United Nations Educational, Scientific And Cultural Organization

Organisation des Nations Unies pour l'éducation, la science et la culture

UNESCO Regional Office of Science and Technology for Africa

Bureau Regional de Science et de Technologie de l'UNESCO pour l'Afrique

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reference :

UNEP-MAB INTEGRATED PROJECT IN ARID LANDS - (IPAL)

DRAFT FINAL REPORT ON PHASE II

PROJECT NUMBER:- FP/1101-75-0(890)(PHASE II)

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28 April, 1977

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SECTION I

1.1 Original title of project

Integrated ecological pilot project in arid grazing lands to promote rehabilitation and management: establishment of coordinating unit and launching of initial field work.

1.2 Project Number:- FP/1101-76-03(890)

1.3 Duration: 15 months - 1 February 1976 - 30 April 1977

1.4 Location of project

a. Co-ordinating Unit: at the UNESCO Regional Office of Science and Technology for Africa, Nairobi, Kenya (operational).

b. Mt. Kulal Field Station, Northern Kenya (operational).

c. Northern Sudan (preparatory work only).

d. Tunisia (preparatory work only).

e. Oman (preliminary discussions).

SECTION II ADMINISTRATION AND GENERAL INTRODUCTION

2.1 Administration

(This report is intended to be presented in a printed and illustrated form to the U.N. Conference on Desertification). Comprehensive background information on the project is available on the project documents prepared for the operational phase (Phase III, 1977-1979). The following introductory sections are amended from those documents

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IPAL is administered under the UNESCO Man and the Biosphere (MAB) Programme and forms part of MAB Project 3, which deals with the impact of human activities on grazing lands. The Project is a component of the UNEP strategy in relation to arid lands and grazing land ecosystems and is also closely related to the UNEP preparations to tackle the problems of desertification.

IPAL was established as a project with the stated intention of extending its operations to several countries in the arid zone. Initially the project has been established and is operational in Kenya, with preparations for its implementation well advanced in Sudan and Tunisia (for which project documents have been submitted by UNESCO to UNEP). Further extension to Senegal, Niger, Botswana, Iran and Oman has been under discussion by UNESCO and the countries concerned.

Project documents for the operational phase in Kenya (1977-1979), and preparatory phases in Sudan and Tunisia, were completed and submitted to UNEP together with the over-view Document for the region.

This report mainly covers the preparatory phase (Phase II) in Kenya, but includes short sections on the other countries in which initial discussions and reconnaissance have taken place.

2.2 Objectives of IPAL

The objectives of the Project have been described in the project documents for Phases II and III and may be summarized as follows:-

Long-term objectives

(a) to identify the causes of ecological degradation and desert encroachment in the arid zone;

(b) document and measure the agents and processes of degradation;

(c) assess carrying capacities and management regimes compatible with the rehabilitation of degraded ecosystems;

(d) carry out experiments in and demonstrations of rehabilitation management procedures;

(e) obtain base-line descriptions of arid and degrading ecosystems for ecological monitoring and initiate such monitoring programmes;

(f) investigate and implement ecologically sound strategies and modified land use patterns which do not contribute, as at present, to the degradation of the arid region, but which are consistent with the rehabilitation of degraded areas;

(g) serve as the scientific support for the whole programme on Arid and Semi-arid Lands by extending progressively its geographical and disciplinary scope.

Immediate objectives

These have been described in the Phase II project document and are basically unchanged. They may be summarized as follows:-

(a) to carry out integrated ecological survey and investigation of representative arid zone ecosystems supporting human populations in order to:

(b) establish base-line descriptions;

(c) establish the successional status and trends of such ecosystems;

(d) to carry out experimental management of sample areas under controlled stocking by livestock in order to :

(e) provide demonstrations of the results of ecologically orientated management;

(f) evolve guidelines for the rehabilitation of vegetation and the restoration of productivity in arid areas.

2.3 Staff (Coordinating Unit and Kenya Section)

Following the customary briefing at UNESCO H.Q., Paris, the Project Coordinator and Senior Ecologist took up their duties in Kenya on 1 February 1976. An office for the Coordinating Unit was established in Nairobi at the Unesco Regional Office of Science and Technology with the considerable help of the Director and his staff.

The Project Administrator (Supply and Procurement Officer) was appointed in May and the Woodland Ecologist in June 1976. The former took charge of the building programme at Mt. Kulal and also of the general administration and accounting of the project. The latter started work on woodland investigations in cooperation with the Senior Ecologist whose work on livestock ecology was in progress.

Field Assistants were recruited and their training was well advanced by the end of this phase of the project.

The provision of counterpart staff by the Kenya and Sudan Governments is dealt with in this report under the respective country headings below.

In accordance with the aims of the project, bilateral assistance has been sought from several sources. The first such assistance made available was the provision by the Ministry of Overseas Development, U.K. of a fully supported research worker to carry out a three year investigation of the ecology of sheep and goats as an integral part of the project in Kenya.

The names of the U.N. and bilateral experts and information on their experience and qualifications are given in Annex I.

2.4 IPAL in Kenya

Section III below is devoted to the implementation of the project in Kenya.

2.5 IPAL in Sudan

In response to a request to UNEP from the Government of Sudan for the implementation of the project, the Project Coordinator has spent several weeks in discussions, planning and travelling in Khartoum, Kordofan, Darfur and Dongola Provinces and has worked closely with the Sudan Government and the Resident Representative of UNDP in Khartoum.

The Coordinator took part in the Desert Encroachment Reconnaissance in October 1975 with field officers of the Sudan Government and prepared a report which has been used in the formulation of the Sudan Desert Encroachment Control Programme and in Government press reports. This report identified areas in which IPAL should operate in northern Sudan and gave a preliminary estimate of the extent and rate of desert encroachment (approximately 100 kms. south-wards in Kordofan and Darfur) since 1958 when the ecological boundaries were first mapped by Harrison and Jackson.

In early 1977, the Minister of Agriculture in Khartoum renewed his request for the implementation of IPAL in Sudan and it was agreed by the Sudan Government and the Resident Representative UNDP, that the project should serve as scientific support for the Desert Encroachment Control Programme.

Discussions on the provision of counterpart staff and facilities were held with the Ministry of Agriculture, Food and Natural Resources and National Council for Research.

UNESCO has submitted a full project document to UNEP for the execution and funding of IPAL in Sudan. This document has been accepted by the Sudan Government. It will be presented to the meeting of potential donors to the Desert Encroachment Control

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Programme to be held in 1977.

2.6 IPAL IN TUNISIA

Following discussions between the Tunisian Government and UNESCO and a reconnaissance visit by the Project Coordinator to Tunisia, a full project document covering the proposed implementation of IPAL in that country has been submitted to UNEP.

2.7 IPAL IN OMAN

In response to requests from the Government of Oman, the Project Coordinator has undertaken two missions to Oman to make observations on the conservation and management of the Jebel Qara and Jebel Qamr regions of Dhofar Province where productive grasslands are threatened by desertification. Discussions were held with the Oman Government on the possibility of their participation in MAB activities and on the possible implementation of IPAL in that country.

SECTION III The implementation of IPAL in Kenya

3.1 Cooperation with the Kenya Government and other organisations in Kenya

Project experts were formally introduced to the Kenya Government by the Secretary-General of the UNESCO Commission in the Ministry of Education.

Close liaison with the Kenya Government was established through the Environment Secretariat of the Office of the President, which is the convening organisation for the Kenya National MAB Committee. The first meeting the Committee held was in February, 1976 to discuss the project's implementation in Kenya. At that meeting the project was explained to representatives from technical

Ministries and their cooperation was requested. Discussion on Kenyan Counterpart participation was started with the Environment Secretariat and it was agreed in principle that Kenya Government counterpart contribution would be made to the project in its operational phase beginning in 1977. The provision of counterpart personnel during the preparatory phase was not possible, owing in part, to the temporary cessation of recruitment in the Kenya Government. Nevertheless considerable Government participation in the project has already taken place. The cooperation of Kenyan authorities in the establishment and operation of the field work in northern Kenya (described below) is greatly valued and has been extremely productive.

Authority for the allocation of two hectares of land at Mt. Kulal, northern Kenya, for siting the project's field station (Figure 2) was given by the Office of the President which also authorized the Provincial Administration to cooperate with the Project in northern Kenya.

Councillors and Chiefs in Marsabit District, particularly those within the project area, have been extremely helpful in obtaining the cooperation of the pastoralist people to enable them to make observations and measurements on livestock herds.

Government officers in Marsabit District have supplied help and advice. Among these have been the District Commissioner, the District Development Officer, the District Agricultural and Veterinary Officer, The District Forest Officer.

A significant meeting was held at the project's field station in December 1976, on the subject of Man and Environment in Marsabit District. Thirty four persons, including the Member of Parliament, representatives of Central and Local Government, missionary organisations (the Africa Inland Mission, the Catholic

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Church and the National Christian Council of Kenya), individual research workers and U.N. specialists. Twenty people presented summaries of their own and their organisations' work in the area. The edited proceedings of this meeting are attached as Annex 7.

Discussions have been held on the following subjects with officers in Government Ministries in connection with the Project's plan of operations:

Ministry of Agriculture:

Range Management; research; livestock marketing; soil survey (see following section).

Ministry of Tourism and Wildlife:

Coordination of survey and monitoring activities with those of the Kenya Ecological Monitoring Unit (KREMU) and the provision of certain facilities at the project's field station to assist KREMU.

Other scientific cooperation

1. Soils:-

Dr. Sombroek of the Kenya Soil Survey carried out a preliminary soil survey in the project area and has provided initial soil data. The training of one of the project's field assistants in soil survey and mapping techniques is dealt with below.

2. Plant identification:-

Plant specimens collected in the working area have been identified by the East African Herbarium staff.

3. Veterinary:-

Blood samples from sheep, goats and camels were collected by Dr. M. H. Woodford (F.A.O. Kenya Wildlife Management Project) for screening by the Government Veterinary Laboratories at Kabete.

choose working areas which are as representative as possible of conditions which are wide-spread in the region.

The Kulal area was selected mainly on account of its similarity, in important respects, to very extensive arid areas in the Sahelian Zone and north-eastern Africa which are experiencing ecological degradation and desertification, including over one third of the total area of Kenya itself.

Like the greater part of the arid zone in Africa north of the Equator, the Mt. Kulal region is inhabited by nomadic pastoralists dependent on their herds of sheep, goats and camels, and more locally on cattle.

As in other parts of the arid zone the problems are compounded by periodic drought, by increasing human populations and the rising number of people dependent on famine relief.

(b) Mt. Kulal was chosen because it includes an exceptional range of eco-climatic zones within a relatively small area, from the rain forest zone on Mt. Kulal with a mean annual precipitation of c.1200 mm to the Koroli Desert, 30 km away, with 100 mm. Most intermediate eco-climatic zones are present in the working area.

(c) The presence of a permanent water supply, a village and a small mission station on the southern slopes of Mt. Kulal have been important considerations in siting the project's field station there. It is roughly central for access to the whole of the working area. It has two airstrips which permit access by the project's aircraft in most weather conditions. Flying time to Nairobi is two hours.

(d) The history of tribal conflict in the arid area immediately to the east of Mt. Kulal has resulted in a relatively low level of exploitation and considerable recovery of the vegetation there as

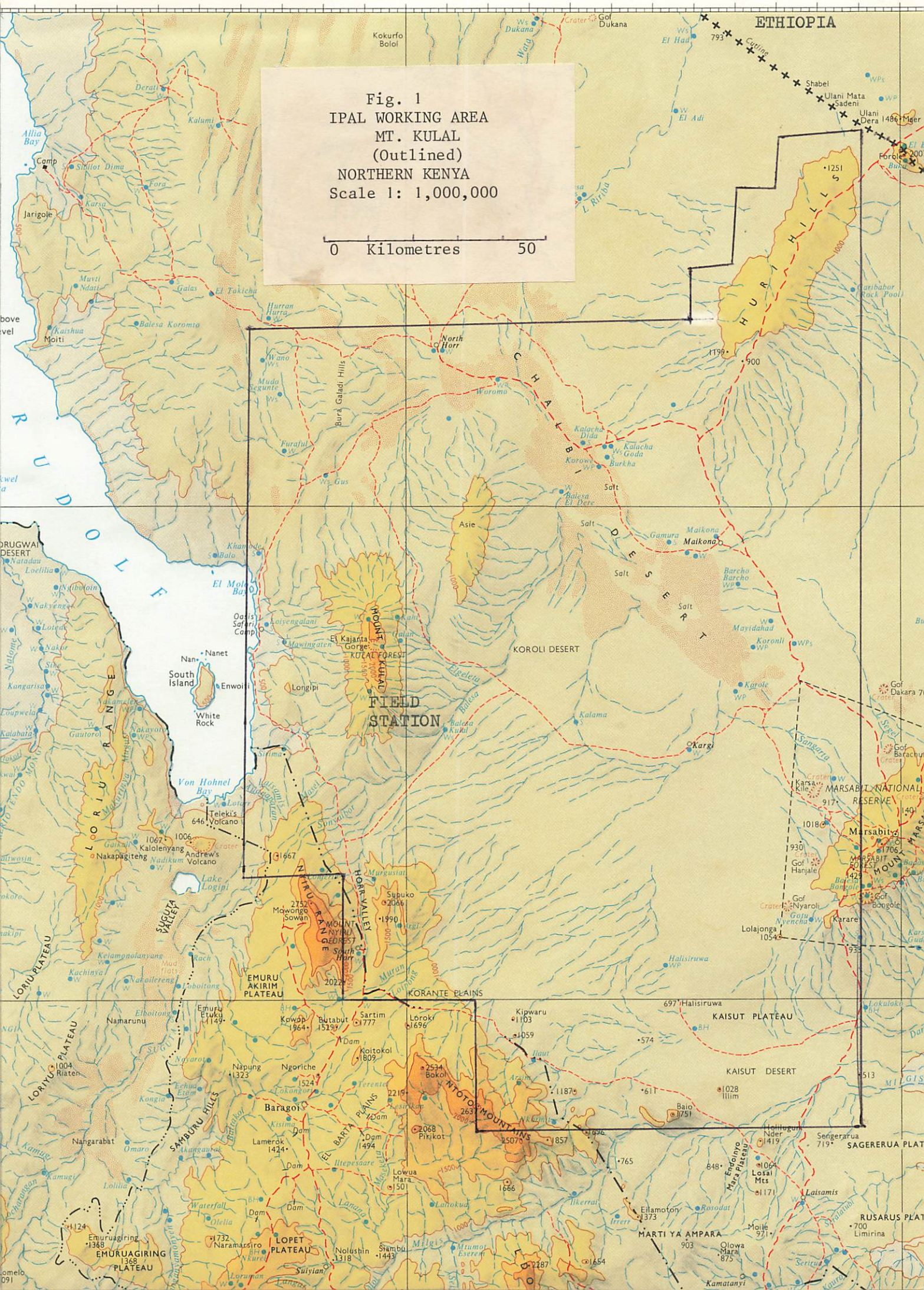
Fig. 1
IPAL WORKING AREA
MT. KULAL
(Outlined)
NORTHERN KENYA
Scale 1: 1,000,000
0 Kilometres 50
ETHIOPIA
L. RUDOLF
CHALBI DESERT
HURI HILLS
KOROLI DESERT
MOUNT KULAL
KULAL FOREST
FIELD STATION
El Kajanta Gorge
South Island
Nanet
Enwoit
White Rock
LORIU RANGE
Teleki's Volcano
Andrew's Volcano
Lake Logipi
SUGUTA VALLEY
NYIRU RANGE
MOUNT NYIRU FOREST
HOR VALLEY
EMURU AKIRIM PLATEAU
KORANTE PLAINS
LORIU PLATEAU
SAMBURU HILLS
EL BARTA PLAINS
NYATOTO MOUNTAINS
KAISUT PLATEAU
KAISUT DESERT
MARSABIT NATIONAL RESERVE
MARSABIT FOREST
MOUNT MARSABIT
Marsabit
Lolajonga
Karare
SAGERERUA PLAT
RUSARUS PLAT
MARTI YA AMPARA
LOPET PLATEAU
EMURUAGIRING PLATEAU
Baragoi
Kokurfo Bolol
Derati
Kalumi
Jarigole
Muvti
Galas
El Tokicha
Hurran Hurra
Balesa Koromto
Kaishua Moiti
Wano Ws
Muda Segunte Ws
Burka Galadi Hills
North Horr
Furaful
Ws Gus
Kalacha Dida
Kalacha Goda
Burkha
Korowe
Balesa El Dere
Salt
Asie
Gamura
Maikona
Barcho
Mayidahad
Koronli
Karole
Kalama
Karga
Balesa Kukul
Loiyengalani
Oasis Safari Camp
Nakuprat
Gulamayo
Nakwel
Nadapal
Lorengelup
Nakamelok
Nakayan
Gautoroi
Nakur
Kangarisae
Loupwelo
Kalabata
Nalome
Loelilia
Nabiboloin
Natadau
DRUGWAI DESERT
Khamode
Balo
El Molo Bay
Von Hohnel Bay
Sirima
Longipi
Elgeleta
Kalama
Sangarra
Karsa Kile
Gof Barachu
Gof Dakara
Gof Hanjale
Gof Nyaroli
Gof Bongole
Gof Bongole
Lolokoloi
Halisiruwa
Kipwaru
Haut
Azim
Illim
Baio
Hollugum Nder
Sengerarua
Endoinyo Mara Plateau
Losai Mts
Laisamis
Ilkerrai
Ilamotoon
Rosodat
Irrert
Moile
Olowa Mara
Kamatanyi
Serima
Mtumot
Eseremi
Lokuka
Lanaru
Lanokua
Waterfall
Olelia
Emuruagiring
Naramarsiro
Nolushin
Siambu
Suiyian
Loruman
Lanaru
Lowua Mara
Meshimeshi
Ilterpesaare
Lamerok
Nangarabat
Kamuge
Omaro
Ikanganak
Barta Kurel
Kongia
Echua Etem
Nyarot
Loroki
Sartim
Butabut
Kowop
Emuru Etuku
Namarunu
Elbottong
Kachinya
Nakoilereng
Kelamonolanyang
Nadikum
Galkal
Kalolenyang
Nakapagiteng
Lokongori
Terenteit
Napung
Ngoriche
Koitokol
Dam
Kisima
Lokwa
Lokorkor
Kamuge
Lolilia
Echarungan
Kamugi
Loriyu Plateau
Riaten
Sugut
Kongia
Nakoilereng
Kachinya
Elbottong
Namarunu
Emuru Etuku
Kowop
Butabut
Sartim
Loroki
Koitokol
Napung
Ngoriche
Lokongori
Terenteit
Baragoi
Kisima
Dam
Lamerok
Nangarabat
Ikanganak
Barta Kurel
Ilterpesaare
Lowua Mara
Meshimeshi
Lanaru
Lanokua
Waterfall
Olelia
Emuruagiring
Naramarsiro
Nolushin
Siambu
Suiyian
Loruman
Mtumot
Eseremi
Serima
Kamatanyi
Olowa Mara
Moile
Ilamotoon
Irrert
Rosodat
Ilkerrai
Laisamis
Losai Mts
Endoinyo Mara Plateau
Hollugum Nder
Sengerarua
Baio
Illim
Azim
Haut
Kipwaru
Halisiruwa
Lolokoloi
Lolajonga
Karare
Gof Bongole
Gof Nyaroli
Gof Hanjale
Gof Barachu
Gof Dakara
Karsa Kile
Marsabit
Sangarra
Karga
Karole
Koronli
Mayidahad
Barcho
Maikona
Gamura
Salt
Asie
Balesa El Dere
Korowe
Kalacha Goda
Kalacha Dida
Burka
Furaful
Ws Gus
Muda Segunte Ws
Wano Ws
North Horr
Waroma
Burka Galadi Hills
Hurran Hurra
Balesa Koromto
Kaishua Moiti
Camp
Allia Bay
Sibilot Dima
Fora
Karsa
Muvti
Ndatt
Galas
El Tokicha
Derati
Kalumi
Kokurfo Bolol
Dukana
Gof Dukana
El Had
El Adi
Shabel
Ulani Mata Sadeni
Ulani Dera
Mder
Foroles
Buna
L. Rirriba
Waribahor Rock Pool
Cutuna
1251
1199
900
793
1486
1667
1067
1006
646
1004
1524
1494
1323
1964
1529
1777
1696
1809
2534
2219
2068
2507
1857
1666
1732
1368
1318
1443
2287
1654
1124
1149
1103
1059
1187
1028
751
1419
1064
1171
1373
971
903
875
700
574
611
765
513
697
930
917
1018
1706
1429
1401
1054
935
2752
2066
1990
2022
1500
1000
500
Mowongo Sowan
Supuko
Murgustiat
Muran
Lolokwe
Nyiru
Mt Kulal
Mt Marsabit
Mt Nyiru
Mt Kulal
Mt Marsabit
Mt Nyiru
Mt Kulal
Mt Marsabit
Mt

compared with the working area as a whole. This situation can be used to advantage by the project since several of the management experiments can be started with the equivalent of at least ten years of protective treatment already accomplished. Also it is possible to observe a gradient in intensity of exploitation from the little-used areas near Mt. Kulal to the intensively exploited lands elsewhere in the project area.

3.4 The Mt. Kulal working area - Kenya

A brief Description (Map, Figure 1)

The working area of the Kenya section of IPAL comprises 19,300 km^2 of mainly arid and semi-arid rangeland, situated between the south eastern shore of Lake Turkana and Marsabit Mountain. It includes Mt. Kulal, on the slopes of which the project's field station is sited. (Figure 2).

The area lies within the administrative District of Marsabit and, except for the mountains, the greater part of it is approximately 500 m. above see level.

The area is about half volcanic, being derived from lava flows from Mt. Marsabit and many satellite craters and the Huri Hills in the east and from Mt. Kulal in the west. The sand soils of the Koroli Desert and the saline alluvium of the Chalbi Desert are derived from the Basement Complex in the centre and south of the working area, where it has not been covered by volcanics.

The climate over the greater part of the region is arid with mean annual rainfall of below 150 mm. During the last eight years of drought conditions the mean has been c.50mm.

Exeptional rainfall (100 mm) occurred in most arid parts of the working area in April 1977. Such occasional wet years provide the main stimulus to natural regeneration of vegetation and perhaps the only opportunity for successful tree planting on a large scale.

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Mt. Kulal, a volcanic mountain 25 km long and 8 km wide, rises to 2,300 m above sea level and supports c. 35 km^2 of montane forest. From the rain and the water gathered from the mists on the mountain, several important springs in the surrounding country are fed, including those at North Horr and Loyangalani. The slopes of Mt. Kulal and the country to the east of the mountain comprise a gradient of eco-climatic types from the humid forest on the top (c.1200 mm mean annual rainfall) to the Koroli Desert (c.100 mm or less).

The vegetation of the area is dominated by scrub Acacia and Commiphora trees and shrubs, and by woody herbs (Disperma and Indigofera). The intervening ground over the greater part of the area tends to be bare, except after rain when a short-lived herb layer, including some grasses, appears. Richer vegetation occurs near water courses and very locally elsewhere, including the tree Acacia tortilis, the palm Phoenix reclinata and the rambling shrub Salvadora persica. Saltbush (Sueda monoica) occurs as thickets adjacent to the salt pan of the Chalbi Desert.

Wildlife characteristic of sub-desert regions of East Africa is present, although evidently greatly depleted. Wild ungulates include Grevy's zebra, Beisa oryx, gerenuk, Grant's gazelle and giraffe. Elephant, and black rhinoceros are now very uncommon. Small numbers of lion, leopard, cheetah and hunting dog are present in the area.

The animal life of the working area is overwhelmingly dominated by the domestic livestock of the pastoral nomads, mainly camels, sheep and goats, but with some cattle on and near

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Figure 2

Aerial oblique photograph of the Mt. Kulal Field Station. View to the south east overlooking the Losigiriache gorge and the IPAL working area in the background.





Figure 3

Mount Kulal Field Station: staff houses under construction.

the mountains. There is no agriculture in the working area except for some small plots of maize and vegetables on Mts. Kulal and Marsabit.

The area is inhabited mainly by pastoral nomads, Rendille people in the south, the Gabra and Boran in the north and the Samburu on Mt. Kulal. They possess an economy almost entirely based on their livestock and, together with their animals, are an important influence upon the successional ecology of the region.

SECTION IV REVIEW OF EXISTING KNOWLEDGE RELEVANT TO THE PROJECT IN NORTHERN KENYA: THE ROLE OF THE PROJECT IN THE LIGHT OF PRESENT KNOWLEDGE

In order to obtain the greatest possible benefit from existing information relevant to the work of the Project the following courses have been adopted:

(i) A survey of literature (reports and publications) including certain U.N. Survey reports and bibliographies.

(ii) A collection of the most important published and unpublished material in the Mt. Kulal Field Station Library. (List of important literature is attached in Annex 2).

(iii) Meetings with people who have a background of relevant knowledge, including members of the indigenous population.

(iv) A seminar held at the Mt. Kulal Field Station for scientists, officials and others with special interest in the area, entitled "Man and the environment in Marsabit District". (Proceedings attached as Annex 7).

(v) The proposed employment of a specialist consultant early in the operational phase to prepare an account of existing knowledge on the history and prehistory of the Mt. Marsabit, Mt. Kulal and Lake Turkana regions.

It will be seen from the attached list of references that there is a small fund of information on the social and anthropological background of the region. There is very general but fragmentary information, mainly of a descriptive, qualitative nature, on the archeology, vegetation and animal life and recently preliminary observations have been made on the soils. The geological mapping of Kenya does not extend to the Mt. Kulal region. The results of previous livestock surveys and estimates, quoted by the relevant FAO report, give crude totals of numbers of livestock species for the period 1960 to 1970 which include certain numerical inconsistencies.

It will be appreciated that, owing to the paucity of investigation in the region (except in the case of three anthropological studies), present knowledge of its resources is superficial and of doubtful reliability. Such a poor background of information is virtually useless as a basis for future monitoring and rational management. This situation appears to be general across the whole arid region of Kenya and neighbouring Somalia and Southern Ethiopia. Lacking critical quantitative data on vegetation, human and animal populations, no reliable statement can be made about ecological trends in the region. Nevertheless observations by residents in the area, combined with circumstantial evidence, indicate a general decline in its productivity manifested by a reduction in vegetative cover, the spread of the desertified areas, a reduction in the flow of streams and a general lowering of water tables.

Two specific examples must suffice to illustrate these trends.

The Chairman of the Marsabit District Council says that the sand-dune area on the west of the Chalbi Desert has extended approximately five miles in the direction of his village, Kargi (in the Mt. Kulal working area) during his own life time and the tree and shrub vegetation around Kargi has been greatly reduced in the same period.

A missionary worker of the Africa Inland Mission based at Ng ronit at the eastern foot of the Ndoto Mountains (also in the Mt. Kulal working area), has described how the recent failure to exclude livestock from the Forest Reserve, which formerly protected the catchment of the Ngoronit perenural stream, has permitted the denudation of the mountain catchment. The stream, one of the very few in the region, ceased to flow (except in spate after rain) for the first time only two years after the entry of the livestock. Water can now be obtained only from a small well three meters deep in the river bed.

Knowledge on vegetation, animal life, including livestock, in the arid zone in north eastern Africa, of relevance to range-management is particularly sparse and virtually no range-management activity is taking place. None of the recommendations contained in the FAO livestock report for the region have been implemented. Among these recommendations, proposals to carry out de-stocking and livestock marketing, which appeared urgent ten years ago, remain to be put into effect. Nevertheless very recent tentative proposals by the Kenya Government to introduce a vigorous livestock marketing operations in the Marsabit District partly for the purpose of supplying meat to the Arabian Gulf, have been the subject of discussions between the District Authorities and the Senior Ecologist of IPAL, in order to determine how IPAL's research

function might be applied to the problems envisaged. The existing practices of livestock marketing do not fall within the Project's terms of reference, but the strategy of the de-stocking proposals should as far as possible complement the experimental work being carried out by the Project and the plans should be available for incorporating into the IPAL system for monitoring changes in the livestock populations.

Important references

A list of references under subject headings is attached to this report as Annexes 2, 3 and 3a.

The most important of these is probably the FAO (1971) document entitled "Range and development in Marsabit District". It outlines possible development of livestock in Marsabit District. Although The report states that camels, sheep and goats have considerable potential in the development of the District, the proposals are mainly concerned with the development of cattle.

The main proposals centre on the development of water; local marketing and block grazing, with the pre-condition of effective control by Government of grazing. Very little of the proposed development has been implemented.

The Range Officer of Marsabit District is evidently basing much of his planning on this report. He has however interpreted the " grazing blocks " as "group ranches", a practice that is of questionable feasibility under the conditions of irregular and spatially uneven rainfall characteristic of the area.

The main constraint to development is the great difficulty of ensuring effective grazing control.

In the reports by the Kenya Government, describing mainly the activities of Government departments in Marsabit District, and giving an outline of development plans, the following points are note worthy:-

a) Lack of data is considered to be the primary constraint.

b) Wildlife and Game Reserves constitute a major natural resource of the area.

c) The development of water resources without concomitant control of livestock is a serious danger.

d) The density of roads in the District is 0.033 km. per km^2.

The symposium "Man and the Environment in Marsabit District" 1976 (Proceeding attached), constitutes an attempt to assess work in progress and ideas and plans for future development with the object of facilitating their integration.

Current development and research in Marsabit District

a) Government of Kenya: Veterinary, livestock, range management, health, game conservation, road maintenance etc.

b) National Christian Council of Kenya and Africa Inland Mission: Hurri Hills Afforestation Scheme. (IPAL acts in advisory role).

c) Catholic Mission: Local tree planting: rehabilitation of destitute people. (IPAL advising in tree planting).

d) Human ecologists and sociologists : Schwartz, Ishikara, Grum, Beaman.

e) Archeologists: Phillips.

Apart from the studies of the human ecologists and archeologist the only research being carried out in Marsabit District is that of IPAL.

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investigation on the four main lines of enquiry assumed to have the highest immediate priority. These are (i) climate, (ii) vegetation and soils, (iii) ungulate animals (wild and domestic) (iv) human populations.

In order to provide the foundation for the essential capability of monitoring ecological trends in the future, stress is laid upon establishing quantitative base-lines in the measurement of biomass and productivity at each trophic level in relation to the prevailing climate, soil moisture and soil type and, in particular, to the land-use practices of the indigenous people.

6.2 Climate

The measurement of climate, particularly rainfall is a fundamental requirement in an investigation of land use capability and ecological trends. In the highly variable climatic conditions of northern Kenya, nearly all ecological measurements, e.g. primary and secondary production, are related to precipitation (but also to drainage and water retention characteristics of the soils).

In order to relate all observations made in the IPAL working area to localized rainfall conditions, a network of 17 monthly-read rain storage gauges and one daily-read gauge has been set up across the working area.

An automatic weather station on loan from The Institute of Hydrology in the U.K., is operated at the field station on Mt. Kulal. Readings on magnetic tape, are sent monthly to the Institute and are returned as computer print-out sheets. These include a calculation of Potential evaporation. From this we have calculated Potential evapotranspiration (Fig. 4) and it can be seen that a water surplus was available for plants in only one of the six months for which data are available.

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SECTION V FACILITIES AND EQUIPMENT

5.1 Facilities

A list of buildings in use by the Project is appended in Annex 4.

The Project Coordinating Unit is provided with an office and considerable administrative assitance by the UNESCO Regional Office of Science and Technology for Africa in Nairobi. The good communications available there have facilitated the administration of the Project as have the proximity of UNEP Headquarters and offices of the Kenya Government.

The Mt. Kulal Field Station in Marsabit District, northern Kenya, was virtually complete at the end of the Project's preparatory phase. The laboratory and other buildings with their site works, provide a working base for up to six resident scientists with ancillary staff of twelve, as well as four visiting scientists and / or students.

All buildings are of prefabricated wooden construction mounted on concrete bases. A piped water supply is connected to that of the nearby mission station and fed by springs on the mountain. Hot water for domestic purposes is provided by solar heating. Electricity will shortly be supplied by wind power (with a stand-by petrol-driven generator).

The first of several experimental livestock management sites is now in use at Balessa, 20 km. east of the Mt. Kulal Field Station and consists of a pattern of fenced paddocks totalling 40 ha, in the sub-desert shrubland and woodland, with a small prefabricated house/laboratory and an airstrip. (See aerial photograph of the site, Figure 5). The site includes a small tree seedling trial plot for Acacia tortilis and a nursery to supply other plantation areas.

5.2 Equipment

Project scientists are provided with cross-country vehicles for their field work. A seven-ton truck carries building and other materials and supplies to the Field Station and experimental sites. The Project's 4-5 seater light aircraft provides rapid transport for personnel and supplies and is used for periodic survey flights, reconnaissance and sample aerial photography. Special equipment for the aircraft includes a radar altimeter for the accurate maintenance of height during transect flying; a motorized (automatic) 35 mm camera for vegetation sample photography and for use in animal censuses; a 6 x 6 cm format camera for special purpose vegetation recording.

Field and laboratory equipment is listed in Annex 4 to this report.

SECTION VI INVESTIGATION, SURVEY AND MONITORING

6.1 General

The design of the project in progress in the Mt. Kulal working area, and the rationale for it are described in the IPAL Project Documents for the preparatory and operational phases.

Basically, the project is a multi-disciplinary and integrated enquiry into the dynamics of an arid-zone ecosystem in which deleterious successional changes taking place are apparently strongly influenced by the impact of human and livestock populations. Ideally, the numerous components of the ecosystem would be investigated simultaneously, necessitating a moderate to large team of specialists. In the case of IPAL in Kenya, limited funding has necessitated the employment of a team of three ecologists in the preparatory phase and five in the operational phase with the emphasis of the

investigation on the four main lines of enquiry assumed to have the highest immediate priority. These are (i) climate, (ii) vegetation and soils, (iii) ungulate animals (wild and domestic) (iv) human populations.

In order to provide the foundation for the essential capability of monitoring ecological trends in the future, stress is laid upon establishing quantitative base-lines in the measurement of biomass and productivity at each trophic level in relation to the prevailing climate, soil moisture and soil type and, in particular, to the land-use practices of the indigenous people.

6.2 Climate

The measurement of climate, particularly rainfall is a fundamental requirement in an investigation of land use capability and ecological trends. In the highly variable climatic conditions of northern Kenya, nearly all ecological measurements, e.g. primary and secondary production, are related to precipitation (but also to drainage and water retention characteristics of the soils).

In order to relate all observations made in the IPAL working area to localized rainfall conditions, a network of 17 monthly-read rain storage gauges and one daily-read gauge has been set up across the working area.

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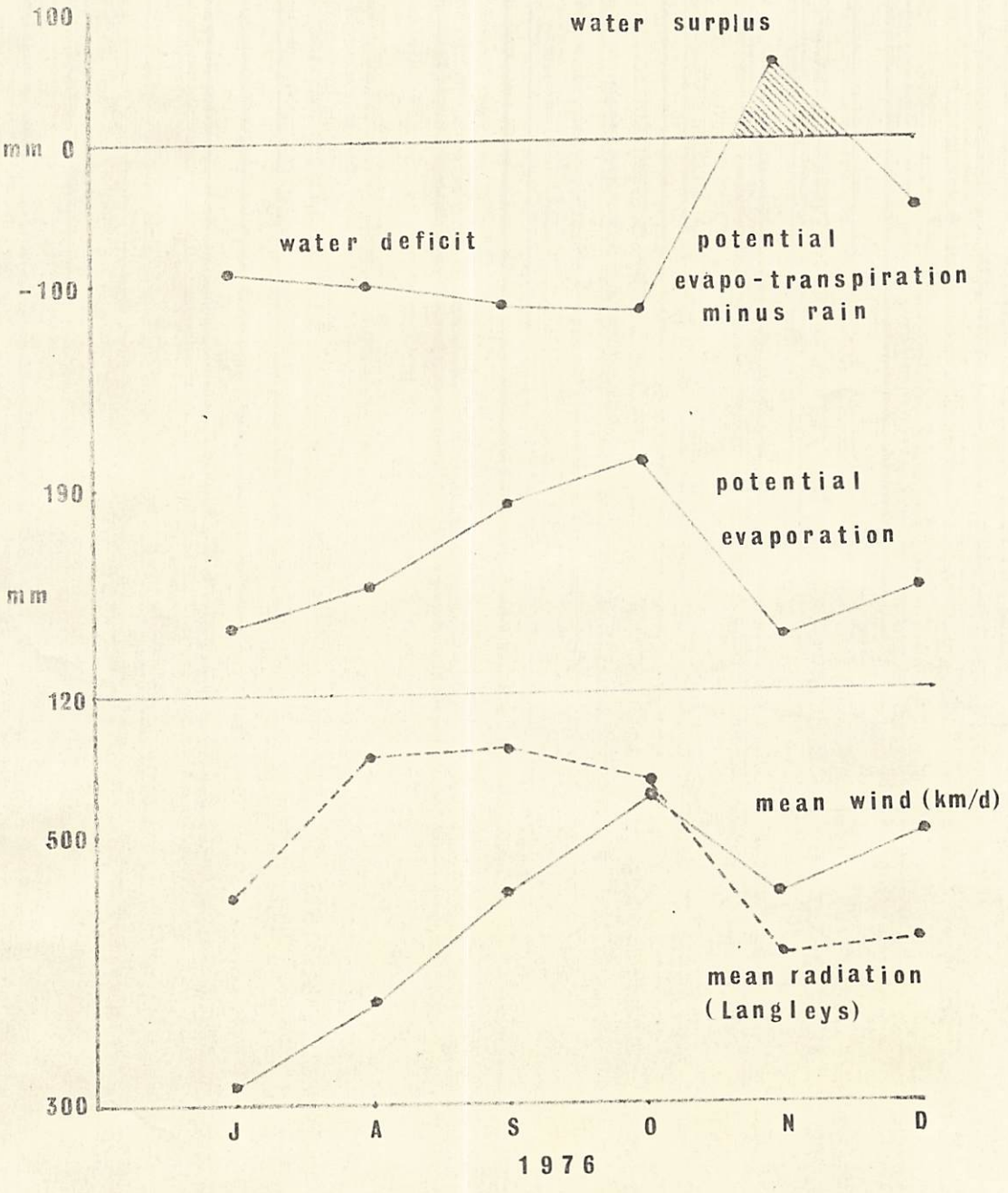
Figure 4



Graphs showing mean monthly run of wind and radiation (lower), Penman potential evaporation, (centre) and potential evapo-transpiration less rainfall (upper), at the IPAL Field Station, Mt. Kulal.

It is intended that the station will be moved down to the sub-desert in the near future and will be replaced by a conventional Stevenson's Screen at Gatab. At present the station is supported by and checked against some daily read conventional instruments. Rainfall during 1976 at the field station on Mt. Kulal (1,800 m a.s.l.) was only 309 mm, the lowest since recordings were begun by the Mission ten years ago. The months of July to September were dry with no significant rain for 117 days. From November 1976 to April 1977 monthly rainfall has been above average with the exception of February. On April 4th no less than 185 mm. fell in seven hours leading to considerable run off and soil erosion.

6.3 Vegetation

(i) Introduction:- Objectives

Ultimately, a major aim of IPAL is to develop a map of land capability classes for the study area with accompanying suggestions for proper use of each land class. A class will represent units of land with similar potential for supporting certain types and degrees of agricultural, pastoral or other economies and to which similar management principles may be applied. This map will draw strongly on experience gained during the IPAL study and will provide a basis for development planning such as that carried out by the Marsabit District Development Committee.

To this end a map is being prepared of the major vegetation communities of the area. Each vegetation community reflects a different combination of environmental factors; climate, soils as well as land use history - and hence, a different potential for biological productivity and stability. A comparison

of the completed vegetation map with maps of climate, soils, and land use patterns will be made to prepare the final map of land capability classes.

Further, 3 different methods of mapping soil/vegetation units will be compared for information content, cost, and time spent to determine the approach or combination of approaches most suitable to similar survey needs elsewhere in arid regions. The methods include: (1) LANDSAT imagery to be used during the next year, (2) mapping units based on assumption of close correlations between vegetation and topographic units, (FAO Rangeland survey of Marsabit District, 1971), (3) mapping units based on a more detailed and intensive field survey being carried out at the present time.

Pastoralism, the principal land-use throughout the study area, depends upon adequate supplies of forage and water for its long term maintenance. Hence it is important to study the timing and amount of primary productivity of the area's vegetation (forage) and its relationship with environmental factors. Such knowledge will assist in defining indices of biological potential of land capability classes. It will also allow estimates of available forage and its subsequent offtake by livestock. An important aspect of this study is a cooperative effort with other IPAL staff members on the impact of different stocking levels of camels and goats on rangeland (vegetation and soils) condition.

Another major aim of the IPAL is to identify any processes leading to desertification within the study area and to develop methods for their containment and eventual reversal. Desertification processes appear in vegetation through reduction in amount of

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vegetation and in compositional changes from relatively mesic to successively more xeric species and growth forms. Also associated are changes in soil conditions such as decreases in organic matter, soil permeability or losses of the finer soil fractions from top soil and increased erosion.

In order to identify adequately and to monitor such processes, it will be necessary to carry out an analysis of rangeland condition and trend. Rangeland condition is estimated by comparing the soils and vegetation of an area with those found under relatively natural or optimal conditions within the same ecological unit. An associated analysis of the land use history of the former area - if possible - can indicate the general factors causing the process and perhaps as well indicate rates of change (trend) of rangeland. Otherwise, the latter analysis requires the monitoring of rangeland condition changes on permanent sample plots over a long period of time.

Should desertification processes be identified within the study area, methods must be developed for their containment and reversal. Depending on the degree to which the process toward desertification has progressed this will require some regulation of use of the area involved or even cultural measures such as dune stabilization or reafforestation. In this case we should consider not just returning soil and vegetation conditions to their former level but also - where feasible - to introduce new approaches to land use. These should be complimentary to those existing as well as create new opportunities to raise the overall productive potential of the land.

A similar opinion appears to be shared by several other organizations involved in development and relief work in

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northern Kenya. This includes all levels of the Kenya Government. Therefore, this part of the IPAL programme is being carried out in close cooperation with those organizations (N.C.C.K., A.I.M., Catholic Church, Kenya Government) active within the IPAL study area. A great deal of interest has been shown in afforestation programmes and in developing agricultural crops adaptable to arid conditions. Here, the contribution of the IPAL is primarily advisory. This includes help in planning tree nurseries and trial plantations and in subsequent analysis of results or in expediting contacts and exchange of information between local people/projects and down country or international organizations which may be helpful to their eventual success. Where another organization has not already become active (portion of the study area or a specific ecological or resource problem) the IPAL will become more directly involved.

(ii) Plant collection and identification

Members of the Arid Lands Project have collected 674 plant specimens of which 396 have been identified by the East African Herbarium in Nairobi. A herbarium cabinet has been obtained. This contains 261 mounted specimens.

(iii) Vegetation mapping

Field work on the vegetation map is approximately 75% finished. Estimated time of completion of the field work is about June - July of 1977.

(iv) Reafforestation

Working relations have been established between the project and several organizations in northern Kenya. These organizations are: the Kenya Government, Catholic Church, Africa Inland Mission,

Figure 5

Marked vertical photograph of the Balesa Kulal fenced experimental plots, each totalling 40 ha, and sub-divided as shown, for several simulated livestock management treatments:

Camel plot I: high density; equivalent to 3 camels/km^2/year.

Camel plot II: low density; equivalent to 0.5 camel/km^2/year.

Camel plot III: medium density; equivalent to 1.5 camels/km^2/year.

Sheep and goat plot I: low density; equivalent to 7.5 sheep and goats/km^2/year.

Sheep and goat plot II: medium density; equivalent to 22 sheep and goats/km^2/year.

Sheep and goat plot III: high density; equivalent to 44 sheep and goats/km^2/year.

CONTROL : NO TREATMENT.

and National Christian Council of Kenya. Emphasis is being placed on applied research to determine species and cultural practices suitable for use in northern Kenya to revegetate degraded areas or to use as fodder and/or other domestic/ commercial products.

The contribution of the IPAL (Arid Lands Project) is primarily advisory, including help in planning nurseries and trial plantations and in subsequent analysis of results. Thus, we are able to carry out needed ecological research while simultaneously contributing to ongoing development projects within Marsabit District.

To date, a small tree nursery has been established at North Horr and preliminary seed germination experiments carried out with seeds of Acacia tortilis, A. albida, Cordeauxia edulis and Tamarindus indica. All four species are indigenous to the arid and/or semi-arid regions of East Africa. A single female date palm was obtained from the FAO irrigation scheme on the Turkwell River and planted in the Chief's compound. The compound contains 2 other date palms, of unknown sex, planted in the 40's. Local authorities have granted permission for establishment of 3 - 1 acre plots for planting out experiments.

At Kalacha permission has been granted for exclosure of 10 acres and use of a nearby spring to establish a tree nursery and experimental plantings. Two female date palms (obtained from the FAO irrigation scheme) have been planted out. These were the first date palms in Kalacha.

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The project has been consulted by A.I.M. and N.C.C.K. about ecological aspects of the Hurri Hills afforestation scheme. Future participation includes monitoring of vegetation within and without control exclosure plots and training of an assistant to continue this work for A.I.M./N.C.C.K. upon completion of our project.

Three hundred and twenty tree seedlings have been planted out in 17 trial plots at Gatab. These were obtained from the Forest Dept. nursery at Marsabit and include: Olea africana, Croton megalocarpus, Casuarina equisetifolia, Jacaranda mimosaefolia, Grevillea robusta, Shinus molle, Eucalyptus maculata, and Melia azedarach. All planted areas were fenced to exclude livestock.

70 Acacia tortilis seedlings were planted at Balessa Kulal at 500 m. elevation.

A reafforestation meeting and the District Development Meeting for Marsabit were attended on March 15 and 16th. Means of expediting afforestation of the district were discussed.

(v) Primary productivity, ecological condition and trends of vegetation communities:

A 1 - acre exclosure plot was established at the 1,500 m level on Mt. Kulal in an Acacia drepanolobium Disperma eremophilum woodland community - an important grazing area for milk cattle from the Gatab area. The study of this community will include:

a. primary productivity;

b. changes in composition, structure, and productivity in the course of recovery of this community from its present over-grazed state.

An initial clipping of herbaceous vegetation in and out-side of the plot was carried out at the end of the rainy period in January. Dry weight analysis awaits installation of the drying oven at Gatab. All trees within the exclosure were measured for

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N
METRES
0
100
200
SCALE
PLOT 1
10 ha.
CAMEL I
10 ha.
CAMEL II
2.5 ha.
SHEEP
GOAT
CONTROL
10 ha.
CAMEL III
2.5
SHEEP
GOAT II
TESSA R.
CAMP


CAMP

Figure 6

Marked oblique aerial photograph of the Balesa Kulal experimental site (shown also in the vertical photograph in figure 5). View from the south.

The fence of the southern boundary of the No.1 plot is visible and, like the other boundaries, is marked on the photograph with a white line. For explanation of the uses of the different paddocks, see figure 5.

Figure 7

Tented camp at the Balesa Kulal experimental plot site for temporary accommodation of ecologists and assistants. A wooden house/laboratory has now been constructed on this site.

Figure 8

Project building and fencing materials off-loaded at the Balesa Kulal experimental site. Note *Acacia tortilis* tree in the foreground on the bank of the water course.









Figure 9

Experimental tree planting: following the heavy rains of April 1977, large numbers of recently fallen fruits of Acacia tortilis in the IPAL working area have resulted in prolific seed germination under the canopies of the parent trees. The seedlings, which normally die in this situation can be removed for planting elsewhere. The photograph shows a seedling Acacia about to be transplanted from the ground below the canopy of a native tree to a plastic bag, using a simple instrument developed by the Project. These instruments, which are being made in Kenya in a somewhat elaborate form, enable rapid transplanting of seedlings to be made by removing the plant together with a cylinder of soil with the root system almost undisturbed.

Figure 10

Project Assitants transferring Acacia seedlings to polythene bags for removal to planting areas.

Figure 11

Rendille sheep and goat herd, at the village of Korr in the south of the IPAL working area, being examined by the small-stock ecologist and visiting veterinarian, Dr. A. Carles, of the University of Nairobi.

Korr is an area badly affected by desertification and has a population of Rendille people subsisting partly on famine relief.

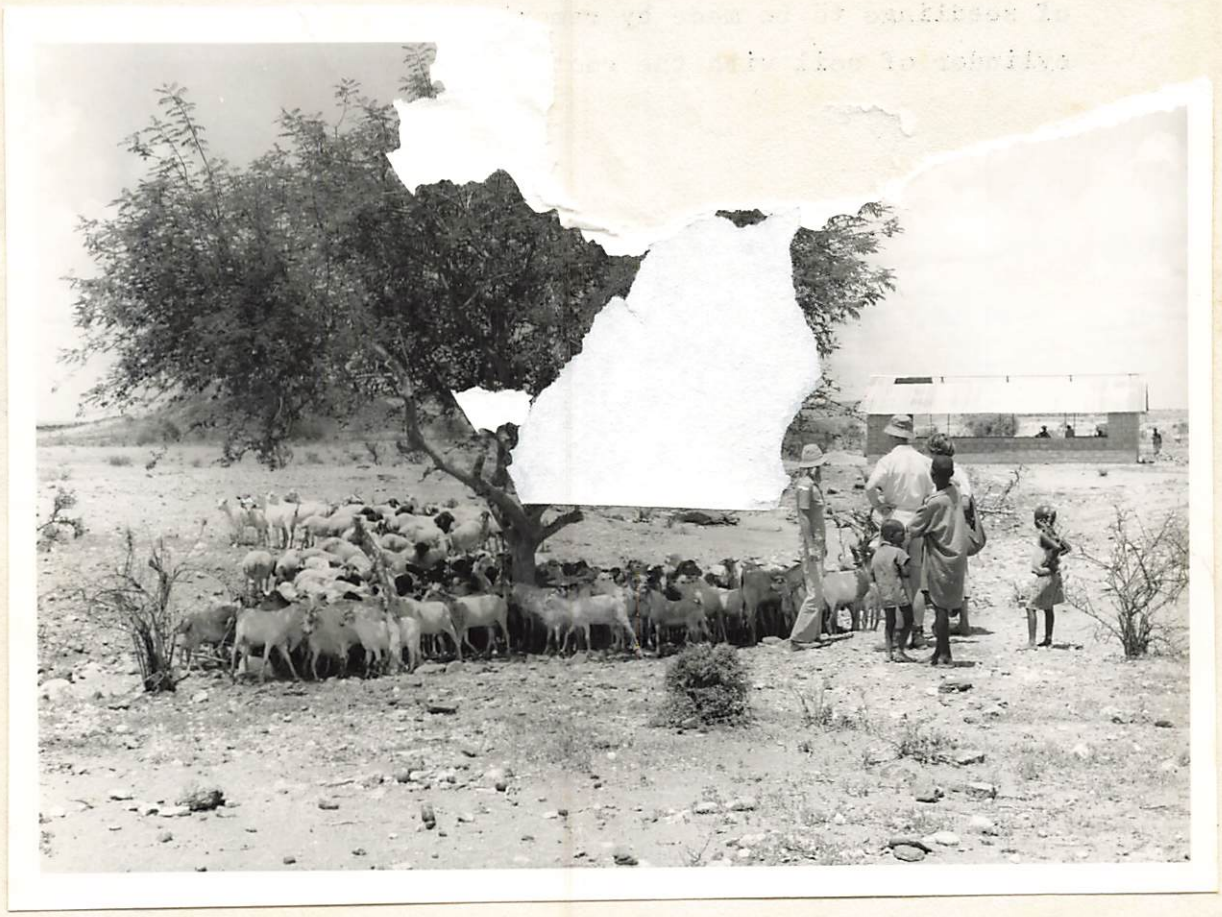
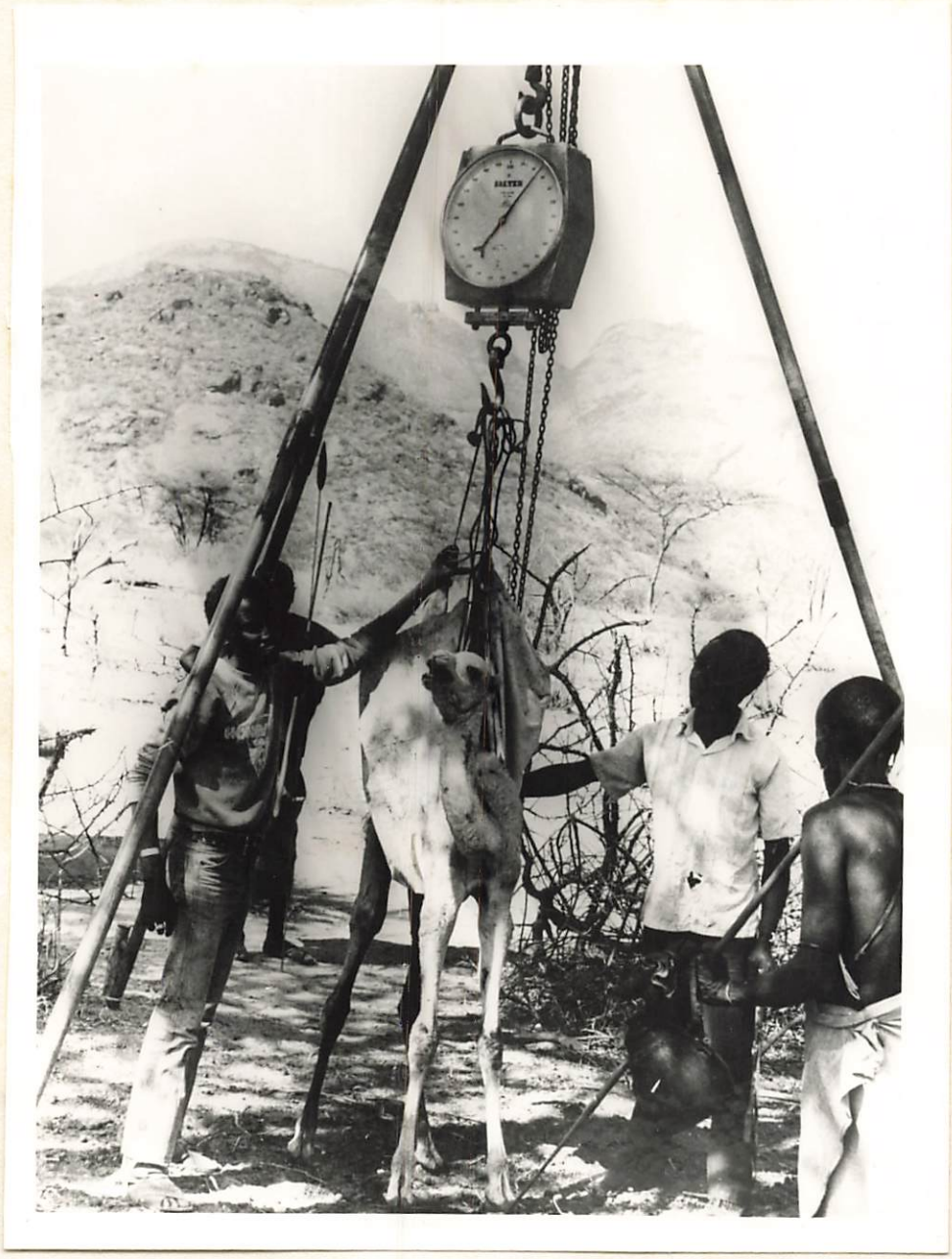




Figure 12

Collection of blood sample from one of the Project's camels for trypanosome count.

Figure 13



Weighing young camel: the programme of data collection for the livestock ecology investigation from which population characteristics, & productivity and consumption figures will be obtained.

37° Figure 14 38°

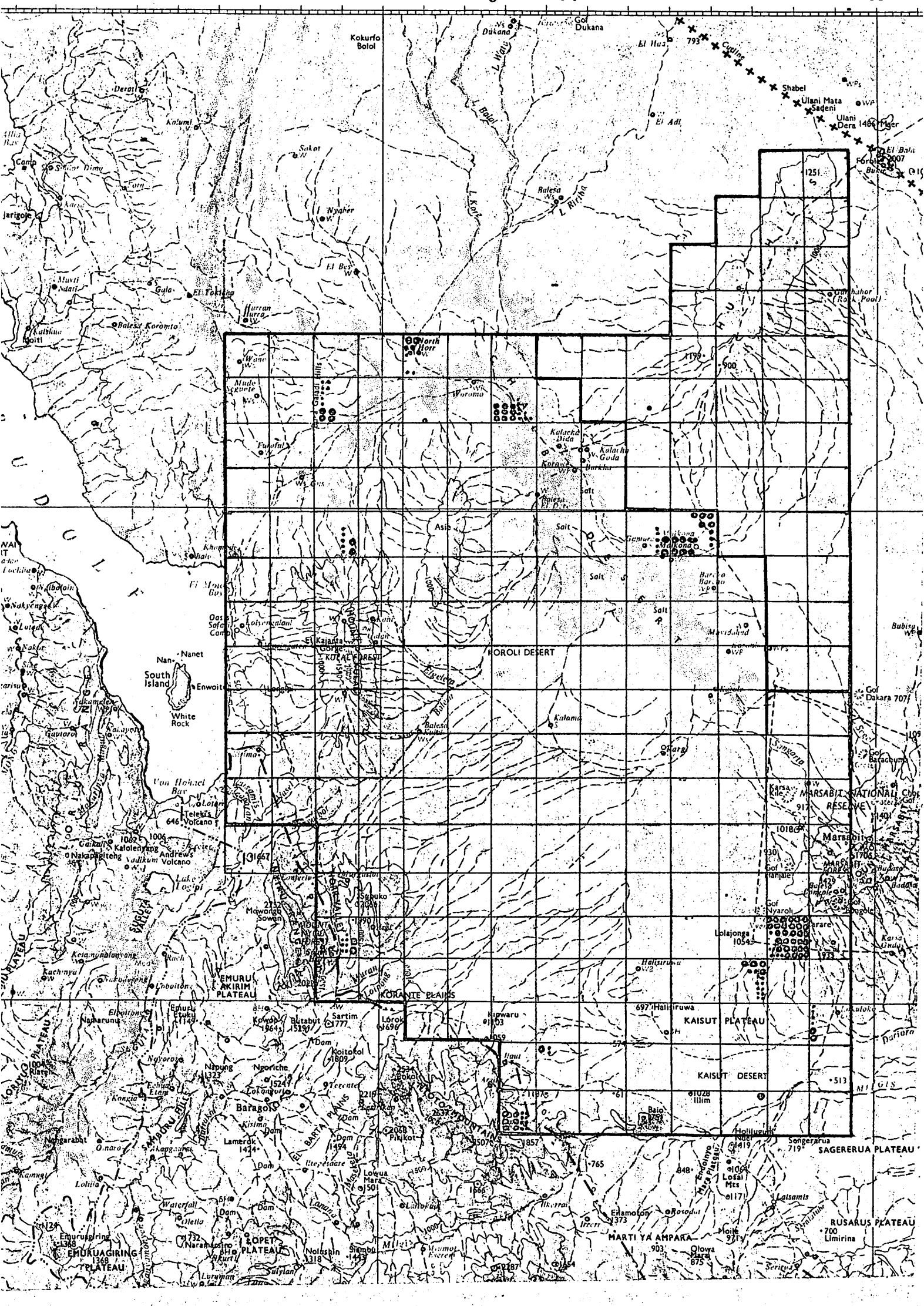

Kokurfo Bolol
Gof Dukana
Dukana
El Hua
793
Shabel
Ulani Mata Sadeni
Ulani Dera 1466
El Adi
Derati
Kalumi
Sukot
Nyaher
Balesa
El Beso
Jarigole
Camp
Muvti Ndati
Gula
El Tokitua
Balesa Koromta
Kalshue Boiti
Hurran Hurra
North Horr
Wane
Mude gumte
Gof Galadi Hills
Furuful
Voroma
Kalacha Dida
Kalacha Goda
Kotaro
Burkha
Salt
Asia
Gamuro
Malkona
Khomo Gofa
Oasis Safari Camp
Nanet
Nan-
South Island
Enwoit
White Rock
Nakuyenga
Loteit
Nabor
Sukamoten
Gautoro
Von Hohnel Bar
Teleki's Volcano
646
Gakali
Kalolenyang
Nakapagiteng
Andrew's Volcano
Kaisamis
Lake Logipi
Kachinyu
Keiangonalanyang
Loboiton
EMURU AKIRIM PLATEAU
KORANTE PLAINS
KOROLI DESERT
KOROLI FOREST
Kaisamis Gorge
Kibolenya
Balesa
Kalama
Karsa
Karsa Kile
MARSABIT NATIONAL RESERVE
Marsabit
Gof Hanjale
Gof Nyaroli
Lolajonga 10543
Halisiruwa
697 Halisiruwa
KAISUT PLATEAU
KAISUT DESERT
Kipwaru 1103
Kowop 1964
Butabut 5190
Sartim 1777
Lorok 1696
Koitotol 1809
Napung 1323
Ngoriche 1524
Lolaguro
Baragoiyo
Kirima Dam
Lamerok 1424
Pikikot
Nagarabat
Omaro
Lowua Mara
Lolokwe
Ilkerrai
Ilkerra
Enamotony 1373
Rosodol
Losai Mts 1171
Laisamis
Sengerarua 719
SAGERERUA PLATEAU
RUSARUS PLATEAU
Limirina
MARTI YA AMPARA
Olowa Mara 875
Moile 971
Lolia
Waterfall
Olletia
Dam
Emuruagiring 1368
EMURUAGIRING PLATEAU
LOPET PLATEAU
Nolushin 1318
Siambu 1449
Suiylan
Luruman
Mt Kuri
Mt Kulal
Mt Nyiru
Mt Ngurunit
Mt Marsabit
Mt Kaisut
Mt Ololokwe
Mt Mansoret Exercet
Mt Ngurunit
Mt Kaisut
Mt Ololokwe
Mt Mansoret Exercet
Mt Nyiru
Mt Kulal
Mt Kuri
Mt Marsabit
Mt Kaisut
Mt Ololokwe
Mt Mansoret Exercet
Mt Ngurunit

Figure 14

Part of the East Africa 10 km grid on the map of the Mt. Kulal working area (scale 1: 1,000,000).

Camel numbers and distribution observed on the IPAL sample aerial survey for August 1976 (very dry conditions). The numbers observed represent a 6% sample, and should therefore be multiplied by 16.67% to give approximate totals.

o = 10 observed. . = 1 observed.

Note: the camels are nearly confined to the vicinity of the permanent water sources around the periphery of the area.

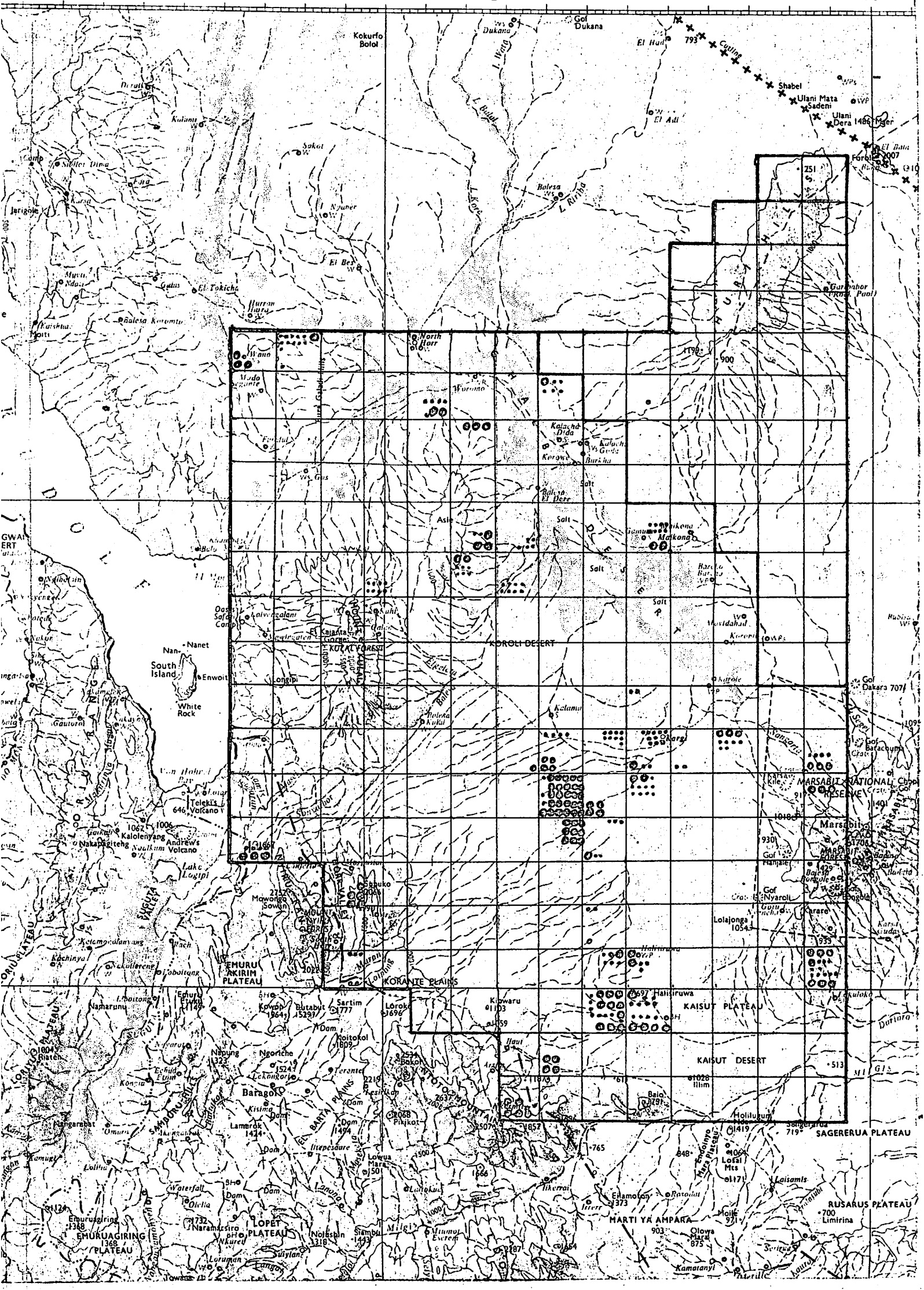
Figure 15

Camel numbers and distribution observed on the IPAL sample aerial survey for March 1977 (after localised rain).

Numbers as for figure 14.

Note: most of the camels have been moved to the site of the rainfall.




Kokurfo Bolol
Gof Dukana
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El Hadi
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Ulani Mata Sadeni
Ulani Dera
Forole
Sakot
Balesa
Jerigole
El Beso
El Tokicha
Kalacha Dida
Kalacha Gedi
Burkha
Salt
Asile
Matkona
KOROLI DESERT
KOROLI FOREST
Nanet
South Island
Enwoit
White Rock
Gof Dakara
Kalama
Olarge
MARSABIT NATIONAL RESERVE
Marsabit
Gof Nyaroli
Lolajonga
Halisiruwa
KAISUT PLATEAU
KAISUT DESERT
Illim
Baio
Holiturum
SAGERERUA PLATEAU
Telekis Volcano
Andrews Volcano
Lake Logipi
Mowonga Sowan
MOUNTAIN
EMURU AKIRIM PLATEAU
KORANITE PLAINS
Loroke
Kiowaru
Namarunu
Kowop
Butabut
Sartim
Koitokol
Ngoriche
Baragoi
Lekongorio
Terentet
Pinykot
Lamerok
Lowua Mara
Waterfall
Olelia
Emuruagiring
EMURUAGIRING PLATEAU
LOPET PLATEAU
Naramasiro
Nojosapin
Siambu
Lorumon
Suiylani
Tangam
Ilkerrai
Ekamotany
Ratoloti
MARTI YA AMPARA
Olowa Mara
Kamaranyi
Loisamis
Lorai Mts
Endigimo Mara Plateau
RUSARUS PLATEAU
Limirina
Mole
Lake Turkana
Kokuro
Nangarabat
Kamuge
Lolitu
Lorubai Plateau
Ndoto Mts
Nyiro
Mt Kulal
Kulal Forest
Oasis Safari Camp
Kalacha
Gof Baracoumo
Crater
Nanyuki
Isiolo
Maralal
Baragoi
Suguta Valley
Suguta Plateau
Kachinyal
Ngoboitong
Ketumpolanyang
Gakuli
Nakamgitehg
Kaloleinyang
Nauikum
Lorian Swamp
Lorian Gabel Hills
Wano
Wudo
Waromo
Gof Dukana
Shifter Dima
Jarigole
Kurkur
Gautoro
Nanet
Longipi
Ngaroto
Echuro Etum
Ngoroto
Ngoriche
Kongia
Lekongorio
Terentet
Kisima
Dam
Lamerok
Lowua Mara
Waterfall
Olelia
Emuruagiring
Naramasiro
Nojosapin
Siambu
Lorumon
Suiylani
Tangam
Ilkerrai
Ekamotany
Ratoloti
Olowa Mara
Kamaranyi
Loisamis
Lorai Mts
Endigimo Mara Plateau
Mole
Limirina
Lake Turkana
Kokuro
Nangarabat
Kamuge
Lolitu
Lorubai Plateau
Ndoto Mts
Nyiro
Mt Kulal
Kulal Forest
Oasis Safari Camp
Kalacha
Gof Baracoumo
Crater
Nanyuki
Isiolo
Maralal
Baragoi
Suguta Valley
Suguta Plateau
Kachinyal
Ngoboitong
Ketumpolanyang
Gakuli
Nakamgitehg
Kaloleinyang
Nauikum
Lorian Swamp
Lorian Gabel Hills
Wano
Wudo
Waromo
Gof Dukana
Shifter Dima
Jarigole
Kurkur
Gautoro
Nanet
Longipi
Ngaroto
Echuro Etum
Ngoroto
Ngoriche
Kongia
Lekongorio
Terentet
Kisima
Dam
Lamerok
Lowua Mara
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Naramasiro
Nojosapin
Siambu
Lorumon
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Tangam
Ilkerrai
Ekamotany
Ratoloti
Olowa Mara
Kamaranyi
Loisamis
Lorai Mts
Endigimo Mara Plateau
Mole
Limirina

Figure 16

A sheep and goat herd. Census photograph. Figures 16, 17 and 18 are examples of photographs taken by the observers during systematic survey flights to facilitate counting of livestock. Note inner white fibre-glass rod defining the inner edge of the 300 m transect strip.

Aircraft height: 100 m above ground level. Transect strip width: 300 m on each side of aircraft defined by white rods mounted on wing struts (see figure 20).

Figure 17

A cattle herd. Census photograph. For further explanation see figure 16.

Figure 18

A camel herd. Census photograph.

Note tip of fibre-glass rod defining the outer edge of the transect strip.









Figure 19

The Project aircraft at the Balesa Kulal experimental site air-strip. The Senior Ecologist, Carpenter-mason and a field assistant are in the photograph.

Mt. Kulal is in the background, 20 km. away to the west.

Figure 20

The aircraft fitted with fibre-glass rods, mounted behind the wing-struts. The rods are positioned to frame for the observers a 300 m transect strip on the ground when the aircraft is flown accurately at 100 m above ground level by means of the radar altimeter.

height/diameter at breast height, and will be remeasured annually.

Herbaceous vegetation within and without the project compound and a smaller fenced meteorological site at Gatab (1800 m) was sampled at the end of the last growing season. The meteorological site plots were clipped to determine primary productivity and grazing use. Annual species of Eragrostis and Chenopodium dominated both sites reflecting an early state of secondary succession of the herbaceous vegetation at Gatab. In other words the area has been heavily overgrazed. Vegetation inside the meteorological site was 78.1% (fresh wt) of the total sampled. Offtake was approx. 3.4 kg/ha/day. Again this indicates the heavy use of the area by livestock.

A survey was made of the size and vigor of all Cedar (Juniperus procera) trees on the project compound because a large number appeared to be dying just prior to the last rainy period. Regeneration appeared low and mortality was high (17%). Mortality was highest in the 2-6 m height class (29.8%). It is probable that while extended drought has decreased rainfall, heavy use of the area by livestock has additionally decreased available soil moisture by increasing surface runoff. Seedling survival is subsequently low. Trees of the 2-6 m height class are just emerging from the surrounding Rhus-Carissa bush layer into the high wind/evapotranspiration zone above. The high water demand in a low water availability situation could explain the greater mortality of this size class.

All healthy cedar trees on the compound were tagged and measured for height. Height measurements will be repeated annually.

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6.4 Aerial Survey

Systematic aerial resource surveys were carried out in the working area in July and August 1976 and January and March 1977. The method involves flying along the middle of the ten kilometres square grid on an east west axis. The aircraft is flown at 100m above ground level with the aid of the radar altimeter. Two observers seated in the back of the plane record all domestic stock and wildlife occurring in a strip 300m wide on either side of the plane. The limits of the strip are defined by rods (Fig 20) attached to the wing struts of the aircraft and calibrated accordingly. Each 10 km. is divided into two sub-units and the two observers count four sub-units per 100 km^2 (or 772 in the whole study area). The occurrence of human settlement, surface water and green vegetation are also recorded. Photographs are taken of herds numbering over 20 individuals to enable accurate counting at leisure. Estimates of population size, density and biomass density of livestock and wild ungulates have been calculated.

Satisfactory trial aerial photography of vegetation was carried out to test the Project's equipment and techniques. Systematic sample photography of vegetation on various scales for base-line documentation and for comparison with past (survey) and future (sample) photography will be undertaken in 1977. This will enable estimation of trends in vegetation cover and in tree and shrub populations.

6.5 Large browsing herbivores (Camels)

Emphasis in this work has been on camels, since wild herbivores are relatively uncommon. The work was carried out by Dr. Field and assistants.

(i) Population size and dynamics

The aerial sample surveys have yielded the following estimates of numbers in the study area (19,300 km^2):-

...../28

	July 1976		August 1976		January 1977		March 1977	
	N+	D	N	D	N	D	N	D
Camels	7,235	0.50	14,352	0.74	59,745	3.10	24,488	1.27
Gerenuk	717	0.05	1,984	0.10	1,400	0.07	1,200	0.06
Giraffe	650	0.04	950	0.05	1,417	0.07	1,800	0.09

N = Number D = Density km^{-2} + = Area of 14600 km^2 only

In the January survey, counts of good photographs of camel herds showed that observers were overestimating by 31%. The corrected estimate of the camels population is 42,092. Confidence limits for these estimates will be calculated when the correct statistical procedure is advised.

During the dry months of July and August many of the 'fora' or nomadic herds had moved south out of the study area to better grazing. Their return in November with the improved conditions explains the large increase in the January and March surveys.

Distribution maps of camels during the August and March censuses are shown in Figs. 14 & 15. These show an August concentration on settlements with possibly only two fora herds at South Horr and N. Mt. Kulal. The fora were very large, probably in response to the need for protection against raiding. In January there was a concentration of camels on Kargi where there had been heavy rain. Localised densities were as high as 53 km^{-2}. More than 20 new Rendille manyattas had moved there from Korr, Loglogo and Ilaut and about 7 Gabbra manyattas from as far as North Horr. At the end of March scattered heavy showers let to a dispersal of the Kargi herds into the little used Hedad and of Gabbra herds to the north west. (Fig. 15).

(ii) Nutritional studies

(a) Eight camels, four females, three castrated males and a bull, have been purchased for nutritional studies and safari purposes. Twelve sets of feeding observations have been carried out at Luai on Mt. Kulal, the Balesa Kulal, Kargi

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and North Horr. These areas are representative of dry mountain slopes, riverine vegetation, Koroli sub-desert and Chalbi desert vegetation respectively. Over 6,000 feeding observations have been recorded and about twice as many observations of available food plants. From these figures the percentage preference for each plant species has been calculated (see Annex 5A).

Among many other things the observations confirm that camels have a high preference for the dwarf shrub Indigofera spinosa and for the saltbushes Sueda monoica and Salsola species. In contrast to the findings of other authors however, camels did not appear to like grasses.

Tentative conclusions are that being bulk feeders the feeding strategy of camels is to strike a balance between highly palatable but uncommon plants and less palatable but abundant plants. The preferred height range of feeding appears to be from dward shrubs (c. 1m) to trees (4m).

(b) A site has been chosen and work has begun on one of the sets of paddocks in which grazing trials using the camels, sheep and goats are to be carried out. The site is on sand at the foot of Mt. Kulal.

(c) Nine different sets of 12 hour activity studies have been carried out on the camels by assistants. The purpose of this work is to understand more fully the behaviour of the camel in relation to food supply and heat stress and to determine whether existing management techniques can be improved. Three of the studies were made at night when the camels were in their 'boma' at Kargi. This was to determine the time camels spend ruminating as it is hoped to develop correlations between this activity and the fibre content of their diet.

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(d) Water consumption of the experimental camels was recorded during September and October 1976. They drank every ten days throughout this dry period. After this, lush growth with the rains enabled the camels to survive for the following 100 days without drinking other than at ephemeral pools.

(iii) Camel productivity

(a) Growth

Using a tripod, pulley and sling 185 young camels up to 20 months old were weighed twice. It was not possible to weigh older camels and we await the delivery of a platform scale for this. Although the majority of camels were weighed at Kargi we also weighed at Maikona, Ngoronet, N. Horr and Kalacha.

Growth curves have been drawn for all camels combined and for camels born in May/June 1976 and those born in November/December 1976. Camels born in the earlier direr period grew at the rate of 0.25 kg/day while those born in the later wetter period have grown at the rate of 0.61 kg per day. This is probably attributable to the better conditions for lactation of their mothers during the wetter period. Likewise older camels from N. Horr and Kalacha, both very dry areas, have grown at the rate of only 0.22 kg. per day up to the age of 20 months.

(b) Manyatta survey

Questionnaire forms have been completed for eight settlement manyattas - three Gabbra and five Rendille.

Results are summarized as follows:-

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average number of people per manyatta: 77

" " " family: 18

" " " house: 3

average number of milking camels per person: 0.7

average number of camel milk per person: 0.9 (Range 0.3-1.4) lts.

average percentage mortality of camels <2 yr. : 38

average percentage mortality of camels >2 yr. : 9

More data are needed before these figures become meaningful.

(c) Mortality

Fifty camel skulls have been collected from presumed natural deaths. These have been measured by Mr. Masheti and their teeth eruption and wear classes have been recorded. It is hoped to assign absolute ages when known age skulls are available. A preliminary survivorship curve has been drawn. Similar methods are being used for giraffe skulls.

Mortality of young camels is attributed to ticks or tick-born diseases (49%) and camel pox (35%). Acaricides have been made available to owners of tick infested camels and the Livestock Marketing Division gave us 20 litres of acaricide for distribution at Kargi. A formal meeting of the elders was held at which the dip was handed over and the opportunity was taken to explain to them the aims and objectives of the project.

Blood sera, faecal samples and ticks from camels have been sent for analysis and for identification by the Veterinary Laboratories at Kabete.

6.6 Sheep and Goats

The following work was carried out by A.C. Field who is funded by the Ministry of Overseas Development, United Kingdom:

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The aim of the project is to determine numbers, distribution and seasonal movements of sheep and goat flocks in the study area, and to combine this data with data on food habits and offtake so that the total effect that sheep and goats are having on the environment can be evaluated. Data on flock species, sex and age ratios, growth rates, reproductive rates and occurrence of diseases are also being collected to give an idea of the productivity of the flocks.

Field work started in August 1976. Flocks have been divided into two main catagories; 1) sedentary flocks which graze around urban centres and provide meat and milk for people who are settled more or less permanently in these centres and 2) nomadic or semi-nomadic flocks which may move over long distances in search of grazing.

To date most work has been done on 6 sedentary flocks situated at Gatab. These total about 300 animals which are weighed, sexed and aged every two months. Growth rates of about 50 kids and lambs are being plotted at regular intervals. Similar data is being obtained from Ngurunit. In addition two flocks at Kargi have been weighed, sexed and aged. The Kargi flocks are semi-nomadic.

Food habits of sheep and goats have been studied at Gatab during wet and dry seasons, and during the wet season at Kargi. It is hoped to combine these with data on offtake; at Gatab this will provide an indication of the effect of the flocks on the watershed vegetation, while the Kargi data would indicate effects of flocks grazing in a small area around a desert settlement.

Activity studies are also being carried out to discover the total time spent feeding of the flocks. It has emerged that during the dry season flocks may spend a considerable

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proportion of the day walking to suitable grazing areas.

Data on milk production will also be collected.

Causes of mortality are being noted where possible both through a questionaire approach and direct observation. It is hoped that more information will be forthcoming during the visit of the veterinary consultant to the project. It appears that the major causes of death in the district are 1) directly due to the effects of starvation during dry periods (mostly young stock, 2) tick-borne diseases, 3) epidemics of anthrax, enterotoxaemia and pleuropnoumonias and 4) plant-poisonings. Occasionally predators take a heavy toll, and many animals are simply reported by their owners as 'lost'.

SECTION VII CONSULTANCIES

7.1 UNESCO Consultancy on Grazing Ecosystems

J.G. Lewis - Hunting Technical Services Ltd.

The short term consultancy will be a reconnaissance survey of the ecological and management aspects of cattle, donkeys and wild grazing herbivores in the Project's study area. The survey will report on the present situation and indicate priorities for future work.

Dr. Lewis will:-

(i) Assess the relative importance of the various components of the grazing ecosystem in the project area.

(ii) Assess the productivity of domestic grazing herbivores and the grass/herb layer.

(iii) Determine the requirements of the people for the products of cattle and other grazing herbivores.

(iv) Investigate the present livestock marketing system in the area and assess the potential for future development.

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(v) Integrate the findings of the surveys with those of other studies in the project area with a view to establishing long term management procedures.

Dr. Lewis started work in Northern Kenya on April 5th 1977. Negotiations for the following consultancies are well under way:-

7.2 Climatology and Hydrology consultancy - Institute of Hydrology, Wallingford, U.K.

7.3 Veterinary consultancy

Dr. E. Allonby, F.A.O./Kenya Government.

7.4 UNESCO Consultancy on the Application of Systems Analysis to Arid Lands Studies - Institute of Terrestrial Ecology, U.K.

7.5 UNESCO Consultancy on LANDSAT imagery interpretation for landscap mapping of broad range types.

Dr. R.H. Haas, Department of Range Science, Texas A&M University, U.S.A.

7.6 Consultancy for a Review of Historical and Bibliographic Data on Northern Kenya

N.W. Sobania, School of Oriental and African Studies, University of London. (Request for funding made to U.S. Government).

SECTION VIII TRAINING

8.1 Dr. P. Sinda, our Senior Soils Assistant, has received two months training in soil survey from Mr. Wijngaarden; Soil Scientist at the Tsavo Research Station under the auspices of the Kenya Soil Survey. He will be returning to the project shortly.

8.2 Four Assistants and two trainee Public Relations Officers have received in-service training in various aspects of general ecology, meteorological recording, botanical collection, aerial survey and large mammal biology.

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SECTION IX. FUTURE WORK PLANS FOR PROJECT COMPONENTS IN PROGRESS AND PROPOSED FOR THE OPERATIONAL PHASE (1977-79) IN KENYA

9.1 Detailed proposals for seven component investigations were included in the project document for IPAL in Kenya. The following are in progress and are designed to continue at least until the end of 1979:-

a) The dynamics of Acacia dominated woodlands (in the Mt. Kulal region of northern Kenya). (Described in Annex 5).
Investigator: D.J. Herlocker - Woodland Ecologist, UNESCO.

b) The management of browsing herbivores for the conservation of woody vegetation in the arid lands of northern Kenya. (Described in Annex 5).
Investigator: C.R. Field, Senior Ecologist, UNESCO.

c) Sheep and goat ecology in the Mt. Kulal region of Marsabit District. (Described in Annex 5).
Investigator: A.C. Field, Small stock ecologist, O.D.M.

9.2 IPAL is designed primarily to investigate the relationships of human populations and their livestock to their environment, in particular to assess the impact of nomadic peoples on the vegetation in arid and apparently degrading ecosystems. The following components are considered essential additions to the operational phase of the project to enable it to fulfill this function.

a) The ecology of grazing herbivores in the sub-desert region of northern Kenya. (Described in Annex 5).
(Support for this component is being sought from a source of bilateral assistance).

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b) The dynamics of ground layer vegetation with special reference to the effects of wild and domestic ungulates in northern Kenya. (Described in Annex 5).

(Support for this component is sought from sources of bilateral aid).

c) The ecology of pastoralism in northern Kenya.

The emphasis of this sub-project will be upon the people of the Gabbra tribe and on their own (rather than their animals' impact) upon their habitat. (Described in Annex 5).

(This component is expected to be implemented by a sociologist/ human ecologist to be recruited by UNESCO as a member of the Project's expert staff).

d) The efficiency of livestock management in traditional nomadic pastoralism. A comparative study of the widely ritualized livestock management of the Rendille in Marsabit District (Kenya) and modern range management and animal husbandry practices.

The emphasis of this study will be upon animal husbandry rather than on the people themselves.

(This component is expected to be implemented by an animal husbandry specialist recruited by UNESCO under the Associate Expert scheme with the sub-project financed by the Federal Republic of Germany). (Described in Annex 5).

SECTION X BUDGET EXPENDITURE

10.1 A statement of approximate expenditure agains budget lines at 30 April 1977 is given in Annex 6 to this report. Accounting for the salaries of expert staff has been carried by UNESCO Headquarters and this budget line has therefore been omitted from the statement.

With two exceptions, expenditure has remained within the allocated sum for each budget heading at 30 April 1977. The first exception is an over-expenditure of $500 on the emoluments of field station staff. The second is an over-expenditure of $5,000 on the purchase of vehicles, due to an unexpected price increase after the budget was prepared. The latter over-expenditure was balanced by a saving of $5,000 in the budget line for the purchase of an aircraft.

At 30 April 1977 an approximate sum of $ 247,000 had been spent out of the allocation of $ 285,600. (These sums do not include the experts' emolument allocation and expenditure).

ANNEX 1

UNESCO EXPERT STAFF

Project Coordinator: H. F. LAMPREY

Biologist (Ecologist): 25 years field experience mainly in East Africa, Sudan and Middle East.

Previous posts held: Wildlife biologist, Tanzania 1953-1963.
Principal, College of African Wildlife Management, Tanzania. 1963 - 1966.
Director, Serengeti Research Institute, 1966 - 1973.
Ecological Consultant, I.U.C.N., 1973 - 1975.
UNEP Consultant, 1975 - 1976.

Degrees: M.A. (Hons. Natural Science; Zoology, Oxford University)
D. Phil. (Animal ecology) (Oxford University).

Main Scientific interests: Interactions between animals and vegetation. Arid zone ecology. Conservation of natural ecosystems.

Publications: Scientific papers, book chapters, and contribution to UNESCO State of Knowledge Reports. Amounting to 36 items.

Subjects: Ecology, faunistics, agricultural crop protection, national park management, conservation of biotic communities.

Languages: English and Swahili.

Senior Ecologist: C. R. Field

Biologist - (Ecologist): 15 years field experience in Uganda and Kenya.

Previous posts: Scientific Investigator, Acting Administrator, Nuffield Unit of Tropical Animal Ecology, Uganda, 1962 - 1969.
Wildlife Scientist, Texas A&M University (working in Kenya) 1970 - 1974.

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Degrees: M.A. (Hons.). (Natural Science, Zoology) Cambridge University.

Ph. D. (Animal ecology and physiology) Cambridge University.

Main Scientific interests: Animal ecology and nutritional physiology.

Publications: 20 Scientific papers.

Subjects: Animal ecology and physiology.

Languages: English and Swahili.

Woodland Ecologist: D. J. Herlocker.

Forester; forest ecologist: 11 years field experience in East Africa.

Previous posts: Timber appraiser, Oragon State Tax Commission, U.S.A. 1960 - 1964.

Assistant Conservator of Forests (Peace Corps) Ngorongoro Conservation Area, Tanzania, 1964 - 1967.

Forest Ecologist, Serengeti Research Institute, 1968 - 1973.

Degrees: B.Sc. Forestry and Forest Management, University of Washington (Seattle).

Master of Forestry, Oragon State University.

Ph. D. Forest Ecology, Texas A&M University, U.S.A.

Main Scientific interest: The ecology of the East African semi-arid woodlands.

Publications: Five scientific papers. Subjects: floristics; vegetation survey and mapping; plant ecology; soil science; rainfall patterns.

Languages: English and Swahili.

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Procurement and Supply Officer (Administrator): E.B. Wilson
Economist.

Posts held: Apprentice Mason, U.S.A.
Research Assistant/Director of Student Workers - American Institute of Public Opinion.

Economic Evaluator - UNEP, Nairobi, Kenya
Programme Officer, Programme Coordinating Unit, UNEP.

Universities: B.A. Economics/Political economy/African studies. Princeton University.
AM/AF Scholar (African/American Institute)
Haile Selassie I University, Addis Ababa, Ethiopia.

Publications: Economic integration in Eastern Africa; A study of two proposals.
Thesis, Princeton University, U.S.A.

Languages: English (French and Swahili slight).

U.K. O.D.M. Sheep and Goat Ecologist: Alison C. Field.

Biologist (Ecologist): 7 years field experience in Uganda and Kenya.

Previous Posts: U.K. Study and Serve biologist, Makerere University, Uganda. 1970-1972.
Part-time Demonstrator, Nairobi University. 1974.
East African Wildlife Society - Consultant with mammal Group. 1975.

Degrees: M.A. (Hons) Natural Science; Zoology, Oxford University.
M.Sc. Zoology, Makerere University, Uganda.

Main Scientific interests: Small stock ecology. Problems of Arid Lands.

Publications: Two scientific papers.

Languages: English and Swahili.

ANNEX 2

Published work on arid zone vegetation relevant to IPAL in Kenya

Chew, R.M. & Chew, A.E. 1965. The Primary Productivity of a Desert Shrub (Larrea tridentata) community. Ecological monographs. 35: 366-375.

Dirschl, H.J. Townsend, G.H. and Sinotte, R.J. 1974. Technical evaluation of the proposed Kenya Ecological Monitoring Project. CIDA. 68 p. 6 appendices. Typescript report.

Edwards, D.C. 1940. A vegetation map of Kenya with special reference to grassland types. J. Ecol. 28, 377-385.

Glover, P.E. 1950. Rain water penetration in British Somaliland soils. E. Afr. agric. J. 16, 26-33.

Glover, P.E. 1950-52. The root systems of some British Somaliland plants. E. Afr. agric. J. 16, 98-112 (Part I); 16, 154-173 (Part II); 16, 205-217 (Part III) and 17, 38-50 (Part IV).

Glover, P.E., Glover, J. and Gwynne, M.D. 1962. Light rainfall and plant survival in East Africa. II - Dry grassland vegetation. J. Ecol. 50, 199-206.

Grum, A. 1975. Rendille habitation. A preliminary report. 137p. Typescript report.

Heady, H. 1960. Range management in East Africa. Government Printer, Nairobi. 125p. (Ecology, management practices, problems and recommendations).

Hemming, C.F. 1971. Recommendations on exclosures. Survey of northern rangelands, Somali Democratic Republic. Workink Paper AGP: SF/SOM 12, FAO, Rome 35p. (Discusses criteria used in selecting sites for exclosures and presents initial results on some established sites).

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Laurie, M.V. 1974. Tree planting practices in African savannas. FAO, Rome. 185p. (Discusses various aspects of tree planting programmes, including ecological zones, possible species, nursery methods, planting out, tending, economics etc.)

National Academy of Sciences, 1975. Underexploited tropical plants with promising economic value. Washington D.C. 188p. (Presents potentially worthwhile plant species; discusses present knowledge and suggests further lines of research).

Le Houérou, H.N. (undated). Relationships between rangeland production and average annual rainfall. Part II. The Sahelo-Sudanean Zone of Africa. Mimeo report. 11p.

Le Houérou, H.N. 1972. An assessment of the primary and secondary production of the arid grazing ecosystems. Proceedings of the International Symposium on the Eco-physiological foundation of Ecosystems in Arid Zones. p.168-172. Academy of Sciences of USSR, Lenigrad.

Le Houérou, H.N.1975. Ecological Management of Arid Grazing Lands ecosystems. Proceedings of the Regional Meeting on Ecological Guidelines for the Use of Natural Resources in the Middle East and South West Asia. Persepolis, Iran. IUCN/FAO WS/F9361. Mimeo 12p.

Lind, E. M. and Morrison, M.E.S. 1974. East African Vegetation. Longman, London. 257p. (The only attempt to date to assemble all information on East African vetetation).

Peberdy, J.R. 1969. Rangeland. In East Africa: its peoples and resources. (Ed. W.T.W. Morgan) Oxford University Press, Nairobi. p. 153-176. (Ecology, range classification, areas, stock populations, commercial ranches, pastoralists' land tenure etc.).

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Pratt, D.J., Greenway, P.J. and Gwynne, M.D. 1966. Classification of East African Rangeland. J. Appl. Ecol. 3, 369-382.

Woodhead, T. 1968. Studies of potential evaporation in Kenya. Ministry of Natural Resources, Water Development Department. 69p. (Used in preparing water budget and in defining ecological zones and land capability classes).

ANNEX 3

Work on Camels in Northern Kenya and elsewhere - The current status

1. At present there is no known programme of work specifically on camels other than that of the UNESCO/IPAL.

2. The following work has been done in Kenya:-

a) Bremaud, O. (1969) Notes on Camel Production in the Northern Districts of the Republic of Kenya. Mission: April-May-June, 1969.

Maisons Alfort IEMUT; Translated to English by I.L.C.A.

(This is the most comprehensive study in the literature, but it was of short duration only).

b) Kenya Government. Annual Reports of District Veterinary Officers. (Give records of slaughter and sales in the Districts, but there is very little data on camels).

c) Sato, S. (1976) Preliminary report of camel ecology among the Rendille in Northern Kenya. Mimeo pp7.

(Study of Rendille Tupcha clan which involves only 405 people & 20 camel herds. From May 1975 to October 1976. Contains some errors in calculations).

d) Spencer, P. (1973) Nomads in Alliance. Symbiosis and growth among the Rendille and Samburu of Kenya. O.U.P. (Work was from 1957 and 1962. Mostly sociological, but contains a chapter on livestock and its management).

e) Grum, A. (1976) Rendille habitation. Nairobi. Mimeo pp137.

(concerns mostly the structure of the Rendille home and manyatta. Shows movements of one manyatta since 1903. Work period Jan-August 1975)

f) Torry, W. (1973) Subsistence ecology among the Gabbra: Nomads of the Kenya/Ethiopia Frontier. Ph.D. Thesis Columbia University. (Work was from November 1969 to May 1971; most of the work was carried out at Bubisa on the Odola/Galbo clans).

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3. Further information is available in the following:-

UNDP/FAO. (1971) Rangeland surveys, Kenya, Range Development in Marsabit District. 134pp Mimeo.
(Contains data gleaned from other sources principally on shoats and cattle, but also camels which are treated more superficially).

Brown, L.H. (1963) The development of semi-arid areas of Kenya. Nairobi. Ministry of Agriculture. Mimeo (Camel numbers).

Spinks, L.H. (1967) East African Livestock Survey - Development requirements Vol.1. FAO 196[illegible]. 215p. (camel numbers).

Watson, R.M. (1970) Aerial Livestock and Land Use Surveys for Marsabit and Isiolo Districts. Nairobi. Min. of Agriculture Mimeo (camel numbers, document apparently unavailable).

Fratkin, E. (1977) The dual cattle-camel economy of the Ariaal Rendille. I.A.S. March. p 12 Mimeo. (Ariaal Rendille are of fringe importance in the study area).

Gwynne, M.D. (1977) Land use by the Southern Turkana. I.A.S. March. pp 13 Mimeo. (Turkana are of fringe importance in the study area).

Maloiy, G.M.O. (1972) Comparative studies on digestion and fermentation rate in the prestomach of the one humped camel and the zebu steer. Res. Vet. Sci. 13: 476-481. (Laboratory study).

- IBID - (1972) Renal Salt and Water excretion in the camel symp. zool. soc. Lond. 31. 243-258 (Laboratory study)

Macfarlane, W.V. & Howard, B. (1972) Comparative water and energy economy of wild and domestic animals. Symp. zool. soc. Lond. 31: 261-296. (comparative physiological study in laboratory).

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Richard, D. (1975) Etude de la pathologie de dramadaire dans la sous-province du Borana (Ethiopie). Vet. Doctorate Thesis. Ecol. Nat. Vet. d'Alfort. ppl81.
(Concerns camel diseases in Boran province of Ethiopia adjacent to northern Kenya boundary).

General literature on camels is reviewed in:-

Dahl, G. & Hjort, A. (1976) Having Herds
Stockholm Studies in Social Anthropology: University of Stockholm.

4. More than 50 references to camels are inour possession. Eleven of these refer to Kenya, but only three are specifically concerned with work on camels.

5. It is understood from the D.V.O. Marsabit District, Dr. Onyango (personal communication) that the Kenya Government have requested a survey of camel numbers and production in Northern Kenya with a view to export to Saudi Arabia and Sudan. This further emphasises the importance of the UNESCO/IPAL camel sub-project. It is envisaged that there will be cooperation with the D.V.O. in this respect.

ANNEX 3a

Published references on human ecology, livestock and range management in the IPAL working area and associated regions

1) AGROTEC (1974) Southern Rangelands Livestock Development Project. Part II. Studies and Surveys
Vol. 1. Range Ecology
Vol. 3. Animal Husbandry and Health
Report to Imperial Ethiopian Government.

2) Baxter, P.T.W. (1954) Social organisation of the Boran of Northern Kenya. D. Phil Thesis, Oxford University.

3) Bremaud, O. (1969) Notes Sur l'elevage camelin dans les districts nord de la Republique du Kenya. April-June (1969) Maisons Alfont IEMVT.
Translated by ILCA.

4) Brown, L.H. (1963) The Development of the Semi-arid areas of Kenya. Mimeo Report, Ministry of Agriculture, Nairobi.

5) F.A.O. (1971) Range development in Marsabit District. AGP: SF/KEN 11 Working Paper. Nairobi.

6) Fratkin, F. (1977) The dual cattle-camel economy of the Ariaal Rendille. IAS, March. pp12. Nairobi.

7) Grum, A. (1976) Rendille Habitation. Mimeo Report, Nairobi.

8) Gwynne M.D. (1977) Land use by Southern Turkana. IAS. March. pp.13. Nairobi.

9) Institute of African Studies (1977) Pastoral Societies in Kenya. Seminar, March 1977. University of Nairobi.

10) Republic of Kenya (1976) Marsabit District Development Plan 1974-78 . Marsabit.

11) Republic of Kenya Reports of District Veterinary Officer
District Livestock Officer
District Range Officer
District Agricultural Officer,
Marsabit District.

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12) Richard, D. (1975) Etude de la pathologie du dromadaire dans la sous-province du Borana (Ethiopie).
Thesis for Veterinary Doctorate - Ecole Nat. Vet. d'Alfort.

13) Sato, S. (1976) Preliminary report of camel ecology among the Rendille in Northern Kenya. Mimeo report. pp7. Nairobi.

14) Spencer, P. (1973) Nomads in Alliance. Oxford University Press.

15) Spinks, R. (1967) East African Livestock Survey, Development Requirement, Vol. 1. FAO. 215pp.

16) Torry, W. (1973) Subsistance ecology among the Gabra; Nomads of the Kenya/Ethiopia Frontier. Ph.D. Thesis, Columbia University.

17) UNESCO/UNEP (1977) Man and the Environment in Marsabit District. Edited Proceedings of Conference at ALP Field Station, Mt. Kulal. December 1976. UNESCO, Nairobi.

18) Watson, R.M. (1970) Aerial Livestock and Land use surveys for Marsabit and Isiolo District. Mimeo Report, Ministry of Agriculture. Nairobi.

ANNEX 4 FACILITIES AND EQUIPMENT

1. Buildings at the Mt. Kulal Field Station (All prefabricated)

1 Laboratory for 6 field scientists.

2 Houses (for Senior and Woodland Ecologists).

3 Small houses for administrator, visiting scientists and students.

Housing for 10 ancillary staff.

1 Store and general workshop building.

1 Carport and vehicle workshop.

1 Rondavel House / Laboratory (at Balessa experiment).

2. Site works and facilities at the Mt. Kulal Field Station

Water piping to laboratory and houses.

Perimeter fence round 2 hectare compound.

4 x 1,000 gallon rainwater tanks.

4 Solar Water-heating units for houses.

3. Vehicles and Aircraft

3 Land Rover Long-wheelbase Pick-up trucks for use of experts.

1 Leyland $7\frac{1}{2}$ ton truck for transport of building material and supplies.

1 Cessna 185 light aircraft for transport and survey work.

4. Equipment

1 set aerial photographs of working area

1 Stereoscope
2 Cameras and accessories for aerial reconnaissance photography
2 Microscopes (high power and dissecting)
117 x 300m rolls of cyclone fencing wire for experimental plots
1 Pocket calculator/computor
1 Radar altimeter (fitted to aircraft)
1 Electric generator (240 v. and 12 v.)
1 Livestock weighing platform
1 Mechanical post-hole digger, and sundry Forestry equipment
10 collapsible aircraft fuel bags.

ANNEX 5

Summaries of current and future work in the component investigations of IPAL.

1. Dynamics and ecology of Acacia dominated woodlands:-

D.J. Herlocker, UNESCO Woodland Ecologist

1. Classification, mapping and inventory of tree and shrub communities, topography, drainage, soils and climate, using aerial and satellite photography, and ground and air reconnaissance, and sample plots.

2. Investigation of woodland dynamics, growth rates, phenology, foliage production and mortality in relation to soils, drainage, climate and the influence of man, domestic animals wildlife and insects, using repeated sample air photography at various scales, exclosure plots and experimental treatments and management regimes, within them.

3. The experimental planting of arid-adapted tree and shrub species, to elucidate the techniques most suitable for their propagation on a large scale and the conditions under which they can be grown most effectively, as an aid to the accelerated recovery of woodland vegetation and the eventual rehabilitation of the region's grass cover and soils.

2. The management of browsing herbivores for the conservation of woody vegetation - C.R. Field, UNESCO Senior Ecologist.

(a) Animal numbers and distribution.
Aerial surveys along regular transects will be carried out at least on alternate months to plot the number and distribution of camels and large wild herbivores in relation to plant communities, their quality and quantity, to habitation and to the availability of water and shade and the occurrence of fire. A computer programme analysis of these data is available. (Cobb, pers. comm). A total count of camels using aerial photographs for large herds will be attempted twice a year.

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(b) Composition and dynamics.

Manyatta surveys will yield sex and age composition of camel herds. Ground track counts after Rodgers (1969) should be made at regular intervals on the existing tracks in the study area. These counts will provide information on gerenuk and dik-dik habitat selection as well as herd structure for the other species. Time allotted: 6 months to run concurrently with 2.

2. Browse Offtake and Browsing Impact.

a. Species composition of diet and food preference.

Direct observations of the food habits of the Project's camels and if possible other herds will be made at monthly intervals in specific plant communities. Food availability will be assessed by eye each minute or by using the Point Centred Quarter method of analysis (Dix, 1961). This will allow computation of species' food preferences.

b. Quantity and Quality of the diet

The quantity of food eaten may be determined either by using fistulated camels, by a penning experiment or indirectly through faecal output. Water consumption will be measured at regular intervals. The chemical composition of the diet will be analysed, and hence it will be possible to determine whether camels are selecting for a particular component, e.g. moisture or minerals. Much work has already been published on heat tolerance, as well as on water economy and excretion of salts and water by camels (Schmidt-Nielson, 1964, Maloiy, 1972). No additional work along these lines is anticipated.

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Food habits of wild herbivores will be studied by direct observation but difficulties are anticipated and indirect methods, such as assessment of damage to vegetation by elephant and giraffe and examination of faeces or stomach contents from any animals that are shot, may also be used.

c. The ecological impact of browsers.

In this context ecological impact = intake of herbage and trampling less the beneficial effects of manuring. Other indirect effects are seed dispersal and the prevention of fire through offtake and trampling.

The gross ecological impact can be assessed with camels by using a paddock trial after Field and Lewis (in prep.). In such a trial camels, sheep and goats would be put in adjacent paddocks at different stocking rates. Vegetation would be analysed before and after the trials. Growth would be assessed by botanists by means of small exclosures within the paddocks which would be measured after each growing period. Overall effects of large herbivores on woody vegetation should be determined by comparing the growth in a control paddock with growth outside. Ideally the paddocks should cut across the main plant communities present. If this is impossible two or three paddock complexes should be constructed. An important consideration for the siting of the paddocks would be the availability of water. Subsequent trials should be aimed at achieving an optimum stocking rate where damage to trees is negligible but impenetrable thicket is prevented. This would serve as a demonstration area to show the indigenous people how to manage their animals.

d. Seed dispersal and germination. The fate of seeds of important woody plants e.g. Acacia tortilis, which have been eaten by camels may be observed. Survival of seeds during drought is important in particular when dispersed by camels which are made to cross desert areas that are not normally used by wild animals. Droppings of wild animals may also be examined for seeds.

Time allotted : 12 months to run concurrently with 1 & 3.

3. Productivity

The aim will be to manage domestic and wild animals for the required productivity but with minimum damage to the environment.

i. Individual production.

Productivity may be assessed in terms of live weight gain in kg/day or yield in litres/day of milk. Some of these data will be derived from the resident herd of camels. Crude growth curves of camels are available from northeast Kenya (Watson, 1972). By consultation with the pastoralists other products such as hides and the value as a beast of burden should be quantified.

ii. Recruitment, mortality and the establishment of life tables which combine with 3(i) to yield the productivity of the population.

iii. Effect of disease and malnutrition on camel productivity.

iv. Requirements of the people for camels for food (meat and milk), ceremonial purposes and for transport. Calculation of the excess of production by sex and age over requirements.

Time allotted: 6 months to run concurrently with 4.

a large part in providing the needed data, but other data will be provided by extrapolation from observations on locally-owned Rendille, Samburu and Gabbra flocks.

2. Importance of sheep and goats in tribal economy; husbandry techniques

A. The role of sheep and goats in the domestic economy of the Rendille, Samburu and Gabbra in Marsabit District will be determined, largely through verbal communications with livestock owners. This data will be difficult to quantify but will be vital in assessing future management techniques and the possibility of setting up industries based on small-stock.

ii) Present management techniques used by the three tribes will be investigated. This will include herding techniques, veterinary medicines currently used, selection procedures (if any) etc.

B. Veterinary problems existing in the small-stock of the area will be investigated and quantified with the help of the Veterinary Consultant to the Project.

3. Development of sheep and goats in the district

Using the data collected above, and by the Arid Lands Project as a whole it is hoped to make, and if possible initiate implementation of proposals to improve the productivity of Marsabit small-stock while at the same time minimising any deleterious effect of sheep and goats on the vegetation. This may include:-

a) Upgrading existing stock either by selective breeding of indigenous animals or by importing of exotic breeds or by a combination of the two dependent on local conditions/facilities. This will be implemented with a view to both local and export needs.

b) Improved husbandry techniques and preventative veterinary care programs will be an integral part of this. This will include advice on optimum stocking rates in various areas.

c) Concurrant with these marketing facilities and rural industries based on by-products will have to be set up as incentives for flock improvement.

Time scale

Sections 1 and 2 will of course be implemented concurrently, with the primary emphasis on Section 1 for the first 18 to 24 months of field work. Towards the end of the study more emphasis will be placed on the developmental aspects of the work.

Development phase

4. Management and Development

This could take place in the following ways:-

a. Improved public relations. An educated Rendille is to be employed as a P.R. Officer.

b. Education of the people through the P.R. Officer and adult education classes to establish :-

a. An improved herd composition.

b. Fewer animals.

c. Improved grazing management.

c. Passive management by demonstration of 2c.

d. Persuasive management by provision of veterinary and animal husbandry clinics for quality control of domestic stock through castration of excess males and breeding programmes. Culling.

e. Provision of outlets for marketing of excess products. This will include the participation of the people in rural industries such as butcheries and tanneries.

Time allotted: 12 months to run concurrently with 3.

N.B. It is appreciated that the above proposal is exhaustive and will require more than one person to effect. It is expected that the following sections will be carried out jointly with other staff members:-

Applied Research phase

1a. Aerial censuses.

2c. Paddock trials and range demonstration.

Development phase

4a Public relations.

4b Adult education.

4d Veterinary clinics and culling.

4e Marketing.

Sheep and goat ecology in the Mt. Kulal region of Marsabit District

An outline by A. C. Field (O.D.M. Small-stock Ecologist).

Duration of field work: approx. 30 months - April 1976 to October 1978.

1. Basic research on sheep and goat ecology

A. Population dynamics, densities and distribution

i. Numbers, distribution and densities of shoats in whole study area. Data taken mainly from aerial surveys, with supplementary data and if possible correction factors from ground counts.

ii. Herd compositions (sheep/goat ratio, sex and age classes) of herds a) near settlements b) fora herds of Rendille, Samburu and Gabbra. Ground observations.

iii. Population dynamics and productivity of selected Samburu, Rendille and Gabbra shoat flocks in selected areas. The selection of flocks will to a large extent depend on the degree of cooperation from the owners. Flocks will be catagorised a) mobile b) 'sedentary' ('urban') and also according to vegetation communities in which they are usually herded (e.g. upper, middle or lower mountain slopes, low country; the vegetation zones would be identified by the project Botanist). A comparison of shoat productivity between the various management regimes will be made.

b. Major food preferences and estimated of offtake of woody and herbaceous vegetation will be determined and thus a model of effects on the vegetation in different vegetation communities will be computed. This will include data on role of shoats in dispersal of woody plants. It is visualised that the grazing enclosure plots will play

The ecology of grazing herbivores in the sub-desert region of northern Kenya

Duration: 3 years - February 1977 - January 1980.

METHODS

The methods used in this enquiry will range from the extensive monitoring surveys of the working area to preliminary investigations into the nutrition and physiology of the animals being studied.

a. Monitoring Programme

The four species of grazing animals being studied, cattle, donkeys, oryx and zebra, will be included in the aerial monitoring surveys that will be carried out by various members of the field station. Data from this programme will yield information on the distribution population numbers, habitat selection and movements of the grazing animals in relation to such environmental factors as vegetation types, quantity and quality, fire, surface water, and inter-specific interaction.

Further detailed information on herd size and structure and animal condition would be obtained from ground counts in selected regions of the study area.

b. Activity Studies

Comparative data on the daily activity of the four species being investigated will be collected at various times during the study. Changes in the daily activity of herbivores with different environmental conditions have been shown to indicate the various ways in which each species is adapted to exigencies of a semi-arid environment (Lewis, in prep.). Such information would be of particular value when comparing the utilization of the habitat by wild and domestic stock. Special emphasis will be placed on the effects of herding and the night enclosure of domestic stock.

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c. Nutritional and Physiological Studies

Aspects of the nutrition and physiology of the important grazing herbivores in the area will be investigated. The species to be observed and the aspects to be investigated can only be decided after an initial period of research has identified the relative importance of each species and the nutritional and physiological parameters which are of greatest importance.

It is expected, however, that the composition of the diet, digestive efficiencies and thermo-regulation will be important. Only limited information on such aspects can be gathered from free-living animals and it will therefore be necessary to obtain captive animals in order to collect suitable data. The cooperation and advice of experienced workers in these specialised fields will have to be obtained before such investigations are undertaken.

The project that has been outlined here is intended to supply information on the ecology of grazing animals in a sub-desert environment. Little is known about the role of both wild and domestic grazing animals in the destruction and possible rehabilitation of arid environments, but if such areas are to be protected and developed this information will be of considerable value.

5. The dynamics of ground layer vegetation with special reference to the effects of wild and domestic ungulates in northern Kenya and the Sahelian Zone.

Duration: 3 years.

METHODS

The methods to be used for each topic of field work are listed below. Inevitably some methods will serve to answer several questions.

a. Mapping from aerial photographs and ground observation using established methods to characterize associations. Vegetation types thus defined will be used as a basis for setting up permanent quadrats and experimental enclosures and will be described quantitatively using the "point centred quarter" method of Cottam and Curtis (1956). Vegetation recording will follow the methods of Barkham and Ridding (1974) adopted in the similar vegetation survey in Samburu District, northern Kenya.

b. Aerial photographs, standard vegetation photographs, ground transects with permanent quadrats and permanently marked individual plants will be used to check changes in different vegetation types and their boundaries over a period of at least three years.

c. Field measurements will consist of destructive sampling inside and outside exclosures in each of the selected different vegegetation types. Harvesting at intervals, drying and weighing different plant parts will be carried out according to the I.B.P. Handbook. Methods used will allow for repeatability and continuation of the project into the monitoring phase.

d. Field measurements will include experiments and soil smapling. Plant parts and faeces will be analysed.

e. Field measurements will consist of analysis using quadrat sampling techniques (according to Greig-Smith 1961, 1964; Kershaw, 1973 and Usher, 1969), plus grazing, root cutting and transplanting experiments.

f. Repeated random sampling inside and outside exclosures or repeated measurements of permanent quadrats will be made.

g. Monitoring individually marked plants. Production of actuarial data from repeat measurements at intervals over three years. Soil sampling and standard techniques for identification of living seeds.

h. Use of pattern and demographic data. Density experiments combined with seedling transplants.

It is provisionally planned as a project to be executed in Kenya by bilateral assistance from the National M.A.B. Committee of the U.K. as a component of the UNESCO-UNEP Arid Lands Project under MAB 3. It is anticipated that this project would incorporate into the UNEP-UNESCO Programme in other countries in the arid zone.

6. The Ecology of Pastoralism in Northern Kenya

Duration:- 3 years.

Proposal

The purpose of the proposed research is to enable us to understand and model this process, and to develop feasible solutions to the economic and ecological problems of the pastoralists in the Mt. Kulal region.

The populations in question are two Nilotic speaking populations, the Turkana and the Samburu, and two populations of Eastern Cushitic speakers, the Rendille and the Gabbra (Boran speaking Galla). These peoples, with their different patterns of social organization and livestock management will be the subjects of the proposed investigation..

The enquiry will take place as follows:

1. The distribution of the four populations within the area under investigation will be determined, and approximate numbers of people and livestock are established (in co-operation with other investigators in the central project).

2. The population structures of the human populations will be determined.

   The method used will be a cohort method where the correct age distribution is reached through an iterative process (see Howell 1973). The method is not a survey method, but demographic research among the four populations is greatly facilitated by the presence of age sets among them all. It may be possible to apply the cohort method to samples of the populations, and establish the age distribution within the age sets. Then one can simply ask people which age set they belong to.

3. The patterns of seasonal and historical migrations will be established; the seasonal migrations through aerial surveys; the historical migrations through interviews, district books, accounts of explorers (von Honnel 1894, 1938) and historical works (Goto 1972, Turton 1969).

4. The social and economic organization of the four populations will be described and interpreted in terms of adaptation to the environment, including other human populations. Recently a number of attempts (Pastner 1971, Rubel 1969, Spooner 1971) have been made to build generative models of pastoralism, concerning the relationship between types of livestock and social organization. These attempts have been overly simplistic, but further developments along the lines suggested in those papers would be worth-while. The area lends itself readily to gradient analysis, e.g. along a gradient of increasing aridity. Along this gradient we may expect change from dependence on cattle to dependence on camels, increasing division of the herding units (e.g. the herd divided up into herds of milch cows, dry cows, milch camels, etc.),

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and increasing complexity of social organization, facilitating the extension of reciprocity.

5. Proposals for improvement of the economic condition of the pastoralists and the long term preservation of their habitats will be made. This involves:-

   a. Studying the effects of sedentarization. Henin (1969) suggests that the settled populations of the Sudan have lower ages of marriage and higher fertility rates than the pastoral populations. My own work in Tanzania indicates the same. Moreover, sedentarization is often followed by a rapid increase in infectious diseases, and sometimes, where famine relief food is handed out, with a general decline in the nutritional value of the diet and settlement in areas which have no possibilities for economic development. Sedentarization is an ongoing process in Northern Kenya; the point is that it brings with it special problems necessitating careful planning.

   b. Planning the long term preservation of the pastoral habitat. This involves determining the carrying capacity of the environment, and getting the local populations to accept the environmental limitations. As most people are more concerened with relatively short term problems, this is extremely difficult. The best way of introducing new livestock management schemes is to prove that they improve the economic position of the people participating in the schemes, the worst way is through police enforcement. Nevertheless, some form of coersion is usually necessary. Hopefully the local populations can be made interested in implementing rules of livestock management, onece these rules have proved beneficial.

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Too often the economic potential of pastoralism is seen as being almost solely one of meat production. An attempt should be made to investigate the possibilities for economic growth based on dairy production, serving the needs of the local populations, including neighboring agriculturalists.

7. The efficiency of livestock management in traditional nomadic pastoralism - A comparative study of the widely ritualized livestock management of the Rendille in Marsabit District (KENYA) and modern range management and animal husbandry practices. Duration: 2 years.

METHODS

a) Traditions, beliefs, rituals

Interviews of groups and individuals and direct observation will render the bulk of information. It is intended to attend a number of ritual occasions personally. Some information is already available in published and unpublished form (Spencer 1973, Grum 1976, Schlee unpubl., Schwartz unpubl.). Informants for the interviews will have to be selected from different clans and different age groups. The interviews will be conducted with the help of interpreters who fortunately are available.

b) Rendille livestock management

Conditions in the settlement and livestock camps differ widely, having significant influence in the performance level and health state of the animals. Management practices in both situations will be recorded through interviews and direct observation.
Migration patterns will be described from ground and aerial surveys over two years. After mapping the various pasture areas and the normal water routes, regular checks every 10 to 14 days on the position of some selected herds may render sufficient information to draw the pattern of migration and pasture utilization.

Milk yields, blood yields and growth rates will be measured or estimated. The product quality will be determined by chemical analysis. Herd structures will be determined from a number of randomly selected herds to estimate the actual and accumulated fertility. The data will be compared with those of countries with a more intensive camel industry like Tunisia (Burgemeister 1974) or Turkey, but also with the respective data of cattle kept by the neighbouring tribes.

c) Water and fodder

Samples will be collected from all water sources which are said to have extraordinary properties. After analysis the results will be related if possible to the characteristics reported by the Rendille.

Samples of the various fodder plants in various growth stages will be analysed chemically and the results compared with the Rendille evaluation.

ANNEX 5A

Summary of Camel feeding habits

Date	Area	Condition of Food Browse/Grass % Green	Grass		Herbs		Dwarf Shrubs		Trees & Shrubs	
			D	P	D	P	D	P	D	P
12.8.76	Kulal Red Hill	20	0.6	-	37.7	-	52.7	-	8.7	-
4.9.76	Kulal Red Hill	5	0.0	-	28.7	-	54.7	-	16.6	-
24.9.76	Kulal Luai	10	0.5	-	12.3	-	11.2	-	75.6	-
19.10.76	Balesa	20	14.8	-	3.1	-	36.4	-	45.7	-
29.10.76	Kulal Luai	5	1.4	-	38.6	-	16.1	-	44.0	-
18.11.76	Kargi/Kurkum	40	0.0	-	21.3	-	77.3	-	1.7	-
26.11.76	Balesa	25	1.2	18.0	0.0	0.0	73.0	76.1	25.8	48.7
(26.11.76	Balesa lava	35	0.6	100.0	1.6	50.0	70.9	65.1	26.9	56.3)
29.11.76	Kulal Red Hill	75	1.0	4.0	21.0	51.0	61.8	69.4	15.6	64.5
6.1.77	Kulal Luai	85	0.0	0.0	1.3	17.4	23.1	65.2	75.8	91.3
11.2.77	Kargi	50	0.5		40.0		53.0	-	6.3	-
22.2.77	N. Horr	Woody 50 Grass/Herb 0	0.2	4.8	0.2	100.0	14.9	85.4	84.7	94.1
		x n=12	1.7	-	17.2	-	45.4	-	35.6	

D = % in Diet

P = % Preferred

ANNEX 6

Integrated Project in Arid Lands - Phase II

F I N A N C I A L S T A T E M E N T

A S A T 3 0 A P R I L 1 9 7 7

		ALLOCATION FOR PHASE II	DEBITED
11. 01) 02) 03) 04)	- ACCOUNTS KEPT BY PARIS ONLY		
		US $	US $
12.	CONSULTANTS	18,000	3,000
13.	SECRETARIAL SUPPORT	16,000	5,000
16.	TRAVEL ON OFFICIAL BUSINESS	18,000	12,000
21.	SUBCONTRACTING	60,000	58,000
41.01	AIRCRAFT MAINTENANCE	7,500	7,500
41.02	VEHICLE MAINTENANCE	10,000	9,000
41.03	MAINTENANCE OF EQUIPMENT AND FACILITIES	2,600	1,000
41.04	FIELD STATION STAFF	14,000	14,500
41.05	SUNDRY (INCLUDING DEPOSITS TO BE RETURNED TOTALING $2,000)	9,000	8,500
42.01	AIRCRAFT (BALANCE TO PURCHASE OF VEHICLES 42.02)	25,000	20,000
42.02	VEHICLES (BALANCE FROM 42.01)	18,000	23,000
42.03	FIELD AND LAB. EQUIPMENT	20,000	18,000
	TOTALS (Less Paris accounts)	285,600	247,000