

125 PAGES

SOMALI DEMOCRATIC REPUBLIC  
CENTRAL RANGELANDS SURVEY

VOLUME 1 PART 1  
STATIC RANGE RESOURCES  
TEXT



RESOURCE MANAGEMENT & RESEARCH  
16B WEST CENTRAL STREET  
LONDON W.C.1

SOMALI DEMOCRATIC  
REPUBLIC

CENTRAL RANGELAND  
SURVEY

VOLUME 1 PART 1

THE STATIC RANGE RESOURCES  
OF THE CENTRAL RANGELANDS

TEXT,

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VOLUME 1 PART 1

## THE STATIC RANGE RESOURCES

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## INTRODUCTION

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1. REPORT STRUCTURE

This volume is one of several describing the results of survey work undertaken in the Central Rangelands of the SOMALIA DEMOCRATIC REPUBLIC, under two contract agreements shown in Appendix 1.05 slightly modified by correspondence also included in Appendix 1.05.

The reporting of this work has been structured in the following way:

✓ VOLUME 1                      PART 1                      - 100 copies

The static range resources of the Central Rangelands

- text, summary maps and appendices

This part describes the structure of the report, the methods employed for examining the static resources, and the results of the survey work carried out. Appendices to this report include detailed notes of site examinations, lists of all plants collected for identification and to build up a herbarium, tabulations of soil data, and the terms of reference for the study as set out in the contract agreement.

✓ VOLUME 1                      PART 2                      - 100 copies

The static range resources of the Central Rangelands

- maps at 1:1,000,000 scale

This part is the large (1:1,000,000) MAPs which accompany the text of volume 1 part 1.

✓ VOLUME 1                      PART 3                      -- 100 copies

The static range resources of the Central Rangelands

-- maps at 1:2,700,000 scale

This part is the smaller (1:2,700,000) coloured maps which accompany the text of volume 1 part 1, and volume 4.

VOLUME 1                      PART 4                      -- 100 copies

The static range resources of the Central Rangelands

-- colour plates of ground sampling sites

This part has a selection of colour xeroxed plates from the sampling site photographs taken on the ground.

VOLUME 1                      PART 5                      -- 50 copies

The static range resources of the Central Rangelands

-- colour plates of aerial sampling sites

This part has a selection of colour xeroxed plates from the sampling site photographs taken at different scales vertically or semivertically from the air.

VOLUME 1                      PART 6                      -- one set

The static range resources of the Central Rangelands

-- site photographs and index

More than 4000 colour transparencies were taken from the air, at a variety of scales of a large number (approximately 750) of precisely located sampling sites.

A selection of these sites was then examined on the ground, when more colour photographs were taken.

As is explained in the next section these site photographs formed an integral part of the investigation method, and will be particularly useful to the Central Rangeland Project for further studies and monitoring of trends.

VOLUME 1                    PART 7                    -- one set

The static range resources of the Central Rangelands

- herbarium specimens

Herbarium specimens of more than 400 plants species have been presented by the RMR Botanist to the Somali National Herbarium.

The collection of over 800 plant species made by the consultants GILLETT and HEMMING is being distributed, where sufficient specimens allow, to four herbaria: KEW in England, NAIROBI, MOGADISHU and FLORENCE (FIRENZE).

VOLUME 1                    PART 8                    - 100 copies

The static range resource of the Central Rangelands

- a preliminary check list of plants

The names of all plants collected or observed in the area are being assembled in check list form with appropriate notes on characteristic appearance, distribution, local names etc. This part has been produced on strong paper and bound in such a way that it will stand up to field-use. It is expected that it will be annotated and added to in the field by Central Rangeland Project workers. In time this preliminary check list will become a definitive check list for the Central Rangelands, which in turn will be a key document in the ultimate production of a Flora of Somalia.

VOLUME 1                    PART 9                    - 1 set

The static range resources of the Central Rangelands

- the enhanced LANDSAT imagery is generally made available as colour prints on large sheets of photographic paper. These have drawbacks in that they are too large for convenient use in the field, are rather easily damaged, and are difficult to relate to standard maps based on a latitude/longitude frame. RMR have therefore mounted the 1:250,000 enhanced colour prints on stiff board, and cut them to match the 1:250,000 map series. These have been presented as a reference set to the National Range Agency.

VOLUME 1                    PART 10                    - 200 copies

The static range resources of the Central Rangelands

- 1:250,000 mapping of land systems

Mapping of the land system units, showing water sources, tracks and roads, towns and villages, and sampling sites has been made at 1:250,000. Two hundred copies of each of the eighteen map sheets have been presented to the NRA.

VOLUME 1                    PART 11                    - 2 copies

The static range resources of the Central Rangelands

- Acetates of the land system map at 1:100,000 and 1:250,000 scales

One positive and one negative of both the 1:100,000 (8 sheets) and the 1:250,000 (18 sheets) land system mapping have been presented to the NRA for dye-line use and plate making respectively.

VOLUME 1                    PART 12                    - 20 copies

The static range resources of the Central Rangelands

- colour copies of LANDSAT imagery and 1:100,000 survey maps

A suggestion has been made (Appendix 1.06) to provide colour copies of the 1:100,000 survey maps of the Central Rangelands, and of the 1:250,000 colour prints of LANDSAT imagery. These items were not budgeted in the original proposal, and will need to be purchased from RIR at costs quoted in Appendix 1.06.

VOLUME 2                    PART 1                    - 40 copies

The dynamic range resources of the Central Rangelands

- Dry season 1979 Census Results

- Tables

This part is a tabulation (in computer print-out form) of the results of the first, dry season, aerial census.

VOLUME 2                    PART 2                    - 40 copies

The dynamic range resources of the Central Rangelands

- Dry season 1979 Census Results - maps

This part is a set of 1:1,000,000 maps showing the distribution of the censused items by land system units from the dry season census.

VOLUME 3                    PART 1                    - 40 copies

The dynamic range resources of the Central Rangelands

- Wet season 1979 Census Results-Tables

This part is a tabulation (in computer print-out form) of the results of the second wet season, aerial census.

VOLUME 3                      PART 2                      - 40 copies

The dynamic range resources of the Central Rangelands

- Wet season 1979 Census results - maps

This part is a set of 1:1,000,000 maps showing the distributions of the censused items by land system units, for the wet season census.

VOLUME 4    - 40 copies

The dynamic range resources of the Central Rangelands

- Aerial census methods and some comments on the results

This part describes the methods employed, the calibration and other weighting values and inferences concerning migration. The main data of the two censuses is re-interpreted here for the three regions, and for the 29 ecological zones and the eight ecological classes.

Human populations have been calculated from house occupation rates deduced during the sampling site studies on the ground.

2. THE CONTENTS OF VOLUME 1 PART 1

This volume concerns the static range resources. It is of course appreciated that, in a strict sense, no resource is static. This concept has been introduced to differentiate those resources or aspects of resources, which are sufficiently non-dynamic (in spatial and temporal terms) to be investigated as though they were static.

The static range resources or features considered in this volume are :

1. GEOMORPHOLOGY LANDSCAPE and TOPOGRAPHY
2. DRAINAGE and WATER SOURCES
3. SOILS, EROSION and DUNES
4. CULTURAL FEATURES - Communications, towns and villages
5. LAND USE
6. VEGETATION, LAND SYSTEMS and LAND CAPABILITY.

In Volume 4 consideration will be given to the mobile biotic components of the system, mainly wild and domestic animals and man.

### 3. THE CONCEPTUAL FRAMEWORK FOR RESOURCE STUDIES

Many studies of range resources provide simple conceptions of the relationships which operate in the ecosystem linking, for example soils, climate, land-use and vegetation. In the majority of cases these conceptions are entirely theoretical. There is, of course, no doubt that the ecosystem acts as a system, but the mechanisms are still largely unresolved, and the hypotheses, in the field, generally untested. We feel that the most prudent statement on this subject would be something like this.

"At any moment in time the disposition of materials and energy in the range ecosystem will reflect a complex series of physical and biological interactions between its physical and biotic components. In the very broadest terms and for quite short periods, we can predict some of the major responses of some of its components to changes in some of its other components. Fortunately the system has inherent stability rather than instability."

In view of this statement, and because of the extreme shortage not to say dubious quality, of existing information about the Central Rangelands we have concentrated our efforts in this study in establishing a base line for the important resources, rather than in attempting to detect trends and ascribe mechanisms. This latter task will be the role of the Central Rangelands Project, which has ample time and resources to address such problems.

#### 4. THE WORK PROGRAMME

The Central Rangelands have been designated as the three regions MUDUUG, GALGADUUD and HIRAAN and cover about 150.000 km<sup>2</sup>. Neither the regional nor the district boundaries are yet definitively established with reference to geographical features and their position must be regarded as provisional.

The security position at the disputed de facto border with ETHIOPIA has made it impossible to work either right up to this border, or in the far east of HIRAAN Region. Furthermore the 1:100,000 mapping has not been carried up to this border (presumably for the same reasons). The position of the project area, the mapped area, the Regional boundaries and the study area are shown in figure 1.21.

All figures are presented in separate binding for the convenience of the reader, who can refer to text or tables simultaneously with figures. Figures 1.01 - 1.08 inclusive are at 1:1,000,000 scale and are in Volume 1 Part 2 : figures 1.09 - 1.25 are at 1:2,700,000 scale and comprise Volume 1 Part 3.

The chief geographical features of the project area are shown in figure 1.01.

The consultants started field work on 16 November 1978 and established an base camp at the GAALKACYO airstrip. This camp was maintained for use by the consultants until 3 August 1979. Field work was completed (at BELLED WEYNE) on 16 August 1979.

Report writing and cartography continued until 12 October, and all reports specified in the contract were delivered on 24 October.

## 5. EARLIER STUDIES AND EXISTING INFORMATION

The consultants have been fortunate to have four important and excellent sources of information about the Central Rangelands.

### i) The 1:100,000 Survey Department maps

These maps are vitally important for fieldwork in the area and are of first class quality. It is important to ensure that several sets are available for the Central Rangelands Project. A practical proposal has been made in Appendix 1.06 for producing more of these maps.

The usability of these maps will be appreciably increased if the key is correctly translated. We have tried to get a definitive translation of the key, but it appears that some of the words are not standard Somali ones. The best translation of the key is shown as figure 1.22.

Four small criticisms of these maps have to be made:

- a) The use of the same colour (brown) for contours and seasonal water courses is confusing in some parts of the map.
- b) The determination of different vegetation densities (as indicated by two green tints) is not very consistent.
- c) The symbols used to denote different vegetation types are not very easy to see or to "envisage".
- d) The interpretations of different vegetation types seem rather inconsistent.

The present index number of the 1:100,000 sheets could be confusing, involving, as they do identities with four numbers and two letters. We have given these sheets new numbers so that the maps of the Central Rangelands are now numbered 1 to 90. These new numbers can be seen in figure 1.02.

- ii) Enhanced LANDSAT imagery at 1:250,000 scale in colour, combining bands 4,5&7 produced by the Earth Satellite Corporation as paper prints

This imagery is of very high quality, and has been invaluable in stratifying the Central Rangelands into land system units. Some proposals are made in Appendix 1.06 for the copying of these prints for field work. The scenes provided to the consultants were:

- P 174 R 055            18 Jan 76
- P 174 R 056            18 Jan 76
- P 174 R 057            11 Feb 73
- P 175 R 056            12 Feb 73
- P 175 R 057            6 Feb 76

Efforts should be made to obtain scenes P 173 R 055 (very important) and scene P 173 R 056 (less important) for the use of the Central Rangelands Project.

- iii) HEMMINGS "Ecological and grazing survey of the MUDUUG Region" (FAO, Rome 1972, reference WS/C9085), updated as Annex 3 of the IBRD Project Preparation Report.

In view of the problems of working in the Project area without aircraft, (particularly before the tarmac road was constructed) HEMMING's report is remarkably accurate. We differ only in the following small respects:

- a) The "under-grazed" central area has not been found in this study. This point is considered in more detail at other stages of the report.
- b) The climatic data assembled by HEMMING must be treated with extreme caution. Rainfall information from remote areas embodies substantial errors due to factors such as rain-gauge siting, recording errors, loss or breakage of subsidiary equipment, loss of records, etc. In a study, carried out in eastern Kenya in 1967 the senior author found 94 % of 110 rainfall recording stations were being faultily operated. Most of these errors (90%) were such that an effective under-reading was resulting. We feel that similar conditions pertain in the Central Rangelands and accordingly rainfall records could be 20 to 50 % below the actual rainfall.

The vegetation in the Central Rangelands certainly seems to indicate slightly higher rainfall than that currently recorded. Furthermore the distribution pattern, shown in

map 2 of HEMMING's report cited above, is a simplification which takes no account of the coastal ridge. One of the first tasks of the Central Rangelands Project will be to establish a network of agro met recording stations, and to ensure these are consistently and accurately operated.

We have, with some difficulty, found a few records for the years since 1971, and some records for stations not included in HEMMING's table. These are shown in table 1.01. Earlier remarks about the reliability of these records should be carefully borne in mind.

In figure 1.23 we have made a sketch of the sort of rainfall distribution to be expected from the relief and vegetation patterns, and critical consideration of the records. The sites of agro met stations to provide definitive information have been shown in this figure.

- c) HEMMING's impression that Cordia alliodora ~~edulis~~ (Yicib) was becoming seriously reduced, and not regenerating seems unfounded. This potentially important plant is still abundant over a large area, and appreciable amounts of regeneration have been seen (see later in this volume).
- d) Finally the views of HEMMING concerning sand dunes will need to be re-examined. HEMMING himself agrees that his first impressions have not been entirely borne out by the additional information collected during aerial reconnaissance and field trips as part of this study. This point is considered later in this volume.

iv) Annex 4 of the IBRD Project Preparation Report "Hydrology and Water Supply"

The IBRD study is an excellent study in every way, and none of our findings are at odds with it. It is pointed out here that the surface drainage patterns described in this volume (see figures 1.04 and 1.10) show three internal drainage systems. The middle of these three is very small, and in ancient times was probably part of the GAALKACYO system described in Annex 4.

We have called the DHUUSA HAREEB system the CEEL BUUR drainage basin.

The stagnation of the ancestral drainages in the region of the fault line and movements of brine across the coastal strip (see hydrologist's report, page 9 paragraphs 32 and 33) have created a water environment of some severity for the unaided nomadic grazer, able to dig only shallow wells. It is possible that this region of stagnant drainage in the upper aquifer, through its influence on water supply, is responsible for an under grazed region in the Central Rangelands, when rainfall is insufficient to fill the surface ballehs.

Possibly this is the area to which HEMMING refers and this idea receives attention later in the study.

Two other sources of information have been seen

i) "Game Animals in the Somali Republic. A review of the present situation and its management problems" Agristudio of Firenze.

This report is a desk study of low precision without quantitative information. It shows limited grasp of the realities of wildlife ecology and management possibilities.

- ii) The 1:1,000,000 Geological Map prepared by UNDP, Mineral and Groundwater Survey Project (Phase II).

This is of extremely low quality where it deals with the Central Rangelands and provided us with no information of value. Indeed it is so inaccurate as to be a liability for field workers and we recommend that it does not become source material for the Central Rangeland Project.

## METHODS

=====

The survey of a wide range of resources over an extensive area, with limited physical infrastructure, clearly involves a variety of methods, many of them so traditional and entrenched as to scarcely deserve the term "method". In this study we feel that particular mention should be made of the following two methods, which have been of fundamental importance in providing a quantitative basis for the study.

- i) Aerial strip sampling to provide numbers and distributions of livestock species, large wild herbivore species, houses and other structures of different types, water sources, and principal crop production areas. The aerial strip sampling method is described in detail in Volume 4, which deals chiefly but not exclusively, with the results derived from this method.
- ii) Phased precision multi-stage sampling of the vegetation and soil.

#### 1. PHASED PRECISION MULTI-STAGE SAMPLING

Phased precision multi-stage sampling of extensive areas is the efficient, cost-effective way to collect data. The alternative approach which is exceedingly wasteful has been used for many decades and has become established as a traditional survey method. This alternative approach would require, for example, that any range survey starts with a complete air photographic cover at 1:40,000, or 1:60,000. In the view of the consultants the most precise (and hence the most expensive) aspects of a survey method should be applied to very limited parts of the area after proper overall evaluation at much lower precision levels has provided a framework within which the results of the sampling of small units can be understood in terms of the whole area, and by which the sampling effort can be most efficiently distributed in

spatial and temporal terms. In short, multi-stage sampling at different levels of precision is employed to resolve the classic dilemma of the resource surveyor - the resolution cover/dilemma of fixed budget surveys. The dilemma in its simplest form is this:

"For a fixed budget I can tell the client about his resources in sufficient detail for his needs over an area far too small for him to take any effective action. Alternatively I can give him information on his resources over the whole area of importance, but this information will be very imprecise and consequently of no use".

So much for generalities. In the Central Rangelands survey the following approach was used, in which each step ascends in order of precision, but covers increasingly small parts of the total range. This approach is summarised in Table 1.02.

#### STEP I Draft Land system boundary plotting from LANDSAT

The 1:250,000 LANDSAT colour composites were marked with the latitude/longitude grid, using recognisable features on the 1:100,000 survey department maps for accurate positioning of the co-ordinates. The LANDSAT images were then examined and the first draft of the land system unit map was drawn from the color/texture variations seen on the images. These draft boundaries were marked on a clear overlay over each paper print.

STEP II Reconnaissance verification and improvement of draft boundaries by aircraft, and first descriptions

Reconnaissance flights were made at heights between 1000 and 10,000 feet (300 - 3000 m) by the two senior authors carrying the LANDSAT imagery and the 1:100,000 map sheets. These flights examined all the draft land system unit interfaces, at a variety of altitudes. In addition a series of systematic flights at 5000 feet above the ground were undertaken at 20 km intervals along NW/SE orientations. During these flights land on either side the aircraft up to 10 km from the aircraft was scanned for significant ecological heterogeneities. Flight paths during these reconnaissance flights were logged on the 1:100,000 maps and are shown in figure 1.24 at 1:2,700,000 scale. Some 17,000 line kilometers were flown in this reconnaissance over a 16 day period (7500 kilometers of systematic flying and 9000 kilometers of boundary examination).

During reconnaissance flying the exact boundaries of the land system units were plotted on the transparent overlays, and observations were made, following a standard format, of the appearance of the land system units, and their ecological characteristics.

Observations during the reconnaissance flying were made on these topics:

- topography
- drainage pattern and density
- colour and texture of "soil"
- colour and texture of any exposed rocks
- pattern of exposed rocks and "soil"

- density of vegetation at the three levels
  - grasses and herbs
  - bushes and low trees
  - trees
- patterns of vegetation
- density and types of termitaria
- density of animal tracks
- density of cropping
- other points of interest such as erosion features, flooding, lagoon formation, and dunes.

At the end of reconnaissance flying the original drafted land system boundaries were modified to incorporate the results of the field work and a first definitive land systems map was drawn (this is the map seen in Volume 2 Part 2 as figure 2.01).

### STEP III Air photography of sampling sites

#### SUB STEP 1 Sample site selection

Within each land system unit a number of sites were selected from the 1:100,000 map sheets and plotted on the 1:100,000 maps. In making this selection no attempt has been made to apply a formal sampling procedure because:

- a) it is intended that repeated observations will be made of vegetation at these sites, thus placing a smaller emphasis on the need for sites to be representative,
- b) the characterisation of land system units is made as much from the aerial reconnaissance (STEP II above and STEP IV-

parallel observations), and from the LANDSAT imagery (STEP I above), as from the sampling sites,

- c) the number of sampling sites selected in each land system unit is so small (averaging about eight per unit) that it would in any event be impossible to take advantage of a formal sampling procedure for producing statistically precise parameters on the land system unit.

In view of the aforementioned, and features of the overall survey design, sites have been selected from the maps on the basis of accessibility, re-locatibility, and typicality.

That is to say at least half the sites have been positioned close to tracks which 4 wheel drive vehicles can traverse (accessibility); all sites have been positioned to include a feature of the landscape (chiefly cut-lines) which makes it possible for a skilled surveyor to return to exactly the same location either on the ground, or for re-photography;

and finally any site which, upon location from the aircraft before photography, is for any reason judged to be atypical, is moved to another location close to the original site.

#### SUB STEP 2 Sample site photography

At each site a number of photographs were taken at a range of scales:

Typically one large scale photograph (scales of 1:60,000 on negatives; 1:12,000 on projections suitable for field studies, down to scales of 1:12,000 on negatives; 1:2,500 on projections),

one medium scale photograph (1:25,000 on negatives; 1:5,000 on projections down to 1:6000 on negatives; 1:1200 on projections ),  
 and two small scale photographs (1:14,000 on negatives; 1:2800 on projections down to 1:2000 on negatives; 1:440 on projections) were taken.

All photographs were on Ektachrome colour transparency film, and are vertical or semi vertical.

#### SUB STEP 3    Printing of field copies

Prints of these transparencies were made on a Xerox colour copier at 6.85 x enlargement of the negatives. A selection of these prints is shown in Volume 1 Part 5.

These field copies were supplied to the ground teams making the more detailed investigation of STEP V.

#### STEP IV    Parallel observations from the air during aerial strip sampling census work

The aerial strip sampling survey involved flying over 5% of the region at 360 feet (110m) above the ground. In the course of this flying, further observations were made of the important characteristics of the land system units, and as a result of these observations (and of the work carried out on the ground - STEPS V & VI) the first definitive land system map was modified to its final form - as shown in Volume 3 Part 2 as figure 3.01, and figure 1.03 in Volume 1 Part 2.

STEP V Site investigations on the ground - general

The ground survey teams visited the accessible sub-sample (about half) of sampling sites. They located the sites by using the 1:100,000 maps and the colour prints of the actual sites. At each site information was collected, according to a standard format, on the following topics:

- A general description of the site covering topography, soil and rock types, drainage patterns and vegetation.
- Specific descriptions of the soil and rocks including soil depth, colour (using MUNSELL colour charts), and pH.
- Information on surface water, wells and bore holes at the site, or in their immediate vicinity.
- Information on erosion and soil redistributions on the site.
- Information on dunes on the site.
- The presence of grazing animals on or near the site.
- The presence of current, recent or abandoned crop production areas on the site.
- Any people near the site were questioned about human activities on or near the site, particularly grazing of livestock and crop production.
- Other ecologically significant observations.

- Overall vegetation cover was recorded as canopy or crown cover (Brown 1954) using a modified line intercept method along two axes at right angles.
- All identifiable or collectable plants in the sampling site were recorded, with notes on their abundance, local names, growth form and growth stage.
- Plants in flower or fruit were collected for the National Herbarium of Somalia.
- A number of photographs were taken in the site to include conspicuous and fixed features. Examples of these photographs are shown in Part 4 of Volume 1.
- Information on the type of termitaria and their density on or close to the site.

STEP VI Site investigation on the ground - botanical

In order to take advantage of the availability of C.F. HEMMING and J.B. GILLETT, both of whom have long experience of semi-arid plant ecology and botany in Somalia, a representative selection of some of the accessible sites was made for more detailed botanical investigation. In selecting these sites a number of considerations were judged to be important:

- i) HEMMING and GILLETT were available for only one month. Therefore the field work programme was somewhat compressed, and some of the less accessible sites could not be visited.

- ii) HEMMING's previous investigation in 1971 and 1977 were focussed in certain parts of the region. Certain inferences were made during those studies about ecological trends and conditions. To take advantage of his return visit it was thought important to have some sites in the same areas, so that HEMMING could observe the changes in conditions, thereby gaining more insights into the longer term trends.
- iii) A proportion of the sites selected for the HEMMING and GILLETT field work had already been examined by the RMR ground survey teams. The second examination of the same site served as a form of calibration or standardisation of criteria and work quality.
- iv) The sites selected for HEMMING and GILLETT were spread over the range of ecological types, with a slight concentration in areas of high botanical interest and high ecological heterogeneity.

The RMR ground survey team accompanied HEMMING and GILLETT during their field work, thereby enhancing the standardisation process.

Finally, since the secondary purpose of HEMMING and GILLETT's presence on the survey was to improve the botanical collection, the route between selected sites was designed to pass through areas of high botanical variety. Moreover the timing of this part of the field work was such as to place the team in the

field at a time of maximum vegetation flowering.

Sites visited by HEMMING and GILLETT and the RMR team were investigated in the way described above, but with more emphasis on the floral descriptions and collections.

STEP VII Synthesis of all data into maps and reports

SUB STEP 1 Final modifications of map boundaries

As stated above the final modifications of the definitive land system maps were made upon information collected in STEPS IV, V and VI.

SUB STEP 2 Range vegetation map

A map of range vegetation types was superimposed on the land system map from a synthesis of data assembled in STEPS II to VII.

SUB STEP 3 Description of land system units and range vegetation

The chief characters of the land system units and the range vegetation units have been described in report form from the information collected in all Steps I to VII, from quantitative data gathered during aerial strip sampling, and from the 1:100,000 survey department maps.

## 2. OTHER METHODS

In addition to these two other special approaches, namely aerial strip sampling and phased precision multi-stage sampling, the normal range of field work and ground survey techniques have been employed in conjunction with the various aerial reconnaissance and observation methods in which RMR have specialised.

## FINDINGS

We prefer to offer the information gathered during this investigation under the term "findings" rather than the more usual heading of "results". The latter to us conveys an image rather too conclusive and precise for this type of inventory study.

Information presented here falls into the following categories:

### VOLUME 1 (ie this volume)

#### 1. LANDSCAPE

TOPOGRAPHY

and GEOMORPHOLOGY

#### 2. DRAINAGE SYSTEMS and WATER SOURCES

#### 3. SOILS, EROSION and DUNES

#### 4. CULTURAL FEATURES (Communications, towns and villages)

#### 5. LAND USE

#### 6. VEGETATION LAND SYSTEMS and LAND CAPABILITY

VOLUME 4

7. LIVESTOCK

8. WILDLIFE

9. HOUSES, BUILDINGS and PEOPLE.

The source and/or method employed is briefly noted at the start of each of the above sections.

1. LANDSCAPE TOPOGRAPHY and GEOMORPHOLOGY

Information following derives from the 1:100,000 survey department maps, the LANDSAT IMAGERY (see Volume 1 Part 6), and observations made during the phased precision multistage sampling (PPMSS) studies of range vegetation and land systems and the aerial stratified strip sampling census (ASSSC) flying.

LANDSCAPE (RELIEF) INFORMATION

The present survey department 1:100,000 maps show 10 m contours throughout, plotted from air photography. We were able to make very crude checks of this relief data using an aneroid altimeter on the ground, and a combination of the pressure altimeter and radar altimeter from the aircraft. In no cases were any faults found in the maps, which are of excellent quality.

The grosser features of the relief have been shown in figure 1.04 (1:1,000,000 scale) and 1.10 (1:2,700,000). It has been necessary to make these larger scale appraisals of relief because the 1:100,000 maps were too large to afford a synoptic view of the position.

Figures 1.04 and 1.10 reveal the landscape of the Central Rangelands to be appreciably more interesting than earlier reports (with the exception of the IBRD Hydrological Annex, 1977) led us to believe. In order to further examine this interesting landscape a series of profiles have been constructed along the lines marked on figure 1.04 and 1.10. These profiles are shown in figure 1.05.

To a large extent these figures are self explanatory and few interpretive notes should be required by users of this report to understand the significance of this landscape. The following points struck us as worthy of particular attention:

- i) The coastal limestone ridge which extends from the southern boundary of the area northwards to about  $5^{\circ} 40'$  has had a profound influence on the ancestral and current drainage patterns (see Section 2 below). This ridge has been responsible for turning the SHABEELLE south westwards parallel to the coast to the south of the project area. In addition the closed internal basins (shown in figures 1.04 and 1.10) are the product of this ridge, which diverted the GAALKACYO drainage system north eastwards, again parallel with the coast.
- ii) Profiles C to H show the structure of this limestone ridge and suggest a twisting of the tilted block, presumably associated with a more severe faulting, towards the north.
- iii) The relatively high land associated with the ridge would be expected to, and does indeed have, appreciable impact on the vegetation, presumably through climatic effects. This impact is the more extreme where the ridge is very close to the sea. (say between  $4^{\circ} 20' N$  and  $5^{\circ} 40' N$ ).

The climatic influence of the ridge, in this position, has been observed over the last 10 months during field work and flying in the region. At times when the rest of the Central Rangelands is unprotected by cloud cover, the coastal ridge, including its southward extensions towards MOGADISHU, is frequently under low cloud, giving intermittent drizzle and mist at ground level. There is also a marked cooling of the air temperature as recorded in the flying aircraft as the ridge is approached, which presumably is an adiabatic effect: this effect can be detected even on clear days.

iv) All profiles demonstrate a number of interesting relationships between land system units and relief (or landscape position). Some of these relationships are not apparent except through this type of examination. A few of these relationships are considered in section 6 below.

v) The relief changes inland from the coastal ridge in the south are unlikely to mediate climatic, and hence vegetational, differences. However in the north some small impact could be anticipated (see Profiles K & L).

#### TOPOGRAPHY INFORMATION

Our use of the terms "landscape" and "topography" follow normal usage: "landscape" refers to the overall, systematically viewed shape of the Central Rangelands and "topography" describes the more detailed aspects of the land-surface in smaller parts of the system.

Topographical variations within the Central Rangelands are not extreme - indeed the overall landscape pattern limits the possibilities for

not extreme - indeed the overall landscape pattern limits the possibilities for topographical development to an unusual degree. Topographical types have been mapped in Figure 1.31, and tabulated in Table 1.03.

Nowhere in the survey area can it be said that topography limits the present or potential use of the land, except:

- (i) on the deeply gulleys slopes of consolidated sands and coastal limestones on both sides of the watershed of coastal ridge,
  - (ii) in the broken country on each side of the Shabeelle valley.
- These areas are marked on figure 1.31.

#### GEOMORPHOLOGICAL INFORMATION

Throughout our examination of the landscape and topography we have been considering the mechanisms under which the land surface can have assumed its present shape. In this consideration the geological origin and physical nature of the surface material clearly provide important information. Certain of our inferences of a geomorphological nature are presented in Table 1.03.

We have attempted a simplified description of the main geomorphological types in Figure 1.32, which is bound in Volume 1 Part 3.

Five types are recognised:

#### 1. WEBI SHABEELLE VALLEY

Alternate cycles of water induced removal and deposition of alluvial materials of a wide range of sizes, coupled with normal valley cutting through the limestone plateau have given rise to this land surface complex. Some drainage stagnation of a large eastward flowing tributary system has been a secondary influence.

#### 11. LIMESTONES/SAND SHEETS

The middle and upper Eocene limestones of the Central Somali plateau have been weathered by water sheet flow and wind carrying abrasive sands. At present they are overlain by a thin sand sheet of mixed quartz and limestone of origin derivation and means of arrival is obscure (and probably mixed). This sand sheet has limited mobility under present climatic conditions.

111. EVAPORITES

Ancestral drainage zones which stagnated against the major coastal fault line as several "playas" at different levels, and so produced the present complex of gypsums & anhydrites. The weathering of the evaporites has been similar to that of the surrounding limestones (but obviously at different rates), and they are in places overlain by the limestone/quartz sand sheet, and in places by the fine pale sands of coastal origin. Deflation has created some relatively deep depressions in the limestones, floored with evaporites.

IV. STABILISED SAND DUNES OF COASTAL ORIGIN

Fine pale Pliocene sands of a former mobile dune sheet have become recently stabilised under different climatic conditions, and the former dune forms have been weathered by wind to characteristic tussocks or undulations. These sands overlie both the upper Eocene limestones, the coastal limestones, and evaporite lagoons. At present these sands are mobile, but do not generally form dunes, indicating they are partially fixed. Deflation of this type has probably provided at least some of the material for the sand sheet of Type II.

V. UNSTABLE SANDS, DUNES AND ROCK DESERT OF THE COASTAL STRIP

Fine pale Pliocene sands close to the coast are still unstable and mobile as dunes (with barchans and seift) and as scarcely stabilised sheets of coarser sands (deflation residues). A foredune has formed along parts of coast where sand can be forced over the low limestone cliffs, and this has been the source of the sands of types IV and V. Along the coast north of 5° 20'N the more developed coastal cliff, and more severe deflationary conditions (i.e. stronger coastal winds), have produced an extensive rock desert in contact with the coast.

## 2. DRAINAGE SYSTEM AND WATER SOURCES

The information in this system has been taken from the 1:100,000 survey department maps, the LANDSAT imagery (Volume 1, Part 6) and observations made during the phased precision multi-stage sampling (PPMSS) studies and the aerial stratified sampling census (ASSSC) flying.

### DRAINAGE SYSTEMS

Contemporary drainage systems are probably less influential in the Central Rangelands than the ancestral patterns. These have been well described in the IBRD study Annex 4. The present surface drainage systems are illustrated in Figures 1.04 (1:1,000,000) and Figure 1.10 (1:2,700,000).

The only perennially flowing drainage channel is the WEBI SHABEELLE; all other channels carry surface water for a few hours at most. The possibilities of making use of this type of surface flow are obviously limited. All the surface channels are clearly marked on the survey department maps, and the catchments can be computed from the same source. We have indicated on Figure 1.33 those parts of the Central Rangelands where surface flow can be expected to take place in confined channels from time to time each year.

### WATER SOURCES

Some information on flowing surface water has been offered above. Information on other water sources is of two basic sorts: that taken from the survey department 1:100,000 maps and that collected as part of the aerial livestock census.

1. Water source information on the survey department maps  
The 1:100,000 survey department maps contain a wealth of detailed information about water sources in the Central Rangelands. Examination of the translated key (Figure 1.22) for these maps gives some impression of the type of information available.

We have transferred these data to the 1:250,000 map sheets (Volume 1 Part 10) delivered with this report. In these maps water sources have been described, with numbers and locations, under these categories:

- well or groups of wells
  - wells with brackish water
  - dry wells
  - wells with sweet water
  - wells yielding water seasonally
  - wells of an unspecified sort
  - wells with motor or wind driven pump
  - bore hole
  - bore hole with a specific test-flow rate
  - man made water reservoir
  - small earth-lined reservoir
  - large earth-lined reservoir
  - natural reservoir
  - cement lined reservoir
- } termed "ballehs"  
in table 1.03 and  
"ballis" in other  
tables  
) termed "berkads" in  
+ Table 1.03 & berkado  
in other tables
- springs
  - natural springs
  - modified springs
  - generally dry water sources
  - permanent rivers

Two reservations must be expressed about these data. Firstly it has proved to be impossible to obtain consistent translations of the terms used on the key of the 1:100,000 maps. We have offered in Figure 1.22 a consensus of opinions.

Secondly, although most of the mapped water sources appear to have been accurately described and positioned, discrepancies were recorded for three important types of source.

- Berkads seem to be under-represented on the survey department maps. This is probably a consequence of the construction of berkads presently taking place in the region. This was recorded earlier by HEMMING, and confirmed by our own observations.
- Wells seem to be substantially under-represented on the survey department maps. It is not possible to determine if wells are dry or yielding water from aerial examination. This point is confirmed later in the section.

- Bore holes: the data of Hemming, (Map 2 of annex 3 of the IBRD report) of the survey department maps and of this study are not immediately reconcilable. We have commented on these differences in Table 1.04C.

The index of water sources supplied in 1972 by the UNDP water survey project could clear up some of the anomalies raised in Table 1.04C. Unfortunately, this index has not been maintained in an up-to-date state and it is now a rather old source, moreover, copies of it are not widely available. It is recommended that the Central Rangelands Project should acquire a copy of this index and relate the information on the 1 : 100,000 maps to it.

The distributions of water sources based on 1:100,000 mapping and limited aerial and ground checking are shown in Tables 1.04A and 1.04B. Indices of relative water source abundance have been calculated on the basis of a "weighting" which is an attempt to ascribe a quantitative level of importance to each type of water source. The weightings used have been:

- 6 for all types of earth-lined (large) reservoirs.
- 2 for all types of hand-dug wells.
- 4 for cement-lined (small) reservoirs.
- 10 for bore holes and pumped wells.
- 12 x the length for flowing rivers.

Figures 1.07 and 1.11 show the pattern of these distributions by land system units (at 1:1,000,000) and by ecological zones (at 1:2,700,000)

The results of the dry and wet season aerial census of water sources are tabulated as Tables 2.04 and 3.04 in volume 2 part 1 and volume 3 part 1 respectively. The categories of water sources and the weighting used in computing an index of relative abundance are:

- all wells (hand-dug);	weighting 2
- small temporary rain water pools;	weighting 1
- riverine pools (isolated);	weighting 4
- flowing rivers;	weighting 12
- small earth lined reservoirs;	weighting 4
- large earth lined reservoirs;	weighting 8
- cement lined reservoirs (berkads);	weighting 4
- bore holes;	weighting 10

The distributions of these indices are shown in Figures 2.12 and 3.12 in volume 2 part 2 and volume 3 part 2 for the dry and wet seasons respectively.

A comparison of all information on water sources reveals the following points of interest:

- i) The index of relative abundance is significantly unchanged between the wet season and dry season censuses (0.785 for the dry season: 0.815 for the wet season). Similarly the distributions of water sources in wet and dry season (Figures 2.12 and 3.12) are not significantly different.
- ii) Both censuses show hand-dug wells to be the most numerous type of water source, contributing 68% to the index in the dry season and 80% in the wet season.
- iii) Data from the survey department maps, on the other hand, are not immediately comparable (Tables 2.04, 3.04 and 1.04B).

For the whole Central Rangelands densities of main water source types compare thus:

	Densities per Km <sup>2</sup>					
	Earth Reservoirs and Pools	Wells	Cement Reservoirs	Bore Holes	Flowing Rivers	Relative Index of Abundance
1979 Dry season Census	0.027	0.268	0.003	0.002	0.013	0.785
1979 Wet season Census	0.006	0.328	0.004	0.000	0.007	0.815

	Earth Reservoirs and Pools	Wells	Cement Reservoirs	Bore Holes	Flowing Rivers	Relative Index of Abundance
1975 Survey Dept. Maps	0.007	0.0628	0.0013	0.0002	0.002	0.198
Difference between 1975 figure & the mean of 1979 wet & dry season results	0.0095	0.2352	0.0022	0.0008	0.0080	0.6020
This difference as % of the mean of 1979 wet & dry season results	57.6%	78.9%	62.86%	80.0%	80.0%	75.3%

Obviously for types of water source occurring in relatively small numbers the degree of imprecision of the estimates made in the aerial census work is large. Thus the information above is not indicative of differences in density of both reservoirs and pools, bore-holes berkadts or flowing rivers. However, the difference in density of wells is significant, and indeed accounts for the bulk of the difference in the index of abundance.

It is then, on these data, possible to say that there are significantly more hand-dug wells in the Central Rangelands than those shown on the 1:100,000 survey department maps.

- iv) The distributions of water sources as evidenced by the survey department maps (Figure 1.07) closely parallel the distributions determined from the aerial censuses. This suggests that there is a rather uniform degree of under-representation of wells over the whole survey area.

### 3. SOILS, EROSION & DUNES

Information in this section has been derived from the 1:100,000 survey department maps, the LANDSAT imagery (Volume 1 part 6) and observations made during the PFMS studies and the ASSC flying.

#### SOILS INFORMATION

Some information on the surface appearance of the soils in the survey area are shown in Table 1.03. Site investigations of soils, involving pH measurements, colour determination, horizon and depth assessments using an auger and observations of naturally occurring profiles have given rise to the data presented in Table 1.05. The actual site by site results are included as Appendix 1.01.

It will be clear from examination of Table 1.05 that soils have been a prime influence in the creation of land systems and ecological zones. Indeed the maps of land systems and ecological zones (Figure 1.03, and Figure 1.03B at 1:1,000,000 scale and Figure 1.09 at 1:2,700,000 scale) will serve to show the distributions of the soil types described in Table 1.05.

As might be expected in an area of such diverse geomorphological history and influences there are few single relationships between geography and soils. We are limited to the following observations.

- i) Soil pH's are first alkaline & neutral and fall within a very narrow range.
- ii) Soils in the gypseous areas of the ancestral drainage zone tend to be less alkaline.
- iii) Soils of coastal sand origins (ecological zones IV, V) and the Webi Shabeelle alluviums (zone VI) are slightly more alkaline.
- iv) The colour of sands tends to become darker reddish brown in the west, lighter reddish yellow in the east.

- v) Fine rounded quartz particles are the major component in the Central Rangeland soils, excepting the alluviums and residual limestone soils of the Shabeelle valley. The quartz sands are variously mixed with evaporite and limestone fragments, ranging in size from very fine clays to large irregular stones depending upon the geomorphological and pedological history of their location. Some coarser quartz particles are found as deflation residues.

### INFORMATION ON EROSION

Table 1.03 summarises the findings on erosion in this study. Considering now some generalisations:

#### i) Water-induced erosion

As one would expect in an area of very small gradients and low rainfall, water-induced erosion is a minor occurrence. Sheet erosion of a non-severe type takes place on the steeper slopes; it is more important where silt in the sand gives a degree of surface consolidation. The following land system units display signs of some sheet erosion:

Ecological Zone	Land System Units
I.1	1, 3, 5
I.2	48
1.7	58, 68, 76
1.8	67, 75
II	42, 50
III.1	6, 7, 13
IV.2	18, 19, 60, 72
IV.3	61, 65
IV.6	86
VI.1	69, 70, 83
VII	24
VIII.1	2
VIII.2	59

Where silt allows a high degree of surface consolidation, run-off water on slopes will tend to form channels with some gully erosion. This type of erosion is a significant influence in these land system units.

Ecological Zone	Land System Units
I.7	58, 68, 76
I.8	67, 75
II.6	42
IV.2	60, 72
IV.3	61, 65, 73, 87
IV.4	90
V.2	4, 8, 91
VI.1	69, 70, 83

Finally the slow creeping movement of small escarpments, under the influence of both water and wind has been seen to be taking place in a few land system units, namely:

Ecological Zone	Land System Units
I.2	48
I.7	58, 68, 76
I.8	67, 75
II.6	42
IV.3	65

ii) Wind induced erosion

It would be most unusual if the Central Rangelands Area was not subjected to severe erosion under the influence of wind. Much of the soil is composed of fine sand, more or less unconsolidated, and winds, particularly in the period June to September are very strong.

We recorded steady winds of 65 Km/hour (40mph) at 400 feet (122m) above the ground and 97Km/hour (60mph) at 1000feet (305m), on many days during this period in 1979 within 20 Km of the coast.

During these periods the air within 20Km of the coast becomes heavy with loess and silt particles up to a level of about 1500 feet (460m) and visibility is reduced to less than 2Km. The wind-borne particles reduce the penetration of sunlight and the adiabatic cooling effect already remarked on is augmented.

On the ground the surface sand and coarser silt is under constant movement (saltation and creep) except where consolidation of some sort has taken place.

To some extent the landscapes and vegetation of the Central Rangelands should be seen as being the result, primarily of wind and deflation acting on relatively fine particled sands and silty sands. The coastal region, particularly, is severely affected by winds and it would be more appropriate to see the dwarf and stunted growth of plants, and the extensive bare areas, as aspects of a natural wind desert, rather than the consequence of low rainfall or overgrazing by livestock.

Obviously many factors promoting consolidation or binding of sand surfaces will be of some significance ecologically, and of particular importance in respect of the future trends of landscape and vegetation.

a) Silt

Small proportions of silt in the fine sands are sufficient to create a consolidated "skin" which resists wind erosion where well developed.

b) Deflation residues of coarser sands and small stones.

The winnowing effects of deflation automatically leave residues of coarser grain size on the surface. These residues protect the finer sands and silts from continuing erosion.

c) Algal or Fungal Filaments

These are widespread on silty sand surfaces and form a thin (1mm thick) dark skin of fine particles bound by organic threads. Specimens of this algal or fungus have been sent for identification. In wet periods liverworts flourish in the damp skin. In the consultants' view this skin is, and has been, a profound ecological influence; without it dunes of mobile sand would almost certainly be much more widespread.

d) Prostrate woody plants

Many woody plants (such as ACACIA spp. COMMIPHORA spp GREWIA sp. IPOOMEA sp) have an extremely spreading prostrate growth form, some rarely rising more than 2cm above the land surface. This vegetation acts to reduce or prevent deflation in these ways:

- Physically the plant holds sand in position (i.e. binds the fine particles)
- They create a micro-climate very close to the soil surface free from severe wind speeds
- They prevent the soil surface from being disturbed by animals' feet (many of these prostrate plants are thorny).
- They depress the growth of other plants which could be more palatable. These plants could attract grazers who would disturb the soil surface by trampling or removing the plant.

Where deflating sands accumulate against an obstacle the possibility of dune formation arises. Dunes receive attention in the next section.

INFORMATION ON DUNES

Dunes are a natural accompaniment of severe deflation. In the Central Rangelands sand dunes have excited a certain amount of attention. They are a focus of interest for conservationists and environmentalists and an obvious manifestation of change in the land surface. It must be realised that "conservation of the environment" as perceived by many enthusiastic but non professional ecologists is an impossible, not to say undesirable, object. The environment knows no status quo: it is dynamic and necessarily so.

In respect of the sand dunes in the Central Rangelands the questions which need eventually to be answered are:

- i) Where are sand dunes located and what areas do they cover?
- ii) What are their chief characteristics in terms of material, profiles, and dynamics?
- iii) What is their influence on the Rangelands, the inhabitants and their land-use activities at present?
- iv) What is their history and in particular have they changed recently in size or mobility in response to potentially manageable aspects of the environment (such as land-use)?
- v) What are the likely future changes in their important parameters in response to planned or unplanned changes in the environment, (particularly those changes over which control can be exercised)?

In this study we have answered question i) and have some limited information relevant to the answering of questions ii) and iii).

i) Location and set out of sand dunes

Sand dune fields presently mobile, or only recently or partially stabilised are marked as:

- LSU 22 area  $120\text{Km}^2$  (0.09%) - a single dune field
- LSU 51 area  $824\text{Km}^2$  (0.63%) - a single large dune field with a few much smaller isolated fields or dunes
- LSU 52 area  $368\text{Km}^2$  (0.28%) - a single dune field
- LSU 53 area  $376\text{Km}^2$  (0.28%) - many medium & small dune fields and dunes
- LSU 54 area  $1264\text{Km}^2$  (0.96%) - one very large field with many medium & small dune fields & dunes
- Total Area  $2952\text{Km}^2$  - 2.23% of total area

ii) Chief characteristics of dunes:

From aerial reconnaissance & site examinations the dunes can be described thus:

LSU 22: These dune fields are mostly recently stabilised and support fair amounts of grass and herb cover.

It is composed principally of limestone particles of fine to medium grain with characteristic "speckly" appearance.

Dune crests are 10 - 20m (and exceptionally 25m) above the surrounding fields, and typical Barchan forms are seen in the active parts of the field. Seif forms along a  $10^\circ/190^\circ$  axis with 10m ridge heights are typical of parts of the recently stabilised dune field.

LSU 51: Rather mobile dune field with little stabilisation most colonising vegetation on the receding dune edges.

It is made up of quartz particles of fine rounded grains, with a negligible limestone component.

Dune crests are 10 - 20m above the level of the dune field, and most of the dunes are Barchan or deflated Barchan types. Seifs are rare, but have the same  $10^\circ/190^\circ$  axis.

LSU 52: Most of this dune field has been recently stabilised, and the mobile areas are now restricted to about 10% of its surface. The stabilised parts support a sparse grass/herb cover.

It is composed of predominantly fine limestone particles of less than 0.1mm grain size. Limestone particles are red and white giving the speckled appearance to the sand when viewed close to.

Well developed active barchans are found in the mobile sections with crests 20 - 30m above the ground level of the field. It seems as though the active dunes of LSU 52 are situated on a lowered deflated floor which constitutes an area from which most sand has been removed in the past. It is interesting to speculate that the dune typically may have a growth and decline cycle: LSU 52 would then be well advanced in the decline phase.

LSU 53: These dunes are mostly active with some patches of stabilised grassland and even dense shrubland isolated within the dune field. They are situated on the summit of the coastal limestone ridge, and are virtually surrounded by dense coastal shrubland.

The material of these dune types is fine rounded quartz of less than 0.1mm grain size with 5 - 20% fine to medium limestone particles.

Barchans are rare in this type, and it is probably less mobile than other LSU's. Possibly it is becoming stabilised.

LSU 54: These dunes are mostly active with stabilised sand areas at the edges. They are situated on the watershed of the coastal ridge and on each side of it.

It is composed of very fine rounded quartz particles with no limestone.

The surface forms of these dune fields are not well developed and few large barchans and no seifs are seen. Low, poorly differentiated barchans of less than 10m are widespread.

#### FOREDUNES IN LSU 60

The fore dunes in LSU60 have advanced from the shore about 4Km. They are composed of limestone particles and are semi-stabilised supporting sparse grass and herbs. They cover about 30Km<sup>2</sup> at present.

#### iii) The impact of dunes on the Rangelands their inhabitants & land-use.

LSU 22: No significant impact apart from a minor reduction of grazing/  
browsing area.

#### LSU 51 to 54

These dunes, to a lesser or greater extent, have at least these influences:

- They reduce the areas of browse and graze available both by occupying land which might support vegetation and by leaving behind at their receding edges deflated limestone surfaces on which vegetation regenerates only slowly.
- They cover wells, roads, houses and crop fields as they advance. The movements of active dunes and the whole dune field are complex. From old tracks (which persist for many decades after dune passage) it is deduced that there are two types of movement:
  - A seasonal advance and retreat under the influence of the two monsoons. The axis of this advance and retreat is approximately 15°/195°.
  - A longer term movement resulting from the net affect of the two seasonal winds. Since

the monsoon winds are not exactly complementary the axis of their longer term movement is in fact close to a N/S orientation.

Dunes then advance approximately from south to north with an asymmetric zig-zagging along a  $15^{\circ}/195^{\circ}$  axis.

From discussions held with local residents it seems that a typical rate of movement for dunes on their long term advance is about 100m per year.

- They store rainfall water, releasing it to a dune aquifer. (On a small scale it was observed that bunds of sand (1m high) are planted with beans in preference to the flatter surrounding areas, in order to make use of this stored water.
- They act as "brush clearance" agents when their movement takes them through shrubland. They kill the vegetation as they pass over it, and the deflated receding edge is colonised by non-woody plants.

At present there is no clear evidence that dunes have recently increased in area or mobility. It has been suggested that cropping is a major cause of dune formation in the Central Rangelands. (Hemming 1972). While this hypothesis cannot be entirely rejected, some critical observations must be made on it:

- i) Dunes would be expected to form on all the fine sands of the Central Rangelands where the consolidating factors do not operate. Thus any event which reduces surface compaction will promote deflation and hence dune formation - this means livestock grazing, crop production, unusually dry periods. Flash flooding etc. can all generate dune production.
- ii) The areas "feeding" the sand dunes of LSU's 22, 51, 52 and 53 are not cropped but support heavy grazing. Most of LSU54 likewise has not been derived from a cropped area, but rather it is advancing

onto a cropped area. There seems to be a relation between the position of the dunes of LSU 54 and 53 and concentrations of wells on the coast and at the coastal towns.

iii) At the actual sites of crop fields small dunes form in the thorn fences down wind of the field. However, after the cropping cycle ends (after 5 - 7 years) regeneration on the field is rapid, and deflation soon stops. It is therefore considered that more investigation of the relation between cropping and dune formation be undertaken, before conclusions are drawn.

iv) In the rains there is a growth of annuals and small <sup>colonising</sup> perennial species on the dunes. Substantial numbers of livestock are seen grazing these LSU's at this time.

DUNE PREVENTION

It is recommended that cropping activity in the very fine sands should in some way be controlled so that very large fields are not cleared. One solution would be to leave the present rather dense shrubland standing between fields in bands of about 15m width, thus preventing fields of more than 50m width (relative to the prevailing wind axes) being made. Obviously such bands should be orientated across the prevailing wind axes (i.e. bands of uncleared vegetation should run along an east/west line approximately).

#### 4. CULTURAL FEATURES - COMMUNICATIONS TOWNS & VILLAGES

The more important static cultural features are marked on the 1:250,000 map sheets (Volume 1 part 10). Of particular importance to the development of the Central Rangelands are the geological trace lines, which, if they are kept open, will enable field work in the area to be executed without undue concentration along the major roads. Moreover these trace lines have provided the precise geographic framework for the positioning of sampling sites, so necessary for their use in any monitoring programmes.

The survey department maps at 1:100,000 scale provide a detailed and comprehensive picture of the cultural features, with two exceptions:

- i) The new tarmac road linking Mogadishu with Harargeisa has not been plotted on all the map sheets. In most cases the survey trace for this road has been marked, and so users can easily amend the map sheets in question.
- ii) Not all the geological cut-lines are marked on the 1:100,000 maps. We have added as many as possible during this survey, but continuous amendment of this aspect of the mapping is recommended until the complete network has been established.

The names on the 1:100,000 maps are generally the accepted names in the area. One exception is the village of Qeycad ( $47^{\circ} 59' 30''\text{E } 5^{\circ} 0' 45''\text{N}$ ) which is known by the inhabitants as Caad. It is suggested that field workers regularly amend the 1:100,000 map sheets since this is the first mapping at this scale to be published by Somalia and some amendments will be necessary.

## 5. LAND USE

Information in this section has been derived from the 1:100,000 survey department maps, the LANDSAT imagery (Volume 1 part 5) observations made during the PPMSS studies, and from the results of the ASSC work.

The land (i.e. the land resources) in the Central Rangelands is used in two chief ways:-

- as a supply of grazing & browse for livestock under the control of subsistence nomadic pastoralists.
- as a resource upon which shifting (or occasionally permanent) crop production can be practiced.

### LIVESTOCK USE OF THE CENTRAL RANGELANDS

Information in volumes 2 and 3 parts 1 and 2 shows the results of the aerial censuses of livestock for the 1979 wet and dry seasons respectively. The implications of these data in respect of the grazing pressures and livestock movements are examined in volume 4. It is considered briefly here because:

- the same people who cultivate fields are the owners of the migrating livestock.
- livestock and crop production are to some extent competitive, to some extent complementary, uses of the land.

The densities of livestock in broader terms in the 1979 wet and dry seasons is better understood from their biomass densities. Table 4.02 shows the biomass densities of livestock by land system units and ecological zones and classes for this period. Figures 1.13 and 1.14 illustrate these data at 1:2,700,000 scale for the land system zones.

Finally for an appreciation of the longer term use of the range by livestock one can examine information on the distributions of abandoned livestock enclosures. These persist in an identifiable form for up to ten

years and so their density in any area is a reflection of grazing and browsing pressures over the previous decade.

Densities of abandoned livestock enclosures for land system units are included in Tables 2.05 and 3.05 of volumes 2 and 3. They are summarised for the ecological classes and zones in Table 4.04 of volume 4, and this summary is illustrated in Figure 1.15 at 1:2,700,000 scale.

Broadly speaking these data show that a highly opportunistic migratory system is being operated by the graziers of the Central Rangelands, but that over a fairly long period of time use of the range is becoming rather uniform, with higher livestock use of the wetter southern areas, the coastal zone (central and southern) and the Shabeelle valley. We shall consider the implications of these findings in respect of the crop production system.

#### CROP PRODUCTION IN THE CENTRAL RANGELANDS

There is a tendency in development work to consider the range areas and range development projects separately from crop production areas and projects. Frequently this approach is wrong, since pastoralists produce crops, and their livestock eat crops (if allowed) or crop residues. Areas in which there is no cropping, and no intergration between crop production and livestock are the exception in Africa, and not the rule.

#### THE RESULTS OF GROUND INVESTIGATIONS

In the Central Rangelands appreciable effort is expended by the local population in producing rain-fed crops. Four "systems" of production have been recognised.

##### i) Opportunistic cropping by town dwellers close to population centres

This type of cropping occurs near any population centre (i.e. near any permanent water supply) and accounts for the very low densities of crop production seen in almost all LSU's.

Town and village people plant small gardens in silty sands (and often in gypseous silts) in the rains (when rain has started falling or is seen in the immediate neighbourhood). If the rains are very substantial a second planting between the first planting is made. They plant in both wet seasons if possible (October/November and April/May).

The crops grown are beans (*Vigna sinesis* - cow peas) and water melon with occasional small fields of millet in the south. Fields are cultivated for at least five years before the site is changed.

Fields are surrounded by low thorn fences or scattered branches. Since the field "owner" is close to, or in the field each day, and because there is a certain degree of control over grazing near towns and villages, it is possible to leave fields fairly unprotected. Small stock and cattle feed in the fields between harvest and the next planting.

Obviously crop failures are frequent, but the investment is restricted to seed and labour (at zero opportunity cost) and any food produced is a valuable supplement to a diet conspicuously lacking in vegetable components.

ii) Opportunistic cropping by nomadic pastoralists on the deep fine silty sands of coastal origin to the west of the coastal ridge

This type of cropping is well developed in the ecological zones I.6, IV.3, IV.4 and V.2. Figures 2.10 and 3.10 show very clearly that these land system units support the bulk of cropping outside the Shabeelle valley.

Pastoralists frequently in a combination of several families, clear large fields, using the considerable volumes of cut shrubs and trees

to make substantial thorn fences round the field. Fields are carefully selected on the grounds of fertility, using the sand colour as an indicator: pale sands are much preferred to dark ones. Fields are planted in the rains as already described, with additional plantings if the early rains are prolonged. Two plantings per year are possible if both rains are good.

Informants consider a field once cleared belongs to the family who cleared it "for ever"; it will take several years, working when the livestock are in the vicinity, to complete the clearance and fencing of a large field. Crops grown are beans (i.e. cow peas), water melons and millet, with a preference for growing millet in the short (DHAIR) rains of October/November, the other crops being grown in both rains.

The massive fences are designed to keep livestock, and wild animals out of the fields. Informants say they lose crops to porcupine, dik dik, warthog, duiker and to a lesser extent Clarke's gazelle in spite of the fences.

Fields in 'good' pale sands can be cultivated for at least 5 years, and fields under continuous cropping for 8 years were not uncommon. Fields on 'poor' dark sands are sometimes abandoned after only 3 years. Fields are left 15 years under fallow before recultivation is considered.

Beans are harvested about 60 days after planting, melons after 60 days and millet after 120 - 150 days. Families claim that their crops last for from 5 months to one year, and some families even sell surpluses.

In some areas it is claimed that all people grow crops; in other areas it is said that owners of large numbers of livestock do not cultivate fields.

The integration of cropping activity with livestock management is very opportunistic. Part of the family will hope to be close to one of their fields (i.e. within 15Km) at a time suitable for planting; and will try to return to that field at harvest time. Some families live on their fields and send stock on long movements in search of suitable grazing with a few young men from the family. Other families move their whole family with the migrating livestock and send small groups of people (with camels) back to the fields at appropriate times. Between harvest and planting crop residues will be consumed by the field owners' livestock (if any are in the vicinity). Fallow fields are grazed by cattle and sheep (and to a lesser extent goats) in preference to the surrounding rangelands.

Some informants suggested that shared fields may be planted by one family of the group, yet be harvested by another family.

iii) Regular rain fed cropping of fields in the Shabeelle Valley

The alluviums and finer alluvial fans of the Shabeelle valley (Ecological Zones I.8, VI.1 and 2, VIII.2) are heavily cropped, and this area is the other important crop producing part of the Central Rangelands.

Most of these fields are smaller than those of the pale silty sands. Thorn fences are generally not well developed; many fields are unfenced.

Families working these fields generally live on them, or close to them (within 5Km), and are therefore able to prevent excessive crop damage from livestock.

Fields are cropped in the same way as has been described for the pale silty sands, but it seems that fields are cropped for fairly short periods (3 to 4 years) with shorter fallow periods (4-6 years)

iv) Regular non-subsistence irrigation in the Shabeelle Valley

Small areas of riverine alluviums are irrigated. These are farmed by town people who employ labour. Many abandoned irrigation channels and fields were observed. It could be instructive to find out why so much irrigation has been abandoned, and to see if different types of management could ensure irrigated areas remain productive.

THE RESULTS OF AERIAL CENSUS WORK

The results of aerial censuses in the 1979 wet and dry seasons for cropping are shown in Tables 2.06 and 3.06 and Figures 2.10, 2.11, 3.10 and 3.11 in volumes 2 and 3. These results are summarised by ecological zones and classes in Table 1.07 and Figures 1.19 and 1.20.

In interpreting these data two problems inherent in the should be borne in mind.

- the estimates of cropping densities embody fairly large sampling errors. This is partly because the census was designed to minimise variance in livestock estimates and is therefore not fully efficient for assessing other features of the range.

- the differentiation of fallow from abandoned fields (and in some cases from cropped fields) rests upon a quality judgement, which will be dependent upon the observer and upon the state of the vegetation. It follows from this that comparisons between seasons will be more revealing if all cropped, fallow and abandoned land is combined.

The data of the Tables cited above show:

- i) By far the most important cropping area is the fine pale sands (ecological zones I.6, IV.3 & 4, V.2)
- ii) The only other cropping area of importance is the Shabeelle valley alluviums and fine colluviums.

- iii) There is a reasonable level of agreement between 1979 wet and dry season results for most ecological zones.
- iv) In the wet season it becomes possible to differentiate abandoned land more easily, and the wet season results accordingly show abandoned fields of greater antiquity than the dry season results.
- v) In the wet season, differentiation of cropped and fallow fields was based upon the presence of growing crops and the stage of regeneration, whereas in the dry season this judgement was based upon the appearance of the field's dry surface. It is considered, in retrospect that this latter judgement included a proportion of abandoned fields as fallow and some fallow as cropped. It follows then that there has been an over-representation of fallow and cropped fields in the dry season results.

A feature of the patterns of cropping seen in the fine silty sands during aerial observations has not been recorded during the census. At certain heights, and in certain lights, it is clear that the land system units on the watershed of the coastal ridge and just west of the watershed, at present densely shrubbed with only medium to low densities of cropping, (i.e. LSU's 66, 73 and 91), have been heavily cropped in the more remote past. The ancient field boundaries can still be discerned in the patterns of dense shrubs.

It is therefore certain that cropping has been a widespread feature of these areas for at least thirty years. The question of why the ridge and higher slopes are now less densely cropped is intriguing. It is recommended that the Central Rangelands Project addresses this problem as part of its overall study of cropping in the area.

In conclusion then it seems that there is a complex and interlocking use of land in the Central Rangelands in which both livestock and crop growing are important. The opportunism and flexibility of both types of land use admirably reflect the patterns of primary (i.e. vegetation) production within

the area, and any development programme which limits this opportunism has real possibilities of failure.

No work was carried out in this study on crop yields. Some broad idea of the possibilities can be gained from the general relationship of 1 ha of crops feeding  $2\frac{1}{2}$  people. This relationship assumes one harvest, but is found to apply in wetter climatic zones. In central Somalia 1 ha will probably feed less than  $2\frac{1}{2}$  people, say 2 people.

In 1979, then approximately  $1000\text{Km}^2$  of cropped land would provide food for about 200,000 people. If we anticipate the results of volume 4 in respect of human numbers it seems that, in good rainfall years, cropping activities could provide about one third of the overall food requirement for the Central Rangelands' human population.

In Figure 1.34 we have illustrated the position of a number of land unit systems. It must be appreciated that it is not implied that these systems are in anyway closed. Indeed the very nature of land-use patterns observed indicates all systems are almost completely open, with families moving freely between them as conditions dictate. A possible exception is the southern part of the fine silty sands, where people appear to be rather sedentary.

## 6 VEGETATION LAND SYSTEMS AND LAND CAPABILITY

Vegetation is the very resource for the livestock in the Central Rangelands, and land systems and land capability are obviously the crucial data in this report with bearing on any development project.

Information on these topics has been collected in PPMSS studies, in aerial reconnaissance and in ASSC work. The LANDSAT imagery and 1:100,000 survey department maps have also been valuable sources.

### VEGETATION

Rangelands present rather special problems to ecologists who wish to describe them. Many of these problems stem from the wish to understand, from the vegetation at any site, the ecological potential of that site. In this study we have attempted, as a first step, to make an objective description of the present vegetation resource, without reference to conceptions of what it could be or what it once was.

It is our belief that the "ecological classification" (PRATT, GREENWAY & GWYNNE 1966), which is intended to describe ecological potential has not yet been usefully applied to range management activities in Africa. One of the main reasons for its failure has been a lack of "sensitivity". Rangelands over most African countries fall in the last two categories of PRATT et al's 1966 ecological zones. The sorts of management measures of rangelands which are economically or sociologically feasible will bring about very small changes in the range

In place of this approach for describing land potential we prefer the following position:

- i) Rangelands under most conditions are grazed, browsed (and cropped) by herbivore and human populations.
- ii) The densities of herbivore and human populations exploiting the range resources are, by definition, carrying capacity densities. It is appreciated that the populations of herbivores (both wild and domestic) will be dynamic, responding rapidly to rather short term changes in carrying capacity.
- iii) Under regimes of use of this sort the vegetation will almost certainly be the most important factor limiting herbivore numbers.
- iv) Over the long term there will be a continuous decline in the amount and quality of range vegetation available as food for the herbivores. There will be short periods, of course, when the herbivore food

supply does not decline, but we are at present concerned with the long term.

- v) It follows that:- the range vegetation is virtually always producing less herbivore food now than it formerly did.
- from considerations of the logistic curve of population growth, which probably has general biological validity, a halving of the livestock population, or a doubling of the food supply, would maximise yields from the livestock.
  - at present there are no feasible ways to de-stock the rangelands to this degree (because of the subsistence link between people and their stock, and the absence of any effective means of storing surplus food production by effective means "capable of providing food in drought periods").
  - likewise at present there are no economically feasible ways of doubling available food production over rangelands.
  - and so the 'ecological potential' is probably sufficiently unrealisable to be treated as an academic mirage.
- vi) Range management will proceed (if at all) by almost imperceptibly small steps towards raising the productivity of the range over many decades.
- vii) Descriptions of range resources and conditions should be geared towards allowing a perception of the "almost imperceptible", i.e. they must be very precise.
- viii) For 99% of rangelands it is safe to assume the present vegetation, and specifically its production of food for the herbivores, is well below its "ecological potential".

#### A PHYSIOGNOMIC DESCRIPTION OF THE CENTRAL RANGELANDS.

We have used an expanded version of the classification system of Pratt et al (1966) to describe the physiognomic characteristics of the Central

Rangelands.

The results of this description are presented as Figure 1.03C (at 1:1,000,000 scale) and as Table 1.07A, and part of Table 1.07.

The detailed site descriptions and the 35mm colour aerial photographs on which these summaries & descriptions are based can be examined as Appendix 1.01 and Volume 1 part 6. Some examples of these photographs have been illustrated as Volume 1 parts 4 and 5.

#### A BOTANICAL DESCRIPTION OF THE CENTRAL RANGELANDS

In grassland range management is usually not vitally important to identify the plants involved. Bell (1968) has provided an excellent description of the significance of grassland species differences in the herbivore food supply, which explains why this is so.

However, for a rangeland composed principally of browse plants, the significance of plant species becomes immediately greater, and we have accordingly devoted appreciable attention to the botanical description of the area.

Botanical information is presented at a number of levels:

i) For the whole Central Rangelands

a) Herbarium Specimens

We have collected and identified between 800 and 900 plants in the area, and prepared specimens of these for herbarium stocks.

b) Species Lists

Two species lists are shown as Appendices 1.02 (J.J.B - 416 numbers) and 1.03 (J.B.G. C.F.H. & R.M.W. - 820 numbers approximately - not complete at time of writing).

c) A preliminary check list

A preliminary check list of all plants known to occur in the Central Rangelands, for use by field workers is under preparation as Volume 1 part 5. It is not specified in the Contract Agreement but the consultants feel it is an important document, which puts the botanical collecting and identification work into a form which will be most useful for ecologists and range management Personnel.

ii) For the land system units

Anticipating the land system mapping described in the next section we have assembled the botanical data to fit the land system units in Table 1.07. This table lists only the common species over each land system unit; for

more complete lists of plants seen in each unit the reader is referred to Appendix 1.01 and 1.03 (site descriptions and safari notes of J.B.G. respectively).

iii) For the sampling sites

The position of sampling sites is shown in Figure 1.06 (at 1:1,000,000 scale - to illustrate the cover achieved) and on the 1:250,000 map sheets. In addition the index of sampling sites (see Volume 1 part 6) lists the latitude and longitude of all sites.

The botanical descriptions of each site are listed in Appendix 1.01.

### THE SAMPLING SITES

The sampling sites were selected with two aims in view:

- firstly they were judged to be representative of the land system unit in which they are found, and so formed convenient points at which to quantify or in other ways describe the botanical and other environmental features of the units.

- secondly it is envisaged that one of the major activities of the Central Rangelands Development project will be monitoring changes and trends in range conditions. In the consultants' view it will not be possible to undertake an efficient monitoring programme without using permanent sampling sites and photogrammatic techniques. Ektachrome photographs of easily locatable sites at a variety of scales are expected to form the core of a range resource monitoring programme. We have selected and photographed more sites than necessary for such a programme in the expectation that further selection of the more significant and representative locations will take place as the Central Rangelands team develops an understanding of the area.

### LAND SYSTEMS

Land systems have been mapped on the basis of all observable ecological information, but with emphasis on soils and geomorphology (since these are the dominant ecological factors in arid and semi-arid regions).

The information is tabulated in Table 1.03 (main physical characteristics - topography, drainage system, water sources, soil/rock cover types, erosion and soil redistribution, and dunes), Table 1.04A (more detailed water source information), Table 1.05 (more detailed soil information) Table 1.06 (detailed land-use information) and Table 1.07 (main biotic characteristics - canopy cover classes for trees, shrubs and grasses and herbs with the more important plant species in each category; vegetation

patterns, overall physiognomic description and canopy cover estimate; densities and types of termitaria relative densities of herbivore tracks; and cropping.)

The final land system unit map is shown at 1:1,000,000 scale as Figure 1.03 (Volume 1, part 2). The boundaries of the land system units, since they will be the boundaries of fundamental importance, have been plotted on the 1:250,000 maps (Volume 1 part 10).

Land system units are capable of a two stage ecological classification - termed zones and classes in this study. This classification, with the relevant land areas expressed in absolute terms, and as percentages of the whole area and of each class, is set out in Table 1.08. Ecological zones and classes have been mapped as Figure 1.03B.

These land system units have become the strata used in the aerial census of livestock, wildlife, water sources, houses and other structures and crop production (See Volume 4).

## LAND CAPABILITY

### Pasture Units

In the Contract Agreement (Appendix 1.05 part 1) mention is made of the grouping of land system units into pasture units for the purposes of pasture management. As work has proceeded it has become evident that the concept of "pasture" is more or less irrelevant in the Central Rangelands. The patterns of livestock use of the range (see Volume 4 for details) are so opportunistic at present, that one can fairly state that, over the long term, grazing and browsing pressures are proportional to rainfall, for small stock and camels. Cattle, which are more or less sedentary, graze all the year near towns and villages and close to permanent water.

In some ways this position represents a good starting point for a development project, in that no particular range area can be regarded as tied to any particular group of people's livestock. This deduction must be qualified to the extent that sociological examination of selected areas could provide a contrary view: it is likely, in that event, that there would be only weak ecological justification for such ties.

Of course the situation in respect of cropping is totally different: cleared areas belong to the family in perpetuity. Any developments in the cropping zones are therefore likely to cut across traditional usufructary positions. In order to exploit their fields the owners must be able to bring their livestock close to them several times a year (or they

live on their fields permanently with small "milk" herds and flocks).

In these circumstances we are not able to group land system units into pasture units.

#### A LAND CAPABILITY MAP

For an ecologist the land capability of the Central Rangelands is a problem. From the available and inferred information, the area should not support so many livestock (in apparently good condition) nor should there be so much cropping.

However it does, and presumably our understanding of the ecology of these semi-arid sand/sedimentary areas overlooks some important factors.

In drawing a land capability map we have simply marked those areas already under crop production as capable of supporting rain-fed cropping. (See Figure 1.35 Volume 1 part 3.) In addition we have shown LSU 84 and the southern part of LSU 74 as also potentially capable of supporting rain-fed agriculture.

The rest of the Central Rangelands can be used only for livestock grazing and browsing.

In map 1.35 we have identified a number of possibilities for development.

i) The fine silty sands of coastal origin

Cropping here could be expanded and improved, if studies indicate our views on dune formation are correct. New crops, new cropping methods etc. should be tested on an experimental farm.

ii) LSU 84 and the southern part of 74

At present these are not cropped, but could probably support rain-fed crop production.

iii) Colluvial fans on the upper valley terrace

Run-off water descending from the plateau in well defined channels could be properly managed by simple diversions and harvesting to produce more food crops or fodder.

iv) The Shabeelle valley alluviums and colluvial fans

Run-off water could be managed to produce more crops or fodder.

An expansion of irrigation, using low technology water lifting should be considered.

v) LSU 24 and the northern part of LSU 74

At present two species (or sub-species) of CORDEAUXIA EDULIS (Yicib) grow in LSU 24 and 74 at fairly high densities. The second species (or sub-species) was collected for the first time in flower during this study. It was particularly useful to find the second species (or sub-species) since this increases the chances of finding other areas where one of the two forms can be grown. It is recommended that attention is given to the possibilities of farming for nut production in LSU 24 and 74, and that trials are made of establishing the plants in other areas (see Figure 1.35).

vi) Other areas suitable for water harvesting

Three other places may be suitable for water harvesting

- the eastern slopes and fans running off the coastal ridge.
- the southern and western edges of LSU 3.
- the western slopes of LSU 58.

vii) Port development

At present the physical infrastructure of the Central Rangelands is concentrated on the western side of the region. There would be advantages in developing a small port on the coast, which could export livestock, and possibly be a base for a fishing industry.

Ultimately it could sustain seasonal tourism.

## 7. BURNING

It is obvious that burning in the Central Rangelands is a regular form of management over those parts of the range where sufficient herbs and grasses grow to support fires. Although grass burning is illegal the practice is widespread. Unfortunately, because of its illegality, no graziers were prepared to discuss the issue - all fires were "accidental", - and so it has not been possible to investigate the real or perceived benefits of grass burning.

It does appear that the effects of a grass fire persist for many years. Areas which have been burnt seem to have a reduced cover (of grasses, herbs and shrubs) for at least 3 years.

The habit of grass burning cannot be dismissed as mere pyromania. It is recommended that a detailed study of its long term and short term influences be undertaken in the Central Rangelands Project.

The Land System Units being most consistently burnt are 24, 74, 25, 16, 45, 39, 14 and 11.

## SHRUB CROPS

Mention has already been made of Yicib farming. One other indigenous plant should be considered in the context of food production.

Cordyla somalensis produces a large fruit which is said to be edible. Unfortunately we did not ask any informants which part of the fruit is "edible". If it is the kernel (i.e. protein rich part) then some use might be found for these fruit in producing a food for people.

Possibly the kernel would need to be processed before it could be widely accepted as a human food.

However if it is the soft fleshy exterior of the fruit which is eaten, then it will have little potential value as a food source.

It is recommended that more information be collected on this topic.

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TABLE I.OI

RAINFALL RECORDS FOR STATIONS IN THE CENTRAL RANGELANDS

<u>STATION</u>	<u>ALTITUDE</u>	<u>NO. OF YRS WITH COMPLETE RECORD</u>	<u>PERIOD</u>	<u>MEAN ANNUAL RAINFALL</u>	<u>WETTEST YEAR</u>	<u>DRIEST YEAR</u>
BELED WEYNE	182	39	1926 - 76	248	553	44
BEYRA	328	5	1953 - 58*	220	373	93
CADAADO	315	5	1953 - 58*	123	327	28
CEELBUR	150	28	1930 - 76	191	408	20
DHUUSAMAREEB	253	5	1953 - 58*	126	250	15
GALINSOOR	340	6	1953 - 58*	115	221	21
GAALKACYO	285	15	1933 - 58	154	448	33
HOBYO	12	15	1954 - 76	224	447	81
MAREER GUUR	273	4	1953 - 58*	109	182	58
MATABAAN	428	5	1953 - 58*	136	247	44

\* The period 1953 - 58 falls in a spell and these means, even assuming perfect records, will be below the long term mean.

The period 1958 to 1976 seems to have been wetter than the 1926 - 1958 period.

THE CHIEF FEATURES OF THE PHASED PRECISION MULTI STAGE SAMPLING APPROACH TO THE RANGELANDS

STEPS & SUB STEPS	TITLE	TYPE OF INVESTIGATION OR ACTIVITY	AREA COVERED	SELECTION PROCEDURE FOR AREA COVERED	INFORMATION & MATERIALS PRODUCED	TIME SPAN	MAN * MONTHS	OTHER COST FACTORS	% OF TOTAL SURVEY COST
I	Draft land system boundary plotting from LANDSAT	Desk	132,000 km <sup>2</sup> (whole study area)	Nil	Draft overlays	5 days	0.17	Imagery (provided by IBRD) expensive	0.91
II	Reconnaissance, low level verification & improvement of draft boundaries & first ecological descriptions	Aerial in field from 1000 to 10000 feet A.G.L.	132,000 km <sup>2</sup> (whole study area)  18,000 km <sup>2</sup> (14% of study area)	Systematic flying of 7500 line km on 20km on each side of air-craft  Investigation of drafted and new interfaces between land system units on a track 2 km wide & 9000 km long	Aerial reconnaissance, descriptions of land system & range vegetation  1st definitive land system map	16 days	1	110 flying hours	9.32
III	Air photography of sampling sites	Desk	approx. 750km <sup>2</sup>	Sites selected for accessibility, loca- tability & typicality	Site selection map	2 days	0.07	Nil	12.01
	1 Site selection								
	2 Photography of sites	Aerial in field	selected & photographed in 750 sites (0.6% of study area)		Approx. 3000 colour transparencies of fixed locations at a range of scales	20 days	0.67	150 flying hours, film & processing	
	3 Printing of field copies	Desk	Copies of all site photographs (0.6% of study area)		Approx. 3000 Xerox colour copies	3 days	0	Air freight from London of 3000 copies	

IV	Parallel observations from air during aerial strip sampling census work	Aerial in field at 360 feet A.G.L.	5 % of study area.	Samples in strips selected with probability proportional to size across all land system units	Additional low level descriptions of land system & range vegetation	Dry season 30 days wet season 30 days	+	0.20	+	48 flying hours	2.80
V	General investigations of sites on ground	Ground in field	Approx. 375 km <sup>2</sup> of photographs in 373 sites (0.3% of study area)	Sites selected for accessibility	Ground description of site characteristics botanical collections approx. 1000 colour transparencies of sites photographed on ground.	4 months	6			16,000 km ground travel film & processing	47.16
VI	Botanical investigation of sites on ground	Ground in field	Approx. 80 km <sup>2</sup> of photographs in 80 sites (0.06% of study area)	Sites selected for accessibility, proximity to best route, botanical interest and previous work by HEMMING	As above	1 months	4			4,000 km ground travel film & processing	25.10
VII	Synthesis & Report	Desk	Whole study area	Nil	Land systems map & text description, range vegetation map & text description. Filed & indexed transparencies for monitoring work. Lists of plants collected preliminary check list of plants for the region	20 days	2			Report materials printing binding	2.69
I-VII	PHASED PRECISION MULTI STAGE SAMPLING (PEMSS)	Desk aerial & ground	132,000 km <sup>2</sup>	Not applicable	All above	286		14.11		All above	100 %

TABLE 1.03

CHIEF PHYSICAL CHARACTERS OF LAND SYSTEM UNITS IN THE CENTRAL RANGELANDS: RELIEF TOPOGRAPHY, DRAINAGE,  
WATER SOURCES, SOILS AND ROCKS, EROSION AND DUNES

LAND SYSTEM UNIT	ALTITUDE-NAL RANGE IN m	TOPOGRAPHY	DRAINAGE SYSTEM FEATURES	WATER SOURCES	SOILS & ROCKS	EROSION & SOIL REDISTRIBUTION	DUNES
1	710 - 520	NW-SE sloping peneplain, very dissected with convex domes & ridges of 50 to 80 m height 0.5 to 4km diameter. Land system unit 2 threads between the domes & dome clusters. Slopes from 0.13 at steepest part of slope.	Very few channels in LSU 1; LSU 2 is the drainage zone for LSU 1.	None	Massive tertiary (middle-upper eocene) limestone covers 80-90% of surface. Medium orange to dark orange fine silty sands of mixed quartz & limestone cover the rest. Patches of silty sands associated with termitaria, and are circular or elliptical (with very long axes in some cases) depending on position on slope.	Evidence of some sheet erosion on steeper slopes.	None
3	635 - 290	NW-SE sloping peneplain less dissected than LSU 1 with convex edged micro plateaux in NW and continuous undulating plateau on SE slopes. Steepest slopes 0.05 in NW. A few cliffs of 50-80 m at the NW boundary.	No channels in the more dissected parts where LSU 2 forms drainage zone. Well developed S/SE flowing dry channels elsewhere with separations of about 10 km for major sand filled beds and many smaller channels.	Low densities of ballehs only.	As above but silty sands mostly medium orange toned and covering 20-40% of surface.	Slight sheet erosion. Appreciable movement of silty sands down drainage channels in a SE direction.	None
5	530 - 340	NW-SE sloping gently undulating plain faulted below the level of LSU 3.	Fairly well developed system of shallow channels.	High densities of wells, a few berkads (wells probably associated with local gypsum)	Some massive limestone in "plate" configuration, areas of limestone fragments & stone mantles and limited surface exposures of gypsum/anhydrite mixed with limestone cover 50% of surface. The rest is medium orange silty sand.	Slight sheet erosion.	None

10	365 - 270	NW-SE very gentle slopes with some poorly developed shallow depressions in the northern part. Micro-ridges as a result of banding.	Poorly developed system of shallow channels, but between these a fine pattern of loamy sand narrow bands probably serves as a drainage-system.	Medium densities of wells, some ballehs & berkads.	Massive limestones in plate configurations, areas of limestone fragments and stone mantles with some gypsum/anhydrite exposures in shallow depressions cover 40% of surface. The rest is orange loamy sand, with appreciable secondary concretionary nodules of limestone. The limestones are patterned with narrow slightly wavy orange soil bands. Soil surface frequently has an algal skin.	None	None
12	380 - 330	Gently undulating without obvious axes; some small depressions & micro ridges well developed.	As for LSU 10.	Medium densities of wells, a few ballehs.	50% cover of limestone in plate configurations, as fragments, and stone mantles with some "banding" as described for LSU 10. Some 50% of area is pale orange silty sand. Gypsum/anhydrite exposures are scattered throughout, particularly at border with LSU 28.	None	None
36	300-200	Very gentle NW-SE slope & many shallow depressions: gradients decline to the SW. Some micro ridges.	No development of channels -- narrow bands as for LSU 10.	None	60% cover of limestone in plates, fragments & stone mantles showing banding. 40% is pale orange toned silty sand. No gypsums.	None	None
49	190-140	Extremely slight NW-SE slope, flat with micro relief associated with wide banding.	No development of drainage channels.	None	Mostly fragmented limestones and smaller pavements cover 30%-40% of surface. 60-70% is pale orange toned silty sand. Some gypsums but only at boundary with LSU 37. Sands occur between limestone areas in wide wavy parallel bands.	None	None

48	240 - 120	An extremely gentle NW-SE slope, obscured in many places by local relief, which includes depressions & low escarpments associated with gypsums and fairly steep slopes between limestones & evaporites.	Channel development on the steep slopes (very narrow bands). Many depressions, and much stagnation in the drainages towards the SE.	Medium densities of wells and a few ballehs (all on gypsums).	A transitional area between limestones and evaporites with complex interfaces throughout. Cover is approximately 30% fragmented limestone & limestone stone mantles, set in 20% medium/pale orange silty sands, and 15% gypsums/anhydrites associated with 35% pale gypsecus silts. Overall patterns very intricate & complex, particularly in the gypsecous parts.	Sheet erosion down the steep slopes and movement of cliff faces as the steep edges erode.	None	None
27	345 - 280	An extremely gentle NW-SE slope. Flat with scattered small depressions in the SW part.	No channels developed.	Low density of ballehs only.	Limestones in wide parallel bands, separated by wide dark orange areas of sands (with some silt). Some of the limestone bands are further broken into isolated segments. Limestones cover 25% of surface in loose fragments & nodular concretionary forms.	None	None	None
46	300 - 230	Extremely gentle slopes NW to SE with scattered small depressions. The eastern most part of LSU 46 slightly undulating.	Some narrow channels in the eastern part.	Very low densities of ballehs and wells.	As above, but limestones cover only 15-20% of the area.	None	None	None
16	330 - 230	Gentle NW/SE slope, numerous small hills & depressions (5-10m) in the SE part forming a micro-relief.	Narrow sandy bands form the drainage zones - channel development is poor.	Very low densities of ballehs and wells.	About 60% of the surface is covered by limestones, some massive, some fragmented & mantled. The limestone is "speckled" with pale orange termitaria patches, and medium to narrow wavy bands of pale orange sand.	None	None	None

25	270 - 140	Extremely gentle NW/SE slope. Some limited microrelief of small depressions & hills.	No channels, sand bands are presumably drainage zones.	Medium to low densities of ballehs & wells.	Massive limestones & fragmented stones cover 20 to 40% of the surface. The rest is orange toned sand and pale yellow sand (these latter mainly in the south). Limestone occurs in the segmented wide band pattern (of LSU 27).	None	None
47	290 - 230	Gentle NW/SE slope; ancient peneplain in the south of the LSU with numerous small depressions. Well developed micro relief associated with wavy bands.	A few drainage channels, but generally sandy bands acting as drainage zones.	Low densities of ballehs and wells.	Parallel wavy wide bands of limestone (mostly fragmented stones on surface) and orange toned sands. Sands cover 40% of the area. A few gypsum exposures in small depressions.	None	None
89	230 - 150	Inperceptible NW/SE slope - numerous shallow depressions and a well developed micro relief associated with wide banding patterns.	Very few drainage channels, and sandy bands (slightly below the limestones) act as drainage zones.	Medium densities of ballehs and wells.	As above, with <sup>more</sup> gypsum/wide-spread on the eastern boundary of the LSU, with 1-2% of gypseous soils. Also soils paler orange than LSU 47.	None	None
64	250 - 170	Very gentle NW/SE slope numerous shallow depressions, associated with gypsum exposures, and some micro relief at boundaries between limestones & gypsums.	No channel development.	Medium to high densities of ballehs, medium densities of wells	A transitional area between limestones & evaporites with complex interfaces throughout. Cover is approx. 30% limestone (mostly fragmented surfaces) 30% pale orange sands, 20% gypsums & 20% pale gypseous soils. Patterns are complex between these types.	None	None

80 & 82	Gentle W to E slopes with micro relief of shallow depressions & ridges of limestone. Pale sands still show the relics of an old dune field relief.	No channel development.	Medium to high densities of ballehs & wells.	A transitional area between limestones, with orange silty sands, pale ancestral dune sands, with occasional exposures of underlying gypsums/anhydrites. Some ancient dune movements have left "tracks", which are still distinguishable as predominantly pale sands over weathered limestone cobbled pavements & these constitute LSU 80.	None	None
160 - 115						
58	Very steep (0.26) convex slopes at edges of the northern plateau remnants of LSU 58. Further south slopes are less extreme and the landform is more plateau-like.	Short incised drainages on the steeper slopes.	None.	Massive pale pink, pale grey & pale yellow limestones & stony hillslopes cover 95% of the area. Very small areas of pink toned soils (5%) is washed down slopes in sheet erosion action. Weathering blocks of yellowish laterite widespread.	Some sheet erosion on steep slopes, and appreciable soil movement down the drainage channels.	None
340 - 160						
68	Very steeply (0.25) sloping edges to residual limestone plateaux, with secondary scarps. Some less broken country of colluvial soils.	Narrow deeply incised dendritic drainage system feeding into wider sandy bedded dry channels.	Very low densities of wells & ballehs.	Massive grey & pink toned limestones and fragmented limestone surfaces cover 90% of surface. Weathered blocks of yellowish laterite widespread on limestone surfaces. Small patches of pale orange colluvial soils in the limestone hills, and more extensive alluvial areas on secondary terraces.	Sheet erosion down the steep slopes; much movement down the drainage channels.	
350 - 180						
76	Less steeply sloping, but otherwise as for LSU 68.	As above.	Very low densities of wells & ballehs.	Massive grey, pink & yellow toned limestones & fragmented limestones over 80% of the area. Orange colluvial soils, yellow lateritic boulders, and red lateritic pavements make up the other 20%.	As above.	None
320 - 160						

79	230 - 130	Even less steeply sloping, but otherwise as for LSU 68.	Poorly developed drainages.	Very low densities of wells & ballehs.	Fragmented limestone surfaces cover 60% of the surface: the rest is orange toned sandy clay loam with many stones on the surface.	Small areas of sheet erosion.	None
67	450 - 150	Very broken edges of the Haud plateau escarpment facing westwards, with steep (0.25) slopes & less steep secondary colluvial terraces.	Very well developed deeply incised dendritic drainage on steeper limestones, with colluvial fans and wider sandy bedded dry channels on the gentler colluvial slopes.	One berkad only-negligible water source densities.	The upper valley terrace of the Webi Shabeelle: a complex mixture of broken limestone escarpment, yellow & red lateritic surfaces, and orange & pale colluvial loamy sands. A series of erosional & despositional cycles is responsible for this mixture. No simple pattern explains today's distribution of materials.	Sheet erosion down steep slopes and appreciable soil movement down the drainage channels and onto alluvial fans.	Small area of wind-blown sand close to the main road.
75	350 - 160	As above, but slopes less steep in general & colluvial valleys better developed.	As above.	Low densities of wells only.	As above, but higher proportions of colluviums and lateritic surfaces.	As above.	None
28	380 - 210	Flat with very gentle NW/SE slope. Small shallow depressions and raised areas give a micro relief.	An ancestral drainage zone with typical "shoe-string" form. Current drainage is not developed on surface, but some fossil channels & sink holes can be observed.	Medium to high densities of wells and ballehs with some berkads & bore holes.	Gypsum/anhydrite exposures in massive plates, small secondary fragments, small stones etc. cover 70%. Pale pink gypseous fine sandy silt covers 20%. About 10% is limestone (concentrated at the LSU boundaries).	None	None
29	360 - 160	As above.	As above with some widely spaced incised drainage channels and wider gypsum expanses.	Medium densities of wells.	As above with more gypsum/anhydrite plates & less limestone.	None	None

30	man body 40-25 subsidiary body 80-50	A very flat floored depression, very slightly deeper in its northern-most part - numerous very shallow depressions provide a significant micro relief.	Ancestral drainages ended in this stagnated zone against a faultline. At the edges of the present basin some fans of pale orange & pink sands spill on to the gypsum.	Very high densities of wells & some ballehs.	As above, but more saline/ (nalar) soils and less limestones.	None	None
34	290 - 50	Very gently sloping sides of a shallow "shoe-string" evaporite running NW to SE. Small scarps formed at limestone evaporite boundary.	A shallow ancestral drainage line, with a contemporary drainage zone superimposed some narrow channel development.	Very high densities of wells: a few ballehs.	Gypsum exposures in parts of the LSU. In other parts limestone & pale orange sands overlie or are mixed with the gypsums. Pale orange colluvial sands are mixed with gypseous soils throughout.	None	None
37	340 - 160	Very flat with very slight NW-SE slopes. Micro relief of shallow channels and narrow ridges and micro-scarps of both limestone & gypsum.	An ancestral drainage zone similar to that of LSU 28 but wider. A few shallow contemporary drainage channels.	High densities of wells & ballehs; some berkads & bore holes.	Gypsum/anhydrite exposures in massive plates, with areas of small secondary fragments over 30%. Gypsecus sand; silt very white to pale pink, covers 60%. The other 10% is limestones and medium orange loamy sands.	None	None
57	160 - 100	Western parts of the LSU show very slight NW/SE gradients, with a micro relief of small limestone & gypsum terraces marking different ancient levels in the ancestral drainage system. Eastern part is similar to LSU 30 - a flat floored depression.	A stagnated terminal zone in the ancestral drainage about 60-80m above the final drainage sump of LSU 30. Contemporary drainage patterns include shallow channels and saline lagoons.	Medium densities of wells; low densities of ballehs.	Gypsum/anhydrites on surface cover 30%; limestone 10%; and pale saline gypseous silts 60%.	None	None

31	300 - 180	Flat with a gentle N to S slope. A section across the narrow "shoe-string" zone reveals a shallow channel with a floor about 10m below the surrounding limestone.	As for LSU 28.	Very high densities of wells & ballehs with same berkads & bore holes.	As for LSU 28, but limestone and pale orange soils make up 15% of surfaces.	None	None
32	190 - 140	Northern parts as for LSU 31. Southern part flat with micro relief of small ridges & some very shallow depressions.	A stagnated terminal zone in the ancestral drainage. Contemporary drainage patterns incl. shallow channels & small silt filled lagoons.	High densities of wells & ballehs. Some berkads.	Gypsums/anhydrites in massive plates and as stony fragments cover 40% of the surface. Very pale gypseous soils cover 55% and dark red brown silt 5%.	None	None
33	270 - 160	Flat with gentle W to E slopes. A micro relief of small scarps surrounds the linear depressions in which the gypsums are exposed.	A remnant of an ancestral drainage system. The contemporary drainage system is well developed as a wide channel 10-15m below the surrounding land.	Medium densities of wells & ballehs.	Gypsum/anhydrites in plates and as stony fragments exposed over 10-20% of the surface. Pale gypseous & pale chestnut brown clay loams cover the other 80-90%.	None	None
77	290 - 120	Flat with gentle W to E slope - micro relief of ridges, small stony hills & flat shallow depressions.	No well developed drainage system, but depressions in the east of the LSU indicate a stagnating drainage zone.	Low densities of wells, some berkads & one bore hole.	A complex combination of exposed gypsums/anhydrites (10%), pale brown gypseous clays (20%) limestone wide stony ridges & small hills (20-30%) & dark orange alluvial clays (40-50%).	None	None

42	120 - 30	LS units 42 & 50 slope gently in from their edges towards shallow depressions (the stagnant sump of the ancestral drainage system). There is a well developed micro relief of scarps in the west, marking the transitional area between the sand covered limestone plateau and the gypseous depression. In the east a prominent escarpment marks the major fault line between the coastal limestone block & the earlier limestones of the interior.	Very well developed system of surface channels with some incision & gulleying on the steeper slopes.	Medium densities of wells & ballehs.	A transitional area between pink toned coastal limestones (30%) in massive pavements, pale orange calcareous consolidated sands (30%), gypsums (10%) and pale gypseous sandy silts (30%).	Sheet erosion down steeper slopes; some soil movement down drainage channels and onto the fans and slow movement of escarpment faces up slope.	None
50	130 - 70						
6,7,11, 13,14,15, 17,38,39, 40,88	390 - 60	Flat with gentle NW to SE slopes becoming steeper in the NW margins of the LSU. Each LSU has a characteristic micro relief related to the limestone structures underlying the sand sheet. LSU's 6,7,11,13,15 & 17 have a micro relief of gentle undulations associated with the wide narrow bands of limestone (wider in the N, narrower in the S) which are exposed. Other LSU's are more or less flat.	Well developed sandy channels in the north (LSU 6&13) gradually petering out as they flow south eastwards. Few drainage channels in the southern LSU's.	Very low densities in all LSU's except LSU 17 (which has gypseous exposures) & LSU 14.	All LSU's have a combination of limestones (pavements and fragmented surfaces) and pale orange sands. The fine sands become paler down the slope to the SE, and limestone exposures decrease from 50-60% (as isolated pavements arranged in "waves") in LSU 6 to 2% in LSU 38.	Some sheet erosion and transport of sands down drainage channels in the northern LSU's only.	Nil
9,26,43, 44,45,63, 85	350 - 100	Flat with very gentle W to E slopes in the western parts giving way to a flat region in the east ( an internal drainage system). The land starts to rise again at the far western border of these LSU's. Micro relief is less well developed than for LSU's 6-88, but there are some slight undulating patterns associated with limestone bands. Exposed	Very little drainage development.	Medium densities of wells and ballehs.	All LSU's comprise stony limestone surfaces (with very few massive pavements) (5-20%), red-orange toned sands (75-90%) and gypsums (5%). The sands in the W are medium reddish orange, but become paler in the E. Limestones virtually non existent in the E (LSU 63 & 85).	Nil	Nil

gypsums occur throughout the region at the bottom of shallow depressions.

20,  
21

Gentle slopes W to E with small cliffs near the sea, low ridges of stabilised sand dunes, and micro relief of limestone terraces and small shallow depressions in the limestone pavements.

No drainage development. LSU 21 has high densities of wells close to the shore line. Both LSU's have medium to low densities of ballehs.

Both LSU's are chiefly bare pink/brown toned coastal limestone (70-90%) with patches of pale sand in the form of consolidated mantle & fossil dunes. At the sea's edge a coastal dune is formed which is not entirely stabilised.

Where the coastal cliff allows sand is being forced up the shore by wave & wind actions. The consolidated sheets & fossil dunes were both parts of an ancient dune system; mobile or recently mobile dunes have been separated out of LSU 20 as LSU22.

110-0

18,19,  
23,35,  
41,55,  
60

All LSU's slope NW to SE to the coast except LSU 55 which slopes gently into a central shallow depression. Slopes in the north (LSU 18, 19) & south (LSU 60) are the steepest. The micro relief is fairly well developed, consisting of limestone terraces, fossil dune forms, shallow depressions in the limestone pavements, & consolidated "plates" of pale sand.

No channel development in the north, but deep incised channels with gulleying characterises LSU 60, as run off from the coastal ridge spills onto the consolidated sands. Most of these channels peter out as sandy fans before reaching the sea. LSU 55 has a number of shallow winding drainage channels.

All LSU's except 55 have very low densities of ballehs & even lower densities of wells. LSU 55, which is consolidated coastal pale sand over the stagnated evaporite internal basin, has medium to high densities of wells & ballehs.

Pink & brown toned coastal limestones (60% in LSU 18, 50% LSU 19, 60% LSU 23, 30% LSU 35, 40% LSU 41, 55, 5-10% LSU 60). Some white limestones (5% in LSU 18,19,23). Very rare gypsum exposures (2% in LSU 55), and the rest is pallid sands with some orange tone in the north, pinkish in the south.

Some sheet erosion and movement of soil down the drainage channels on steeper slopes. The strong monsoonal winds (NNE; SxSW) move the surface sands over the whole area, & dunes have been formed where local conditions so dictate. There is probably appreciable sheet movement of sands through wind influences, but the net annual effect will be relatively slight (see section 3)/type. Large mobile dunes have been separated out as LSU 51,52, 53&54. Some small mobile dunes (notably at the shore line) remain in LSU's 18-60. Fossil dunes which have been stabilised for long periods constitute the major surface type.

175 - 0

72	380 - 0	Fairly steep NW to SE slopes from the limestone ridge down to the coastline. An undulating micro relief associated with an ancient dune landscape is apparent. A secondary limestone ridge lies between the primary ridge & the sea.	A deeply incised and dense network of drainage channels, with much gulleying on steeper slopes. Most of the channels do not reach the coast, but peter out as sandy fans.	Medium to high densities of wells & ballehs.	Pink coastal limestone (as eroded pavements) cover 10%. The rest is very pale white sand & very pale pink sand.	As above.	As above.
56	140 - 75	Gentle to medium slopes NW to SL & SE to NW the LSU having a ridge section. Micro relief of undulations typical of a stabilised dune form.	No development of the surface drainage system.	Very low densities of wells.	Pale sands; some with pale pink hue cover the whole LSU.	Wind movement of sand with both removal & deposition taking place.	The whole LSU is a stabilised dune area and retains the micro relief of the dune bases.
61	400 - 130	Fairly steep NW to SE slopes and, to the west of the watershed in the S of the LSU, some SE to NW slopes. A micro relief of undulations as for LSU 56.	A deeply incised & dense network of drainage channels with much gulleying on steeper slopes.	Medium densities of wells.	5% of the surface is weathered white limestone exposed by sand movement, gulleying or dune passage. The other 95% is orange/red loamy sand.	As above plus appreciable sheet erosion down slopes & movement down drainage channels.	As above plus: some small mobile dunes seen in the area & not separated out into LSU 22-54.
65	220 - 90	Steep NW to SE slopes dissected by numerous deep channels, with cliffs, and gorges developing.	A very deeply incised network of drainage channels which have cut through the limestone, creating deep gorges, with cliffs.	Nil.	Upper slopes and drainage channels show limestone surfaces (60-70%). The rest is covered by fine pale sand (30-40%).	As above.	The lower slopes are covered by stabilised sand dunes; upper slopes have little sand cover.

66	370-160	Medium to gentle SE to NW slopes with undulations characteristic of consolidated dunes.	Well developed widely spaced drainage channels without gulleying.	Very low densities of ballehs & berkads.	Pale to pale orange sand - no limestones.	Some movement of sand down the drainage channels. Appreciable movement of surface sands under wind influence.	As for LSU 61.
73	380-160	Medium to gentle slopes on both axes, since this LSU is positioned on the coastal ridge watershed. Undulations.	A very widely spaced distribution of drainage channels with some minor gulleying.	Very low densities of wells & berkads.	Pale orange to medium orange sands - no limestones.	As above.	As for LSU 56.
87	380-130	Steep slopes SE to NW, with undulations typical of consolidated dunes. These undulations are virtually obscured by the dense network of deeply incised & gulleied drainage channels.	A dense network of deeply incised & gulleied drainage channels flowing to the NW & N.	Very low densities of ballehs.	White limestones are exposed by sand removal over 5% of the area. The rest is medium to pale orange sands.	Much sand movement down the drainage lines; some wind movement of surface sand.	As for LSU 56.
90	400-220	Medium to gentle slopes SE to NW, with undulations characteristic of consolidated dunes.	Well developed but widely spaced distribution of drainage channels with some gulleying.	Very low densities of berkads.	Pale to medium orange sands cover most of the LSU. Limestone exposures only cover 2% of the area.	As for LSU 66.	As for LSU 56.
22,51, 52,53, 54	430 - 20	A wide variety of dune formations including crescentic barchans short seifs, and a number of complex ripple system.	None	Very low densities of wells and some ballehs on exposed rocks left by the moving sand.  <u>mainly at the receding edge.</u>	Sands ranging from very pale to medium yellow/orange. Limestone pavements with a characteristic nodular weathering are exposed in dune areas,	Parts of these LSU's are very mobile, parts have recently become stabilised. There is obviously a complex movement along the two main wind axes, with a small net effect of movement.	These LSU's are the main areas of dune in the Central Rangelands; smaller isolated dunes are found in the other areas but are of negligible importance.

86	Gentle slopes from the water sheds of the coastal ridge.	A few widely spaced shallow channels.	Low densities of ballehs and berkads.	Pale sands cover 98% of the surface. Limestone exposures over 2% only.	Some sheet erosion on steeper parts of the slopes; the fine silty sands are readily moved by the strong prevailing coastal winds, & small dunes, not isolated as LSU 51 or 53, have formed over small parts of the grassland.	A few small dune areas.
84	Typical stabilised dune undulations - the general slope from E-W is gentle & obscured by the micro-relief	No surface drainage.	Very low densities of ballehs.	Medium to dark orange sands cover the whole LSU.	Nil	This LSU is a stabilised dune field. Several small mobile dunes occur just S of the project area.
4	Flat with slight slopes from SE to NW on its eastern boundaries. The micro relief shows many shallow depressions & small hillocks, which are probably the result of wind erosion on an old stabilised dune field.	Some gulleying of the fine silty sands in the eastern parts of the LSU.	Very low densities of ballehs.	Exposures of limestones & gypsums each provide about 2% of the surface respectively. The rest is pale fine silty sand. These limestone exposures have the weathered nodular appearance typical of dune movements.	Wind movement of surface sand is a very significant phenomenon, and the surface can be considered to be under constant movement. Algal "fixation" in these circumstances is particularly relevant.	No mobile dunes in the LSU, but the whole area is an old stabilised dune field.

390 - 100

240 - 130

120 - 80

68 110 - 280	Gentle slopes from SE to NW, which are more pronounced to the east of the LSU. The micro relief is typical evidence of a stabilised dune field.	Well developed network of drainage channels with some gulleying particularly in the east on the steeper slopes.	Medium to low densities of wells & ballehs; some berkads & bore holes.	Exposures of weathered nodular limestones & gypsums provide about 2% of the surface respectively. The rest is pale fine silty sand.	As above	As above
62 120 - 260	As above	As above	Very low densities of wells & ballehs.	Exposures of weathered nodular limestones cover 2-5%. Very pale sands cover the remaining 95-98%.	As above	As above
71 90 - 280	A flat saucer shaped depression with very gentle slopes in from the E & W. A distinct micro-relief of dune remnants is evident.	No surface drainage development except in the extreme east, where steeper slopes bring rain water run-off from the coastal ridge.	Very low densities of ballehs berkads & bore holes.	Exposed weathered nodular limestones cover less than 1% of the area - the rest of the surface is very pale orange sand, with strips of paler sand.	As above	A few small mobile dunes are seen in this LSU. Otherwise the area is an old stabilised dune field.
81 110 - 280	Very gentle slopes from S to N with a distinct undulating micro-relief characteristic of a stabilised dune field.	No surface drainage development.	Low densities of ballehs, wells, berkads & bore holes.	As above	As above	No mobile dunes, although this LSU is an old stabilised dune field.
91 10 - 280	A gentle NW to SE slope; micro relief as for LSU 81.	A few incised drainages on steeper slopes with gulleying.	Low densities of ballehs, wells & bore holes.	As above	As above. In addition, there is some sheet erosion down steeper slopes, and minor movement of sand down the drainage channels.	A few small mobile dunes are found in this LSU, which is an old stabilised dune field.

69,70, 83 Very gentle sloping beds of alluvial deposits with negligible micro relief. The Webi Shabeelle flows from N to S through LSU's 69&70 in a natural valley incised about 10-15m below the first valley terrace. Colluvial fans and a few wide dry channels enter the terrace (chiefly from the eastern side) at widely spaced intervals representing a relatively undeveloped tributary system.

The river is the principal source of water in the area. Densities of wells & ballehs are very low & there are no berkads or bore holes.

Stony mantled limestone fragments, gravels & coarser particles cover 5% of the surface. The rest is a mixture of pale grey, pale orange & chestnut brown (mostly LSU 83) alluvial and colluvial deposits.

Colluvial fans sweep soils from the surrounding limestones into the Shabeelle valley. The river itself carries heavy silt loads.

190 - 120 Nil

78 Very flat with gentle W to E slopes. No micro relief. Some surface channels, shallowly incised, occur at the boundaries of the LSU close to small limestone hills. Otherwise there is no development of surface drainage.

Very low densities of ballehs & wells.

Very dark chestnut brown clays cover 95% of the LSU. Fragmented limestone surfaces cover the other 5%. Some of the clays have a fine manteling of small limestone particles.

240 - 130 None Nil

24 Gentle W to E slopes with no micro relief. No development of surface channels except for very few minor gulleys.

Low densities of ballehs & wells, some berkads & bore holes.

Limestone exposures (mostly at the western edge of the plateau) cover 1-2% of the LSU. The rest is red brown compacted (& locally cemented) loamy sand with lateritic (dark red) deposits over about 2%.

Sheet erosion over compacted surface with negligible & minor gully formation where compaction of surface not complete.

470 - 220 Nil

74	380 - 150	In the north gentle W to E slopes; in the south gentle SW to NE slopes.	No development of surface channels.	Very low densities of ballehs & wells.	No limestone exposures; the surface is orange to pale orange silty sand compacted & slightly cemented in the north, less compacted & not cemented in the south.	Some wind movement, particularly in the south where compaction of surfaces is less widespread.	Nil
2	630 - 360	Gentle to medium slopes from NW to SE with some micro relief associated limestone bands close to the boundaries of LSU's 1 & 3.	No development of surface drainage channels.	Medium densities of ballehs & wells and medium to high densities of berkads.	Pale chestnut brown fine sandy clay loams with compacted surfaces. About 10% of the area has a mantle of limestone particles.	Moderate sheet erosion associated with vegetation arcing.	Nil
59	300 - 170	Gentle to medium slopes from W to E. Micro relief associated with limestone bands which occur sporadically in the LSU.	Near the fringing limestone hills (LSU 58) some gulleys have formed under the influence of hill slope run-off. Otherwise no development of surface channels.	Very low densities of ballehs & wells.	Pale orange toned silty clay surfaces with compaction. 15-20% of the area is covered by stone mantles & stony limestone banding.	As above.	Nil

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TABLE 1.04A

Numbers of water sources in the land system units based on 1:100,000 survey dept. maps.

Land System Unit	All Wells	Earth Lined Reservoirs	Berkads	Bore Holes	Flowing Rivers	Index of Relative Water Source Abundance
1	0	0	0	0	0	0
2	50	5	38	0	0	0.309
3	0	7	0	0	0	0.007
4	0	5	0	0	0	0.039
5	153	0	16	0	0	0.907
6	0	1	5	0	0	0.016
7	0	3	0	0	0	0.009
8	23	16	2	0	1	0.131
9	102	0	1	0	0	0.104
10	88	10	24	0	0	0.202
11	42	20	2	0	0	0.068
12	46	2	0	0	0	0.382
13	19	7	10	0	1	0.037
14	176	3	0	0	0	0.249
15	0	6	0	0	0	0.051
16	13	17	0	0	0	0.023
17	16	2	0	0	0	0.284
18	5	7	0	0	0	0.036
19	0	4	0	0	0	0.042
20	0	37	0	0	0	0.137
21	743	7	0	0	0	1.278
22	0	3	0	0	0	0.153
23	0	7	0	0	0	0.081
24	59	38	10	0	1	0.070
25	26	28	0	0	0	0.083
26	20	7	0	0	0	0.105
27	0	3	0	0	0	0.034
28	175	15	3	2	2	0.556
29	22	1	0	0	0	0.202
30	179	21	0	0	0	1.165
31	708	99	3	0	4	2.566
32	233	40	3	0	0	0.809
33	29	7	0	0	0	0.444
34	553	19	0	0	0	1.882
35	1	0	0	0	0	0.003
36	0	0	0	0	0	0
37	239	60	29	1	0	0.533
38	0	1	0	0	0	0.003
39	0	2	0	0	0	0.012
40	10	9	0	0	0	0.078

Land System	All Wells	Earth Stns Reservoirs	X 6	Berkads	X 4	Bore Holes	X 10	Flowing Rivers	X 12	Index of Relative WATER Source Abundance
41	0	7		0		0		0		0.074
42	155	34		0		0		0		0.467
43	103	3		0		0		0		0.501
44	0	10		0		0		0		0.076
45	64	15		0		0		0		0.042
46	1	3		0		0		0		0.033
47	11	6		0		0		0		0.063
48	271	10		1		0		0		0.231
49	0	0		0		0		0		0
50	96	38		0		0		0		0.291
51	17	0		0		0		0		0.044
52	0	0		0		0		0		0
53	13	0		0		0		0		0.069
54	35	0		0		1		0		0.064
55	129	11		0		0		0		0.452
56	5	0		0		0		0		0.011
57	233	13		0		0		0		0.193
58	0	0		0		0		0		0
59	12	2		0		0		0		0.020
60	30	3		0		0		0		0.054
61	100	0		0		0		0		0-318
62	13	1		0		0		0		0.032
63	136	5		0		0		0		0.377
64	9	30		0		0		0		0.394
65	0	0		0		0		0		0
66	0	5		2		0		0		0.041
67	0	0		1		0		0		0.014
68	16	2		0		0		0		0.059
69	1	1		0		0		28cm 55cm		2.366
70	9	20		0		1		36cm 50cm	19cm 61cm	1.312
71	0	12		5		4		0		0.034
72	2219	2		0		2		0		0.779
73	1	0		2		0		0		0.008
74	6	13		0		0		0		0.022
75	11	0		0		2		0		0.037
76	2	1		0		0		0		0.011
77	57	4		0		0		0		0.039
78	4	2		0		0		0		0.023
79	2	1		0		0		0		0.014
80	20	26		1		2		0		0.376
81	15	19		1		3		0		0.079
82	12	8		0		0		0		0.043
83	2	4		0		0		0		0.102
84	0	3		0		0		0		0.014

## TABLE 1,04 A

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Land System Unit	All Wells X 2	Earth Lined Reservoirs X 6	Berkads X 4	Bore Holes X 10	Flowing Rivers X 12	Index of Relative Water Source Abundance
85	647	63	0	0	0	0.275
86	0	1	1	0	0	0.089
87	0	1	0	0	0	0.028
88	0	0	0	0	0	0
89	92	23	0	0	0	0.134
90	0	0	7	0	0	0.20
91	41	2	0	2	0	0.081
TOTALS	8320	923	167	27	249 cm	
Density Per Km <sup>2</sup>	0.0629	0.0070	0.0013	0.0002	0.0019	

TABLE 1.04B Page 1

## WATER SOURCE DENSITIES BY ECOLOGICAL ZONES

ZONE	AREA in Km <sup>2</sup>	BALLIS	WELLS	BERKADO	ALL TEMPORARY SOURCES	BORE HOLES	FLOWING RIVERS	INDEX OF ALL /SOURCE DENSITIES
I.1	11,709	0.0016	0.0245	0.0034	0.0295	o	o	0.0722
I.2	2,592	0.0039	0.1046	0.0004	0.1089	o	o	0.2342
I.3	1,384	0.0043	0.0007	o	0.0051	o	o	0.0272
I.4	8,760	0.0084	0.0162	o	0.0244	o	o	0.0828
I.5	504	0.0535	0.0179	o	0.0774	o	o	0.3928
I.6	2,332	0.0146	0.0137	0.0004	0.0287	0.0009	o	0.1256
I.7	2,660	0.0015	0.0075	o	0.0090	o	o	0.024
I.8	1,700	o	0.0065	0.0006	0.0071	0.0012	o	0.049
I	31,641	0.0056	0.0242	0.0014	0.0312	0.0001	o	0.0886
II.1	2,144	0.0261	0.4342	0.0014	0.4608	0.0009	o	1.0396
II.2	4,708	0.0155	0.1003	0.0062	0.1211	o	o	0.3184
II.3	1,687	0.0824	0.5578	0.0036	0.6420	0.0024	o	1.6484
II.4	228	0.0307	0.1272	o	0.1579	o	o	0.4386
II.5	3,252	0.0012	0.0175	o	0.0181	o	o	0.0422
II.6	2,556	0.0282	0.0982	o	0.1264	o	o	0.3656
II	14,580	0.0241	0.1839	0.0026	0.2106	0.0004	o	0.5268
III.1	17,308	0.0031	0.0151	0.0010	0.0192	o	o	0.0528
III.2	16,840	0.0061	0.0637	0.0001	0.0698	o	o	0.1644
III.	34,148	0.0046	0.0391	0.0006	0.0443	o	o	0.0915
IV.1	2,816	0.0156	0.2639	o	0.2784	o	o	0.6214
IV.2	11,844	0.0037	0.2013	o	0.2041	0.0003	o	0.4278
IV.3	4,169	0.0014	0.0254	0.0010	0.0278	o	o	0.0632
IV.4	1,572	o	o	0.0045	0.0045	o	o	0.018
IV.5	2,952	0.0010	0.0220	o	0.0230	0.0003	o	0.08
IV.6	116	0.0086	o	0.0086	0.0172	o	o	0.086
IV	23,469	0.0040	0.1406	0.0005	0.1451	0.0002	o	0.3092

TABLE 1.04B Page two

## WATER SOURCE DENSITIES BY ECOLOGICAL ZONES

ZONES	AREA in Km <sup>2</sup>	BALLIS	WELLS	BERKADO	ALL TEMPOR- ARY SOURCES	BORE HOLES	FLOWING RIVERS	INDEX OF ALL W/SOURCES DENSITIES
V.1	1,508	0.0020	o	o	0.0020	o	o	0.012
V.2	11,764	0.0046	0.0067	0.0007	0.0120	0.0009	o	0.0528
V	13,272	0.0043	0.0060	0.0006	0.0109	0.0008	o	0.0482
VI.1	2,242	0.0112	0.0058	o	0.0161	0.0009	0.1111	1.4210
VI.2	964	0.0021	0.0041	o	0.0062	o	o	0.0208
VI	3,206	0.0084	0.0053	o	0.0137	0.0006	0.0777	0.9994
VII.	9,456	0.0054	0.0069	0.0011	0.0134	0.0001	o	0.0516
VIII.1	912	0.0055	0.0548	0.0417	0.1020	o	o	0.3094
VIII.2	1,648	0.0012	0.0073	o	0.0085	o	o	0.0218
VIII	2,560	0.0027	0.0242	0.0148	0.0417	o	o	0.1242
CENTRAL RANGE- LANDS	132,327	0.0070	0.0628	0.0013	0.0711	0.0002	0.0019	0.1976

TABLE 1.04 C

BORE HOLES & PUMPED WELLS IN THE CENTRAL RANGELANDS -A RECONCILIATION OF INFORMATION FROM DIFFERENT SOURCES

NUMBER	SOURCE 1:100,000 SURVEY DEPT. MAPS	HEMMING'S REPORT	THIS SURVEY AND 1:250,000 MAPS	COMMENTS
1	outside mapped area	BORTINLE (bore hole)	outside mapped area	probably still working
2	JIRRIIBAN (wells only)	JIRRIIBAN (pumped well)	JIRRIIBAN (only wells seen)	pump no lon- ger working
3	outside mapped area	GALDOGOB (bore hole)	outside mapped area	no information
4	not shown	BEYRA (bore hole)	not found	probably no longer working
5	GAALKACYO (bore hole)	GAALKACYO (bore hole)	GALKACYO (bore hole)	8 km north town. HEMMING marks two bore holes for GAALKACYO
6	GOWLALLO (bore hole in black)	not named <u>printed</u> (bore hole)	GOWLALLO - no bore hole seen not marked as a bore hole	No longer working
7	no location no bore hole	not named (bore hole 25km south of Gaalkacyo)	Not seen and not marked	?
8	outside mapped area	GALINSOOR (bore hole)	GHELINSOR outside mapped area	probably still working
9	"	DHABAD (bore hole)	"	no information
10	"	CABUUD WAAQ (3 bore holes)	"	"

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11	CADAADO (bore hole)	CADAADO (bore hole)	CADAADO (bore hole)	None
12	GODINLABE (bore hole)	GODIN-LAABE (bore hole)	GODINLABE (bore hole)	None
13	outside mapped area	BALAMBAALE (2 bore holes)	outside mapped area	no information
14	MAREER GUR (bore hole)	MAREER - GUUR (bore hole)	MAREER GUR (bore hole)	None
15	DHUUSAMARREEB not shown	DHUUSA-MAREB (bore hole)	DHUUSAMARREEB not seen	probably not working now
16	WISIL (bore hole)	WISIL (bore hole)	WISIL (bore hole)	None
17	GURI CEEL (bore hole)	GURI-CEEL (2 bore holes)	GURI CEEL (bore hole)	None
18	MATABAAN (on the very edge of the mapped area)	MATABAAN (bore hole)	MATABAAN not seen in the mapped area	possibly just outside the map area
19	CEEL GAAL (wind driven motor well)	JAWIIL (bore hole)	CEEL GAAL not working and not mapped	no location called JAWIIL in this area according survey dept. maps
20	BELEDWEYNE (wind driven motor well)	BELED-WEYNE (pumped well)	BELEDWEYNE not working & not mapped	no longer working
21	BELEDWEYNE (3 km east) (bore hole)	BELEDWEYNE (20 km east) (pumped well)	BELEDWEYNE (3 km east) bore hole marked on maps	location nearest fit
22	GARABLE (bore hole)	GARABLE (bore hole)	GARABLE (bore hole)	None
23	XARARDHEERE (bore hole)	XARARDHEER (pumped well)	XARARDHEERE (bore hole)	None

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24	DAB. XARAR (not shown)	DAC (pumped well)	DAB XARAR (not seen & not mapped)	?
25	CEEL BUUR (not shown)	CEEL-BUUR (not shown)	CEEL BUUR (bore hole mapped)	Cartographer's <sup>error</sup> ; no bore hole there
26	GAL HAREERI (bore hole)	GAL-HAREERI (bore hole)	GAL HAREERI (bore hole)	None
27	BARGAAN (bore hole)	BARGAAN (bore hole)	BARGAAN (bore hole)	None
28	JACAR (bore hole)	JACAAR (bore hole)	JACAR (bore hole)	None
29	HALGEN (bore hole)	not shown	HALGEN (bore hole)	possibly a new source
30	NOOLEEYE (bore hole)	CAWS WEYNE (bore hole)	NOOLEEYE (bore hole)	Name changed from HEMMING's
31	DABAYOODLE (bore hole)	not shown	DABAYOODLE (not seen but mapped)	probably not working
32	ABOREY (bore hole)	ABOOREY (bore hole)	ABOREY (bore hole)	None
33	MUQAKOORI (bore hole)	not shown	MUQAKOORI (bore hole)	possibly a new source
34	MABAAX (bore hole)	not shown	MABAAX (bore hole- not seen but mapped)	probably not working
35	AADAN YABAAL (bore hole)	not shown	AADAN YABAAL (bore hole)	None
36	NAWIR (bore hole)	not shown	NAWIR (seems to be not working, but mapped)	None

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37	CEELDHEER (bore hole)	CEEL DHEER (pumped well)	CEELDHEER (bore hole)	None
38	GALCAD (bore hole)	not shown	GALCAD (bore hole)	possibly a new source
39	RUNUNGOD (bore hole)	not shown	RUNUNGOD (bore hole)	possibly outside the area studied by HEMMING
40	CALIWEYD (bore hole)	not shown	CALIWEYD (bore hole)	"

TABLE 1.05  
A SUMMARY OF SOIL INFORMATION COLLECTED AT GROUND SAMPLING SITES BY ECOLOGICAL ZONES

ECOLOGICAL ZONE	MEAN & RANGE OF pHs	SOIL COLOURS	HORIZONS	DEPTHS	FIELD DESCRIPTION	DETAILED EXAMINATION OF SOILS	NUMBER OF SAMPLES
I.1 N.W. LIMESTONES LSU.s 1, 3, 5, 10, 12, 36, 49	7.45 7.2 - 7.8	Predominantly 5yr 5/6 Yellowish red (40% of sites) but ranges from 2.5yr 3/6 dark red to 7.5yr 6/6 reddish yellow. Redder colours are found in LSU.s 10 & 36.	None	Shallow through out & rarely more than 1m deep.	Shallow orange toned <sup>fine</sup> silty sands over limestone. Throughout the zone the surface in respect of sand & limestone varies between massive limestones with almost no sands to areas of sand with occasional small limestone fragments. Manteling has produced surface concentrations of weathered limestone particles in characteristic patterns (see Table 1.03). Deflation (& water erosion in places) give rise to exposure of the underlying massive limestones.	90% of sand particles are well rounded, small (Less than .1mm) of quartz origin. Small limestone particles comprise about 2%, larger limestone fragments (irregular shapes) 3% and larger quartz particles about 5% of the sand	36
I.2 LSU 48	7.25 7.2 - 7.3	Predominantly 5yr 5/6 yellowish red and 5yr 7/4 pink	None	AS ABOVE	AS ABOVE, and including some gypseous silty materials, with a mantle of coarser sands in parts. In general sands in LSU 48 are more silty than those in zone I.1	Silty sands of two types:- i) Quartz type made up of fine rounded quartz particles (70%) medium (.1mm - .5mm) irregular quartz particles (20%), and limestone particles of a wide range of shapes and sizes (10%) ii) Limestone type made up of 100% rounded limestone particles of wide size range.	6
I.3 LSU.s 27, 46	7.60 7.5 - 7.7	Predominantly 2.5yr 5/8 to 4/8 red.	None	AS ABOVE	AS FOR ZONE I.1, but overall less silty.	98% of particles are quartz of up to .5mm size, fairly rounded in shape.	4
I.4 LSU.s 16,25,47,89	7.55 7.5 - 7.6	Predominantly 5yr 5/6 yellowish red, but LSU 25 is 2.5yr 4/8 red & LSU 16 has redder colours.	None	AS ABOVE	AS FOR ZONE I.1	AS ABOVE	12
I.5 LSU 64	7.5 -	7.5yr 6/4 light brown.	None	AS ABOVE	Shallow medium orange toned sands over limestone; gypseous silts in places under a sand mantle; limestone stone mantles exposed massive limestones, and exposed evaporites in a complex pattern.	Many types of soil, basically mixtures of medium quartz particles (up to .5mm), silts, limestone particles (up to 1mm) and gypsum particles (up to 1mm).	2
I.6 LSU.s 80, 82	7.50 7.4 - 7.6	Predominantly 5yr 5/6 yellowish red.	None	AS ABOVE	A shallow fine silty sand over limestone, orange in tone. The surface is bound in places by algal or fungal filaments.	A fine (less than 0.1mm) sand of evenly graded quartz particles fairly rounded in shape. Silt proportion up to 5% and no limestone particles.	9
I.7 LSU.s 58,68,76, 79.	7.50 7.4 - 7.6	Predominantly 7.5yr 5/6 yellowish red.	Some horizons where different alluvial & colluvial regimes have become established.	Generally shallow but some deeper deposits.	Sandy clay loams with many stones, both mantled and below the surface. Some clays and some stony colluviums. Massive rock outcrops and laterite surfaces in places.	Very mixed, with coarse (up to 1mm) particles of limestone, silts, clays & fine limestone soils. Larger (1 - 2mm) limestone & quartz chips are widespread.	13
I.8 LSU.s 67, 75	7.63 7.6 - 7.7	5yr 5/8 yellowish red.	None	AS ABOVE	A shallow orange loamy sand of mixed grain size, compacted & slightly cemented where the loose sand mantle has been removed. Some small areas of wind blown fine sand.	Fine and medium particles (less than .1mm and .1 - .5mm) of quartz with silt and some clay. Very small proportion of limestone in the sand.	6
ALL LIMESTONES I.1 - I.8	7.48 7.2 - 7.8	5yr 5/6 yellowish red is the predominant colour with redder colours in the western LSU.s (10, 16, 25 & 36)	None	Shallow - rarely more than 1m.	Predominantly shallow fine silty sands of quartz with some limestone; orange in tone mixed with limestone rock & stones in a variety of forms & combinations.	Predominantly sands of rounded quartz particles with a small proportion of irregular limestone particles of greater size.	88

TABLE 1.05

II.1 NORTHERN GYPSUMS LSU.s 28, 29, 30, 34	7.24 7.2 - 7.3	Predominantly 7.5yr 8/4 & 7/4 pink colours, but ranging between 5yr 5/6 yellowish red and 7.5yr 8/2 pink.	None	Shallow rarely more than 1m.	Very heterogeneous shallow fine sandy gypseous silt with evaporite and limestone exposures. Some clays are found. Surfaces are frequently bound by algal or fungal filaments.	Silt particles not rounded (50%); coarse (5mm) gypsum particles covered by secondary limestones (15%), coarse limestone particles (30%) & medium quartz particles (5%).	16
II.2 LSU.s 37, 57	7.43 7.2 - 7.6	A mixture between 5 to 7.5yr 7/4 (pinks) and 5 to 7.5 7/6 reddish yellows, with some 7.5yr 6/4 light browns	None	AS ABOVE	Shallow orange toned loamy sands with nodular secondary limestones (5%) mixed with silty gypseous sands (30%) and silty gypseous clays (30%). The rest of the surface is evaporite (30%) & limestone (5%). Much of the surface is fixed by the algal or fungal filaments. Some surfaces have pisolitic secondary limestone and washed sand.	Most of the fine particles, which make up 80% of all the soils, are gypsum or gypsum coated by secondary limestone.	14
II.3 LSU.s 31, 32	7.25 7.2 - 7.3	A mixture of 7.5yr 5/6 brown (the predominant colour) with 7.5yr 6/6 reddish yellow.	None	AS ABOVE	Shallow very heterogeneous fine sandy gypseous silts with evaporite & limestone exposures, with pockets of clays & loams and mud-floored dry lagoons. Surfaces are frequently bound by algal or fungal filaments.	As for ecological zone II.1	12
II.4 LSU 33	7.30 7.2 - 7.4	7.5yr 5/6 brown	None	AS ABOVE	Shallow orange toned loamy sands mixed with silty gypseous sands brown sandy clay loams and clay loams. A fine stone mantle forms in places. Algal or fungal filaments binding the surface are widespread.	Silt particles (40%) coarse gypsum particles & coarse limestone particles. No quartz particles.	3
II.5 LSU 77	7.30 7.2 - 7.5	10yr 7/4 very pale browns and 7.5yr 5/6 brown.	None	AS ABOVE	Saline gypseous clays mixed with pale gypseous silts, and pale orange loamy sands. Evaporites & limestone rocks are on the surface in places. Algal or fungal filaments binding the surface are widespread.	Silt particles, medium to coarse limestone (.5 - .7mm) particles and medium gypsum particles.	3
II.6 LSU.s 42, 50	7.40	7.5yr 6/4 light brown	None	AS ABOVE	Soil hard consolidated calcareous and gypseous fine silty sands with some windblown sand and areas of limestone stone mantles. The consolidated sands are locally eroded by small drainage lines with some gully-ing. Algal or fungal filaments widespread.	Medium quartz particles (to 0.5mm) much fine limestone, gypsum & quartz. (less than .1mm) & a few large limestone particles.	2
ALL GYPSUMS	7.31 7.2 - 7.6	Predominantly 7.5yr 8/4 & 7.4 pinks, and 7.5yr 6/4 & 5/6 light brown and brown. Some 7.5yr 7/6 & 6/6 reddish yellows.	None	Shallow - rarely more than 1m.	Predominantly shallow heterogeneous silty sands. Loamy sands, clays & silts of gypseous & limestone origins with small quartz additions. Surfaces bound by algal or fungal filaments. Exposures of gypsums & anhydrites and limestones common.	No Summary meaningful.	50
III.1 LSU.s 6, 7, 11, 13, 14, 15, 17, 38, 39, 40, 88.	7.31 7.1 - 7.5	Red and dark red in the west (2.5yr 5/8, 4/8 mostly for LSU.s 11, 14) toning through yellowish reds (5yr 5/6, 5/8) to reddish yellows in the extreme east (7.5yr 6/6 5yr 6/8 in LSU.s 7 & 17)	None	Shallow to medium depth of up to 2m.	Predominantly fine to medium quartz orange toned sands with traces of silt. With some areas of silty and loamy sands. Deflation has created limestone exposures & mantling of large limestone stones. Algal or fungal filaments bind the surface in parts of LSU 88.	95% of particles are fine to medium rounded quartz of up to .5mm. Irregular limestone fragments of 1 - 5mm, & silts make up the other 5%.	28
III.2 LSU.s 9, 26, 43, 44, 45, 63, 85	7.53 7.3 - 7.65	Similar to the northern sands over limestones (III.1) with red & dark red in the west. (2.5yr 4/8, 5/8, 3/5, 4/6 in LSU.s 43, 44, 45) toning through yellowish reds (5yr 5/8, 4/6) to reddish yellows in the east (7.5yr 6/6 in LSU 63)	None	AS ABOVE	Predominantly shallow medium to coarse grained loamy orange toned sands, showing less deflation, but more erosion than ecological zone III.1 limestones are exposed in places, and coarse sand stones mantling in parts of the zone.	Medium to coarse (.4 - 1mm) rounded quartz particles 80% of the soil. Silts, & widely graded limestones make up the other 20%.	37
ALL SANDS OVER LIMESTONES III	7.44 7.1 - 7.65	A regular west to east gradient from dark red, red, yellowish red to reddish yellows.	None	AS ABOVE	Shallow fine to coarse grained orange toned sands, & Loamy sands with some silt. Surfaces modified by deflation & erosion with some mantling of coarser sands & small stones.	Quartz particles (.1 - 1mm) make up 80 - 95% of soils. Silts & generally coarse limestones form the rest.	65

TABLE 1.05

IV.1 LSU 20, 21	7.40 7.31 - 7.5	Predominantly 7.5yr 7/6 reddish yellow	None	Shallow except as old dunes .	Shallow fine to medium pale orange limestone sands in a wind blown patchy (60%) mantle over pink limestonecavitated pavements, with some partially stabilised small dunes. Low cliffs and micro-scarps characterise the limestone near the sea.	Fine rounded particles of various colours give a speckled appearance. Most particles (70-80%) are of limestone. Very little silt.	6
IV.2 LSU 18, 19, 23, 35, 41, 55, 60, 72	7.60 7.4 - 7.7	Predominantly 7.5yr 6/6 6/8 & 7/6 and 5yr 6/8, 7/8 & 6/6 reddish yellows with some 7.5yr 6/4 light browns & 10 yr 7/4 very pale browns	None	Shallow except as old dunes but deep in parts of LSU 72	Patchy shallow fine to medium pale orange limestone mantle of fixed PLIOCENE sand over pink limestone pavements. Mantle cover is 80 - 90%. Partially stabilised dunes common. Deeper sand is well consolidated. The more elevated parts of LSU 72 are covered by a deeper gritty highly calcareous silty clay loam, with a surfaced fixed by algal or fungal filaments.	AS ABOVE, but a trace more silt.	15
IV.3 LSU 56, 61, 65, 66, 73, 87	7.55 7.5 - 7.6	A mixture of reds (2.5yr 5/8, 4/8) yellowish reds (5yr 5/6, 4/6, 5/8) and reddish yellows (5yr 6/6 6/8) without any apparent pattern or gradient.	None	Generally deep but underlying limestones exposed in places.	Deep fine grained silty orange sands with occasional superficial limestone stones. Most surfaces have consolidated, and so are susceptible to erosion & gulleying on slopes. This erosion has removed most of the sand from LSU 65, revealing deep gorges in the limestone ridge. Algal or fungal filaments bind some of the surfaces.	Fine (less than .1mm) evenly graded fairly rounded quartz particles with very few limestone particles.	16
IV.4 LSU 90	7.6 -	Predominantly 5yr 5/6 yellowish red	None	Deep	AS ABOVE	AS ABOVE	4
IV.5 LSU 22, 51, 52, 53, 54	7.60 7.50 - 7.7	A mixture of reddish yellows (5yr 6/8, 6/6 & 7.5yr 7/6) and yellowish reds (5yr 5/8) without apparent pattern or gradient.	None	Deep	Dunes of deep fine pale sand over more consolidated silty sand. The receding edge of the dune leaves white limestone pavements with bouldery type weathering, resembling secondary limestone.	Some LSUs are mainly quartz, some mainly limestone. (LSU 22, 52 - 90% limestone; 51, 53 & 54 90% quartz) All particles fine & fairly rounded.	6
IV.6 LSU 86	7.35 7.3 - 7.4	Predominantly 5yr 5/8 yellowish red.	Isolated concretions at 3m & a cemented layer at 5m. No other horizons.	Deep	A fine pale orange silty clay loam, blown over in parts by fine silty sand. Algal or fungal filaments bind the surface.	Fine quartz sand particles with very fine limestone particles as silt & clay.	3
ALL IV	7.54 7.3 - 7.7	Reddish yellows, yellowish reds in a complex mosaic (7.5yr 6/6, 6/8 & 7/6; 5yr 6/8, 7/8, 6/6 reddish yellows; 5yr 5/8 5/6 & 4/6 yellowish reds) with some reds (2.5yr 5/8 & 4/8) browns, (7.5yr 6/4) & light browns (10yr 7/4) in the more northerly LSUs.	No horizons in the strict sense but secondary limestones at depth below calcareous sands	Generally deep	Shallow to deep fine sands of limestone & quartz origin. The coastal strip is largely a patchy mantle of silt-free limestone sand; inland on the coastal limestone ridge silty sands predominate, with quartz particles more important.	No summary meaningful.	50
V.1 LSU 84	7.6 7.5 - 7.7	Predominantly 5yr 5/8 yellowish red.	None	Deep	Fine deep pale orange sands with traces of silt. Consolidated with algal or fungal filaments.	Fine (0.1mm) well rounded quartz particles with no limestone.	8
V.2 LSU 4, 8, 62, 71, 81, 91	7.63 7.5 - 7.9	Predominantly 7.5yr 6/6 7/6 & 5/6 reddish yellow with some 5yr 5/8, 4/6 & 7.5yr 5/6 yellowish red soils	None	Generally not deep (less than 1m), except for LSU 62 and 71.	Medium pale orange sands with little silt in the north, with finer silty sands in the south which are consolidated but not cemented. Algal or fungal filaments are common on the surface throughout.	Medium to very fine quartz particles with almost no limestone. Particles are well rounded; silt not more than 5%.	18
V LSU 84, 62, 71	7.62 7.5 - 7.9	Mixed reddish yellow & yellowish red sands with no apparent pattern or gradient.	None	L.S.U.s 84, 62, 71 deep, others not deep.	Fine to medium pale orange sands of variable depth with traces of silt. Frequently consolidated but not cemented; algal or fungal filaments common	Quartz particles well rounded & smaller than .1mm diameter. Traces of silt.	26

TABLE 1.05

VI.1 LSU 69, 70, 83	7.65 7.6 - 7.7	Mixed light yellow browns (10yr 6/4, 6/3) and yellowish reds (7.5yr 5/6 & 5yr 5/6)	None	Deep	Pale deep silty clay loams in mosaic with pallid beige silty cracking clays. (LSU 69 & 70) and chestnut brown deep silty clays containing very small stones & laterite fragments, which form a partial stone mantle in places (LSU 83) "Puffed-up" surfaces common.	Very fine silts & clays with some larger sand particles almost all of limestone origin.	15
VI.2 LSU 78	7.5 -	Predominantly dark red-dish brown (5yr 3/4) with some yellowish reds (5yr 5/8 & 7.5yr 5/6).	None	Deep	A deep chestnut brown silty clay with angular stones up to 5cm. The clay is finely cracked & "Puffed-up" at the surface. Shallowly incised drainage channels.	80% of the material is limestone; larger stones include lateritic fragments.	4
VI	7.62	Very mixed dark & light alluviums with yellowish red soils.	None	Deep	Very heterogeneous limestone derived alluvial soils of silty clay loams, silty deeply cracking clays with partial manteling "Puffing-up" & incised drainages.	Limestone derived fine particles with larger irregular stones including laterite fragments.	19
VII LSU 24, 74	7.40 7.2 - 7.5	Yellowish red in the south (LSU 74 - 5yr 5/8; 7.5yr 5/6) & reddish brown (5yr 5/3) and dark reddish brown. (Not matchable on the Pursell Chart) in the north (LSU 24).	None	Deep	A deep reddish brown loamy sand of mixed (but mainly coarse) grain size with a compacted & slightly cemented surface (breaking into angular pods). The surface has patches of mantle of paler toned washed sand set in in smoother compacted areas. (LSU 24). Further south (LSU 74) the soil is a beige to orange medium to coarse mixed grain sand with traces of silt. The surface is weakly consolidated but not cemented	Coarse to medium (.5 - 1mm) well rounded quartz particles with silt and some clay.	9
VIII.1 LSU 2	7.45 7.4 - 7.5	Predominantly yellowish reds (5yr 5/8, 5/6, 4/6)	None	Deep	A pallid chestnut brown fine sandy clay loam with some surface consolidation (gentle run-off essential for the arcing of vegetation) & a partial stone mantle caused by deflation.	Very fine (less than .1mm) rough quartz particles, with large (2.3mm - 12mm) irregular limestone particles manteling over the sands.	10
VIII.2 LSU 59	7.43 7.4 - 7.5	Predominantly yellowish red (5yr 5/8) soils.	None	Deep	An alluvial valley soil of pale orange toned fine silty clay. Some fine cracking, of the consolidated surface; small limestone stones are manteling on the surface. Flow of run-off water on the consolidated surfaces gives rise to arcing.	Very fine mixed limestone/quartz particles, (limestone 60%), with rather irregular shape.	6
VIII	7.44 7.4 - 7.5	Predominantly yellowish red (5yr ; 5/8, 5/6, 4/6)	None	Deep	Fine silty clay loams & fine silty clays with fairly consolidated surfaces promoting run-off & arc formation in the vegetation. Some manteling of larger limestone particles.	Very fine irregular quartz & quartz/limestone particles with irregular large limestone particles.	16
CENTRAL RANGELANDS	7.488 7.1 - 7.9	No summary meaningful	Generally None		No summary meaningful	No summary meaningful	323

TABLE 1.06  
CROPPING PATTERNS IN THE CENTRAL RANGELANDS IN 1979 BY ECOLOGICAL  
ZONES & CLASSES

ECOLOGICAL CLASS & ECOLOGICAL ZONE	CURRENT CROPPING & FALLOW LAND (%)		ABANDONED		ALL CURRENT & RECENT CROPPING	
	DRY SEASON	WET	DRY SEASON	WET	DRY SEASON	WET
I.1 N.W. LIMESTONE	0.0960	0.0186	0.0390	o	0.1350	0.0186
2	0.1200	0.0450	0.1070	0.0860	0.2270	0.1310
3	0.0196	0.1768	o	0.0363	0.0196	0.2130
4	0.5594	0.3726	0.1443	1.7320	0.7037	2.1047
5	o	o	o	o	o	o
6	7.2470	1.7083	2.9085	7.1923	10.1555	8.9005
7	1.0136	0.1058	0.3341	0.0501	1.3476	0.1559
8	4.8504	2.9133	0.9126	6.2090	5.7630	.1223
I.1-8	1.0776	0.4068	0.3537	1.3490	1.4313	1.7558
ESTIMATES KM <sup>2</sup>	341	129	112	427	453	556
II.1 GYPSUM DOMINANTS	o	0.2112	0.0277	0.2940	0.0277	0.5052
2	0.0513	0.0061	0.0258	0.0251	0.0771	0.0312
3	1.5279	0.5674	0.4389	0.4646	1.9668	1.0320
4	13.969	1.114	0.855	3.382	14.824	4.496
5	1.8770	0.2090	0.4540	0.0310	2.3310	0.2400
6	o	o	o	o	0.0114	o
II.1-6	0.8307	0.1628	0.1799	0.1650	1.0106	0.3277
ESTIMATES KM <sup>2</sup>	121	24	26	24	147	48
III.1 ALL SANDS OVER LIMESTONE	0.0639	0.1060	0.037	0.2403	0.1009	0.3464
2	0.7692	0.2949	0.1984	0.5644	0.9676	0.8593
III.1-2	0.4117	0.1992	0.1166	0.4001	0.5283	0.5993
ESTIMATES KM <sup>2</sup>	141	68	40	137	180	205

IV.1	ALL COASTAL LAND SYSTEM UNITS	o	o	0.2529	o	0.2529	o
2		0.104	o	0.118	o	0.222	o
3		2.6797	1.1037	2.6294	1.5619	5.3090	2.6657
4		-	9.264	-	15.077	-	24.341
5		0.0619	o	o	0.0787	0.0619	0.0787
6		o	o	o	0.0206	o	0.206
IV.1-6		0.5363	0.8166	0.5570	1.2983	1.0932	2.1149
ESTIMATES KM <sup>2</sup>		126	192	131	305	257	496
V.1	STABILISED SAND DUNES	0.9670	0.3330	0.7820	0.3090	1.7490	0.6420
2		111.7235	7.0752	5.6194	8.1975	17.4249	15.2727
V.1-2		10.5043	6.3091	5.1336	7.3012	15.6432	13.6103
ESTIMATES KM <sup>2</sup>		1393	837	681	969	2076	1806
VI.1	W. SHABEELLE ALLUVIUMS	15.9635	9.4717	10.6758	39.44	26.6393	48.9157
2		5.4870	7.0950	7.4470	13.8580	12.9340	20.9530
VI.1-2		12.8134	8.7571	9.7049	31.7506	22.5183	40.5077
ESTIMATES		411	281	311	1018	722	1299
VII.1	HAUD TYPE	0.0702	0.0144	0.1763	0.0601	0.2465	0.0745
		0.0702	0.0144	0.1763	0.0601	0.2465	0.0745
ESTIMATES KM <sup>2</sup>		7	1	17	6	23	7
VIII.1	ALL ARCED SILTS	o	0.4260	o	o	o	0.4260
2		9.3180	0.1900	3.0450	0.6780	12.3630	0.8680
VIII.1-2		5.9985	0.2741	1.9602	0.4365	7.9587	0.7105
ESTIMATES KM <sup>2</sup>		154	7	50	11	204	18
<u>CENTRAL RANGELANDS</u>							
%		2.0490	1.2250	1.0870	2.2850	3.1370	3.5100
AREA IN KM <sup>2</sup>		2699	1556	1432	2900	4132	4455

TABLE 1.07

PHYSIOGNOMIC & TAXONOMIC FEATURES OF VEGETATION IN THE LAND SYSTEM UNITS IN THE CENTRAL RANGELANDS & OTHER BIOTIC INFORMATION

LAND SYSTEM UNIT	TREES (ie woody species usually over 2 1/2 m high with single woody stem branching only above ground)		SHRUBS (ie woody species rarely more than 3 m high with many branched stem)		GRASSES & HERBS (ie non woody species rarely more than 1 m)	
	Abundance	Common species	Abundance	Common species	Abundance	Common species
1	medium	<u>Boscia minimifolia</u> ; <u>Sesamothamnus</u> sp. dense <u>Commiphora</u> spp. <u>Balanites</u> sp. <u>Delonix baccal</u> <u>Acacia</u> spp; <u>Acacia tortilis</u> <u>Boswellia microphylla</u>	dense	<u>Commiphora</u> spp; <u>Euphorbia cuneata</u> <u>Grewia</u> sp. <u>Iphiona rotundifolia</u> <u>Dalbergia commiphoroides</u> <u>Ipomoea donaldsonii</u> <u>Cadaba glandulosa</u>	sparse to very sparse	<u>Aristida</u> sp. <u>Pavonia</u> spp. <u>Indigofera ruspolii</u> <u>Corchorus bricchetti</u>
3	medium to sparse	As above	dense	As above	sparse to very sparse	As above
5	sparse to very sparse	As above	dense to medium	As above	sparse	As above, plus <u>Sporobolus</u> sp. & <u>Latipes senegalensis</u>
10	Sparse with some areas of medium density	As above but no <u>Delonix baccal</u> or <u>Boswellia microphylla</u>	medium	As above plus <u>Salvadora persica</u> & <u>Jatropha</u> sp.	sparse to medium	As above plus <u>Abutilon</u> sp. <u>Pterodiscus</u> sp. <u>Crotalaria</u> spp. <u>Barleria</u> sp. <u>Triumfetta</u> sp. <u>Cenchrus</u> sp. <u>Cyperus</u> spp. <u>Eragrostis</u> sp.
12	sparse	As for LSU 5.	medium	As for LSU 5.	sparse	As for LSU 5 plus <u>Aerva lanata</u>
36	sparse	As for LSU 5	medium dense	As for LSU 5	sparse	As for LSU 1 but <u>Indigofera ruspolii</u> very dominant
49	very sparse	As for LSU 10.	medium dense	As for LSU 10.	sparse	As for LSU 36.
48	<u>Limestones &amp; pale orange soils</u> As in LSU 49		As in LSU 49 plus <u>Solanum</u> sp. & <u>Jatropha</u> sp.		As in LSU 49	
	<u>Gypsums/anhydrites</u> very sparse	<u>Acacia</u> sp.	very sparse	<u>Euphorbia cuneata</u> <u>Commiphora</u> spp. <u>Salvadora persica</u>	medium	<u>Sporobolus ruspolianus</u> <u>Xylocalyx</u> sp. <u>Zygophyllum simplex</u> <u>Dactyloctenium scindicum</u> <u>Aristida</u> sp. <u>Ipomoea</u> sp.
	<u>Gypseous soils</u> sparse to very sparse	<u>Cadaba heterotricha</u> <u>Dobera glabra</u>	sparse to medium	<u>Commiphora</u> spp. <u>Salvadora persica</u> <u>Ipomoea donaldsonii</u>	medium to sparse	<u>Sporobolus ruspolianus</u> <u>Xylocalyx hispida</u> <u>Aristida</u> sp. <u>Indigofera</u> sp.

TABLE 1.07

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27	very sparse	<u>Acacia tortilis</u>	sparse to medium	<u>Commiphora</u> spp. <u>Balanites</u> sp. <u>Acacia edgeworthii</u> <u>Cadaba glandulosa</u> <u>Ipomoea donaldsonii</u>	medium to dense	<u>Indigofera ruspolii</u> <u>Aristida</u> sp. <u>Chrysopogon aucheri</u> <u>Barleria</u> sp. <u>Aerva persica</u> <u>Eragrostis</u> sp. <u>Indigofera</u> sp. <u>Solanum</u> sp.
46	Nil to very sparse	<u>Acacia tortilis</u>	sparse to medium	As above	sparse to medium	As above but <u>Indigofera</u> very dominant.
16	medium to sparse	<u>Acacia tortilis</u> <u>Commiphora</u> spp. <u>Delonix baccal</u> <u>Acacia</u> spp. <u>Albizzia</u> sp. <u>Cordia</u> sp.	medium to dense	<u>Commiphora</u> spp. <u>Jatropha</u> sp. <u>Grewia</u> sp. <u>Dalbergia</u> sp. <u>Solanum</u> sp.	sparse to very sparse	<u>Indigofera</u> spp. <u>Solanum</u> sp. <u>Aristida</u> sp.
25	medium to sparse	As above	medium to dense	As above	sparse	As above
47	sparse	As above	medium	As above plus <u>Ipomoea donaldsonii</u> <u>Euphorbia cuneata</u> <u>Acacia</u> spp.	sparse	As above plus <u>Latipes senegalensis</u> <u>Cyperus</u> sp.
89	very sparse	As above	medium	As above	sparse	As for LSU 16.
64		<u>Limestones &amp; pale orange sands</u>				
	sparse	<u>Acacia tortilis</u> <u>Commiphora</u> spp.	medium	<u>Commiphora</u> spp. <u>Dalbergia</u> sp. <u>Euphorbia</u> sp. <u>Merremia</u> sp. <u>Cassia</u> sp. <u>Acacia edgeworthii</u> <u>Jatropha</u> sp.	sparse	<u>Indigofera</u> sp. <u>Barleria</u> sp. <u>Eragrostis</u> sp. <u>Aristida</u> sp.
		<u>Gypsums &amp; pale gypseous soils</u>				
	sparse	<u>Boscia minimifolia</u> <u>Salvadora persica</u> <u>Commiphora</u> sp. <u>Acacia tortilis</u> <u>Sesamothamnus</u> sp.	sparse to medium	<u>Commiphora</u> spp. <u>Commicarpus reniformis</u> <u>Salvadora persica</u> ; <u>Jatropha</u> sp. <u>Euphorbia</u> sp.; <u>Ipomoea donaldsonii</u> <u>Cleome</u> sp. <u>Dobera glabra</u>	medium	<u>Chrysopogon aucheri</u> <u>Triumfetta</u> sp. <u>Xylocalyx hispida</u> <u>Indigofera</u> sp. <u>Dactyloctenium scindicum</u> <u>Aristida</u> sp.
80 & 82		<u>Pale yellow sands &amp; old dune tracks</u>				
	sparse	<u>Acacia tortilis</u>	sparse to medium	<u>Acacia</u> sp. aff <u>senegal</u> <u>Commiphora</u> spp. <u>Dalbergia</u> sp. <u>Boswellia</u> sp. <u>Ipomoea donaldsonii</u> <u>Sesamothamnus</u> sp. <u>Grewia</u> sp. <u>Solanum</u> sp. <u>Cordyla</u> sp.	dense	<u>Indigofera ruspolii</u> <u>Tephrosia subtrifolia</u> <u>Commelina</u> sp. <u>Notonia</u> sp. <u>Iphiona</u> sp. <u>Pavonia</u> sp. <u>Aristida</u> sp. <u>Cenchrus</u> sp. <u>Tetrapogon</u> sp.
		<u>Limestones/orange silty sands</u>				
	sparse	<u>Terminalia orbicularis</u>	dense	<u>Anisotes</u> sp. <u>Sesamothamnus</u> sp. <u>Commiphora</u> (7 spp.) <u>Lanea greenwayii</u> <u>Euphorbia</u> spp. <u>Grewia</u> spp. <u>Dobera glabra</u>	sparse	<u>Indigofera ruspolii</u> <u>Triumfetta</u> sp. <u>Pavonia</u> spp. <u>Corchorus</u> sp. <u>Aerva</u> sp.

TABLE 1.07

58	medium to sparse	<u>Boscarella</u> sp. <u>Commiphora</u> spp. <u>Boscia minimifolia</u> <u>Dobera glabra</u> <u>Acacia</u> sp.	medium to dense	<u>Acacia senegal</u> <u>Euphorbia</u> spp. <u>Acacia misera</u> <u>Grewia</u> sp. <u>Maerua</u> sp. <u>Commiphora</u> spp.	sparse	<u>Polygala</u> sp. <u>Pavonia</u> spp. <u>Seddera</u> sp. <u>Cassia</u> sp. <u>Aristida kelleri</u> <u>Latipes</u> sp.	<u>Chloris</u> sp. <u>Sporobolus</u> sp. <u>Enneapogon</u> sp.
68	medium to sparse	As above plus <u>Cordia</u> sp. <u>Terminalia</u> sp.	medium to dense	As above	sparse	As above	
76	medium to sparse	As above plus <u>Acacia tortilis</u>	dense	As above	sparse	As above	
79	sparse	<u>Acacia tortilis</u> <u>Cordia</u> sp. <u>Boscia minimifolia</u> <u>Commiphora</u> spp. <u>Ziziphus hamur</u>	medium to dense	<u>Anisotes</u> sp. <u>Grewia</u> sp. <u>Lamnea greenwayii</u> <u>Commiphora</u> spp.	sparse	<u>Aerva</u> sp.; <u>Aristida</u> sp. <u>Sida ovata</u> <u>Indigofera spinosa</u> <u>Glossyrium somalense</u> <u>Aristida kelleri</u> <u>Sporobolus</u> sp.	
67	sparse to medium	<u>Acacia tortilis</u> <u>Dobera glabra</u> <u>Delonix elata</u>	medium to dense	<u>Sesamothamnus</u> sp. <u>Grewia</u> sp. <u>Euphorbia cuneata</u> vel. aff. <u>Acacia edgeworthii</u> <u>Jatropha dichter</u> <u>Acacia</u> spp.	sparse but locally medium to dense	<u>Indigofera ruspollii</u> <u>Euphorbia</u> sp. <u>Corchorus</u> sp. <u>Aristida kelleri</u> <u>Enneapogon</u> sp. <u>Chrysopogon</u> sp.	
75	sparse	As above	medium to dense	As above plus <u>Cordyla somalensis</u>	medium	As above plus <u>Aerva</u> sp. <u>Melhania</u> sp. <u>Pavonia</u> spp. <u>Iphiaonia rotundifolia</u>	
28	sparse (in clumps)	<u>Acacia tortilis</u> <u>Ficus</u> sp.	sparse	<u>Salvadora persica</u> <u>Solanum</u> sp. <u>Heliotropium</u> sp. <u>Acacia edgeworthii</u> <u>Balanites</u> sp. <u>Commiphora</u> spp. <u>Euphorbia</u> sp. <u>Dobera glabra</u>	sparse to medium	<u>Zygochloa</u> sp. <u>Pterodiscus ruspollii</u> <u>Senra incana</u> <u>Aerva lanata</u> <u>Chrysopogon aucheri</u> <u>Dactyloctenium scindicum</u> <u>Tribulus terrestris</u> <u>Abutilon</u> sp. <u>Cleome brachycarpa</u> <u>Cassia</u> sp. <u>Limonium distichum</u> <u>Cyperus</u> spp.	
29	sparse	As above	sparse to medium sparse	As above	medium	As above	
30	very sparse	<u>Acacia tortilis</u> only	sparse	<u>Acacia senegal</u> <u>Salvadora persica</u> <u>Suaeda</u> sp. <u>Senada schimperii</u>	sparse	<u>Limonium distichum</u> <u>Sporobolus ruspollianus</u> <u>Dactyloctenium scindicum</u> <u>Urochondra setulosa</u> <u>Zygochloa</u> sp.	
34	very sparse	<u>Acacia tortilis</u> <u>Salvadora persica</u> <u>Dobera glabra</u>	sparse to medium	As for LSU 28.	sparse	As for LSU 28.	

TABLE 1.07

37	very sparse	<u>Boscia minimifolia</u> <u>Cadaba heterotricha</u> <u>Secanothamnus</u> sp.	sparse	<u>Salvadora</u> sp. <u>Commiphora</u> spp. <u>Euphorbia somalense</u> <u>Acacia</u> spp.	medium to dense	As for LSU 28 plus <u>Aristida</u> sp. <u>Sporobolus ruspolianus</u>
57	very sparse	As above plus <u>Maerua</u> sp.	medium to sparse	As above.	sparse to medium	As for LSU 28 plus <u>Sporobolus ruspolianus</u> <u>Urochondra setulosa</u> <u>Suaeda</u> sp.
31	sparse	As for LSU 28.	medium	As for LSU 28.	medium	As for LSU 28.
32	sparse	As for LSU 57.	medium to sparse	As for LSU 57 plus <u>Euphorbia cuneata</u> <u>Kelleronia</u> sp.	medium	As for LSU 57.
33	sparse to medium	<u>Delonix elata</u> <u>Acacia</u> sp. <u>Commiphora</u> sp.	medium	As for LSU 37 plus <u>Anisotes</u> sp. <u>Acacia misera</u> <u>Cordia</u> sp. <u>Crewia tenax</u>	medium	As for LSU 37 plus <u>Indigofera spiniflora</u> <u>Melkania</u> sp. <u>Leucas</u> sp. <u>Chrysopogon aucheri</u> <u>Latipes</u> sp. <u>Enneapogon</u> sp. <u>Aristida</u> sp.
77	medium to sparse	<u>Acacia tortilis</u> <u>Albizzia anthelmintica</u> <u>Euphorbia</u> sp. <u>Cordia</u> sp.	dense to medium	<u>Commiphora</u> spp. <u>Acacia mellifera</u> <u>Acacia</u> spp. <u>Caesalpinia</u> sp. <u>Adenia</u> spp. <u>Salvadora persica</u> <u>Euphorbia</u> spp. <u>Suaeda micromeris</u>	medium to sparse	<u>Limonium axillare</u> <u>Urochondra setulosa</u> <u>Asparagus</u> sp. <u>Senra incana</u> <u>Barleria</u> sp. <u>Crotalaria</u> sp. <u>Abutilon</u> sp. <u>Heliotropium</u> sp. <u>Dactyloctenium scindicum</u> <u>Chloris</u> sp. <u>Cyperus</u> spp.
42 50	very sparse	<u>Acacia tortilis</u> <u>Boscia minimifolia</u>	medium to dense	<u>Acacia edgeworthii</u> <u>A. reficiens</u> subsp. <u>misera</u> <u>Balanites</u> sp. <u>Commiphora</u> spp. <u>Salsola</u> sp. <u>Jatropha villosa</u> var <u>glabra</u> <u>Crewia</u> sp.	medium	<u>Indigofera</u> sp. <u>Favonia</u> sp. <u>Iphiona rotundifolia</u> <u>Rhynchosia</u> sp. <u>Aristida</u> sp. <u>Chrysopogon aucheri</u> <u>Dactyloctenium scindicum</u> <u>Cyperus</u> sp.
6	sparse	<u>Acacia tortilis</u> <u>Boscia minimifolia</u> <u>Dobera glabra</u> <u>Balanites orbicularis</u>	dense	<u>Acacia horrida</u> subsp. <u>benadirensis</u> <u>Commiphora</u> spp. <u>Euphorbia cuneata</u> <u>Balanites</u> sp. <u>Ipomoea</u> sp.	sparse to very sparse	<u>Indigofera ruspolii</u> <u>Barleria</u> sp. <u>Abutilon</u> sp. <u>Heliotropium</u> sp.
7	very sparse	<u>Balanites orbicularis</u> <u>Boscia minimifolia</u>	dense to medium	As above	sparse to medium	As above
11	very sparse	As above	medium	<u>Acacia edgeworthii</u> <u>A. reficiens</u> subsp. <u>misera</u> <u>A. horrida</u> subsp. <u>benadirensis</u> <u>Commiphora</u> spp. <u>Jatropha dichter</u>	medium	<u>Indigofera ruspolii</u> <u>Aristida</u> sp. <u>Latipes senegalensis</u> <u>Aerva lanata</u> <u>Corchorus</u> sp.

TABLE 1.07

13	very sparse	<u>Erythrina</u> sp. <u>Acacia tortilis</u>	dense to medium	As above plus <u>Acacia</u> sp. <u>Ziziphus hamur</u> <u>Cissus</u> sp.	sparse	As above plus <u>Jatropha</u> sp. <u>Tribulus terrestris</u> <u>Cassia</u> sp., <u>Cenchrus</u> sp. <u>Dactyloctenium scindicum</u>
14	extremely sparse	As for LSU 11.	sparse to medium	As for LSU 11 plus <u>Cissus</u> sp. <u>Jatropha villosa</u> <u>Courtonia</u> sp.	medium to dense	As for LSU 11 plus <u>Indigofera</u> sp. <u>Melhania</u> sp. <u>Tephrosia</u> sp. <u>Corchorus</u> sp.
15	As above.	As above.	medium	As above.	medium	As above.
17	Nil		medium to sparse	<u>Euphorbia</u> sp., <u>Jatropha villosa</u> <u>Loewia glutinosa</u> , <u>Commiphora</u> spp. <u>Acacia</u> spp., <u>Balanites</u> sp.	medium	As above plus <u>Chascanum</u> sp., <u>Pavonia</u> spp. <u>Melhania</u> sp., <u>Kelleronia</u> sp. <u>Cassia</u> sp., <u>Lourea</u> sp. <u>Monsonia</u> sp., <u>Oxygonum</u> sp.
38, 39, 40	Nil		sparse	As for LSU 11 plus <u>Jatropha villosa</u> , <u>Euphorbia</u> sp.	medium	As for LSU 11.
88	Sparse	<u>Boscia minifolia</u> <u>Acacia</u> sp.	medium	As for LSU 11 plus: <u>Jatropha villosa</u> , <u>Ipomoea donaldsonii</u> <u>Sesamothamnus</u>	medium	As for LSU 11 plus: <u>Phyllanthus</u> sp., <u>Kelleronia</u> sp. <u>Crotalaria</u> sp., <u>Cassia</u> sp. <u>Tephrosia</u> sp. <u>Merremia</u> sp.
9	Nil		sparse to medium	<u>Cadaba glandulosa</u> ; <u>Commiphora</u> spp. <u>Dichrostachys</u> sp., <u>Acacia edgeworthii</u> <u>Sesamothamnus</u> sp., <u>Jatropha</u> sp. <u>Boscia coriacea</u> , <u>Euphorbia</u> sp. <u>Cissus</u> sp.	Medium	<u>Pavonia</u> spp.; <u>Indigofera</u> spp. <u>Iphiaea rotundifolia</u> , <u>Aristida</u> sp. <u>Merremia</u> sp., <u>Melhania</u> sp.
26	very scattered	<u>Acacia</u> sp.	medium	As above plus <u>Cordia</u> sp., <u>Ipomoea donaldsonii</u> <u>Euphorbia cuneata</u>	medium to dense	As above plus <u>Tribulus terrestris</u> <u>Cenchrus</u> sp., <u>Psilotrichum</u> sp. <u>Latipes senegalensis</u> <u>Cassia</u> sp.
43	very scattered	<u>Acacia</u> sp.	medium to sparse	<u>Commiphora</u> sp., <u>Cordia</u> sp. <u>Acacia benadirensis</u> <u>A. edgeworthii</u> <u>Jatropha villosa</u> <u>Cassia</u> sp., <u>Iphiaea rotundifolia</u>	medium	<u>Indigofera ruspollii</u> <u>Tribulus cistoides</u> <u>Aristida</u> sp., <u>Cenchrus</u> sp. <u>Pleuroptera revouillii</u> <u>Heliotropium</u> sp. <u>Cleome tenella</u> <u>Leucas minimifolia</u> <u>Blepharis</u> sp.
44	Nil	As above.	As above.	As above.	As above.	As above.
45	Nil		sparse to medium	As above plus <u>Euphorbia cuneata</u> <u>Ipomoea donaldsonii</u>	medium to dense	As above plus <u>Latipes senegalensis</u> <u>Corchorus</u> sp. <u>Melhania</u> sp.
63	sparse	<u>Acacia</u> sp.	dense	As for LSU 9 plus <u>Acacia benadirensis</u>	medium to sparse	As for LSU 9 plus <u>Indigofera ruspollii</u>

TABLE 1.07

PHYSIOGNOMIC & TAXONOMIC FEATURES OF VEGETATION IN THE LAND SYSTEM UNITS IN THE CENTRAL RANGELANDS & OTHER BIOTIC INFORMATION

LAND SYSTEM UNIT	VEGETATION PATTERNS	POSITION IN CLASSIFICATION & OVERALL CANOPY COVER	TERMITARIA	HERBIVORE TRACKS	CROPPING
1	Termitaria & associated stripes support densities of woody species giving a sparse "speckling" & "dashing" pattern.	Medium density <u>Commiphora</u> shrubland with scattered low <u>Boscia</u> , <u>Commiphora</u> & <u>Acacia</u> trees.  (60%)	Medium density of columnar & weathered columnar types.	Very low density	Nil
3	As above, but trees and larger bushes concentrate in younger drainage zones and at the edges of the more mature ones accentuating the "dashing" and adding a slight "striping" to the pattern.	As above  (50-60%)	As above	Very low to low density	Nil
5	Extensive limestone free areas as "speckles" and "dashes" above, but also larger patches of silty orange sand occurring between the separated limestone plates (which are approximately circular (or clusters of circles)	Medium to low density <u>Commiphora</u> shrubland with very scattered <u>Acacia</u> , <u>Commiphora</u> , <u>Boscia</u> trees.  (cover 50%)	High density of wind eroded columnar type.	Low density	A few fields of beans & melons close to steeper limestone slopes where natural concentration of water run off occurs.
10	Woody vegetation concentrated in slight depressions; noticeable concentration on the narrow dark bands.	<u>Commiphora</u> Medium density / dwarf shrubland with zones of dwarf shrub herb grassland.  (cover 40%)	Medium density of columnar eroding to conical type.	Low density	As above
12	As above	Medium density <u>Commiphora</u> shrubland mixed with <u>Commiphora</u> dwarf shrubland.  (cover 40%)	Low density of columnar type.	Low density	Nil
36	As above but with woody vegetation slightly clumped, & <u>Indigofera ruspolii</u> dominating the inter-limestone sandy bands.	Medium density <u>Commiphora</u> shrubland with scattered low <u>Boscia</u> <u>Commiphora</u> and <u>Acacia</u> trees  (cover 30%)	High densities of conical & short columnar termitaria on limestones; none on silty sands.	Density medium	Nil
49	A slight concentration of woody vegetation on the sandy bands and at their margins.	Medium density <u>Commiphora</u> dwarf shrubland (cover 25%)	Low density of columnar termitaria	Medium density	Nil
48	As in LSU 49	Medium density <u>Commiphora</u> dwarf shrubland.  (cover 25%)	Medium densities of columnar termitaria on orange soils & limestones.	Medium to high density of tracks.	Low densities of cropping on pale silts of mixed gypseous limestone origin.
	Woody vegetation in isolated clumps - herbs & grasses uniformly distributed.	Medium density, short <u>Sporobolus</u> <u>Xylocalyx</u> dwarf shrub herb grassland.  (cover 35%)	Nil on pale soil & gypsums.		
	Woody vegetation tending to concentrate in wide wavy bands.	Medium density short dwarf shrub herb grassland mixed with dwarf shrubland. ( <u>Commiphora</u> ) (cover 30%)			

The overall pattern depends upon the distribution of soils & rocks which is complex. Many intermediate stages between the three basic types can be observed.

TABLE 1.07

27	Woody species tend to be concentrated on the limestone bands; herbs & grasses tend to concentrate on the shallow silty sands.	Medium density degraded <u>Chrysopogon</u> dwarf shrub herb grassland in a mosaic with <u>Commiphora</u> dwarf shrubland.	Sparse to medium columnar type on limestones; conical type at low density on sands.	Medium to low density.	Very low densities of cropping.
		(cover 40%)			
46	As above	Medium to low density degraded <u>Chrysopogon</u> dwarf shrub herb grassland.	Sparse to medium large columnar type.	medium	Very low densities of cropping.
		(cover 25%)			
16	Rather uniform vegetation patterns, but trees tend to be concentrated in the bands of sand.	Medium to high density <u>Commiphora</u> shrubland with scattered <u>Acacia</u> spp. trees.	High densities of short columnar type & pillar type.	medium	nil
		(cover 35%)			
25	Very uniform without pronounced patterning.	Medium to high density <u>Commiphora</u> shrubland with scattered <u>Acacia</u> spp. trees.	Very low conical <u>turreted</u> type; medium density of pillar type.	medium	Medium densities of cropping.
		(cover 60%)			
47	Rather uniform, but herbaceous & grassy plants concentrated on the sandy areas, with woody plants on limestone.	Medium density <u>Commiphora</u> shrubland.	Low densities of columnar type; medium density of pillar type.	medium	Low densities of cropping.
		(cover 30%)			
89	As above	Medium density <u>Commiphora</u> shrubland.	Medium densities of conical <u>turreted</u> <u>termitaria</u> and columnar <u>termitaria</u> on orange soils & pillar <u>termitaria</u> on gypseous soils.	Medium to low.	Dense cropping
		(cover 30%)			
64	Rather uniform with a concentration of woody plants on the limestones.	Medium density <u>Commiphora</u> shrubland.	Medium densities short conical <u>termitaria</u> .	Low to medium.	Nil
		(cover 40-50%)			
	Clumps of woody vegetation in small depressions: gypseous soils are covered mainly by herbaceous & by grass cover & gypsum exposures/low densities of short herbs.	Medium density dwarf shrub herb grassland with isolated clumps of low <u>Commiphora</u> shrubs and trees.	Medium densities of pillar type.	Medium to high.	Nil
		(cover 40%)			
80 & 82	Patterns dominated by disposition of old dune tracks, cropping scars and position of limestone "plates".	Medium density <u>Acacia</u> <u>Commiphora</u> shrubland.	On orange soils low densities of conical <u>termitaria</u> medium densities of pillar type on pale and orange soils	Medium to high densities.	Appreciable amount of cropping, concentrated on the paler sands.
		(cover 40%)			
	Densest woody vegetation on limestones, densest grass/herbaceous cover on pale sands.	High density <u>Commiphora</u> shrubland.	As above	As above	As above
		(cover 60%)			

TABLE 1.07

58	Steeper slopes have less soil but higher densities of woody vegetation.	High density <u>Acacia Commiphora</u> shrubland with scattered trees.  (cover 65%)	Nil	High densities.	Nil
68	As above. More extensive colluvial areas have low densities of woody species & medium herbaceous/grass cover.	As above.  (cover 70%)	Nil	Medium to high densities.	Nil
76	As above	High density <u>Acacia Commiphora</u> shrubland with scattered trees & isolated shrub thickets.  (cover 80%)	Low densities of conical termitaria.	Medium to low densities.	Very low densities of cropping on colluvial terraces.
79	Woody vegetation concentrated on limestones, more herbs & grasses on the orange loams.	Medium density <u>Acacia Commiphora</u> shrubland.  (cover 50%)	Medium densities of conical termitaria.	Medium densities.	As above.
67	Trees concentrated along drainage channels; shrubby growth concentrated on limestones & grasses & herbs densest on colluvial slopes & fans.	Medium to dense <u>Commiphora</u> shrubland with scattered <u>Dobra glabra</u> interspersed with short annual <u>Aristida Indigofera Chrysopogon</u> shrub herb grassland.  (cover 60%)	Low densities of medium conical types.	High densities.	Nil
75	As above.	As above.  (cover 60%)	Low densities of small conical types.	High densities.	Appreciable amounts of cropping on gentle colluvial slopes and fans.
28	Pale pink gypseous sandy silts are in small depressions. Larger woody species concentrate in clumps in or near these. More halophytic species are found on the more stagnated parts of the drainage system.	Medium density gypseous short dwarf shrub herb grassland with very scattered <u>Acacia Ficus</u> trees in a mosaic with low density saline very short herb grassland.  (cover 20-30%)	Nil	Medium to high.	Very small amount of cropping on silty fans and drainage zones.
29	Clumping of woody vegetation more pronounced.	As above.  (cover 25-35%)	Nil	Medium.	Nil
30	No obvious patterns.	Low density gypseous/saline very short herb grassland.  (cover 20 - 30%)	Nil	Medium to low.	Nil
34	No obvious patterns: denser woody vegetation on limestone & pale orange sands.	Low to medium density gypseous short dwarf shrub herb grassland in a mosaic with medium density dwarf shrubland.  (cover 30%)	Nil	Medium to high.	Low to medium densities of cropping on deeper silts mixed with limestone derived sands.

TABLE 1.07

37	Wide pale silts support minimal woody cover: lines & ridges of gypsums & limestones have a concentration of woody species.	Medium density gypseous short herb grassland.  (cover 35%)	Low densities of conical termitaria.	Medium density.	Very low densities on "milder" colluvial silts.
57	Medium densities of woody species in the upper parts of the drainage area (on exposed gypsum & limestones) Sparse woody vegetation & medium herbaceous & grassy cover on the lower parts on silts & colluvial sandy silts.	Medium density, gypseous dwarf shrubland in a mosaic with low density gypseous/saline short herb grassland.  (cover 25%)	Low densities of small conical & low columnar types.	Medium density.	Nil
31	Clumps of woody species in slight depressions and denser woody stands on massive gypsums & limestones (at the zone boundaries) Wider expanses of sandy silts support medium herbaceous & grassy cover.	Medium density gypseous dwarf shrubland in a mosaic with medium density gypseous short dwarf shrub herb grassland.  (cover 45%)	Low densities of small conical types.	High density.	Medium densities of cropping on colluvial silts.
32	As above.	Medium density gypseous dwarf shrub herb grassland.  (cover 30%)	Low densities of pillar type & pillar/columnar type.	High density.	Very low densities of cropping on colluvial silts.
33	Gypseous exposures have medium woody cover. Pale gypseous soils chiefly grass & herb cover. Sandy clay loams support dense woody associations.	A complex mosaic between gypseous dwarf shrubland, dense <u>Commiphora</u> shrubland, and gypseous short shrub herb grassland.  (cover 35%)	Medium densities of small conical termitaria.	High density.	Medium to high densities on the pale brown alluviums.
77	Most complex with saline grassy herbaceous zones, in which there are clumps of trees & bushes mosaiced with denser woody vegetation, in which bush thickets occur.	Low density saline gypseous short herb grassland with small <u>Acacia</u> shrubland, and <u>Commiphora</u> <u>Euphorbia</u> thickets; dense <u>Commiphora</u> shrubland with scattered shrub/tree thickets.  (cover 50%)	Medium density of conical turreted termitaria.	High densities.	Low densities of cropping in dark orange alluviums.
42 50	Very complex & heterogeneous: woody vegetation concentrated along drainage lines and at the top of small escarpments. Gypseous soils and gypsums predominantly grassy & herbaceous cover.	Low density short dwarf shrub herb land mixed with herb grassland.  (cover 20%)	Low density of conical & short columnar termitaria.	Low densities.	Nil
6	Dense woody vegetation & thickets along drainage lines & on limestone surfaces - less dense on the expanses of shallow pale orange sand.	Medium to dense <u>Commiphora</u> dwarf shrubland with scattered <u>Acacia</u> <u>Commiphora</u> trees.  (cover 35%)	Low densities of conical & short columnar termitaria.	Low densities.	Very low densities except LSU 88 which has medium densities of abandoned crop fields.
7	As above.	Medium dwarf shrub <u>Indigofera</u> herbland.  (cover 25%)			
11	As above, but also denser thickets of <u>Acacia</u> on very pale sand.	Medium to dense <u>Acacia</u> <u>Commiphora</u> dwarf shrubland in a mosaic with dwarf shrub <u>Indigofera</u> herbland.  (cover 30%)			

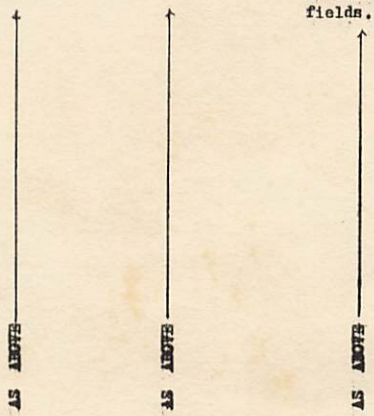


TABLE 1.07

13	As above.	Medium dwarf shrub <u>Indigofera</u> herbland in mosaic with <u>Commiphora</u> dwarf shrubland.  (cover 20-30%)	As above	As above	As above
14	As above with very pronounced concentrations of shrubs on exposed limestones and very pale (ie shallow) sands.	Medium to sparse dwarf shrub <u>Indigofera</u> herbland in a mosaic with medium short herb grassland.  (cover 30 %)			
15	Rather uniform distributions of woody & herbaceous vegetation.	Medium <u>Commiphora</u> dwarf shrub <u>Indigofera</u> herbland in mosaic with medium <u>Indigofera</u> herbland.  (cover 30-35%)			
17	No obvious patterns.	Low density short dwarf shrub <u>Indigofera</u> herbland.  (cover 15 %)			
38 39 40	No obvious patterns.	Low density short <u>Indigofera</u> herbland.  (cover 10-15%)			
88	As for LSU 11	Medium <u>Jatropha</u> <u>Commiphora</u> dwarf shrubland in a mosaic with medium density dwarf shrub herbland  (cover 25%)			
9	Very uniform patterns of distribution.	Medium/low density dwarf shrub herbland.  (cover 30%)	Sparse densities of conical termitaria.	Low densities.	Nil
26	As above.	Medium to dense <u>Commiphora</u> <u>Euphorbia</u> dwarf shrub <u>Indigofera</u> <u>Aristida</u> herb grassland.  (cover 50-70%)		Low densities.	Medium densities of cropping.
43	A discernable concentration of woody species in the paler soils and limestones.	Medium density short dwarf shrub herb grassland in mosaic with medium density short herb grassland.  (cover 30-50%)	Sparse densities of columnar termitaria.	Very low densities.	High densities of cropping.
44	As above.	As above.	As above. Sparse to medium densities of conical termitaria.	Low densities.	Nil
45	As above.	Medium density short <u>Aristida</u> herb grassland in mosaic with medium/sparse density low dwarf shrub <u>Indigofera</u> herbland.  (cover 50-60%)	Sparse densities of conical termitaria.	Low densities.	Low densities of cropping.
63	No obvious patterns.	Medium to dense <u>Acacia</u> <u>Commiphora</u> dwarf shrubland in mosaic with medium density short <u>Acacia</u> <u>Commiphora</u> dwarf shrub <u>Indigofera</u> herbland.  (Cover 60%)	Nil	Low densities.	Medium to low densities of cropping on pale sands.

TABLE 1.07

85	Nil	medium to dense	As for LSU 26 plus <u>Acacia benadirensis</u>	medium to sparse	As for LSU 26.	
20 21	Nil	sparse	<u>Acacia</u> sp. (very prostrate) <u>Commiphora</u> sp. " " " <u>Pavonia</u> sp. <u>Justicia flana</u> <u>Psilotrichum</u> sp. <u>Capparis galeata</u> <u>Euphorbia</u> sp.	sparse to medium	<u>Oldenlandia saxifragoides</u> <u>Chenopodiaceae</u> spp. <u>Limonium</u> sp. <u>Eragrostis</u> sp. <u>Cynodon dactylon</u> <u>Dactyloctenium scindicum</u> <u>Aristida</u> spp. <u>Digitaria</u> sp. <u>Cyperus</u> spp. <u>Heliotropium</u> sp. <u>Tephrosia</u> sp. <u>Indigofera</u> sp.	
18,19 23	Extremely rare	<u>Acacia tortilis</u>	sparse	<u>Acacia</u> sp. aff. <u>edgeworthii</u> <u>Commiphora</u> sp. (prostrate) <u>Euphorbia</u> sp. <u>Acacia leucospira</u> <u>A. sarcophylla</u>	medium	<u>Chrysopogon aucheri</u> var. <u>quinqueplumis</u> <u>Aristida</u> sp. <u>Latipes senegalensis</u> <u>Cyperus</u> sp. <u>Indigofera</u> sp. <u>Chloris</u> sp.
35, 41	Nil	sparse	<u>Commiphora</u> spp. } <u>Grewia</u> sp. } All prostrate forms. <u>Acacia</u> sp. }	medium	<u>Aristida</u> sp., <u>Chloris</u> sp. <u>Heteropogon contortus</u> , <u>Tetropogon spattaceus</u> , <u>Cenchrus</u> sp., <u>Latipes senegalensis</u> <u>Cyperus</u> spp., <u>Indigofera</u> spp. <u>Adenium</u> sp., <u>Crotalaria</u> spp. <u>Merremia</u> sp., <u>Helichrysum</u> sp. <u>Jatropha</u> sp., <u>Blepharis</u> sp. <u>Tephrosia</u> sp., <u>Rhynchosia</u> sp. <u>Cynodon dactylon</u>	
55	Nil	medium & locally dense	<u>Balanites</u> sp. <u>Sesamothamnus</u> sp. <u>Acacia</u> sp. (prostrate) <u>Euphorbia cuneata</u> <u>Ormocarpum</u> sp. <u>Commiphora</u> sp.	medium to sparse	<u>Chrysopogon aucheri</u> <u>Tetropogon spattaceus</u> <u>Dactyloctenium scindicum</u> <u>Cassia</u> sp., <u>Alce</u> sp. <u>Indigofera raspolii</u> , <u>Chascanum</u> sp. <u>Barleria</u> sp.	
60, 72	Nil (below 200 m)	Very sparse	<u>Dichrostachys</u> sp. <u>Euphorbia cuneata</u> <u>Grewia</u> sp. (prostrate form)	medium	As for LSU 35, 41 plus <u>Panicum</u> sp. <u>Sporobolus</u> sp. <u>Digitaria</u> sp., <u>Leucas</u> sp. <u>Justicia</u> sp., <u>Chascanum</u> sp. <u>Abutilon</u> sp., <u>Hildebrandtia</u> sp. <u>Crotalaria</u> sp., <u>Sida</u> sp. <u>Oldenlandia</u> sp., <u>Solanum</u> sp.	
72	sparse to medium (above 200 m)	<u>Terminalia kelleri</u> <u>Commiphora</u> spp. <u>Acacia</u> sp.	sparse to medium	<u>Kleinia</u> spp., <u>Commiphora</u> spp. <u>Acacia</u> sp. aff. <u>senegal</u> <u>Premna resinosa</u>	medium	<u>Cenchrus</u> sp., <u>Aristida</u> sp. <u>Heteropogon contortus</u> <u>Lauraea</u> sp., <u>Commelina</u> sp. <u>Anilema</u> sp., <u>Indigofera</u> sp. <u>Helichrysum</u> sp. <u>Grewia</u> sp., <u>Evolvulus</u> sp. <u>Pentanisia</u> sp. <u>Melhania</u> sp.
56	medium	<u>Terminalia kelleri</u> <u>Acacia tortilis</u>	medium to dense	<u>Commiphora</u> spp., <u>Loewia glutinosa</u> , <u>Iphiaea rotundifolia</u> , <u>Jatropha</u> sp. <u>Acacia mellifera</u> , <u>Dichrostachys</u> sp. <u>Cadaba</u> spp.	medium to sparse	<u>Aristida</u> sp., <u>Tetropogon spattaceus</u> <u>Heteropogon contortus</u> <u>Cyperus</u> sp. <u>Sporobolus</u> sp.
61	medium to dense	As above plus <u>Acacia</u> sp., <u>Delonix elata</u> ; <u>Dobera glabra</u>	medium to dense	As above plus <u>Commiphora</u> spp., <u>Acacia benadirensis</u> <u>Dalbergia microphylla</u> ; <u>Dichrostachys</u> sp. <u>Erythrochlamys spectabilis</u> ; <u>Cadaba heterotricha</u> , <u>Cadaba</u> sp. <u>Euphorbia cuneata</u> , <u>Hildebrandtia</u> sp. <u>Boswellia</u> sp., <u>Commiphora rostrata</u> <u>Kleinia</u> sp., <u>Euphorbia</u> spp.	medium	As above plus <u>Sarcostemma</u> sp. <u>Kelleronia</u> sp., <u>Adenia</u> sp., <u>Caralluma</u> sp., <u>Abutilon</u> sp. <u>Indigofera raspolii</u> , <u>Jatropha</u> sp. <u>Solanum</u> sp., <u>Crotalaria</u> sp. <u>Sansevieria</u> sp., <u>Euphorbia</u> sp. <u>Vernonia</u> sp., <u>Ipomoea</u> sp., <u>Latipes senegalensis</u> , <u>Panicum</u> sp., <u>Eragrostis</u> sp. <u>Cynodon dactylon</u>

85	As for LSU 43.	Medium <u>Acacia Commiphora</u> dwarf shrubland in mosaic with medium density short dwarf shrub herbland	Sparse densities of small conical type.	Low densities.	As above.
20 21	Grasses & herbs on the small plate like areas of consolidated sand sheet; the fossil dunes support mainly grasses; limestone pavements are covered by a specialised community of prostrate shrubs & succulents.	A mosaic of medium density/very short herb grassland with low densities of dwarf prostrate shrubland with specialised succulents on bare rock surfaces	Sparse densities of conical & large columnar types.	Low densities.	Nil
18,19, 23	Grasses & herbs on the consolidated sands; woody species & succulents on limestone pavements.	Sparse to medium short herb grassland with scattered dwarf shrubs in a mosaic with sparse short herbland.	Sparse densities of low conical type.	Low to very low densities.	Nil
35,	As for LSU 20 21.	A mosaic of medium to low density short herb grassland with low density dwarf prostrate shrub herbland.  (cover 25-30%)	High densities of conical with some columnar type.	Low densities.	Nil
55	Concentrations of woody plants along shallow drainage channels & on limestones. Pale sands & gypseous types support mostly herbs & grasses.	Medium density short dwarf shrub grassland mixed with medium density short grass herbland.  (cover 45%)	Medium densities of conical type.	Low densities.	Nil
60, 72	No patterns - very uniform vegetation.	Medium density very short herb grassland, (cover 40-50%) and bare rock surfaces.	Low densities of columnar type.	High densities of tracks.	Nil
72	Clumps of trees & bushes in micro thickets. Also woody vegetation concentrated in drainage lines.	A mosaic of medium density short herb grassland (sub-coastal plateau grassland type) and medium density short <u>Terminalia</u> scattered tree <u>Acacia Commiphora</u> shrub thicket grassland.  (cover 50-60%)	Nil	High densities of tracks.	Nil
56	No obvious patterns.	Medium to dense short <u>Acacia terminalia</u> wooded <u>Commiphora</u> shrub grassland.  (cover 70%)	Nil	High density of tracks.	Nil
61	No obvious patterns except for the different regenerative stages on old cropping areas.	Dense <u>Acacia Terminalia</u> wooded <u>Commiphora</u> shrubland. (cover 85-90%)  With areas of short sub coastal plateau grassland.  (cover 60 -70%)	Nil	Very high density of tracks.	Medium density of cropping on flatter parts of LSU.

TABLE 1.07

65	dense to medium	As above plus <u>Sterculia sp.</u> <u>Entada sp.</u>	dense	As above plus <u>Gardenia sp.</u> , <u>Acacia reficiens</u> subsp. <u>miseria</u> , <u>Buxus hildebrandtii</u> , <u>Jatropha sp.</u> , <u>Ghiakaea speciosa</u> <u>Anisotes sp.</u> , <u>Triumfetta sp.</u> <u>Omnocarpum sp.</u> , <u>Acacia spp.</u>	sparse	<u>Barleria sp.</u> , <u>Indigofera sp.</u> <u>Heteropogon contortus</u> <u>Cenchrus sp.</u> <u>Latises senegalensis</u> <u>Tephrosia sp.</u> <u>Hartogea aquifolia</u>
66	dense to medium	<u>Terminalia kelleri</u> <u>Boswellia sp.</u> <u>Albizzia sp.</u> <u>Sesamothammus sp.</u> <u>Acacia tortilis</u> <u>Erythrochlamys sp.</u> <u>Dobera glabra</u>	dense	<u>Commiphora spp.</u> , <u>Dalbergia sp.</u> <u>Premna resinosa</u> , <u>Grewia sp.</u> <u>Hildebrandtia sp.</u> , <u>Allophylus sp.</u> <u>Acacia nilotica</u> , <u>Acacia sp. aff. benadirensis</u> , <u>Acacia sp. aff. edgeworthii</u> , <u>Kleinia sp.</u> , <u>Croton sp.</u>	sparse to medium	<u>Aloe sp.</u> , <u>Rhynchosia sp.</u> <u>Kelleronia sp.</u> , <u>Cissus sp.</u> <u>Euphorbia sp.</u> , <u>Abutilon sp.</u> <u>Sansevieria sp.</u> , <u>Cenchrus sp.</u> <u>Dactyloctenium scindicum</u> <u>Eragrostis sp.</u> , <u>Cyperus spp.</u> <u>Latises senegalensis</u>
73	medium to sparse	<u>Terminalia kelleri</u> <u>Boswellia sp.</u> <u>Erythrochlamys sp.</u> <u>Albizzia sp.</u>	dense	As above plus <u>Solanum sp.</u> , <u>Gardenia sp.</u> , <u>Masera sp.</u> , <u>Indigofera sp.</u>	sparse	As above but only <u>Aristida sp.</u> , & <u>Cyperus sp.</u> of the grassy edges.
87	medium	As for LSU 61.	dense	As for LSU 61 plus <u>Salvadora persica</u> , <u>Anisotes sp.</u> <u>Iroscum europaeum</u> , <u>Hartogea aquifolia</u> <u>Boscia sp. aff. coriacea</u> , <u>Grewia tenax</u> , <u>Gardenia fiorii</u> <u>Salsola sp.</u> , <u>Hildebrandtia sp.</u>	medium to sparse	<u>Leucas sp.</u> , <u>Anilema sp.</u> <u>Aerva lanata</u> , <u>Crotalaria sp.</u> <u>Asparagus sp.</u> , <u>Cenchrus sp.</u> <u>Sporobolus ruspolii</u> <u>Dactyloctenium scindicum</u>
90	sparse to medium	As for LSU 73.	dense	As for LSU 73.	medium	As for LSU 73.
22, 51, 52, 53, 54	very sparse	<u>Acacia sp.</u>	very sparse	<u>Melhania sp.</u> <u>Oldenlandia sp.</u> <u>Grewia sp.</u>	very sparse	<u>Cyperus sp.</u> , <u>Tephrosia sp.</u> <u>Sporobolus spicatus</u> <u>Crotalaria spp.</u> <u>Ipomoea sp.</u> <u>Aristida sp.</u>
86	very sparse	<u>Terminalia kelleri</u>	very sparse	<u>Dobera glabra</u>	medium to dense	<u>Heteropogon contortus</u>
84	medium to sparse	<u>Boscia minimifolia</u> <u>Delonix elator</u> <u>Acacia tortilis</u>	dense	<u>Commiphora spp.</u> , <u>Acacia edgeworthii</u> <u>Acacia benadirensis</u> , <u>Acacia sp aff. senegal</u> , <u>Dalbergia sp.</u> , <u>Kleinia sp.</u> <u>Arthrocarpum sp.</u> , <u>Grewia sp.</u> <u>Euphorbia sp.</u> , <u>Anisotes sp.</u> <u>Hildebrandtia sp.</u> , <u>Sesamothammus sp.</u>	sparse	<u>Aristida sp.</u> , <u>Kelleronia sp.</u> <u>Euphorbia sp.</u> , <u>Barleria sp.</u> <u>Aerva sp.</u> , <u>Pavonia sp.</u> <u>Melhania sp.</u> , <u>Sansevieria sp.</u> <u>Dactyloctenium scindicum</u>
4	sparse	<u>Delonix elata</u> <u>Acacia sp.</u>	dense to medium	<u>Acacia nilotica</u> subsp. <u>subalata</u> <u>Acacia reficiens</u> subsp. <u>miseria</u> <u>Acacia sp. aff. senegal</u> <u>Euphorbia cuneata</u> , <u>Ipomoea donaldsonii</u> <u>Sesamothammus sp.</u> , <u>Euphorbia longispina</u> <u>Acacia horrida</u> subsp. <u>benadirensis</u> <u>Commiphora spp.</u> , <u>Dobera glabra</u>	sparse	<u>Indigofera sp.</u> " <u>ruspolii</u> <u>Aerva lanata</u> <u>Cenchrus sp.</u>
8	sparse	As above.	dense to medium	As above plus <u>Jatropha sp.</u> , <u>Psilotrichum sp.</u> <u>Cassia sp.</u> , <u>Dalbergia sp.</u> <u>Dichrostachys sp.</u>	sparse	As above plus <u>Cyperus sp.</u> , <u>Dactyloctenium scindicum</u> <u>Latises senegalensis</u> <u>Solanum sp.</u> , <u>Sida sp.</u>
62	sparse	<u>Delonix elata</u> <u>Acacia tortilis</u> <u>Acacia mellifera</u>	dense to medium	As above plus <u>Caesalpinia sp.</u> , <u>Kleinia sp.</u> <u>Hartogea aquifolia</u> ; <u>Hildebrandtia sp.</u>	sparse	As above plus <u>Notonia sp.</u> , <u>Ipomoea sp.</u> <u>Allophylus sp.</u> , <u>Vernonia sp.</u>
71	sparse	As above.	medium	As for LSU 4 plus <u>Grewia tenax</u> , <u>Balanites sp.</u> , <u>Cissus</u> , <u>Salvadora persica</u> <u>Acacia edgeworthii</u>	sparse to medium	As for LSU 8 plus <u>Barleria sp.</u> , <u>Pavonia spp.</u> <u>Vernonia sp.</u> , <u>Aristida sp.</u> <u>Emneapogon sp.</u>
81	sparse to very sparse	As above plus <u>Boscia minimifolia</u>	medium	As above plus <u>Anisotes sp.</u> , <u>Arthrocarpum sp.</u> <u>Hildebrandtia sp.</u>	medium	As above plus <u>Tephrosia sp.</u> <u>Orthosiphon sp.</u>

TABLE 1.07

65	Very dense woody vegetation & thickets in valleys and on valley sides (cliffs & gorge sides); some patterning as a result of regeneration on old cropping areas.	Dense wooded <u>Acacia</u> shrubland with dense woodland and thicket woodland associated with drainage system.  (cover 75%)	Nil	Very high density of tracks.	Medium density of cropping on flatter parts of LSU.
66	No obvious patterns except for the different stages of regeneration on old cropping areas.	Dense <u>Terminalia</u> <u>Acacia</u> wooded <u>Acacia</u> <u>Commiphora</u> shrubland.  (cover 85%)	Nil	High densities of tracks.	Medium to high densities of cropping.
73	No obvious patterns rather uniform distributions except for old cropping areas.	Dense <u>Acacia</u> <u>Commiphora</u> shrubland with scattered trees.  (cover 85%)	Nil	High densities of tracks.	Low to medium densities of cropping, but ancient cropping scars very widespread & abundant.
87	Woody vegetation denser along drainage lines and the broken gully sides.	Dense <u>Acacia</u> <u>Commiphora</u> wooded shrubland.  (cover 70-80%)	Nil	High density of tracks.	Very low densities of cropping.
90	Most of the LSU has been cropped in the recent past & the vegetation in consequence is a mosaic of small patches at various stages of regeneration. Fallow & recently abandoned fields have good grass/herb cover. (Cover of "undisturbed" vegetation 85%; cover on old fields 20-70%).	Dense <u>Acacia</u> <u>Commiphora</u> shrubland with scattered trees, much modified by cropping.	Nil	High densities of tracks.	Very high densities of cropping.
22,51, 52,53, 54	Most of the dune areas are bare sand but the leading & receding edges have characteristic plants.	Dunes (less than 1%).	Nil	Low densities of tracks.	Nil
86	No obvious patterns.	Medium density short <u>Heteropogon</u> herb grassland.	Nil	Medium densities of tracks.	Very low densities of cropping.
84	Uniformly dense throughout, except where old cropping areas support less dense bush.	Dense <u>Acacia</u> <u>Commiphora</u> shrubland with scattered trees.  (cover 80%)	Nil	Medium to low densities of tracks.	Very low densities of cropping.
4	No pronounced pattern. Larger trees tend to be concentrated along the banks of the drainage channels.	Dense to medium <u>Acacia</u> <u>Commiphora</u> shrubland with scattered trees.  (cover 60%)	Nil	High density of tracks.	Nil
8	As above but old cropping patterns have imposed their own patterns.	As above but much modified by cropping, & the various stages of regeneration.  (cover 50-60%)	Nil	Very high densities of tracks.	High densities of cropping.
62	As above.	As above.  (cover 60%)	Low densities of conical termitaria.	Very high densities.	Medium to high densities of cropping.
71	Old crop areas dominate the patterning of vegetation with a mosaic of regenerating patches at different phases.	Medium density <u>Acacia</u> <u>Commiphora</u> shrubland with scattered trees.  (cover 60-65%)	Nil	Very high densities of tracks.	High densities of cropping.
81	As above.	A mosaic of medium density <u>Acacia</u> <u>Commiphora</u> shrubland with medium density <u>Acacia</u> <u>Commiphora</u> shrub herb grassland.  (cover 65%)	Low densities of pillar type.	Very high densities of tracks.	High densities of cropping.

TABLE 1.07

91	sparse to very sparse	As for LSU 71	medium	As for LSU 71.	medium	As for LSU 71
69, 70, 83	very sparse	<u>Acacia tortilis</u> <u>Boscia minimifolia</u>	sparse	<u>Commiphora</u> spp., <u>Acacia seyal</u> , <u>Acacia nubica</u> , <u>A. stuhlmanii</u> , <u>A. benadirensis</u> , <u>A. reficiens</u> subsp. <u>misera</u> , <u>Crocin</u> sp., <u>Cissus quadrangu-</u> <u>laris</u> , <u>Cassia</u> sp., <u>Ziziphus hamur</u> <u>Anisotes</u> sp., <u>Salvadora persica</u> , <u>Caralluma</u> sp., <u>Aloe</u> sp.	sparse to medium	<u>Dactyloctenium aegyptium</u> , <u>Cyperus</u> sp., <u>Latipes senegalensis</u> <u>Pavonia</u> spp., <u>Cleome brachycarpa</u> <u>Indigofera</u> sp., <u>Solanum</u> sp. <u>Heliotropium</u> sp., <u>Tribulus</u> sp. <u>Crotalaria</u> sp., <u>Blepharis</u> sp.
78	very sparse	As above plus <u>Terminalia obicularis</u>	sparse to medium	<u>Acacia mellifera</u> , <u>Acacia seyal</u> , <u>Cordia</u> sp., <u>Acacia misera</u> , <u>Commiphora</u> spp., <u>Salvadora persi-</u> <u>ca</u> , <u>Cissus</u> sp., <u>Cadaba glandulosa</u> <u>Caucanthus</u> sp., <u>Grewia</u> sp., <u>Anisotes</u> sp., <u>Adenia</u> sp.	sparse to medium	<u>Senra incana</u> , <u>Blepharis</u> sp. <u>Glossyrium somalense</u> , <u>Sericocomopsis</u> sp. <u>Caralluma</u> sp. <u>Dactyloctenium aegyptium</u> <u>Sporobolus</u> sp. <u>Indigofera</u> sp.
24	sparse to medium	<u>Acacia tortilis</u> <u>Delonix elata</u> <u>Albizia anthelmintica</u> <u>Acacia bricchettiana</u>	medium to dense	<u>Acacia edgeworthii</u> , <u>Cordia</u> sp. <u>Grewia</u> sp., <u>Commiphora</u> spp., <u>Cordyla somalensis</u> , <u>Cordeauxia</u> <u>edulis</u> , <u>Solanum</u> sp.	medium	<u>Indigofera spinosa</u> , <u>I. ruspolii</u> <u>Corchorus</u> sp., <u>Aerva persica</u> <u>Solanum</u> sp., <u>Aristida kelleri</u> , <u>Cassia</u> spp. <u>Blepharis</u> sp.
74	As above.	As above.	dense	As above plus <u>Acacia benadirensis</u> , <u>Dichrostachys benadirensis</u> <u>Erythrochlamys spectabilis</u> <u>Acacia nilotica</u> , <u>A. nubica</u> , <u>Acacia</u> sp. <u>Solanum</u> spp., <u>Sesamothamnus</u> sp. <u>Euphorbia</u> sp. aff. <u>cuneata</u> , <u>Boswellia</u> sp., <u>Dalbergia microphylla</u> <u>Gardenia fiorii</u>	sparse to medium	As above plus <u>Tephrosia obbiadensis</u> <u>Jatropha</u> sp. <u>Melhania</u> sp., <u>Iphiona</u> sp. <u>Abutilon</u> spp., <u>Ipomoea</u> sp. <u>Pavonia</u> sp., <u>Cenchrus</u> sp. <u>Latipes senegalensis</u> , <u>Aristida</u> sp. <u>Ormocarpum</u> sp.
2	sparse to medium	<u>Acacia tortilis</u> , <u>Delonix elata</u> , <u>Boscia minimifolia</u>	medium to dense	<u>Acacia mellifera</u> , <u>A. nubica</u> , <u>A. reficiens</u> subsp. <u>misera</u> <u>Commiphora</u> sp., <u>Boswellia</u> sp. <u>Dalbergia</u> sp., <u>Cadaba glandu-</u> <u>lulosa</u> , <u>Grewia villosa</u>	medium	<u>Sericocomopsis</u> sp. <u>Indigofera ruspolii</u> <u>Asparagus</u> sp. <u>Sporobolus ruspolianus</u> <u>Latipes senegalensis</u> <u>Cenchrus</u> sp., <u>Aerva</u> sp. <u>Sporobolus</u> sp., <u>Barleria</u> sp. <u>Andropogon kelleri</u> , <u>Triumfetta</u> sp. <u>Chrysopogon aucheri</u>
59	sparse to medium	<u>Delonix elata</u> <u>Euphorbia</u> sp. <u>Boscia minimifolia</u>	medium to dense	<u>Acacia</u> sp. aff. <u>senegal</u> <u>Cordia</u> sp., <u>Anisotes</u> sp. <u>Commiphora</u> spp., <u>Cadaba glandulosa</u> <u>Jatropha</u> sp., <u>Lannea trinhylla</u>	sparse to medium	<u>Euphorbia bifida</u> , <u>Tribulus terrestris</u> , <u>Caralluma</u> sp. <u>Dactyloctenium aegyptium</u> <u>Sporobolus</u> sp., <u>Andropogon</u> sp.

TABLE 1.07

91	As above.	As above.	Nil		Medium to high densities of cropping.
			(cover 50-60%)		
69, 70, 83	Almost all the LSU has been cropped & the vegetation pattern reflects only the present pattern & recent history of cropping.	Under the influences of cropping the vegetation is a low density regenerating short herb grassland with scattered trees, shrubs and small shrub thickets in a mosaic with crop fields & fallow fields.	Nil	Very high densities.	Very high densities of cropping.
			(cover 40%)		
78	As above.	Medium density regenerating <u>Acacia Commiphora</u> shrubland in mosaic with low density regenerating short herb grassland. Both these types have very scattered trees & shrubs or small shrub thickets. Crop fields & fallow fields make up part of the mosaic.	Low densities of dark brown conical termitaria.	Medium to high densities.	Very high densities of cropping.
			(cover 50-60%)		
24	More open grasslands dominate the N. part of the LSU. Burning of grass has created some patterning throughout the LSU.	Medium density medium height <u>Acacia</u> wooded <u>Acacia Commiphora</u> shrub herb grassland in mosaic with medium to dense <u>Acacia Commiphora</u> shrubland with scattered trees.	Sparse conical pillar & columnar type termitaria.	Medium to low densities.	Very low densities of abandoned cropping areas.
			(cover 55%)		
74	Very uniform distribution of vegetation, but old burnt patches evident as low densities of all cover types.	Dense <u>Acacia Commiphora</u> shrubland with scattered trees.	Nil	Medium to low density of tracks.	Very low densities of cropping.
			(cover 70%)		
2	Well defined arcs of vegetation of 10-30 m width set in bare areas.	Arced <u>Acacia</u> wooded <u>Acacia Commiphora</u> shrub herb grassland with areas of very low density short herb grassland and bare areas; overall cover 30%.	Medium to high density columnar type.	Medium to high density of tracks.	Low densities of cropping on areas of silt receiving run off water from adjacent limestone hills.
59	Poorly defined arcs of 10-15 m width in sparsely covered areas; some fairly uniform distributions.	Arced <u>Acacia Commiphora</u> shrubland with scattered trees in a mosaic with medium to low density <u>Acacia Commiphora</u> shrubland & shrub herb grassland.	Low densities of conical & columnar termitaria.	Medium to high densities of tracks.	Low densities of cropping.

TABLE 1.07A

THE CLASSIFICATION OF VEGETATION TYPES IN THE  
CENTRAL RANGELANDS - REFER TO FIGURE 1.03C

Land System Unit	Cover Category	Ecology	Minor Character(s)	Major Character(s)	Subsidiary Character(s)	Pattern	Ecological Zone
1	m			S.	tsc.	tp.	I.1
3	m			S.	tsc.	tp.	Northwest limestones
5	m-1			S.	tvsc.	tp.	
10	m		dws.	HG/		lrp.	
	m			dwS.		mz.	
12	m			S/		lrp.	
	m			dwS.		mz.	
36	m			S.	dwtsc.	lrp.	
49	m			dwS.		lrp.	
48	m			dwS/		cp.	I.2
	m		dws.	sHG.		mz.	
27	m	dg.	dws.	HC/		lrp.	I.3
	m			dwS.		mz.	
46	m-1	dg.	dws.h.	G.		lrp.	
16	m-d			S.	tsc.	lrp.	I.4
25	m-d			S.	tsc.	u.	
47	m			S.		lrp.	
89	m			S.		lrp.	
64	m			S/		cp,	I.5
	m		dws.	HG.	tcl.scl.	mz.	
80	m			S/		lrp/ sdp	I.6
82	d			S.		mz	
58	d			S.	tsc.	cp.	I.7
68	d			S.	tsc.	cp.	
76	d			S.	tsc.sth.	cp.	
79	m			S.		lrp.	
67	m-d			S/	scc.	cp.	I.8
75	m	an.		sHG.		mz.	
28,29	m	gy.	dws.	sHG/	tvsc.	drp.	II.1
	l	sl.	h.	vsG.		mz.	
30	l	gy/sl.		HG.		u.	
34	l-m	gy.	dws.	sHG/		u.	

TABLE 1.07A cont:

Land System Unit	Cover Category	Ecology	Minor Character(s)	Major Character(s)	Subsidiary Character(s)	Pattern	Ecological Zone
	m			dwS.		mz.	
37	m	gy.	s.h.	G.		drp.	II.2
57	m	gy.		dwS/		drp.	
	m	gy.	dws.h.	sG.		mz	
31	m	gy.		dwS.		drp.	II.3
	m	gy.	dws.h.	sG.		mz.	
32	m	gy.	dws.	HG.		drp.	
33	m	gy.		dwS//		drp.	II.4
	d			S/			
	m	gy.	s.h.	sG.		mz	
77	l	gy/sl.	s.h.	G/	sth.	drp.	II.5
	d			S.	s/t th.	mz.	
42,50	l		dws.	sH/		cp.	II.6
	l		h.	sG.		mz.	
6	m-d			dwS.	tsc.	lrp.	III.1
7	m		dws.	H.		lrp.	
11	m-d			dwS/		lrp.	
	m		dws.	H.		mz.	
13	m		dws.	H/		lrp.	
	m			dwS.		mz	
14	m-l		dws.	H/		lrp.	
	m			sHG.		mz.	
15	m		dws.	H/		u.	
	m			H.			
17	l		dws.	sH.		u.	
38,39,40	l			sH.		u.	
88	m			dwS.			
	m		dws.	H.		lrp.	
9	m-l		dws.	H.		u.	III.2
26	m-d		dws.	HG.		u.	
43,44	m		dws.	sHG/		lrp.	
	m			sHG.		mz.	
45	m			sHG/		lrp.	

TABLE 1.07A cont:

Land System Unit	Cover Category	Ecology	Minor Character(s)	Major Character(s)	Subsidiary Character(s)	Pattern	Ecological Zone
63	m m-d		dws.	sH. dwS/		mz. u.	
85	m m		dws.	sH. dwS		mz. lrp. mz.	
20,21	m l			vsHG/ dw pr S.		clp. mz.	IV.1
18,19,23	l-m l			sHG/ SH.	dws sc.	lrp. mz.	IV.2
35,41	l-m l			sHG/ dw pr S.		clp. mz.	
55	m m		dws.	sG./ sGH.		cp. mz.	
60,72	m			vs HG.		u.	
72	m m			sHG. sG.	sth.tsc.	cp. mz.	
56	m-d		w.s.	sG.		u.	IV.3
61	d m		w.	S/ sG.		crp. mz.	
65	d d d		w.	S/. W/ thW.		crp/g. mz.	
66	d		w.	S.		crp.	
73	d			S.	tsc.	crp.	
87	d		w.	S.		g.	
90	d	cr.		S.	tsc.	crp.	IV.4
22,51 52,53,54				D.		dp.	IV.5
86	m		h.	sG.		u.	IV.6
84	d			S.	tsc.	crp.	V.1
4	d-m			S.	tsc.	u.	V.2
8	d-m	cr.		S.	tsc.	crp.	
62	d-m	cr.		S.	tsc.	crp.	
71	m			S.	tsc.	crp.	
81,91,	u m		s.	S. HG.		crp. mz.	

TABLE 1.07A cont:

Land System Unit	Cover Category	Ecology	Minor Character(s)	Major Character(s)	Subsidiary Character(s)	Pattern	Ecological Zone
69, 70, 83	l	cr.rg.		sHG.	tsc.ssc. sth.	crp.	VI.1
78	l-m	cr.rg.		S.	tsc.ssc. sth.	crp.	VI.2
	l	cr.rg.		sHG.	tsc.ssc. sth.ssc.	mz.	
24	m		w.s.	mHG.		bp.	VII
	m-d			S.	tsc.	mz.	
74	d			S.	tsc.	u.	
2	m	a.	w.s.	HG./		a.	VIII.1
	vl			sHG.		mz.	
59	m	a.		S/	tsc.	a.	VIII.2
	m-l			S/			
	m-l		s.	HG.		mz.	

KEY TO TABLE 1.07ACOVER CATEGORY

vd : very dense  
 vd-d: very dense to dense  
 d : dense  
 d-m : dense to medium  
 m : medium  
 m-l : medium to low  
 l : low  
 l-vl: low to very low  
 vl : very low

ECOLOGY

dg : degraded  
 an : annual  
 gy : gypseous  
 sl : saline  
 cr : cropped  
 rg : regenerating  
 a : arced

MINOR CHARACTER(S)

w : wooded                      dw : dwarf wooded  
 s : shrub                        dws : dwarf shrub      dwprs : dwarf prostrate shrub  
 h : herb                         sh : short herb

MAJOR CHARACTER(S)

W : woodland                      dwW : dwarf woodland  
 S : shrubland                      dwS : dwarf shrubland, dwprsS: dwarf prostrate shrubland  
 H : herbland                        sH : short herbland  
 HG : herbland/grassland            sHG : short herbland/grassland  
 G : grassland                        sG : short grassland  
 D : duneland                        vsG : very short grassland  
    mHG : medium herb grassland

SUBSIDIARY CHARACTER(S)

tsc : scattered trees                ssc : scattered shrubs  
 tvsc: very scattered trees           svsc : very scattered shrubs  
 tcl : isolated clumps of trees       scl : isolated clumps of shrubs  
 tth : tree thickets                   sth : shrub thickets  
 dwts: scattered dwarf trees          dwssc: scattered dwarf shrubs

PATTERN

tp : termitaria patterns            drp : patterns of ancestral drainage zones  
 lrp : limestone ridge pattern  
 mz : mozaic                         crp : cropping pattern  
 cp : complex transitional area      g : gulleying  
 u : uniform                         a : arcs  
 sdP : stabilised dune pattern        bp : burning patterns

## AN ECOLOGICAL CLASSIFICATION OF LAND SYSTEM UNITS WITH LAND AREAS

TABLE 1.08

ECOLOGICAL CLASS I-VIII	AREA IN KM <sup>2</sup>	% OF TOTAL	ECOLOGICAL ZONE	AREA IN KM <sup>2</sup>	% OF TOTAL	% OF CLASS	LAND SYSTEM UNIT	AREA IN KM <sup>2</sup>	% OF TOTAL	% OF CLASS	% OF ZONE
INLAND LIMESTONES (I)	31,641	23.91	N.W. LIMESTONES (1)	11,709	8.85	37.01	1	580	0.44	1.83	4.95
							3	5997	0.45	18.95	51.22
							5	408	0.31	1.29	3.48
							10	1640	1.24	5.18	14.01
							12	272	0.21	0.86	2.32
							36	2248	1.70	7.10	19.20
							49	564	0.43	1.78	4.82
							48	2592	1.96	8.19	100.0
							27	708	0.54	2.24	51.16
							46	676	0.51	2.14	48.84
SOUTHERN LIMESTONES (4)	8,564	6.47	27.07				16	2544	1.92	8.04	29.71
							25	2764	2.09	8.74	32.27
							47	976	0.74	3.08	11.40
							89	2476	1.87	7.83	28.91
TRANSITIONAL S. LIMESTONES/ S GYPSUMS (5)	504	0.38	1.59				64	504	6.38	1.59	100.0
TRANSITIONAL S. LIMESTONES/ CULTIVATED STABILIZED SAND DUNES (6)	2,332	1.76	7.37				80	576	0.44	1.82	24.70
							82	1756	1.33	5.55	75.30
WEBI SHABEELLE LIMESTONES (7)	2,660	2.01	8.41				58	368	0.28	1.16	13.83
							68	788	0.60	2.49	29.62
							76	772	0.58	2.44	29.02
							79	732	0.55	2.31	27.52

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			WEBI SHABEELLE MIXED LIMESTONES & HAUD ESCARPMENT (8)	1,700	1.28	5.37	67 75	728 972	0.55 0.73	2.30 3.07	42.82 57.18
GYPSUMS (II)	14,575	11.01	NORTHERN GYPSUMS(I)	2,144	1.62	14.71	28	836	0.63	5.74	38.99
							29	244	0.18	1.67	11.38
							30	412	0.31	2.83	19.22
							34	652	0.49	4.47	30.41
			CENTRAL GYPSUMS (2)	4,708	3.56	32.30	37 57	1792 2916	1.35 2.20	12.30 20.01	38.06 61.94
			SOUTHERN GYPSUMS (3)	1,687	1.27	11.57	31 32	803 884	0.61 0.67	5.51 6.07	47.60 52.40
			WEBI SHABEELLE GYPSUMS (4)	228	0.17	1.56	33	228	0.17	1.56	100.0
			WEBI SHABEELLE GYPSEONS ALLUVIUMS (5)	3,252	2.46	22.31	77	3252	2.46	22.31	100.0
			TRANSITIONAL (6) N&C GYPSUMS COASTAL LIMESTONES	2,556	1.93	17.54	42 50	1100 1456	0.83 1.10	7.55 9.99	43.04 56.96
SANDS OVER LIMESTONES (III)	34,148	25.81	NORTHERN SANDS OVER LIMESTONE (1)	17,308	13.08	50.69	6	1588	1.20	4.65	9.17
							7	1960	1.48	5.74	11.32
							11	3108	2.35	9.10	17.96
							13	3492	2.64	10.23	20.18
							14	1488	1.12	4.36	8.60
							15	732	0.55	2.14	4.23
							17	160	0.12	0.47	0.92

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						38	1980	1.50	5.80	11.44	
						39	1152	0.87	3.37	6.66	
						40	894	0.68	2.62	5.17	
						88	664	0.50	1.94	3.84	
<hr/>											
						9	2004	1.51	5.87	11.90	
						26	724	0.55	2.12	4.30	
						43	448	0.34	1.31	2.66	
						44	852	0.64	2.50	5.06	
						45	6120	4.62	17.92	36.34	
						63	804	0.61	2.35	4.77	
						85	5888	4.45	17.24	34.96	
<hr/>											
THE COASTAL	23,469	17.74	N.E. COASTAL	2,816	2.13	12.00	20	1624	1.23	6.92	57.67
RIDGE			LIMESTONES				21	1192	0.90	5.08	42.33
(IV)			(1)								
<hr/>											
						18	1444	1.09	6.15	12.19	
						19	680	0.51	2.90	5.74	
						23	520	0.39	2.22	4.39	
						35	712	0.54	3.03	6.01	
						41	568	0.43	2.42	4.80	
						55	728	0.55	3.10	6.15	
						60	1492	1.13	6.36	12.60	
						72	5700	4.31	24.29	48.13	
<hr/>											
						56	696	0.53	2.97	16.69	
						61	632	0.48	2.69	15.16	
						65	57	0.04	0.24	1.37	
						66	964	0.73	4.11	23.12	
						73	1608	1.22	6.85	38.57	
						87	212	0.16	0.90	5.09	
<hr/>											
						90	1572	1.19	6.70	100.0	
ELEVATED COASTAL	1,572	1.19	CULTIVATED STABI-								
LISED SAND DUNES			(4)								

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			MOBILE OR RECENTLY STABILISED SAND DUNES (5)	2,952	2.23	12.58	22 51 52 53 54	120 824 368 376 1264	0.09 0.62 0.28 0.28 0.96	0.51 3.51 1.57 1.60 5.39	4.07 27.91 12.47 12.74 42.82
			COASTAL PLATEAU GRASSLAND (6)	116	0.09	0.49	86	116	0.09	0.49	100.0
INLAND STABI- LISED SAND DUNES (V)	13,272	10.03	UNCULTIVATED STABILISED SAND DUNES (1)	1,508	1.14	11.36	84	1508	1.14	11.36	100.0
			CULTIVATED STABI- LISED SAND DUNES (2)	11,764	8.89	88.64	4 8 62 71 81 91	772 1224 1216 4976 2096 1380	0.58 0.92 0.92 3.76 1.66 1.04	5.82 9.22 9.16 37.49 15.79 10.40	6.56 10.40 10.34 42.30 17.82 11.73
WEBI SHABEELLE ALLUVIUMS (VI)	3,206	2.42	W. SHABEELLE PALE ALLUVIUMS (1)	2,242	1.69	69.93	69 70 83	436 1538 268	0.33 1.16 0.20	13.60 47.97 8.36	19.45 68.60 11.95
			W. SHABEELLE DARK ALLUVIUMS (2)	964	0.73	30.07	78	964	0.73	30.07	100.0

TABLE 1.08

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HAUD TYPE (VII)	9,456	7.15	HAUD TYPE (1)	9,456	7.15	100	24 74	5544 3912	4.19 2.96	58.63 41.37	58.63 41.37
ARCED SILTS (VIII)	2,560	1.93	N.W. ARCED SILTS (1)	912	0.69	35.63	2	912	0.69	35.63	100.0
			S.W. ARCED SILTS (2)	1,648	1.25	64.38	59	1648	1.25	64.38	100.0
CENTRAL RANGELANDS (I - VIII)	132,327		29 ECOLOGICAL ZONES	132,327			91 LAND SYSTEM UNIT	132,327			

TABLE 108