ stones) has created fair rather than poor condition rangeland. This is because this dwarf shrub species is resistant to browsing and because the surface stones have protected the soil from further erosion.

Some areas along the edge of the Chalbi Desert, but especially around North Horr, are less degraded than they at first look. Very high winds blow westward across the Chalbi, which has little potential to support vegetation. Fine dust removed by these winds from the desert is deposited when they encounter trees and shrubs along its western perimeter. The result is a layer of fine powdery dust and the build up of small dunes. This has all the outward appearance of a highly degraded rangeland but is, in fact, unrelated to the use of either the immediate area or even of the Chalbi Desert. Thus, it is not an indicator of overuse and subsequent degradation of the area.

Fair/good condition

The Huri Hills-Furole-Turbi area is a mixture of fair and good condition rangeland. This comprises 4% of the areas rangelands. Although much of the area supports perennial grasses, limited water availability (especially in the Huri Hills) has limited the degree of land use impact. This is good because the soils of the area are very sensitive to erosions and would quickly degrade under increased water availability and the associated land use impact.

Poor condition

The productivity of poor condition rangelands has been significantly lowered by overuse. The process of degradation has begun. Soil erosion is apparent to varying degrees. In Marsabit District, poor condition rangelands are centred on major water sources and heavily settled areas: Dukana, El Yibo, Furole, Turbi, Sololo, North Horr, Kalacha, Kargi, Korr, Laisamis, Logologo, Marsabit and the Horr Valley, although most of these areas are small and restricted to a few kilometres radius around the water point concerned. Foot slopes of basement system mountains (Furole, Sololo and the Horr Valley) are particularly susceptible to degradation even when water supplies are relatively limited. Water draining from higher ground to the east and west stands for some weeks along the base of the Marsabit lavas from Halisiruwa northward. This has supported a heavy use of the surrounding area which has degraded the relatively light soils of the Hedad and Kaisut Plains to the west and south. However, over all, only about 1% of the district's rangelands are in poor condition.

Very poor range condition

Very poor range condition is characterized by heavily overused vegetation, low in both vigour and cover, and by accelerated erosional processes. Less than 1% of the district's rangelands are in very poor condition but these are concentrated into a single area of about 150 km ;centred on the village of Korr. This is the result of the establishment (in the early 1970ies) of several closely spaced water sources in an area of shallow, easily erodible soils. Since that time, the original vegetation has largely been removed and there has been a strong invasion by undesirable (Jathropha) plant species. Erosional processes have reached the point where the exposure of underlying rock and the formation of desert pavement (through the removal of the lighter surface soil particles) is now common. Unfortunately, this has probably irreversibly lowered the potential productivity of the soils of the Korr area.

CHAPTER III
WATER RESOURCES
GERNOT BAKE

INTRODUCTION

The first research on the hydrology of the Marsabit District was carried out by Dixey in the early 1940s. His report (not traceable in Nairobi) led to the implementation of the so called DIXEY scheme. During its existence (1950-1958) only a small number of dams and pans were constructed in Marsabit District, mainly around Moyale and Marsabit townships. In the 1950s and early 60s the geology of the Laisamis, South Horr, Moyale and Northeast Marsabit areas was mapped at various scales. However, these reports do not, to any extent, refer to water resources.

FAO carried out a survey on the range resources in the 1970s, including a comprehensive inventory of the water resources. Yet due to security problems, large sections of the northwestern district could not be visited. Studies carried out by UNESCO's Integrated Project in Arid Lands (IPAL) from 1976 to 1986 in southwestern Marsabit District, resulted in several reports regarding surface and sub-surface hydrology (Bake 1983,1985,1986 a,b; Baur 1983; Borgeson 1983; UNESCO, IPAL 1984; King et al 1983; Ndombi 1983; Ongweny 1983).

In 1987, two geological reconnaissance surveys of the Marsabit and North Horr areas were published (with maps); they contain short chapters on water resources. Other reports in the series of the Samburu-Marsabit Geological Mapping and Mineral Exploration Project will follow for Marsabit District and adjacent areas. Further information might also become available when the detailed results of on-going oil exploration in the district are published. Meanwhile, several new boreholes became available for the nomads (eg. Kurkum) as a result of these activities.

THE SURVEY

The water resource survey for the Marsabit District was carried out in June 1988 after an exceptionally long rainy season. In North Horr 154.8mm (annual average 157mm, median 137mm) were reported for April 1988. Although, normally dry during this time, showers were also observed in June. North Horr and Kalacha, part of the driest zone of the district, both received 12mm during the night of the 12th of June within five hours; Dukana, located further North reported 32 mm.As a result of this exceptional rainfall surface-water was found in a number of places which are normally dry during this time of the year.

The vegetation in a number of places was still green, thus reducing the water requirements of the animals. Most water sources visited were therefore not in use during the survey.As the Chalbi Desert was flooded, a number of water sources on its fringe could not be visited. Although, open surface-water in Marsabit District is not typical, it was possible to exclude this exceptional phenomenon. No new water quality samples were taken, as the results would have only been available after completion of the study.

The Range Management Division of the Ministry of Livestock Development compiled a list of the major water sources of the district, which included a preliminary exemplar to the number of animals watered.

THE GEOLOGY OF MARSABIT DISTRICT

The geology of the district largely pre-determines the availability of sub-surface-water and also, to a lesser extent, the distribution of surface-water; therefore, it is presented as an overview here. Detailed information may be obtained from the geological literature.

The geology of Marsabit District is characterized by the alternating occurrence of basement rocks, volcanics of various ages and unconsolidated sediments of quaternary and tertiary origin. All of them have different aquifer characteristics, that can even vary significantly within a group.The foundation of the area consists of proterozoic, sedimentary and volcanic rocks which have been folded during the Mozambiquian Orogeny. Towards the end of the Miocene, concurrent with the Rift Valley formation, volcanism occurred and lasted up to the end of the Pleistocene. Various kinds of materials were brought to the surface, accumulated, and were eroded sequentially in accordance with changing climates since the Miocene.

The metamorphic basement

The metamorphic basement consists of a wide variety of different rocks: gneiss, granite, hornblende, marble, etc. In general terms, the basement is a very bad aquifer, as most drilled boreholes in this strata did not strike water. This is due to the general characteristics of metamorphic and intrusive rocks. However in fissures and fractures, local aquifers may probably be expected (eg. at Korr). Also when the weathered material of basement rock becomes thick enough, water may expected in it (eg. a few km North of Ngurunit).

Aquifers of the basement system normally exhibit very low yields, except for thick weathered materials.The basement is very important in the district, as many if not all) territories overlay these rocks. This means for example that, after penetrating the sediments of tertiary/quaternary origin, with perhaps good aquifer characteristics, reduced or non-water bearing rocks will be encountered, since neither fissures nor fractures can be detected.

The Maikona formation

The Maikona Formation mainly consists of gritstone, probably of cretaceous or cenozoic origin and is medium to coarse grained. This formation crops out in the vicinity of Maikona and most likely also underlies the Chalbi sediments.The Maikona Formation should be an excellent aquifer, but so far only three boreholes have been drilled in its weakly consolidated sediments. Although slightly saline, the one at Kargi has a very high yield, confirming the previous assumption. It seems that also the new borehole drilled at Kurkum, in the course of oil exploration tapped this aquifer.

Tertiary and quarternary sediments

Most of the unconsolidated sediments of tertiary and quarternary origin may be regarded as good aquifers, and of these, most are perched and drain towards the Chalbi (the ultimate watersink). The best shallow depth water sources are to be found along the water courses (luggas) like Balesa Kulal; however, their yields might not always be satisfactory.

Although untapped to date, a regional aquifer with good yield may be expected at depths greater than 200 metres in most places (Bake 1983).

Volcanics

Large parts of Marsabit District are covered by volcanic materials like lava, ash, tuffe, etc. Water can usually be found in friable horizons and is often of good quality with yields up to 8 cum/h (Marsabit). Dykes (these are horizontally stretched impermeable strata) can impede water flow along the gradient and create favourable conditions. Water occurrence in volcanic materials is dependent on the altitude of the mountains derived from them, since they serve as catchment areas. The low lying volcanic plateaus (Kurkum, Illaut,etc.) have very little water

Regional groundwater aquifers

Water holes or shallow wells in dry riverbeds provide permanent water in a number of places (Balesa Kulal, Dukana, El Dere, etc.). Using proper techniques, higher yields could be expected from these wells; however, forage availability will limit the number of animals which can be sustained around the well.Most likely, a major aquifer exists within the alluvial deposits, at the confluence of the Balal and Ririba luggas with the Chalbi playa. Although the depth might be as much as 100m, good quality water may be expected here.

The Chalbi basin is not only a sink for surface drainage but also for the flow of sub-surface water from large sections of the district. The water comes from the Highlands that receive more rainfall (Marsabit, Kulal, Asie, Huri Hills and Ethiopian Highlands), and where water has accumulated here since mesozoic times. It may however be saline and/or alkaline.The Huri Hills also act as a recharge area for aquifers under the Dida Galgallo, which may in turn be connected with the aquifer under the Lag Bogal drainage system. This is important not only for this area but also for the Wajir District, as water infiltrated here will flow toward it. Since ground-water recharge in Wajir is limited due to the absence of high mountains, water from Marsabit supplements it.

The drainage system

The course of drainage lines (luggas) in Marsabit District, is mainly determined by the distribution of mountains within the district, the borders of the district and partly by mountains outside of the district (see Map No 18). The system is mainly endhorheic (ie. internal drainage only, without an outlet toward an ocean base). However, there are two drainage lines where, in the geological past, water has reached the base level of the ocean - the Milgis River and the Lag Bogal. The Milgis River drains parts of Samburu District, and flows through the lowlands between Mt. Marsabit and the Oldonyo Lenkiyio (Mathews Range) and then south-eastwardly until it joins the Ewaso Nyiro drainage system.

Lag Bogal originates in the Ethiopian Highlands and is first directed south before flowing southeast and then, in Wajir District, east. Run-off in both drainage systems is seasonal and often episodic, except in their upper parts. Neither of them carries enough water to reach base level under present climatic conditions.

The western Marsabit District is drained by short luggas, some 30 km (or less) long, into the perennial, but alkaline Lake Turkana, which has no outlet.The district's base level (400m a.s.l), for the most part, is the Chalbi Desert into which the major luggas from the north, like Lag Bagal, drain. The major southern drainage line is the Balesa Kulal, initially following the South Horr valley and the edge of the Mt. Kulal lava before entering the Chalbi in a big alluvial fan.

Debris may be found on trees as high as 2m, indicating the occurrence of high floods. However, most of the year, these luggas are completely dry and run-off is limited to periods during or shortly the after rains; floods occur only rarely. Therefore, run-off has to be characterized as episodic.

The importance of lowland luggas in Marsabit District is not derived from surface water storage but from the occurrence of local aquifers around them, which may be tapped with shallow wells. Their recharge is seasonal, but during non-drought years or seasons, the supply can last for the entire year.

The three major volcanic mountains of the district (Huri Hills, Mt. Kulal and Mt. Marsabit) give rise to a number of small drainage systems following the general gradient of the mountains. As they consist of volcanic matter, they hardly have any run-off due to the high permeability of these materials.

In the upper course of the luggas originating from the southern basement mountains (Ndoto Mts., Njiru Mts.), permanent water may be found. Lower sections of these rivers have seasonal run-off only. This is an important factor for livestock watering and further development potential exists here. Few other options exist to improve the surface water situation in Marsabit District.

THE DISTRIBUTION OF WATER SOURCES

General

The distribution of water sources by type is indicated on Map No 18. The types of water sources present in Marsabit District are as follows:

- boreholes
- permanent wells
- seasonal wells
- springs
- pans
- dams
- permanent surface water
- ephemeral surface water.

The spatial distribution of the different water sources is not regular but is determined by the surface water potential and the existence of subsurface water. Thus, the water distribution map also presents a map for the possibility (or the potential) of finding water. In general, areas already possessing a number of water sources also have high potential (and vice versa). However, there are some areas where there are, for a number of reasons, no actual water sources but which have nevertheless a high water potential (eg. the central Hedad). At depth (>200m) a good aquifer can be expected. Here, however, forage availability is limiting, allowing grazing for dromedaries of less than 250 days. Cattle and smallstock forage is very limited.

The distribution of permanent surface water

The most prominent permanent surface water is Lake Turkana. It is located on the western district border, extends about 250 km north to south, and lies at an altitude of about 370m a.s.l. During the last decade the water level has been observed to decrease.The water is strongly alkaline (recent chemical analysis not yet available) and is "unfit" for human consumption, but camels and smallstock are watered from the lake on a permanent basis. Cattle are known to take ill-effect. Although, theoretically great numbers of animals could be watered from the lake, forage availability in its vicinity is very limited due to low rainfall and high edaphic aridity. The local people also prefer to water their animals from other sources in the vicinity, if these are within reach.Another permanent lake is Lake Paradise on Mt. Marsabit, but since this lake is situated in the Marsabit National Park it is of no importance to the watering of livestock.Southwest of of Mt. Baio (on the Laisamis/Illaut/Ngurunit road) a fluctuating, semi-permanent lake is located (Larapasi). It was completely dry during the first rainy season of 1982; however, the presence of mudfish indicates that this drying-up was exceptional.The "lake" is of great importance as a dry season watering reservoir. All livestock species can find plenty of water here and even animals from the adjoining Samburu District are watered on a regular basis. It seems that the lake level fluctuates in accordance with run-off to the nearby Milgis River, thus suggesting an underground connection between the two. Notably, the lake at Baio should not be regarded as a drought water reservoir (1982 shows that 1 to 2 failed rainy seasons will cause its total drying-up).

On the edge of Mt. Marsabit and Huri Hills (Chalbi side) lava a number of permanent springs form pools which are important for livestock watering (Kalacha [P14], Korole [R20], Gamura [Q18], Barcho [S19], Mayidahad [S19], Koronli [S20]). All these springs have two major sources:

> [1] Water confined within shield volcanoes and the flow away from the summit discharge, at the interface of the thin lava and sedimentary rock.
> [2] Artesian water held in sedimentary rock where it underlies volcanic shields, discharges where the confining volcanic layer ends.

Fractures in the sedimentary rock and/or an adjacent impermeable layer may act as an additional control. At Maikona it is obvious that the water tableis very high on the edge of the lava, so that one has to dig only a few decimetres to reach water. Consequently, there are hundreds of water holes around the village.These springs mainly serve the limited livestock population grazing the lava. Available water by far exceeds demand, as forage availability on the lava, with its high edaphic aridity, is limited. Thus, the spring at Koroli is used almost entirely by wildlife, without competition from livestock.Other important springs that feed pools can be found at North Horr, Gus, and at various sites on Mt. Kulal (Kari [K18], Galan [K20], Moruset [J21]).

The distribution of ephemeral water in Marsabit District:

Ephemeral water can be found after rainfall of above ca. 10mm in all water courses affected by a particular rain storm, ie. in various volcanic gofs (maars or craters) and on the Chalbi playa, where it is dependent on run-off. Water on the playa is not used for watering livestock as it is very salty. Additionally, puddles may be found in small depressions, on roads and in various other places. The water rarely lasts longer than a few days, dependent on the permeability of the soil.

The ephemeral water sites are not shown on Map# 18, as their occurrence is highly variable. The areas marked on the map as "seasonal water" carry it after a normal rainy season for a few weeks and are thus important for livestock watering. However, they are not reliable water sources for droughts or even an entire dry season.During the rains ephemeral water is used only to a small extent by animals, since they require very little water as their needs are largely met by plant moisture. However, herdsmen need to drink and rely on these puddles.

Surface storage systems (pans and dams)

As extensive sections of the district are covered by unconsolidated sediments of tertiary and quaternary origin, infiltration is normally very high, limiting the possibilities for surface storage systems such as dams and pans. The terrain's flatness, certainly an advantage in terms of soil erosion and ensiltation control, does not encourage surface run-off. Therefore, areas where successful surface storage systems can be established are limited. Lava fields, due to their high permeability, do not favour water storage either.

On the sedimentary plains, only a limited number of dams or pans have been constructed: one at Falam (on a lava plateau), the other between Kargi and Korr (in a lugga); both have been completely ensilted. Almost all of the dams and pans that are functional in Marsabit District are located in the north, close to the Moyale-Sololo escarpment. The new dam at Turbi is an exception. A list of dams can be found in the Appendix (Table A.1). Map No 18 shows that the area around Moyale and Sololo is well supplied with water of not only well or borehole origin.

A number of pans and dams in the district are not functional any longer, as they have been destroyed by heavy run-off or poor maintenance; 7 dams are listed as broken or silted-up (Appendix: Table A.1). In 1986-87 three new dams were built. Two of these (Mansille and Turbi) have a capacity of 108,000 cum, while the one at Funanyata only has a capacity of 38,400 cum. Larger dams normally tend to have water for a longer period into the dry season; however, they attract larger animal populations, who deplete the forage supply. During the survey only the dam at Turbi was still filled, implying the possibility of high seepage loss at Mansille.

Generally, surface storage systems are not suited for livestock watering in the district except in the Moyale-Sololo area, and even here, they are only a means of reducing walking distance to water during the dry season.The characteristics of the district's substratum, geology and the flatness of terrain make it doubtful if further dam construction could be successful.

The distribution of wells

Most water sources in Marsabit District are shallow wells, dug by the local population. Most of them tap the perched, localized aquifers in or around luggas; thus, their yield-potential is quite limited (ref. section on yields).In order to increase the amount of water available at a particular location, several wells are dug, frequently only a few metres apart. Thus, most of the wells shown on the Map No 18 are in fact groups of wells, whose number vary from location to location; from 2 to 3 in isolated locations like Hurran Hurra to well over 50 and up to 100 close to villages like Illaut, Korr or Maikona (Appendix: Tables A.2 and A.3).

The majority of the shallow wells in the district are not cased, and since most of them are dug in unconsolidated sediment, there is always the danger of collapse when the well is dug deeper than a few metres. Also, after every run-off during the wet season the well is filled up with lugga sediments, unless protected by raising the well shaft above the lugga level with concrete (like at Korr and Illaut).

Map No 19 shows the area (in radii of 10 and 15 km respectively) wells normally serve. It clearly points out those in Marsabit District which are not within watering distance during the dry season. The species affected most are cattle, which have to be watered every second day. Smallstock are affected to a lesser degree and can be without water for about four days. Camels may roam, more or less freely, over the range, as they are watered every 10-11 days traditionally, enabling them to graze as far away as 50km from a water source. Areas not within walking distance for smallstock and cattle during the dry season are:

- the central Hedad (eg. a north-south orientated corridor north of Illaut)
- the eastern slopes of Mt. Kulal
- the area north of Mt. Marsabit towards the Huri Hills
- a corridor parallel to the Milgis River
- the Asie mountains
- parts of the Huri Hills.

This fact coincides with the district's water potential (eg. Dida Galgallo north of Mt. Marsabit only has a limited potential). An exception, however, is the central Hedad. This area offers very good water-potential for deep boreholes (regional aquifer in unconsolidated sediment) and along several luggas for shallow wells (King et al 1983). Rangeland utilization, however again, is limited by forage availability.

The importance of wells varies significantly within Marsabit District. For example, wells close to Kargi, Maikona, Dukana, etc. are primarily utilized for human consumption, and only secondly for livestock requirements. Livestock wells may be found all over the district, but show differences in utilization. For example, the wells at Hurran Hurra [H12], El Tackicha [G12] and Fora [E9] are used by animals in transit from the southern plains to Alia Bay and vice versa (clearly indicated on the map of distance to permanent water).

Wells (as other water sources) located on the district's boundary are not only used by people and livestock from Marsabit District but also by people from neighbouring districts. This is particularly true for the border to Wajir District, where there are a number of high-yielding wells like Baji [F24], and the border with Samburu District where watering points like Ngurunit, Illaut, Merille etc. are jointly used. Conversely, livestock from Marsabit District are also watered in neighbouring districts; however, these frequently important water sources could not be included within the structure of this district report.

The distribution of boreholes

Boreholes are the most reliable water sources for livestock, as they are normally higher yielding than shallow wells; however, they tend to break down frequently due to poor maintenance and lack of fuel.The number of operating boreholes in Marsabit District is limited; a listing of the operational ones can be found in the Appendix (Table A.4). Their the locations may be found on Map No 18, while Map No 19 indicates the amount of water available per day.

Boreholes in Marsabit District are rarely located with respect to range water requirements, and road construction, supply of police posts etc. has often been regarded as more important in the location of a borehole. Due to high-yield potential, especially in the lowland plains, borehole development opportunities exist in the region.In the development of new boreholes the amount of available forage has to be considered, and so it would be ideal if boreholes would be distributed evenly over the district allowing access to them especially during drought when the yield of shallow wells is limited.

Concentrations of boreholes (see Map No 18) may be found in the following places:

- along the Isiolo-Marsabit-Moyale road, (some of them drilled during World War II, others during the road construction in the early 1970s)
- on Mt. Marsabit (mainly for the supply of Marsabit town and some irrigation schemes on the mountain)
- at Sololo (drilled by missions and Non Governmental Organizations, most of the boreholes are not on file with the MoWD)
- at Korr (during the survey, inoperational).

Most boreholes drilled by missions and NGOs are not on record with the Ministry of Water Development in Nairobi or Marsabit. Yields and official borehole numbers are listed in Appendix 1.

The yield of water sources

In the absence of periodic pumping tests it is difficult to assess the yield of water sources in the district. An approximate guide to the yield of a particular water source are the number of animals watered at it per day (see RMH vol. I). The appendix (Table A.4) shows the tested yields of the operational boreholes in the district. Notably, only one pumping test after the drilling of a borehole had been carried out. Especially in volcanic areas, yields can vary considerably (for details on pumping tests see RMH vol. I).The highest yield in the district was observed at Sabarei (32.7 cum/h). It is doubtful that the full yield is utilized since this would require a very powerful submersible pump.

Other boreholes with high capacities (ie. >= 10 cum/h) are Logologo (2), Laisamis, Walda, Kargi, Golole and Moyale Oda. Also here it is not known if the tested yield is fully utilized since installed pumps may not be strong enough.

High outputs are often not possible due to maintenance and fuel problems.A borehole with an output of 10 cum/h will discharge 100 cum during an operational time of 10 h (the average operation time in Marsabit District). This is sufficient to water 1,000 camels, 25,000 head of smallstock or 2,500 cattle per day. The available vegetation around the borehole will never be sufficient for such high animal concentrations and overgrazing may result.

Already some boreholes in Marsabit District are overpumping, thus mining the aquifer. The worst situation occurs at Korr, where at any given time more than 10 boreholes, and numerous wells, are operational. Tritium (3 H) analyses indicated that the aquifer in the basement outcrop of Korr was being depleted at an alarming rate.

The yields of shallow wells are not easily assessable. The author observed a maximum output of 8 cum/h at a typical Borana well in southern Ethiopia (Bake 1986). Such values seem to be realistic for Borana and Gabra wells like the ones at Ulan Ula. Ndombi (1983) reports on two pumping tests. The first, at North Horr, was indicated to discharge 1.6 cum/h (this estimate seems to be quite high). The second, at Oltorot, yielded only 0.8 cum/h. This figure was confirmed by long-term measurements (Bake 1983) and calculations.Thus, it seems justified to assume that the average yield of shallow wells, eg. wells in or close to lugga beds, is around 1 cum/h. With practical use of 10 h per day, these wells yield approximately 10 cum for livestock use. This is sufficient for approximately 100 camels, 2,500 heads of smallstock or 250 cattle.

Especially toward the end of the dry season, particularly after poor rainfall rainy-seasons and/ or during periods of drought, shallow-well yield decreases significantly. They are not reliable watersources for these crucial times.

Some spring yields are now available, and on Mts. Kulal and Marsabit seem to be substantial. At the Korole waterhole (a spring on the Marsabit lava Chalbi Desert interface) 1,000 camels were observed to be watering without lowering the water table. This would correspond with an approximate discharge of 10 cum/h.

Map No 19 shows the estimated and pump tested yield per 100 sqkm grid. For boreholes, the figures may be high, as only test-pumped figures were available; also, breakdowns and lack of fuel should be considered.Based on a conservative estimate, the district has approximately 6,000 cum/ day of reliable water resources. This does not account for a number of well groups, with much higher total outputs; however here, the measurement reliability is decreased as mining of the aquifer should be assumed.

WATER QUALITY

The international standards (WHO) for drinking water, threshold values and limiting concentrations for humans and livestock may be obtained from RMH vol.I. No recent water quality analysis is available for Marsabit District except those shown in Tables 3.3 and A.5 (Appendix). However, water quality is highly variable at different locations and over time.The local variability of just one such factor (Electric Conductivity = E.C.) is presented in Table 3.1 by its coefficient of variation (C.o.V.). Other parameters vary as well.

Table 3.1 shows the high variability for Kurkum, North Horr and Gus (C.o.V >60). This means, most likely, that in these locations different aquifers are tapped.Water for human consumption should not exceed E.C. values of 780 mymhos/cm. All recorded values exceeded this. For livestock the threshold value lies around 3,900 mymhos/cm while the limiting concentration is 7,800 mymhos/cm. Adapted desert livestock, like camels, are able to drink water with values up to 16,000 mymhos/cm for short periods.

Table 3.1: Variability of Electric Conductivity (E.C.) in Selected Locations

Location	mean*	C.o.V.	n
Korr	1855.8	0.7	4
Kargi	2200.0	39.1	3
Olturot	1089.5	27.2	2
Kurkum	4458.3	93.8	4
North Horr	6790.5	283.1	2
Gus	37713.0	92.8	3

* in μmhos/cm

Table 3.2: Wells which exceed E.C. values recommended for livestock

Location	Threshold reached	Limiting intake	Unfit for consumption
Kurkum	*	*	
North Horr	*	*	
W.H. Chalbi	*		
Gus (east)	*	*	*
Gus (central)	*	*	*
Gus (southwest)	*		

Water sources at the northern and northwestern edge of the Chalbi Desert tap saline aquifers. In general terms, the quality of ground water in perched aquifers is better than that of the water in the deeper ones (Borgeson 1983). Tables 3.2 and 3.3 show other quality parameters for water sources in Marsabit District. Their significance is explained in RMH vol.I.

Water quality varies with time; however, no exact data is available for Marsabit District. Water salinity exhibits delayed seasonal effects, through eg., freshening of water with high rates of recharge after excessive rainfall and vice versa.Surface water sources are very highly variable in their quality characteristics and depend almost entirely on surface run-off. Their chemical quality standards are most frequently acceptable in Marsabit District (Ongweny 1983).

It is mainly the bacteriological quality that causes problems. In Marsabit District animals are not prevented from entering open water sources, thus polluting it with excreta. Open water sources in Marsabit District are not suitable for human consumption and treatment for animal use is highly recommended.

The sub-surface water quality in most locations is not a severe problem. However, cases where values for salinity (E.C.), fluoride, pH and hardness are exceeded, occur. The 'red spring' at Gus is unusable. Maikona and North Horr have salinity problems (for further details see Tables 3.3 and A.5). Gus, Loyengalani, Kalacha, Korole and North Horr show high fluoride levels. Although fluoride is beneficial at low levels, preventing tooth decay etc. (< 3ppm), extended use at higher concentrations will have adverse effects on human beings and livestock.

pH levels are very high at North Horr and Logologo, where the water is almost undrinkable. The school and mission supply etc. is obtained from other wells that tap different, higher quality aquifers. Other locations with high pH include

Table 3.3: Chemical Analysis of water fringing the Chalbi Desert [ppm]

Location	Kalacha Goda	Merunde	Kalacha Dida	Karawe Spring	Maikona Well
Calcium	55	18	15	25	100
Magnesium	-	34	28	69	31
Sodium	60	5500	1480	260	515
Potassium	9	100	36	25	22
Chloride	30	6850	1690	200	398
Sulphate	1	553	257	204	74
Bicarbonate	50	672	348	342	530
Fluoride	0.3	0.6	0.5	0.3	0.4
TDS	225	13335	3620	1050	1500
pH	6.7	8.7	7.6	7.3	7.5
E.C. [μmhos/cm]	300	25000	6500	-	2500

Kalacha, Maikona and Korole.In general terms, water quality in the district is not as severe a problem as in other districts (eg. Wajir). Nevertheless, since large sections of the district lie within volcanic areas, where sudden changes in the chemical composition of sub-surface water can still occur, it is strongly recommended that the water quality of the major sources is analyzed on a regular basis (ie. once a year).

THE CONSTRUCTION COSTS FOR WATER SOURCES

The cost for open surface water storage systems at the end of 1988 was as shown in Table 3.4:

Table 3.4: Approximate costs (1988) for the construction of open surface water storage systems (water pans)

Small size pan	<10 000 cum	250 000 KSh
Medium size pan	10 000 - 13 000 cum	320 000 KSh
Large size pan	> 13 000 cum	450 000 KSh

Rehabilitation of a pan can cost up to 1,000,000 Ksh. and is therefore rarely undertaken.Costs for shallow wells are difficult to estimate. They depend mainly on the price of cement, which is about 200 Ksh. per 50kg bag (1988). For reinforcement of the ring structure stainless steel is required. Sand and rocks are normally available in the vicinity of the building site. The amount of material needed depends on the depth of the well - normally not more than 20m.Usually, no more than 10,000 Ksh. are needed for a single shallow well, if the labour is provided free of charge. If the well is dug in hard rock, the main cost incurred will be for labour, as this type of construction can be time consuming.

Water is usually elevated with ropes and buckets (some made of giraffe and buffalo hides). Handpumps are used infrequently after trials showed that they break down frequently due to mishandling and vandalism. More sophisticated devices like windpumps are prone to the same problems and are hardly used, unless supervision and control are available.

Boreholes are the most expensive way to utilize water resources. For Marsabit District, the estimated drilling cost for one borehole with a depth of 200m is around 1,000,000 Ksh. This is partially due to the high transportation cost of the drilling rig and its accessory vehicles (more than 500km from Nairobi) and partly due to the difficult terrain. Drilling and casing costs can be as high as 1,200 Ksh/m (1988).The operating costs of a borehole, including running costs, repairs, and depreciation are well over 50,000 Ksh/yr. For government boreholes these costs are met by the Kenya Government, and usually not by the local population ie. the livestock owners do not contribute, except in some situations where diesel is bought.

RECOMMENDATIONS FOR WATER DEVELOPMENT

Surface structures

Surface water storage system construction has limited potential in Marsabit District. This is partly due to the character of the soils and the geology of the area as well its terrain structure. The substratum is frequently highly permeable, and there are only a few natural depressions suitable as catchments.It would be possible to dam some of the rivers coming from the Ndoto and Njiru Mts.; however, the costs would be excessive in relation to the benefits. One dam has already been constructed at South Horr. Other possible dam-sites are found along the lugga, and its 2 tributaries, bordering the Wajir District in the Sololo-Moyale area. Since the area is already well supplied with water, there is little need for further development.

Subsurface structures

Springs

On the mountains there are a number of springs which could be utilized. On Mt. Kulal the gazetted Biosphere Reserve prohibits direct access to these. Therefore here, as well as on other mountains, it is recommended to pipe water further down the slope. Thus the forests, which act as catchment guards, will be protected; it will also eliminate the accessibility problem.The pipeline at Gatab should be extended down to the lower airstrip (at Luai), where there is more forage available. At Gatab, soil erosion has already reached alarming proportions; it could be reduced if livestock would not go as far up the mountain.The pipeline at Arabel (North Kulal) should be rehabilitated and extended further downhill. However, this area offers limited amounts of forage, so that the final decision to rehabilitate and extend the pipeline should be dependent on actual range condition and production.The spring at Moruset has potential, and water could be piped further down the slope.

Sub-surface dams

The potential for sub-surface dams was not investigated. Potential sites have been described (Baur 1983). Certainly other potential sites may be found in various luggas. Sub-surface water storage has the advantage of reduced evaporation, good water storage quality and almost no risk of pollution by drinking animals.Wells:Development of the existing wells will increase the yield and enhance the quality of water. The development has to occur in 2 ways:

[1] As most wells are situated on run-off lines, they have to be protected from ensiltation. This may easily be done by raising the well shaft above the flood level by putting a concrete collar around it and sealing it with a metal lid. (eg. at Korr and Illaut)
[2] To prevent collapse of the well and to tap deeper water (thus increasing the yield), concrete rings have to be used.No well development should be carried out before investigation if forage resources are sufficient to allow increases in animal numbers.It is very likely that there are perched aquifers in run-off systems other than those already utilized (also see King et al 1983, Bake 1983 and IPAL 1984).

Similar conditions may be expected in most sections of the district covered by tertiary/quaternary sediments.Other possible sites may lie at the interfaces of the various lava shields (Kulal, Marsabit, Asie, Huri Hills) with the respective sedimentary plains. Water flows along the gradient of these shields and could be tapped at shallow depths.The occurrence of a lot of water, located in the shields, is indicated by an air vent on Mt. Kulal (Key and Rop 1987). A borehole was recommended at this site. Again, the available forage should be the deciding factor.

Boreholes

Borehole development should only be carried out if it has been established that the forage can support an increased number of animals. However, it may be sensible to plan boreholes for animals during drought periods.Basement boreholes can only be successfully drilled in fault or crack lines; otherwise they usually do not strike water.Groundwater in volcanic areas will mainly be found in friable materials like weathered lava, fossil soil, tuffe and other pyroclastics. In those substrata, good yields can be expected when recharge through joints and fractures is adequate. Careful predrilling investigation utilizing electric resistivity and magnetic anomaly soundings is absolutely necessary.

The Maikona formation is more than likely the best aquifer of the district. High yielding boreholes can be expected there due to the sedimentary character of the formation. Deep boreholes could tap saline water. Key and Rop (1987) propose sinking several boreholes into the Maikona Formation, which could then supply a large region, including even Marsabit township, with water.

However, pumping water up the mountain, over longer distances (ca. 70 km) will pose technical problems as well as demand high financial input. Questionable is, wether this water is really needed as the range will most likely not support the increases in animal population. For the moment, existing water sources, especially those provided by the springs on the edge of the Marsabit and Huri Hill lava, seem to be adequate to support the existing animal population.

Aside from perched aquifers there is likely to be a regional aquifer underlying most parts of the Chalbi drainage basin as well as vast areas of the surrounding volcanoes. The depths vary significantly from a few metres in the Chalbi to several hundred metres in the Hedad and the Dida Galgallo. Due to the high costs of drilling, it is recommended to drill new boreholes only when absolutely necessary (eg. for droughts). It has been shown (King et al 1983) that enough well-water exists for grazing animals stocked to the seasonally recommended carrying capacity in the Hedad.

CONCLUDING RECOMMENDATIONS

Large sections of Marsabit District have a high water-yield potential, which could be utilized with shallow wells and/or boreholes. The potential for surface water storage systems is limited and is reflected by the actual number of pans in the district. The development of shallow wells offers several advantages. They are inexpensive and provide only limited amounts of water, thus reducing overgrazing around them.Therefore, it is strongly recommended to look into the possibilities of developing shallow wells before drilling boreholes. Human population centres should be provided with water systems based on reliable boreholes. During normal rainy periods, all livestock, except the village milking herds should be grazed away from the villages. This will conserve the district's sparse vegetation and protect its environment.

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APPENDIX 1

Table A.1: List of dams and pans and their storage capacity

Location	Capacity (cum)	Remarks
Dambala Fachana	27300	not effective
Sololo Dida	27300	
Ramata	27300	
Kubitari	27300	
Yasake	3000	broken
Harbadana		silted-up
Harbasasa		silted-up
Kate	?	
Dirdima		broken
Harmisa	?	
Kozangido	8000	
Kubitari	?	
Harbadano Diko		broken
Falam		silted-up
Turbi	108000	built 1987
Funanyata	38400	built 1986
Kanabamba	5000	
Kuboli	6300	
Duboya	2500	rock catchment
Mansille	108000	built 1986

Table A.2: Water sources listed by coordinates (referring to Map No 18)

Well Name	Coordinate
Modokelu	A27
Bani	B1
Garba Merille	B1
Qicha	B10
Kasar	B11
Arigole (spring (2))	C10
Kaishu	C13
North Horr (airstrip)	C13
Koobi Fora	C13
Illgimirr	C3
Kokai	C5
El Abo	D10
Waye	D10
Modo Adi	D10
Mado Karma	D11
El Gata	D11
Ramata	D11
Hadu	D12
Murti Ndati	D12
Sidam	D14
Afgudud	D18
Kawari	D3
Rimesa	E12
Adadi	E12
Guna	E12
Adadi	E13
Dubuya	E14
Irile	E19
Shashafi	E19
Tuli	E19
Fora	E9
Galas (spring)	F12
Dololo Dikacha 1	F13
Dololo Dikacha 2	F15
Diribsoi	F19
Titu	F20
Bodete	F20
Moyum	F20
Dadacha	F22
Gonchi	F23
Chaichut	F23
Eres Wachihu	F23
Moleral	F24
Baji	F24
Derati	F7
Saberei	G1
Hara Quandi	G11
El Tackicha	G12
Dololo Chake	G14
Garba	G14
Lag Dedachi	G16
Balo (spring)	G18
Moyuma	G18
Tamsa	G26
Buluk	G3
Kalumi	G8
Hurran Hurra	H12
Hari Jilo	H12
Wano	H13
Funanyata	H13
Modo Segunte	H14
Daka Dima	H14
Futaful	H15
Komate (spring)	H18
Loyengalani	H19
Ladarabach (spring)	H19
Mawingatan	H20
Serima (Serimo)	H22
Kersa Bis	H4
Komor Aliga	I14
Harade	I14
Dudati	I15
Kamor Jane	I15
Kamor Guyo Timo	I15
Cheracha	I16
Kuboli	I17
Kuloli (2)	I18
Sakot	I9

Nyaber	J10
El Bes	J11
Dabel-El Der well group	J15
Arapel	J19
Arabtiris	J2
Loroni (spring)	J20
Luai	J21
Gatab	J21
South Horr	J26
Semurai	J27
Kari	K18
El Galan (spring)	K19
Galan (spring)	K20
Oltorot	K21
Murgusiat	K25
Chanau	K26
Argi	K26
Horr Dika	L14
Horr Guda	L14
Molobot	L15
Balesa Kulal	L22
Woromo	M14
El Sardu	M4
Saru	M4
El Gade	N13
Gus (springs and wells)	N16
Illaut (numerous wells)	N29
El Yibo	N4
Bulti Jaldessa	N4
Dukana	N6
Balesa	O10
Kalacha Dida	O14
Falama (spring)	O22
Ngurunit (rock pool)	O30
Lependera	O30
Ngurunit (wells)	O30
Kalacha (numerous wells	P14/Q14
Burkha	P17
Korome	P17
Baio	P31
Larabasi	P31
Korr (numerous wells)	PQ27/28
Afgab	Q14
Gamaura (springs and we	Q18
Kurkum (2)	Q20
Milgis	Q31
Lempara	Q34
El Adi 2	Q9
Maikona (numerous wells	R19
Karole (2)	R20/S20
Kargi (wells)	R22
Milgis	R31
Resodat (Losodan)	R32
El Adi 1	R6
Barcho Barcha	S19
Mayidahad	S19
Koronli	S20
Losai	S31
Maile	S33
Kamataini	S34
Merille 1,2,3	S34/T34
Huri	T11
Garibabor (rock pool)	T12
Koronde (2)	T20
Hogichu	T24
Gatu Nyencha	T26
Laisamis	T32
Kie	U22
Ret	U26
Chakyole	U30
Kurato 1,2	U34
Semirura	U34
Hulan Hula	V24
Karsaderu	V24
Koya	V34
Forole	V9
Mudo	W22
Badesa	W25
Songa	W25
Bale Burgaba	X15
Kwial	Y11
El Bor	Y11
Liis (Turbi)	Z12
Mado Derdeku	Z30

Table A.3: Water sources listed in alphabetical order (referring to Map No 18)

Well Name	Coordinate
Adadi	E12
Adadi	E13
Afgab	Q14
Afgudud	D18
Arabtiris	J2
Arapel	J19
Argi	K26
Arigole (spring (2))	C10
Badesa	W25
Baio	P31
Baji	F24
Bale Burgaba	X15
Balesa	O10
Balesa Kulal	L22
Balo (spring)	G18
Bani	B1
Barcho Barcha	S19
Bodete	F20
Bulti Jaldessa	N4
Buluk	G3
Burkha	P17

Chaichut	F23	Irile	E19
Chakyole	U30	Kaishu	C13
Chanau	K26	Kalacha Dida	014
Cheracha	I16	Kalacha (numerous wells)	P14/Q14
Dabel-El Der well group	J15	Kalumi	G8
Dadacha	F22	Kamataini	S34
Daka Dima	H14	Kamor Guyo Timo	I15
Derati	F7	Kamor Jane	I15
Diribsoi	F19	Kargi (wells)	R22
Dololo Chake	G14	Kari	K18
Dololo Dikacha 2	F15	Karole (2)	R20/S20
Dololo Dikacha 1	F13	Karsaderu	V24
Dubuya	E14	Kasar	B11
Dudati	I15	Kawari	D3
Dukana	N6	Kersa Bis	H4
El Abo	D10	Kie	U22
El Adi 1	R6	Kokai	C5
El Adi 2	Q9	Komate (spring)	H18
El Bes	J11	Komor Aliga	I14
El Bor	Y11	Koobi Fora	C13
El Gade	N13	Korome	P17
El Galan (spring)	K19	Koronde (2)	T20
El Gata	D11	Koronli	S20
El Sardu	M4	Korr (numerous wells)	PQ27/28
El Tackicha	G12	Koya	V34
El Yibo	N4	Kuboli	I17
Eres Wachihu	F23	Kuloli (2)	I18
Falama (spring)	022	Kurato 1,2	U34
Fora	E9	Kurkum (2)	Q20
Forole	V9	Kwial	Y11
Funanyata	H13	Ladarabach (spring)	H19
Futaful	H15	Lag Dedachi	G16
Galan (spring)	K20	Laisamis	T32
Galas (spring)	F12	Larabasi	P31
Gamaura (springs and wells)	Q18	Lempara	Q34
Garba	G14	Lependera	030
Garba Merille	B1	Liis (Turbi)	Z12
Garibabor (rock pool)	T12	Loroni (spring)	J20
Gatab	J21	Losai	S31
Gatu Nyencha	T26	Loyengalani	H19
Gonchi	F23	Luai	J21
Guna	E12	Mado Derdeku	Z30
Gus (springs and wells)	N16	Mado Karma	D11
Hadu	D12	Maikona (numerous wells)	R19
Hara Quandi	G11	Maile	S33
Harade	I14	Mawingatan	H20
Hari Jilo	H12	Mayidahad	S19
Hogichu	T24	Merille 1,2,3	S34/T34
Horr Dika	L14	Milgis	R31
Horr Guda	L14	Milgis	Q31
Hulan Hula	V24	Modo Adi	D10
Huri	T11	Modo Segunte	H14
Hurran Hurra	H12	Modokelu	A27
Illaut (numerous wells)	N29	Moleral	F24
Illgimirr	C3	Molobot	L15

Moyum	F20
Moyuma	G18
Mudo	W22
Murgusiat	K25
Murti Ndati	D12
Ngurunit (rock pool)	O30
Ngurunit (wells)	O30
North Horr (airstrip)	C13
Nyaber	J10
Oltorot	K21
Qicha	B10
Ramata	D11
Resodat (Losodan)	R32
Ret	U26
Rimesa	E12
Saberei	G1
Sakot	I9
Saru	M4
Semirura	U34
Semurai	J27
Shashafi	E19
Sidam	D14
Serima (Serimo)	H22
Songa	W25
South Horr	J26
Tamsa	G26
Titu	F20
Tuli	E19
Wano	H13
Waye	D10
Woromo	M14

Table A.4: List of boreholes and estimated water yields

Borehole#	Location	Yield [m³/h]	Built	Quality
C1758	Loglogo	7.9	?	good
C3008	Moyale Oda	5.6	?	good
C3039	Jaldessa	4.5	1960	potable
C3056*	Halisruwa	2.3	?	potable
C3602	Laisamis	4.5	?	potable
C3612	Laisamis	5.4	?	potable
C3625	Laisamis	10.9	?	potable
C3681	Loglogo	12.7	1970	good
C3682	Loglogo	23.6	1970	good
C3723	Bubisa	2	1974	good
C3819	Gudas	8.2	1972	potable
C3840	Dabel	5.5	?	good
C3890	Wran	4.5	1975	good
C3896	Walda	27.3	?	good
C3943	Yamicha	9	1973	potable
C3960	Kargi	10.9	1973	potable
C3966	Golole	10	?	good
C3984	Moyale Nana	1.8	?	saline
C4071*	Korr	3.6	?	saline
C4073*	Korr	0.5	?	saline
C4084*	Korr	7.8	?	good
C4107*	Korr	9	?	potable
C4108*	Korr	3.8	?	good
C4112*	Korr	5.4	?	saline
C4113*	Korr	9	?	saline
C4119*	Korr	6	1975	potable
C4181	Bori	4.5	?	good
C4573	Sagante	8.1	?	good
C4965*	Moyale Oda	13.4	?	?
C5001	Sabarei	32.7	?	saline
C5047	Illeret	3.6	?	saline
C5901	Godona	2.2	1984	?
C6063	Sololo	2.3	1985	saline
C6357	Dukana	5.4	1985	good
SA112*	Maikona	0.2	?	good

Table A.5: Some quality parameters of various water sources in Marsabit District

Sample date	Location	Electric Conductivity µmhos/cm	Na mg /l	K mg/l	Mg mg/l	Ca mg/l
Sep 77	Ngurunit. old airstrip		985	16.5	96.1	127.5
Sep 77	Ngurunit. source piped water		1175	71	151	140
Dec 79	Korr. village handpump	1838		26		
Dec 79	two km west of Korr	1874				
Dec 79	AIM-Handpump	1862				
Apr 81	C 4071	1849				
Sep 77	six km SW Korr		275.5		81	128.3
Dec 79	Kargi. exclosure	2631				
Apr 81	Kargi. well 500 m south	1698				
Apr 81	C 3960	2971				
Sep 77	Korole WH		3000	300	0.6	5.8
Sep 77	Karole		800	9.2		
Sep 77	Maikona 1		2800	250	420.9	35.8
Sep 77	Maikona 2		5600	520	550.9	9.6
Sep 77	Maikona 3		560	20	37	23.6
Sep 77	Maikona 4		425	130	87.1	44.4
Sep 77	Maikona 5		270	30	48.1	15.7
Sep 77	Maikona W of town 1		190	20	52.3	20.4
Sep 77	Maikona W of town 2		240	25	52.3	
May 81	Kurkum. well upstream	1325				
May 81	Kurkum. well downstream	1608				
May 81	Kurkum. old British well	3323				
Jun 81	Kurkum. UNESCO well	1577				
Sep 77	Kalacha AIC 1					
Jun 80	Kalacha AIC 2	1244				
May 81	Kalacha UNESCO well	1269				
Sep 77	Upper Kalacha		270	30	53	8.2
Sep 77	Kalacha town 1		300	50	69.2	25.8
Sep 77	Kalacha town 2		1200	180	14.5	9.2
May 81	Kalacha	1841				
May 81	C 4825	1300				
Jun 81	Burka springs (Kalacha)	1512				
Sep 77	North Horr 1		375	30	11.4	14.4
Sep 77	North Horr 2		2600	150	0.1	4.6 1
Sep 77	North Horr 3		320	20	2.1	4.6 1
May 81	North Horr town supply	1146				
May 81	North Horr Mission	12435				
Jun 81	Cattle WH Chalbi	4288				
Sep 77	Gus 1		640	20	21.7	15.7
Sep 77	Gus 2		720	20	20	16.7
Sep 77	Gus 3		660	23	22.5	16.7
Sep 77	Gus 4		860	40	28.7	24.3
Sep 77	Gus 5		780	15	1.2	4.6
Jun 81	Gus spring brown	17688				
Jun 81	Gus spring red	75040				
Jun 81	Gus spring grey	5411				
Jun 81	Oltorot	1386				
Jun 81	Balesa Kulal road crossing	793				
Jun 81	Bubisa	3430				
Jul 81	Soriadi	3150				
May 81	Gudas	1000				

Table A.5: Quality parameters (continued)

pH	Alkalinity [mg/l $CaCO_3$]	Hardness [mg/l $CaCO_3$]	Chloride [mg/l Cl-]	Sulfate [mg/l Na_2SO_4]	Fluorid mg/l F	SAR by calculation
8.5					1.55	
8.9					1.27	
7.5						
8.5						
8						
8.3	222	440	301	345	1.00	3.70
8.4					1.45	3.72
8.5						
9	32	444	216	306		0.53
8	862	68	233	240	1	30.30
9.8					4.17	
9.6					2.3	
8.4					2.4	28.53
9.2						50.90
8.5					2.2	16.76
9						8.53
9					2.4	7.61
9					2.6	5.06
9.5						6.76
7.6	168		173			
7.2	412	448	210			
8.3	256	544	644	528		7.74
8.4	174	528	700			
7.9	306	70	124			
9.6					3.2	
9.2					3.2	7.56
9.5					1.56	6.98
7.7	378	344	196	432	0.4	57.44
8.4	318	292	133	284		5.82
					7.68	
8.6					12.4	
10.2					58	17.89
10.2					7	
8.5	412	112	82	178	1.4	31.10
8.5	944	116	669			9.63
7.5	1726	144	179			
8.2					11.6	
8.4					10.4	
8.1					10.8	
8.3					13.2	
8.6					16	
8.9			3985		0.6	
9.6						
8.6			1390			
7.5	520	128	136	136	0.8	
8.2	290	332	23			11.60
7.9	582	504	596			
8.4	352	130	522	1032	0.6	
7.9	426	124				26.48

Table A.5 (cont): Some quality parameters of various water sources in Marsabit District

Sample date	Location	Electric Conductivity µmhos/cm	Na mg /l	K mg/l	Mg mg/l	Ca mg/l
Sep 77	Loglogo		600	80	146.3	19.5 1
Sep 77	Looiengalani		715	17	2.5	1.1
Sep 77	Dukana		24	6.8	15.2	30
Sep 77	Hurran Hurra	460	10	20.6	4.6	9.4

Table A.5 (cont): Quality parameters (continued)

pH	Alkalinity [mg/l $CaCO_3$]	Hardness [mg/l $CaCO_3$]	Chloride [mg/l Cl-]	Sulfate [mg/l Na_2SO_4]	Fluorid mg/l F	SAR by calculation
10.1					2	10.19
9.8					12	8.63
8.5					2.4	0.86
9.4					8.4	20.90

APPENDIX 2

Summary description of water sources by Range Unit (referring to Chapter IV and Map No 20)

Remarks
The summary describes the number of different water sources per range unit and their added safe water yield. It was not intended to name the water sources as this would lead in some cases to very long lists. The names can easily be taken from the maps and the lists of water sources, as well as their specific yield.

The estimated safe water yield means the amount of water which can be expected during dry seasons. Droughts have not been included, as during these times water sources become rather unpredictable. But (!)it has to be noted that the effect of the drought in a water source might be felt only after a certain delay (lapse time) which can be several years. The limitations mentioned apply only to aspects of hydrology.

Range Unit 1: Illeret
Boreholes: 1
Wells: 3
Estimated safe water capacity: 30m^3/d
Limitations: Borehole at Illeret slightly saline and mainly for domestic use

Range Unit 2: Moiti
Wells: 10
Springs: 3
Estimated safe water capacity: 130m^3/d
Limitations: Variable spring yield

Range Unit 3: Loyengalani
Wells: 1
Springs: 4
Estimated safe water yield: 40m^3/d

Range Unit 4: South Horr
Wells: 8
Springs: numerous
Estimated safe water yield: Owing to numerous springs, extended river flow by several luggas and higher rainfall in up-mountain country the exact capacity is not known. But there is enough water to provide for more than the actual animal population.

Range Unit 5: Hurran Hurra
Boreholes: 1
Wells: 10
Springs: 1
Estimated safe water yield: 210 m^3/d
Limitations: This unit has a borehole with a very high yield, due to the remote location it is frequently broken down (Sabarei).

Range Unit 6: North Horr
Boreholes: 2
Wells: 6
Springs: 2
Estimated safe water yield: more than 200 m^3/d
Limitations: Boreholes in North Horr only for domestic use, springs close to N. Horr have very high capacity.

Range Unit 7: Kulal
Wells: 6
Springs: 4
Estimated safe water yield: 150m^3/d
The water supply for this unit is sufficient if the water from the upper mountain could be brought to the lower slopes.
Limitations: The water pools at Gus are excessively saline.

Range Unit 9: Dukana
Boreholes: 2
Wells: 4
Estimated safe water yield: 80m^3/d
Limitations: Both medium yield boreholes at Dukana trading centre

Range Unit 10: Kalacha
Wells: Numerous
Springs: Numerous
Estimated safe water yield: very high
Limitations: Almost all, but expecially the high yield wells and springs are located at the Chalbi Desert edge. The northwestern slopes of the Hurri Hills are almost waterless. A very uneven distribution.

Range Unit 11: Koroli
Boreholes: 2
Wells: 4
Springs: 1
Estimated safe water yield: 120m^3/d
Limitations: Wells at Kargi and Kurkum saline, as well as borehole in Kargi. Borehole at Kurkum drilled and in use by oil company.
Note: The spring at the Chalbi edge with the same name does not belong to this unit.

Range Unit 12: Kaisut

Boreholes: 3*
Wells: Numerous
Estimated safe water yield: over 200m^3/d
The area comprises three high yield boreholes at the edges in Loglogo and Laisamis.
*There are a number of water yielding boreholes at Korr, all out of order in June 1988

Range Unit 13: Hurri Hills

Wells: 2*
Pans: 3 (1 rock catchment)
Estimated safe water yield: 40m^3/d
Limitations: Pans last only a few weeks after rains.
*There are a number (over 10) new shallow wells built by AIC, Kalacha in this unit. As their location and yield is unknown, they are not included here.

Range Unit 14: Maikona

Wells: 2
Estimated safe water yield: 20m^3/d
Numerous wells at Maikona are not located in this unit.

Range Unit 15: Marsabit West

Boreholes: all located within the National Park
Wells: 2 plus several in the National Park
Springs: 3
Estimated safe water yield: over 300m^3/d
Limitations: The 3 high yield springs are located at the edge of the unit (Koroli, Karole, Mayidahad). Various good water sources are within the National Park. Those serve in fact most of the animals of this unit.

Range Unit 16: Sololo

Boreholes: number unknown, because of unlicensed drilling
Wells: numerous
Pans: 4, plus several road side excavations
Estimates safe water yield: over 500m^3/d
Limitations: good supply around Sololo and in the north, but strong out thinning towards the south, unever supply

Range Unit 17: Dida Galgalu

Boreholes: 1
Wells: numerous
Estimated safe water yield: 100m^3/d
Limitations: uneven supply as most wells are at Maikona

Range Unit 18: Marsabit East

Boreholes: 2
Wells: several on Mt. Marsabit
Estimated safe water yield; 150m^3/d
Limitations: Although there is a good water potential on Mt.Marsabit this has reached its limits due to increasing population and more and more irrigation.

Range Unit 19: Milgis

Wells: 2
There is an additional seasonal water supply in swampy areas
Estimated safe water yield: 20m^3/d

Range Unit 20: Rusarus

Wells: 2
Estimated safe water yield: 20m^3/d

Range Unit 21: Sibiso Malbebale

Boreholes: 3
Wells: numerous
Pans: 4
Estimated safe water yield: over 300m^3/d
Limitations: Pans have water for limited time only. Water supply is uneven to the east, where it has to be shared with Wajir District.

Range Unit 22: Galba

Wells: 5
Estimated safe water yield: 50m^3/d
Limitations: The wells are all at the eastern edge.

Range Unit 23: Mado Kelu

The only known water source is at Bubisa at the western edge.

CHAPTER IV
RANGE UNIT INVENTORY

H.J.SCHWARTZ AND M.WALSH

THE CONCEPT OF RANGE UNITS

The Kenyan rangelands comprise of vast areas of land which are traditionally utilised for extensive livestock production. These areas however are by no means of an identical or even similar ecological potential. They occur over a wide range of altitudes, receive widely varying amounts of rainfall and are furthermore characterised by different soils and vegetation types, drinking water availability, as well as geomorphological and topographical features. Rangelands are also used as feed resource for different livestock species which have distinctly different forage and water requirements and different capacities to harvest feed from natural pastures under adverse conditions as they are common on rangelands. This complexity makes it difficult to apply uniform management to the rangelands and leads frequently to a gross over- or underestimation of the productive potential of these areas.

To allow an easier and realistic evaluation of the productive potential of rangelands the concept of range units was developed. Range units are defined as areas of reasonably uniform ecological potential for their use as pastures, i. e. areas at similar altitudes, with similar precipitation and soils which usually results in a similar vegetation. Range units can be delineated at a very small and accurate scale of a few hundred square meters. This however would defeat the purpose of the concept, i. e. to provide a range management tool for practical application. A unit size of between 2,000 and 3,000 sqkm was considered to give sufficient differentiation and resolution under the conditions in Marsabit District and at the same time keep the number of units small enough for management purposes.

The range units were delineated on the basis of the major landforms (Map No 11) and the primary vegetation types (Map No 17). In most cases the boundaries are clearly recognisable in the field by topographical features such as hill ranges, lava flows or seasonal watercourses and by distinct changes in the vegetation. In a few instances major roads serve as boundaries where other features were not obvious enough. Range unit boundaries must not be understood as administrative boundaries like those of National Parks and Reserves, Forest Reserves, Grazing Blocks or District boundaries. They are merely ecological boundaries and a matter of convenience for land evaluation and resource management planning.

Marsabit District was divided into 23 range units with an average size of approximately 2,400 sqkm, with 980 and 6,035 sqkm as the smallest and the largest unit respectively. The units were not surveyed in the field but delineated using various maps from this volume, aerial photographs and satellite immages. Consequently the unit sizes are only approximate values.

THE RANGE UNIT INVENTORY

The range unit inventory consists of three parts: Part 1 are 46 reference sheets, two for each unit; Part 2 is a summary table of the most important characteristics of all units; Part 3 are four annotated maps of the District summarising potential use (season, duration) and production risks for the major livestock species cattle, sheep, goats and dromedaries. National Parks and Reserves are not included in the inventory since grazing in those areas is normally restricted.

Part 1: Reference Sheets

First Section

The first section of the reference sheets is descriptive. It gives the range unit number, name, size and information on landforms, soils, vegetation types and watering points.

Second Section

The second section is quantitative and furnishes the base data for resource management planning of the individual range unit. In Table 1 all parameters used are summarised together with the calculation procedures for derived figures. 9 groups of values are listed:

[1] Median Rainfall

The values for median rainfall, separately expressed in annual and seasonal terms, were extracted from the Maps Nos 3, 4 and 5.

[2] Forage Biomass Production

The median rainfall figures were used to calculate potential forage biomass production [kg/ha] for the herblayer and the shrublayer separately. In units where the rainfall shows larger spatial differences the values used for the calculation were weighted according to the proportional area receiving different rainfall. The calculation was based on the regression developed by LeHouerou and Hoste, modified for the conditions in Northern Kenya.

$$y = a + bx$$

y = dry matter production [kg/ha/yr]
x = annual precipitation [mm]
a = regression constant
b = regression constant

The regression is reliable for the estimation of biomass production for a limited range of precipitation values between 100 and 400 mm per year or season. Where total rainfall values were below 100 mm no accurate estimates were possible and were left out. A critical evaluation of this method is provided in Vol. 1 of the Handbook.

[3] Permissible Off-take

Constant values for the permissible off-take as % of the total biomass produced are given for four rainfall classes. Off-take at the recommended levels ensures that overgrazing, degradation of vegetation and long-term changes in the botanical composition of the pastures are avoided.

[4] Forage Availability

Forage availability is defined as the number of days per annum or per season with conditions conducive to plant growth, ie. when green biomass is produced. The values are extracted from Maps No 8 and 9 separately for the two rainy seasons each for the herblayer and the shrublayer. No values are given when the seasonal rainfall remains below 100 mm since biomass production under such conditions can not be estimated with any degree of accuracy.

[5] Optimal Number of Grazing Days

The optimal number of grazing days per year or per season is determined by forage availability, forage quality and animal species. After the last effective rainfall of one season forage quality starts to decline to a level where feed intake by livestock becomes restricted even if the available quantity is still ample (see Handbook Vol. 1). At this stage the animals start to mobilise body reserves to maintain their metabolic functions, ie. they switch from an anabolic to a catabolic nutritional status. This means they start to loose body weight. The optimal number of grazing days is therefore defined as the number of days per season when adequate quantities of forage with an adequate nutrient density are available to the animal. The recommended number of grazing days, consequently is that period during which the animals can cover their nutrient requirements for maintenance and production from the available pasture.

Cattle for instance feed exclusively on the herblayer, where quality deteriorates most rapidly after the end of the rainy season since the plants of the herblayer usually do not tap into the ground-water. As a result cattle grazing can only be recommended for short periods in excess to those with conditions which are conducive to plant growth in the herblayer. With an increasing proportion of browse in the habitual diet of animals as it can be observed in sheep, goats and dromedaries respectively (see Handbook Vol. I) the optimal number of grazing days increases since the woody vegetation retains higher forage quality levels for longer periods and may even remain green throughout the year.

[6] Total Forage Production

Total forage production expressed as metric tons per range unit is computed from forage biomass production and range unit size within each major vegetation type within the unit and subsequently added for the whole unit.

[7] Total Permissible Off-take

Total permissible off-take [tons/range unit] is the proportion of the total forage produced which is usable as animal feed if range deterioration is to be avoided.

[8] Animal Requirements

Animal requirements were calculated as kg dry matter forage per tropical livestock unit (TLU) per day. One TLU is equivalent to 250 kg live weight. Considering the types and breeds of livestock prevalent in Marsabit District one TLU is equivalent to 1.0 head of cattle, 10 sheep, 11 goats or 0.7 dromedaries.

The requirements were calculated at maintenance level, i. e. with no body weight changes and no other out-puts like milk or work, and based on the assumption that the available forage contains a minimum of 1.8 mcal metabolizable energy and approximately 40 gms digestible protein per kg dry matter, which is a quality commonly found at the beginning of the dry season on semi-arid and arid rangelands in East Africa. For the calculation of the requirements for maintenance plus a moderate production the following levels of production were assumed:

cattle	300 gm daily gain or 2.5 l milk/day
sheep	80 gm daily gain
goats	60 gm daily gain or 0.45 l milk/day
dromedaries	450 gm daily gain or 4 l milk/day

To achieve these levels of production the available forage needs to contain a minimum of 2.2 Mcal metabolizable energy and approx. 60 gms digestible protein per kg dry matter. Such qualities are available in the herblayer only during the growing phase of the vegetation. In the shrublayer and in particular in larger bushes and small trees qualities in this range can be available for much longer periods.

[9] Maximum Stocking Density

In the last step of the calculation maximum sustainable stocking densities by animal species were determined. Cattle and sheep can be classified as grazers, ie. they utilise the herblayer competitively, just as goats and dromedaries compete for the forage in the shrublayer. However, there is little or no competition between the two groups. As a result stocking densities for the two groups are independent from each other but are cumulative within the groups (see Handbook Vol 1, Chapter "Forage Requirements").

Third section

The third section of the reference sheets is again descriptive. It incorporates into the range unit evaluation other features such as restrictions to accessibility, drought risk and other characteristics which have a bearing on the productive potential of the range unit. Furthermore a brief evaluation of the development potential of the unit is given. Three utilisation categories (Range types) are used to summarise the development potential:

Range Type 1

Range units with low rainfall, high rainfall variability, high drought risk and a low proportion of woody perennials in the vegetation and/or severe permanent restrictions to access by livestock are classified as for opportunistic use during high-rainfall years by all livestock. Little or no infrastructural improvements can be recommended for such units.

Range Type 2

Range units with higher rainfall, higher probability of actual precipitation during the second (short) rains, reduced drought risk, high proportion of woody perennials and moderate to slight restrictions to access by livestock are classified as for opportunistic use by cattle and sheep and regulated use by goats and camels. These units have a limited development potential for browsing livestock, in particular for the improvement of water supplies during the dry season.

Range Type 3

Range units which comprise of large proportions of high-rainfall areas (high altitude areas) or extended run-on areas (floodplains) with little or no drought risk, high proportions of woody perennials in the vegetation and/or perennial grasslands are classified as for regulated use by all livestock species. These range units offer a safe forage supply to grazers for more than 180 days per annum, have a moderate development potential for livestock raising and a limited potential for rainfed agriculture. They are the only areas in the District which allow year-round keeping of cattle.

Part 2: Summary Tables

In this table the most important key figures for all range units are summarised for quick refe-rence. These are by range unit the size, total permissible forage off-take for median rainfall years, recommended season and duration of use by animal species and recommended stocking densities by season and animal species.

Part 3: Annotated Maps

In four maps, one for each animal species, the productive potential is shown for the whole District in median rainfall years. Maximum sustainable animal numbers and foreseeable production risks are commented upon.

Table 1: Steps for calculating the recommended stocking density for a range unit

Parameter	Code	Source of Information, Calculation or Constants			
(1)Median rainfall [mm]					
Annual	A	Extracted from Map # 3			
Long rains	AL	dto. # 4			
Short rains	AS	dto. # 5			
(2)Forage biomass production [kg/ha]					
Herblayer					
Annual	BHA	-180 + (6.3 * A)			
Long rains	BHL	-180 + (6.3 * AL)			
Short rains	BHS	-180 + (6.3 * AS)			
Shrublayer					
Annual	BSA	-400 + (10 * A) - BHA			
Long rains	BSL	-400 + (10 * AL) - BHL			
Short rains	BSS	-400 + (10 * AS) - BHS			
(3) Permissible off-take [% of biomass produced]		at median rainfall [> ... mm]			
		100	200	300	400
Herblayer	CH	30	35	40	50
Shrublayer	CS	25	30	40	50
(4)Forage availability [days]		Extracted from Map # 11			
		Long rains		Short rains	
Herblayer	DH	DHL		DHS	
Shrublayer	DS	DSL = DHL + 30		DSS = DHS + 20	
(5)Optimal Number of grazing days		Long rains		Short rains	
Cattle	EC	DHL + 10		DHS	
Sheep	ES	DHL + 30		DHS + 20	
Goats	EG	DSL + 30		DSS + 20	
Dromedaries	ED	DSL + 45		DSS + 30	
(6)Total forage production [,000 tons/range unit]		Calculated within vegetation type and season and added for the whole unit			
Herblayer	FH	BH * Unit size/10			
Shrublayer	FS	BS * Unit size/10			
(7)Total permissible off-take [,000 tons/range unit]		Calculated within vegetation type and season and added for the whole unit			
Herblayer	GH	FH * CH/100			
Shrublayer	GS	FS * CS/100			

Table 1: (continued)

Parameter	Code	Source of Information, Calculation or Constants	
(8)Animal requirements [kg dry matter forage/TLU/d]		Maintenance only	Maintenance and production
Cattle	HC	4.8	6.4
Sheep	HS	6.2	7.9
Goats	HG	6.4	7.3
Dromedaries	HD	6.1	7.3
(9)Maximum stocking density [ha/TLU] for optimal number of grazing days			
Cattle	IC	HC * EC / BH * CH/100	
Sheep	IS	HS * ES / BH * CH/100	
Goats	IG	HG * EG / BS * CS/100	
Dromedaries	ID	HD * ED / BS * CS/100	

Note: The following areas are not included in the the above calculation because of their special legal status

Marsabit National Park	395 km^2
Marsabit National Reserve	1435 km^2
Losai National Reserve	1820 km^2
Mt.Kulal Biosphere Reserve	410km^2
Sibiloi National Park	1420 km^2
South Island Park	40km^2

The Chalbi Desert (1195 km^2) is likewise excluded since it is bare of any vegetation

Range Unit NO 1 — ILERET — approx. 2050 km²

Landforms:	Lacustrine plains, uplands, piedmont plains, no severe restrictions to access.
Soil Types:	loamy sand to sand, deep, excessively to imperfectly drained (PlX); strongly calacacerous gravelly clay loam, shallow, well drained (UP); stony loam, very deep, well drained (YP).
Vegetation Types:	40% barren lands, 30% deciduous grassland, 15% dwarfshrub/annual grassland, 15% bushed grassland, minor areas of bush/grassland on waterlogged soils.
Watering Points:	1 Borehole, 3 Wells, Estimated safe water yield: 30m³/d

	1st rains	2nd rains
Median Rainfall [mm]:	200	75
Forage Biomass Production [kg/ha]:		
Herblayer:	1080	-
Shrublayer:	520	-
Forage Availability [days]:		
Herblayer:	55	-
Shrublayer:	85	-
Total forage production [,000 t]:		
Herblayer:	221.4	-
Shrublayer:	106.6	-
Total permissible off-take [,000 t]:		
Herblayer:	77.49	-
Shrublayer:	31.98	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	0.8 (65)	-
Sheep:	1.4 (85)	-
Goats:	4.7 (115)	-
Camels:	6.0 (130)	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.1 (65)	-
Sheep:	1.8 (85)	-
Goats:	5.4 (115)	-
Camels:	6.1 (130)	-

Summary and Recommendations:

The range unit 1 (Ileret) comprises of approx. 2050 km² and receives a median annual rainfall of 250 to 300 mm. A risk of drought occurs in 2 years out of 10. 40% of the total area is barren. Forage availability over the remaining 60% of the unit is limited to the rainy seasons and the immediate post-rain periods. During these limited periods large numbers of animals could be grazed. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed. There are, however, some small areas along the lakeshore where flood retreat cultivation of millet is practised and some slightly larger areas of perennial grassland (mainly *Sporobolus spicata*) which remain green through most of a normal rainfall year. Both areas can be used as dry season grazing reserves for a limited number of cattle. Permanent watersources are Lake Turkana, several wells and water- holes along the lake shore, one well at Garba Merille, two wells near the Eastern boundary of the unit and one borehole at Illeret, which is slightly saline and mainly for domestic use.

Because of the seasonal limitation of forage availability, the quick decline of the forage quality, the high drought risk and the limited water sources, which characterise the major part of the range unit no infrastructural improvements can be recommended. Opportunistic use of the range unit **(Range type 1)** during high-rainfall years is the only feasible alternative.

Range Unit NO 2 — MOITI — approx. 4020 km²

Landforms: Lava plateaus, piedmont plains, no severe restrictions to access

Soil Types: strongly calciferous gravelly clay loam,shallow, well drained (UP); stony loam, very deep, well drained (YP).

Vegetation Types: 60% barren land, 20% bushed grassland, 20% dwarfshrub/annual grassland.

Watering Points: 10 Wells; 3 Springs; Estimated safe water yield: 130 m^3/d.

	1st rains	2nd rains
Median Rainfall [mm]:	150	75
Forage Biomass Production [kg/ha]:		
Herblayer:	765	-
Shrublayer:	335	-
Forage Availability [days]:		
Herblayer:	40	-
Shrublayer:	70	-
Total forage production [,000 t]:		
Herblayer:	307.53	-
Shrublayer:	134.67	-
Total permissible off-take [,000 t]:		
Herblayer:	92.26	-
Shrublayer:	33.67	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	1.1 (50)	-
Sheep:	2.0 (70)	-
Goats:	7.6 (100)	-
Camels:	8.4 (115)	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.4 (50)	-
Sheep:	2.4 (70)	-
Goats:	8.7 (100)	-
Camels:	10.0 (115)	-

Summary and Recommendations:

The range unit 2 (Moiti) comprises of approx. 4020 km² and receives a median annual rainfall of 200 to 250 mm. A risk of drought occurs in 2 to 4 years out of 10. 60% of the total area is barren and offers very limited amounts of forage in narrow vegetation bands along drainage lines only. Forage availability over the remaining 40% of the unit is limited to the rainy seasons and the immediate post-rain periods. During these limited periods large numbers of animals could be grazed. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed. Small areas of perennial grassland (mainly *Sporobolus spicata*) along the lakeshore can be used as dry season grazing reserve for a limited number of cattle.

Permanent watersources are Lake Turkana and several wells and springs with seasonally variable water yields. Water and forage availability appear to be balanced during the dry season.

Because of the high proportion of barren land, and the seasonal limitation of forage availability, the quick decline of the forage quality and the high drought risk, which characterise the useable part of the range unit no infrastructural improvements can be recommended. Opportunistic use of the range unit **[Range type 1]** during high-rainfall years is the only feasible alternative.

Range Unit NO 3 LOYENGALANI approx. 1390 km²

Landforms:	Lava plateaus, lacustrine plains, 25% severe permanent restrictions to access.
Soil Types:	very stony clay, varying depths, well drained (LV2); loamy sand to sand, deep, excessively to imperfectly drained (PIX).
Vegetation Types:	65% dwarfshrub/annual grassland, 30% deciduous grassland, 5% deciduous bushland.
Watering Points:	1 Well; 4 Springs; Estimated safe water yield: 40 m^3/d.

	1st rains	**2nd rains**
Median Rainfall [mm]:	150	75
Forage Biomass Production [kg/ha]:		
Herblayer:	765	-
Shrublayer:	335	-
Forage Availability [days]:		
Herblayer:	35	-
Shrublayer:	65	-
Total forage production [,000 t]:		
Herblayer:	106.34	-
Shrublayer:	46.57	-
Total permissible off-take [,000 t]:		
Herblayer:	31.9	-
Shrublayer:	11.64	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	0.94 (45)	-
Sheep:	1.76 (65)	-
Goats:	7.26 (95)	-
Camels:	8.01 (110)	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.25 (45)	-
Sheep:	2.24 (65)	-
Goats:	8.28 (95)	-
Camels:	9.59 (110)	-

Summary and Recommendations:

The range unit 3 (Loyengalani) comprises of approx. 1390 km² and receives a median annual rainfall of 200 to 250 mm. A risk of drought occurs in 2 to 4 years out of 10. 25% of the total area has severe and permanent restrictions to access for livestock (steep slopes and lava boulders). Forage availability over the remaining 75% of the unit is limited to the rainy seasons and the immediate post-rain periods. During these limited periods large numbers of animals could be grazed. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed. Small areas of perennial grassland (mainly *Sporobolus spicata*) along the lakeshore can be used as dry season grazing reserve for a limited number of cattle. The vegetation in the vicinity of the Loyengalani settlement is severely degraded. Permanent watersources are Lake Turkana and several wells and springs with seasonally variable water yields. The lake water is highly mineralised and has pH-values of 8 to 9. Its use for drinking or watering stock bears the danger of digestive disorders and the occurrence of Fluorosis in humans and animals.Water and forage availability appear to be balanced during the dry season. Because of the considerable proportion of inaccessible land, and the seasonal limitation of forage availability, the quick decline of the forage quality and the high drought risk, which characterise the useable part of the range unit no infrastructural improvements can be recommended. Opportunistic use of the range unit **[Range type 1]** during high-rainfall years is the only feasible alternative.

Range Unit NO 4 — SOUTH HORR — approx. 980 km²

Landforms: Hills, footslopes, lava plateaus, 25% severe permanent restrictions to access, 10% severe temporary restrictions to access.

Soil Types: rocky to stony loam to sandy clay, shallow, well drained (HU); gravelly clay loam, varying depths, well to excessively drained (FP); very stony clay, varying depths, well drained (LV2).

Vegetation Types: 80% deciduous bushland, 20% bushed grassland.

Watering Points: 8 Wells; Numerous springs; Estimated safe water yield; Exact capacity is not known.

	1st rains	2nd rains
Median Rainfall [mm]:	240	140
Forage Biomass Production [kg/ha]:		
Herblayer:	1332	702
Shrublayer:	668	298
Forage Availability [days]:		
Herblayer:	55	40
Shrublayer:	85	60
Total forage production [,000 t]:		
Herblayer:	100.57	53.0
Shrublayer:	65.46	29.2
Total permissible off-take [,000 t]:		
Herblayer:	35.2	15.9
Shrublayer:	19.64	7.3
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	0.7 (65)	0.9 (40)
Sheep:	1.1 (85)	1.8 (60)
Goats:	3.7 (115)	6.9 (80)
Camels:	4.0 (130)	7.4 (90)
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.0 (65)	1.2 (40)
Sheep:	1.4 (85)	2.3 (60)
Goats:	4.2 (115)	7.8 (80)
Camels:	4.7 (130)	8.8 (90)

Summary and Recommendations:

The range unit 4 (South Horr) comprises of approx. 980 km² and receives a median annual rainfall of 250 in the lowlands to 600 mm in the mountain ranges. A risk of drought occurs in 2 years out of 10 in the low altitude areas of the range unit. 25% of the total area has severe and permanent restrictions to access for livestock (steep slopes and lava boulders) and 10% are subject to severe temporary restrictions through flooding and mud formation. Forage availability in the low altitude areas of the unit is limited to the rainy seasons and the immediate post-rain periods. The high proportion of woody perennials in the vegetation improves forage availability for browsing stock considerably. Some bushed grassland at higher altitudes might serve as dry season grazing reserve for a very small number of cattle. There is a limited potential for tree crops and/or agro-forestry in the Horr valley. Owing the numerous springs, extended river flow by several luggas and higher rainfall in the mountain areas it can safely be stated that water availability exceeds forage availability in all seasons, although the exact capacity is not known yet. Due to the high variation of the natural conditions in this range unit, which includes some small areas with medium potential, and the high proportion of woody perennials in the vegetation it can be classified as for oportunistic use by cattle and sheep and regulated use by goats and camels **[Range type 2]**. The areas with higher precipitation within the unit might be suitable for experimental forage shrub establishment.

Range Unit NO 5 — HURRAN HURRA — approx. 6035 km²

Landforms:	Lava plateaus, 10% severe permanent restrictions to access 35% severe temporary restrictions to access.
Soil Types:	cracking clay, very deep, moderately drained (LV1); very stony clay, varying depths, well drained (LV2); calciferous, locally stony cracking clay, very deep moderately drained (LV3).
Vegetation Types:	50% barren land with dwarfshrub/annual grassland, 30% barren land, 10% bushed grassland, 5% deciduous shrubland, 5% riparine woodland.
Watering Points:	1 Borehole; 10 Wells; 1 Spring; Estimated safe water yield: 210 m³/d

Median Rainfall [mm]:	**1st rains**	**2nd rains**
	200	100
Forage Biomass Production [kg/ha].		
Herblayer:	1080	450
Shrublayer:	520	150
Forage Availability [days]:		
Herblayer:	55	40
Shrublayer:	85	60
Total forage production [,000 t]:		
Herblayer:	612.68	255.29
Shrublayer:	313.82	90.53
Total permissible off-take [,000 t]:		
Herblayer:	214.44	76.59
Shrublayer:	94.15	22.63
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	0.4 (65)	1.4 (40)
Sheep:	1.4 (85)	2.7 (60)
Goats:	4.7 (115)	13.7 (80)
Camels:	5.1 (130)	14.6 (90)
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.1 (65)	1.9 (40)
Sheep:	1.8 (85)	3.5 (60)
Goats:	5.4 (115)	15.6 (80)
Camels:	6.1 (130)	17.5 (90)

Summary and Recommendations:

The range unit 5 (Hurran Hurra) comprises of approx. 6035 km² and receives a median annual rainfall of 250 to 400 mm. A risk of drought occurs in 2 to 4 years out of 10. Approx. 10% have severe permanent restrictions to access by livestock (lava boulders) and 35 % have severe temporary restrictions due to flooding. 30% of the area is barren and a further 50% barren with narrow vegetation bands of dwarf shrubs and annual grasses along drainage lines and in shallow depressions only. Forage availability over the remaining 20% of the unit is limited to the rainy seasons and the immediate post-rain periods. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed. Small areas of bushed grassland and riparine woodlands can be used as dry season grazing reserve for a limited number of camels and goats. Permanent watersources and several wells and springs and a borehole at Sabarei. This borehole has a very high yield, but due to the remote location it is frequently broken down. Water availability is generally better than forage availability during all seasons.
Because of the high proportion of barren land, the restrictions to access and the seasonal limitation of forage availability, the quick decline of the forage quality and the high drought risk, which characterise the useable part of the range unit no infrastructural improvements can be recommended. Opportunistic use of the range unit **[Range type 1]** during high-rainfall years is the only feasible alternative.

Range Unit NO 6 NORTH HORR approx. 2250 km²

Landforms:	Piedmont plains, lacustrine plains, 5% severe temporary restrictions to access.
Soil Types:	stratified sandy loam, very deep, well drained (Pl1); complex calciferous saline clay loam, varying depths, well drained (YC);
Vegetation Types:	50% barren land with dwarfshrub/annual grassland, 30% bushland to grassland on saline soils, 10% riparine woodland, 10% deciduous shrubland.
Watering Points:	2 Boreholes; 6 Wells; 2 Springs; Estimated safe water yield: 200 m^3/d

	1st rains	2nd rains
Median Rainfall [mm]:	125	75
Forage Biomass Production [kg/ha]:		
Herblayer:	608	-
Shrublayer:	242	-
Forage Availability [days]:		
Herblayer:	35	-
Shrublayer:	65	-
Total forage production [,000 t]:		
Herblayer:	135.46	-
Shrublayer:	54.45	-
Total permissible off-take [,000 t]:		
Herblayer:	40.64	-
Shrublayer:	13.61	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	1.2 (45)	-
Sheep:	2.2 (65)	-
Goats:	10.1 (95)	-
Camels:	11.1 (110)	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.6 (45)	-
Sheep:	2.8 (65)	-
Goats:	11.5 (95)	-
Camels:	13.3 (110)	-

Summary and Recommendations:

The range unit 6 (North Horr) comprises of approx. 2250 km² and receives a median annual rainfall of 200 mm. A risk of drought occurs in 4 years out of 10. Approx. 10% have severe temporary restrictions to access by livestock due to flooding. 50% of the area is barren with narrow vegetation bands of dwarf shrubs and annual grasses along drainage lines and in shallow depressions only. Forage availability over the remaining 50% of the unit is limited to the rainy seasons and the immediate post-rain periods. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed. Small areas of riparine woodlands can be used as dry season grazing reserve for a limited number of camels and goats.

Permanent water sources and several wells and springs and 2 boreholes. The boreholes at North Horr are for domestic use only, the springs near North Horr are high yielding. Water availability is generally better than forage availability during all seasons.

Because of the high proportion of barren land, the restrictions to access and the seasonal limitation of forage availability, the quick decline of the forage quality and the high drought risk, which characterise the useable part of the range unit no infrastructural improvements can be recommended. Opportunistic use of the range unit **[Range type 1]** during high-rainfall years is the only feasible alternative.

Range Unit NO 7 KULAL approx. 2920 km²

Landforms: Footridges, 20% severe permanent restrictions to access.
Soil Types: calciferous stony clay loam, shallow, well drained (FrV1);saline and sodic cracking clay, deep, imperfectly drained (FrV2); complex stony to rocky clays, varying depths, varying drainage (FrV3).
Vegetation Types: 60% bushed grassland, 20% evergreen to semi-deciduous bushland with perennial grassland, 10% deciduous grassland, 5% dwarfshrub/annual grassland, 5% bush to grassland on saline soils.
Watering Points: 6 Wells; 4 Springs; Estimated safe water yield: 150 m³/d.

	1st rains	2nd rains
Median Rainfall [mm]:	190	95
Forage Biomass Production [kg/ha]:		
Herblayer:	1017	-
Shrublayer:	483	-
Forage Availability [days]:		
Herblayer:	75	-
Shrublayer:	105	-
Total forage production [,000 t]:		
Herblayer:	282.12	-
Shrublayer:	141.04	-
Total permissible off-take [,000 t]:		
Herblayer:	84.63	-
Shrublayer:	35.26	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	1.3 (85)	-
Sheep:	2.1 (105)	-
Goats:	7.2 (135)	-
Camels:	7.6 (150)	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.8 (85)	-
Sheep:	2.7 (105)	-
Goats:	8.2 (135)	-
Camels:	9.1 (150)	-

Summary and Recommendations:
The range unit 7 (Kulal) comprises of approx. 2920 km² and receives a median annual rainfall of 250 to 350 mm. A risk of drought occurs in 2 years out of 10. Approx. 20% have severe permanent restrictions to access by livestock (steep slopes). Forage availability over the remaining area of the unit is limited to the rainy seasons and the slightly extended post-rain periods. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed. Small areas of riparine woodlands and evergreen bushland can be used as dry season grazing reserve for a limited number of camels and goats.
Permanent watersources are several wells and springs. Water availability and forage availability appear to be balanced during the dry season. The wells at Gus are excessively saline and not suitable for all classes of stock.
Because of the restrictions to access and the seasonal limitation of forage availability and the quick decline of the forage quality which characterise the useable part of the range unit no infrastructural improvements can be recommended. Opportunistic use by cattle and sheep and regulated use by goats and camels in some parts of the range unit **[Range type 1/2]** during high-rainfall years is the only feasible alternative.

Range Unit NO 8 HEDAD approx. 2555 km²

Landforms: Sedimentary plains, no restrictions to access.

Soil Types: loamy sand to sandy loam, very deep, varying drainage (PsU3); sand to sandy saline and sodic clay loam, very deep, well drained (PsU4); sodic sand to saline sandy loam, dunes, very deep, varying drainage (DX).

Vegetation Types: 95% bushed grassland with dwarfshrub/annual grassland, minor areas of riparine woodland and deciduous bushland.

Watering Points: No information available.

	1st rains	2nd rains
Median Rainfall [mm]:	150	75
Forage Biomass Production [kg/ha]:		
Herblayer:	765	-
Shrublayer:	335	-
Forage Availability [days]:		
Herblayer:	40	-
Shrublayer:	70	-
Total forage production [,000 t]:		
Herblayer:	195.46	-
Shrublayer:	85.59	-
Total permissible off-take [,000 t]		
Herblayer:	58.64	-
Shrublayer:	21.40	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	1.1 (50)	-
Sheep:	2.0 (70)	-
Goats:	7.6 (100)	-
Camels:	8.4 (115)	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.4 (50)	-
Sheep:	2.4 (70)	-
Goats:	8.7 (100)	-
Camels:	10.2 (115)	-

Summary and Recommendations:

The range unit 8 (Hedad) comprises of approximately 2555 km² and receives a median annual rainfall of 200 to 300 mm. A risk of drought occurs in 4 years out of 10. Forage availability over the area of the unit is limited to the rainy seasons and the immediate post-rain periods. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed. Small areas of riparine woodlands as dry season grazing reserve for a limited number of camels.

There are no permanent watersources in this range unit. The establishment of a few dams would allow a slightly extended use of the range unit by goats and camels during the immediate post-rain periods.

Because of the severe seasonal limitation of forage availability, the quick decline of the forage quality and the high drought which characterise this range unit no infrastructural improvements can be recommended. Opportunistic use by all livestock species **[Range type 1]** during rainy seasons is the only feasible alternative.

Range Unit NO 9 DUKANA approx. 2060 km^2

Landforms: Lava plateaus, footslopes, 75% severe temporary restrictions to access.

Soil Types: very stony clay, varying depths, well drained (LV2); calacacerous, locally stony cracking clay, very deep, moderately drained (LV3); gravelly clay loam, varying depths, well to excessively drained (FP).

Vegetation Types: 60% barren land, 15% deciduous shrubland, 10% dwarfshrub/annual grassland, 10% bushed grassland, 5% deciduous bushland.

Watering Points: 2 Boreholes; 4 Wells; Estimated safe water yield: 80 m^3/d.

	1st rains	2nd rains
Median Rainfall [mm]:	175	100
Forage Biomass Production [kg/ha]:		
Herblayer:	923	450
Shrublayer:	427	150
Forage Availability [days]:		
Herblayer:	40	30
Shrublayer:	70	50
Total forage production [,000 t]:		
Herblayer:	199.14	92.70
Shrublayer:	87.96	30.90
Total permissible off-take [,000 t]:		
Herblayer:	57.04	27.81
Shrublayer:	21.99	7.73
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	0.8 (50)	1.0 (30)
Sheep:	1.6 (70)	2.0 (50)
Goats:	6.0 (100)	11.5 (70)
Camels:	6.6 (115)	13.0 (80)
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.2 (50)	1.4 (30)
Sheep:	2.0 (70)	2.9 (50)
Goats:	6.8 (100)	13.6 (70)
Camels:	7.9 (115)	15.6 (80)

Summary and Recommendations:

The range unit 9 (Dukana) comprises of approx. 2060 km^2 and receives a median annual rainfall of 150 to 300 mm. A risk of drought occurs in 2 to 4 years out of 10. Approx. 75% have severe temporary restrictions to access by livestock due to flooding and mud formation. 60% of the total area is barren land. Forage availability over the remaining area of the unit is limited to the rainy seasons and the immediate post-rain periods. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed.

Permanent watersources are 4 wells and 2 boreholes. Water availability exceeds forage availability during the dry season.

Because of the restrictions to access, the seasonal limitation of forage availability and the quick decline of the forage quality which characterise the range unit no infrastructural improvements can be recom-mended. Oportunistic use by all livestock species **[Range type 1]** during high-rainfall years is the only feasible alternative.

Range Unit NO 10 KALACHA approx. 4240 km²

Landforms: Footslopes, lavaflows, 10% severe permanent restriction to access.
Soil Types: complex stony to rocky clays, varying depths, varying drainage (FrV3); extremely rocky clay loam, varying depths, well drained.
Vegetation Types: 90% bushed grassland, 10% barren land with bushed grassland or dwarfshrub/ annual grassland.
Watering Points: Numerous wells; Numerous springs; Estimated safe water yield: very high.

	1st rains	2nd rains
Median Rainfall [mm]:	125	75
Forage Biomass Production [kg/ha]:		
Herblayer:	608	-
Shrublayer:	242	-
Forage Availability [days]:		
Herblayer:	35	-
Shrublayer:	65	-
Total forage production [,000 t]:		
Herblayer:	257.79	-
Shrublayer:	102.61	-
Total permissible off-take [,000 t]:		
Herblayer:	77.34	-
Shrublayer:	25.65	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	1.3 (45)	-
Sheep:	2.2 (65)	-
Goats:	10.1 (95)	-
Camels:	11.1 (110)	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.6 (45)	-
Sheep:	2.8 (65)	-
Goats:	11.5 (95)	-
Camels:	13.3 (110)	-

Summary and Recommendations:

The range unit 10 (Kalacha) comprises of approx. 4240 km² and receives a median annual rainfall of 150 to 250 mm. A risk of drought occurs in 2 to 4 years out of 10. Approx. 10% have severe permanent restrictions to access by livestock due extremely rocky surfaces. Approx. 10% of the total area is barren land. Forage availability over the remaining area of the unit is limited to the rainy seasons and the immediate post-rain periods. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed.

Permanent watersources are numerous wells and springs. Water availability exceeds forage availability during the dry season but almost all, and especially the high yield wells and springs are located at the Chalbi Desert edge. The northwestern slopes of the Hurri Hills are almost waterless. The construction of some water catchment would facilitate a more even utilisation of the range unit.

Because of the restrictions to access, the seasonal limitation of forage availability and the quick decline of the forage quality which characterise the range unit no infrastructural improvements can be recom-mended. Oportunistic use by all livestock species **[Range type 1]** during high-rainfall years is the only feasible alternative.

Range Unit NO 11 — KOROLI — approx. 1805 km²

Landforms: Sedimentary plains, no severe restrictions to access.
Soil Types: sand to sandy saline and sodic clay loam, very deep, varying drainage (PsU4); sodic sand to saline sandy loam, dunes, very deep, varying drainage (DX).
Vegetation Types: 50% dwarfshrub/annual grassland, 50% deciduous shrubland, minor areas of riparine woodland and bushland to grassland on saline soils.
Watering Points: 2 Boreholes; 4 Wells; 1 Spring; Estimated safe water yield: 120 m³/d

	1st rains	2nd rains
Median Rainfall [mm]:	125	75
Forage Biomass Production [kg/ha]:		
Herblayer:	608	-
Shrublayer:	242	-
Forage Availability [days]:		
Herblayer:	35	-
Shrublayer:	65	-
Total forage production [,000 t]:		
Herblayer:	109.74	-
Shrublayer:	43.68	-
Total permissible off-take [,000 t]:		
Herblayer:	32.92	-
Shrublayer:	10.92	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	1.1 (45)	-
Sheep:	2.2 (65)	-
Goats:	10.1 (95)	-
Camels:	11.1 (110)	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.6 (45)	-
Sheep:	2.8 (65)	-
Goats:	11.5 (95)	-
Camels:	13.3 (110)	-

Summary and Recommendations:

The range unit 11 (Koroli) comprises of approx. 2030 km² and receives a median annual rainfall of 200 to 250 mm. A risk of drought occurs in 2 to 4 years out of 10. Forage availability is limited to the rainy seasons and the immediate post-rain periods. During these limited periods large numbers of animals could be grazed. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed. Some minor areas of riparine woodland can serve as dry season grazing reserves for a small number of camels.

Permanent watersources are limited and found only at the Southern border of the range unit, ie. Balesa Kulal, Kalama, Kargi and Korole. The Northern half of the range unit is therefore only useable for sheep, goats and cattle after heavy rains, when surface water is abundant. Camels can use this part for longer periods.

Because of the seasonal limitation of forage availability, the quick decline of the forage quality, the high drought risk and the limited water sources no infrastructural improvements can be recommended. Opportunistic use by all livestock species **[Range type 1]** of the range unit during high-rainfall years is the only feasible alternative.

Range Unit NO 12 KAISUT approx. 1560 km²

Landforms: Sedimentary plains, uplands, 10% severe temporary restrictions to access.

Soil Types: loamy sand to sandy loam, very deep, varying drainage (PsU3); sand to sandy saline and sodic clay loam, very deep, well drained (PsU4); gravelly sandy clay loam, shallow, well drained (UU).

Vegetation Types: 50% bushed grassland, 35% bushed grassland with dwarfshrub/annual grassland, 10% riparine woodland, 5% deciduous bushland.

Watering Points: 3 Boreholes; Numerous wells; Estimated safe water yield: 200 m^3/d.

	1st rains	2nd rains
Median Rainfall [mm]:	150	100
Forage Biomass Production [kg/ha]:		
Herblayer:	765	450
Shrublayer:	335	150
Forage Availability [days]:		
Herblayer:	40	30
Shrublayer:	70	50
Total forage production [,000 t]:		
Herblayer:	119.34	70.20
Shrublayer:	52.26	23.40
Total permissible off-take [,000 t]:		
Herblayer:	35.80	21.06
Shrublayer:	13.07	5.85
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	1.1 (50)	1.1 (30)
Sheep:	1.9 (70)	2.3 (50)
Goats:	7.6 (100)	12.0 (70)
Camels:	8.4 (115)	13.0 (90)
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.4 (50)	1.4 (30)
Sheep:	2.4 (70)	2.9 (50)
Goats:	8.7 (100)	13.6 (70)
Camels:	10.0 (115)	15.6 (90)

Summary and Recommendations:

The range unit 12 (Kaisut) comprises of approx. 1560 km² and receives a median annual rainfall of 200 to 250 mm. A risk of drought occurs in 2 to 4 years out of 10. 10% of the area have severe temporary restrictions to access by livestock due to flooding. Forage availability is limited to the rainy seasons and the immediate post-rain periods. During these limited periods large numbers of animals could be grazed. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed. Some minor areas of riparine woodland can serve as dry season grazing reserves for a small number of goats and camels.

The area comprises three high yield boreholes at the edges in Loglogo and Laisamis and numerous wells. Water availability and forage availability appear to be balanced during the dry season.

Because of the seasonal limitation of forage availability, the quick decline of the forage quality, the high drought risk and the limited water sources no infrastructural improvements can be recommended. Opportunistic use by all livestock species **[Range type 1]** of the range unit during high-rainfall years is the only feasible alternative.

Range Unit NO 13 — HURI HILLS — approx. 1590 km²

Landforms: Hills, footridges, no severe restrictions to access.

Soil Types: stony to gravelly clay loam, moderately deep, well drained (HP2); saline and sodic cracking clay, deep, imperfectly drained (FrV2); sandy clay loam, moderately deep, well drained.

Vegetation Types: 90% evergreen to semi-deciduous bushland with perennial grassland, 10 % perennial grassland, minor areas of woodland.

Watering Points: 2 Wells*; 3 Pans (1 rock catchment); *Estimated safe water yield: 40 m^3/d.

	1st rains	2nd rains
Median Rainfall [mm]:	250	150
Forage Biomass Production [kg/ha]:		
Herblayer:	1395	765
Shrublayer:	705	335
Forage Availability [days]:		
Herblayer:	75	50
Shrublayer:	105	70
Total forage production [,000 t]:		
Herblayer:	221.81	121.63
Shrublayer:	112.10	53.27
Total permissible off-take [,000 t]:		
Herblayer:	77.63	36.49
Shrublayer:	33.63	13.32
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	0.8 (85)	1.1 (50)
Sheep:	1.3 (105)	1.9 (70)
Goats:	4.1 (135)	6.9 (90)
Camels:	4.3 (150)	7.3 (100)
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.1 (85)	1.4 (50)
Sheep:	1.7 (105)	2.4 (70)
Goats:	4.7 (135)	7.8 (90)
Camels:	5.2 (150)	8.7 (100)

Summary and Recommendations:

The range unit 13 (Huri Hills) comprises of approx. 1590 km² and receives a median annual rainfall of 300 to 500 mm. A risk of drought occurs in 1 year out of 10. Forage availability is limited to the rainy seasons and extended post-rain periods. During these limited periods large numbers of animals could be grazed. Forage quality, particularly in the herblayer, deteriorates at a moderate pace after the rains and becomes unsuitable as ruminant feed only during the advanced dry seasons. A major risk to regulated range use are frequently occurring grass fires.

Permanent water sources are 2 low yielding wells. Some pans and rock catchments are quickly exhausted after the rains. Forage availability exceeds water availability during all seasons. Because of the limited water availability within the range unit the pasture potential is not fully utilised. Opportunistic use by cattle and regulated use by sheep, goats and camels **[Range type 2/3]** of the range unit would be possible if water supplies could be extended.

Range Unit NO 14 MAIKONA approx. 2015 km²

Landforms:	Footridges, no severe restrictions to access.
Soil Types:	complex stony to rocky clays, varying depths, varying drainage (FrV3).
Vegetation Types:	95% bushed grassland, 5% deciduous bushland.
Watering Points:	2 Wells; Estimated safe water yield: 20 m^3/d.

	1st rains	2nd rains
Median Rainfall [mm]:	185	100
Forage Biomass Production [kg/ha]:		
Herblayer:	986	450
Shrublayer:	464	150
Forage Availability [days]:		
Herblayer:	65	45
Shrublayer:	95	65
Total forage production [,000 t]:		
Herblayer:	198.68	90.68
Shrublayer:	93.50	30.23
Total permissible off-take [,000 t]:		
Herblayer:	59.60	27.20
Shrublayer:	23.37	7.56
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	1.2 (75)	1.6 (45)
Sheep:	2.0 (95)	3.0 (65)
Goats:	6.9 (125)	14.5 (85)
Camels:	7.4 (140)	15.5 (95)
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.6 (75)	2.1 (45)
Sheep:	2.5 (95)	3.8 (65)
Goats:	7.9 (125)	16.6 (85)
Camels:	8.8 (140)	18.5 (95)

Summary and Recommendations:

The range unit 14 (Maikona) comprises of approx. 2015 km² and receives a median annual rainfall of 200 to 400 mm. A risk of drought occurs in 2 years out of 10. Forage availability is limited to the rainy seasons and extended post-rain periods. During these periods large numbers of animals could be grazed. Forage quality in the northern half deteriorates at a moderate pace after the rains and becomes unsuitable as ruminant feed only during the advanced dry seasons.

Permanent water sources are 2 low yielding wells. Numerous wells at Maikona settlement are not located in this unit but could serve the southern part. Forage availability exceeds water availability during all seasons. Because of the limited water availability within the range unit the pasture potential is not fully utilised. Opportunistic use by cattle and sheep and regulated use by goats and camels **[Range type 2]** of the range unit would be possible if water supplies could be extended.

Range Unit NO 15 MARSABIT WEST approx. 4035 km²

Landforms: Footridges, lavaflows, uplands, 10% severe permanent restrictions to access.
Soil Types: complex stony to rocky clays, varying depths, varying drainage (FrV3); extremely rocky clay loam, varying depths, well drained (LA).
Vegetation Types: 80% bushed grassland, 20% evergreen to semi-deciduous bushland with perennial grassland, minor areas of barren land and dwarfshrub/annual grassland.
Watering Points: All Boreholes are located within the National Park; 2 Wells; plus several in the National Park; 3 Springs; Estimated safe water yield: 300 m³/d.

	1st rains	2nd rains
Median Rainfall [mm]:	175	75
Forage Biomass Production [kg/ha]:		
Herblayer:	923	-
Shrublayer:	427	-
Forage Availability [days]:		
Herblayer:	55	-
Shrublayer:	85	-
Total forage production [,000 t]:		
Herblayer:	372.43	-
Shrublayer:	172.29	-
Total permissible off-take [,000 t]:		
Herblayer:	111.73	-
Shrublayer:	43.07	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	1.1 (65)	-
Sheep:	1.9 (85)	-
Goats:	6.9 (115)	-
Camels:	7.4 (130)	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.5 (65)	-
Sheep:	2.4 (85)	-
Goats:	7.9 (115)	-
Camels:	8.9 (130)	-

Summary and Recommendations:

The range unit 15 (Marsabit West) comprises of approx. 4035 km² and receives a median annual rainfall of 200 to 400 mm. A risk of drought occurs in 2 years out of 10. 10% of the area have severe permanent restrictions to access by livestock (steep slopes, lava flows). Forage availability is limited to the rainy seasons and the immediate post-rain periods. During these limited periods large numbers of animals could be grazed. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed.

3 high-yield springs are located at the edge of the unit (Koroli, Karole, Mayidahad)in the low altitude part. Various good water sources are within the National Park. Those serve in fact most of the animals in this unit. Water availability exceeds forage availability during the dry season.

Because of the seasonal limitation of forage availability and the quick decline of the forage quality infrastructural improvements can be recommended only for the high altitude areas of the unit. Here opportunistic use by cattle and sheep and regulated use by goats and camels **[Range type 2]** can be recommended, particularly if the area of the Marsabit National Reserve could be included in this unit. Opportunistic use by all livestock species **[Range type 1]** of the range unit during high-rainfall years is the only feasible alternative for the low altitude part of the unit.

Range Unit NO 16 — SOLOLO — approx. 3660 km²

Landforms: Valley complexes, volcanic plains, 15% severe permanent restrictions to access, 80% severe temporary restrictions to access.

Soil Types: calciferous cracking clay, deep, imperfectly drained (PV1); complex of bouldery clay soils (VC); extremely rocky clay loam, varying depths, well drained (La).

Vegetation Types: 30% deciduous bushland, 30% barren land with bushed grassland, 20% deciduous shrubland, 20% bushed grassland.

Watering Points: Boreholes; number unknown, because of unlicensed drilling; numerous wells; 4 Pans; plus several road side excavations; Estimated safe water yield: 500 m³/d.

	1st rains	2nd rains
Median Rainfall [mm]:	215	165
Forage Biomass Production [kg/ha]:		
Herblayer:	1175	860
Shrublayer:	575	390
Forage Availability [days]:		
Herblayer:	75	55
Shrublayer:	105	75
Total forage production [,000 t]:		
Herblayer:	180.60	132.18
Shrublayer:	210.45	142.74
Total permissible off-take [,000 t]:		
Herblayer:	63.21	39.65
Shrublayer:	52.61	35.69
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	1.0 (85)	1.0 (55)
Sheep:	1.6 (105)	1.8 (75)
Goats:	6.0 (135)	6.2 (95)
Camels:	6.4 (150)	6.6 (105)
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.3 (85)	1.4 (55)
Sheep:	2.0 (105)	2.3 (75)
Goats:	6.9 (135)	7.1 (95)
Camels:	7.6 (150)	7.9 (105)

Summary and Recommendations:

The range unit 16 (Sololo) comprises of approx. 3660 km² and receives a median annual rainfall of 200 to 500 mm. A risk of drought occurs in 2 years out of 10. 15% of the area have severe permanent restrictions to access by livestock (steep slopes, lava flows) and 80% of the area have severe temporary restrictions to access due to flooding and mud. Forage availability is limited to the rainy seasons and the immediate post-rain periods in the southern part of the unit and to extended post-rain periods in the northern half. During these periods large numbers of animals could be grazed. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed. Permanent water sources are numerous boreholes and wells, complemented by pans and water catchments. Water sources are concentrated around Sololo and in the north, but limited and with uncertain yields in the southern half.
Because of the seasonal limitation of forage availability and the quick decline of the forage quality infrastructural improvements can be recommended only for the northern half of the unit. Here opportunistic use by cattle and sheep and regulated use by goats and camels **[Range type 2]** can be recommended. Opportunistic use by all livestock species **[Range type 1]** of the range unit during high-rainfall years is the only feasible alternative for the southern half of the unit.

Range Unit NO 17 — DIDA GALGALU — approx. 3490 km²

Landforms: Lava plateaus, no severe restrictions to access.
Soil Types: calciferous, locally stony cracking clay, very deep, moderately drained (LV3).
Vegetation Types: Barren land with bushed grassland.
Watering Points: 1 Borehole; Numerous Wells; Estimated safe water yield: 100 m^3/d.

	1st rains	2nd rains
Median Rainfall [mm]:	150	125
Forage Biomass Production [kg/ha]:		
Herblayer:	765	608
Shrublayer:	335	242
Forage Availability [days]:		
Herblayer:	65	45
Shrublayer:	95	65
Total forage production [,000 t]:		
Herblayer:	266.99	212.19
Shrublayer:	116.92	84.46
Total permissible off-take [,000 t]:		
Herblayer:	80.10	63.66
Shrublayer:	29.23	21.11
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	1.6 (75)	1.2 (45)
Sheep:	2.6 (95)	2.2 (65)
Goats:	9.6 (125)	9.0 (85)
Camels:	10.2 (140)	9.6 (95)
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	2.1 (75)	1.6 (45)
Sheep:	3.3 (95)	2.8 (65)
Goats:	10.9 (125)	10.3 (85)
Camels:	12.2 (140)	11.5 (95)

Summary and Recommendations:

The range unit 17 (Dida Galgalu) comprises of approx. 3490 km² and receives a median annual rainfall of 200 to 300 mm. A risk of drought occurs in 2 to 4 years out of 10. Forage availability is limited to the rainy seasons and extended post-rain periods. The whole unit is barren land with narrow vegetation strips along drainage lines and patchy vegetation in numerous shallow depressions. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed.

Permanent water sources are 1 borehole and numerous wells. Water sources are concentrated around Maikona, the major part of the unit is inadequately supplied.

Because of the scarcity of the vegetation, the seasonal limitation of forage availability and the quick decline of the forage quality no infrastructural improvements can be recommended. Opportunistic use by cattle, sheep and goats (and regulated use by camels) **[Range type 1/2]** of the range unit during high-rainfall years is the only feasible alternative.

Range Unit NO 18 **MARSABIT EAST** **approx. 2250 km²**

Landforms: Footridges, 10% severe temporary restrictions to access.
Soil Types: saline and sodic cracking clay, deep, imperfectly drained (FrV2); clay loam to clay, very deep, well drained (MV2); stony to gravelly clay loam, moderately deep, well drained (HP2).
Vegetation Types: 90% evergreen to semi-deciduous bushland with perennial grassland, 5% riparine woodland, 5% dwarfshrub/annual grassland.
Watering Points: 2 Boreholes; Several wells on Mt. Marsabit; Estimated safe water yield: 150 m^3/d.

	1st rains	2nd rains
Median Rainfall [mm]:	275	150
Forage Biomass Production [kg/ha]:		
Herblayer:	1553	765
Shrublayer:	797	335
Forage Availability [days]:		
Herblayer:	75	55
Shrublayer:	105	75
Total forage production [,000 t]:		
Herblayer:	349.43	172.13
Shrublayer:	179.33	75.38
Total permissible off-take [,000 t]:		
Herblayer:	122.30	51.64
Shrublayer:	53.80	18.84
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	0.8 (85)	1.2 (55)
Sheep:	1.2 (105)	2.0 (75)
Goats:	3.6 (135)	7.3 (95)
Camels:	3.8 (150)	7.7 (105)
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.0 (85)	1.5 (55)
Sheep:	1.2 (105)	2.0 (75)
Goats:	4.1 (135)	8.3 (95)
Camels:	4.6 (150)	9.2 (105)

Summary and Recommendations:

The range unit 18 (Marsabit East) comprises of approximately 2250 km² and receives a median annual rainfall of 200 to 600 mm. A risk of drought occurs in 1 year out of 10. Forage availability is limited to the rainy seasons and extended post-rain periods. The high proportion of evergreen and semi-deciduous woody perennials in the vegetation of the unit allow relatively high stocking densities for goats and camels for most of the year. The quality of the herblayer deteriorates at a moderate pace after the rains and becomes unsuitable as feed for cattle and sheep during the middle of the dry season.

Permanent water sources are 2 boreholes and several wells on Mt.Marsabit. Although there is a good water potential on Mt. Marsabit, this has reached its limits due to the rapidly increasing human population and increased off-take for irrigation purposes.

Both water and forage availability within the range unit are probably fully utilised or even overutilised locally at the present stocking densities. Opportunistic use by cattle and regulated use by sheep, goats and camels **[Range type 2/3]** of the range unit is recommended. Rotational grazing schemes and expansion of the water supply would allow a slight increase over the present stocking densities.

Range Unit NO 19 — MILGIS — approx. 2350 km²

Landforms: Sedimentary plains, 25% severe temporary restrictions to access.

Soil Types: sand to sandy saline and sodic clay loam, very deep, well drained (PsU4); calciferous clay to sandy loam, locally saline or sodic, very deep, imperfectly drained (AA)

Vegetation Types: 70% bushed grassland, 15% woodland to grassland on seasonally waterlogged soils, 15% bushed grassland, riparine woodland and dwarfshrub/annual grassland.

Watering Points: 2 Wells; Estimated safe water yield: 20 m^3/d.

	1st rains	2nd rains
Median Rainfall [mm]:	125	75
Forage Biomass Production [kg/ha]:		
Herblayer:	608	-
Shrublayer:	242	-
Forage Availability [days]:		
Herblayer:	75	-
Shrublayer:	105	-
Total forage production [,000 t]:		
Herblayer:	142.88	-
Shrublayer:	56.87	-
Total permissible off-take [,000 t]:		
Herblayer:	42.86	-
Shrublayer:	14.22	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	2.2 (85)	-
Sheep:	3.6 (105)	-
Goats:	14.3 (135)	-
Camels:	15.1 (150)	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	3.0 (85)	-
Sheep:	4.6 (105)	-
Goats:	16.3 (135)	-
Camels:	18.1 (150)	-

Summary and Recommendations:

The range unit 19 (Milgis) comprises of approximately 2350 km² and receives a median annual rainfall of 200 mm. A risk of drought occurs in 2 to 4 years out of 10. 25% of the area have severe temporary restrictions to access by livestock due to flooding. Forage availability is limited to the rainy seasons and the immediate post-rain periods. During these limited periods large numbers of animals could be grazed. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed. Some minor areas of riparine woodland can serve as dry season grazing reserves for a small number of goats and camels.

Permanent water sources are 2 low yielding wells complemented by larger bodies of surface water during the rainy seasons. Forage availability exceeds water availability during the dry season.

Because of the seasonal limitation of forage availability, the quick decline of the forage quality, the high drought risk and the limited water sources no infrastructural improvements can be recommended. Opportunistic use by all livestock species **[Range type 1]** of the range unit during high-rainfall years is the only feasible alternative.

Range Unit NO 20 RUSARUS approx. 1510 km²

Landforms: Lava plateaus, uplands, 75% severe temporary restrictions to access.
Soil Types: very stony clay, varying depths, well drained (LV2); calciferous, locally stony cracking clay, very deep, moderately drained (LV3).
Vegetation Types: Bushed grassland with minor areas of riparine woodlands and deciduous shrubland.
Watering Points: 2 Wells; Estimated safe water yield: 20 m^3/d; Shallow Wells; Pans.

	1st rains	2nd rains
Median Rainfall [mm]:	125	75
Forage Biomass Production [kg/ha]:		
Herblayer:	608	-
Shrublayer:	242	-
Forage Availability [days]:		
Herblayer:	40	-
Shrublayer:	70	-
Total forage production [,000 t]:		
Herblayer:	91.81	-
Shrublayer:	36.54	-
Total permissible off-take [,000 t]:		
Herblayer:	27.54	-
Shrublayer:	9.14	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	1.3 (50)	-
Sheep:	2.4 (70)	-
Goats:	10.6 (100)	-
Camels:	11.6 (115)	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.8 (50)	-
Sheep:	3.0 (70)	-
Goats:	12.1 (100)	-
Camels:	13.9 (115)	-

Summary and Recommendations:

The range unit 20 (Rusarus) comprises of approximately 1510 km² and receives a median annual rainfall of 200 mm. A risk of drought occurs in 2 to 4 years out of 10. 75% of the area have severe temporary restrictions to access by livestock due to flooding and mud formation. Forage availability is limited to the rainy seasons and the immediate post-rain periods. During these limited periods large numbers of animals could be grazed. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed. Some minor areas of riparine woodland can serve as dry season grazing reserves for a small number of goats and camels.

Permanent water sources are 2 low yielding wells complemented by shallow wells, pans and water catchments. Forage availability exceeds water availability during the dry season.

Because of the seasonal limitation of forage availability, the quick decline of the forage quality, the high drought risk and the limited water sources no infrastructural improvements can be recommended. Opportunistic use by all livestock species **[Range type 1]** of the range unit during high-rainfall years is the only feasible alternative.

Range Unit NO 21 — SIBISO MALBEBALE — approx. 5115 km²

Landforms: Lavaflows, footslopes, sedimentary plains, 35% severe permanent restrictions to access, 15% severe temporary restrictions to access.

Soil Types: extremely rocky clay loam, varying depths, well drained (LA); complex of varying soils, varying depths, varying drainage (PsU2); sandy clay loam, very deep, well drained (FU).

Vegetation Types: 40% deciduous shrubland, 30% deciduous bushland, 30% barren land with bushed grassland.

Watering Points: 3 Boreholes; Numerous Wells; 4 Pans; Estimated safe water yield: 300 m³/d.

	1st rains	2nd rains
Median Rainfall [mm]:	195	115
Forage Biomass Production [kg/ha]:		
Herblayer:	1049	545
Shrublayer:	501	205
Forage Availability [days]:		
Herblayer:	50	40
Shrublayer:	80	60
Total forage production [,000 t]:		
Herblayer:	155.57	80.82
Shrublayer:	256.26	104.86
Total permissible off-take [,000 t]:		
Herblayer:	46.67	24.25
Shrublayer:	64.07	26.21
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	0.9 (60)	1.2 (40)
Sheep:	1.6 (80)	2.3 (60)
Goats:	5.6 (110)	10.0 (80)
Camels:	6.1 (125)	10.7 (90)
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.2 (60)	1.6 (40)
Sheep:	2.0 (80)	2.9 (60)
Goats:	6.4 (110)	11.4 (80)
Camels:	7.3 (125)	12.8 (90)

Summary and Recommendations:

The range unit 21 (Sibiso Malbebale) comprises of approx. 5115 km² and receives a median annual rainfall of 200 to 600 mm. A risk of drought occurs in 2 years out of 10. 35% of the area have severe permanent restrictions to access by livestock (lava flows, thicket formation) and 15% of the area have severe temporary restrictions to access due to flooding and mud. 35% of the total area is barren land with narrow strips of vegetation along drainage lines and in shallow depressions. Forage availability is limited to the rainy seasons and the immediate post-rain periods in the southern part and for extended post-rain periods in the northern half. During these limited periods large numbers of animals could be grazed. Forage quality, particularly in the herblayer, deteriorates very quickly to moderately after the rains and becomes unsuitable as ruminant feed. Permanent water sources are 2 low yielding wells complemented by shallow wells, pans and water catchments. Pans and catchments have water for limited time only. Water supply is uneven to the east, where it has to be shared with Wajir District. Forage availability exceeds water availability during the dry season. Because of the seasonal limitation of forage availability, the quick decline of the forage quality, the high drought risk and the limited water sources no infrastructural improvements can be recommended. Opportunisticuse by all livestock **[Range type 1]** of the range unit during high-rainfall years is the only feasible alternative.

Range Unit NO 22 GALBA approx. 4225 km²

Landforms:	Lavaflows, sedimentary plains, 60% severe permanent restrictions to access, 5% severe temporary restrictions to access.
Soil Types:	extremely rocky clay loam, varying depths, well drained (LA); complex of various soils, varying depths, varying drainage (PsU2).
Vegetation Types:	65% barren land with bushed grassland, 30% bushed grassland, 10% barren land and deciduous bushland.
Watering Points:	5 Wells; Estimated safe water yield: 50 m^3/d.

Median Rainfall [mm]:	**1st rains**	**2nd rains**
	150	75
Forage Biomass Production [kg/ha]:		
Herblayer:	765	-
Shrublayer:	335	-
Forage Availability [days]:		
Herblayer:	40	-
Shrublayer:	70	-
Total forage production [,000 t]:		
Herblayer:	320.00	-
Shrublayer:	141.54	-
Total permissible off-take [,000 t]:		
Herblayer:	96.00	-
Shrublayer:	35.38	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	1.1 (50)	-
Sheep:	1.9 (70)	-
Goats:	7.6 (100)	-
Camels:	8.4 (115)	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.4 (50)	-
Sheep:	2.4 (70)	-
Goats:	8.7 (100)	-
Camels:	10.0 (115)	-

Summary and Recommendations:

The range unit 22 (Galba) comprises of approximately 4225 km² and receives a median annual rainfall of 200 mm. A risk of drought occurs in 2 to 4 years out of 10. 60% of the area have severe permanent restrictions to access by livestock (lava flows). 75% of the total area is barren land with narrow vegetation strips along drainage lines and patchy vegetation in shallow depressions. Forage availability over the remaining 30 % of the unit is limited to the rainy seasons and the immediate post-rain periods. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed.
Permanent watersources are several wells which are all situated along the eastern boundary of the unit. Because of the general scarcity of forage, the seasonal limitation of forage availability, the quick decline of the forage quality, the high drought risk and the limited water sources no infrastructural improvements can be recommended. Opportunistic use of the range unit **[Range type 1]** during high-rainfall years is the only feasible alternative.

Range Unit NO 23 — MADO KELU — approx. 2680 km²

Landforms:	Volcanic plains, 5% severe permanent restrictions to access, 95% severe temporary restrictions to access.
Soil Types:	calciferous stony cracking clay, very deep, imperfectly drained (PV2).
Vegetation Types:	Barren land with bushed grassland and minor areas of dwarfshrub/annual grassland.
Watering Points:	The only known water source is at Bubisa on the western edge.

	1st rains	2nd rains
Median Rainfall [mm]:	175	75
Forage Biomass Production [kg/ha]:		
Herblayer:	923	-
Shrublayer:	427	-
Forage Availability [days]:		
Herblayer:	40	-
Shrublayer:	70	-
Total forage production [,000 t]:		
Herblayer:	247.36	-
Shrublayer:	114.44	-
Total permissible off-take [,000 t]:		
Herblayer:	74.21	-
Shrublayer:	28.61	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance level:		
Cattle:	0.9 (50)	-
Sheep:	1.6 (70)	-
Goats:	6.0 (100)	-
Camels:	6.6 (115)	-
Maximum stocking density [ha/TLU] for optimal number of grazing days () at maintenance + production level:		
Cattle:	1.2 (50)	-
Sheep:	2.0 (70)	-
Goats:	6.8 (100)	-
Camels:	7.9 (115)	-

Summary and Recommendations:

The range unit 23 (Mado Kelu) comprises of approximately 2680 km² and receives a median annual rainfall of 200 to 300 mm. A risk of drought occurs in 2 to 4 years out of 10. 95% of the area have severe permanent restrictions to access by livestock (lava flows). The total area is barren land with narrow vegetation strips along drainage lines and patchy vegetation in shallow depressions. Forage availability is limited to the rainy seasons and the immediate post-rain periods. Forage quality, particularly in the herblayer, deteriorates very quickly after the rains and becomes unsuitable as ruminant feed.

The only permanent watersource is well at Bubisa, situated at the western boundary of the unit. Because of the general scarcity of forage, the seasonal limitation of forage availability, the quick decline of the forage quality, the high drought risk and the limited water sources no infrastructural improvements can be recommended. Opportunistic use of the range unit **[Range type 1]** during high-rainfall years is the only feasible

Summary Table 1: Approximate range unit size, median rainfall [mm] as extrapolated from Map Nos 4 & 5 and calculated forage biomass production [kg/ha] by range unit

Range Unit			Rainfall [mm]		Forage Biomass Production [kg/ha]			
No	Name	Size [km2]			Herblayer		Shrublayer	
			1st rains	2nd rains	1st rains	2nd rains	1st rains	2nd rains
1	Ileret	2050	200	75	1080	293	520	57
2	Moiti	4020	150	75	765	293	335	57
3	Loyengalani	1390	150	75	765	293	335	57
4	South Horr	980	240	140	1332	702	668	298
5	Hurran Hurra	6035	200	100	1080	450	520	150
6	North Horr	2250	125	75	608	293	242	57
7	Kulal	2920	190	95	1017	419	483	131
8	Hedad	2555	150	75	765	293	335	57
9	Dukana	2060	175	100	923	450	427	150
10	Kalacha	4240	125	75	608	293	242	57
11	Koroli	1805	125	75	608	293	242	57
12	Kaisut	1560	150	100	765	450	335	150
13	Huri Hills	1590	250	150	1395	765	705	335
14	Maikona	2015	185	100	986	450	464	150
15	Marsabit West	4035	175	75	923	293	427	57
16	Sololo	3660	215	165	1175	860	575	390
17	Dida Galgalu	3490	150	125	765	608	335	242
18	Marsabit East	2250	275	150	1553	765	797	335
19	Milgis	2350	125	75	608	293	242	57
20	Rusarus	1510	125	75	608	293	242	57
21	Sibiso Malbebale	5115	195	115	1049	545	501	205
22	Galba	4225	150	75	765	293	335	57
23	Mado Kelu	2680	175	75	923	293	427	57

Summary Table 2: Optimal number of grazing days and maximum stocking densities [ha/TLU] for optimal number of grazing days by range unit for CATTLE during a median rainfall year

Range Unit		Optimal Number of Grazing Days			Maximum Stocking Density for			
					Maintenance only		Maintenance and production	
		annual	1st rains	2nd rains	1st rains	2nd rains	1st rains	2nd rains
1	Ileret	105	65	40	0.83		1.10	
2	Moiti	80	50	30	1.05		1.39	
3	Loyengalani	60	45	15	0.94		1.25	
4	SouthHorr	105	65	40	0.67	0.91	0.89	1.22
5	HurranHurra	105	65	40	0.83	1.42	1.10	1.90
6	NorthHorr	60	45	15	1.18		1.58	
7	Kulal	140	85	55	1.34		1.78	
8	Hedad	80	50	30	1.05		1.39	
9	Dukana	80	50	30	0.87	1.07	1.16	1.42
10	Kalacha	60	45	15	1.18		1.58	
11	Koroli	60	45	15	1.18		1.58	
12	Kaisut	80	50	30	1.05	1.07	1.39	1.42
13	HuriHills	135	85	50	0.84	1.05	1.11	1.39
14	Maikona	120	75	45	1.22	1.60	1.62	2.13
15	MarsabitWest	105	65	40	1.13		1.50	
16	Sololo	140	85	55	0.99	1.02	1.32	1.36
17	DidaGalgalu	120	75	45	1.57	1.18	2.09	1.58
18	Marsabiteast	140	85	55	0.75	1.15	1.00	1.53
19	Milgis	140	85	55	2.24		2.98	
20	Rusarus	80	50	30	1.32		1.75	
21	SibisoMalbebale	100	60	40	0.92	1.17	1.22	1.57
22	Galba	80	50	30	1.05		1.39	
23	MadoKelu	80	50	30	0.87		1.16	

Summary Table 3: Optimal number of grazing days and maximum stocking densities [ha/TLU] for optimal number of grazing days by range unit for SHEEP during a median rainfall year

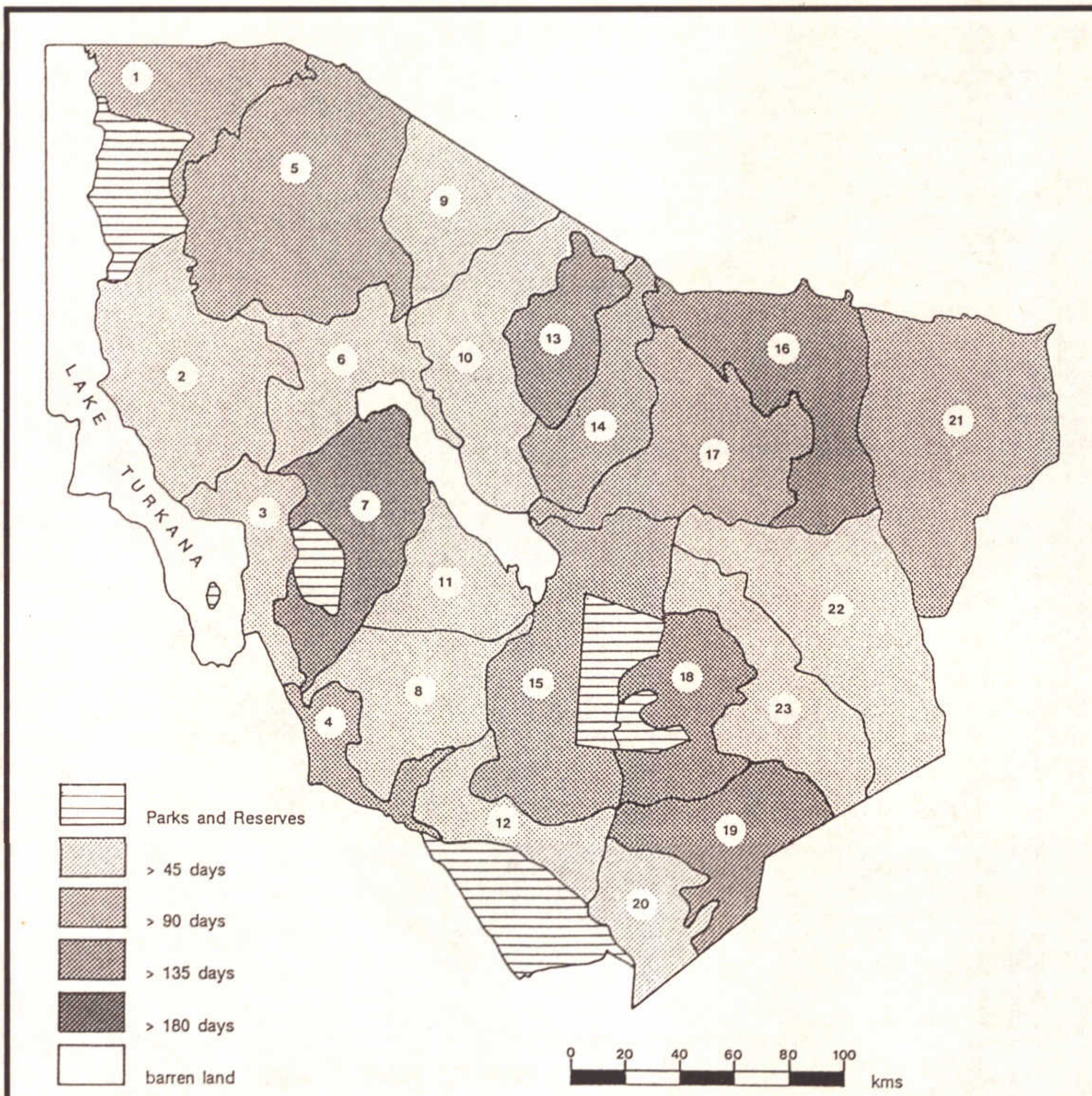
Range Unit		Optimal Number of Grazing Days			Maximum Stocking Density for			
					Maintenance only		Maintenance and production	
		annual	1st rains	2nd rains	1st rains	2nd rains	1st rains	2nd rains
1	Ileret	145	85	60	1.39		1.78	
2	Moiti	120	70	50	1.89		2.41	
3	Loyengalani	100	65	35	1.76		2.24	
4	SouthHorr	145	85	60	1.13	1.77	1.44	2.25
5	HurranHurra	145	85	60	1.39	2.76	1.78	3.51
6	NorthHorr	100	65	35	2.21		2.82	
7	Kulal	180	105	75	2.13		2.72	
8	Hedad	120	70	50	1.89		2.41	
9	Dukana	120	70	50	1.57	2.30	2.00	2.93
10	Kalacha	100	65	35	2.21		2.82	
11	Koroli	100	65	35	2.21		2.82	
12	Kaisut	120	70	50	1.89	2.30	2.41	2.93
13	HuriHills	175	105	70	1.33	1.89	1.70	2.41
14	Maikona	160	95	65	1.99	2.99	2.54	3.80
15	MarsabitWest	145	85	60	1.90		2.43	
16	Sololo	180	105	75	1.58	1.80	2.02	2.30
17	DidaGalgalu	160	95	65	2.57	2.21	3.27	2.82
18	Marsabiteast	180	105	75	1.20	2.03	1.53	2.58
19	Milgis	180	105	75	3.57		4.55	
20	Rusarus	120	70	50	2.38		3.03	
21	SibisoMalbebale	140	80	60	1.58	2.28	2.01	2.90
22	Galba	120	70	50	1.89		2.41	
23	MadoKelu	120	70	50	1.57		2.00	

Summary Table 4: Optimal number of grazing days and maximum stocking densities [ha/TLU] for optimal number of grazing days by range unit for GOATS during a median rainfall year

Range Unit		Optimal Number of Grazing Days			Maximum Stocking Density for			
					Maintenance only		Maintenance and production	
		annual	1st rains	2nd rains	1st rains	2nd rains	1st rains	2nd rains
1	Ileret	195	115	80	4.72		5.38	
2	Moiti	170	100	70	7.64		8.72	
3	Loyengalani	150	95	55	7.26		8.28	
4	SouthHorr	195	115	80	3.67	6.87	4.19	7.84
5	HurranHurra	195	115	80	4.72	13.65	5.38	15.57
6	NorthHorr	150	95	55	10.05		11.46	
7	Kulal	230	135	95	7.16		8.16	
8	Hedad	170	100	70	7.64		8.72	
9	Dukana	170	100	70	6.00	11.95	6.84	13.63
10	Kalacha	150	95	55	10.05		11.46	
11	Koroli	150	95	55	10.05		11.46	
12	Kaisut	170	100	70	7.64	11.95	8.72	13.63
13	HuriHills	225	135	90	4.09	6.88	4.66	7.84
14	Maikona	210	125	85	6.90	14.51	7.87	16.55
15	MarsabitWest	195	115	80	6.89		7.86	
16	Sololo	230	135	95	6.01	6.24	6.86	7.11
17	DidaGalgalu	210	125	85	9.55	8.99	10.90	10.26
18	Marsabiteast	230	135	95	3.61	7.26	4.12	8.28
19	Milgis	230	135	95	14.28		16.29	
20	Rusarus	170	100	70	10.58		12.07	
21	SibisoMalbebale	190	110	80	5.62	9.99	6.41	11.40
22	Galba	170	100	70	7.64		8.72	
23	MadoKelu	170	100	70	6.00		6.84	

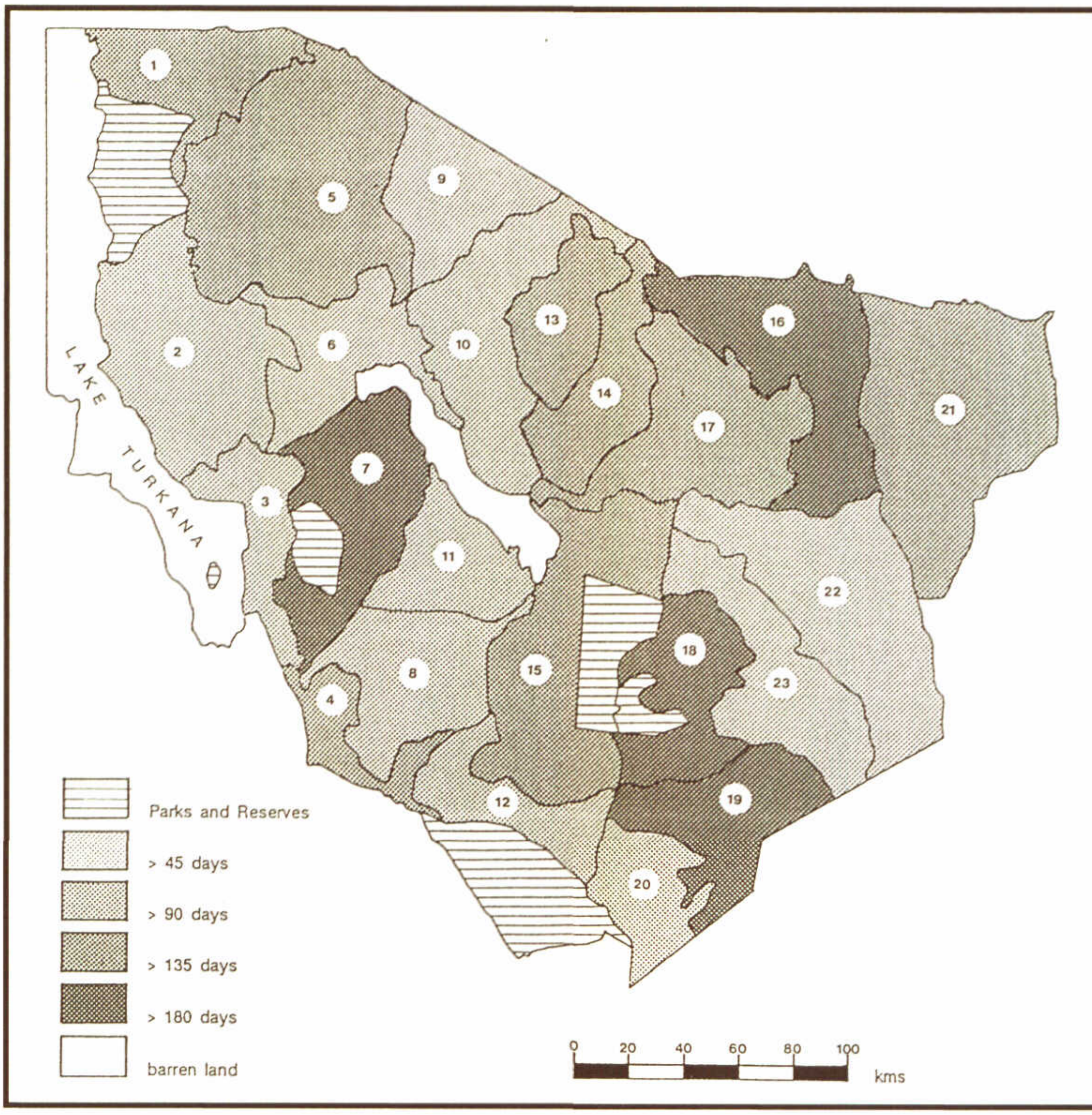
Summary Table 5: Optimal number of grazing days and maximum stocking densities [ha/TLU] for optimal number of grazing days by range unit for DROMEDARIES during a median rainfall year

	Range Unit	Optimal Number of Grazing Days			Maximum Stocking Density for			
					Maintenance only		Maintenance and production	
		annual	1st rains	2nd rains	1st rains	2nd rains	1st rains	2nd rains
1	Ileret	220	130	90	5.08		6.08	
2	Moiti	195	115	80	8.38		10.02	
3	Loyengalani	175	110	65	8.01		9.59	
4	SouthHorr	220	130	90	3.96	7.37	4.74	8.82
5	HurranHurra	220	130	90	5.08	14.64	6.08	17.52
6	NorthHorr	175	110	65	11.09		13.27	
7	Kulal	255	150	105	7.58		9.07	
8	Hedad	195	115	80	8.38		10.02	
9	Dukana	195	115	80	6.57	13.01	7.86	15.57
10	Kalacha	175	110	65	11.09		13.27	
11	Koroli	175	110	65	11.09		13.27	
12	Kaisut	195	115	80	8.38	13.01	10.02	15.57
13	HuriHills	250	150	100	4.33	7.28	5.18	8.72
14	Maikona	235	140	95	7.36	15.45	8.81	18.49
15	MarsabitWest	220	130	90	7.43		8.89	
16	Sololo	255	150	105	6.37	6.57	7.62	7.86
17	DidaGalgalu	235	140	95	10.20	9.58	12.20	11.46
18	Marsabiteast	255	150	105	3.83	7.65	4.58	9.15
19	Milgis	255	150	105	15.12		18.10	
20	Rusarus	195	115	80	11.60		13.88	
21	SibisoMalbebale	215	125	90	6.09	10.71	7.29	12.82
22	Galba	195	115	80	8.38		10.02	
23	MadoKelu	195	115	80	6.57		7.86	



Map IV/1:
Recommended number of grazing days for CATTLE in a median rainfall year

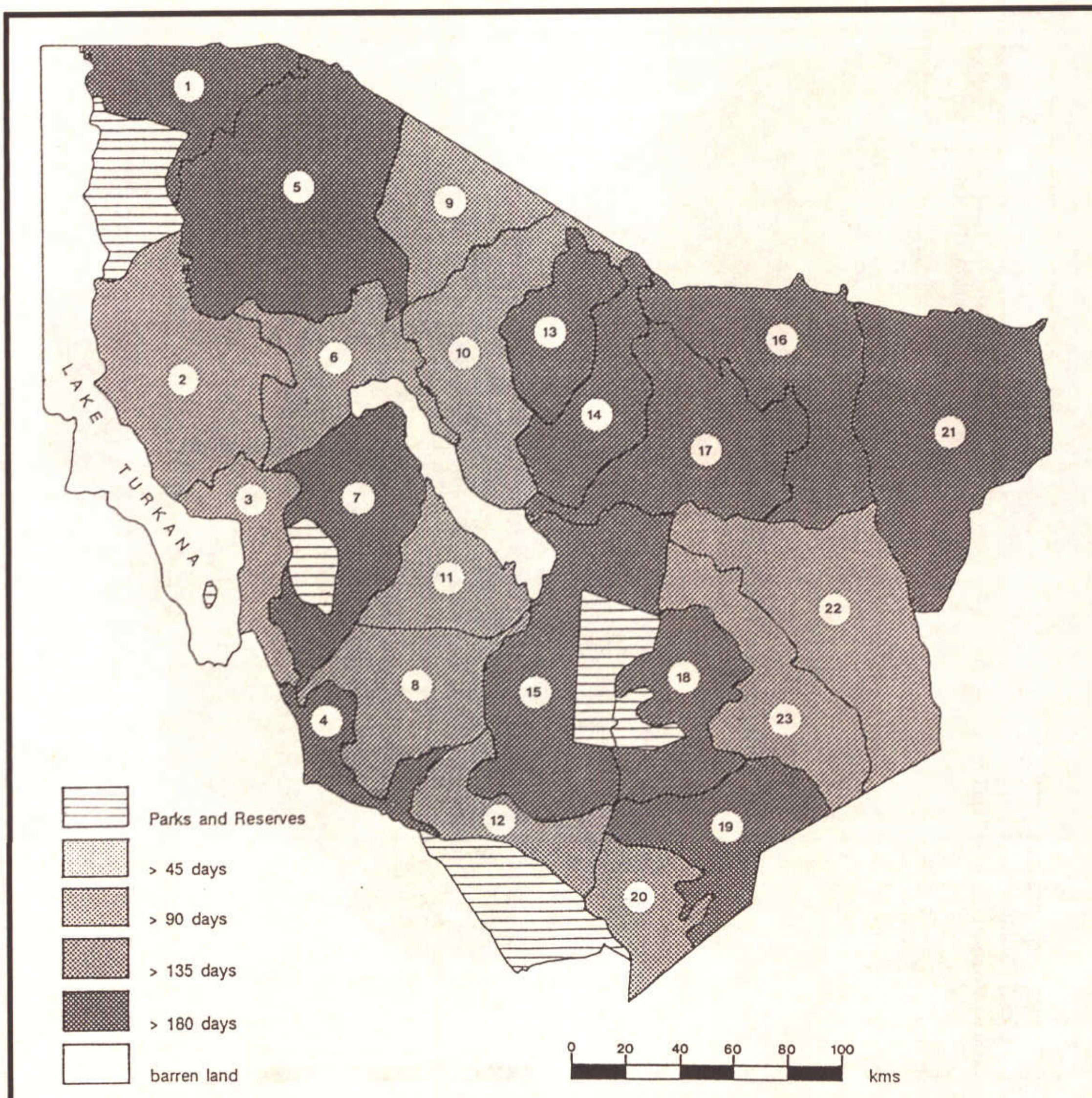
In all range units forage availability for cattle exceeds 45 days and reaches a maximum of 140 days in 4 units only. Because of the relatively high density of forage species utilised by cattle in most range units, optimal stocking densities are comparatively high: 0.9 to 3.0 ha/TLU during the long rains and 1.2 to 2.1 ha/TLU during the short rains; however, periods of forage availability are very short in all units and do not allow regulated range utilisation by cattle in any range unit. Dry season grazing reserves for cattle exist only in high altitude and run-on areas, which are limited in size. Additional water development will not increase rangeland potential for cattle. All range units are suitable only for opportunistic use by cattle during and after high rainfall. During the rainy seasons, preferably those range units with lower grazing potential (ie. lower no. grazing days), should be utilised first.



Map IV/2:

Recommended number of grazing days for SHEEP in a median rainfall year

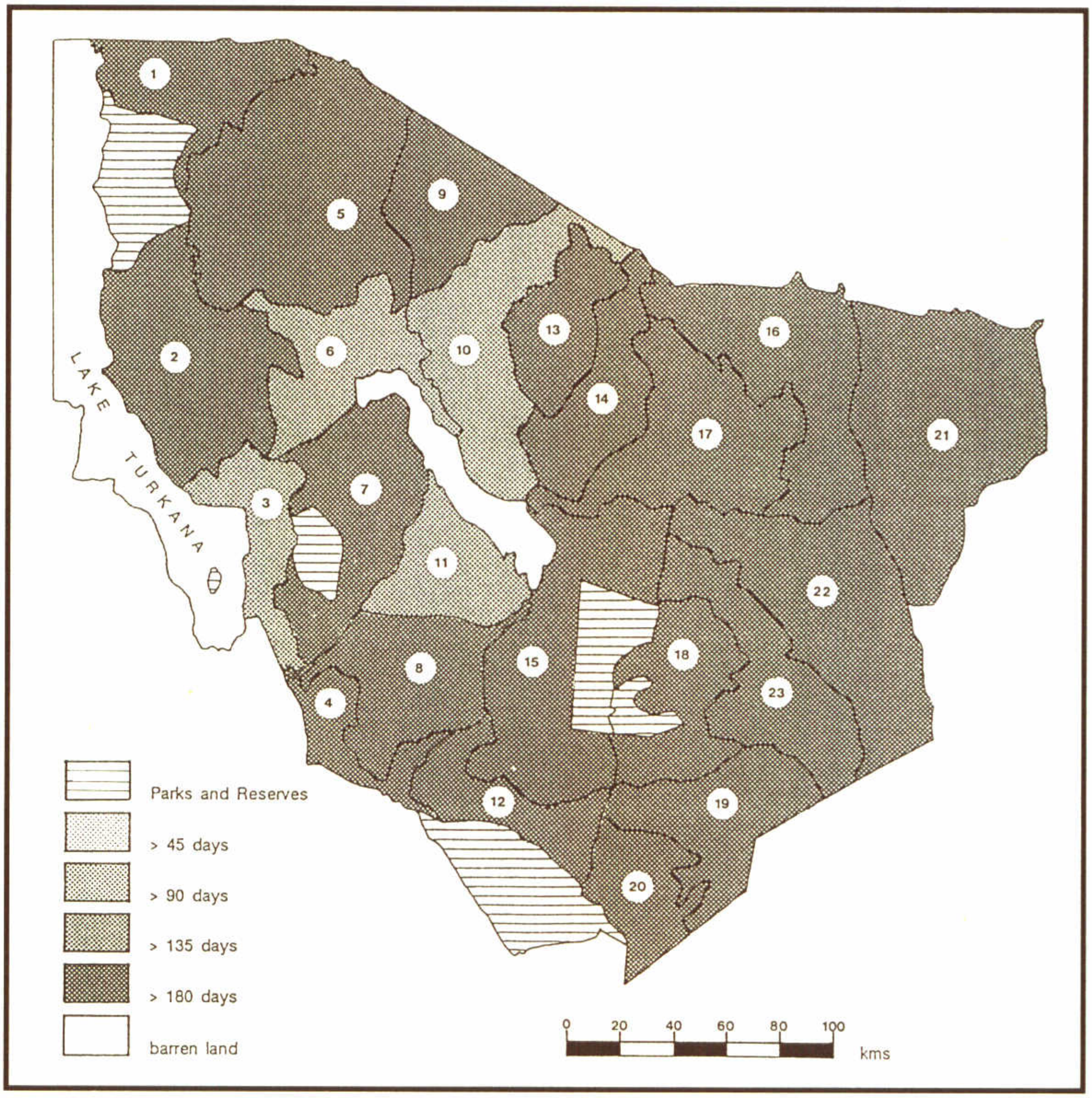
In all range units forage availability for sheep exceeds 90 days and reaches 180 days in 4 units. Because of the relatively high density of forage species utilised by sheep in most range units, optimal stocking densities are comparatively high: 1.4 to 4.5 ha/TLU during the long rains and 2.3 to 3.8 ha/TLU during the short rains; however, periods of forage availability are short in all units and do not allow regulated range utilisation by sheep in any range unit. Dry season grazing reserves for sheep exist only in high altitude and run-on areas, which are limited in size. Additional water development in range unit 13 (Huri Hills) would increase rangeland potential for sheep. All range units are suitable only for opportunistic use by sheep during and after high rainfall. During the rainy seasons, preferably those range units with lower grazing potential (ie. lower no. grazing days), should be utilised first.



Map IV/3:

Recommended number of grazing days for GOATS in a median rainfall year

In all range units forage availability for goats exceeds 135 days and reaches 210 days and over in 7 units. Because of the relatively low density of forage species utilised by goats in most range units, optimal stocking densities remain low: 4.2 to 16.3 ha/TLU during the long rains and 7.8 to 16.6 ha/TLU during the short rains. Regulated range utilisation by goats is possible in range units: 4,5,9,12,13,14,16,17,18 and 21. Additional water development in range unit 13 (Huri Hills) would increase rangeland potential for goats. 12 range units are suitable only for opportunistic use by goats during and after high rainfall. During the rainy



Map IV/4:

Recommended number of grazing days for DROMEDARIES in a median rainfall year

In all range units but 4 forage availability for dromedaries exceeds 180 days and reaches 250 days and over in 5 units. Because of the relatively low density of forage species utilised by dromedaries in most range units, optimal stocking densities remain low: 4.7 to 18.1 ha/TLU during the long rains and 8.7 to 18.5 ha/TLU during the short rains. Regulated range utilisation through dromedaries is possible over the whole district. Additional water development would yield only marginal advantages with regard to range use by dromedaries due to their low water requirements and their capacity to endure long watering intervals (see Vol 1, Chapter ()). During the rainy season, preferably those range units with lower grazing potential (ie. lower no. grazing days), should be utilised first.

CHAPTER V
LIVESTOCK MARKETING

Francis N. Chabari & George K. Njiru

INTRODUCTION

Land use

The agricultural potential of the district is low, as only about 5% of the land area is arable (areas surrounding Mts. Marsabit and Kulal, and Moyale and Sololo divisions). Subsistence cultivation is practised in these areas, mainly with cereals. Horticultural crops and coffee are important enterprises on Mt. Marsabit. The total area under cultivation in the district is about 10,000 ha. Nomadic pastoralism is common with distribution dependent on prevailing weather patterns in the drier parts of the district. Large portions of the rangeland are currently not used because of water scarcity and high risk of stock theft. Per capita income for pastoral producers in the region are low. The remaining 10% of the land area is gazetted as game reserves, national parks or forests. The latter are important as dispersal regions for livestock during the dry season.

Administrative Units and Human Population

The district is divided into six administrative divisions namely: Laisamis, Loyengalani, North Horr, Central (Mountain), Sololo and Moyale. The divisional boundaries nearly conform to the traditionally recognized grazing lands of the Rendille, Gabra and Borana subtribes. In the 1979 district census, the population was estimated at 96,000 people, an increase of 86% over the 1969 estimate of 51,500. Estimates of the main subtribes in 1979 were 19,900 Rendille, 23,400 Gabra and 30,400 Borana. The minor subtribes (the Burji, Samburu, Turkana, El Molo and Shangilla) constituted approximately 22,500 people (G.o.K. 1980). Recent estimates show a district population of 157,000 (G.o.K. n.d.). Of these, 70% are pastoralists, 10% agriculturalists, 10% in commerce and 10% employed.

Infrastructure

An international road, the Nairobi-Addis Abeba highway, passes through the district and crosses into Ethiopia at the border town of Moyale. This is the single most important road for the economic activity of Marsabit district. The poor condition of this road (corrugation in dry weather and impassable sections in wet weather) severely limits mobility in the district. Most of the roads are accessable only to trucks and 4- wheel drive vehicles, even in dry weather.

Telephone and postal services have greatly improved with the recent installation of Subscriber Trunk Dialling telephone facility and with the upgrading of post offices in Marsabit and Moyale townships. The district is also well served by airstrips at almost all market centres. In total, there are 8 airstrips registered with the Directorate of Civil Aviation, two of which, at Marsabit and Moyale, are tarmaced and therefore usable year-round.

Relevant Projects

Investigations by the UNDP/FAO in 1970 recommended the development of extensive grazing blocks for improved grazing control, water supply and livestock marketing. Recommendations for smallstock were to encourage commercial offtake and to establish a market for live animals and export meat to the Middle East. The recommendations were never implemented but some limited marketing facilities were developed by the LMD in the early 1970's. Sporadic use was made of these facilities until the early 1980s when LMD stopped buying livestock in the district.

The Integrated Project on Arid Lands carried out comprehensive investigations in the district, with the objective of seeking solutions to the serious environmental problems posed by the ecological degradation of arid lands.

This investigation included the study of socio-economic issues, particularly the concept of increasing commercial livestock offtakes thereby generating household income and reducing grazing pressure. Some of the findings are being implemented in the West Marsabit Integrated Development Pilot Project. The main objective of WMIDPP is to create a supportive environment for novice livestock traders by providing small-scale loans.

Development of water resources has received considerable emphasis in the district's development programmes. In the rangelands, people and livestock use the same water points as they search for grazing. Distribution of watering points is crucial to the timing of marketing activities. The trekking routes depend mainly on water availability between livestock producing areas and the market. Except for two boreholes on Jaldessa LMD holding ground, no water projects have been planned specifically to improve stock routes or marketing facilities. However, several agencies have participated in drilling or equipping water facilities now used by production herds and market livestock in transit, as well as people.In addition to G.o.K., some of these agencies include the Swedish International Development Agency, Inter-Aid, Kenya Water for Health Organisation, various church groups and oil exploration companies.

The district's livestock marketing societies have not been active. For instance, the Moyale Livestock Traders Cooperative Society registered in 1965 and the Marsabit Ranching and Marketing Cooperative registered in 1976, are both dormant. Consequently, most of the marketing activities have been privately initiatiated with only sporadic buying by the LMD and KMC. The latter has recently been reorganised and renamed the Kenya Meat Corporation. LMD's livestock buying activities in the district slowed down considerably in the early 1980's and ceased completely in 1983.

Prevention of two important cattle diseases, ie. Rinderpest and Contagious Bovine Pleuropneumonia (CBPP), has been the major occupation of the Veterinary Services Department since the 1960's. Annual vaccination campaigns have been undertaken in collaboration with neighbouring states (under Joint Programme 15, OAU).

The major impact of JP15 is the marked reduction, near erradication, of CBPP and Rinderpest in cattle in northern Kenya, that has greatly enhanced movement of live market stock from the region. No cases of either disease have been reported in the district during the past several years.

Other important livestock diseases have been vaccinated against or treated; the main ones are Foot and Mouth Disease (FMD), Anthrax, Blackquarter and Trypanosomiasis.

Aspects of the District Economy

The district does not have many natural resources. Tourism is undeveloped largely because of the bad state of the roads and the large distances between sites of attraction. The forest reserves are not sufficiently large to support even moderate timber industries. There are no permanent rivers in the district.

The potential for petroleum and natural gas is still under investigation. The district has potential for the generation of solar and wind power. None of these power resources have been exploited to any extent. The potential for commercially refining salt from the deposits in the Chalbi desert has not been explored. There is only one plant at Loyengalani for packing fish which is then transported out of the district. People in the fishing industry are mainly immigrants from neighbouring districts. There is a small bakery in Marsabit and Moyale. These are also the only towns supplied with electricity. The district output of goods, services and employment opportunities in the industrial sector are therefore, rather limited.

The main income generating activities are trade in consumer goods and livestock. The two are related in that the trucks used to haul consumer goods from major towns are also used to transport livestock on the return trip. Without livestock, these trucks would be empty on the return trip, resulting in high operating costs. One may argue, therefore, that the livestock industry contributes to lowering marketing costs and consumer prices. The main traders in merchantile goods own trucks and many are also licensed to trade livestock.

THE PROBLEM

A high proportion of the district's human population, approximately 70%, is almost completely dependent on livestock for survival, and as these pastoral communities are rapidly being drawn into the wider national cash economy, they are forced to sell their livestock to meet cash needs eg. for the purchase of food grain, clothing, health services, transportation and veterinary care of the livestock.

Additionally, pastoral communities use livestock for social purposes like bride prices, settlement of debts, as fines and for many social occasions. The need for pastoralists to keep large numbers of livestock for the above requirements and herd survival through drought is overwhelming. It is also well known that livestock producers readily accept opportunities to diversify their sources of income in order to ensure viability of the household.

Livestock trade is one, and probably the most convenient form of diversification, even for illiterate pastoral groups in northern Kenya. As mentioned earlier, livestock trade supports commerce and other economic activities in various ways, for instance, selling off part of one's herd in order to diversify into trade. In rural centres, most trade is conducted through barter with shopkeepers who accept livestock in exchange for commercial goods and/or cash. Hides and skins are also bartered in this manner. The shop keeper has to sell the livestock and hides as they accumulate, to replenish his diminishing stock of commercial goods. Timing of sale of the livestock, for the trader/shopkeeper or any large livestock producer, is dictated by many factors, among which are:

[1] Transportation mode and ease of passage. If livestock are trekked, the availability of water and feed along the route are important.

[2] Frequent outbreaks of disease and imposition of quarantines disrupt the producers' and traders' marketing plans.

[3] Condition of the animals for sale. Weak animals are not able to walk long distances, and cannot fetch good prices when transported by truck to the market. The favourite time to sell is a few weeks after the end of the rainy season, before the next dry season starts and stresses the livestock.

[4] Prevailing market prices. Information on market prices is not always freely available to livestock traders and very little indeed passes to the producers. Market information services, through government and county council departments, are almost non-existent in Marsabit district. Marketing decisions are, therefore, taken with insufficient information.

[5] Buying by large buyers like KMC and LMD are sporadic, and producers/traders frequently receive only short notice, thus pressuring them to sell even if prices are unattractive.

The irregularity of purchases by LMD and KMC makes them undependable buyers. Livestock producers therefore resort to bartering their stock to shopkeepers, sometimes for values the producers consider to be very low. Despite these impediments to marketing, livestock will continue to be the major income generating source, as well as providing food and meeting various social needs in the future. Commercial sales are particularly important in generating cash required to participate in the wider economy.

To minimise the marketing impediment, it is necessary that some interventions are made in the system. The first major purpose of this study is therefore to point out areas of possible intervention and to provide suggestions through which the marketing system could be improved. These are needed especially since Marsabit district has not benefited from coordinated livestock/range improvement and marketing programmes since independence.

The second major purpose is to gather data on parameters of economic interest that are usful for planning purposes.

THE MARKETING SYSTEM

Facilities and Infrastructure

Although Marsabit is a large and major livestock producing district, few marketing facilities have been set aside for this purpose. LMD, for instance, only partially developed one holding ground at Jaldessa, constructed one selling yard at Sololo and only operated mobile weighing scales at other points in the district.

Jaldessa LMD Holding Ground

The holding ground is located about 45 km east of Marsabit township and has an estimated size of about 25,000 ha. Its capacity is estimated at 7,000 head of cattle in two herds of 3500 head each. These estimates are based on two growing seasons of equal magnitude (March to May and October to December) with a rainfall of 200mm per year. Infrastructures include:

- two boreholes (one of them non-functional during the survey)
- two steel water storage tanks (180,000 l. capacity)
- two concrete water troughs
- two spray races (one unserviceable during the survey)
- two inoculation crushes
- two staff houses
- one portable cattle weighing scale.

Additionally, there are about 40 Km of access roads which also serve as firebreaks. The roads were in poor condition during this period.

Currently the holding ground is being used by pastoralists and livestock traders, especially during the dry season. For the use of facilities and forage, the livestock owners pay a monthly fee of 4/= Ksh per head of cattle.

Proposals by MLD include using the facility for both holding and quarantining cattle while screening them for CBPP. Uninfected stock would then be transported directly to ranches for fattening or breeding. The proposal is based on the fact that livestock owners incur high costs when they have to trasport cattle to Isiolo holding ground and have to maintain close supervision on them for the six week period required for CBPP screening. The proposal, however, has not received consent from the Department of Veterinary Services.

Waldaha Proposed Holding Ground

The size of this proposed holding ground, located 100 km north of Marsabit town, is still undecided, altough in principle, the Marsabit county council has agreed to allocate sufficient land for it. The operation of the holding ground and sharing of the generated revenues still has to be settled between the council and MLD.

Buying Centres: Sololo and Badassa

These are developed sales yards, of approximately 4 ha each. Sololo sales yard includes sorting pens, a weighing scale, a loading ramp and a house used only during sales. It is located about 1 km off the Marsabit-Moyale road near Sololo township. Badassa sales yard only has one crush. Elsewhere in the district LMD has bought livestock using mobile scales at crush sites normally used for cattle inoculations.

The Informal Marketing Network

Lengthy interviews were carried out with livestock traders selling stock out from the district to the larger markets like Isiolo, Nairobi and townships in between. There are also groups of traders who will buy stock from the remote markets for resale in Moyale and Marsabit. These larger towns act as gathering points for stock destined for markets outside of the district.

LINKS IN THE MARKETING CHAIN

Sales by Producers

Subsistence needs of the household and the desire to keep a large breeding herd for build-up are the main factors determining selection of stock for sale. For cattle and small-ruminants, the sequence of sale is: castrates and infertile females, immature males, breeding males and, finally, productive females. It was emphasised that pregnant and lactating females are sold only under extreme circumstances.

Camels of all sexes are very rarely sold, partly due to the scarcity of domestic outlets and partly due to the negative social stigma attached to a pastoralist who sells productive camels. Exchanges of camels for smallstock are common, because it is easier to sell smallstock received in exchange.

From the discussions, it was clear that buying activities occur year round at the small markets. There is increased selling/barter activity during the dry season when milk output declines as forage decreases, and the majority of livestock migrate to dry season grazing areas - "fora". In this situation prices, or exchange values, are dictated by the shopkeepers. The buying process is slow and may take several weeks. Only when prices are lucrative in centres outside of the district, do traders increase their buying activity, usually through purchase agents. There are, however, also itinerant livestock traders whose principal occupation is livestock trade as opposed to shopkeeping with livestock trading. These traders cover long distances on foot in order to buy livestock directly from the producers, or may locate themselves at trading centres for short periods to wait for producers seeking the buyers. Samburu itinerant traders are particularly active in the southern part of the district. Producers may also sell directly to butchers at the trading centres.

The producers agreed that butchers offered the best prices when compared to other buyers, partly because butchers bought stock for immediate slaughter without any maintenace costs. The risk of loss, other than through condemnation of carcasses, is also minimal, and the business has a fast rate of turnover. Producers prefer selling to itinerant traders rather than shop owners because they offer better prices and pay in cash.

The Intermediate Markets

Livestock purchased by shopkeepers or itinerant traders is resold at larger markets in or outside of the district. The main livestock suppliers in Marsabit and Moyale are itinerant traders, and although they tend to concentrate in geographic areas they are familiar with, there are large numbers of them spread evenly over the district. Buying orbits occasionally cross district boundaries, eg. the Samburu traders operating in the southern and southwestern parts of Marsabit. Traders from the Wajir border readily found smallstock buyers in Marsabit as it is commonly accepted that Galla goats from this area are larger and fatter than smallstock from other areas of the district.

Producers also sell directly at these larger markets, and usually the high attendance of buyers ensures higher prices. The feeling of most producers is, however, that it would not be worth the trouble of selling at larger markets if distances exceeded two days trek.

Other intermediate markets for stock originating from the district are those at Baragoi and Maralal and in Isiolo. Clearly, many traders would like to by-pass Isiolo and sell at markets in the densely populated districts of Meru, Embu, Nyeri, Muranga, Kiambu and Nairobi. Between 1986 and 1988 an average of only 60 cattle and 125 smallstock per month officially arrived from Marsabit in Isiolo. The unofficial rate is thought to be considerably higher, especially in the Isiolo-Meru district border market of Kinna. Large numbers of livestock also passed through Isiolo on trucks for the Nairobi/Dagoretti markets.

The Terminal Markets

Many of the traders interviewed in Marsabit indicated that they regard Nairobi/Dagoretti as the major terminal market. In the past they had sold livestock to markets in the densely populated districts mentioned previously. However, in "disease free" districts livestock have to be certified to be free of contagious pleuro-pneumonia before being marketed. Suppliers can therefore only operate within very strict guide-lines: that is, for instance, all animals originating from Marsabit, by regulation have to be transported by truck to abattoirs at Dandora and KMC factories where they are expected to be slaughtered immediately. Although frequent, nonconformance to the regulation is illegal!

Investigations revealed that no animals had recently been slaughtered at any KMC plants. Dandora is also not favoured because it operates under virtual monopoly. Prices for cattle at Dagoretti were compartivly higher as the result of competition between butchers, wholesalers and middlemen who buy live animals on arrival to resell later. A major hinderance is however, the lack of holding-facilities at Dagoretti. Sudden uncoordinated stock-influx frequently causes severe price drops. Dagoretti is mainly a cattle market, and smallstock are invariably sold at Kariobangi in Nairobi. Prices fluctuate considerably depending on numbers offered and level of demand. During holidays, prices are usually extremely good, and many traders try to respond to these periods of peak demand. Delivery of cattle and smallstock from the district to the terminal markets in Nairobi and Dagoretti, for 1985-87, averaged approximately 4700 cattle and 12,400 smallstock per annum.

Modes of Transport

The only econommically feasible mode of transport for livestock from the remote production areas to the major road network is by walking. From all parts of the district livestock are walked to the Moyale-Isiolo road or west to the Maralal-Rumuruti road. Occasionally, animals are transported by truck, if the condition of the roads permit and it is neccesary to save time. Where this is the case, animals are normally not resold at intermediate markets but are sent directly to the terminal markets.

Particularly during the rainy season, when there is plenty of forage and water along the routes, trekking is common. It is said that animals can even gain weight during this time as they walk. Trekking can take several weeks as is the case from Moyale south, along the eastern district boundary, through Arabajahan and Merti, to Isiolo.

A major concern during trekking is the security of people and livestock. Rustling is relatively common, esspecially on the eastern and southeastern side of the district along the Isiolo district boundary. Traders frequently hire security personnel to accompany them through these risky sections.

A typical trek from Moyale through Arabajahan to Isiolo includes the herdsmen, hired security personnel and several camels transporting food and water. Additionally, there may be a 4-wheel drive vehicle (conditions permitting); if not, the herdsmen and security personnel rely on camels to transport all the food and water. Such elaborate arrangements are necessary as large herds, of up to 3,000 cattle, are moved on a single journey.

Since rainfall distribution is frequently uneven across the routes, the herders have then to change them according to the availability of green pastures. Traders indicated the following as the shortest travel times from places shown below.

Table 5.1: Estimated shortest trekking times

From	To	Days
Moyale	Merti	10
Merti	Kinna	5
Kinna	Ishiara (Embu)	4
North Horr	Marsabit	11

During the dry season, the more expensive transport by truck has to be utilized but livestock still need to be walked to the Moyale-Isiolo or to the Maralal-Rumuruti roads. During the survey, trucks carrying live animals from Moyale required one full day to arrive in Nairobi. Livestock destined for terminal market have to be transported by truck, especially since trucks moving to Nairobi are empty. Truck owners regard livestock trade as a major enterprise, and even commision unlicensed traders, under their own license, with the stipulation that their trucks are used. From western Marsabit (eg. Mt. Kulal, South Horr and Loyengalani) the most common route is to Baragoi or Maralal, where the stock is loaded onto trucks bound for the Nairobi market.

MARKETING OF LIVESTOCK PRODUCTS

Hides and Skins

Trade in hides and skins is highly variableand is strongly influenced by drought, disease outbreaks and imports from neighbouring countries. Generally, camel hides are never sold, but are used as sleeping mats, rain protection, ropes and various other uses including manyatta construction etc. Some cattle hides may be sold but the majority is used in the household for the same purposes as camel hides. In contrast to this, about 90-95% of all smallstock skins are sold or bartered for food, clothing, batteries etc. Shopkeepers in turn sell the hides and skins to middlemen, who then sell them to traders and/or tanneries in Nairobi. Intermediary market prices were said to be satisfactory (also ref. appendix 5).

Milk Products

Milk products are used almost exclusively for subsistence; surpluses (only from the households in the proximity of markets) are sold for cash but are generally only available during the rainy season when livestock are brought back to the permanent settlements. Recently, the development of privately owned small-scale dairies has been observed in Marsabit town.

LIVESTOCK OFFTAKE

Estimates of livestock offtake from pastoral production systems have always been relatively crude given existing methodologies for estimating size and demography of livestock populations, and the large number of home slaughters that are rarely recorded. Additionally, constant stock movement even during quarantines complicate the matter. In making estimates, previous attempts by MLD personnel at estimating offtakes, hide and skin production , commercial slaughter and official figures of stock movement have been utilized. It is acknowledged that none of these data accurately reflect the real situation.

It is worth noting however, that of all the revenue collected by the County Council, income from taxes on livestock and livestock products is the largest component. In 1985, 1986 and 1987, revenue from these taxes contributed 42.5%, 33% and 37% respectively of the council's total earnings. It is projected that almost half (48%) of the earnings in 1988 will come from taxes on the sale of livestock and hides and skins. In recognition of the large contribution livestock sales make to the council's revenues, additional markets are planned for the near future. The market sites will be under supervision and management of the council, and taxes will be levied on all transactions made at these sites. Until now, only Marsabit and Moyale townships have gazetted market sites.

Camels

Although Marsabit district, and indeed the whole of arid northern Kenya, has a large camel population, very little commercial use is made of them. One sees very few camels at the market site on any given day. For instance, only 23 camels were sold at Marsabit market over the 62 day recording period.

On the other hand, the camel is highly regarded with exchange values of 30-35 mature smallstock in many parts of the district. In many pastoral communities, the camel is an essential part of the bride-price, (numbers vary according to the relative importance each ethnic group attaches to ownership of camels).

A major advantage of the camels' is that it can provide milk at the height of the dry season when the other species are dry from lack of grazing. The camel is adapted to live in areas where water sources are scattered. Camels are rarely slaughtered for food, and some communities, like the Gabra, do not slaughter even old males for food but instead, leave them in the bush to be eaten by wild animals.

Camels are also used to transport food, water and shelter as well as sick persons and children during migrations. The only organised marketing of camels was observed at Moyale where a group of Sudanese have been buying camels for sale in the Middle East; they are herded through Wajir district to the coast of Somalia and loaded onto ships to the Middle East.

Cattle

A full list of cattle population estimates are given in Appendix 1. Recently (ie. 1986-87), these were shown to be 299,000 and 314,000 respectively. Table 5.2 shows calculations made in estimating cattle offtake over two years. The estimates are influenced by illegal as well as authorised imports of hides from Ethiopia. The estimates on quantity of hides utilised by households, provided by the MLD, appear to understated.

Tab 5.2: Estimates of cattle offtake 1986-87

Description	Year 1986	1987
Cattle populations	299,000	314,000
Cattle exported from district	4,210	3,250
Recorded sales of hides	24,290	18,790
Home use of hides	500	400
Estimated annual offtake (%)	9.7	7.1

Source: Annual Report 1987, Marsabit District

Despite the fact that the district suffered serious losses during the 1984/85 drought (ie. losses as high as 40%), no significant changes were noted in the numbers of cattle slaughtered locally or exported from the district. Likely is that significant numbers of cattle from Ethiopia introduced into the Kenyan market through Marsabit district, since during the survey, active movement of cattle trucks originating from the Sololo-Moyale area was observed.

Sheep and Goats

Using the same data sources as for cattle, estimates for smallstock offtake during 1986-87 are presented Tables 5.3 and 5.4.

Tab 5.3: Estimates of Sheep Offtake 1986-87

Description	Year 1986	1987
Sheep populations	382,000	401,000
Sheep exported from district	6,460	2,085
Recorded sales of skins	92,550	132,190
Home use of sheep skins	900	2,900
Estimated annual offtake (%)	26.2	34.2

Source: Annual Report 1987, Marsabit District

Tab 5.4: Estimates of Goats Offtake 1986-87

Description	Year 1986	1987
Goat populations	414,200	435,000
Goats exported from district	9,690	3,130
Recorded sales of skins	141,520	173,700
Home use of goat skins	2,800	3,400
Estimated annual offtake (%)	37.2	41.4

Source: Annual Report 1987, Marsabit District

These rates are clearly inflated, assuming that the population base is acceptable. It is almost certain that large numbers of imported skins from Ethiopia, are the main reason for the high offtakes.

IMPORTS OF LIVESTOCK , HIDES AND SKINS

It is extremely difficult to estimate especially the illegal imports, as there is no clear method for separating imports from locally produced livestock and/or hides and skins.

It has been previously estimated, (Cossins et al 1987) that about 40,000 head of cattle per year come onto the Kenyan market from southern Ethiopia.

Available data from Moyale suggests disproportionately small numbers of hides and skins imported into Kenya from Ethiopia. The 1985-86 figures of hides and skins imported and officially recorded are given in Table 5.5.

Tab 5.5: Hides and Skins Produced/Imported in Moyale Sub-District 1985-86

	Cattle Hides	Sheep Skins	Goats Skins
1985			
Total recorded	10305	10210	20133
Imported from Ethiopia	4457	3534	4970
Import proportion (%)	43.3	34.6	24.7
1986			
Total recorded	2356	16822	31469
Imported from Ethiopia	1089	3600	6230
Import proportion (%)	46.2	21.4	19.8

Source: Various Reports 1985-86, Moyale Sub-district

In early 1987, prices for hides and skins in Ethiopia were higher than the prices in Kenya, the flow of imports to cease almost completely in March 1987. No record was kept of the exports of Kenyan hides and skins into the better markets of Ethiopia.

There was some unofficial selling of sheep from Kenya to Ethiopia in 1985-87, the Ethiopian government was exporting live sheep to the Middle East. Since prices paid by the Ethiopian government were higher than the Kenya ones, there was an "exodus of sheep", northwards, from areas as far south as Garba Tulla in Isiolo district.

CONSTRAINTS TO THE EFFECTIVE MARKET FLOW OF LIVESTOCK AND LIVESTOCK PRODUCTS

Survey Results indicated that there were a number of constraints to the smooth operation of the marketing system, they are discussed below:

Lack of Stable Terminal Markets

All traders complained about the fact that there are few markets where they can sell their livestock. The main markets at Nairobi and Dagoretti are highly variable and affect prices at the intermediate markets through which the animals are brought. Market transperency is lacking. Traders without adequate communication facilities, are unable to react quickly to extreme price fluctuations, which are frequently due to uncoordinated supply of the market. Additionally, the lack of satisfactory livestock holding facilities forces suppliers to sell at throw away prices when there is a temporary market glut. It is generally true that prices rise during the wet season and national holidays and fall during the dry season. There is however, no way of accurately predicting prices over any given period.

Because of communication delays (of up to five days), small traders, especially in the remote districts, are frequently unaware of extreme price-oscillations making the livestock trade an extremely risky business. Traders owning a truck, and with access to a telephone, are in a better position as they can respond relatively quickly to improvements in prices. The risk that others will do the same, of course, remains.

Poor Quality of Roads

All traders also complained about the poor quality of roads in Marsabit district, especially the Isiolo-Marsabit road, as marketing costs are raised. The cost of transporting a head of smallstock (35-40 Ksh) or a steer (350-450 Ksh) from Marsabit to Nairobi (app. 500km) is disproportionately higher than transport costs from Mandera to Nairobi ie. at 20-30 Ksh and 200-300 Ksh for smallstock and cattle respectively and almost twice the distance. The rough ride occasionally causes some deaths due to exhaustion. The animals are in poor condition when they arrive in Nairobi/Dagoretti market and therefore fetch poor prices and cannot be held for long as their condition deteriorates quickly.

During the rains, the roads between Marsabit and Isiolo frequently become impassable for trucks. But since this is also the period for high prices for all livestock, traders are forced to trek from the district to Isiolo or points in between that are accessible.

Difficulties associated with trekking

Not only are the roads in bad condition, but there is also an increase in livestock rustling during the wet season when the abundance of water makes get-a-ways easier. Wet season trekking also increases the rate of spread of diseases and frequently causes market livestock in transit to be held up by quarantines.

During the dry season, lack of forage leads to unacceptable weight losses and animals are thus rarely herded. This is unfortunate as prices of livestock tend to be lower during this time and trekking, being considerably cheaper than trukking, would be a more profitable option.

Frequent Quarantine Restrictions

The veterinary department imposes restriktions on movement of animals from an area where contagious diseases have broken out, or are endemic. This is a necessary measure to check the spread of disease, but due to poor disease control, especially in vaccination and the inflow of infected animals from neighbouring countries, quarantine restrictions in Marsabit have almost become annual phenomenon (Table 5.6, quarantines during 1974-87 were mainly due to outbreaks of FMD).

Tab 5.6: Quarantine Impositions in Marsabit District between 1974 and 1987

Date imposed	Date lifted	Area affected
Jun 1974	na	Sololo Division
Sep 1975	na	Sololo Division
Mar 1976	na	Bodossa Location
Aug 1976	na	Karare Location
Jan 1977	na	North Horr Division
Jan 1978	na	North Horr Division
Mar 1978	Jul 1978	Moyale Division
Jul 1987	na	Marsabit Division
Aug 1978	Nov 1978	Wolde-Sololo Division
Sep 1979	Mar 1980	Logologo Location
Jul 1981	Oct 1981	Whole District
Jul 1982	Dec 1982	North Horr Division
Aug 1982	na	Moyale, Sololo,
Oct 1982	na	Whole District
Jul 1985	na	Ulan Ula Location
Jul 1985	na	Whole District
Aug 1985	na	Whole District
Nov 1986	Jul 1987	Whole District (LSD)
Nov 1986	na	Moyale Division
Oct 1986	na	Sololo Division
Mar 1987	Jul 1987	Whole District
Sep 1987	Feb 1988	Whole District

LSD = Lumpy Skin Disease, na = Not available
Source: D.V.O.'s office, Marsabit

If, as is the case for many small traders, all available capital is invested in animals, crippling revenue losses frequently ensue. A few traders break the quarantine, but if caught face heavy fines and/or withdrawal of the trading license (aside from additional costs of circumventing the authorities).

Cumbersome Regulations

Livestock trade is one of the most regulated forms of commerce in Kenya, but despite the acceptance of the need for regulating movement, most traders complained that some regulations did not appear to be aimed at encouraging trade. For example, in order to take a truck-load of goats to Nairobi, a "No Objection" letter from the DVO in Nairobi would have to be obtained. Then a "Movement Permit" would have to be issued in Marsabit on the strength of the "No Objection" letter. The permits are usually only valid for one week, and do not make allowance for difficulties in obtaining a lorry or returning to the animals.

Although not expressly stated on official movement permits, traders are not permitted to transport livestock at night without an endorsement from the responsible veterinary officer. Transporting livestock during the day exposes the animals to considerable heat stress, causing loss of condition and sometimes death.

Marsabit is classified as a CBPP area, and thus, cattle from the district cannot be sold to farms in CBPP-free areas unless they have been quarantinined and CBPP tested at Isiolo.

The matter is frequently complicated by outbreaks of other diseases, and livestock from Marsabit are usually taken for immediate slaughter to Nairobi, by-passing all potentially attractive markets around Mt. Kenya and making it difficult for small traders to participate in livestock marketing.

Lack of Capital to Finance Livestock Trade

The majority of livestock traders in the study area depend on family savings and support from friends to raise capital and usually run their shops and livestock businesses with capital outlay of less than 40,000 Ksh. Since this amount is not enough to fill one lorry, turnover is usually very low. In an attempt to make their money go as far as possible, they tend to depress prices and thus discourage sales by pastoralists.

The Agricultural Finance Corporation (AFC), a government development agency, formed to provide agricultural credits at relatively low interest rates, and the Kenya Commercial Bank (KCB), have offices in Marsabit. They do not lend money for livestock trade. KCB for instance, requires securities like land, buildings or chattel, that few of the traders have. Most of the livestock traders do not even operate bank accounts, preferring to keep large sums of cash on themselves in case they have a chance to buy livestock cheaply. Livestock are regarded as unacceptable security as they could die or be quarantined and unavailable for liquidation. The AFC does provide credit for production purposes but considers livestock trade to be outside of its mandate. The District Trade Board gives loans to local traders, but these vary from 5,000-15,000 Ksh and many traders find them to be inadequate. Less than 10% of all traders surveyed claim to have received such loans. The district trade office indicated that many more have received the loans but have defaulted payment and changed their names, making it difficult to trace them.

Lack of Reliable Market Information

As previously mentioned concerning the Nairobi/Dagoretti markets, the lack of market transperency applies to all aspects of market information. For instance, information on quarantines would enable a trader to make better decisions concerning the timing of purchase and sale, as well as the mode of transport of animals. Most of the information is passed along by word of mouth and it is generally impossible to verify its authenticity. It is also often too late to take advantage of the information as the market changes very quickly.

Scarcity of Handling Facilities

Another major constraint, mentioned by very few traders, but nevertheless there, is the lack of adequate handling facilities. Except for a few sites in western Marsabit where WMDPP has built sales yards and the few sites improved by LMD in Sololo, Badassa and Jeldassa, there are no other facilities for handling market livestock. Loading of livestock is usually very tedious (eg. loading by reversing a truck into a raised river bank or smallstock onto the lorry. This sometimes involves beating or the use of ropes which causes bruising and lowers the meat quality.

At the markets, animals sometimes break their limbs by jumping off lorries, as there are no loading ramps. Most lorries are not designed for carrying livestock and have slippery floors or poor ventilation frequently causing trampling and suffocation. This is especially true for lorries with double decks. Losses of up to ten smallstock in a consignment of 160 are common.

Stock Rustling

This is a major concern for all livestock owners in the district, especially near the district borders. Livestock traders particularly worry about security when moving animals on foot and usually consider it prudent to hire security personnel. The fee for security personnel is about Ksh.150

per day and person, including food.

Poor Terms of Trade for Pastoral Producers

Producers who wish to sell smallstock or cattle at remote markets often get very poor value for their animals, since they are dependent on the good will of traders. With increased participation in the cash economy and declining exchange, the producer is forced to sell more of his livestock to buy a constant number of goods and services. The situation is worse in the dry season when decreased milk supply necessitates increased purchases of grain. Producers therefore, sell only when they have to as the poor prices do not constitute sales incentives.

Absence of Consistent Livestock Marketing Policies

The collapse of KMC and the cessation of purchasing activity by LMD has left the livestock market basically without competition. Also since droughts are common in Marsabit appropriate planning must provide capacity for the purchase of large numbers of livestock during a crisis. Presently, pastoral producers are almost entirely dependent on private traders.

Inadequate Market for Camels

Very few camels leave the system, mainly due to a shortage of outlets for live animals. Slaughter figures show that only negligible numbers are slaughtered commercially for consumption within the district, and it is said that the camel population is steadily increasing and probably displacing smallstock and cattle in some areas. A commercial outlet for camels would significantly contribute to the incomes of households that have large milk-producing herds of camels.

Poor Methods for Curing Hides and Skins

The majority of hides and skins from home slaughter are cured on the ground, which greatly decreases their commercial value. The district could increase revenue from sale of hides and skins if the method for drying could be improved.

MARKETING EFFICIENCY AND MARKET PERFORMANCE

Since the period of time between barter and sale at market varies the calculation of marketing efficiencies does not include maintenance costs and only the purchase and destination market prices were used. It was assumed that animals would be disposed of as soon as practicable.

From the Gabra territory, marketing performance was estimated using data from traders from North Horr. These traders teamed up to fill a lorry with livestock for sale in Nairobi or Dagoretti and on the return trip hired a truck to transport commercial goods. Cost analysis, gross margins and returns to capital outlay are presented in Tables 5.7 to 5.10.

Moyale was used as the farthest point of origi for livestock from the Boran territory, but in praktice, producers and traders bring their stock for sale or loading to Moyale market from all corners of the division. The main reasons for this are: firstly, for inspection and issuance of a movement permit; secondly, Moyale township has the only gazetted market in the division; and thirdly, trucks for transporting livestock are readily available in Moyale. It is believed that large numbers of livestock sold in Moyale, especially cattle, originate from Ethiopia. Analysis of costs, margins and returns to capital are presented in Tables 5.11 to 5.13. Similar analysis for Ilaut in Laisamis division are presented in Tables 5.14 to 5.16. Laisamis is inhabited mainly by the Rendille.

Marketing Costs and Margins: North Horr to Nairobi

Marketing costs are defined as the expenses incurred in addition to the purchase price until the animal is resold. The marketing margins are defined as the difference between buying and selling price. The margins incorporate the costs of marketing and the profits of the trader. The largest cost is the trucking of livestock between Marsabit and Nairobi, accounting for over 70% of the total estimated marketing costs for cattle and about 54% for small ruminants. Total transport costs (trekking and/or trucking) account for 81% and 65% for cattle and smallstock respectively, between North Horr and Nairobi/Dagoretti. The costs for cattle are presented in Table 5.7.

Table 5.8 summarises marketing margins and returns to the trader's capital (purchase price plus marketing costs) for cattle.

The above results indicate that the mature steers were the most profitable category. Good quality slaughter cattle are in high demand at the Nairobi meat market, especially in butcheries specialising in selling top grade cuts. Female cattle, usually culls, were normally not taken to Nairobi-Dagoretti markets, were sold to local butchers.

The marketing costs for smallstock are presented in Table 5.9. Table 5.10 summarises marketing margins and estimated returns to traders capital for smallstock (North Horr-Nairobi).

The results support concerns about poor sheep prices in the region. Traders do not buy as many sheep because Nairobi consumers prefer goat meat. Most of the sheep bought in the area, therefore, ended up in local butcheries where their fat is in high demand. During survey, unrendered sheep fat was selling at 30.00 Ksh per Kg in Marsabit, 25% higher than the price for meat (24.00 Ksh; mutton and goat meat had same price). The mean price of sheep in Marsabit was 13% lower than the mean price of goats (892 goats and 563 sheep).

Tab 5.7: Estimated Marketing Costs (Ksh) by Cost Category per head for Cattle: Trekking North Horr-Marsabit, Trucking Marsabit-Nairobi (N=250 Cattle)

Cost Category	Ksh	%
Trekking charges	53.70	8
Trucking charges	500.00	73
Veterinary care	1.00	-
Death loss	-	-
County Council Cess	30.00	4
Helpers subsistence	52.00	8
Helpers return fare	38.00	5
Helpers salary	13.30	2
Total Estimated Costs	688.00	100

Table 5.8: Marketing Margins and Returns per Head of Cattle: North Horr - Nairobi (N= 250 Head Cattle)

		Mature	Immat
	Bulls	Castr.	Castr.
Mean Buying Price (Ksh)	2100	2900	1800
Mean Selling Price (Ksh)	3125	4570	2800
Marketing Margin (Ksh)	1025	1670	1000
Marketing Costs (Ksh)	688	688	688
Mean Gross Profit (Ksh)	337	982	312
Return on Capital (%)	12.1	27.4	12.5

Tab 5.9: Marketing Costs (Ksh) by Cost Category per Head of Smallstock: North Horr - Nairobi

Cost Category	Ksh	%
Trekking costs (N.Horr-Marsabit)	8.60	10.6
Trucking costs (Marsabit-Nairobi)	43.80	54.1
Veterinary care in transit	T	T
County council cess	6.00	7.4
Night boma charges Nairobi	1.00	1.2
Helpers subsistence	15.20	18.7
Helpers return fare	4.70	5.9
Helpers salary	1.60	2.0
Total costs	81.00	100.0

In Nairobi quality of smallstock meat is not important to consumers. Although one would expect that castrates have higher quality meat, there are no differences in prices for grades. There is therefore no incentive to pay relatively higher prices per unit weight for castrates.

Tab 5.10: Mean Marketing Margins and Returns per Head of Smallstock by Species and Sex Category: North Horr - Nairobi

	Sheep		Goats	
	Male	Castr	Male	Castr
Buying Price (Ksh)	190	225	275	343
Selling Price (Ksh)	287	357	475	512
Marketing Margin (Ksh)	97	132	200	169
Marketing Costs (Ksh)	81	81	81	81
Gross Profit (Ksh)	16	51	119	88
Return to Capital (%)	6.1	16.8	33.4	20.9

Marketing Costs and Margins: Moyale-Nairobi

Most of the interviewed traders are resident in Moyale town. The estimates of marketing costs and returns are based on prices paid at this market and the costs between Moyale and Nairobi. These are presented in Table 5.11. Clearly the trucking of livestock from Moyale to Nairobi was the major cost item, accounting for over 80% of the total marketing costs. Estimated marketing margins and returns to traders' capital for cattle trade are shown in Table 5.12. The same figures are given for smallstock in Tables 5.13 and 5.14, and show similar trends.

Tab 5.11: Estimated Marketing Costs per Head of Cattle by cost category: Moyale - Nairobi (N=410 Head Cattle)

Cost Category	Ksh	%
Trucking (Moyale-Nairobi)	500.00	82.0
Helpers salary	39.00	6.4
Overnight Boma fee	1.70	0.3
County Council cess	30.00	4.9
Death Loss	38.80	6.4
Total costs	609.50	100.0

Tab 5.12: Estimated Mean Marketing Margins and Returns to Capital per Head of Cattle by sex Category: Moyale-Nairobi (N=410 Cattle)

	Mat	Mat.	Imm.	Cull
	Bull	Castr	Castr	Cow
Buying Price (Ksh)	2450	2730	1550	1650
Selling Price (Ksh)	3625	4075	2900	2725
Marketing Margin (Ksh)	1175	1345	1350	1075
Marketing Costs (Ksh)	609	609	609	609
Gross Profit (Ksh)	565	735	740	465
Return to Capital(%)	18.5	22	34.3	20.6

Tab 5.13: Estimated Marketing Costs per Head of Smallstock by cost category: Moyale-Nairobi

Cost Category	Ksh	%
Trucking	50.00	70.4
Helpers salary	8.00	11.3
Helpers susbsistence	6.00	8.4
Boma fees (Nairobi)	1.00	1.4
County Council cess	6.00	8.4
Total costs	71.00	100.0

Tab 5.14: Estimated Mean Marketing Margins and Returns per Head of Smallstock by Sex* and Species: Moyale-Nairobi

	Sheep		Goats	
	Male	Castr	Male	Castr
Buying Price (Ksh)	300	350	380	425
Selling Price (Ksh)	400	450	490	560
Marketing Margin (Ksh)	100	100	110	135
Marketing Costs (Ksh)	71	71	71	71
Gross Profit (Ksh)	29	29	39	64
Return to Capital (%)	7.8	6.8	8.6	12.9

* Cull females were normally not bought for resale in the Nairobi market. These were mostly bought and slaughtered in the local butcheries.

Marketing Costs and Margins: Ilaut-Nairobi

Laisamis division, although more arid than most of the rest of the district, has an active livestock marketing system. Part of the activity is due to stimuli in the form of loans to livestock traders by WMIDP from Ngurunit.

Marketing data gathered from Ilaut trading centre have been used in calculating costs and returns from this area and are presented below.

Tab 5.15: Marketing Costs per Head of Cattle by Cost Category: Illaut-Nairobi

Cost Category	Ksh	%
Trucking	350.00	69.5
Helpers subsistence	67.00	13.3
Death loss	55.00	10.9
County Council Cess	30.00	5.9
Overnight Boma Fees	1.70	0.3
Total Estimated Costs	503.70	100.0

Tab 5.16: Estimated Mean Marketing Margins and Returns to Capital per Head of Cattle: Illaut-Nairobi

	Mature Castrates*
Buying Price (Ksh)	3000.00
Selling Price (Ksh)	4500.00
Marketing Margin (Ksh)	1500.00
Marketing Costs (Ksh)	503.70
Gross Profit (Ksh)	996.30
Return to Capital (%)	28.4

Tab 5.16 (continued)

* Marketing data for cattle were available only for mature castrates averaging approximately 375 Kg liveweight.

Tab 5.17: Marketing Costs per Head of Smallstock by Cost Category: Illaut-Nairobi

Cost Category	Ksh	%
Trucking	35.00	65.8
Vet. Drugs in Transit	6.00	11.3
County Council Cess	2.50	4.7
Death Loss	2.70	5.0
Overnight Boma Fees	1.00	1.9
Total Estimated Costs	53.20	100

Tab 5.18: Estimated Mean Marketing Margins and Returns per Head of Smallstock: Illaut-Nairobi

	Sheep & Goats
Buying Price (Ksh)	235
Selling Price(Ksh)	350
Gross Marketing Margin (Ksh)	115
Marketing Costs (Ksh)	53.20
Gross Profit (Ksh)	61.80
Return to Capital (%)	21.4

PERFORMANCE OF THE MARSABIT (TOWN) MARKET

[1] Composition of market stock:

Over a 62 day recording period, 491 cattle, 563 sheep, 892 goats, 23 camels and 10 donkeys were sold. Goats dominated the market with 46% of the total cattle and small-ruminant transactions. Sheep and cattle transactions accounted for 25 and 29% respectively.

Of the cattle sold, the majority (74%) were bulls.Steers and females comprised 11% and 15% respectively. The herd compositions for sheep and goats were very similar with 68%, 14% and 18% as male, castrate and female sheep; and 68%, 16% and 16% for goats. Of the sheep and goats, almost all the females sold were the old and infertile.

About 72% of the cattle transactions were mature stock, approximately 26% for immediate slaughter and 44% for resale markets. Approximately 29% were bought for production purposes (26% for breeding and 3% for traction). About 79% of the sheep and 88% of the goats were destined for slaughter houses directly or through resale markets. It would appear that the demand for slaughter stock is rather large, as only 77% of the sheep and 82% of the goats sold were adults, the difference in slaughter stock is made up of+ immatures. Only 22% of sheep and 12% of goats bought returned to the production system.

Tab 5.19: Percentage Composition of Market Livestock by Species and Body Condition

Species	Body Condition			
	Poor	Fair	Good	Excel.
Cattle (%)	4	35	47	14
Sheep (%)	2	26	60	12
Goats (%)	4	27	45	24

[2] Mean prices at Marsabit

Over all, a good correlation between body condition and price paid for cattle and smallstock was observed (goats r= 0.8; sheep and cattle r=0.74). These are important indicators for a livestock market that primarily supplies slaughter stock for buyers paying according to visual assessment of quality. Sex was poorly correlated to prices paid for both cattle and smallstock. Table 5.20 presents the calculated mean price according to species and sex.

Tab 5.20: Mean Prices of Stock Sold at Marsabit Township Market

Species/Sex		Price (Ksh.)	N
Cattle	All Cattle	1750 ± 735	491
	Males Only	1845 ± 807	361
	Castrates Only	1478 ± 359	56
	Females Only	1494 ± 383	74
	Males-Immature	1116 ± 380	115
	Adult	2185 ± 724	246
	Cast.-Immature	1531 ± 355	14
	Adult	1460 ± 362	42
	Fem. -Immature	1490 ± 288	10
	Adult	1495 ± 398	64
Sheep	All Sheep	232 ± 66	563
	Males Only	228 ± 64	381
	Castrates Only	243 ± 66	82
	Females Only	238 ± 74	100
Goats	All Goats	276 ± 99	892
	Males	280 ± 101	602
	Castrates	281 ± 94	145
	Females	250 ± 90	145

N indicates numbers of animals recorded in the survey

Prices offered for steers were 25% less than prices of bulls. The analysis however, indicated that these animals were for local slaughter and were relatively smaller in size than the bulls. In fact, of 56 castrates observed sold, only one was in excellent body condition and went to Nairobi. Most of male cattle sold were heavy, culled, breeding bulls. Mean prices of castrate smallstock appeared slightly better than mean prices for males or females. Most of the females sold were select culls in good body condition.

The price differences by body condition classes, as shown in Table 5.21, were dramatic. The mean price paid for cattle in excellent body condition was almost four times higher than the price of those in poor condition, more than the double of those in fair condition and over one and a half times of those in good condition. The prices of sheep in excellent condition were 133% higher than the prices of those in the poor condition group, 98% higher than the mean prices for the fair condition group and 44% more than the mean price of the good condition class. Similarly, the mean prices of goats in excellent body condition were 171%, 110% and 53% better than the mean prices of the poor, fair and good classes. These prices were indicative of expected carcass quality and meat yield.

Tab 5.21: Mean Prices by Species and Body Condition Category

	Body Condition			
	Poor	Fair	Good	Excel.
Cattle:Price (Ksh)	821	1261	1844	2916
	(21)	(169)	(232)	(69)
Sheep: Price (Ksh)	131	173	238	342
	(10)	(145)	(341)	(67)
Goats: Price (Ksh)	151	195	267	410
	(37)	(241)	(404)	(210)

Figures in brackets ( ) indicate numbers of animals recorded in the survey

[3] Destinations of stock and Rate of transaction

Most of the stock sold at Marsabit ended up in slaughter houses or were resold in town. About 53% of the sold stock (cattle and smallstock) were for resale, 71% in Marsabit and 29% (15% of the total cattle and smallstock transactions recorded) were destined for resale at Nairobi/Dagoretti.

The final destination influenced prices paid for cattle and goats at Marsabit. Prices of cattle destined for Nairobi/Dagoretti were 83% higher than prices paid for cattle in Marsabit for resale, breeding or the local abattoirs. Similarly, prices paid for goats destined for Nairobi were 64% higher than those of goats remaining in Marsabit district.

Tab 5.22: Mean Prices of Livestock Sold by Destination and Transportation Mode

Destination	Marsabit	Nairobi
Transport	(trek)	(truck)
Cattle (Ksh)	1529	2794
	(405)	(86)
Sheep (Ksh)	232	230
	(546)	(17)
Goats (Ksh)	242	396
	(694)	(198)

Figures in brackets ( ) indicate numbers of animals recorded in the survey

Over the recording period, an average of 11 head of cattle and 27 smallstock were offered for sale daily. Of the total offered for sale, 71% of the cattle and 85% of the smallstock were sold, and only 29% of the cattle and 15% of the smallstock remained unsold. Most of the unsold stock were presented on subsequent days or loaded on trucks for Nairobi/Dagoretti.

RECOMMENDATIONS FOR IMPROVING LIVESTOCK MARKETING FROM MARSABIT

Livestock production is very difficult and seasonally mobile. Livestock buyers also take inordinate risks in trying to bring livestock to the terminal markets.The recommended changes presented in this section are suggested to be for implementation by local and/or central government agencies.

[1] Institutional support in developing competitive markets

It should be appreciated that producers in Marsabit are restricted to the production of livestock, making them very price vulnerable. To protect producers from exploitation and hopefully to encourage them to continue selling commercially, a workable policy of floor prices for cattle and smallstock needs to be re-established, i.e like when LMD and KMC were active, although both suffered heavy losses and require improvements in operational efficiency.

The fact that small traders have been engaged profitably in livestock trade for many years suggests the need to reorganise KMC's and LMD's operational methods. Reducing transfer costs, transit time and the total time the livestock are held, are the main issues that need addressing.

Investigations revealed that producers and traders in the interior wished to have LMD and KMC reactivated and purchasing stock at least twice a year in the district. The buying points would need to be sufficiently spread out in the area so that the majority of producers would have a chance to sell directly to them.

Also LMD's excessive overhead costs when buying livestock are unjustifiable; a low cost arrangement could easily be worked out to reduce marketing costs per head drastically. LMD's official estimates for transporting cattle from Marsabit to Isiolo were Ksh.200/= per head while private entrepreneurs estimated Ksh.20/= per head for a herd of approximately 5,000 head.

[2] Development of Export Markets for Livestock

Kenya is strategically placed to take advantage of the lucrative Middle East meat market. So far, no serious effort has been made to develop this market despite repeated favourable studies. As mentioned previously, producer prices for sheep improved greatly in northern Kenya when marketed through Ethiopia.

Most probably allowing LMD or KMC regulated access to the export market for live animals will not adversely affect domestic supply. And to the contrary, the impact of good prices received in export markets might trickle down to allow higher producer prices, thereby stimulating increased production. If higher prices catalise regular offtakes, a strong impact on decreasing stocking intensities could result.

Existing disease control policies, if maintained, are adequate to ensure sufficient disease free stock for the export market, and especially the promotion of smallstock exports should be relatively easy as few disease problems are encountered.

An export market for camels is another urgent issue to address. Since there is very little domestic demand for camel products outside of northern Kenya, an export market is the only solution to this problem. The closure of the Archer's Post abattoir during the 1960's was a big setback for the development of the camel market.

[3] Improvements in the Marketing System

The current marketing system requires improvements to reduce seasonal fluctuations in the numbers of livestock sold and prices offered. The emphasis should be on sustaining flow of market stock from Marsabit through out the year. It is believed that intermediate traders, and shopkeepers, who hold large numbers of stock would be willing to sell them in the wet season, provided the previously discussed price incentives are operative. The infrastructure also requires improvement. For instance, there are strategic markets in the producing areas that need crushes, loading ramps and water. These are markets where large buyers like LMD and KMC could buy. Trek routes from these markets to larger regional markets would need improvement, basically the provision of water at strategic points and secure overnight facilities for people and livestock. Figure (1) illustrates the trek routes suggested for major improvements to make them usable year round. It is suggested that only the major roads be developed initially to make them passable in dry weather. From Ileret this seems to be no problem as livestock trek along the eastern edge of Lake Turkana.

From Dukana, the livestock trek to North Horr. In between Dukana and North Horr, an additional water point is needed. From North Horr, livestock normally trek to Marsabit through Kalacha and Maikona and loaded onto trucks or sold at Marsabit. One water point was suggested at Tulu Dimitu to ease the trek between Kalacha and Maikona.

From Moyale, the preferred trek route is southwards through Arabajahan, Amicha and Merti to Isiolo.To enhance security along the trek routes, it is suggested that facilities around water points should include inexpensive overnight shelters for people and improved enclosures for livestock, as it is also easier for security personnel to intensify surveillance at known points of livestock concentration.

[4] Establishment of a Price Monitoring and Dissemination Service

The objective would be to provide traders and producers with useful information on prices, supply and demand of market stock at the various markets. The government has personnel stationed at almost all market centres who could be deployed to collect market data at minimal costs. Such information could be used widely if broadcast over the radio for instance. The data would also facilitate the validation of current estimates of market offtake, especially for camels.

[5] Improvement of the Trunk and Internal Roads Network

Admittedly, this is a capital intensive investment proposal but must be addressed as soon as possible if the development of Marsabit district has to keep pace with the rest of the country. Notably, tarmacing this road has received repeated emphasis in the previous development plans. There is no doubt that the present condition of roads slows down all sectors of development in the district.Speedy delivery of livestock on trucks is not possible during the rainy seasons, and in dry weather, the bad road condition is the major reason for the high trucking costs. Most other roads in the district are very poor and do not allowlivestock to be transported by truck important production areas. At minimum, it is recommended that the Isiolo-Moyale road is improved and maintained through out the year.

[6] Provision of Financing for the Livestock Trade

The majority of traders indicated that they started livestock trading with savings from other occupations or sold part of the home herd to raise a starting capital,and most of the traders have remained small scale. Private and public credits are limited and generally only available to other forms of commerce considered to be relatively lower risk.

A form of line credit could be instituted to assist especially small-scale traders in expanding their businesses as demonstrated by the WMDPP. Such programmes should be administered with the backing of the District Development Committee (DDC) under the District Focus for Rural Development strategy.

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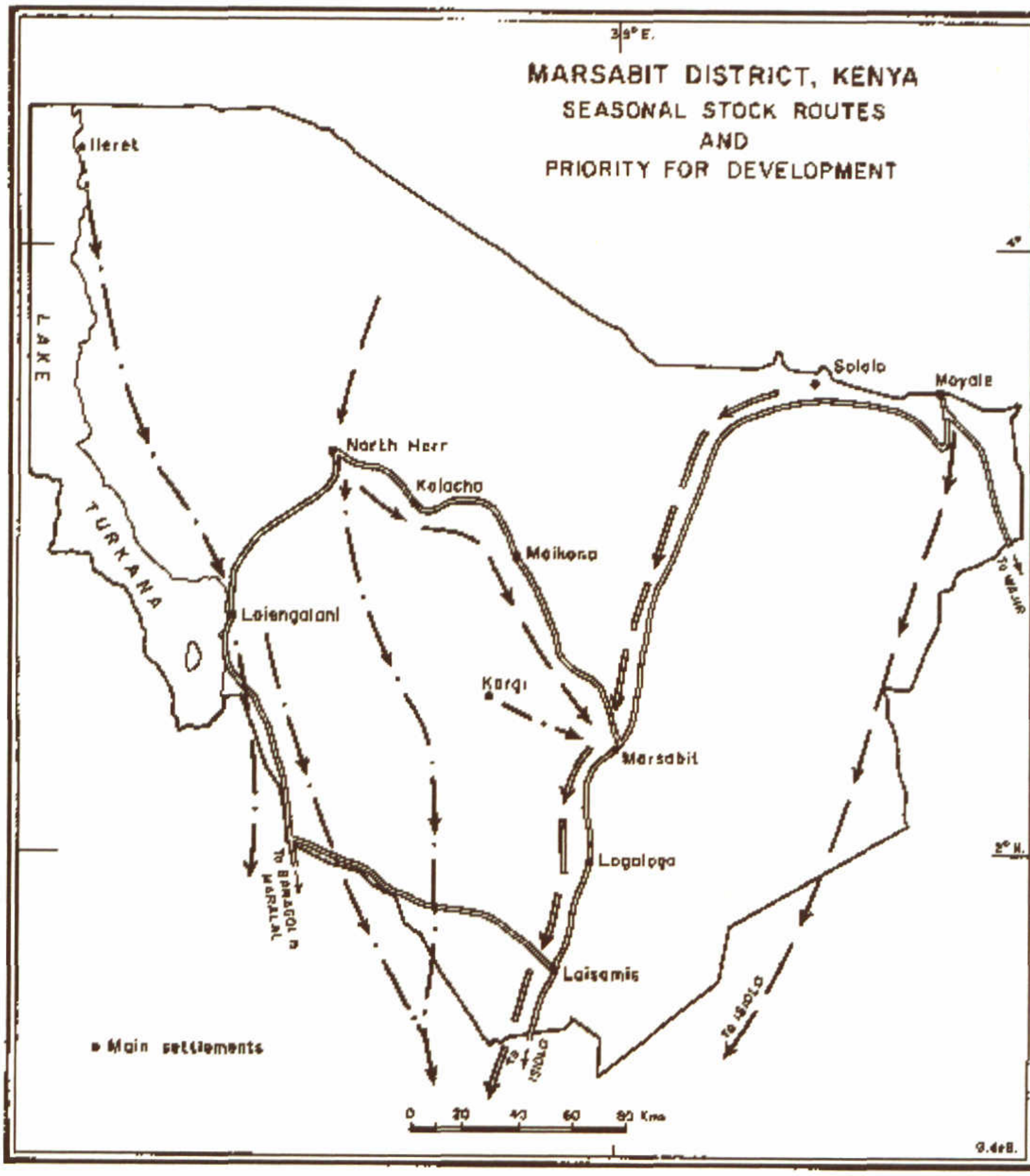


MAP NO V/1

Main LMD stock routes (trekking in wet season, trucking in dry season)

Primary wet season routes used by private traders

Secondary wet season routes used by private traders

APPENDIX

Table A.1: Livestock populations in Marsabit District ['000]

Source	Year	Cattle	Goat	Sheep	Camel	Donkey
Brown	1963	225	375	174	207	na
Spinks	1964	280	418	200	320	6
Watson	1970	196	350	159	146	na
Watson	1972	142	229	146	131	na
MLD	1977	395	464	464	134	17
MLD	1979	291		-840-	145	na
MLD	1980	277		-805-	138	na
MLD	1981	360		-1040-	145	na
MLD	1982	400		-1300-	160	20
MLD	1983	420	520	525	220	20
MLD	1984	252	312	315	200	18
MLD	1985	260	345	318	206	21
MLD	1986	299	414	382	204	22
MLD	1987	314	435	401	227	23

Source: GoK (1980) Marsabit District Dev. Plans 1979-1983, 1984-88

Table A.2: Number of livestock sales 1972 -76

	Exported from the District			Consumed internally		
Year	Cattle	Sheep	Goats	Cattle	Sheep	Goats
1972	6891	4501	13767	2189	7120	10845
1973	8412	4246	8493	2291	370	2384
1974	6307	4335	8670	2734	713	3561
1975	10770	2000	5132	3600	800	3800
1976*	164	3567	5542	4008	5421	3500

Source: GoK; Dev. Plan 1984-88. Min. of Finance and Planning, Nairobi.

* Cattle exports were low because of serious drought in the district in 1974-75.

Table A.3: Comercial slaughter of livestock 1973 - 1986 (Abattoir figures)

Year	Cattle	Goats	Sheep	Camels
1973	1924	1703	296	367
1974	1515	1932	715	195
1975	1942	3269	1176	405
1976	2567	4641	1628	375
1977	1018	3464	1472	168
1978	641	5793	1498	79
1979	845	10158	2591	141
1980	1962	6972	1288	266
1981	2207	4929	1271	337
1982	1318	2624	1051	49
1983	1559	3470	1000	262
1984	1907	3630	1026	455
1985	806	2699	1026	455
1986	2026		-5545-	110
MEAN KILL per year	1536	4252	1205	244

Source: District Public Health Office, Ministry of Health, Marsabit

Table A.4:
Hides and skins production and sales

Year		Cattle	Sheep	Goats
1972	Nos.	2286	34101	19679
	KSh/piece	10	4	4
1973	Nos.	3541	33033	12264
	KSh/piece	10	4	6
1974	Nos.	7264	32422	29298
	KSh/piece	15	4	6
1975	Nos.	2939	53945	68121
	KSh/piece	24	4	4
1976	Nos.	3508	64421	734
	KSh/piece	22	6	8
1977	Nos.	2284	65825	78281
	KSh/piece	22	6	8
1979	Nos.	2438	97918	83052
	KSh/piece	25	6	8
1980	Nos.	2763	89539	66996
	KSh/piece	25	6	8
1981	Nos.	8266	51811	57726
	KSh/piece	25	8	6
1982	Nos.	1349	34198	38587
	KSh/piece	25	8	6

Source: GoK, Dev. Plan 1984-88. Min. of Finance and Planning, Nairobi.

Table A.5:
District production of hides and skins by grade 1982-87

Year	Species	Grade 1	2	3	4	Total
1982	Cattle	664	541	333	232	1770
	Sheep	15716	20714	4296	1942	42668
	Goats	12916	18683	5185	2358	39142
	Camels	-	-	-	134	134
1983	Cattle	396	398	213	128	1135
	Sheep	18174	17716	4640	2936	43466
	Goats	16004	16006	7180	3179	42369
	Camels	-	-	-	152	152
1984	Cattle	2380	1335	974	698	5389
	Sheep	37725	18932	13630	3471	74838
	Goats	49699	30373	19267	10277	109616
	Camels	-	-	-	60	60
1985	Cattle	8904	5876	4477	1877	21124
	Sheep	31120	22391	13786	4485	73782
	Goats	40007	29122	19636	6230	94994
	Camels	-	-	-	241	241
1986	Cattle	10499	7310	4610	1786	24205
	Sheep	35597	27617	20178	9165	92553
	Goats	54463	46704	29461	10895	141523
	Camels	-	-	-	165	165
1987	Cattle	7024	5135	3395	1584	17138
	Sheep	54915	36957	23362	16953	132187
	Goats	70756	52044	32569	18308	173677
	Camels	-	-	-	62	62

Source: MLD Annual Reports 1982-1987, Marsabit District

Table A.6:
Prices of meat, honey and milk at Marsabit Town Market 1985-87

	1985	1986	1987
PRODUCT	(Ksh)	(Ksh)	(Ksh)
Bone-in Beef /Kg	16.50	17.50	20.00
Goat Meat/Mutton /Kg	16.10	16.10	20.00
Camel meat /Kg	12.00	12.00	14.00
Tripes /Kg	10.00	10.00	14.00
Liver /Kidneys/Kg	10.00	10.00	20.00
Honey/Kg	30.00	35.00	35.00
Milk (700 ml bottle)	4.50	5.00	5.50

Source: MLD Annual Reports 1985-87, Marsabit District.

CHAPTER VI
TRADITIONAL PASTORALISTS: LAND USE STRATEGIES

Günther Schlee

PASTORAL MIGRATIONS

Nomadism, as a system of livestock production defined by the mobility of herds and households, is a cultural system. The reason for a given movement can either be phrased as an adjustment to the availability of resources like pasture and water - in which case they are immediately intelligible to the livestock expert who stems from a different cultural environment -, or they can be attributed to the necessity to go on a pilgrimage, to hold age-set promotions on a traditional holy site, to gather for communal circumcisions in large clan settlements, to have the satellite herds in the main settlement on given lunar dates for blessing ceremonies or other ritual requirements. This second type of reason can only be understood by somebody who studies the respective cultures, understands the different age-set systems and calendars, and can discuss these matters with the nomads in their languages. Nevertheless it would be wrong to draw a rigid line between these two types of migrations: there might be ecologically motivated and ritually motivated migrations, but if we leave motivations aside and turn to effects, this distinction becomes blurred. Mass migrations with people with their stock have ecological impacts even if they are ritually motivated. If, for example, hundreds of Gabbra households spent several months in 1985 and 1986 in the Sidamo Province of southern Ethiopia to hold sacrifices on their holy mountains and to perform their age-set promotion rites at the prescribed sites, there can be no doubt that this reduced the stress on the vegetation on the Kenyan side of the boundary considerably.

Both on the search of pasture and for social and cultural reasons like visiting their places of origin and renewing ties with clansmen, the pastoral populations of Marsabit District throughout their history have criss-crossed the present boundaries of the district because it is neither ecologically viable as an isolated unit nor ethnically or culturally distinct from the sorrounding areas: the Gabbra straddle the Kenyan/Ethiopian boundary; the Boran do the same and also form a major element of the population of Isiolo District; the Sakuye live in two major clusters, one around Dabel in the Marsabit District, the other on the Ewaso Ngiro (Waso) in the Isiolo District; the Ajuran and Degodia Somali live, apart from the eastern Marsabit District, also in the Wajir District. Only the Rendille live mainly in the Marsabit District as far as their main camps are concerned, but even they could not subsist if they could not regularly send their herds in satellite camps into Samburu and Isiolo Districts.

The boundaries of Marsabit District therefore appear rather arbitrary and, if they were enforced to restrict movements of herds and people (as they were in colonial times), potentially dangerous to nomadic livestock production, i.e. to the only major economic asset of the district. To explain how these boundaries have come about, we need to have a brief look at history, more precisely at British colonialism which has bestowed these boundaries on Kenya.

By an analysis of the historical sources it can be shown that the boundaries of Marsabit district have been established only in this century, that they take insufficient account of long grown cross-cutting social structure and that they neglect ecological requirements of the pastoralists, for whom this district does not provide adequate pasture throughout the year.

Pre-colonial social entities like the Worr-Libin alliance which comprised the Boran and a number of peoples of Somali and Somaloid origin like the Gabbra Malbe, the Gabbra Miigo, the Sakuye and certain Ajuran and Garre sections stretched well into what is now Ethiopia in the north and the North-Eastern Province of Kenya in the east.

The northern boundary of the Kenya Protectorate, of which the northern boundary of the modern Marsabit District is a part, resulted from a local aspect of the "scramble for Africa", the race against

Ethiopian expansionism under Menelik.

The eastern boundary of Marsabit District resulted from the British policy towards the Somali. It dates back to the Galla-Somali line, a crude attempt by the British to separate the peoples they classified as "Galla" from the "Somali". This separation indicates a misunderstanding of the complex interethnic relationships in the area and establishes categories which are neither historically separate nor politically or economically viable. This boundary can rather be understood in the light of the colonial imperatives of "indirect rule" (which calls for territorially distinct administrative units) and "divide and rule".

The southern boundary, with what now is Isiolo District, results from a resettlement policy: the Boran in 1932 had to give up the wells of Wajir, which were allotted to the Somali, and where compensated with what now is the Isiolo District, from which the earlier Samburu occupants were squeezed out into the Samburu and Marsabit Districts.

In the south-west there has been a zone of age-long interaction and intermigration between the Rendille and Maa-speaking peoples, among whom the Samburu only seem to be the latest representatives. That the British here attempted a strict ethnic division and a boundary to herd and settlement movements left a particularly bitter memory.

To summarize: The present boundaries of Marsabit District are the result of the attempts of the colonial administration to divide pastures along "tribal" lines. Because of misconceived ideas about ethnicity, the English frequently drew such dividing lines even where in the feeling of the local people there were no such divisions but ethnic transitions, double affiliations by adoptive clan relationships, ethnic reaffiliation etc. Closing these boundaries to stock movements had no positive results, because the regulations were circumvented anyhow, but led to a lot of conflict and resentment.

Boundaries of tribal grazing grounds were even drawn within the district, e.g. between the Rendille and Gabbra, leading to an estrangement between the two peoples which might have contributed to the violence of the clashes between them in the Sixties and Seventies. (Now the Rendille/ Gabbra relationships are peaceful again and characterized by interlocked settlement and intermarriage.)

These colonial mistakes are not worth to be repeated. It would be wise to keep these boundaries open to nomadic movements, and to open them where even now these boundaries are used by local chiefs to restrict nomadic movements. The people of Marsabit District still speak of "reserves" with reference to rural areas. It should be made clear to them that in independent Kenya there are no reserves.

The following discussion of nomadic movements shows how frequently the pastoralists are forced to cross district boundaries, not only by ritual requirements which need to be respected if the freedom of religion is to mean anything, but also for ecological and economic reasons, in order to guarentee their survival and attempt to generate a surplus for the market.

MIGRATIONS MOTIVATED BY RITUAL REQUIREMENTS

Ritually motivated movements have to be examined along the dimensions of time and space. The timing is determined by the calendar of the respective culture, which might distinguish between ordinary and special years in longer cycles, between sacrificial and profane months in the lunar calendar etc. The spatial dimension is determined by the ritual topography: a mental map of holy sites and prescribed routes which link them which is superimposed on the physical landscape visible to all of us.

We shall first discuss some movements which happen at long intervals (14 or more years) and them rituals which take place once in a solar year or even four times in a twelve-month cycle.

Movements determined by the age-set cycle

Both the Rendille and the Gabbra have age-set systems of the gada type, i.e. systems which are based on exact time calculations rather than social and demographic pressure, ad-hoc adjustments, etc. Because of their common origin, the calendars of both groups are identical, and they frequently single out the same years as promotion years in their age-set cycles. The similarities which emerge from a comparison of the examples given below are therefore not coincidental.

Also the Boran have a gada system and ritual movements determined by it. Here, however, we concentrate on the examples of the Gabbra and Rendille.

A Gabbra example: the jila-journey of the Galbo phratry in 1986

The Gabbra of northern Kenya and southern Ethiopia are Boran-speaking camel herders. Inspite of their linguistic affiliation, other aspects of their culture indicate a close relationship to the Rendille and to hypothetical early, non-Islamic stages of Somali culture rather than to the Boran or other Oromo speakers (Schlee 1984b, 1985a).

The Gabbra form two local clusters, the Gabbra Miigo and the Gabbra Malbe. The former are an eastern branch; they live in the northern part of Wajir District of Kenya and the adjacent parts of Ethiopia. Due to their high mobility and the erratic changes of pasture conditions one can, however, also find them far outside their areas of usual or most frequent residence, such as Agere Maryam, 250 km north of the Kenyan/Ethiopian border at the north-western fringe of the territory of the Boran, as whose south-eastern neighbours the Gabbra Miigo are normally regarded.

The area occupied by the Gabbra Malbe lies generally more to the west. In the Marsabit District they number some 23,000 (Rep. of Kenya, 1981). A smaller population lives on the Ethiopian side, especially in the Mega Woreda (District) of the Arero Awraja, Sidamo Administrative Region.

The Gabbra have lived for many centuries on the fringe of the Islamic world, in an area of interaction of African and Middle Eastern cultures. The Gabbra Miigo have nominally accepted Islam in the last decades, at least in their contacts with outsiders. One elder once explained to me that in town they are Muslims and in the bush they are Gabbra. Their traditional culture, which for some centuries has been their ideological stronghold against Islam, is itself in many aspects reminiscent of Islam. Some such similarities may predate Islam (Jensen 1960: 101f.), others be due to either of the two periods in which Islam florished in the southern Horn (Schlee 1985a). The Gabbra Malba in their vast majority still resist conversion to a modern world religion, although they are exposed to some social pressure of the type Baxter (1966a) has described for the Isiolo Boran, and Christian missions, starting with the destitute as they do among the Rendille (Schlee 1982), try to get a foothold in their midst.

The Gabbra Miigo perform periodic rituals on a mountain called Hees in the Borena Awraja, Sidamo Administrative Region, Ethiopia. The holy sites of the Gabbra Malbe, mountains and craters, are mostly in the Arero Awraja of Sidamo or in the Gemu Gofa Region. Fewer sites of minor importance are on the Kenyan side of the border. Of the five phratries ("drums") of the Gabbra Malbe, Gaar, Galbo, Alganna and Odoola have their own holy sites, while Sharbana shares those of Alganna. The Gabbra Malbe perform pilgrimages or mass migrations to these sites at points of times determined by a combination of solar and lunar cycles of their calendar. It has to be in an appropriate month of a given year in the seven-year-cycle, in the case of the Gaar phratry a Thursday-year, in the case of all others the subsequent Friday-year, normally after two or three such cycles, i.e. once in 14 or 21 years. These pilgrimages are closely connected with age-set promotions which take place on these journeys. In the Friday year 1986 I have joined the ritual journey of the Galbo phratry, a migration which comprised 140 households with thousands of camels and large flocks of smallstock.

Due to its association with clan origin myths and the spirit being which is believed to inhabit it, the Mountain Farole on the Kenyan/Ethiopian border is of special importance as a ritual site. During the pilgrimage a female sheep has to be sacrifieced on top of it and the nanesa ceremony, a large communal festival, is perfomed on the northern (Ethiopian) part of its base cone.

The laf Farole, the country of Farole, comprises the mountain itself and its case cone which consits of red earth. Its boundary is marked by the sharp transition from the red earth to the grey earth of the surrounding plain. Within this holy area it is by tradition forbidden to hunt and no plants or parts of plants may be removed from it; even a fibrous twig used as a toothbush has to be thrown away before one leaves laf Farole and therefore no herding sticks or tent poles are cut there. The only wood cut for house building is that used by the small trading community of the Kampi Farole to which no restriction applies because it is still situated on the red soil. It is further forbidden to swear or talk indecently within this area. This rule is, of course, honoured by the breach by women scoulding their children and in many other situations, but it is also often heard as an admonishment.

Due to demographic pressure in the Ethiopian highlands a number of Boran had moved to the northern part of the base cone who had not been there during the last pilgrimage in 1972. These Boran had tried hoe cultivation of maize and kept cattle. The Gabbra sent a delegation to these Boran, telling them to leave their fields and settlements and to move away from the general area, because the small water ponds among the rocks half way up the mountain would not be sufficient for both population groups. The Gabbra do not use such pockets of water on the inselbergs for large stock; they take their camels to the crater lake of Magado 30 km NE of Farole. The water would be sufficient only for people and occasionally also for smallstock which, when possible, was driven to Magado, too. The Boran, however, used this water for their cattle which drink large quantities of water at frequent intervals and cannot walk to distant water points as camels do. Apart from the threatening water shortage the Boran were made aware of their ritual undesirability. Especially in a jila year, they were told, the holy ground should not be polluted by their presence.

The Boran were not that easy to chase away. They had automatic weapons which always give them an advantage over their neighbours from Kenya, where the possession of arms is more effectively restricted. (At the Sudanese and Somali boundaries similar desequilibria have developed.) They also had a notion of statehood and how it could be used to their advantage; their first reaction to the Gabbra demands was to ask them for their residence permit in Ethiopia. (A very small fraction of the Galbo in question usually lived in Ethiopia, the bulk of them had Kenyan identity cards.) The Gabbra showed them a letter from the DC, Marsabait, which had no legal force in Ethiopia but which was accepted with respect by the Boran, mainly because they could not read it.

The threat of a collective curse by the Gabbra made many of the Boran move. One of the remaining Boran later, when the Gabbra had crowded them away from the pockets of water in the rocks, fell to death when looking for natural cisterns higher up on the mountain: an event attributed to divine interference.

The Boran occupation, however, had already left traces: The vegetation cover had changed in its composition and certain plants of ritual importance were difficult to obtain. Also other characteristics of the area had changed: Due to the traditional prohibition to hunt, it used to be rich in game. Now the absence of conspicuous large species like giraffe and rhinoceros was also blamed on the Boran who had profaned the laf Farole by hunting. That the Boran are spoiling the area was a frequent comment on any changes which could be observed.

Events like this migration show some features of nomadic land use which may be relevant to policy making:

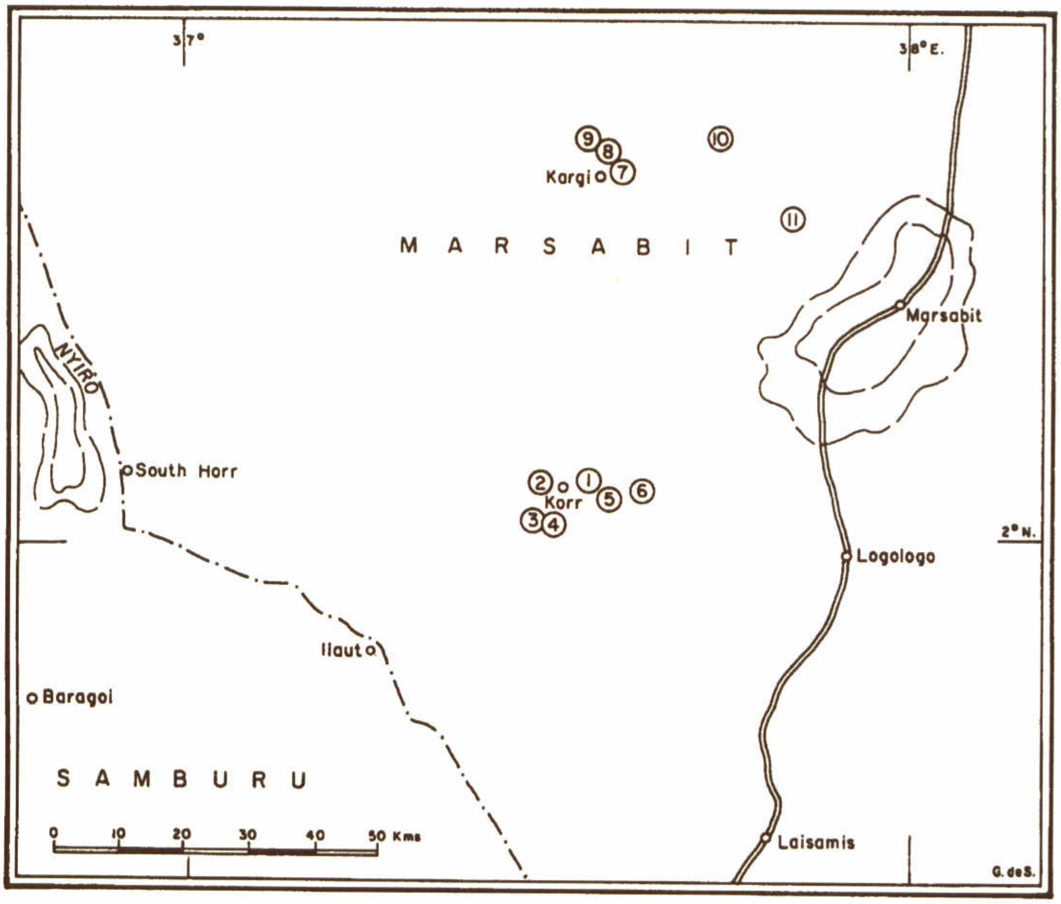
- Ecological conservationism which may be due to religious beliefs and aims at the protection of areas regarded as holy, beneficial as such an attitude may be also from the point of view of the State, cannot be maintained if other occupants than those sharing these beliefs are not made to respect the restictions in the utilisation of such areas.
- The Gabbra use of the territory in question is intermittent; a feature characteristic of nomadic land use in general. The periodic absence, which can easily last 14 or 21 years, invites competing land claims. Also such intermittent forms of use need to be protected for religious and economic/ecological reasons.
- The penetration of modern statehood in formerly uncontrolled lands is another factor which endangers future migrations across the Kenyan/Ethiopian boundary. Nascent national identities in Africa often seem to require the enforcement of boundaries at high expenses and without economic justification while boundaries between nations with more firmly established identities tend to lose importance, like e.g. in western Europe. Ways have to be sought to keep the borders open to the nomadic movements of local populations. Otherwise ethnic identities would be split, family ties severed, forms of worship interfered with and nomadic routes closed with the resulting underutilization of border areas.

A Rendille example: communal circumcisions and the gaalgulamme ('camel stampede')

While Gabbra circumcisions are performed individually or in small groups before the age-set promotions into the luba (young mature men, warriors) grade, Rendille age-sets are constituted once in fourteen years by large communal circumcisions which take place in settlements which comprise ideally one entire clan each.

Although ideally Rendille settlements comprise the clan after which they are named, D'ubsahai being the clan settlement of D'ubsahai, Rengumo the one of Rengumo etc., in practice most Rendille settlements comprise more than one clan.

Affines might decide to stay near the parental families of their wives even longer than they are required to do so by custom, others might prefer to stay with their friends in the clan settlements of the latter rather than staying in their own clans where personal relationships are encumbered with incompatible tempers or fraternal strife about property. In addition to comprising members of more than one clan in normal times Rendille settlements never comprise one entire clan. Although Rendille settlements tend to be much larger than those of the Samburu or Gabbra (with the exception, of course, of a phratry which goes on a jila journey, cf. above), there are often four, five or more settlements the bulk of which consists of the members of one clan, so that they are named after that clan. To specify which particular settlement one means one would then add the lineage name of one influential



MAP NO VI/1

⑤ Settlements (for description see text)

—·— District boundaries

elder to the clan name, like Saale goob Sono, 'Saale, the settlement of Sono'.

For the discussion of movements motivated by the circumcision, I shall single out the clan Gaaldeilan, neither the largest nor the smallest Rendille clan. I start with a house census and description of the spatial distribution of this clan at the time of writing (Sept. 1988) in order to illustrate:

- the size of the clan (there has been demographic growth since 1979 and new households have been founded by marriages)
- the varition of size of the constituent settlement groups,
- the widely dispersed settlement pattern of this clan at a time when there were no special ritual occasions.

The numbers of the settlements correspond to the numbers on map VI/1:

1. Gaaldeilan goob Adicharreh
2 km north of Korr-Mission, 20 houses

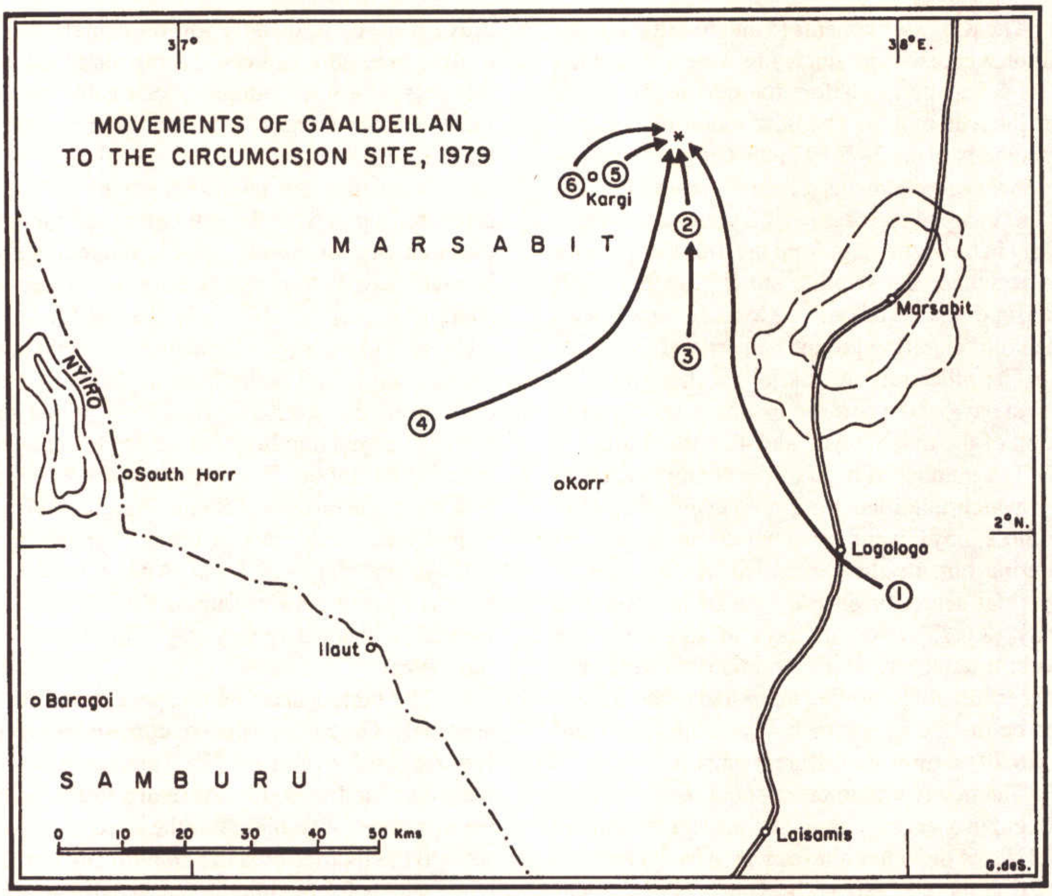
2. Gaaldeilan goob Suda
2 km west of Korr-Borondadi, 10 houses

3. Gaaldeilan goob Toordeer
west of Halisisruwa, 4 km from Korr, 11 houses

4. Minan Farre, the houses of Farre, Elemo
west of Halisiruwa, 2 km from Korr, 7 houses

5. Gaaldeilan goob Elemo
in the lava fields above Korr, 6 km east of Korr, 14 houses

6. Gaaldeilan goob Tomboya
13 km east of Korr, 31 houses



MAP NO VI/2

⑥ Settlements (for descriptions see text)

* Circumcision site

—·— District boundaries

7. Gaaldeilan goob Eisimfeecha
2 km east of Kargi, 11 houses

8. Gaaldeilan goob Keele
2 km north of Kargi, 29 houses

9. Goob Elemo ki Kargi
near no.8, 28 houses

10. Gaaldeilan goob Keele (Siilo)
6 km east of Bagasi, 6 houses

11. Gaaldeilan goob Tarwen
Karsigela, a trader near the Kargi-Marsabit road, 20 houses

Before the last circumcisions, which were held in 1979, the clan Gaaldeilan settled in a different, but similarly dispersed configuration. The whole clan then combined into one big cluster of several rings of houses near the Bagasi waterhole some 20 km north-east of Kargi. The choice of this location was determined its good pasture (it had not been occupied recently), the waterhole which provided enough water for the settlement while the stock could be driven to nearby Korolle, the accessibility by road (it was on the Kargi-Marsabit road) and the presence of streches of level ground which were relatively free of lava boulders and provided suitable settlement sites. The movements of 1979 are shown on map VI/2. The numbers of this map stand for:

1. Goob Tomboya, 9m east of Logologo
2. Goob Eisimfeecha at Korongab
3. Goob Narugo on Durr, west of Burgacha
4. Goob Elemo (with Madacho), Chalgo
5. Goob Keele, Kargi
6. Goob Tarwen, Kargi

The Kargi settlements (5 and 6) settled in the position where the circumcisions were to be held in the moonless period before the new moon of the first Sondeer month. The new moon of Sondeer corresponds to the 28.5.79 in the Gregorian calendar. As these settlements joined the position of the satellite camp of their camels, all their camels were present in the settlement from the time the new site was occupied: the satellite stock plus the milch herds for domastic use and the loading camels with which the migrating groups had arrived.

The other settlements joined them there in the first days of the new moon: nos. 1 and 3 on the second of the moon, nos 2 and 4 on the fourth.

The number of boys of the combined settlement which qualified for circumcision was 101. All these boys were circumcised in a hectical gathering outside the settlement in the order of segmental seniority on the 12th of the moon, a Friday (8.6.79). Not all days of the week are ritually suitable and so the circumcisers were very busy because all Rendille youths had to be circumcised before the full moon between the 2.6.79 and the 9.6.79 on only six different days.

The newly circumcised spent the following fortnight in a large communal house built form the materials of the other houses which in the process were slightly reduced in size. The days were spent in a large shade built of thorn branches right next to the house. It is considered a propitious sign for the prospering of the age-set that now, nine years later, the twigs (dolo = Euphorbia triaculeata, yahar = Aloe sp., hangiya = ?) which were stuck into the ground under this dome of branches have grown into well developed trees.

The newly initiated warriors during this period of reconvalescence go out to hunt birds with bows and blunt arrows. They dangle their victims from their beaded headgears. The importance attributed to traditional circumcision and the associated rituals is illustrated by the fact that migrant workers who had not been seen for years returned for this occasion from Nairobi and elsewhere in order to undergo these rituals.

All camels remained in the settlement also for the following second Sondeer month, because the browse was still abundant and because sorio sacrificial ceremonies, which also serve the well-being of the camels and at which the camels therefore need to be present, are held in both Sondeer months.

The relatively small herds of cattle also stayed in the settlement while all the warriors were there. Later they moved into satellite camps independently of the camels. The Rendille have a proverb 'the cattle do not know the camels', i.e. it is useless to inquire in a cattle camp about the whereabouts of camel camps, because the requirements of the two species are so different that the herds rarely meet.

After that, the satellite herds of the camels separated again from the settlement and moved to the area east of Bubisa were arrangements had been made with the local Gabbra for the peaceful sharing of pastures. Not only the Gaaldeilan camels went to that area where there had been plenty of rain, but camel herds from all Rendille clans, even from the Korr and Ilaut area joined them there. The total number of these camels may have been about 15000. These camels stayed around Bubisa for the months of Soom, Furám, and Harrafa and then came back in the settlements to the sorio in the month of Daga. After this sorio the camels from the Kargi-Bagasi-Korolle area went back to Bubisa where they stayed until the second rains (yer).

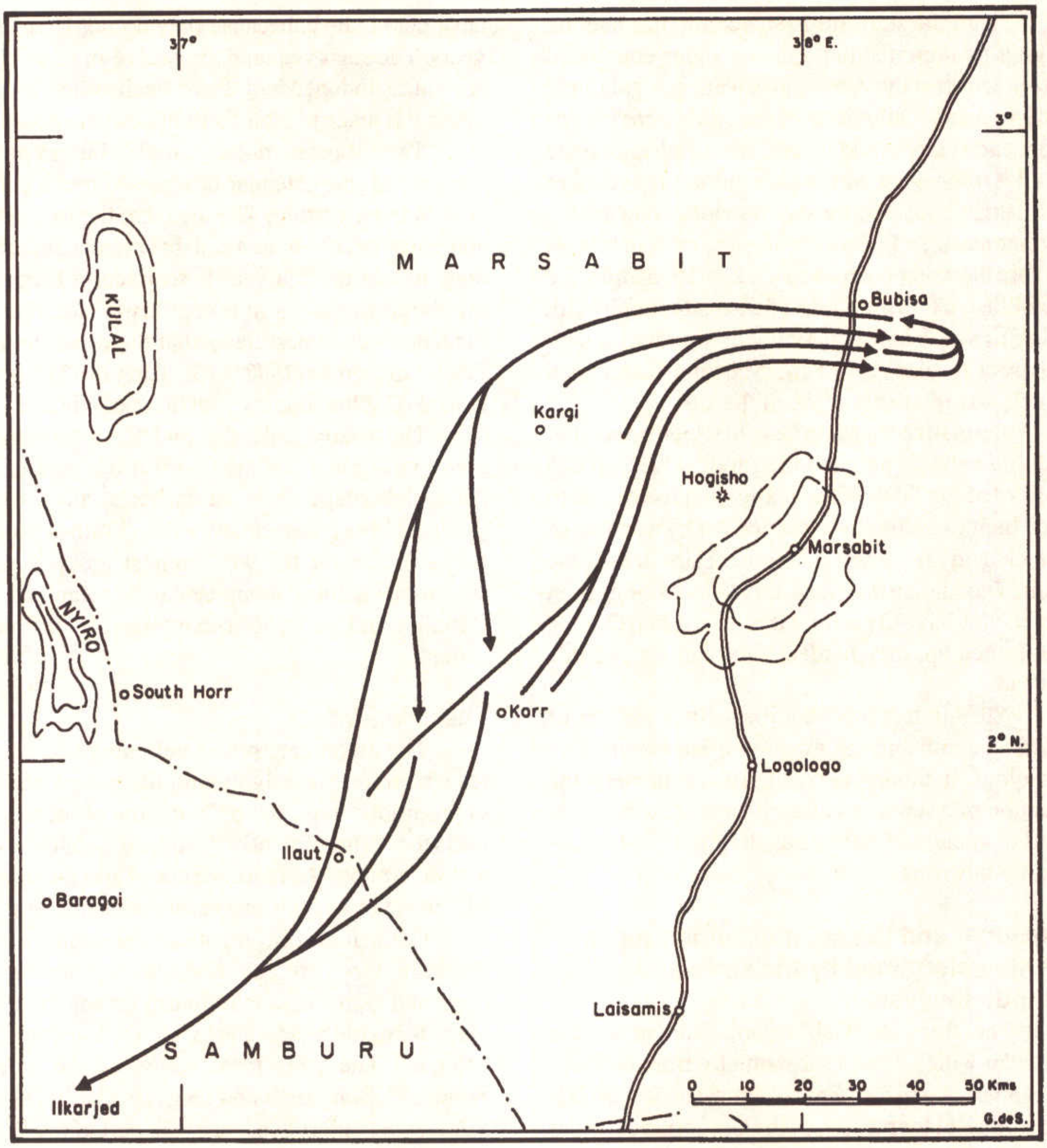
The period these herds spent in the Bubisa area in the Gregorian calendar corresponds roughly to August-November 1979. The camels from the Korr and Ilaut area did not return to the heavily used pastures of Bubisa after the sorio in Daga but went to the Ilkarjed area in Samburu District. That name stands for the middle reaches of the Malgis (Parsaloi) seasonal river after its descent from the Leroghi Plateau, i.e. the area NE of the twon of Parsaloi (Barsaloi). These migrations of the camel camps are depicted on map VI/3.

The same pattern of contraction into one single large settlement cluster which has been illustrated by the example of the clan Gaaldeilan can be shown for most other clans.

In the Saturday year which follows the Friday year of the circumcisions, the Rendille hold the gaalgulamme ceremony. This ceremony has been discussed in the anthropological literature: (Spencer (1973: 46f; Schlee 1979: 161f, 224ff, 245). Schlee (1979) elaborates on the settlement order of the clans which gather on the gaalgulamme site and Schlee (1989, chap. 4) discusses the role of this ceremony in the working of the age-set system.

In the following description , like above in the discussion of the circumcisions, the focus is placed on the effect this ceremony has on the movements of people and stock.

Traditionally, the Rendille held the gaalgulamme on the eastern shores of Lake Turkana. Unlike the circumcision settlements, where more proximity is the motive of gathering and several rings of houses form a cluster, at the gaalgulamme site ideally all Rendille form one giant ring of



MAP NO VI/3

houses in clockwise order of seniority starting in the west. Such settlements may have had a diametre of 2 km. Chorr, as the Rendille call the area north of Mt. Kulal and east of Lake Turkana, was chosen as the site because one of the rituals constituting this ceremony was a bath in the lake. All camels should be present for two reasons: first, because no Rendille age-set rituals are carried out without the camels being fenced in close to the site or all around the site of the ritual (in contrast to the Samburu and Ariaal stile ilmugit sacrifices), second, because some of the gaalgulamme rituals involve driving camels, as the name of the occasion implies (gaalgulamme means 'camel stampede').

One rule concerning the gaalgulamme is that no iron weapons, neither spears nor swords, should be taken to the site. The warriors only take their ritual sticks (gumo). In 1980 the Chorr area was considered unsafe because of the Turkana threat which was aggravated by the rule not to take weapons along. The requirement that a bath should be taken in Lake Turkana was therefore reconsidered and it was said that the important aspect of it was that the warriors should wash themselves with water from a source that never dries up (tehim ti iiguin). The Sokorte wells on Mt. Marsabit were thus accepted as a replacement. The Rendille gathered at Bur Gaalgarawah west of Hogisho (map 3) on the western slopes of the Marsabit highlands and the warriors went from there to Sokorte to wash themselves.

From the start the 1980 ceremonies had the stigma of imperfection and one elder concluded afterwards that the ceremonies were gaalgulamme only in name. Only parts of the settlement groups from each clan turned up and from Nahagan none at all. Of the segments which did not move there with their houses only the warriors went to the ceremonial site. Because of the low ratio of houses (where the water containers are kept) to people, the Rendille ran into problems of adequate supply with drinking water and a government lorry with a tank was sent to that part of the Marsabit-Kargi road which was relatively close to the site.

A ritualized herding task, in which one camel bull, four she-camels and their four calves have to be herded for a day without allowing the calves to suck their dams has to be carried out by warriors of one clan on the camels of another clan. In the case of the Gaaldeilan warriors, it is Odoola camels on which they have to perform this task. As no Odoola had turned up, they herded some camels ot Saale instead.

All this left the Rendille with a feeling of dissatisfaction and the function often ascribed by sociological theory to such rituals, namely the creation of a sense of solidarity and the strengthening of social cohesion, was definitely not achieved by this ritual.

The lunar and the solar calendar: movements determined by the sorio and almodo festivals

The Rendille, Gabbra and Sakuye have a calendar which differs substantially from both our Gregorian calendar and the Islamic calendar. While the empirical foundation of the Gregorian calendar is the observation of the sun, through which the length of the solar year is determined , which is then divided in twelve artificial subunits which are called months although they have nothing to do with the moon, the Muslim calendar goes the opposite way by observing only the moon and ignoring the sun totally: in the Muslim calendar a cycle of twelve empirical months is simply called a year, although such a cycle is about eleven days shorter than a solar year and therefore shifts through the seasons. The Rendille, Gabbra and Sakuye do not follow neither the Gregorian nor the Muslim way of reckoning: they do have a sequence of twelve empirical months, each of which has a name, but they do not refer to such a cycle as a "year". They know that a solar year is longer than twelve months: the Gabbra count 365 days from one new-year ceremony to the next, and thus diverge from the Gregorian calendar only by 25 days per century, because they do not have leap-years. The solar year and the twelve-months-cycle are quite independent from each other and no attempt is made to establish a link between the two.

This appears rather simple, but improper analysis of this calendar has caused much confusion in the literature. The idea that the two cycles somehow have to match and that months somehow have to add up to a year is so fixed in European minds that Spencer - quite contrary to the empirical evidence - even postulates that the Rendille must have leap months (1973: 123). Torry (1973) simply equates Gabbra months with those of our calendar.

The shared calendar and the similarity of many customs associated with it are part of the cultural heritage from an earlier stratum which Schlee (1985) has called PRS (Proto-Rendille-Somali) because the westernmost group, among whom this cultural complex can be found, are the Rendille and its eastern extreme certain Somali groups.

The lunar cycle

The moon determines not only different dates which recur everly month, like propitious and unpropitious days, but by being the observational basis for the unrolment of the twelve-months-cycle also determines the reoccurrence of special months, like those in which sorio ceremonies are held.

Of the four sorio sacrificial ceremonies of the Rendille, three are common also to Gabbra, Sakuye and Garre while the fourth (in the month of Harrafa) might have some link to the Muslim ritual calendar. The other three sorios, in the months Sondeer I, Sondeer II and Daga (in Gabbra usage: Somdeera I and II and Yaga) are part of the Proto-Rendille-Somali culture.

Wherever a sorio or any other important ritual happens, the camels should be present and in their enclosures, even if this means that they cannot go to pasture for hours. There can be no sorio without camels, ad no properly handled camels without sorio.

Among the Ariaal, irrespective of their ethnic origin (Samburu or Rendille) and their language, those groups that keep camels perform sorio, and those who have cattle and smallstock only, see no necessity to do so. A man may have one wife in a camel settlement and slaughter sorio in front of her house, and another wife in a cattle settlement, where he does not perfom this custom.

Seen from outside the cultural system, from the prespective of livestock management, the most important question which arises in connection with the sorio sacrificial ceremonies is, of course, which movements of people and herds are caused by these rituals. (The nomads themselves would not share this perspective. They think that their herds would dwindle if no proper sorio ceremonies were held for them and thus regard the rituals themselves as important aspects o their livestock management.)

For the sorios of the months Sondeer I, Sondeer II and Daga all camels must be present in the settlements. (For their additional sorio in the month of Harrafa the Rendille drop this requirement.) This implies that the satellite camps, in which most of the camels are kept most of the time, must join the main encampments at least on these occasion. The movements of the satellite herds thus acquire a cyclic character to and from the settlements. This does not limit the range in which the camels can graze or browse, because camel herds can walk far distances and can reach any part ot the available territory around the settlements, because the period during which the camels have to spend the nights in the enclosures of the settlements can be kept rather short.

The rule is that the camels should be present at the time of the sacrifice, i.e. the ninth or tenth of the moon depending on the moiety affiliation of the settlement, and should stay there for an even number of days, at least four. The herds can thus move on the fourteenth or fifteenth of the moon respectively, at the earliest.

If the vegetation around the settlements is inadequate, the camels can be taken up to 20 km to better pastures every day, which is far from ideal because of the high energy expenses it involves, but which would not harm the camels because of the brevity of the period involved. The cyclic character of the camel camp migrations caused by the sorios does, however, have an effect on where the camel camps are situated in the course of a year. If a camel camp, which has used the pastures in the extreme reaches of the Rendille territory or in neighbouring districts, joins the settlement, which is typically situated in a more central part, for sorio, it might be decided that after the stay there it moves on in a different or opposite direction instead of returning to its former whereabouts.

We have described one such movement above in connection with the circumcisions, where the camel camps from the Korr area, after joining the settlements from their pastures east of Bubisa, over one hundred kilometers to the north-east, for the sorio in the month of Daga, after the ceremonies left in the opposite direction and went to Ilkarjed in the centre of the Samburu District.

Almado and related ceremonies which mark the solar year

Quite independently from the cycle of twelve empirical months the Rendille, Gabbra, Sakuye and various Somali groups calculate and mark the solar year.

Odoola differ from the other parts of Rendille and Gabbra in the customs concerning the solar year. They kindle the dab Odoola (R), ibid Odoola (B), i.e. the fire of Odoola to mark the beginning of the autumn rains. Customs involving fire to mark some point of the solar cycle are widespread. Cerulli describes the dab-shid as a general Somali feature (1957, I:186).

In the case of Odoola the fire ceremony is only an addition to a similar ceremony they share with the other Rendille, Gabbra, Sakuye and Garre: almodo (R), almado (B). While the Rendille rules for the timing of almodo are constructed in a way to ajust it very closely to the solar year in the long term average, if these rules were followed strictly and almodo held on the earliest date permitted by these rules; but in practice the Rendille tend to postpone almodo for all possible reasons and different clans even have almodo at different times and in fuller or abbreviated versions. We may thus conclude that the Rendille almodo was at one time meant to be timed according to the solar year and is now cut of step. More rigidity is applied by the Gabbra who space their almodo ceremonies exactly 365 days from each other.

The fire of Odoola would precede almodo in the following way: After three seasons of 100, 100 and 66 days have been counted, the three fires of Odoola are burned in a period of two weeks. After the last of these fires exactly 10 weeks are counted to the beginning of almodo which ends 15 days later. (Tablino 1980:82) As the whole cycle lasts 365 days, i.e. 52 weeks and a day, almodo would always be concluded on the day of the wek which follows the day of the week of last year's almodo. A link is thus established between the seven-year cycle and the days of the week: a Monday year would start with a Monday, a Tuesday year with a Tuesday, etc. This, of course, makes it possible to determine the recurrence of any solar date in the following year without counting days. One simply waits for the recurrence of the lunar date in the following year, knowing that the solar date one wishes to determine will be in second week after that on the day of the week following its day of the week in the last year.

Descriptions of the chronological course of events at an almodo festival and the manifold social and religious dimensions accentuated by its rich symbolism are given for the Gabbra by Venturino (1974:60-62), and for the Rendille by Schlee (1979:1O8-27).

Again, like in the discussion of the sorio, above, we here omit the details of the ceremony itself (cf. fuller version of this report) which consist of ritual ablutions of female sheep, communal milk drinking, ceremonial gates through which the herds are driven and fires. We rather concentrate on the effects almodo has on the movements of herds and people.

The pull effect the almodo exerts on the satellite herds is much weaker than that going out from the sorio. There is no rule that all satellite herd camels should join the settlement for almodo, although, of course, one needs milk for the libations and the ritualized drinking, and some camels should be present to be driven through the gate. The presence of camels at an almodo ceremony can therefore be kept to a minimum if the conditions require so (if, e.g., the satellite camp is far away and water and grazing near the settlement inadequate).

Whenever possible, all smallstock should be in the settlement, but if that cannot be achieved, also this requirement can be minimalized: one would fetch only one female sheep per house for the milk ablutions and two such sheep to be tied to the gate.

Rendille also shave their heads at almodo and as a rule a settlement should not move on while the scalps of the men are still bare. One should wait for about one month, a period which can be reduced to c. two weeks if the need to move a settlement is very urgent, like in the case of water shortage.

During the period a settlement is at the almodo position, no livestock and no items belonging to the household should be given away. This restriction is only lifted when the settlement moves to a new site. This rule is honoured in the breach by impoverished Rendille who have become sedentarized around the Mission stations: as they stay all year round in the same spot, they would live in a permanent state of almodo restrictions if they still followed these rules.

RESPONSE TO ECOLOGICAL CONSTRAINTS: MIGRATIONS OF THE SATELLITE CAMPS

Among the Rendille a common lament of the elders and women left together with the children in the settlements is that "our livestock has moved far away from us!" This lament can be heard more often the more the dry season advances. Then the camels are all in satellite camps, where they are herded by the boys and warriors, and also the smallstock can be driven 100 or 200 km away and be herded there by a labour force that in addition to some elders, boys and warriors consists largely of girls. When asked where the livestock is, the respondents often give very far locations: once substantial herds of cattle (by Rendille standards) were taken all through Samburu District into West Pokot, at other times Rendille herds intermingled with those of the Dasanech who live in the Ethiopian borderland at the northern end of Lake Turkana.

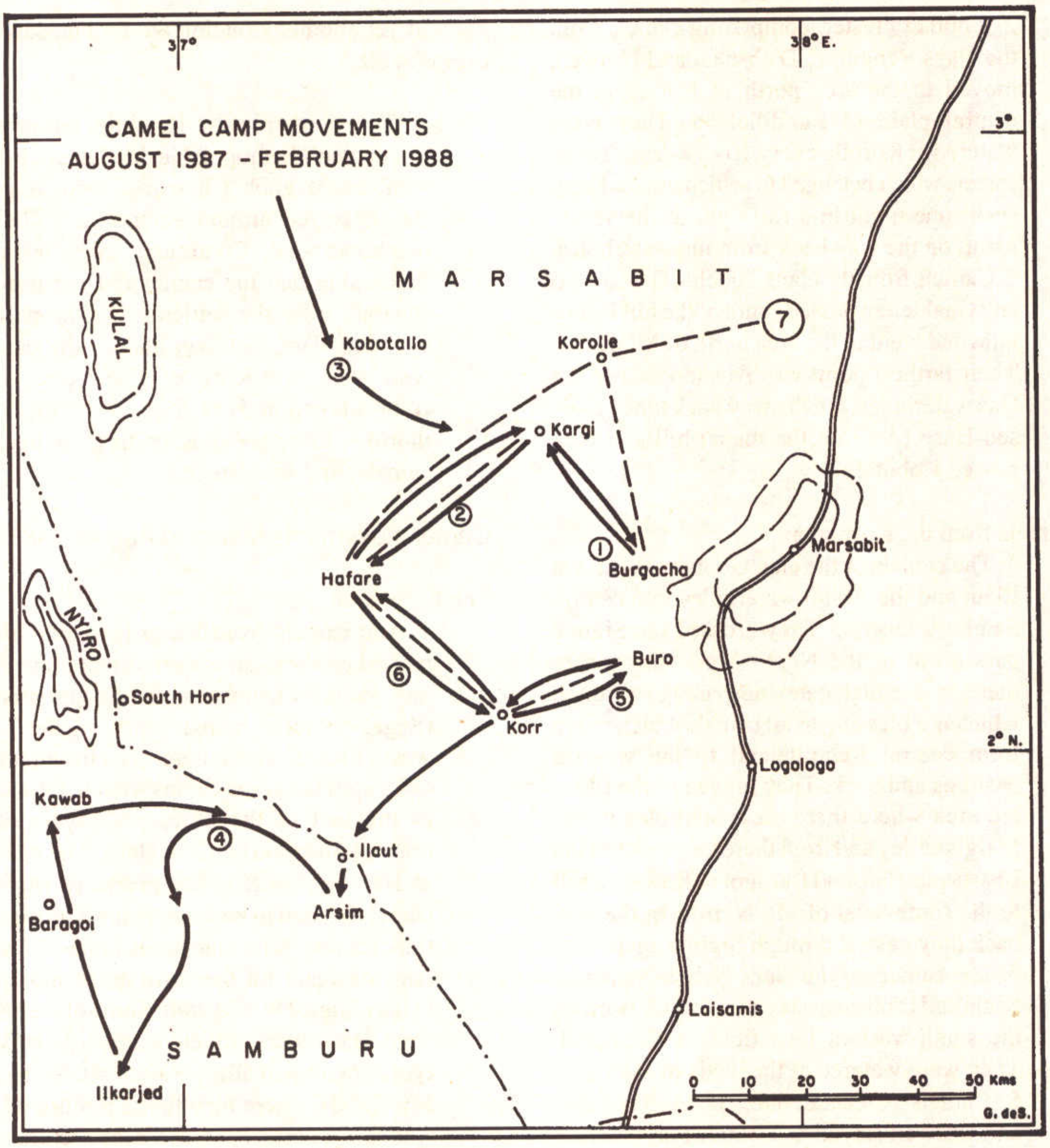
In describing such movements, one is tempted to select the most conspicuous and longest migrations. That might evoke the criticism that such extremes are rare and of little value to planners. It might also be said that some of those movements have taken place some years ago and that in the meantime the radius of herd movements may have become shorter. Some systematic sampling is therefore required. The movements which are described below all have taken place between September 1987 and August 1988, and I have taken care to record all movements of major contingents of camels and smallstock, the longer ones and the shorter ones and those cases in which stock was kept in the settlement all the time rather than being taken to satellite camps because the settlement itself had moved to good pasture.

Here the question arises whether this year can be taken as representative or not. As far as the distances involved are concerned, it can be said that the period in question was not particularly harsh as far as rainfall is concerned and therefore no conspicuous increase in long distance movements to avoid drought conditions occurred.

Does this mean that the movements recorded for this year represent patterns which can be generalised for other years? One caution is necessary: nomadism in northern Kenya due to the irregular local distribution of the scattered rainfalls is not of a transhumant or otherwise patterned type but can be termed opportunistic: one goes wherever conditions are best. There are general tendencies to move to higher ground, also in neighbouring districts in the dry season and to move closer to roads and markets when one wants to sell, but these are tendencies and not strict patterns.

The following examples therefore describe options which need to be kept open and reasons for particular movements rather than fixed routes.

As the camels have to join the settlements for the sorio celebrations, this period can, as far as camels are concerned, be subdivided in the span between the sorio in the month of Daga (August



MAP NO VI/4

Movement of camel camps
Regular movements to and from water
⑥ Routes (for description see text)
District boundaries

1987) and the sorio in the month of Sondeer I (February 1988) and (neglecting the one month between Sondeer I and Sondeer II) the span between the sorio in Sondeer (March 1988) and the sorio in Daga (August 1988).

Camel movements August 1987 - February 1988

The migrating units (mostly clusters of satellite camps from different clans) are numbered and the numbers correspond to those on map VI/4: Camels from settlements around Kargi and the lava fields east of Kargi:

1. One cluster of satellite camps stayed near the hill Burgacha on the western slopes of Marsabit. From there the camels were taken regularly to the Korolle waterholes (dotted line), because the pasture was dry.

2. Another cluster, comprising camels from the clans Rengumo, D'ubsahai and Urawen, moved to the area north of Hafaré in the central plain of Rendilleland. They were watered at Korolle every 10 - 14 days. Those camels which belonged to settlements at Kargi spent one night in a fortnight in the settlement, on the way back from the waterholes.
3. Camels from the clans Tubcha, Gaabanayó and Gaaldeilan passed south of the hill Kobotallo and went to the area north of Mt. Kulal. Their farthest point was Alwano east of the Gas waterholes. On the way back tghey crossed Hasé (Asie on the maps) hill and then passed Kobotallo.

Camels from the Korr area:

4. The camels of the clan Gooborre went via Illaut and the Arsim waterholes into central Samburu District. They crossed the Siginte pass north of the Ndoto Mountains where there is a ritual gate the passage through which is a blessing to all camels which move from central Rendilleland to the western pastures and back. They moved to the Ilkarjed area where there are waterholes in the Malgis valley and from there they crossed the Lbarta plain around Barogoi to Kawab, a hill to the south-west of Mt. Nyiro. On the way back they passed through Siginte again.
5. The camels of the clans Nebei, Nahagán, Saale and D'ubsahai stayed at the hill Buro on the south-western lava fields of Marsabit. They were watered at the wells of Korr.
6. Camels of Gaaldeilan, Saale, Rengumo and Urawen stayed at Hafaré. For watering these camels were divided: those without young calves were taken to Korolle, while the lactating she-camels were taken to Korr, although watering there is an arduous task, because the distance to Korr was shorter and the dams could thus rejoin their calves, which were left behind in the enclosures, sooner.

In the case of the clusters 1, 2, 5 and 6 we find relatively stable satellite camps from which the camels are taken to distant wells and waterholes at regular intervals. To calculate the total distance walked by the camels one would have to add all these movements to and from the water to the migration from the settlement to the satellite camp and back. The clusters 3 and 4 were more peripatetic; they moved from waterhole to waterhole building new enclosures at every site rather than oscillating to and from the old enclusures.

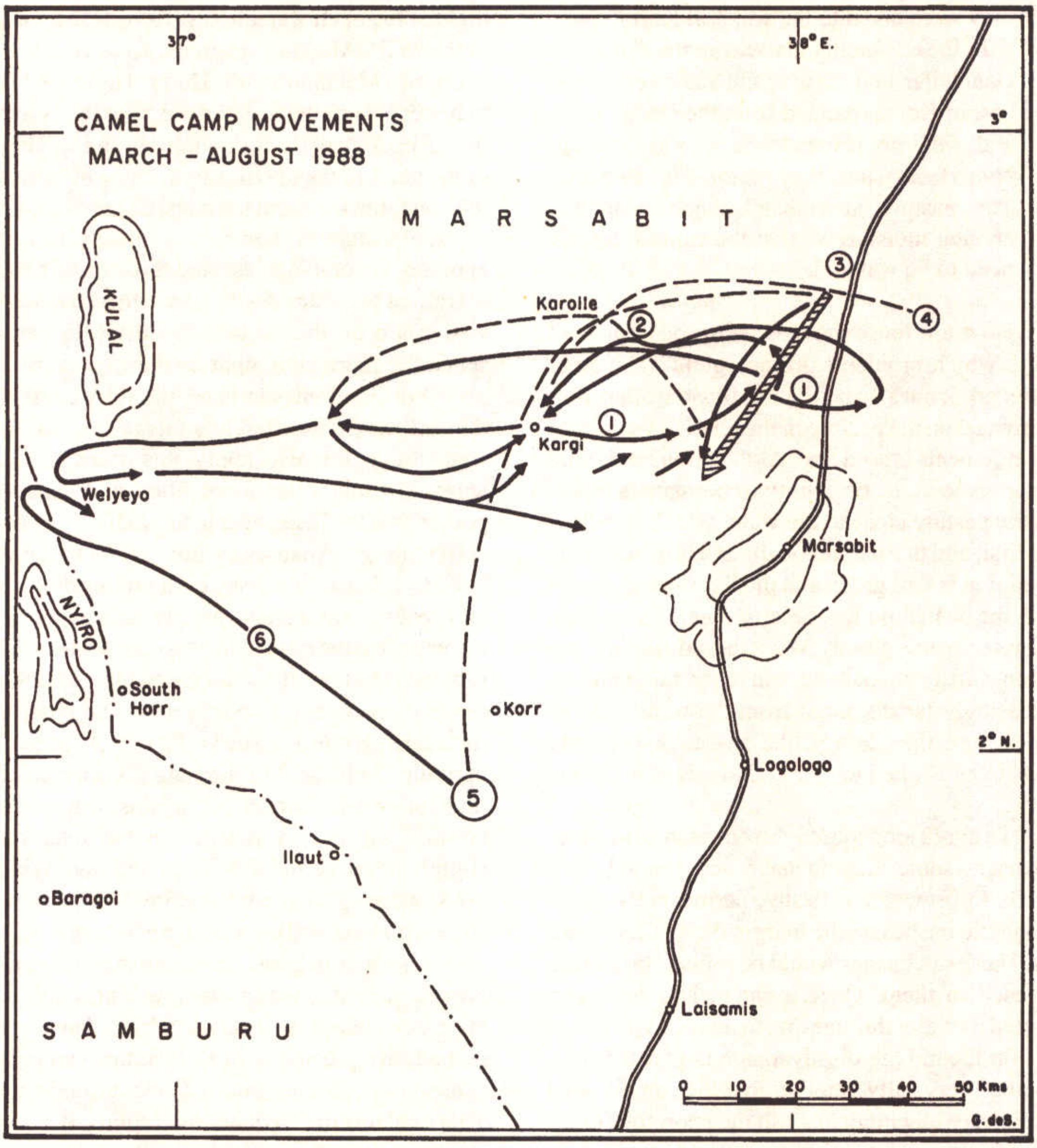
In yet another situation we find no satellite camps at all:

7. The northernmost Rendille settlements (Saale goob Kimogol, Gaaldeilan goob Tarwen, Saale goob Chorrodo, Odoola goob Ballo) stayed around Bubisa in a Gabbra neighbourhood. Conditions there were so favourable that the camels did not need to separate from the settlements. The pasture was abundant, but dry, and so the camels were watered at Korolle. (The access to the Bubisa borehole is restrictived by local authorities to households (with their loading camels) and smallstock.)

Camel movements March to August 1988

The Kargi area

1. The camels from Kargi (see map VI/5) moved partly in an eastern direction to Kallam and Gas Ogor near the Shegel airstrip (Segel on some maps), partly to the plain west of Kargi, Haro. Later the cluster at Gas Ogor split up: some camps went to Orondere to the east of the Marsabit-Moyale road, others joined the herds at Haro. The pasture at Haro was still rather green, so that the camels needed to be taken to the Korolle waterholes only when the herds joined the settlements again for the sorio in the month of Daga (August 9/10, 1988). Some of the herds from Haro were driven westwards to Welyeyo (two small hills between Mt. Nyiro and Mt. Kulal), where they found pasture which was still greener. From there they returned to the Daga sorio.
2. A smaller cluster, the camels of parts of Gaaldeilan and those of Urawen, stayed at Marmar, west of Korolle, where some water had gathered after the April rains, and later went to Bul, east of Korolle.
3. Some of the clan settlements which had been near Bubisa in the April rains started to move south-west towards Karsigela (thick arrow on the map). These settlements comprised Saale goob Komogol, Gaaldeilan goob Tarwen and one settlement of Tubcha. While the settlements took a route on which small water catchments could be found in the rocks which provided enough water for domestic use, the camel camps (thin arrow) took a generally more westerly way, where the pasture was better, but in easy walking distance from the settlements largely parallel to them. The



MAP NO VI/5

camels were watered at Korolle.

4. Saale goob Chorrodo and Odoola goob Ballo stayed in their Gabbra neighbourhoods near Bubisa. The pasture there was so good that the camel herds did not need to separate from the settlements. The camels were watered at Korolle, just like those of their Gabbra neighbours. (Few years earlier the Gabbra would not have dared to take their camels to Korolle.)

5. Most camels of the Korr/Ilaut region stayed either in the settlements or in satellite camps in relative vicinity to the settlements because the April rains had been plentiful and there was no need to go far on the search of pasture. When the vegetation became dry,

they were taken to the water at Korolle.
6. In the advancing dry season the camels of Gaaldeilan and those of the Saale settlement east of Korr separated from the cluster no. 5 and went to Dabandakhano north of Mt. Nyiro from where they returned for the sorio. The pasture at Dabandakhano contained enough moisture so that the camels did not need to be watered.

How are these movements to be explained and to which problems do they point? The large cluster no. 5, but also no. 1 and 2 illustrate that after a rainy season the pasture in the relative vicinity of the settlements is used first. As the settlements tend to aggregate in the proximity of permanent wells, it is the pasture close to the water which is exhausted first, and this paradoxically at a time when the vegetation is still green and the livestock does not need the water points because there is enough moisture in the plants. With the advancing dry season sufficient pasture can only be found in increasingly far distances from the water, and as that pasture then is dry, the livestock regularly needs to be walked longer and longer ways to the water.

To avoid long journeys from pasture to water and back, some Gabbra have accustomed their camels to browse the fleshy, permanently green halophytic bushes on the margin of the Chalbi salt pan. These salt bushes would be refused by camels not used to them. Once a camel has, however, adapted its water through-put to them, it will thrive well on them. One disadvantage is that the milk becomes very salty, another that the camels need water every other day to wash the enormous overdose of salt out of their kidneys. Water, howeve, is not scarce on the fringe of the Chalbi, so that a limited population of camels can actually be supported there. If these camels would be moved to sweet, dry pasture far from the wells they would soon become thirsty because of the salt still accumulated in their bodies and of their habit of drinking much water frequently.

As camels used to sweet pasture would simply refuse to browse on these holophytes, we thus have two separate systems of dry season management with difficulties of transferring animals from one system to the other. The salt-bush strategy, however, because of its disadvantages like the bad taste of the milk, is applied by few herdsmen.

The bulk of Rendille and Gabbra camels in the dry season follows the commuter strategy between far, sweet pasture and water (R: a-fuula, B: oba deema). The camels would typically spend the night at the open water holes (Korolle, Meidahad) or the wells (Maikona, Gamura, Karawe, Kalacha, Woromo, Malabot, North Horr). They would rest to better absorb the water, drink repeatedly and be driven back all of the following day and maybe part of the next. In the grazing area they would browse with appetite for about ten days, depending on how dry the pasture is, and then gradually lose their appetite, become restless and threaten to get lost, searching for water. So they have to be taken to the well again on the twelvth or thirteenth day and spend the fourteenth night by the well again.

For the domestic herd, the milk camels for the settlement, a different strategy is often followed. Some for also apply this strategy. These animals drink water more often and subsist on poorer pasture, being near to the wells. They do not suffer energy expenses by long walks to the well, have to subsist, however, on a poorer diet. Here, both energy intake and energy consumption are lower so that the ratio of the two can be theoretically similar to that of the long distance commuting camels. Practice, however, shows that apart from fortunate exceptions, such milk camels often need periodically be sent to the long distance commuting for and be exchanged against other camels because the energy balance in the long run is slightly negative and they lose condition. Whichever strategy is adopted: the animals either have to cope with long walks or with poor pastures.

One way to break up this dilemma is to move into a different climatic zone. As long south-north migrations like those untertaken by Sudanese camel nomads are precluded in Kenya, this can only be achieved by moving into different altitude zones. This explains the frequent migrations of Rendille stock into the higher parts of Samburu district, where the rains last longer, the vegetation is still moist when it has dried in Marsabit District, and even later when there it has become dry, there are ponds or wells in riverbeds with a sufficiently narrow spacing to make long journeys to water points superfluous.

Another remedy to the above mentioned dilemma that the ways to the water become longer the poorer the pasture becomes, would be to restrict grazing around the water points in the wet season and the months following it by moving away from the herds and the settlements to the remoter pastures (the ones used by the Rendille now at the peak of the dry season). These pastures would then still be green so that the animals would not or only rarely be taken to the wells. After the rainy season ponds in depressions and pockets of water in the rocks are also frequent in the remoter parts so that the settlements and even - if the need arises - the smallstock would find enough water there. The areas around the permanent wells could then be reserved for the dry season. In such a system of management it would not to be expected that the animals lose weight in the dry season, because even in the present situation it is not the quality of the vegetation but the energy expenses needed to cover the long distances to the water which are responsible for losses of weight and life.

If full mobility of the settlements cannot be achieved, another, not optimal but still recommendable, solution would be to restrict the grazing around the wells after the rains to the milk herds needed for domestic use and to confine all satellite herds to remote pastures. The communal actions required for such measures, however, are beyond the organisational potential of the Rendille. Because of the sectionalist and largely acephalous character of Rendille society, authorities which tried to enforce such measures would not be akknowledged. In fact, one of the chiefs at Korr has already made such proposals and has not got far with them, although few Rendille would disagree that in principle what he says is true. But in practice it would to be feared that some segments would ignore the restrictions with impunity and thus reap the benefits procured by the abstinence of others. One should, however, not blame the Rendille for their stubbornness and individualism, because this attitude is generated by their harsh environment and might be adaptive in other circumstances. If the Rendille were a docile people and had obeyed the misconceived colonial grazing policies and had followed all suggestions made to them by foreign experts since Independence, they might have died out by now.

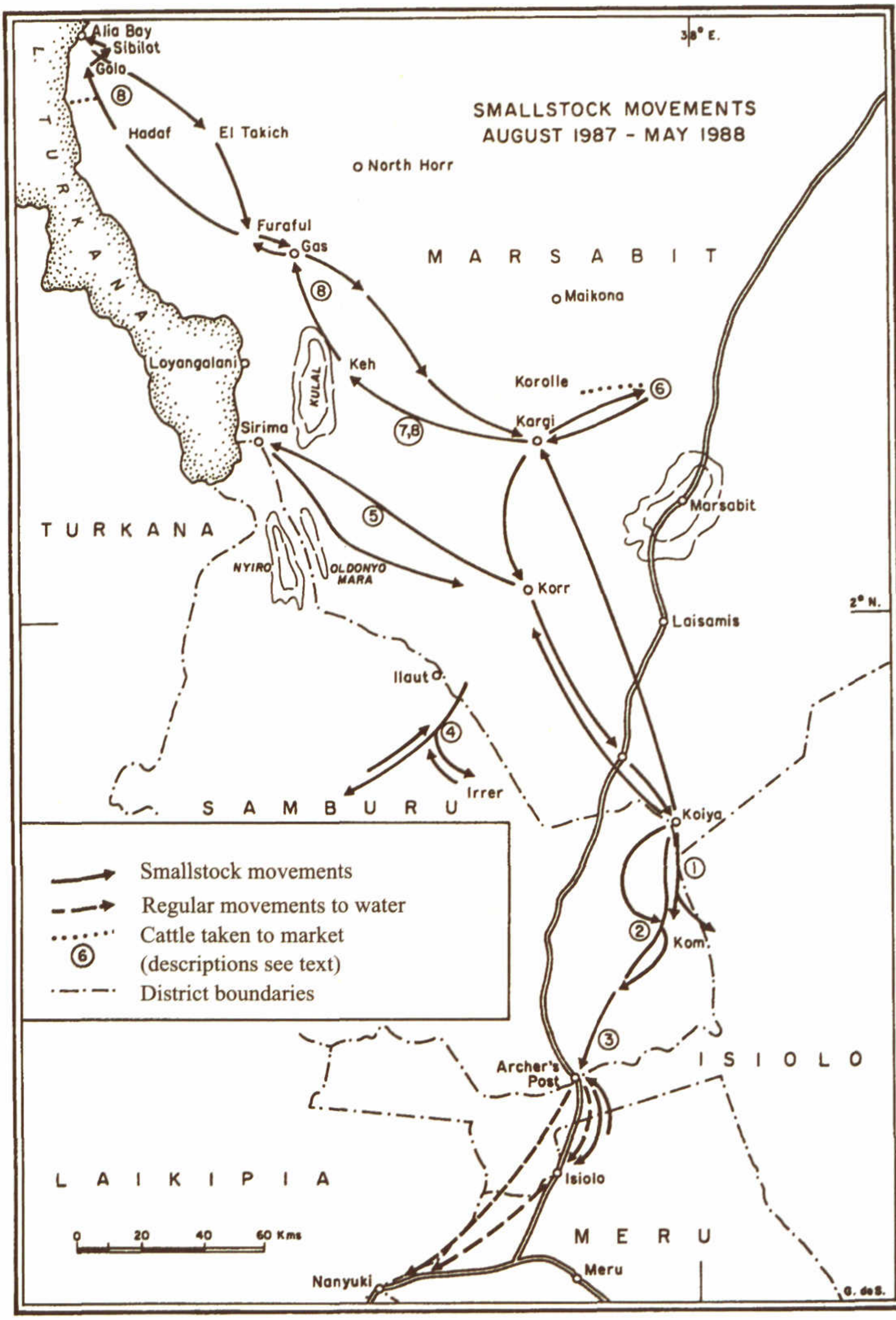
It needs to be stressed that such measures, if the Rendille agreed to them and helped to enforce them, would not reduce the range of pastures needed by the Rendille but only invert the order in which these pastures are used: with the necessary coordination and communal action the outlying pastures could be used first and those close to the wells later.

Smallstock movements

While a satellite herd of camels can opt either for the far range commuter strategy between dry pasture and water point or for moving out of the area into higher altitudes with moister pasture and/or areas with a denser distribution of water points, the smallstock satellite camps only have the second option. They cannot opt for the long distance commuter strategy because, unlike camels, sheep and goats are not able to walk 60 km to the wells and back every fortnight.

This is also illustrated by the smallstock movements in the period September 1987 to May 1988. After the pastures in central Rendilleland had deteriorated, camps moved either to higher pastures or to water points in distant river beds which descend from higher areas. These movements were varied and far reaching, stretching from the Ethiopian borderland to Isiolo (see map VI/6). The period covered by the following descriptions differs from that used for the documentation of camel camp movements (above), because unlike the camels the smallstock did not join the settlements for the sorios in February, March and August. They stayed in the satellite camps until May, when the rains had fallen in central Rendilleland, and later moved out again, but this latter cycle of migrations has not been concluded by the time of writing, so that the migrations described here are those between August 1987 and May 1988. The numbers in the text and those on the maps correspond to each other:

1. Smallstock camps from Kargi and Korr gathered at the Koiya waterholes south-east of Laisamis. They then moved on to Kom, where they used the waterholes on both sides of the Samburu/Isiolo district boundary but grazed their animals mainly to the west, because east of Kom there were Somali.
2. A second cluster moved south from Koiya by a different way. They followed the chain of waterholes in the Sera riverbed, of which Worr Odoola (the well of the Odoola clan) is the one mentioned with preference. After an interval at Kom these camps moved further south-west to the area east of the mountain Ol Kanjo.
3. Cattle herds which had followed these smallstock movements were driven on to Archer's Post where they crossed the Ewaso Ng'iro to look for pastures in Isiolo and Meru Districts. Those parts of these herds which were to be sold were driven on to Isiolo and Nanyuki (interrupted line).
4. Smallstock of Gooborre, Ong'eli, Masula and Lokumai went via Nkoronit up the Malgis riverbed. A part of them turned south to the Irrer waterholes.
5. Smallstock of Nahagan and Saale from Korr went to the Sirima waterholes between Mt. Nyiro and Loyangalani. On their way back they kept close to Oldonyo Mara (Halicharreh in Rendille).


SMALLSTOCK MOVEMENTS
AUGUST 1987 - MAY 1988
Alia Bay
Sibilot
Golo
Hadaf
El Takich
North Horr
Furaful
Gas
M A R S A B I T
Maikona
Keh
KULAL
Korolle
Kargi
Loyangalani
Sirima
Marsabit
T U R K A N A
NYIRO
OLDONYO MARA
Korr
Laisamis
2° N.
Ilaut
Irrer
S A M B U R U
Koiya
Kom
Archer's Post
I S I O L O
L A I K I P I A
Isiolo
M E R U
Meru
Nanyuki
0 20 40 60 Kms
Smallstock movements
Regular movements to water
Cattle taken to market
(descriptions see text)
District boundaries

MAP NO VI/6

6. Smallstock from Kargi went to Bul (Rable) from where they were taken to the Korolle waterholes in a six-day rhythm (the normal interval is four days), because these waterholes were beyond easy walking distance for smallstock.
7. Some herds were grazed around the Keh waterholes on the eastern flank of Mt. Kulal.
8. A part of cluster 7 was taken on to Alia Bay, making use of the waterholes of Gas, Furaful, Hadaf and El Takich, and drinking also from Lake Turkana while being in its vicinity. Security was provided by 10 Rendille of the Police Reserve ("homeguards" in local usage) with guns, plus 20 Samburu homeguards alotted to Samburu cattle herds in the vicinity. On the way back these herds crossed the Hasé elevation (Asie).

To summarize these smallstock movements: Cluster no. 6 by its change from a 4-day watering cycle to a 6-day one clearly shows the difficulties involved in taking smallstock to dry pastures which are far from waterholes.

All other cluster have therefore moved out of the central plain of Rendilleland to areas where altitude and relief provide a better distribution of wells and surface water. Such conditions were given in many different places, to the north, west, and south - a situation reflected by the different directions taken by the migrations. On the other hand, the fact that all Rendille smallstock moved in only eight clusters instead of despersing into smaller units shows that a degree of coordination took place. The motives for clustering of satellite camps into larger neighbourhood are of two types: there are social reasons like to stay close to one's girlfriend who herds the animals of another clan, being able to go to other camps for an evening chat etc. and security reasons: while raiding in the southern reaches of the migration area is infrequent, the theft of single animals by Samburu warriors is a constant annoyance.

THE DISTRIBUTION OF THE SEMI-PERMANENT SETTLEMENTS OR MAIN CAMPS (GOOB)

In the discussion on satellite camp movements it has been mentioned that the settlements (houses, women, children, elders) from which these satellite camp movements radiate outwards, comprise a much smaller area than the total grazing grounds used by the Rendille, an area which we have called the plains of central Rendilleland.

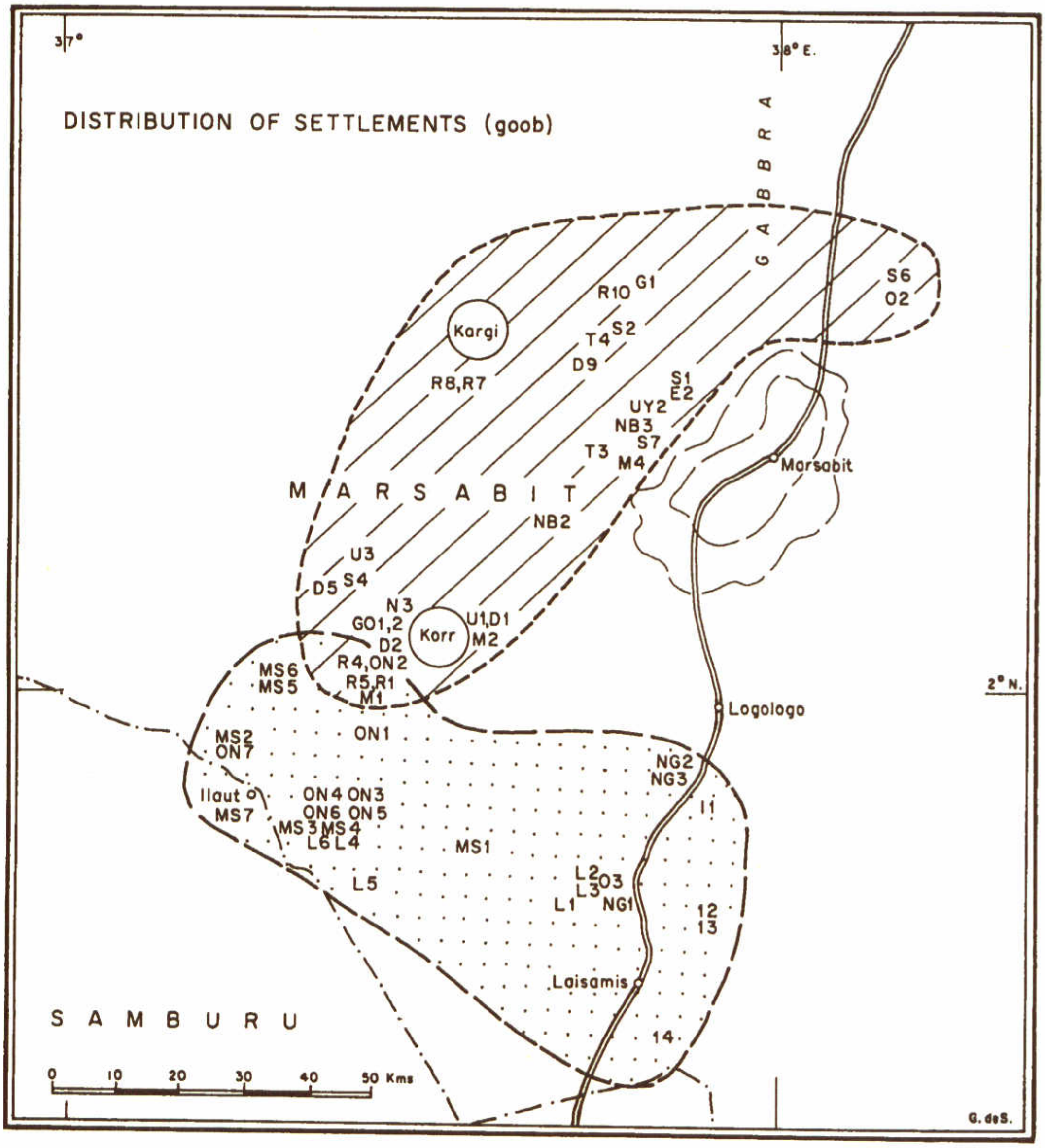
It is frequently claimed by visitors and short term experts that practically all Rendille have gathered in two clusters around Korr and Kargi, due to the pull-factors discussed below . To find out to which extent this is true, I have carried out a quick and rough settlement and house census in September 1988 to reflect the actual situation. This census has been carried out with one key informant, Mr. Barowa Adicharreh, a very knowledgable man whom I have known for 14 years, because it was out of question to visit all settlements and count the houses. These data have been checked by observations made on visits by car or camel to a smaller number of settlements. The figures given below therefore mostly represent estimates, but partly also house by house counts (which showed that Mr. Adicharreh's estimates were not far off the mark).

The results show that some of the more pessimistic assumptions about the Rendilles' loss of mobility are exaggerated. On the total of 2,902 Rendille and Ariaal houses counted, 2,072 are located more than 5 km from Korr and Kargi, while 830 are within that radius around the two centres, all of them "white" Rendille (as opposed to the Ariaal, except for Ariaal who might have joined settlements which are named after Rendille lineages). For the "white" Rendille alone this proportion is 1,004 : 830. As the settlements within the 5 km radius are smaller than those which stay away from the "towns", this proportion becomes inverted if we count the number of settlements: "white" Rendille form 36 settlements with an average of 28 houses outside 5 km radius around Korr and Kargi, and 41 settlements with an average of 20 houses inside the same radius.

The largest settlement can be found among the Ariaal, whose 1,068 houses are divided into 27 settlements, of approximately 40 houses each. This reflects two factors: the remotenes from the "towns", which, as we have seen in the case of the "white" Rendille, favours larger settlements, and the outside threat. One particularly large settlement (No 14 on map VI/7, east of the Merile-Laisamis road) has moved altogether after two warriors had been shot by Somali.

These numbers do not comprise those Rendille and Ariaal who have left their traditional settlement patterns and moved into the towns as individual households. Also the 22 houses of the "California" settlement at Korr, which mainly consists of widows and abandoned women and is not called by a Rendille lineage name are not comprised in this count.

The Ariaal are the camel Ariaal who live mainly in Rendille type houses. These Ariaal might



MAP NO VI/7

S2 Settlements (for descriptions see text)
Rendille settlements 1988
Ariaal settlements 1988

have relatives on Marsabit mountain or in the Samburu District which are indistinguishable from Samburu (unless elaborate genealogies were collected) and could therefore not be listed up here. The town dwellers of Korr, Kargi, Logologo and Laisamis which do not form separate settlements recognized by their tribesmen as such do not only comprise drop-outs but also some rich people who live on their money and prefer the denser communication of the towns and the availability of beer and miraa to the more austere nomadic life, disregarding the nutritional demands of their children, for whom milk can rarely be purchased even by the rich town dwellers in certain seasons.

On map VI/7 circles with a radius of 5 km have been delineated around Korr and Kargi. No settlement positions could be marked within this radius because the density of settlements is too high there. The motive for settling within this radius can bee assumed to be the proximity to the towns, because grazing and browse are practically absent there with the exception of a few weeks in a good year (1988 was such a year in which even the apparently completely overgrazed vicinity of the waterholes started fo flower). Outside this radius at least the lactating stock can be kept for longer periods in the settlements, and a combination of availability of pasture and the relative proximity of water and urban facilities can be regarded as motivating such a choice of location.

The further a settlement stays away from the towns, the more the search of adequate pasture and the desire to keep the lactating stock as long as possible in the settlements can be regarded as the motivating factors. Around Logologo and Laisamis there are no such clusters of settlements, although there are (ex-)nomads staying in the towns themselves. There are also hundreds of Rendille and Ariaal living in permanent settlements on Marsabit Mountain engaged in agriculture, cattle keeping, wage labour etc. These are not included in the census or on the map. We can therefore specify that the following is a census of settlements of camel keeping Rendille and Ariaal. They are numbered clan by clan, with the numbers referring to settlements which are not marked on the map because they are situated within a radius of 5 km around Korr and Kargi given in brackets. The clan Gaaldeilan is not listed up here because the distribution of its settlements and their numerical strength has been described above.

"White" Rendille. Moiety: Belesi Bahai

D'ubsahai (D)

l. Goob Wambile, 10 km east of Korr Mission, 45 houses
2. Goob Wambile, 6 km west of Korr, 32 houses
3. Goob D'abalen, 1 km from Korr Mission, 32 houses
4. Goob Amio, Geyo Padri (Korr), 20 houses
5. Goob Chaule, west of Balah, 16 km from Korr, 40 houses
6. Goob D'ogo, 2 km southwest of Korr-Borondadi, 50 houses
7. Goob Gaalhai, 1 km west of Kargi, 60 houses
8. Goob Bakha, 2 km east of Kargi, 45 houses
9. Goob Aranddie, Burarrahle, 16 km east of Kargi, 30 houses

Matarbá (M)
1. Goob Gaalgid'ele, on Ilaut road, 12 km from Korr
2. Goob Gaalgid'ele, 6 km east of Korr Mission, 21 houses
3. Goob Meite, Kargi town, 10 houses
4. Goob Mindissa, west of Hogisho, 7 houses

Uyam (UY)
1. Goob Eisimsanchir, Geohi Badri (Knorr), 15 houses
2. Goob Alyaro, Korongagab, 30 km east of Kargi, 20 houses

Rengumo (R)
1. Goob Arbele, 8 km southwest of Korr-Borondadi, 30 houses
2. Goob Nalle, 4 km from Korr-Borondadi, 30 houses
3. "The Rengumo of the town", 1 km from Korr-Borondadi, 20 houses
4. Goob Sahado, 10 km west of Korr, 30 houses
5. Minan Eisimgoobanai, near R 4, 5 houses
6. Goob Burchaya, Kargi, 17 houses
7. Goob Add'i, 8 km south of Kargi, 25 houses
8. Goob Malo, near R 7, 30 houses
9. Goob Hambule, Kargi Town, 30 houses
10. Goob Ilbarduba, 10 km east of Bagasi, 25 houses

Nahagán (N)
1. Goob Nkusa, 2 km from Korr-Borondadi, 30 houses
2. Goob Gaalmagalleh, near N 1, 20 houses
3. Goob Burolo, Balah, 9 km from Korr, 30 houses
4. Goob Mirgaalkora, 1 km west of Kargi, 10 houses
5. Goob Gaalgorowle, Kargi town, 16 houses

Moiety: Belesi Berri

Nebei (NB)
l. Goob Eisimbasele, 2 km west of Korr, 40 houses
2. Goob Eisimmirdana, Khurkhud Kirima, 26 km northeast of Korr, 27 houses
3. Goob Bagajo, north of Hogisho, 30 houses
4. Goob Ilwas, Kargi town, 10 houses

Saale (S)
1. Goob Kimogol, Karsigela, 30 houses
2. Goob Bargeri, Malbe Dub Taye, 25 houses
3. Goob Dahaleyo, Kargi town, 15 houses
4. Goob Sano, Chalgo, 75 houses
5. Goob Sirayon, Korr town, 10 houses
6. Goob Chorrodo, Hagargaabo, 15 houses
7. Goob Haile, west of Hogisho, 20 houses

Gooborre (GO)
1. Goob Orre, 8 km west of Korr, 50 houses
2. Goob Leibor, near GO 1, 30 houses
3. Goob Ilkibaeng'i, 2 km east of Korr Mission, 25

houses
4. Goob Choya, Kargi town, 10 houses

Elegella (E)
1. Goob Obeile, Kargi town, 20 houses
2. Goob Orkhobesle, Karsigela, 15 houses

Gaabanyó (G)
1. Goob Orkholam, Gedinohi Deidaayo, 35 houses
2. Goob Ilimo, Kargi town, 17 houses
3. Goob Bullo, Kargi town, 35 houses
4. Goob Ilimo, (2), Kargi town, 21 houses
5. Goob Miifo, Kargi town, 17 houses
6. Goob Liito, Kargi town, 17 houses

Urawén (U)
1. Goob Kahle, 6 km east of Korr, 27 houses
2. Minan Silamo, 1 km from Korr Mission, 7 houses
3. Goob Eisandáb, 20 km from Korr on Kargi road, 30 houses
4. Goob Ogom, Korr town, 10 houses
5. Goog Ogom, Kargi town, 30 houses

Tubcha (T)
1. Goob Luhmorrogo, 2 km east of Korr Mission, 11 houses
2. Goob Eisimsidele, Korr Mission, 9 houses
3. Goob Eisimigaabana, Bur Gaalgarawah, 60 houses
4. Goob Gaalalle, Malbe Dub Taye, 30 houses

Odoola (O)
1. Goob Timbor, Kargi twon, 5 houses
2. Goob Ballo, Hagargaabo, 10 houses
3. Goob Mooga, Sagardalla, 33 houses

Ariaal

Ong'eli (O)
1. Goob Chorre, 16 km from Korr on the Ilaut road, 27 houses
2. Goob Lesilau, north of R 1, 8 km from Korr
3. Goob Lomurrut Namarei, 30 houses
4.'Goob Ng'osoni, Namarei, 37 houses
5. Goob Ilmongoi, Namarei, 40 houses
6. Goob Harugura, Namarei, 13 houses
7. Goob Lomurrut, Faradkore, 6 km northwest of Ilaut, 60 houses

Maasula (MS)
1. Goob Lengima, east of Hali Balladan 29 houses (Baio)
2. Goob Chongorro, 6 km from Ilaut on the way to Faradkore, 20 houses
3. Goob Kainit, Lemendera, 15 houses
4. Goob Loroonyauki, near MS 3, 47 houses
5. Goob Wano, 16 km north of Ilaut, 27 houses
6. Goob Kisige, north of MS 5, 26 houses
7. Goob Olmele, north of Arsim in Samburu District, 70 houses

Lukumai (L)
1. Goob Bargeri, Kirim, 70 houses
2. Goob Gaalhaile, Halilukhumdeer, 32 houses
3. Goob Lobula, near L 2, 23 houses
4. Goob Baadi, Saboku Ilming'i, 20 houses
5. Goob Taabo, Tungar, 40 houses
6. Goob Engessen, north of Lonyeri Pesho, 50 houses

Nerugusho (NG)
1. Goob Kukuton, west of Sangererwa, 49 houses
2. Goob Learabo, juction of Korr and Marsabit roads, 30 houses
3. Goob Khuyan, south of NG 2, 20 houses

Ilturriya (I)
1. Goob Kobir, Kohte, west of Chalgole, 60 houses
2. Goob Marleni, Sengererwa, 60 houses
3. Goob Marleni (2), Sengererwa, 70 houses
4. Goob Hoigan, Sirirwa, 100 houses

The first impression derived from plotting these settlement positions on the map is that the Rendille live well to the north of the Ariaal and that there is a very small area of overlap [12]. This is true for the present situation but cannot be assumed to be a stable pattern. Many Rendille settlements which stayed in the area between Ilaut and Logologo in the late seventies moved northwards for the 1979 circumcisions and the 1980 gaalgulamme. Some relatively good rains on the northern parts of the range have contributed to maintain this situation. Before that, Rendille and Ariaal settlements were interspersed among each other in the south, and the northern part of Rendilleland belonged exclusively to the "white" Rendille.

On the other hand, there was no interlocking of settlement areas between the Rendille and Gabbra in the late seventies, because the memory of the massacres of the preceeding years was still too fresh on both sides. Now there are Rendille settlements in the Bubisa area, which is predominantly Gabbra, and Gabbra settlements close to Kargi.

It has been claimed that the Ariaal are more nomadic than the Rendille because the proportion of them which has become sendentarized around the mission stations is lower. A glance at the map confirms that indeed the Ariaal settlements keep away from the towns. Nevertheless the "nomadic" aspect of Ariaal life needs some specifications. If one introduces measurements of mobility (the defining criterion of nomadism) such as frequencies of movement and distances covered, one finds that a number of "white" Rendille settlements have made long distance movements between the Korr,

Kargi and Bubisa areas in recent years, while Ariaal settlements are often found within a radius of a few kilometres for decades and only move their settlements to a new spot if the old one has assembled too much dung. One example is Goob (MS 1) which has stayed on the eastern flank of the mountain Hali Balladan (Baio) for seven years and shows no inclination to move away from there. The leading elder makes clever use of small water pockets in the rocks of the mountian which can be used for human consumption and for lambs, while those categories of stock which can walk longer distances are taken to the wells of Ilaut and Laisamis in the dry season, unless there is still water in the seasonal lake Larabasi on the other side of the mountain. The run-off from the mountain and seasonal rivers coming from the higher areas to the west, in Samburu District, provide occasionally small pockets of green pasture even if there has been little or no rain in the area itself. Because of the long stay in the same area the herdsmen of this settlement always find these spots. Because of the efficient use of this micro-habitat, which might just support this one settlement, at least the milch stock is permanently present in this settlement, even at times when other settlements have been forced to take all their herds into satellite camps.

In 1988 the elder was about to destroy this micro-habitat having invited a charitable institution to dig a pan for him with a tractor. This easily accessible watering facility might soon cause overcrowding and erosion on the Baio flancs.

The strategy of making long term use of highly localized resources by single settlements is by no means restricted to the Ariaal but seems to be employed by them more often than by the Rendille. A - perhaps untypical - Rendille example of a settlement which uses a similar strategy is S 7, Goob Haile, which uses some water holes far away from any major settlement cluster or town. These water holes provide just enough drinking water for this one settlement for most of the dry season, so that Goob Haile is only forced to fetch water on camel back from Hula Hula on top of Mt. Marsabit for relatively short periods.

Apart from all these details about the motivation for the whereabouts of specific settlements, may be the most important information which can be obtained from a glance at map 6 is that there is still a substantial Rendille population living far away from the towns. These are the livestock producers and develompent efforts therefore should be directed to them, not to the town dwellers.

For the Gabbra no detailed census of this type could be carried out, but there is little doubt that the proportion of the Gabbra who have withstood the pull of the towns and remained nomadic is higher than that of the Rendille and that these nomadic Gabbra settlements are much smaller and move more often.

For the Boran generalizations are difficult. They comprise large numbers of agriculturalists on Marsabit Mountain and in the Sololo areas. These agriculturalists often keep cattle in satellite camps. Some Boran practice short range vertical cattle normadism up and down the slopes of Mt. Marsabit: Generally the cattle would stay in the lower reaches after the rains, until the surface water and the humidity in the pasture become insufficient there and then move uphill.

MOVEMENTS OF SLAUGHTER STOCK: THE OUTLETS OF THE DISTRICT

There is no time in history in which movements of slaughter stock across the boundaries of Marsabit District was entirely regulated by market forces. The colonial administration often kept traders out of the district, if they did not belong to one of the local tribes, because of the policy of tribal segregation mentioned above. Demand was thus curbed. If anybody, nomad or trader, wanted to drive his stock outside the district, he met with the difficulties of crossing into other restricted areas, and if he got the required permission or circumvented the restrictions and approached the densely settled Kenyan Highlands with their higher demand, he finally had to overcome a wide belt of noman's land (now belonging to the Livestock Marketing Division) which served to enforce quarantine regulations on all stock coming from the nomadic areas.

The legitimation for this cordon sanitaire was that the cattle of the nomads was believed to suffer from all sorts of infectious diseases from which the stock of the white settlers on the other side of the belt was to be protected. With regard to the spread of diseases the quarantine might have little effect, since often the same diseases were endemic on both sides of the belt.

Although the veterinary effect might have been negligible, the quarantine had a profound economic effect. It created a dual livestock economy: one with a relatively high price level in the settler areas, and one with a low price level in the nomadic areas (Raikes 1981:118-128). And this may have been the covert purpose of the quarantine, because as early as 1937 a Government husbandry expert gives the following evaluation of the possibilities of exterminating the diseases of the nomadic stock and the reasons for not exterminating them:

"For many years the pastoral native reserves have been in perpetual quarantine. This has been caused partly by the presence of disease, but largely by economic considerations. The expenditure at any time of comparatively small sums on veterinary services for these areas would have enabled them rapidly to be liberated from quarantine with disastrous effect upon the price of stock and stock products within the Colony."

While effectively blocking the market outlets of the nomadic areas, the colonial administration gave quite different explanations for the low level of sales: according to them, the nomads did not w a n t to sell their animals. It is this period in which the myth of the conservtive nomad with his irrational emotional attachment to his animals evolved. The nomads therefore were forced to sell a given proportion of their stocks to prevent "overstocking" and "overgrazing", and they were forced to sell at prices for which their purportedly more rational and market-oriented competitors, the white ranchers, would never have sold, since these prices sometimes amounted only to about one quarter of those achieved in the protected areas.

Whether the nomads would have sold if akcess to the market had been given to them and prices had not been discriminatory, has never been tried in the colonial period. Instead, the stereotype of the irrational nomad was used without hesitation for "destocking measures" which amounted to expropriation because of the pitiable compensations paid. An example for this attitude from the yearly report of the District Commissioner, Marsabit, from 1948:

There is little doubt that the District is carrying more camels than it should. Whenever the question of selling off camels to the Meat Marketing Board is raised the Rendille look wooden and say they haven't got any, the Gabbra make a long story about the camel being man's best friend, the motor car of the desert and the Bank of England rolled into one. Until a rough census is made it will not be easy to enforce a destocking policy as regrads camels (Kenyn National Archieves, DC Marsabit, 1948).

In other words: a vague opinion by a layman about the carrying capacity of an area, plus a humorous description of what some nomads are claimed to have said are enough to demand a "rough census" followed by a suspension of the property rights of the nomads. In 1948, the "experts" were not exaggeratedly cautious.

In the 50s, the African Livestock Marketing Organisation (ALMO) was set up to stimulate the African side of the dual livestock economy. In the postcolonial period ALMO was replaced by the Livestock Marketing Division (LMD).

The activities of these organisations provided some market outlet for nomadic stock but did not change the basic dual structure of the livestock economy. The nomadic part of the livestock sector remained cut off from important markets by the continued existence of quarantines which have no meaning for disease control since the big traders overcome them easily, but which are an insurmountable barrier to small suppliers without money or influence. Competing traders are also believed to use their influence with the authorities to impose quarantines on each other's stock. The quarantine thus - from its beginnings until now - has been amenable to manipulation.

Another institution which can easily be manipulated are the "auctions", as the purchasing fairs of the parastatal marketing orgnisation are called locally. Such manipulations usually favour the large suppliers, town dwelling traders, at the disadvantage of the nomads. If, for example, shortly before or during the auction it is announced that only oxen in a given weight bracket are bought, but no smaller or larger ones and no cows, then the local supplier can select aminals of the required category, while a nomad who has come from far with two or three animals which happen to be of the wrong category, will have to drive them back, or, if they are no longer in a condition to be driven back, to sell them at dumping prices to the local traders.

Another disadvantage for suppliers who are not residents of the location where the auction is held is that the prices are often not paid in cash but in certificates which can be cashed only weeks later. Whatever a nomad may have gained by selling animals is thus partly or entirely spent on his maintenance in town during this waiting period. The outlets of Marsabit District, as far as nomadic livestock is concerned, are thus still characterized by artificial bottlenecks, barriers, handicaps, traps and stumbling stones. Much remains to be done in the field of marketing. These outlets have to become much wider and much smoother to guarantee a steady flow.

IMPOVERISHED NOMADS AND THE MISSIONS: THE AID ADDICTION SYNDROME

In many places in Marsabit District one can observe the sudden growth of small rural towns. A locality which one remembers as consisting of a well, an Administration Police line of corrugated iron nailed to wooden frames, a shelter for the missionary who comes once a week built in the same fashion, and a shop in the only permanent building (wood and mud with a cement coat) may four or five years later consist of twenty and more permanent houses and a grandly laid out mission compound around a huge church. The size of such settlements would still rather correspond to our ideas about a "village" rather than a "town", but the term village would be misleading because these settlements have no agricultural base whatsoever.

The inhabitants of the permanent houses and of the cardboard, tin and sack structures surrounding them mostly engage in trade, some as a permanent occupation, others as occasional petty trade interrupted by periods of idleness: selling chewing tobacco or miraa if they can get some, spending days waiting for a car of lorry to take them to Marsabit or another place on the main road to get fresh supply etc. This type of petty trade, sometimes also termed subsistence trade because it takes place at the survival level, has a deceptive boom all over the Third World wherever a real productive base is missing. By the multiplication of such enterprises the possible income from trade is split into smaller and smaller shares without anything being added to the total volume of trade which is ultimately determined by the bying power of the producers, in this case the nomads.

The local chief may pride himself with the "development" of his town and thereby mean the increase in the number of permanent structures. Urban growth has indeed often been equated with or taken as an indicator of societal development and economic progress, not only by African chiefs but also by urbanization and modernization theorists all over the world. Elsewhere, however, urbanization has been accompanied by a refinement of the division of labour and the emergence of new crafts and skills, and none or little of that can be seen here. These towns are not of a productive but of a parasitic character.

The typical history of the foundation of such a town would involve a missionary coming out of the blue, distributing large amounts of "famine relief" from overseas donors to impoverished nomads, who then interrupt their cycle of migrations to wait for more food. Later a missionary from the rival denomination sets up his enterprise at the opposite end of town and engages in the same exchange trade of food for souls. Because of the competition between the denominations aid now flows continuously, irrespective of whether there is an acute famine or not. Misconceived food aid by Government and other agencies contributes to this development by being given out at the wrong places (at such centres rather than being widely distributed) and the wrong times (when the actual famine is over). I have heard a chief urging nomads to settle closer to his office because otherwise he would not be able to hand out their shares to them. Rehabilitaion of nomads which would enable them to engage in viable livestock procution again is thus actively prevented.

The ex-nomads then suddenly find themselves in what has been called a poverty trap: self-aggravating poverty. Because their herds have been decimated by drought and raids and have become too small to live on, they become sedentary around the mission stations. This settlement concentration leads to local overgrazing so that the remaining animals die or have to be left in the care of others. Such stock is often permanently separated from the families, with the dire dietary consequence that there might be milk but it is not where the children are, and the children are brought up on maize pulp without any supplements with all the health hazards involved in such a one-sided diet. In addition to their physical toughness these children lose their nomadic skills, so that their life time perspective, too, is to become food aid recipients.

SUGGESTIONS FOR THE IMPROVEMENT OF MOBILITY

While the trend, as described in part 1.4., is towards sedentarization of the poorer segments of the nomadic societies and large settlement concentrations with overgrazing in a certain radius around them, the opposite development should be encouraged: nomadic mobility is to be preserved and enhanced.

The twin aspect of overgrazing is undergrazing. Both are destructive to the pasture. Certain areas of the eastern Marsabit District, which are no longer frequented because of the described concentration process and the fear of mostly Somali bandits, are severely undergrazed and underbrowsed. This leads to bush encroachment with all its concomitant aspects like

- spread of the tse tse fly

- the shelter such vegetation offers to lions and other predators

- impenetrability, all paths are overgrown,

- low visibility which makes herding arduous,

- poor palatability of the vegetation (high lignine content, low protein).

To open such areas up again would require some clearing and some burning and above all an improvement of the security situation by mobile patrols. The camel riders of the colonial days were very effective for such tasks. Motorized patrols would be uneconomical because of the high expenses for road building and ineffective because the bandits could easily evade them. Only regular periodic use could then maintain these areas in a state of usability.

Another threat, which mainly concerns the Rendille while the security situation also affects the Gabbra and Boran and even the Somali themselves, is the delineation and fencing of ranches in the Samburu District, even as far north as Baragoi.

Individuals, mostly residents of the town Baragoi, there can acquire immense areas for as little as 20,000 to 50,000 Ksh. These ranches then are often not even put to use, because the owners prefer to use the remaining communal pastures, which become more and more congested, rather than letting their cattle eat their own grass. Some such ranches are even acquired exclusively with the idea of a possible increase of values for resale; these ranches would then be grazed as little as possible to let the vegetation grow beautifully to make the land look more fertile. Even now there is increased friction between Turkana, Samburu and Rendille herdsmen over the remaining open part of the range.

This strain on the open range and its degradation through overgrazing have become proverbial in sociological theory as the "tragedy of the commons", in which the "commons", originally the common grazing grounds, have come to stand for overused collective resources in general. While purely communal systems of land use are often selfregulating, mixed systems with private and communal land rights tend to lead to such tragedies as the commons become smaller and smaller and more heavily used.

Even now Turkana herdsmen (although they, too, are outside their "own" district) are constantly trying to stampede Rendille camels which use pastures on the Lbarta plain around Baragoi. If this development continues, it might lead to demands to close the District boundaries again, as they were in colonial times (negative experiences tend to be forgotten).

This would preclude the Rendille from higher altitude pastures which are a necessary seasonal complement to their dry plains and which they have used for generations - even the colonial restrictions were constantly circumvented by the Rendille because under certain recurrent conditions they had no other choice but to drive their animals into Samburu District.

On the other hand, such a regulation would prevent the Samburu from crossing into Marsabit District, which they have to do on an increasing scale. The Rendille resent Samburu encroachment and say that the Samburu after having sold their own district to the ranchers now want to take over Rendilleland, but so far they have tolerated Samburu in their midst because they expect to be reciprocated with continued access to Samburu pastures.

When after the April rains of 1988 there were substantial cattle herds from Samburu District at Buro, one of the south-western foothills of Marsabit, some Rendille wanted the chiefs to interfere and send them back, but among the elders the opinion prevailed that the Rendille should not be the first ones to appeal for such measures because they, in their turn, depend on being granted grazing rights in the Samburu District.

Continued granting of land titles to individuals would take out a small but essential part - the area with relatively high rainfall - of the nomadic range and thereby greatly reduce the use to which much wider areas can be put. The losses to nomadic livestock production would be much higher than the possible gains for the ranchers. A continuation of this policy is not in the interest of the national economy.

It has been mentioned above that security needs to be provided on a much more mobile basis. The same applies to other Government services like health and education.

The availability of health care in the dispensaries of the settlement agglomerations is a major pull-factor which attract nomads to settle in their already overgrazed environs, in addition to the factors described above. If more of this care could be provided on a mobile basis, this could reduce the migratiory pressure on the towns.

Under the present system of education being a nomad implies to remain illiterate and unable to interact as a modern livestock producer with the business world. Those children who have a chance of inheriting a part ot the herd are not sent to school because their labour is needed for herding and because they need the herding experience as a part ot their pastoral training. If they are sent to school at all, they are taken out of school again after a short interval when the settlements and/or herds move to a different area.

Those children which finish school are mostly those who are low in the order of birth, third, fourth and subsequent children. These are dispensable in the nomadic division of labour and they have low prospects of inheriting a viable herd. They are sooner or later separated from their families by being sent to a boarding school where they become thoroughly alienated from the "primitive" pastoralists from whom they stem. In other words: those who become nomads do not receive formal education and those who are educated do not become nomads. This system therefore does not contribute anything to the integration of the pastoral economy - the only economic potential of the district - so far into the national economy and the modern world.

If one wanted to reach the future herd owners, one would have to provide mobile education for them. Such mobile schools, instead of being equipped with a compound full of stone buildings, would need to be given a lorry and tents.

The Gabbra in the Dukana area have organized themselves in large but fully mobile settlements of about 200 households with a sufficient number of licenced guns because of Ethiopian raiders. If so many nomadic households can coordinate their movements for security purposes, there is no reason to assume that the same organizational efford could not be made to provide formal education for the children of the nomads. Such settlements should be considered large enough to deserve the allocation of a teacher.

LIVESTOCK MANAGEMENT AS A CULTURAL SYSTEM

The Degodia Somali inhabit the eastern part of Marsabit District, Wajir District and Garissa District and can also be found in Ethiopia and Somalia. Some of them migrate in the Marsabit-Isiolo-Wajir-triangle, i.e. in an area adjacent to that of the Gabbra and Rendille. There are certain topographical differences: the Degodia stay more in open plains while the Rendille and, above all, the Gabbra spend much of their lives on lavafields consisting of large boulders where even the mere locomotion is a formidable task. But there are no dramatic climatic differences between western and eastern Marsabit District and therefore one cannot easily attribute the differences in the livestock management systems of the Degodia, Gabbra and Rendille to different ecological adaptations.

Culture comes in as an independent variable. Of course, camel management cannot very ad libitum but has to take into account ecolocigal and physiological constraints. Nevertheless, within these limits, cultural variation can be quite considerable, even between such neighbouring and linguistically related peoples.

To exemplify some of such differences, I order my observations in the following way: I start with daily activities like leading camels to pasture or milking them and then proceed with progressively larger cycles of time: watering, which happens once in a couple of days or weeks, seasonal differences and finally the life-cycle of a camel. Then some observations are added on events which do not reccur on a cyclical basis like disease and special ritual states.

The daily Rhythm: Grazing, Browsing, Milking

Rendille herds are either kept in the relatively inert nomadic settlements or in the more mobile satellite camps, where only boys and warriors, i.e. unmarried junior men, live without any form of shelter. In both cased suckling dams have to be milked by sexually inactive males, i.e. young boys in a satellite camp, or, in a settlement where old men are available, also by these. Only dams whose calf has died can be milked by a sexually active man, because there no longer is a calf whose health could be endangered by this indirect contact with sex.

The first milking is done in the morning. The camels are driven out to pasture at about 8.30 if pasture is far and not before 9.00 in more favourable conditions. Daraaro darag matirti - "the morning does not prevent satiety", i.e. staying in the enclosures until late in the morning does not prevent the camels from browsing enough later, the Rendille believe. From a settlement the camels would be walked up to twenty kilometers at a steady speed before they reach sufficient pasture. A satellite camp, for, being much less dependent on water, would normally be situated within good pasture, so that the camels would disperse in the immediate vicinity of the enclosures. In both cases the herds would be back in the enclosure shortly after sunset. Wilson (1984:122) says that "camels tend to feed more actively at certain times of the day than at others, for example just before and after sunset." That is just the time when Rendille camels are driven back, often in a hurry, so that they have to "cool down", it is believed, before they can let enough milk. The milking in a settlement would take place around 21.00, in a satellite camp ca. 23.00.

If we compare this with the daily grazing regime of the Degodia or Ajuran Somali, we would find that milking in the evening takes place at the same time. The difference is that the camels have not spent several hours standing in the enclosures to "cool down" but are driven home only now, at a leisurely speed, satiated, taking a lustless bite from a shrub here and there. The milk can easily be four times as much as that of a Rendille camel at a similar point of the lactation period. Somali camels would be milked again very early and go out to pasture with the first light. As Somali do not practice the division of settlement and for, but follow the herds with their women and houses at the expense of fetching water from very far, the pasture would always be close to the corrals.

The Watering Cycle

As long as there is green vegetation, the moisture is sufficient for the camels and they can stay without water for months. To drive them to the well would be a waste of energy. If the vegetation is dry, the Rendille would drive the herds to the water once in fourteen days, the Somali, however, once in four days.

The Rendille would keep sick camels or such that have been wounded by predators in the enclosures for weeks without any food and water, again to allow them to "cool down".

Water is regarded as weakening if taken too often. The animals would get used to it and late be unable to withstand long stretches of thirst and effort. Similar beliefs apply to people. Water supposedly cools and weakens, while a certain measure of thirst makes one hot and strong. After eating roasted meat or drinking blood, i.e. "hot" food that makes one thirstly, one should not drink water or milk (both "cold"), because otherwise one would neturalize the effects of the "hot" food and not gain any strength.

Sometimes dietary considerations yield precedence to ritual ones. Camels have to be present in the settlement or on ritual sites for sacrificial and other ceremonies because, as the analysis of prayers, blessings etc. shows, these aim at their well-being. Thirst and hunger of the camels do not outweigh these ritual benefits. This attitude is shared by the culturally related Gabbra, among whom the following rather extreme example of apparently tough camel management was observed during a month of particular ritual importance: at the occasion of the jila journey described above.

On August 28th, 1986 the ritually relevant parts of the Galbo phratry moved to a hill called Mata Lama, some hours walk north of the Kenyan/ Ethiopian border in the lowlands below the escarpment. The ceremonies happened during the first half of the month of Yaka (6.9.-19.9.). During this period so many ceremonies were be held at four different settlement positions and at many other localities which were visited without moving the settlements there, that there was hardly any time for herding activities. The vegetation was dry, because the dry season had reached its peak. Originally the ceremonies were planned in a month called somdeera eege (11.4.-25.4.) when the vegetation was green and pools were plenty, but because of internal dissent the joint migration could not be organised then and had to be postponed to the next appropriate month. As no watering was possible after the 6.9., the herds needed to be driven to the nearest point with sufficient water for camels herds, several thousands, and these can not be taken to the water on the same day: one reason is that the mixing-up would be too bothersome and another that the settlements would be left without milk. The camels of the household of my host had gone to the water on the 29/30 of August. They stayed without water until the 16/17 of September. Although the distance to Magado, 30 km as the crow flies, does not look very impressive on the map, the ascent to the vulcano and the descent to the crater lake on paths which go half around the mountain on the outside and again on the inside is quite lengthy and tiring. As the camels need to rest at the water and drink repeatedly, the whole enterprise takes more than a day (on the 16/17 the camels were away for 29.5 hours).

During this 17-day period without water, with only dry browse, the camels had been prevented from bowsing for all or most of the following days:

Thursday, 4.9., migration of about 10 km. The camels started to browse after 14 h. Reason: the new moon has to be awaited at this particular settlement position.

Saturday, 6.9., the day after the new moon has been sighted. The camels were driven back into the enclosure at 10.30 because of two sacrifices of smallstock and started to browse again after 16 h.

Monday, 8.9., migration of about 16 km, the long way around a mountain because the passage between two holy sites can only be passed in one direction. Some camels started to browse at 14.30, but the loading camels were only unloaded at 16.00 because those who had to determine the exact camp position were late.

Thursday, 11.9., migration through the ritual gate that marks the passage between the two holy mountains and the one from one age-set to another. About 15 km. The camels start to browse around 16 h.

Friday, 12.9. Sacrifice of a sheep. The camels remain in the enclosures from ca. 10 to 15 h.

Saturday, 13.9. The camels were driven to a ritual site about 2 km away where they spent the whole day in a vast enclosure where also dances, sacrifices and other activities were going on. Because there was vegetation in the enclosure they could browse, although not necessarily their preferred plants.

Sunday, 14.9., the regular domestic sorio ceremony which has nothing to do with the age-set ceremonies and one sacrifice which forms part of the latter. The camels had to be driven back into the enclusres repeatedly. They were hungry and restless. Ceremonies now tended to be performed with less enthusiasm and greater haste. The camels were allowd to browse already at 10.45.

Monday, 15.9. Regular sorio, second day. Transfer of holy drum and horn to new custodians. Preparations for the slaughter of a goat and for consultations about installations into age-set offices which are going to happen outside the settlement. The camels started to browse not before 13 h (exact time not noted).

This was not the end of the ceremonies, but the end of the period for which the camels had to stay without water a n d free access to pasture; and only the camels interest us here (the age-set promotions shall be described elsewhere).

When asked about the effects of this extended period of thirst and the little time left to browse, the Gabbra responded: Aadan quufsa - "the ceremonies satiate", or "the law satiates (the camels)", meaning that the divine order requires the rituals and therefore cannot allow them to have negative effects on the camels. Camel herds would get lost or decline if the rituals were not carried out properly and cannot possibly suffer from them being carried out.

That the camels are a ritually important species is also illustrated by the contrast with cattle, mere utility animals. The Gabbra kept their cattle in satellite camps all the time; there was no need for them to join the settlements on ritual occasions.

A Somali who hase witnessed these rituals would possibly be more upset about the hardships they involve for the camels than about their "pagan" character (practically all Somali are Muslims).

The better access the Somali give their camels to water and pasture is reflected by their appearance. The Benadir strain of the Somali camels belong to the largest and fleshiest camels on earth (Wilson 1984:45, 159). They are not popular with the police as riding camels because of their phlegmatic gait and their large feet that make them stumble in stony areas. The Rendille and Gabbra camels are much smaller and of a tougher and more nervous appearance.

In the fifties many Rendille have bought Somali camels to up-grade their herds and increase body size and milk yield. Today the Rendille's admiration for Somali camels has ceased. The more a camel approximates the Somali type the higher the likelihood that it is the first to succumb to a drought.

The reason why the Rendille from of dry season grazing management requires mobile camels with modest demands has to do with the spatial destribution of pasture and water.

While the Somali are more mobile in terms of wide range movements of settlements and herds between districts and countries, the Rendille and Gabbra have to move their camels further away from water in the dry season than the Somali ever do and have to cope with longer regular journeys to and from the water points. This has to do with the uneven distribution of water points on the fringe of the Chalbi.

This watering regime, which we have called "long distance commuter strategy", has been described above. We have found that the dry season energy balance of camels submitted to this treatment oscillates around a rather low level. The high-demand, high-productivity Somali camels would not thrive under such conditions. In their own territory they do not need to be submitted to such a watering regime because of the wider distribution of water points (the Juba, Dawa and Ewaso Ngiro rivers, the wells of Wajir, El Wak, Buna, Giriftu, and many others), which give them access to good camel pasture consisting of trees and dwarf scrubs.

A Camel's Life Cycle

Camel calves are kept by Rendille in thorn bush enclosures and only released to suckle their dams twice a day, in the morning and evening, at milking time. They then are given access to the teats of one side of the udder while the other side is milked for human comsumption. When old enough to supplement their diet by browsing, they are driven to pastures nearby the camp well after the milk herds have left, so that they cannot follow them. Zoologists regard this restriction as responsible for limited growth (IPAL 1984:308).

Somali camel calves are more fortunate. They go to pasture with their dams and can suckle whenever they wish. Contrary to Rendille camels, which are never milked outside the camp, Somali camels are milked whenever the herders wish to do so or travellers ask for it (one of the pleasant features of travel in ethnic Somali territories). The access to the milk is as free for humans as for calves. This is made possible by the fact that the milk of Somali camels in comparison to Rendille ones is truly abundant.

Weaned young camels are the ideal object for bleeding among the Rendille (breeding stock would only be used for this purpose in times of emergency). In the satellite camp the herders would enrich their morning milk every day with blood, the proportion of which becomes higher with the scarcity of milk in the advancing dry season.

Ideally Somali do not drink blood. They find, however, all sorts of medical excuses for circumventing this aspect of Muslim law. Pregnant women or people who have influenza or pretend it do, in fact, enjoy blood. As blood is not an everyday feature of the Somali diet, however, the strain bleeding involves for the camels is much less than in the Rendille case.

Some males are trained as loading camels. Rendille camels are tied around the the lower jaw, so that the animal can be held or forced down by the power of the arm of a woman. Somali camels only have the rope around the head in the form of a halter, so that the camels have to follow voluntarily. This can only be achieved by early playful training of the calves by children. Rendille camels, which are trained late, often virtually have to be broken in. In such occasions one can hear Rendille say: gaal a bina - "Camels are wild beasts" or gaal a chi tó - "Camels are a kind of enemies". This does not combine with the Somali attitude about their beasts of burden. One can see a whole train of giant Somali loaders, all entire, not castrated like their Rendille and Gabbra equivalents, tied loosely to the tail of their respective fore-camel, the rope of the front one not being held by the woman walking ahead but by the infant in her arms!

To complete the life-cycle, we may have a look also at the reproductive males. (Some observations about reproductive females have already been rendered above). A coloured twisted rope (heerar) is tied by the Rendille around the neck of the herd sire. This gives the bull a special status. He would not be used for sale, work or slaughter unless in a bad need and be left alone in the bush to die when his virility dwindles. The Somali have a less ceremonial attitude and do not honour their sires with such marks of distinction.

Times of Crisis

Disease is treated quite differently among the Rendille and Somali. Somali skilfully splint the broken leg of a calf; something the Rendille would not even attempt. They only treat bone fractures of smallstock which heal faster, and of human beings. In the latter case a broken leg would be tied to the ground and the patient immobilized for weeks.

There are other examples where Somali appear as the good shepherds and the Rendille as the tough ones. Camel herds afflicted by non-fatal contagious diseases are kept in quarantine for many years, so that single households move about in complete isolation in their own nomadic routes and apparently sometimes even enjoy it. This would not combine with the pronounced social cohesion of large Rendille settlement groups. Rendille would leave such camels to infect each other and recover or not at God's will. Even Somali with healthy camels would often avoid areas where they find footprints of camels for near-paranoic fear of contagion and ticks. Thus, where space is available, mutual preventive quarantine, i.e. general isolation, becomes a normal herding practice.

Conclusion

The tough attitude of the Rendille is paralleled by their thoughness towards people. This is best illustrated by the remark of a warrior in the camel camp to a five year old boy: "We have no water. And if we had water, I would not give you any, because in the coming months there will be no water either. You have to get used to thirst." The Somali do not share any of these attitudes. They may occasionally suffer but they are not looking for it.

We have seen that the result of the Rendille form of management are small camels with low milk yield and that the Somali management produces huge animals with abundant milk.

At this point the question comes up why anyone should keep Rendille camels in the Rendille way. The question of course can be put in more general terms: What is the biological sense of low yield breeds? Or: What is the economic sense of low cost forms of animal husbandry?

Low yield breeds are tough and can be kept under harsh conditions with limited inputs (food, water, care). They produce little but survive where high yield animals would die. The Rendille strategy might therefore be regarded as not very rewarding but relatively safe: low inputs produce low, but rather reliable, outputs.

Property rights

Property rights are insofar relevant to a survey which tries to show the potentials and the limitations of the pastoral economy and its prospects for integration into the national economy, as multiple claims on the same animal might reduce its availability for marketing. In an earlier part we have seen that the problem of marketing stock in Marsabit District does not lie in the low readiness of the nomads to sell stock (rather they are dependent on regular sales because their dry season diet consists largely of grain), but in the bottlenecks of the marketing system and administrative impediments. Especially small stock cattle and male slaughter camels are offered for sale more often than demand can be found for them at acceptable price levels. Shared rights and obstacles for sale can be mainly found in only one category of stock, namely female camels. The property rights of the Rendille and Gabbra described in that section contrast with those of the Boran.

The Rendille and Gabbra

The two most usual forms of shared rights in female camels are R: maal, B: dabarre* and R: kalaksimé, B: kalassime. The customs concerning these two forms of loans and the legal principles involved in them are so similar in the case of the Rendille and Gabbra (they are also shared by the Sakuye and certain Garre) that we can describe them as one single system.

Both formes fo shared rights over a camel have important functions in balancing economic risk, in establishing social bonds, in re-distributing wealth and re-allotting labour. We find similar insitutions in many pastoral societies, since nomadic pastoralism is a high risk enterprise amidst warlike competitors in an insecure, ecologically marginal environment. Here the need arises for insurance against losses by drought, epidemics and human and animal predators or simply against the ever present possibility that an entire herd may stampede for no apparent reason and never be reassembled. The need also arises for wide-spun networks of mutual help and solidarity for shared defense, shared labour and political and jural assistance. Sharing beasts helps to meet both these needs.

Maal and kalaksimé camels differ in regard to the rights in their offspring and the period of the loan. The more attractive form for the recipient is maal. While no etymology of the term B: dabarre is known to me, the Rendille word maal is derived from a a-maald'a, I milk for myself, e.g. aitó maald'a, I milk a she-camel for myself, have a she-camel milked for me (i.e. milked for my household, by whoever does the actual milking). Usually, a maal camel needs to be asked for, formally applied for or begged for. The applicant, after a long introduction which stresses the good relationships between himself and the owner as well as between their respective kin groups and ancestors, will carefully and respectfully approach the subject, since he is the interested party and in the weaker position. Once the transaction of a camel is agreed upon, an occasion must be awaited when the camels are in the settlement, e.g. for a sorio festival, and not in the satellite camp, so that the lent camel can actually be collected. This is only possible, however, on the appropriate day of the week. On the morning when the recipient comes to collect the promised camel, he has a twig of R: gaer, B: mad'er (Cordia sinensis lam.) in his hand. When he leads his camel away, usually a recently weaned calf or young heifer, he deposits the twig on the house of the donor as a ritual payment.

This camel, although a loan, would normally never be recovered by the original owner. indeed it would even be slightly shameful for him to be too inquisitive about the animal's condition and that of it's progeny, and the prestige gained by loaning out the animal would definitely be diminished if he did so. The male offspring of a maal-camel is the full property of the holder, i.e. the borrower, in other words, it becomes alál (R, B).

The word alál is easily recognizable as derived from the Arabic halal, an Islamic concept that means: a) ritually clean, slaughtered in the prescribed way, and b) rightful, legal (as in "rightful" wife a opposed to "mistress"). In Rendille and Boran, the use of the word is restricted to camels and, with a slight undertone of irony, to women*. A close English translation would be "own", in this context.

Any female offspring of a maal-camel, however, belongs to the original owner, at least in theory; it is branded with the brand of the clan of origin and ear-clipped or otherwise marked correspondingly by the holder. Every herdsman thus must know how to apply many different brands to his camels. This nominal ownership of the original maal-giver does not entitle him to actual possession. A giver who asks for repayment of a female calf is likely to be stalled and told that the camels are still few, the holder is in need, and to try again a few years later. To extract a camel forcibly would be considered unworthy behaviour. One Rendille elder, who sought a girl for a second marriage, was reminded of having taken back by force a maal-camel from a clansman of the girl years ago. He had to pay a fine in excess of the bride-wealth to soothe the anger of his future affines, and was only then promised the girl. It was never contested that the camel which caused this turmoil bore his brand, was known to be his property and offspring of his property; but possession and "ownership" are two different things.

On the other hand, a maal-holder can very well give a female calf or heifer of the maal-herd to a third person, thereby making the animal second-degree maal. Then the rule applies: Gaal et lama malakakhabo (R). "A Camel is not owed to two people," i.e. the second-degree maal-holder owes gratitude to the first-degree holder and nothing to the original owner, although the property marks of the latter will be retained throughout the generations. The offspring of a camel given from clan A to clan B, and in the next generation from B to C may thus end up in clan D, while all camels connected by uterine descent to the camel originally given, retain the property marks of A. It is difficult to see the advantage of giving a maal-camel, since the gain so clearly seems to be on the side of the taker. Spencer (1973:38) is right in stressing the prestige acquired; giving a camel is considered generous and contributes to make the giver appear as a mejel, a worthy man.

Apart from the prestige, the giver retains latent rights in animals of the maal herds. He can make use of these rights when he can show a plausible need like the imminent circumcision or marriage of a son or a second marriage of himself, where a sudden need of alál-camels for bride-wealth arises. Such a need can also be made plausible by pointing to losses by drought, epidemics or raids. A maal giver who has lost the herd in this possession can now use his wide-spread latent rights to the offspring of camels he or his ancestors have originally shared out.

On the other hand, no compensation can be claimed for any maal camels received from others which may have belonged to the lost herd. (Maal givers often are at the receiving end of other maal transactions.) An alál-("own")-camel, that was given away as maal, may thus entitle the victim of a major loss to a heifer. The one he kept, on the other hand, might have died or been taken by enemies, i.e. has gone without replacement, and so have the maal-camel he had from others. In the case of the latter, the loss is alleviated, however, by being partly not his own. Thus the insurance factor favours giving and taking shared beasts. The only camel really lost is the dead or stolen alál.

Another incentive to lend out a camel may lie in the human:animal ratio of a given household. A wealthy man with few sons and few other junior patrilineal relatives could be forced to hire herdsmen to handle his vast herd. These herdsmen would be customarily provide with tyre-sandals, cloths, smallstock for slaughter and paid a female calf every other year. An animal given to a hired herdsman is one that has changed from the side of benefits to the side of costs and remains there for generations, although, in the case of a camel it nominally is maal, while camels given as maal to an independent herdsman may diminish the need for hired labour, establish claims on camels if at a late time the human:animal ratio has changed, and may at the moment not be necessary for subsistence anyhow, since at present the human:animal ratio is low. A man whose sons are too young to herd camels may prefer to loan out camels, so that he can claim back a part of their offspring, when his own sons are grown-up and, especially, when they marry, instead of spending them on hired labour.

The rules for the other type of loan (kalaksimé) are completely different. The kalaksimé animal is always an adult female camel which has just given birth and is given to a household that is short of milk. After the lactation period the camel is given back to the owner. The latter can now say niyrakh kagoi (R) - "cut the calf away (from the mother)", i.e. "keep the calf!", or he an take back both animals and thus limit his gift to the milk. Kalaksimé thus is the preferred form of helping a poor person without necessarily establishing a long-term relationship.

Yet another form of transfer of stock is darnán (R), i.e. "adding" animals to someone else's herd. The giver more than the recipient would be regarded the beneficiary of such a transaction. It means to give stock to somebody to herd, because one is short of labour. No rights are on the side of the herder, except usufruct of the milk and the usual gifts for herdsmen, in proportion to the number of animals of diverse owners and to their respective generosity. Darnán thus is a service to the owner, not to the herder.

The Boran

The Kenyan Boran live mostly in Isiolo and Marsabit Districts. The two clusters are separated by Samburu, Somali and Rendille grazing areas. While the Isiolo Boran coverted to Islam between 1922 and 1952 (Dahl 1979: 26f.), most of the Marsabit Boran adhere to their traditional religion and law (aada). Conversion to Islam implies a change in the rules for inheritance from the aada, which provides for the eldest son (angafa) to inherit the entire herd upon the death of his father, to the shari'a, the Islamic law, which states that the herd should be divided in equal parts, two of which are to be passed on to each son and one to each daughter. The Muslim Boran disregard the rights of the daughters, and as to the rights fo the sons the differences between customary and Muslim law appear smaller in practice than in theory for two reasons:

1) Both Muslim and traditionalist Boran pass on property to their sons (and in the case of affluent people even to their daughters) during their lifetimes in the form of gifts, so that the residual herd (which is alternatively divided or passed on entirely to the firstborn) upon the death of a family head (abba worra) may be rather small.

2) Even in the case of Muslims, the herd of the younger brother remains under the trust and care of firstborn, until the marriage of the junior brother. The increase of the herd during this time belongs to the junior son, and if he has inherited a substantial herd which subsequently fares well, the Muslim system in this case can be said to favour the junior son. If, on the other hand, the residual herd was small or the herd inherited by the junior son shrinks, this system does not favour the junior son, since the obligation for the eldest son to help the younger is smaller, if the formal property rights have been divided already. Under the aada, on the other hand. a firstborn son would inherit the herd together with the function of abba, (father/owner) which implies responsibility for his younger brother's wellfare.

Gifts to the children during the lifetime of the father comprise both among Muslim and traditionalist Boran the following categories of animals: Handura (navel). According to Baxter (1966: 125) "each male child is presented at his naming ceremony, which takes place when he is around a year old, with a heifer. This is known as handura or navel, and is the nucleus of his own independent herd." Additional gifts may be given to a child when he succeeds in saying abba, 'father', for the first time or accomplishes some other feat of childhood (Dahl 1979: 95).

There are also gifts as rewards for killing an enemy or a large game animal. The independent herd of a son can also be supplemented by war loots and in modern times increasingly by animals bought from the proceeds of wage labour.

As some animals are owned by women (e.g. gifts from their fathers), in a polygynous household sons who are not the first-borns of their father but of their mother can inherit animals in this way in the aada-system. (Haberland 1963: 62) Where the Muslim law is followed, the inheritance of a stock owning woman would again be more widely distributed among her children.

There is a form of loan of an animal which the Boran call dabarre which can, however, mot be equated with the homonymous institution of the Gabbra (which corresponds to the Rendille maal, cf. above. While Rendille customs about maal refer mainly to camels, the Boran customs are mostly concerned with cattle.) The Waso Boran would also refer to the loan of a bull as dabarre (Dahl 1979: 180). According to Dahl's description, in the case of a female the rules applying to dabarre are reminiscent of the Rendille and Gabbra practice, in so far as the male offspring of a dabarre cow may be left with the debtor when the creditor reclaims his stock. As Dahl includes the Sakuye as a subunit of the Boran in her account, one may ask whether this is not really a Sakuye custom. Boran informants from Marsabit District deny that the male offspring of a dabarre cow belongs to the debtor. The gain for the debtor in accepting dabarre consists of the milk alone.

Dahl (1979: 181) mentions the possibility that "after a number of years, if the original animal has not been handed back and if the donor has not asked for the return of its offspring, it is possible that the transaction can fall into obscurity, so that the 'loaned' animals come to be counted as the property of the client's descendants." This would be quite unthinkable for Rendille and Gabbra who brand their dabarre (maal) camels with the property mark of the creditor's clan even after generations and irrespective of whether they have acquired these animals from the original creditor himself or through one ore more intermediate links. Animals acquired in the way described by Dahl for the Boran would be believed by Rendille and Gabbra to bring death and misfortune to their holders.

Also from Baxter's account on the Marsabit Boran the impression emerges that among the Boran possession is more easily converted into property than among the Rendille or Gabbra. As the Boran place different categories of stock in different herds under related or unrelated wardens because of shortage of labour in the nuclear family, their stock rights are widely dispersed. After some time "the beasts for which a man has been acting as warden become to his heirs part of their patrimony, while in turn those beasts of the patrimony which have been herded by wardens become absorbed into the patrimony of the herds of those wardens. The movement of stock from lactating to dry herds, the wide dispersal of flocks and herds, the mobility of brothers as they move up from herd to herd, the impermanent composition of villages and homesteads, the long period which it takes a man to collect his own herd about him and to order his stock being cared for by others to his liking, the moral difficulties involved in removing stock from another's care, etc. would all ease this forgetting." (Baxter 1966: 126f.)

The right to sell: implications of property rights for marketing

We have seen that property rights are sometimes diffused, i.e. that more than one person can have a claim to an animal. For example, the herd of a junior brother may remain under the guardianship of an elder brother, and thus the property rights of the junior brother remain restricted and he may not have the right to sell an animal. The same situation can be interpreted as the senior brother having the "full" property rights at the time being and the junior brother having a promise for the future, that one day those animals will be his. In this case the owner's (i.e. the senior brother's) property right is limited and might not include the right to sell. Distinctions like property vs. posession vs. guardianship vs. option vs. shareholding might become somewhat theoretical in this context: the essential point is that no matter who is the "owner" and who the "guardian" there is more than one person with an interest in and a claim to the same animal and the decision to sell may therefore become difficult.

On the other hand, not in all situations does the decision to sell need to be taken by the person who is, in the legal categories of the society in question, the owner of an animal: herdsmen in a satellite camp of smallstock can sell animals to buy provisions for themselves; brothers like to sell each other's animals rather than their own because negative sanctions for such breaches of property rights - which among strangers would be regarded as theft - might, among brothers, be averted by appeals to brotherly solidarity.

On the whole it must be said that shared or multiple property rights are no effective obstacle to livestock marketing in northern Kenya, since the offer of animals is much higher than the demand and we therefore have a typical buyer's market with a low price-level.

That smallstock makes up such a large share of the market can possibly be explained by the fact that shared rights in smallstock are unusual and that one head of smallstock is easily replaced by another: if one takes some animals from the herd of a brother for sale because one's own are not within easy reach, one can later compensate him with an equivalanet number of animals. Camels and cattle, however, are not counted but named: one is entitled to a given animal by a specific history of acquisition (inheritance, bridewealth, war spoils...) and one camel or cow cannot be replaced easily by another, at least not without lengthy collective negotiations, formal transactions and witnesses.

Conclusions

It has been demonstrated by a number of empirical examples from different ethnic groups that the pastoral systems of the Marsabit District territorially transcend the district boundaries and form integrated wholes with climatically different areas outside the district. To cut off these outlying areas would presumably do much more damage to the productivity of these systems than would correspond to the surfaces involved, since also the remaining part of the range would cease to be viable. It might provide good grazing, - but not throughout the year.

Mobility of all factors of nomadic production, people, herds, public services, slaughter stock etc. therefore needs to be encouraged rather than being gradually reduced, as it is currently the case. Especially the numerous obstacles to marketing need to be removed. A policy which would include improvement of "marketing" in all development projects without effectively removing the administrative obstacles to marketing will in the long run get into problems of credibility and acceptance.

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