D. Herlocker

RANGE SURVEY AND DEVELOPMENT IN THE CENTRAL RANGELANDS OF SOMALIA

A PRESENTATION OF ACTIVITIES
AND ACCOMPLISHMENTS
AND PROPOSAL FOR A FUTURE RANGE
DEVELOPMENT STRATEGY

CENTRAL RANGELANDS DEVELOPMENT PROJECT
USAID PROJECT 649-0108

LOUIS BERGER INTERNATIONAL INC.

Prepared by

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MOGADISHU, SOMALIA
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SUMMARY

The project approach was divided into (a) survey and monitoring, which determined the basic nature of the range resource; (b) planning, in which survey results were used to develop range management plans and (c) implementation in which range management plans were put into operation with the co-operation of Range and Livestock Associations (RLA's) in carrying out interventions.

The vegetation of the survey area consists of a 5-30 km wide coastal strip of perennial grassland and an interior dominated by woody plants. Vegetation in the latter area varies along a climatic gradient from woodland/bushland in the S.W. (>300 mm rainfall/year) to shrub grassland in the N.E. (<150 mm rainfall/year). The most abundant genera of plants within the survey area are *Acacia*, *Indigofera*, *Commiphora* and *Euphorbia* (woody); *Leptothrium* and *Aristida* (herbaceous). Approximately 90% of all vegetation is useable forage. The Central Rangelands was found to be part of a unique floristic zone the richness and uniqueness of which climaxes here and in the Ogaden.

The survey area consists of 42 range sites, land units homogeneous as to productive potential. These have been grouped into 11 "management units" which support a particular type or combination of land uses and the management of which is closely linked with that of a key range site.

"Key" plant species have been identified that provide crucial support to livestock populations. The most important "key" species are probably evergreen species that provide dry season forage. "Key" species should now receive emphasis in subsequent range development, monitoring and research activities.

Indicator species that demonstrate a marked and predictable response to grazing (and other types of use) pressures have been identified for the area surveyed to date. These species should now be used to upgrade the sensitivity of the existing range condition classification guidelines. They should also be important elements in the long term monitoring of range trend.

Agropastoralism is a major type of land use over significant parts of the survey area. Most agropastoral land has been cleared and farmed at some time resulting in post-cultivation successions of vegetation that take 60 to 100 years or more to complete and include significant quantities of low forage quality invader plant species. However, early seral (invader) species in pastoral perennial grasslands are more apt to be of high forage quality.

The Central Rangelands, taken as whole, is in fair (to low fair) range condition; fully to slightly overstocked with livestock and probably in a slight downward trend in range condition. However, there are wide variations from lightly stocked good condition rangelands far from water to heavily overstocked (and/or

otherwise utilized) very poor condition rangelands near permanent water, often with long histories of use. The extensive areas of dune fields near the coast are probably primarily of natural origins and for the most part do not reflect poor land use practices of the surrounding rangeland.

Degraded rangelands (or those on sands at any rate) have the potential for quick recovery given adequate protection and normal rainfalls.

The basis for a long term program of range trend monitoring has been established. This consists of (a) 1,050 "low precision" permanent sample plots; (b) 11 mapped "management units", which set the context within which permanent sample plots are established and their resultant data analysed; (c) a climatic monitoring system and (d) identified "key" and indicator species which can be used to increase the sensitivity of vegetation measurements to trend patterns.

The six priority districts within the project area comprise 68 degaans (traditional use areas), 16 of which have been organized into Range and Livestock Associations (RLA's) by a World Bank funded project component. Range management plans have been developed for 19 degaans.

The following interventions have been carried out: 7 tree nurseries, which have produced 176,800 tree seedlings; 15 shelterbelts; 15 ha of fuelwood plantations; 25 village tree planting programs; 85 ha of sand dunes stabilized using 11,800 meters of live fencing; 34 stock water dugouts constructed, 10 with special water harvesting systems; 25 existing shallow wells upgraded; 22 boreholes drilled (9 successfully); 9 stockwater river access sites bulldozed; 286 km track constructed and 82 km maintained; 6,800 meters of fencing constructed for a fodder farm and experimental revegetation site; water erosion control measures begun at one site; 9 wet season grazing reserves (4,258 km^2) and 6 dry season grazing reserves (958 km^2) established.

A range development strategy is proposed that would (a) emphasize small, low capacity and appropriate technology water developments, (b) rehabilitate poor and very poor condition rangelands, (c) use a strong extension and demonstration approach supported by research and directed at individual farmers in agropastoral areas, (d) use a few carefully established controlled and monitored small deferred grazing programs in communal rangeland, (e) reserve the few climax stands of vegetation remaining in agro-pastoral areas, (f) continue village - related activites as the primary organizational units for rural developents, (i) continue the range survey and monitoring program and (i) encourage continued research in the Central Rangelands by Faculty of Agriculture staff.

1. INTRODUCTION

The Central Rangelands Development Project was planned to survey and monitor range resources and implement development interventions throughout all of Central Somalia (Fig. 1).

The USAID-funded range development component of the CRDP had as its first step a resource inventory of vegetation, geology, soils, human and animal populations, habitations, water points and cropping activities (USAID 1979). This part of the range development component was completed by the firm of Resource, Management and Research (1979).

The second step was to be a range ground survey which was to verify the resource inventory, establish range condition guides, identify areas of high erodibility and areas suitable for grazing reserves. There were to be specific numbers, areas and types of reserves; famine, range and town/village, which would then be established. A quarter of each reserve was to be rested each year. Access roads and reserve demarcation lines were to be located and established and the need for stockwater development determined. Actual stock water development was to be carried out by the USAID funded LBII/WDA Comprehensive Ground Water Project (649-0104). Soil and water conservation measures were to include trials of water spreading techniques at three sites and demonstration of anti-erosion measures elsewhere. Three experimental grazing cooperatives were to be established within the project area and evaluations made of existing cooperatives in northern Somalia.

Rangelands studies and trials were to be carried out. These would (a) establish 96 range reference areas to observe the effects of grazing systems, (b) carry out range improvement experiments, (c) establish a small laboratory for forage analysis, (d) continue the identification and registration of range plants and (e) fund a resource survey of northern Somalia.

The third stage was to be a range monitoring unit which would, by repeated observations, establish a record of condition as a basis for range management. This would consist of a specific number of permanent sample plots over a fairly short period of time. Work was to be carried out throughout the three administrative regions of the Central Rangelands (USAID, 1979).

The inception plan drawn up by Louis Berger International Inc (1982) made some major changes in the operational approach of the range development component. The range ground survey and monitoring unit activities were combined and made the reponsibility of each range ecologist within his area of responsibility. Emphasis was changed from working throughout an entire region to a more methodical district by district approach. Finally, the concept of range reserves was changed from narrowly specific in terms of number, area and type to a more flexible

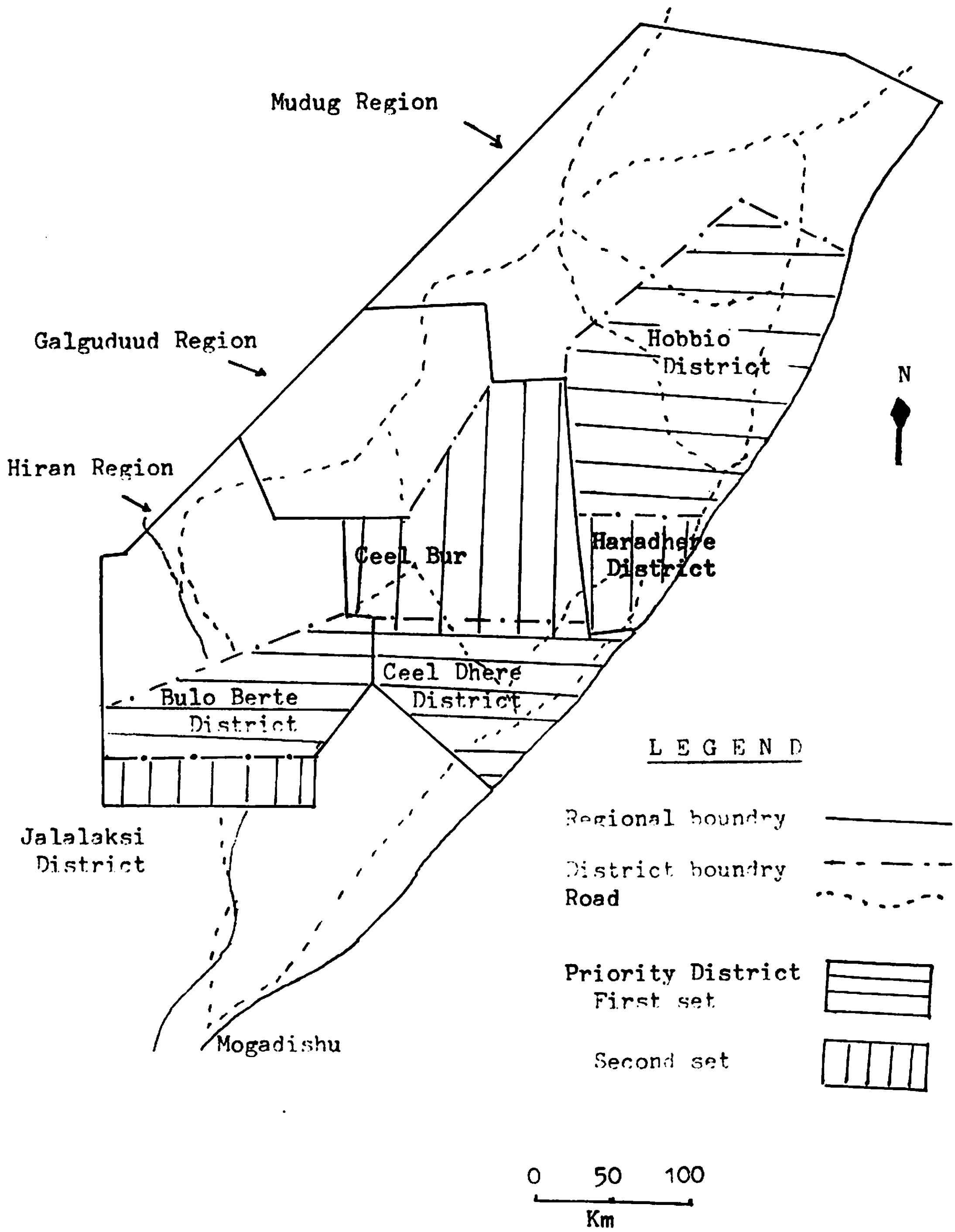


Figure 1. Map of Central Somalia

interpretation that allowed the nature of the reserve to reflect existing ecological and socio-ecological realities. Also, instead of a scatter of reserves over 30% of the Central Rangelands, each district was to be fully covered by reserves, each of which would have a range management plan, however simple. Except for range plant identification and the resource survey of northern Somalia, responsibility for the rangeland studies and trials component was given to the Formal Training Component of the project. Unfortunately, although the inception plan was the major guide for range development activities for several years, it was never formally accepted by USAID.

During the next seven years the range development component increased its understanding of-and gained considerable experience in-dealing with the pastoral and agropastoral systems of the Central Rangelands. Also occurring during this period were: two USAID evaluation missions (USAID 1983; 1985); a mid term review (ANNON, 1984); a project paper amendment (USAID, 1986); a major review (Mascott, 1986); a project Seminar/Workshop on Future Range/Livestock Development Strategies for the Central Rangelands (Wieland 1986) and an interim evaluation (CID, 1987). There was a broad consensus in the reported findings and recommendations.

a) There was concern about the introduction of untested techniques into-and their impact on-relatively unknown production systems. For this, among other reasons, recommendations were made to:

    1) Reduce the scale of the project to a smaller area

    2) Increase emphasis on intensive studies/investigations of existing production systems.

    3) Increase the monitoring of rangeland ecology and of the functioning, success and impact of interventions on the environment and human communities.

b) There was a need to reduce emphasis on boreholes and water spreading trials as water development interventions.

c) Increased emphasis needed to be put on more technologically appropriate interventions such as surface water dugouts and rehabilitation of existing shallow wells.

As a result there was a significant evolution in the range development program over this period of time. This included a more cautious approach in the use of deferred grazing. Fewer and smaller reserves were established and greater emphasis was placed on seasonal (wet and dry season) reserves rather than on formal long term rest-rotational grazing programs. Studies of vegetation dynamics and dry season forage availibility were carried out. A reduced emphasis was placed on new boreholes, water spreading trials and grazing cooperatives and greater emphasis placed on smaller, less productive, more seasonal water development interventions, such as dugouts and shallow wells. The range development component also became responsible for both site selection and implementation of water development.

There were a number of other potentially valuable activities that either arose from project experience or from review recommendations. Although it was not possible to implement these during the present phase, due to a lack of resources and time, some of the more important were included in a proposal for a phase II of the project (PPC, 1986).

2. APPROACH

2.1 Resource Survey and Monitoring

Vegetation comprises the rangeland resource. Its character reflects climate, soil, prevailing types and levels of utilization and, sometimes, fire. Its principal attributes are: type, distribution, amount, quality, health (condition) and dynamics/trend. Range surveys record and analyse these attributes to provide an understanding of the present and potential productivity of a rangeland. Recommendations can then be made regarding the actions required to achieve this potential.

A range survey of the Central Rangelands was thought to require the following components:

1. Familiarization with the flora (plant species).

2. Delineation of land units of homogenous productive potential as a tool to facilitate subsequent sampling, research, planning and development/management activities.

3. Inventory of the basic nature of the resource (type, amount and distribution) within the context of homogenous land units, estimate available forage biomass and characterize forage quality. These attributes influence stocking rates and carrying capacity.

4. Record vegetational dynamics (secondary succession and response to utilization) to assist in interpretation of vegetation/soil patterns in terms of condition and trend.

5. Determine range condition and trend, which describe the relative health of the rangeland and its direction and rate of trend over time.

6. Establish a meteorological recording system, but especially of rainfall, which is the principal driving factor of rangeland productivity in arid and semi-arid areas.

2.2 Planning

Range survey results were integrated with those of the Non-Formal Education/Extension Component surveys. The latter activities, which were carried out concurrently with those of the range survey, included the gathering of information on:

1. Livestock type, number and seasonal movements

2. Type and location of existing water sources

3. Pastoralists' perceptions of principal environmental and husbandry problems (such as stock diseases, need for water, inadequate quality of rangeland etc.)

4. Location and extent of traditional grazing areas.

This information on the nature of existing land use and perceived ecological and husbandry problems was then integrated with that on the nature of the rangeland resource obtained from the range survey to develop range management plans for each of the traditional (existing) use areas (degaans).

2.3 Implementation

The Non-Formal Education/Extension Component of the project organized Range and Livestock Associations (RLA) based on the boundaries of the traditional (existing) use areas. RLA committees were formed that were made up of the most respected elders of the degaan the proposed management plan or aspects of it, was then presented to the RLA committee for discussion, modification -- if necessary -- and, hopefully, approval.

The Range and Livestock Association, through its committee, was to take partial responsibility for carrying out range management activities agreed to in the management plan, such as in the provision of range guards or the organization of labor to dig and repair wells. This was to be done in cooperation with district staff of the CRDP and other local government authorities. The long term hope was that the RLAs could and would increasingly take over additional responsibilities in carrying out the RLA management plans.

3. METHODOLOGY

3.1 Range Survey and Monitoring

3.1.1 Differing methodologies

Each of the five Range Ecologists employed during the course of the project used the same basic approach to range survey -- that which was presented in the previous section on approach.

However, the specific methodologies used in carrying out some of the components of this approach differed between ecologists and even, sometimes, over time for a single ecologist. This was influenced by a number of factors.

1. Different levels of experience of the various Range Ecologists

2. An evolution over the course of the project in perception of the nature of realistic and achievable objectives, which influenced subsequent changes in methodology.

3. Differing logistical constraints between regions. For instance, the large area and relative innacessibility of Hobbio District (Mudug Region) imposed a more approximative approach to range survey than in the other two regions. This was especially true when the ecologist had to take all his fuel with him to the district, which was 500 km distant from Mogadishu.

4. Lack of experience with the local vegetation and soils. This was especially relevant regarding range condition classification which usually presupposes a considerable knowledge of a rangeland's ecology.

5. A desire to accumulate sufficient experience and knowledge to develop a survey methodology directly applicable to the Central Rangelands environment and situation. This is best accomplished by comparing the relative performances of different methodologies.

6. Also: some major differences in rangeland physiognomy, notably grassland vs: bushland which require different sampling techniques.

3.1.2 Familiarization with the flora

A knowledge of the existing plant species is obviously important to a successful range survey. However, there was little available at the beginning of the project (such as a published flora, check list of plant species or keys for identification) of any practical value to project staff in familiarizing themselves with the flora of the Central Rangelands. Guides and keys were available for portions of the neighboring floras of Kenya and Ethiopia but the Central Rangelands flora is unique enough that such references were only of occasional value to the project. Several steps were taken to overcome this problem:

1. Collect and identify plant species

2. Develop published floras, checklists of plant species and identification keys

3. Develop lists of Somali names for plant species.

3.1.3 Delineation of land units

Rangelands were stratified into land units homogeneous as to vegetation, soils and productive potential. This was done to increase the accuracy and applicability of survey and research results and support planning and development activities.

Existing maps and satellite imagery were taken into the field during a reconnaissance survey. Visual inspections were made of gross landscape, soil and vegetation characteristics (physiognomy, obvious dominant plant species, surface soil color and texture, topography etc.). The major landscape patterns seen on the ground were compared with those seen on the maps and satellite imagery to pick out boundaries of probable land units. The existing maps and imagery consisted of:

1. 1:100,000 topographic maps (Ministry of Defense, 1970's)

2. 1:250,000 planimetric maps with land unit boundaries deliniated by RMR (1979)

3. LANDSAT false color composite satelite images (1:250,000).

The land unit boundaries deliniated by RMR (1979), which were considered to be the "first approximation" of the final land units or range sites, were kept where these coincided with landscape features seen in the field and were changed where they did not coincide.

3.1.4 Inventory

The inventory or follow up survey:

(1) Used sample plots to record basic soil and vegetation attributes such as vegetation composition, structure, physiognomy and utilization and soil surface color and texture.

(2) Recorded miscellaneous information on type, degree and timing of land use and other relevant aspects of an area's ecology that throw light on the functioning of the rangeland ecosystem.

(3) Classified range condition. This was carried out as an integral part of the range inventory but is important enough to be discussed separately.

Two different methodologies were used to collect data from sample plots. In Hiran Region, Kuchar et al (1985) used occular estimates of vegetation attributes (cover %., height, crown diameter etc) on plots of about 0.5 hectare in area but with no fixed boundaries (Fig. 2). He emphasized the woody over the herbaceous component based on the view that the former provided the bulk of livestock forage. A relatively dense pattern of sample plots was established (goal was 1 plot per 10 km^2). This was made possible by the use of abbreviated data sets on 50% of all sample plots and a dense network of roads and geological/seismological exploration cut lines that could be used for access. The data was collected with a view to computerized storage and analysis and was certainly abundant enough to make this necessary.

This approach was meant to produce a field technique useable by Somali Counterpart staff.

In Ceel Dhere District Herlocker and Ahmed (1985) used relatively small fixed area circular plots (100 and 10 m^2 for shrubs and dwarf shrubs respectively) and 10 meter point transects of 1,000 points each for the grass layer. Attributes were measured rather than estimated ocularly (Fig. 3). The network of sample plots was less dense than in Hiran Region and equal consideration was given to all growth forms.

The emphasis on measurements was based on the need felt at the beginning of the project to obtain forage biomass estimates for both shrubs and grasses for the calculation of stocking rates. Mean shrub density and crown diameter (by species) were to be combined with predictions of individual shrub species forage biomass from crown diameter - obtained from dimension analysis and destructive sampling - to estimate shrub forage biomass for each range site. Naylor and Jama (Hobbio District) used a similar approach which was carried out in a more abbreviated and approximative form because of the greater logistical constraints in that place (Mudug Region) and time (early years of the project).

However, it was soon apparent in Ceel Dhere District that the goal of providing adequate information on forage biomass on a range site by range site basis - given the available resources - was unrealistic. Therefore, subsequent surveys in Ceel Bur District (Herlocker et al, 1988a) and Hobbio District (Wieland, 1987a) used modified forms of Kuchar's methodology.

LOCATION ______________________________

LANDFORM ______________________________

STAND NO.	
DATE	
START(h)	
FINISH(h)	
SLOPE(o)	
ASPECT	
SOIL COLOR	
SOIL TEXTURE	
SOIL SAMPLE	

COVER (%)	
ROCK	
PEBBLE	
LITTER	
GRASS	
FORB	
DW. SHRUB	
SHR./TREE	
ALL WOODY	

CONDITION RATING (0=best, 3=worst)	
EROSION	
TRAILS	
LITTER	
GRASS ABUND.	
GRASS CROWN	
HEDGING	
DUNG	

INDIVIDUAL SPECIES ESTIMATES	% COVER	HEIGHT(m) RANGE	MEAN	MEAN CROWN DIAM. (m)	HEDGING RATING (0=untou 3=extrem

Figure 2. Field form used in range inventory of Hiran Region

PLOT NO.
Location

Soil color
surface texture

Species	CD (m)	CA (m/2)	HT (m)	Hedging class

Figure 3. Field form used in range inventory of
Ceel Dhere District, Galgaduud Region.

The survey method used in Ceel Bur District, Galgaduud Region, was simplified to enable its use by Somali staff. Thus, only the most abundant species were dealt with, estimates of cover % were replaced by ranking of importance and estimates were made of overall stand canopy cover, height and dominant growth form (Fig. 4). Also, the previous reconnaissance and follow up survey were combined into a single integrated survey.

3.1.5 Vegetation dynamics

During the course of the project several studies were carried out on aspects of rangeland vegetation dynamics. Five studies were based on data already obtained by rangeland inventory and from a fenced exclosure and another four were additional cooperative studies with faculty of the Department of Botany and Range Management. There were five types of studies.

(a) Response of vegetation to gradients in land use extending out from major water sources.

(b) Post-cultivation succession on a shrubland range site.

(c) Ecology and dynamics of pastoralist camp sites

(d) Vegetation dynamics in response to sand dune encroachment.

(e) Response of degraded vegetation to protection from grazing.

3.1.6 Soils

Further information on soils was obtained by contracting out a reconnissance soil survey (including laboratory analyses) of Ceel Dhere District to a Somali soil scientist (Dr. Ibrahim Tubea) (Herlocker et al. 1988b). Soil samples collected during the range inventory of Bulo Burte District were analysed in the laboratory by the same man. Soil analysis methods are described in Herlocker et al. (in review).

3.1.7 Range sites

Range sites are units of land that have a similar productive potential, such as in the production of forage and, subsequently, of livestock. They are the basic land units used by the range manager in planning and implementing development and management activities. Range sites were identified by their unique combination of soils, physiognomy, dominant plant species and, sometimes, topography.

RANGE FIELD SURVEY FORM

Date

Plot no. Names of surveyors

Plot location

RANGE CONDITION
Soil
  Erosion
  Trails
  Surface crust
  Litter
    Mean value
Herb layer
  Growth form
    Mean value
Shrub layer
  Hedging
    Mean value
Final mean value

Soil color
Soil texture
Rock cover %
Other information

Average height of vegetation

Tree
Shrub
Stand average
(Where applicable)

Grasses found in protected areas

Plant species; number major species according to relative dominance (1) major dominant(s), (2) secondary dominant(s), (3) common, (4) rare. Also note when herbs are annual (A).

Species	Rating	Notes

Figure 4. Field form used in range inventory of Ceel Bur District, Galgaduud Region

Sample plots with similar soil and vegetative attributes were grouped into the same range site. Range site boundaries were extrapolated and interpolated using survey data, maps and satellite imagery.

3.1.8 Forage biomass

Net standing crop of forage biomass was obtained as an approximation of forage productivity. This was to allow calculations of allowable stocking rates for livestock which are needed by the range manager if he is to balance available forage against its use by livestock. Comparison of allowable and actual stocking rates is also a way of determining whether a rangeland is being over, under or adequately used.

Herbaceous (grass) biomass (net standing crop) was determined by clipping up to 20 1/2 m^2 quadrats, drying and weighing the forage and expressing the results on a unit area basis. Placement of quadrats varied with the ecologist: at random within a range site (Kuchar et al, 1985) (Fig. 5); systematically within a representative portion of a range site (Martin pers comm; Naylor pers comm.) or within a fenced ecological exclosure (Herlocker et al 1986; Wieland 1987a).

Shrub forage standing crop was estimated by dimension analysis, destructive sampling and the development of regression equations predicting shrub forage biomass from shrub size attributes (crown diameter, crown volume, shrub height etc.). This approach was used by Kuchar et al. (1985); Kuchar (1987) and Herlocker et al. (1987). Kuchar et al. (1985) also used a predictive equation (using crown volume) developed by Western et al. (1981)

In either case, forage biomass of the average sized shrub was applied to all shrubs within the range site using an area related shrub attribute (cover %, ~~or shrub density)~~. or shrub density

3.1.9 Forage quality

It was not possible to obtain laboratory analyses of forage quality during the life of the project. However, forage quality was estimated by other means. This was done by questioning pastoralists about the relative palatability of as many plant species as possible and, more specifically, which species were preferred forages for their stock and which were considered best for their stock by the pastoralists themselves (Figs. 6, 7). Palatability was rated as high, medium, low or non palatable. The type of livestock using the forage and the season of use were also recorded. Several opinions were usually collected for each plant species.

DATA FORM 2: HERB LAYER

NOTE: if DF 1 is also filled out, do only the asterisked sections

LOCATION ______________________

LANDFORM ______________________

*STAND NO.	
DATE	
START(h)	
FINISH(h)	
SLOPE(°)	
ASPECT	
SOIL COLOR	
SOIL TEXTURE	
SOIL SAMPLE	

QUAD. SIZE

BIOMASS(g/___)	
GRASS: ANNUALS	
GRASS: PERENNIALS	
GREEN	
BROWN	
FORBS	
WOODY <1m	
%palat.	
>1m	
%palat.	

COVER(%)	
ROCK	
PEBBLE	
MINERAL SOIL	
LITTER	
GRASS: ANNUALS	
GRASS: PERENN.	
FORBS	
*DWARF SHRUBS	
SHRUB/TREE 1-2m	
> 2m	

QUADRAT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
*COVER ESTIMATES (%)																									
ROCK																									
PEBBLE																									
MINERAL SOIL																									
LITTER																									
DUNG																									
GRASSES																									
FORBS/DW. SHRUBS																									
BIOMASS ESTIMATES (g)																									
GRASS: ANNUALS																									
GRASS: PERENNIALS																									
GREEN																									
BROWN																									
FORBS																									
DWARF SHRUBS																									

Figure 5. Field form used for herbaceous layer in range inventory of Hiran Region

Plant Forage Value Questionaire

Date ---------------

Location ------------------- Degaan ------------------

Name of informant -----------------

Type of informant (villager, nomad, elder, man, woman etc.)
----

1. What are the most important dry season plant species for

A) Camels

B) Goats

C) Sheep

D) cattle

2. What are the most important wet season plants for

A) Camels

B) Goats

C) Sheep

D) Cattle

Figure 6. Plant forage questionaire used in Ceel Bur District.

WILD PLANTS OF SIGNIFICANCE IN YOUR DEGAAN

List your no.1 choice in each category, and add other species wherever possible.

Top food plant of camel	1 ______	2 ______	3 ______
	4 ______	5 ______	6 ______
Top food plant of goat	1 ______	2 ______	3 ______
	4 ______	5 ______	6 ______
Top food plant of sheep	1 ______	2 ______	3 ______
	4 ______	5 ______	6 ______
Top food plant of cattle	1 ______	2 ______	3 ______
	4 ______	5 ______	6 ______
Top dry-season camel food	1 ______	2 ______	3 ______
Top dry-season goat food	1 ______	2 ______	3 ______
Top dry-season sheep food	1 ______	2 ______	3 ______
Top dry-season cattle food	1 ______	2 ______	3 ______
Top food for all stock	______	______	______
Best saltbush	______	______	______
Poisonous to stock	______	______	______
Building pole	______	______	______
Lath (for hut sides)	______	______	______
Curved pole for nomadic hut	______	______	______
Door	______	______	______
Chair, bench, stool	______	______	______
Koran board	______	______	______
Bowl	______	______	______
Plate	______	______	______
Spoon	______	______	______
Meat-roasting platform	______	______	______
Walking stick	______	______	______
Herding stick	______	______	______
Implement handle (hoe, axe)	______	______	______
Club, fighting stick	______	______	______
Arrow	______	______	______
Bow	______	______	______

Figure 7. Plant forage value and additional use questionaire used in Hiran Region.

Comb (normal)			
Comb (1-tooth)			
Camel bell			
Frame for water container			
Prayer beads			
Firewood			
Charcoal			
Firemaking by friction			
Live fencing			
Dry fencing			
Mats for nomadic hut roof			
Rope			
Water container			
Mattress, pillow stuffing			
Thatch			
Dye			
Soap			
Ink			
Cleaner for milk container			
Toys			
Bush tea			
Edible fruit			
Edible leaf			
Edible root/tuber			
Toothbrush			
Medicinal			
Poison manufacture			
Harmful to skin or eyes			
Gum for: eating			
chewing			
medicine			
incense			
glue			
wash vs. ticks			
poisoning hyenas			

Figure 7 (continued)

3.1.10 Range condition

The classification of range condition is based on an ability to relate the health/ecological/productive status of the existing vegetation with that of its potential. This usually is done within the context of a range site which is homogenous throughout in terms of such potential. Thus, each range site has its own unique set/array of soil/vegetation characteristics that indicate specific range condition classes.

Considerable study and/or experience with the vegetation and soils of a range site and their response to different types and degrees of use is usually required before a set of sensitive indicators of range condition classes can be developed. Such experience was not available at the beginning of the project because so little was known of the flora, much less ecology, of the Central Rangelands. Furthermore, if conducted on a range site by range site basis, this knowledge would be slow in coming because of the large area (and number of range sites) of the Central Rangelands.

Thus, there was a need to provide a first approximation of range condition classes over a large area of relatively unknown rangeland within a fairly short period of time. To meet this need, Naylor and Herlocker (1987) developed guidelines for classifying range condition that were useable across all (or most) range sites with a minimum of knowledge of an area's ecology. The guidelines allowed ocular ratings to be made (on a scale of 0-3, best to worst) for condition of soil (erosion, trails, surface crust, litter), herbaceous layer (growth form and vigor) and shrub layer (vigor and degree of hedging/utilization) attributes. Herbaceous and shrub composition could be included if known.

The final range condition rating, therefore, was a value integrating the impact of grazing, browsing, clearing etc. on the vegetation/soil complex. Speed was acheived by not using measurements or estimates of numerical values other than the four-point ratings. Each attribute was given equal weight both to speed subsequent analysis and allow eventual analytical comparisons of the relative performance of individual attributes which might allow different weights to be assigned to each. This approach was used in Galgaduud and Mudug Regions (Herlocker and Ahmed (1985); Herlocker et al. (1987;1988a;1988b); Naylor and Jama, (1984) and Wieland, (1987a).

A modified form of this method was developed by Kuchar et al. (1985) in Hiran Region. This attempted to provide a more sensitive classification by adding some different attributes (abundance, cover, dung); the estimation for some of the attributes of numerical values (such as cover %) and the use of weighted ratings where the relative importance of an attribute in influencing range condition supported this. In addition, a sliding scale of weights was used for some attributes once these attained certain threshold values.

3.1.11 Range trend

It is extremely important to the range manager not only to have a knowledge of the condition of rangeland but also its trend (or change) through time. A knowledge of the degree and direction of change in the resource enables much more reliable management decisions to be made than if these were based on the present (apparently static) status alone. For instance, rangeland in fair condition with a downward or deteriorating trend implies different management actions than if the trend were stable or improving. The same can be said regarding the difference between fast, quick, gross trends and slow, gradual, subtle trends.

Traditionally, range trend has been monitored by remeasuring soil/vegetation attributes on permanently placed sample plots. Such "high precision" plots are located and measured very precisely so that there is a minimum of sampling error to obscure actual vegetation/soil changes that have occurred between repeated measurements on the small plot.

"High precision" permanent trend monitoring plots placed by the project usually consisted of a transect of variable length (but usually 200 meters long) referenced at either end to well marked and recorded points, such as iron rods, for accurate relocation. The transect served as a baseline along which measurements of vegetative and soil attributes, such as cover %, were taken in the form of sample points or plots of various sizes.

The necessarily few "high precision" permanent trend monitoring plots that were placed by the project were complemented by a larger number of "low precision" permanent trend monitoring plots placed over a wider area.

Such plots are located only approximately and subsequent observations on each plot are also less precise than on "high precision" plots. The reduction in precision is compensated for by the larger number and wider distribution of plots made possible by the relative ease of establishment, measurement, relocation and remeasurement.

Observations on "low precision" plots will record fairly gross trends of easily observable attributes like grass height, or litter cover whereas observations on "high precision" plots will record less easily observable trends such as species cover and vigor.

3.1.12 Climatic monitoring

A limited network of rain gauges was established within the survey area where they could both be protected from vandalism and be maintained by observers. Later in the project a more extensive system of automatic meteorological recording stations was established, one at each of the priority district CRDP headquarter compounds within the survey area plus two others at especially important locations.

4. RESULTS

4.1 FLORA OF THE CENTRAL RANGELANDS

During the course of the project several reference works and keys were prepared which are valuable sources of information on the flora of the Central Rangelands and are tools for use in familiarization with that flora. Some were completed at the National Herbarium, a closely related USAID/LBII/CRDP component. These included a glossary of botanical terms (Kazmi and Elmi, 1983); a key to Somali grasses (Cope 1985); Somali plant names (for Somalia) (Kazmi 1985) and a guide to the flora of Somalia (Kazmi 1986). Those that resulted from activities of the Range Development Component were: Somali plant names for Ceel Dhere and Bulo Burte Districts (Kuchar and Herlocker 1985); the plants of the Central Rangelands (Kuchar 1986a) and the plants of Somalia, an overview and check list (Kuchar 1986b). In preparation are a vegetative key for the identification of shrub species by Kuchar and an updated report on Somali plant names for the Central Rangelands by Kuchar and Herlocker.

Lists of Somali names for plant species, especially if applicable to the area being surveyed (variations do occur throughout the country), have proven to be especially useful in naming plants in the field and in communicating with local pastoralists about rangeland vegetation. CRDP staff often work entirely with local names in the field but need to translate these into scientific terms when writing reports and discussing these plants with others unfamiliar with the district.

The Central Rangelands was found to be part of a unique floristic vegetational zone characterized by *Acacia*-*Commiphora* spp. whose richness and uniqueness climaxes in the Central Rangelands and Ogaden (Kuchar 1986a).

4.2 RANGE SITES

4.2.1 Hobbio District, Mudug Region

The following information has been taken from Naylor & Jama (1984). Hobbio District contains seven range sites. The major environmental factors influencing their occurrence are (a) topography, (b) rainfall, (c) soil salinity & gypsum content, (d) strong winds near the coast and, to a lesser extent perhaps, soil depth and texture.

Three topographically related range sites (no's 1,2 & 3) comprise all of the eastern and central parts of the district (Figs. 8, 9c. This area, the interior plateau/basin, consists of limestone ridges and wide valleys which drain into filled basins and salt lakes. The average relief is about 20 meters. Winds here are not as strong as near the coast. Rainfall occurs as scattered showers of short duration and there is an almost complete lack of violent storms. This is one of the driest areas of the Central Rangelands and drought is apt to occur somewhere within the area every year.

The largest range site, *Balanites orbicularis*-*Boscia minimifolia* - *Leptothrium senegalense*-*Cenchrus ciliaris* shrub grassland (range site no.3) (Tables 1, 2), covers the eastern half of the district (Fig. 9). It occurs on fine orange sands that have a considerable gypsum component and are up to a meter deep. These occur midway on the topographic sequence (or catena) between range site 2 (limestone ridges) and range site 1 (lower slopes and basin bottoms) (Fig. 8). The latter two range sites recur throughout the area of range site 3 but in units too small to map.

Limonium cylindrifolium/*Ipomoea donaldsonii* - *Sporobolus ruspolianus*/*Cenchrus ciliaris* dwarf shrub grassland (range site one) is a shrub grassland averaging about 20% woody canopy cover and 9% herbaceous (basal) cover. Mature shrub height is about 3.5 meters. The dominant species are *Acacia horrida*, *A. reficiens*, *Ipomoea donaldsonii* (shrubs); *Indigofera ruspolii* (dwarf shrub); *Aristida kelleri*, *Leptothrium senegalense* and *Dactyloctenium scindicum* (perennial grasses).

The most valuable forage species, however, are the evergreen shrubs *Balanites orbicularis* and *Boscia minimifolia*, which would probably dominate the range site except that they are so heavily browsed that the *Acacia* species, including *Acacia edgeworthii*, are increasing at their expense. In order of decreasing importance, *Leptothrium senegalense*, and *Cenchrus ciliaris*, which

Figure 8: Topographic profile of Hobbio District extending along a SE-NW axis from the sea into the interior. An additional profile gives an idealized view of the topographic relationship of range sites in the eastern half of the district. Numbers refer to range sites (see text & Figure 9)

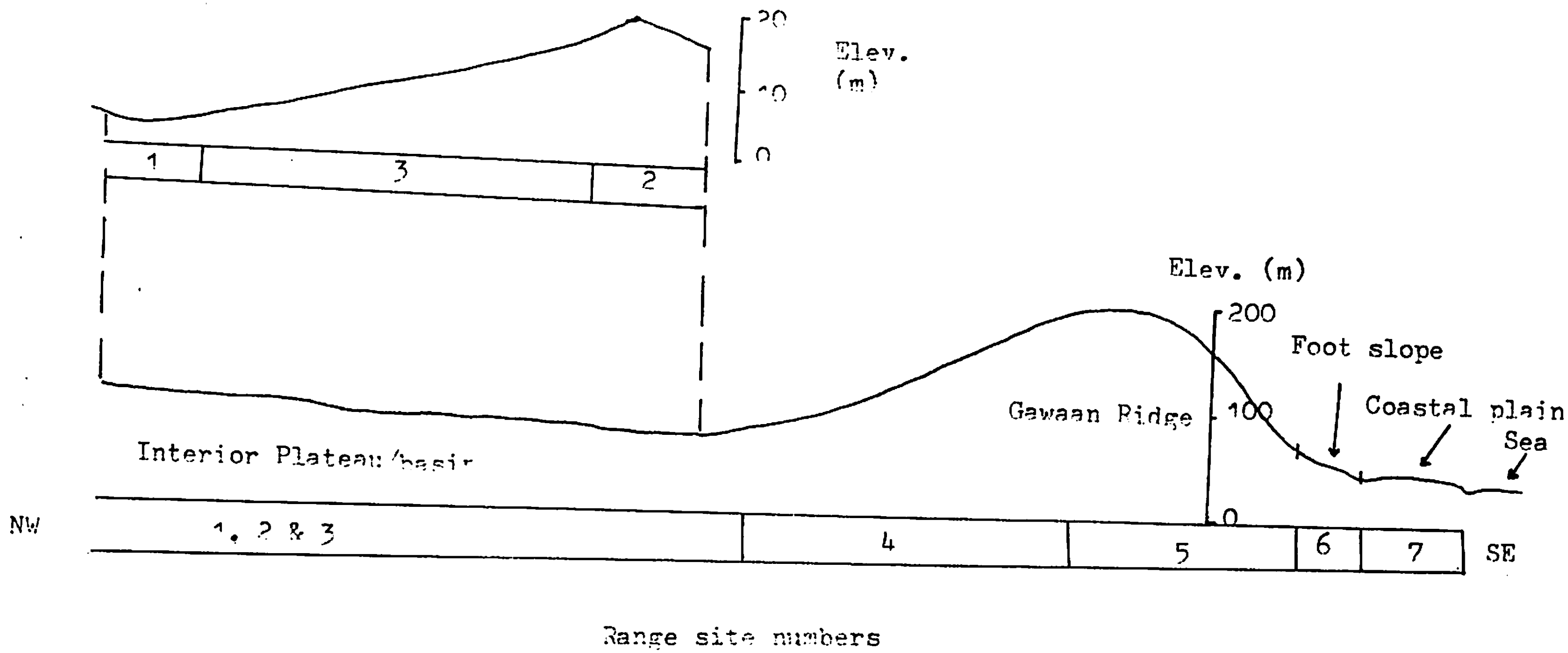
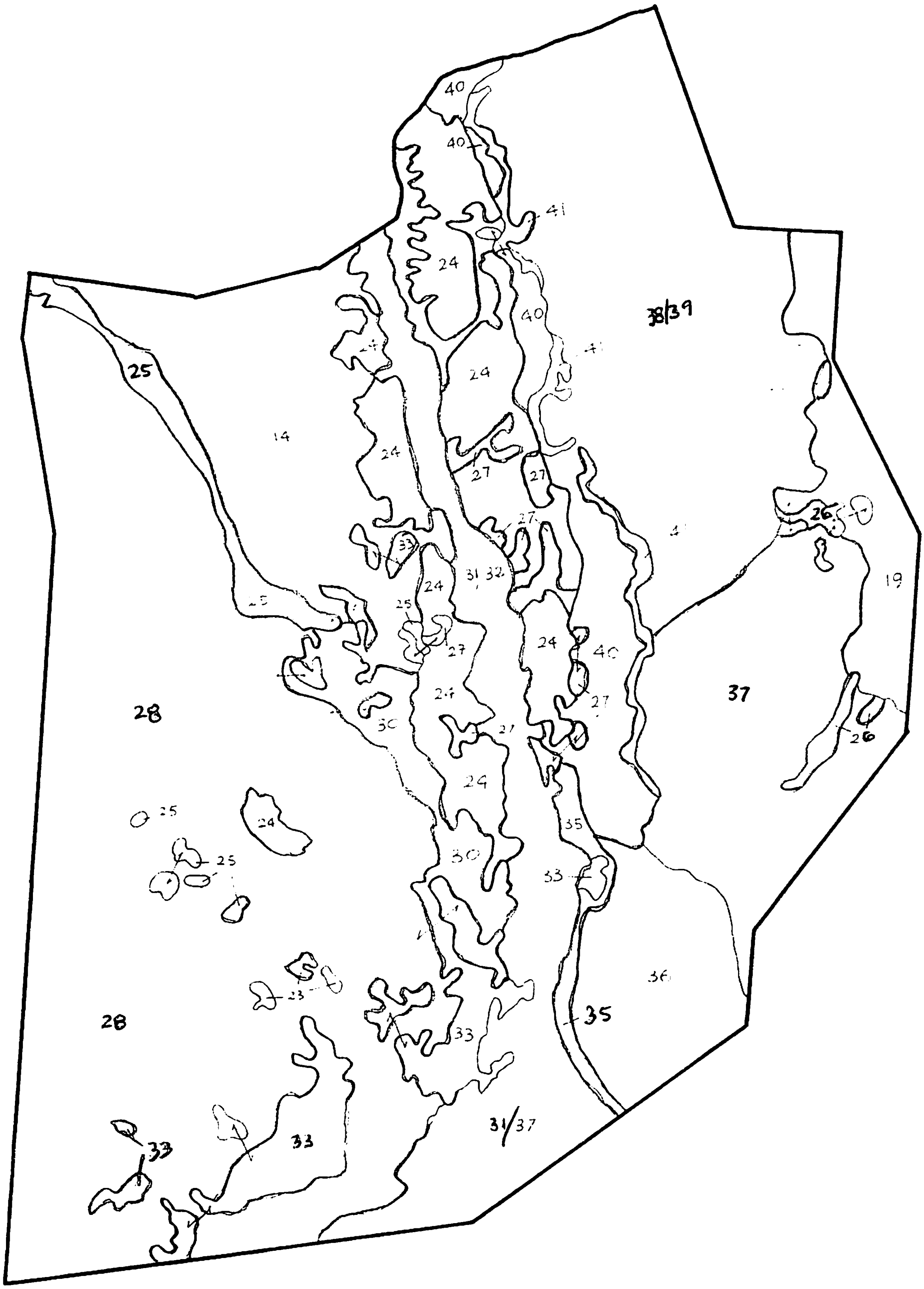


Fig. 9a MAP of RANGE SITES
HIRAN REGION

SCALE



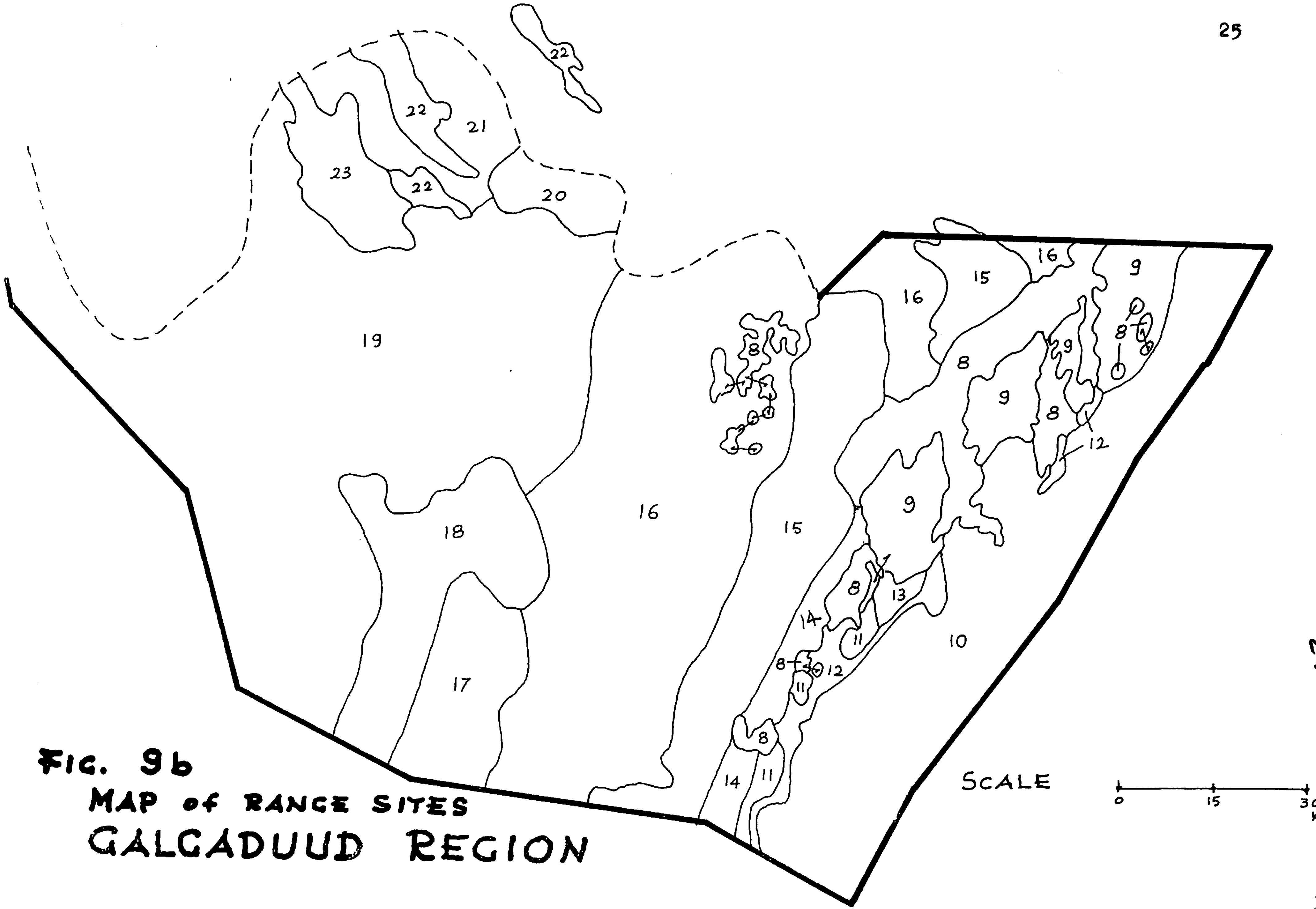


FIG. 9b
MAP of RANGE SITES
GALGADUUD REGION

FIG. 9c MAP of RANGE SITES
HOBYO DISTRICT

SCALE 0 15 30 Km.

Table 1: Major woody species for the range sites of Hobbio District

Species(1)	Range sites (2) 1	2	3	4	5	6	7
Salsola bottae (E)(SB)	X	X					
Euphorbia matabelensis	X	I					
Acacia tortilis	X	X		X			
Commiphora spp.	D	X	X	X			
Ipomoea donaldsonii	X	X	I	X			
Indigofera ruspolii	X	D	I	X	X		
Acacia edgeworthii	X	D	X		X	X	
Sesamnothamnus busseanus		X	X				
Hildebrandtia africana		X	X				
Dalbergia uarandensis		X		X			
Dobera glabra (E)		X	X	X			
Indigofera ogadensis		X	X		X		
Acacia horrida		X	D	X	X		
Acacia nilotica			X	D			
Dichrostachys cinerea				X	X		
Limonium cylindrifolum	X						
Lagenanthus nogalensis (SB)	X						
Zygophyllum album (E)(SB)	X						
Suaeda micromeris (E) (SB)	X						
Salsola pycnophylla (E) (SB)	X						
Salvadora persica (E)	X						
Acacia nubica	X						
Euphorbia somalensis		X					
Acacia reficiens			X				
Balanites orbicularis (E)			X				
Boscia minimifolia (E)			X				
Anisotes velutinus				X			
Euphorbia cuneata				X			
Acacia mellifera				X			
Grewia tenax				X			
Terminalia spinosa					D		
Asparagus sp.						X	
Indigofera intricata						X	
Grewia cerasiformis						X	
Maytenus obbiandensis						X	
Heliotropium sp.						X	
Chamaecrista puccioniana						X	

(1) D,I and X indicate three successively lower levels of dominance.

(2) See next page.
(E) = Evergreen; (SB) = Salt bush

Table 1 (continued)

Mngt unit	Range site no.	Range site name(1)
1	1	Limonium cylindricum - Ipomoea donaldsonii - Sporobolus ruspolianus - Cenchrus ciliaris dwarf shrub grassland
1	2	Indigofera ruspolii - Ipomoea donaldsonii - Sporobolus ruspolianus - Leptothrium senegalense dwarf shrub grassland
1	3	Balanites orbicularis - Boscia minimifolia - Leptothrium senegalense - Cenchrus ciliaris shrub grassland
2	4	Acacia nilotica - Anisotes velutinus - Brachiaria somalensis - Leptothrium senegalense shrubland
3	5	Terminalia spinosa - Indigofera ruspolii - Cenchrus ciliaris - Heteropogon contortus bushland
4	6	Indigofera intricata - Grewia cerasiformis - Leptothrium senegalense - Cenchrus ciliaris dwarf shrub grassland.
4	7	Leptothrium senegalense - Indigofera intricata - Cenchrus ciliaris grassland

(1) The mobile dune fields of Hobbio District are included with those of Ceel Dhere District (range site 8).

Table 2: Major herbaceous species and physical attributes of range site vegetation, Hobbio District, Mudug Region(1)

Species	Range sites 1	2	3	4	5	6	7
Aristida kelleri		X	D	X	X	X	
Leptothrium senegalense	X	D	I	I	X	D	D
Dactyloctenium scindicum			I	I			
Cenchrus ciliaris	I	X	X	I	D	D	I
Chrysopogon plumulosus			X	X			
Sporobolus ruspolianus	D	D	X	X	I		I
Sporobolus spicatus	I						
Sporobolus iocladus	X						
Brachiaria somalensis				D			X
Afrotrichloris martinii				X	X		
Heteropogon contortus					I	X	X
Cyperus sp.					X		I
Digitaria sp.						X	X
Eragrostis perbella						X	
Indigofera intricata							D
Eragrostis sp.							X
Physical attributes(2)							
Physiognomic class (3)	DSG	DSG	SG	S	B	DSG	G
Woody canopy cover %	18	20	20	47	36		
Herbaceous basal cover %	8	10	9	13			13
Woody plant height (m)(4)	1	1	35	4	7	0.3	

(1) D, I and X indicate three successively lower levels of dominance

(2) Empty spaces indicate a lack of data in Naylor and Jama (1984)

(3) Criteria for physiognomic vegetation classes follow Pratt and Gwynne (1977)

(4) Range site 5 also supports an understory of shrubs two meters in height.

are potential dominants, and Chrysopogon plumulosus, are the most valuable forage grasses. However, their cover has been reduced by grazing in favor of Aristida kelleri, which is of relatively low palatability, and the grazing resistant low, stoloniferous Dactyloctenium scindicum. The range site is named after the probable dominant climax species.

The Indigofera ruspolii - Ipomoea donaldsonii - Sporobolus ruspolianus/Leptothrium senegalense dwarf shrub grassland (range site no.2) occupies the same limestone ridges as occur in small bits and pieces throughout range site 3 but this time over areas large enough to be mapped (Fig. 9c. This range site is compositionally related to adjacent range sites but is distinct probably because of the relatively high gypsum content of its soil. This appears to be greater than that of range site 3 but less than that of the basin soils at the bottom of the topographic sequence(Fig. 8).

This dwarf shrub grassland has a woody canopy cover of about 20%, a herbaceous (basal) cover of about 10% and woody plants less than a meter in height (Table 2). Acacia edgeworthii, Euphorbia matabelensis (shrubs) and Indigofera ruspolii (dwarf shrubs); Leptothrium senegalense and Sporobolus ruspolianus (grasses) are the major dominant species. However, the former two shrub species have been replaced in the range site name by Ipomoea donaldsonii, which is a more valuable forage species.

The lowest slopes of the topographic sequence that recurs throughout the interior plateau/basin, support a distinct vegetation community (range site) characterized by an abundance of succulent salt bushes such as Salsola, Lagenanthus, Zygophyllum and Suaeda. In several parts of eastern and central Hobbio District, these areas are of mappable size (Fig. 9c. This range site (no. 1) has been named the (Limonium cylindrifolium/Ipomoea donaldsonii - Sporobolus ruspolianus/Centhrus ciliaris dwarf shrub grassland.

Soils are fairly deep (3-4 meters), grey, calcareous silts and silty fine sands that are highly saline and gypsic. Filled basin bottoms often support only grasses, possibly because of the occurrence of periodic standing water and silty, alluvial soils that inhibit growth of most woody species. The lowest lying areas are often salt lakes without vegetation.

This dwarf shrub grassland has a woody canopy cover of about 18% and a herbaceous (basal) cover of about 8%. Woody plants are under 1 meter in height (Table 2).

The vegetation growing on this range site is very salt tolerant. Tolerance increases nearer the bottom of the basin. Plant species that also occur on other range sites are stunted here.

This range site is a special purpose habitat for stock which are brought to it periodically to obtain salt-bearing forage.

Otherwise, however, it is not an important forage producer and, as a result, it is only lightly used.

The dominant species are Commiphora spp. (with Acacia edgeworthii and Euphorbia matabelensis) (shrubs); Sporobolus ruspolianus, Cenchrus ciliaris and Sporobolus spicatus (perennial grasses) (Table 1). The shrub species above have been replaced in the range site name by Limonium cylindrifolium and Ipomoea donaldsonii possibly because the former best characterizes the salt bush component and because both are more valuable forage species.

The Acacia nilotica/Anisotes velutinus - Brachiaria somalensis/Leptothrium senegalense shrubland range site (no. 4) occupies the western slope of Gawaan Ridge which rises to about 200 meters elevation (Figs. 8 & 9c. This is a gently to moderately sloping range site with deep (1.5-2 meters), light orange, non gypsic, alluvial, sand to sandy loam soil. The soil is highly erodible and numerous, deep gullies are being cut by accelerated erosion in the eastern (upper) part of the range site. Winds are seasonally strong.

A relatively high rainfall is implied by the 200 meter elevation of the Gawaan Ridge as well as the relatively dense and tall woody vegetation. Rainfalls tends to occur at night.

Woody canopy cover averages 47% and herbaceous (basal) cover 13%. Average mature shrub height is 4 meters (Table 2). The dominant plant species are also probably those of the climax vegetation community. This range site is the highest producer of forage of any in the district. Because of the relative abundance of shrubs, shrub forage production is over twice that of grasses. As a result of the combination of good soils and relatively high rainfall, the range site supports cultivation which will probably increase over time and compete with the use of the range site for forage production.

The top and eastern slopes of the Gawaan Ridge are dominanted by the Terminalia spinosa - Indigofera ruspolii - Cenchrus ciliaris/Heteropogon contortus bushland range site (range site 5) (Table 1). Acacia edgeworthii, another dominant, has not been included in the range site name because it is not a climax dominant.

This range site is characterized in the south by steep slopes with long deep canyons but by gentler slopes in the north. The top of the ridge is nearly flat. The soils are shallow, pale orange sands over limestone. There is no gypsum.

Winds are seasonally high. There are few violent storms and the combination of the abrupt rise in elevation of the Gawaan Ridge to 200 meters and the relatively dense, tall vegetation imply a relatively high rainfall. Woody canopy cover is about 36%. Trees (Terminalia spinosa) grow to 7 meters tall at maturity (Table 2).

The tree Terminalia spinosa is probably able to grow here because of the higher rainfall and the accumulation of water in cracks and cavities in the underlying limestone. Terminalia spinosa is being heavily cut for building materials, fuel wood and charcoal. It resprouts following cutting, thereby providing a useful forage. However, it has been almost entirely killed off in some areas. Its loss here has been compensated for to some extent by increased grass production. Grasses are important forage producers and may become more so as additional trees are removed. Lightly grazed grasslands will probably support fire. Indigofera ruspolii and I. ogadensis are the most important woody forage producers.

The two western most range sites (6 & 7) share a similar environment in terms of low rainfall, relatively gentle topography and seasonally high winds. This is reflected in the minimal cover of low, often stunted and spreading woody plants, or of none at all.

The Indigofera intricata/Grewia cerasiformis - Leptothrium senegalense/Cenchrus ciliaris dwarf shrub grassland range site (no. 6) occurs on a gentle footslope at the eastern base of the Gawaan Escarpment (Fig. 8). It extends in a long narrow strip between the interior Terminalia bushland and the coastal plain range sites (Fig. 9).

The soils are shallow non gypsic, orange, slightly silty sands. This, plus the slight slope, make these soils susceptible to both wind and water erosion.

The woody species are low, often stunted and widely spreading dwarf shrubs. Among them are Grewia cerasiformis, Maytenus obbiadensis and Acacia edgeworthii. Woody plant height seldom exceeds 0.3 meter (Table 2). The species that make up the name of the range site are the climax dominants.

The Leptothrium senegalense/Indigofera intricata/Cenchrus ciliaris grassland range site (7) occupies the coastal plain (Figs. 8 & 9). These species are climax dominants. There are almost no woody plants and the reason for this is not known. Grasses grow to about 30-40 cm high.

The coastal plain has a gently undulating topography that slopes gently upward to the west. Soils are white to very pale orange, medium coarse sands about a meter deep and with no horizon development. The underlying limestone is occasionally exposed in the south as low fossil ridges. However, in the north, from 10-15% of the surface is bare rock. This was probably caused by blow outs during a previous drier climate but provides an example of the possible consequences of environmental degredation during the present time.

The effect of the relative severity of the environment can be seen (in this case) in the physiognomic class of the vegetation. As the environment becomes less arid, woody plants increase in height and canopy cover. Thus, grassland and dwarf shrub grassland occur in areas of low rainfall (range sites 1,2,6, & 7), seasonally high winds (range sites 6 & 7) and highly saline gypsic soils (range sites (1 & 2). Shrub grassland occurs in low rainfall and on moderately gypsic soils (range site 3), whereas shrubland and bushland occur at higher elevations with higher rainfall and, in some cases, deeper soils (range sites 4 & 5).

The range sites differ compositionally primarily in terms of woody, rather than herbaceous, species (Table 1). The latter tend to be fewer in number and more constant in their occurence throughout the district - even as important/abundant species (Table 2). Each range site has from 1-7 woody species that are relatively important only in a specific range site. For instance, Terminalia spinosa, the major dominant of range site 5, occurs in any quantity only on this site.

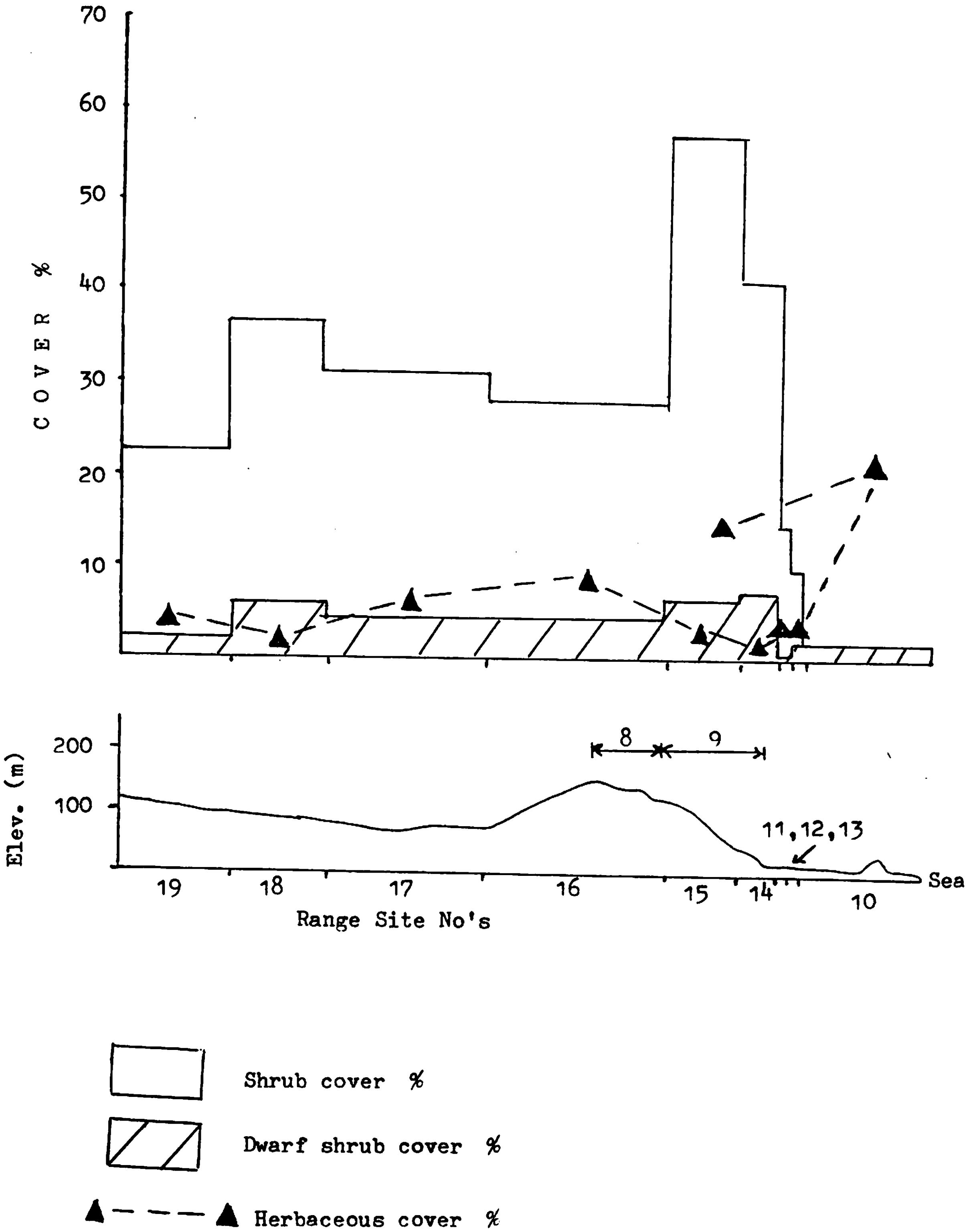
In terms of relative importance within a range site, Indigofera ruspolii and Acacia edgeworthii (at 5 range sites each); Ipomoea donaldsonii and Acacia horrida (at 4 range sites each) - all of which occur at least once as a major dominant - are the most widely distributed "important" species. Indigofera ruspolii and Ipomoea donaldsonii are important because they are valuable forages and Acacia edgeworthii and A. horrida because they are active increasers in heavily utilized rangeland. Also widely distributed are Acacia tortilis, Dobera glabra and Indigofera ogadensis (at 3 range sites each). Each is a valuable forage producer - Dobera glabra and Acacia tortilis especially so in the dry season. Balanites orbicularis and Boscia minimifolia are important on only one range site (as dry season forage) but this site covers over half of the district.

4.2.2 Galgaduud Region

4.2.2.1 Physiography

An extensive plain, about 15-20 km wide, usually level to gently undulating and seldom over 30 meters in elevation, extends along the coast (Fig. 10). Inland, a large ridge, (called here the "coastal" ridge) some 30-40 km wide, rises to 200-300 meters elevation. Slopes are generally gentle. Gullies, which carry seasonal streams, only occur in two locations on the eastern slopes. The western part of Ceel Dhere District and most of southern Ceel Bur District is an extensive plain with little topographical variation (130-150 meters elevation) (RMR, 1979). The principal feature breaking this physiographic uniformity is a shallow depression about 5-30 km wide, which extends northward from Ceel Bur Town towards Dusa Mareb. The topography is usually level to very gently undulating. Seasonal streams and gullies do not occur except locally within the large shallow depression

Figure 10. Relationship of shrub, dwarf shrub and herbaceous cover to range site and topography



which receives surface water runoff from the surrounding area. Shallow lakes form in the lowest parts of the depression during the rainy seasons. These can last up to 3-4 months.

4.2.2.2 Geology

Geologically, the district consists primarily of stabilized sand dunes. These tend to be shallow in the west and deep on the coastal ridge. Limestones underlie the sands. In the west, this limestone substratum is usually very shallow and often outcrops through the soil. Rock covers 2-8% of the soil surface. Even where normally not apparent at the soil surface, rock is commonly exposed on nearby roads and cutlines where the upper few centimeters of soil have been eroded away. The large, shallow depression extending north from Ceel Bur Town is an ancient streambed which has since filled with alluvial and colluvial deposits (RMR, 1979). The parent material here is anhydrite weathered to gypsum at the surface (Hemming, 1972).

4.2.2.3 Soils

The soils of the region are primarily sands. They vary in depth from relatively deep on the coastal ridge to shallow or almost non existent in the west. In Ceel Dhere District soil color and texture change gradually inland from pinkish grey, primarily medium sands on the coastal plain to reddish yellow, fine to very fine, sands in the west. The soils are mildly alkaline and have low levels of moisture retentivity and fertility (Table 3). missing Relatively deep deposits of $CaCO_3$ concretions in soils on the high eastern face of the large ridge imply higher rainfall and lower erosion rates here than elsewhere in the district (Tubea, 1986).

Soils of the transitional zone between coastal grasslands and interior shrublands are particularly erodible because of their floury consistence and weak, blocky structure. Soils occuring in the lee (eastward) of the large dune field on the ridge appear more erodible than those further south at the some elevation which have not been influenced by passage of the dune field. The former soils probably have a finer texture (silty clay loam) and poorer structure than the latter soils. Most of Southern Ceel Bur and Western Ceel Dhere Districts is covered by soils that are primarily yellowish red to red and red to reddish yellow shallow sands.

These soils tend to become loose when disturbed and are easily eroded by wind action. This is especially evident where dunes have formed at or near villages. For instance at Derri Village, a dune, formed several years ago, has moved 1 km removing all soil

(page 36 is missing)

drainage is often not free, so that standing water and soil saturation by water are common, the occurence and degree of advancement of these processes varies greatly in relation to relatively minor variations in topography. Soil and vegetation characteristics vary accordingly.

Seasonal lakes form during the rainy season in the lowest parts of the depression range sites. These may last up to 3-4 months. Soils of dry lakes beds are very saline and remain moist for much, if not all, of the dry season. They are covered by a thin mat of whitish fibrous crystalline material (gypsum?) which can be peeled back from the soil surface like a blanket. They support no vegetation. Somewhat more freely drained, but still highly saline, soils, such as occur at the edges of seasonal lakes and on the gentle lower slopes of swales, support succulent salt bushes, such as Limonium cylindricum. These soils also remain moist below the surface throughout much of the dry season but become very powdery when dry. They typically have a bubbly salt crust at the surface.

Reddish cracking clays with small pebbles at the surface occur locally. These vary from 1 ha to several km^2 in area and probably occupy sites which are seasonally flooded for short periods. These areas support a fairly limited vegetation. Elsewhere, soils of both depression range sites tend to compact. This is most evident near Ceel Bur Town where use by livestock has been heaviest. Depression soils do not support farming.

4.2.2.4 Physiognomy

According to the criteria of Pratt and Gwynne (1977) there are three major physiognomic vegetation types within the survey area. Grassland occupies the coastal plain and, in the north of the district, the eastern face of the (coastal) ridge where it is the lee of a large dune field. Further south there is a distinct transition zone of shrub grassland between coastal plain grassland and interior shrubland. The remainder of the survey area supports shrubland. The only exceptions to this are the large dune fields which have no vegetation. It is assumed, however, that should these ever be stabilized, they would support a form of shrubland vegetation. Dwarf shrubland occurs locally within range site 23, a depression range site (Fig. 9b

Shrub and dwarf shrub cover is highest on the seaward facing slopes of the coastal ridge (shrub cover on the upper slopes and dwarf shrub cover on the mid to lower slopes) (Fig. 10). This implies higher rainfall and/or lower evaporation rates. Cover is lowest on the rocky, sand soils on limestone plains in the far west. This reflects both reduced rainfall and shallow soils.

Shrubland less than 2 meters tall occurs locally where specific species - but especially Tephrosia obbiadensis - dominate on rocky outcrops. Dwarf shrubland (shrubs less than 1 meter tall) also occurs locally within the shallow depression where Limonium cylindricum and other succulent salt bush species dominate saline soils. Evergreen shrubs are more abundant on finer textured soils. Annual species are abundant on sands but less so on finer textured soils.

Cover of woody plants probably reflects available moisture, which is influenced by rainfall, soil depth and texture. Thus, deeper soils of fine textured sands receiving higher rainfall will probably support taller, denser shrubs and dwarf shrubs (as on the upper seaward slopes of the coastal ridge) than the shallower, rockier soils that receive less rainfall in the west of the district (Fig. 10).

Competition with woody plants restricts herbaceous cover except in the coastal plain and slope grasslands. Slope grasslands on the seaward flank of the otherwise well wooded coastal ridge probably reflect alteration of soil characteristics by passage of the large, nearby, dune field.

A combination of highly porous infertile soils, through which rainfall can qiuckly in filtrate into the underlying limestone; long periods of high winds which increase evaporative stress and the ability to quickly utilize nutirents from rapidly decomposing litter, may explain why grasses, with their fine root systems, are able to out compete woody plants on the coastal plain.

4.2.2.5 Range sites

The unvegetated mobile dunes range site (no. 8) occurs in the form of a large dune field along the top of the coastal ridge (Figs. 9b& 10). It is oriented SW-NE and has several arm-like extensions to the south. There are isolated smaller areas to the south west and north west. It also occupies large areas in Haradhere and Hobbio Districts.

This range site conists entirely of an extensive field of sand dunes which is a mixture of deep reddish yellow and yellowish red sands overlying more consolidated Silty sands (RMR, 1979). The sand dunes composing the dune field are probably mobile but it is not known to what extent. In any case the rate probably varies from place to place. Estimates of 100,120 and 200 meter per year have been made by RMR (1979) Naylor and Jama (1984) and Wieland (1987b) for three dune fronts. On the other hand, Herlocker et al. (1988b) inferred almost no advance for about 100 years at one point along the lateral edge of a dune field.

This dune field probably reflects hundreds of years of slow accumulation of sand blown across the coastal plains grassland to the south and east. The degree to which this process is natural or man-induced is not known. However, both are likely to play a part.

The position of the large dune field relative to the extensive area of grassland up wind to the south and east and to the shrubland area to the south west implies that the dune field has moved slowly northward up the ridge from the coastal plain below. In doing so it appears to have modified the soils to the extent that they no longer support shrubland. The result is a dwarf shrub grassland (Range site no. 9).

This range site was not surveyed because the vegetation is so very sparse. However, RMR (1979) state that Acacia, Melhania, Oldenlandia, Grewia, Cyperus, Tephrosia, Crotalaria, Ipomoea and Aristida sp. occur in very sparse quantities.

The assumption for making this large dune field a separate range site is that if it were to eventually be stabilized and vegetated it would support a vegetation significantly different in composition and/or production from the other range sites in the district. This approach was used instead of dividing the dune field among the appropriate adjacent range sites for which it would represent the bare soil, pre-early successional stage. As the dune field is unlikely to be stabilized anywhere in the near future, it will not be known whether this was the correct approach or not. However, as it must be treated differently from the other range sites it is for all practical purposes, a distinct range site in itself.

The Afrotrichloris martinii-Enneapogon schimperianus-Heteropogon contortus grassland range site (no. 10) occupies the coastal plain (Fig. 9). Elevation varies from sea level to 50 meters. Topographic relief is level to gently undulating and is associated with an ancient dune system (RMR, 1979).

The coastal plains are composed of aeolian and marine sediments dating rom the quaternary and pleistocene (Pozzi et al. 1983) which, until fairly recently (geologically speaking), formed the ocean floor. These sediments overlie pink to brown limestone which is often exposed by erosion (RMR 1979) (Naylor and Jama 1984).

The soils are shallow to moderately deep pinkish grey, mildly alkaline, infertile medium sands (Tubea 1986), although Frye and Khalif (unpublished data) found a sandy loam texture at one meter's depth. There is little horizon development.

The most important geomorphological process acting on the coastal plains is the wind borne movement of sands. The entire landscape consists of stabilized dunes as well as active mobile dunes, tracks and blow outs. These latter probably reflect a combination of natural geomorophlogical processes, i.e. the movement of beach sands inland by high winds, (UNSO 1984).

Although only one of the major dominants is a grass, grasses as a group dominate (75% of all herbaceous cover). Annual grasses and forbs are not abundant. Indigofera intricata (a woody herb/dwarf shrub), <u>Cyperus chordorrhizus</u> (a rhizomatous sedge) and <u>Cenchrus ciliaris</u> (a bunch grass) dominate this range site (Table 4).

Table 4: Relative cover of species comprising 5% or more of total herbaceous cover

Species	Range site number (1)									
	18	17	16	15	14	11	12	13	9	10
Barleria sp	8									
Leptothrium senegalense	**10**	**23**	**19**	**20**	**10**	**15**	**9**	**19**	**22**	**7**
UK (Malvaceae)										
U.K. herb spp.	7	7			6			7		
Crotalaria dumosa	1	6			12					
Aristida sieberiana	58	18	28	9	7					
Dactyloctenium scindicum		11		8	10		9			
Cenchrus ciliaris			9	7	9	10	22	12	9	13
Gutenbergia sp.				15	14		10	5		
Enneapogon cenchroides				13						
Afrotrichloris hyaloptera				7	14					
Sporobolus brockmanii					8					
Heteropogon contortus						32	6			
Panicum coloratum						8				
Lippia carviodora							5			
Sporobolus somalensis							15			
Indigofera intricata								24	29	23
U.K. herb								6		
Aristida kelleri								6	6	
U.K. herb									8	
Cyperus chordorrhizus										20
Panicum pinifolum										8
Species > 10% cov.	68	52	47	48	60	57	47	55	51	56
Species > 55% cov.	83	65	56	79	90	65	76	79	74	79

Dominant speces > 10% relative cover.
(1) See next page for range site names

Table 4 (Continued)

Mngt unit no.	Range site no.	Range site name
-	8	Unvegetated mobile dunes
5	9	Indigofera intricata - Euphorbia cuneata - Leptothrium senegalense dwarf shrub grassland
5	10	Afrotrichloris martinii - Euneapogon - schimperianus - Heteropogon contortus grassland
5	11	Heteropogon contortus - Cordia ovalis - Acacia senegal shrub grassland
5	12	Cenchrus ciliaris - Indigofera intricuta - unknown shrub sp. shrub grassland
5	13	Indigofera ruspolii - Terminalia spinosa shrub grassland
6	14	Acacia nilotica - Indigofera ruspolii - Afrotrichloris hyaloptera shrubland
6	15	Acacia horrida - Leptothrium senegalense shrubland
6	16	Acacia nilotica - Dichrostachys kirkii Indigofera ruspolii Aristida sieberiana shrubland
6	17	Acacia reficiens -Dichrostachys kirkii - Indigofera ruspolii - Leptothrium senegalense shrubland
7	18	Tephrosia obbiandensis - Indigofera ruspolii - Aristida sieberiana shrubland

Composition varies with intensity of grazing. Heteropogon contortus, Aristida kelleri and Panicum pinifolium dominate lightly grazed areas. Indigofera intricata, Cenchrus ciliaris and Leptothrium senegalense dominate medium to heavily grazed areas (Herlocker and Ahmed 1986).

However, composition may also reflect the effects of wind erosion and deposition. Leptothrium senegalense and Indigofera intricata, for instance, are intolerant of sand saltation and deposition whereas Cenchrus ciliaris is more tolerant and is the last species of the original community to persist in the face of advancing sand or increasing overgrazing. Cyperus chordorrhizus invades and dominates large areas of newly deposited sand (Herlocker and Ahmed, 1986; Barker and Herlocker, in prep).

Those species used to name the range site are probable decreaser components of the climax.

Also of importance out of all proportion to their abundance/occurence - are the low growing early successional species, Cynodon dactylon and Dactyloctenium scindicum. These species, which are invaders and major wet season forage species for cattle and sheep, form a lawn-like sod on seasonally used pastoralist campsites, which comprise less than 1% of the total area of the range site (Barker et al in prep.; Thurow et al in prep). In the dry season, cattle, sheep and Spekes gazelle feeding preferences shift to decreaser forage species such as Heteropogon contortus and Enneapogon schimperianus, probably because these species retain higher quality longer (Thurow et al. in prep).

A compositionally similar range site, Indigofera intricata - Euphorbia cuneata - Leptothrium senegalense dwarf shrub grassland (range site no. 9), extends up the eastern flank of the large ridge in the lee of the dune field (Figs. 9b& 10).

This range site occurs on stabilized coastal sand dunes (RMR, 1979). Elevation ranges from 50-200 meters and slopes are gentle to moderate. RMR (1979) state that the soils are shallow to deep, gritty, highly calcareous silty clay loams, which are well consolidated at depth, and are underlain by limestone. The soils tend to surface cap and are subject to sheet and gully erosion. The microtopography is often hummocky as though recently eroded although the associated vegetation in these areas is usually healthy and in good condition.

In the upper part of the range site (within 5 km of the large dune field that forms its western border) erosion is greatly advanced. There are many erosion gullies here that exceed 4-5 meters deep, have vertical walls and are only 3-4 meters wide. However, here too the associated vegetation, although of lower cover, is still very healthy and in good condition. It is relatively lightly used being distant from permanent water and settlements.

It is interesting that this grassland range site occupies a topographical position on the coastal ridge that, further south, is dominated by shrubland. It is possible that the large mass of the dune field now occupying the top of the coastal ridge (Figs. 9b & 10) may have so modified the soil characteristics of the range site as it passed over its surface that this area will now support only grass.

The species comprising the range site name are the major dominants. The climax dominants are not known.

A transition zone of shrub grassland separates the coastal grassland and interior shrublands (Figs. 9b & 10). This comprises three small range sites (nos. 11, 12 & 13) dominated by _Terminalia spinosa_, _Cordia ovalis_, and _Acacia senegal_ (shrubs); _Indigofera intricata_ and _I. ruspolii_ (dwarf shrubs) and _Leptothrium senegalense_, _Cenchrus ciliaris_ and _Heteropogon contortus_ (grasses) (Tables 4 & 5).

The range site occupies a narrow foot slope at the eastern base of the large ridge. It occurs on particularly erodible sands that have a floury consistence and weak blocky structure. Surface sealing is locally common so that high surface runoff and low infiltration rates may reduce the amount of soil moisture available for plant growth.

~~Range site 8 has the highest cover (6%) of evergreen shrubs in the district as well as some prostrate woody plants such as _Grewia carasiformis_~~. Range site 12 supports some farming.

This zone supports heavy concentrations of livestock in both wet and dry seasons. (Thurow et al, in review). As a result from 50-73% of all shrubs have been heavily to very heavily hedged. The climax vegetation is not known (Herlocker et al, 1988b).

Four compositionally and physiognomically related range sites occupy the large coastal ridge. Two range sites occur on the eastern flank of the ridge which receives the highest rainfall and has the deepest soils. These are _Acacia nilotica_ - _Indigofera ruspolii_ - _Afrotrichloris hyaloptera_ shrubland (range site no. 14) (lower slopes) and _Acacia horrida_ - _Leptothrium senegalense_ shrubland (range site no. 15) (upper slopes). _Commiphora incisa_,

Table 5: Relative cover of species comprising 5% or more of total woody cover

Species	Range site number (1)									
	18	17	16	15	14	11	12	13	9	10
Euphorbia somalense										
Commiphora gurreh	6									
Euphorbia cuneata	6								29	
Ipomoea donaldsonii					6					
Acacia horrida		8	6	13						
Tephrosia obbiadensis	17									
Indigofera ruspolii	13	11	12	9	18		15			
Acacia nubica	9				5			6		
Euphorbia matabelensis	7									
Boswellia neglecta	6					6				
Anisotes trisculus	6									
Acacia reficiens		29	7	6	9					
Dichrostachys kirkii		15	11	8						
Acacia nilotica		8	25	8	11					
Solanum jubae		8	8							
Acacia mellifera			6		8					
Commiphora incisa				9	7					
Parkinsonia scioana					6					
Cordia ovalis					5	22	10			
Dalbergia uarandensis										
Acacia senegal						37				
Cordia suckertii						6				
Acacia tortilis						6				
Terminalia spinosa						5	7	40		
(white bark shrub)							16	6		
Gardenia fiorii							5			
Grewia tenax								9		
Acacia seyal								8		
(Recubant d.s.)									32	
Maytenus obbiadensis									26	99
Unknown d.s.									13	
Cover of species>10% cov.	30	55	48	13	28	59	41	40	87	99
" " " <10% cov.	70	79	75	53	68	82	59	69	100	99

Dominant species > 10% relative cover
(1) See table 4 for range site names

Indigofera ruspolii, Dichrostachys kirkii and Acacia nilotica are also abundant in the latter range site.

Most of the area of both range sites has been cleared and farmed at some time in the past so that most of the vegetation is successional (Fig. 11). Although mid-successional vegetation is probably predominant, there are significant amounts of early successional species which are of low palatability. The major such species are Commiphora incisa, Solanum jubae and Aristida sieberiana. Uvaria denhardtiana, which is considered to be poisonous to stock, is at its most abundant here (Range site 14).

Climax vegetation is unknown for range site 14. However, there are still a few small areas of probable climax remaining in range site 15. These are typically dense thickets of high species diversity. In particular, these thickets contain many Commiphora species several of which are rare or absent elsewhere in the region. Some of the known components of the climax are Commiphora hildebrandtia, Acacia reficiens, A. mellifera and Afrotrichloris hyaloptera (Table 5). The grass Aristida sieberiana found everywhere else throughout the two range sites, (Table 4) is absent from climax thicket stands.

Climax thickets are preferred camel habitat because of the greater diversity of species and higher forage quality. Successional stands have fewer species and higher amounts of the less palatable species.

It probably takes at least 60-100 years for post-cultivation succession to return to the original (climax) state. This is much longer than the 20-30 years fallow needed to return the soil to an acceptable level of fertility (Herlocker et al. in review). Thus, it is unlikely that, once climax vegetation is cleared, it will ever return to its original state again.

Figure 11. The successional stages of vegetation on range site 15 in which certain shrub species are most abundant.

```
Species             Pioneer   Early     Mid       Late      Climax
--------------------------------------------------------------------

Solanum jubae       ---------------
Commiphora incisa   ------------------------
Acacia horrida                --------------------------------------
Dichrostachys kirkii          --------------------------------------
Acacia nilotica               --------------------------------------
Grewia spp.                        ---------------------------------
Commiphora ancistropha             ---------------------------------
Dalbergia uruandensis                   ----------------------------
Acacia mellifera                        ----------------------------
Acacia reficiens                             -----------------------
Commiphora hildebrandtia                          ------------------
Other Commiphora spp.                             ------------------
--------------------------------------------------------------------
```

Range site 15 supports the most unique shrubland vegetation within the region. Both species diversity and equitability are high. For instance, the primary dominant comprises only 13% of total woody cover (Table 5). There are 13 Commiphora species, more than were recorded in any other range site.

Both range sites 14 and 15 are important late wet and dry season pastures. Outbreaks of Ribi, a biting fly, enforce growing season rest. In addition range site 15 is the furthest from permanent water so that utilization levels are relatively low. As a result, only 23% of all shrubs have been heavily or very heavily browsed (54% in range site 14) (Herlocker et al. 1988b).

The two range sites that occupy the west slope of the ridge are also closely related compositionally (Herlocker et al. 1987; 1988c). The Acacia nilotica - Dichrostachys kirkii - Indigofera ruspolii - Aristida sieberiana shrubland range site (no. 16) occurs on moderately deep soils wheras the Acacia reficiens - Dichrostachys kirkii - Indigofera ruspolii - Leptothrium senegalense shrubland range site (no. 17) occurs on relatively shallow soils with occasional outcrops of limestone.

Acacia reficiens and A. mellifera (shrubs) and Aristida sieberiana (grass) are probable decreaser components of both climax vegetation communities, whereas Leptothrium senegalense (grass), Dichrostachys kirkii and Acacia horrida (shrubs) are probably also decreaser components of range site 16.

Most, if not all, of both range sites have been cleared and farmed at some time in the past. Thus, the existing vegetation is in various stages of secondary succession. Two species in particular are good indicators of post-cultivation successions. Both the shrub Solanum jubae and the perennial grass Aristida sieberiana invade recently abandoned cropland. Both species are also peristant until Solanum jubae is crowded out by shrubs of the next successional stage and/or Aristida sieberiana is heavily grazed. Both species are of low palatability but Aristida sieberiana is grazing intolerant and persists only when lightly grazed. Both species may persist up to at least 50-60 years. Post-cultivation succession attains original levels of shrub canopy cover in about 30-40 years and mid-late successional status at about 50-60 years (Herlocker et al. in review).

Shallow sands over limestone comprise most of western Ceel Dhere and southern Ceel Bur District (Fig. 9, Tables 6 & 7). The major dominant species are Indigofera ruspolii Acacia reficiens, Tephrosia obbiadensis, and Dichrostachys kirkii (shrubs) and the perennial grass Aristida sp. (Xalfo) (range sites 18, 19, 20 and 21) (Fig. 9b Tables 4, 5, 6 & 7). The climax dominants are not known. Soil depth frequently varies from shallow to almost non-existant and such apparently minor fluctuations seem to strongly influence vegetation composition.

Table 6: Major shrub species for the range sites of Ceel Bur District

Species	Range sites(1) 19	20	21	22	23
Indigofera ruspolii		D			
Acacia reficiens		D			
Tephrosia obbiadensis		D			
Dichrostachys kirkii		D			
Commiphora chiovendana		I			
Solanum jubae		I			
Sesamnothamnus busseanus		I			
Triumfetta actinocarpa		I			
Euphorbia longispina		X		X	X
Commiphora spp		X			
Commiphora incisa		X			
Dalbergia uruandensis		X			
Acacia senegal		X		X	X
Anisotes trisculis		X		X	X
Acacia edgeworthii		X			
Cassia sp.		X			
Jatropha sp		X			
Commiphora truncata		X			
Commiphora (Gunrey)		X			
Commiphora (Hagar)		X			
Acacia mellifera				D	D
Caesalpinia sp (Gurri)					D
Commiphora guidotti				D	
Gossypium somalense				X	X
Cissus sp.				X	
Dobera glabra				X	X
Limonium cylindrifolim					X

Mngt unit no.		
7	(1) Rs (19, 20 & 21)	Indigofera ruspolii - Acacia reficiens - Tephrosia obbiandensis - perennial Aristida sp (Xalfo) shrubland
8	Rs 22	Commiphora guiddotti - Acacia mellifera - Dactyloctenium sp (Dooyo Dameer) shrubland
8	Rs 23	Caesalpinia sp (Gurri) - Acacia mellifera - Dactyloctenium scindicum - Sporobolus sp. (variegatus?) shrubland

Table 7: Major grass species for the range sites of Ceel Bur District

Species	Range sites (19, 20 & 21)	22	23
Aristida sp. (Xalfo)			
perennial	D		
annual	I	X	
Aristida sp. (Fay Fay)	I		
Sida sp. (forb)	I		
Leptothrium senegalense	I	X	
Cenchrus ciliaris	X		
Afrotrichloris hyaloptera	x		
Dactyloctenium sp. (Dooyo Dameer)		D	
Dactyloctenium scindicum			D
Sporobolus sp (variegatus)		X	D
Sporobolus helvolus		X	I
Chrysopogon plumulosus			I

Commiphora chiovendana appears more likely to be important on soils with little rock at the surface. Associated species are Euphorbia matabelensis, E. longispina, Commiphora incisa, Dalbergia uarandensis and Commiphora spp. Rocky areas are often dominated by Acacia reficiens, Tephrosia obbiadensis, A. senegalense and Anisotes trisculus, often as fairly uniform stands of a single species.

Almost all areas capable of being cultivated have been cleared and farmed at one time or the other. These sites are now occupied by different stages of successional plant communities. Acacia edgeworthii, A. reficiens, Solanum jubae, and Senna sp. are often abundant in post-cultivation succession. A pungent smelling, broadleaf shrub Triumfetta actinocarpa (Ramosen) dominates entire post-cultivation stands on six contiguous plots-enough to present the possiblity that this area may be a separate range site.

Areas up to 100-200 meters or so in radius surrounding semi-permanent nomadic camp sites on non-arable soils have been cleared of the larger shrubs leaving behind only the lower shrubs, such as Dichrostachys, Tephrosia, Anisotes, Grewia spp. and Euphorbia longispina, which are of little value for fuel, building and fencing materials. Vegetation composition is even quite variable on distinctly rocky soils. This must reflect the degree of rockiness and the nature and amount of cracks in the rock and of interstitial soil.

Variation in grasses reflects a decline in rainfall from the southwest (perennial Aristidas) to northeast (annual Aristidas). Variation also probably reflects grazing pressure which favors perennial Aristida species over Leptothrium senegalense and Cenchrus ciliaris - and annual grasses over perennial Aristidas.

Thus, there appears to be a complex mosaic of compositionally varying vegetation stands throughout this large area. Occasionally, however, edaphic conditions are adequately homogenus enough over a large enough area to warrant its deliniation as a distinct range site. Thus, Tephrosia obbiadensis, Indigofera ruspolii and Aristida sieberiana dominate a low shrubland on relatively shallow, rocky soils in range site 18 (Fig. 9b, Tables 4 & 5); (Ramosen), a pungent broad leaf shrub, dominates post-cultivation successional vegetation on the slightly deeper soils of range site 20 and the significantly lower stature of woody vegetation denotes the possibility of another range site (no. 21).

Two further range sites occur on the relatively more heavier textured (loamy sands -- clay loams) and often saline/gypsic soils of the shallow depressions extending north from Ceel Bur Town.

Acacia mellifera is a dominant on the heavier textured soils of both depression sites while Caesalpinia sp. (Somali = 'Gurri) is a dominant on range site 23 (Dibir Caad) and Commiphora guidotti (Somali = "Hedi") is the principal dominant on range site 22 (Dibir Madoobe). An unpalatable perennial Dactyloctenium species (Somali = Dooyo Dameer) dominates range site 22 (Dibir Madoobe), while a more palatable perennial Dacyloctenium species is a dominant on range site 23 (Dibir Caad). Two Sporobolus species, one palatable (S. variegatus?) and the other of low palatability S. helvolus (Somali = Sifaar) are either dominants (range site 23) or have a high frequency of occurence (range site 22) (Tables 6 & 7).

Variability in vegetative composition on the heavier textured soils primarily parallels variation in soil characteristics, such as texture and salinity, although soil depth may also be locally important. Overall, the edaphic environment of range site 23 (Dibir Caad) appears fairly extreme as is evidenced by the common occurrance of areas with no vegetation (dry lake beds), stands dominated by only a single succulent dwarf shrub species (Limonum) and the frequent occurrence of shrub stands with low cover. Range site 22 (Dibir Madoobe) is easily charactized by Commiphora guidotti (Somali = Hedi) which is a dominant species throughout the range site.

Grazing of vegetation growing on the heavier textured depression soils probably favors the unpalatable Dactyloctenium (Dooyo

Dameer) and the less palatable Sporobolus helvolus (Sifaar) over the more palatable Sporobolus variegatus(?), Dactyloctenium sp and Chrysopogon plumulosus.

Depression range sites have the largest amount of evergreen shrubs in the region. Evergreen shrub species were minor dominants on 40-50% of all plots within these range sites. Dobera glabra was the principal evergreen species. These range sites also sustain one of the heaviest concentrations of browsing in the region. Approximately 65% of all palatable shrubs have been heavily to very heavily browsed. This is probably because of the relative proximity to permanent water, the abundance of evergreen shrubs and the unpalatability of the dominant grass Dactyloctenium (Dooyo Dameer). These range sites play an especially important role in sustaining local camel populations in the dry season - if not for the rest of the year as well (Herlocker et al. 1988c).

4.2.3 Hiran Region

The following is taken from Kuchar (1989a). Hiran Region is primarily an extensive bushland rich in plant species (especially woody species), occupying a diverse landscape of great antiquity and supporting prbably some of the richest pastoralists in the Central Rangelands.

4.2.3.1 Physiography

Nineteen range sites have been described to date. These are closely identified with 7 major land forms that parallel the Shabelli River and comprise two dissimilar vegetational/physiographic regions to the river's east and west (Fig. 9).

An alluvial plain, (range sites 31, 32, 34) (Fig. 9) a 8-10 km wide strip of flat, seasonally wet, heavy (silt) soil, abuts the Shebelli River. This has a long history of settlement, cultivation and use by livestock which has created a highly degraded vegetation and the poorest condition rangeland in the region.

Limestone hills (range site 24) flank both sides of the alluvial plain. Rounded prominences, ridges and stony plateaus, with a 15-50 meter local relief, interdigitate with small to moderate sized valleys of heavily farmed and over used, heavy, yellowish silts (range site 27).

A low (50-100 meter) escarpment of rapidly weathering sandstone (range site 41) borders the Shebelli Valley on the east.

Valley sands forming the footslope of the escarpment (range site 40) are easily eroded. The most serious water erosion problem in the region occurs in this unit east of the Shebelli River.

Above and to the east of the escarpment is an enormous, deep (30 meter), ancient sand plain (hawd) (range sites 37, 38, & 39) that covers most of eastern Hiran region. This flat to gently sloping terrain descends eastward in a series of shallow steps. There is no surface drainage.

East of the hawd another very large land unit, shallow (and somewhat silty) sands over limestone (range site 19), extends into Galgaduud Region.

Where the sandstone escarpment ends abruptly in southern Bulo Burte District, the adjacent valley and hawd sands grade equally abruptly into stable dunes (range sites 35, 37, 38 & 39). These sands, which typify eastern Jalalaksi, are predominantly stable but are locally eroded at their western flank where human activity is greatest.

?

Most of western Hiran Region consists of a complex of low limestone outcrops in which are pockets and small plains of silt soil (range sites 28 & 29). The vegetation on these soils appears from the air as distinct "arcs" or "fine stipples" of vegetation in the north and south respectively.

Elsewhere, gypsum plains (range site 25) (Fig. 9a) occur in western Jalalaksi. These used to support good stands of very valuable Terminalia spinosa, most of which have since been cut. Basalt plains of rich brown stony soils in western Bulo Burte (range site 30) support some farming, which has degraded range condition despite its high productive potential. Saline soils in Jalalaksi (range site 33) support evergreen salt bushes (Suaeda, Limonium).

4.2.3.2 Physiognomy and general composition

Although some of the silt and clay soils have the potential of supporting woodlands (mostly of Terminalia spinosa) most of the region is a deciduous bushland with a well developed tall shrub - tree layer 2-5 meters high, scattered emergent trees to 10 meters high, 30-50% canopy cover, a well developed dwarf shrub layer and a relatively poorly developed herbaceous layer. There are usually 15-40 woody species per range site although usually only one to a few dominate. Only a few species, but especially Indigofera ruspolii - dominate the dwarf shrub layer. Evergreen species comprise 10% of the flora (plant species) (Table 8) but rarely over 2% of vegetative cover. Both annual and perennial grasses comprise the herb layer. The latter, which are the most important forage of the two are prominent only beyond 20-25 km from permanent water. Basal cover averages about 1%. Low quality annual and perennial Aristidas dominate the sands east of the

Shebelli River. Higher quality and potentially more productive perennials, Schizachyrium kelleri and Chysopogon plumulosus, dominate the herb layer on heavier soils west of the river (Tables 9 & 10).

Table 8: Various woody plant classes, as percentages of total abundance in Hiran Region.

CATEGORY		ABUNDANCE (%)
Special features		
Armed		39.4
Evergreen		9.2
Succulent		2.3
Palatability class		
0	unpalatable	10.0
1	Low palatability	20.8
2	Moderate palatability	32.4
3	High palatability	36.8
Top genera		
Acacia		20.5
Commiphora		15.1
Indigofera		5.9
Grewia		3.8
Euphorbia		3.0
Cordia		2.6
Terminalia		2.5
Dalbergia		2.2
Top families		
Mimosaceae		22.1
Burseraceae		17.2
Papilionaceae		9.6
Tiliaceae		5.8
Acanthaceae		5.7
Caesalpiniaceae		5.6
Euphorbiaceae		4.2
Boraginaceae		3.8
Combretaceae		3.1
Compositae		2.4
Malvaceae		2.1

Table 9 : Dominant woody plant species of the sand series of range sites, Hiran Region

	Range site						
	35	36	37	38	31	40	41
Loewia glutinosa	I	D					
Triumfetta actinocarpa	X	X			D		
Acacia edgeworthii		X	D	D	X	D	
Indigofera ruspolii		I	D	D	D	D	X
Boswellia microphylla		X	X	D			
Caesalpinia erianthera		I	D		X	X	
Euphorbia cuneata		X	X	X		X	D
Cordeauxia edulis			D	D	D		
Acacia horrida			D			X	X
Commiphora horrida				D			
Boswellia neglecta					D		
Anisotes tricsculis						D	
Commiphora unifoliolata							D
Commiphora chiovendana							D
Acacia senegal							D

Table 10 : Dominant woody plant species of the limestone series of range sites, Hiran Region

	Range site										
	24	25	26	27	28	29	30	31	32	33	34
Commiphora stellatopulescens	D										
Commiphora chiovendana	D										
Satanacrater spp.	I				D						
Anisotes trisculus	I		X	X		X	X	D			
Cordia sinensis	X	X		X	X	X	I	D			
Acacia horrida	D		D	X	X	X	D	I			
Acacia reficiens	D	X	D		X	X	I	I		X	
Acacia senegal	D		D		I						X
Terminalia spinosa		D	X								X
Acacia tortilis			X	I	X				D		
Occimum tomentosum				X				D			X
Duosperma eremophilum							D	D			
Acacia zanzibarica							D	D	D	X	
Thespesia danis								X			X
Acacia nilotica									D	X	
Suaeda micromeris										D	
Limonium axillare										D	
Acacia robusta											D
Mimusops fruticosa											D

(1) See next page for range site names

Tables 9 & 10 (Continued)

Mngt unit no.	Range site no.	Range site name
11	24	Acacia senegal-Commiphora stellatopubescens - bushland
9	25	Terminalia spinosa - Commiphora spp. woodland
11	26	Acacia reficiens - Acacia horrida shrubland
11	27	Acacia tortilis - Commiphora ellisae bushland
9	28	Dalbergia commiphoroides-Satanocrater somalensis bushland
9	29	Terminalia orbicularis- Dalbergia commiphoroides bushland
11	30	Acacia zanzibarica - Duosperma eremophilum shrubland
11	31	Acacia zanzibarica - Cordia sinensis shrubland
11	32	Acacia nilotica - Acacia zanzibarica bushland
11	33	Suaeda micromeris - Limonium axillare dwarf shrub grassland
11	34	Acacia robusta - Mimusops fruticosa riverine forest
11	35	Aristolochia rigida-Tribulocarpus dimorphanthium dwarf shrub grassland
11	36	Loewia glutinosa - Cordia spp bushland
10	37	Caesalpinia erianthera - Cordeauxia edulis bushland
10	38	Boswellia mircophylla-Cordeauxia edulis bushland
10	39	Boswellia neglecta - Cordeauxia edulis bushland

11	40	Acacia edgeworthii-Indigofera ruspolii bushland
11	41	Acacia senegal - Commiphora chiovendana bushland

Although evergreen plant species are relatively few, sparse in cover and usually low in palatability, they are very important dry season forages - especially Cordeauxia edulis (yicib) on hawd sands east of the river and Satanocrater somalensis west of the river. The exceptional livestock populations and relative wealth of the nomads in these areas probably derive from these evergreen shrub species.

Acacia and Commiphora species dominate the region (36% of total cover). Indigofera, Grewia, Euphorbia, Cordia, Terminalia, and Dalbergia are also abundant genera. A significant amount of vegetation is armed (39%) and unpalatable (10%) (Table 8).

The range sites of Hiran have been organized into 2 groups or series, the sand series east of the Shebelli River, and the limestone series covering all of western Hiran and portions of the Shebelli Valley east of the river.

4.2.3.3. Dominants of sand series

Indigofera ruspolii is the no.1 dominant of sands and the top unifier species. It is also found on heavy non-alluvial silts in the Shabelli Valley but does not penetrate west of the valley (Table 9).

Caesalpinia erianthera is common on all sands. It is abundant and a leading dominant in the southern hawd in particular. It is virtually absent from western Hiran and therefore a good sand characterizer.

Acacia edgeworthii is another leading dominant of the sand group, and a characterizer species. It is also found throughout the west though only in relatively small amounts, never in the frequently dominant status in which it is encountered in the east. It is particularly abundant in highly disturbed hawd e.g. after fire.

Euphorbia cuneata is found throughout the sand group, also on rock. It is scarcer in the west. It sometimes exhibits hedging, but often looks untouched, even in areas with moderately heavy stock use. Opinions on its value are mixed, but it is generally not rated high as a browse.

Boswellia microphylla ranges widely through the region but is most prominent on sands, especially parts of the hawd where it forms a prominent open overstory in yicib bushland. Not uncommon on shallow limestones in the west and abundant in occasional stands (Fig. 9, Table 9).

Tephrosia obbiadensis occurs predominantly on sands though is also found in rocky areas, especially the far eastern limestones, and occurs in small amounts on silts.

4.2.3.4 Dominants of limestone series

Cordia sinensis is the best characterizer of this series (Table 10). This broad-crowned shrub is often the leading dominant of heavily impacted alluvial stands, and sometimes virtually the only woody cover of any significance. Surprisingly, it is highly regarded by pastoralists as stock fodder and a multipurpose plant, valued especially for its abundant edible fruits, laths, and firewood.

Jatropha arguta is another good characterizer of the limestone series. It is unpalatable and totally useless except for indicating rather heavy stock impact.

Gossypium somalense is often found together with *Jatropha* and similarly is an indicator of overused areas. It can be browsed but palatability is low, and is said to cause diarrhea in stock.

Anisotes trisulcus, like *Jatropha* a completely unpalatable shrub, has the saving grace of being a top lath, and evidently its numbers are often controlled by heavy demand for this building material. It is common throughout the limestone series and can form fairly dense, pure stands 1-2 m high on silts and limestone. It is common through the Shabelli Valley but is not found on hawd or dune sands.

Ocimum tomentosum is a dwarf shrub of disturbed areas; it is common in the limestone series and rare on sands. Though some pastoralists say it is browsed, it hardly ever appears utilized and can be regarded as a weed species.

Acacia reficiens is the overall no.1 dominant of the limestone series, and extends to limestone hills though not onto sands. It is not a particularly good browse as the leaves are very small and hard to get at on the many closely spaced branches. It is highly regarded as a food plant for game, and has valuable domestic uses. The bark makes good rope, second only to *A. tortilis*. Not used in construction.

Acacia mellifera is widespread and often abundant in stands of the limestone series, except for limestone hills. It can be regarded as a good unifier species of this series. Besides its use by stock, this is a top game plant, liked especially at flowering time. Produces good firewood and charcoal but not used in construction.

4.2.3.5 Dominants of both sand and limestone series

Acacia tortilis is the most ubiquitous of all 223 woody plants species treated in the study, and the most evenly distributed of all (though with a leaning toward the limestone series) (Table 10). It was the only species found in significant amounts in every range site (except riparian forest), which bears out the literature (e.g. Herlocker 1979) which indicates that this tree is essentially substrate-independent. This distribution, its high overall ranking, and the fact that it produces highly nutritious and palatable pods, suggest that it is one of the key range species of the region. Some pastoralists rate it no.1 for providing lopped green fodder well into the dry season. Besides its range value, this tree yields good charcoal and construction material. The bark is the no.1 producer of fiber for making rope. It is one of the top food plants for all game; the fruit is the main part eaten.

Acacia horrida is the most abundant species in Hiran (Tables 9 & 10). It is virtually ubiquitous, but especially abundant on sands where it is frequently a leading dominant. It is not highly esteemed as a food plant for stock, though is sometimes lopped for goat. The bark yields the red dye used for coloring water containers. The gum is edible. The wood is not used in construction: sometimes for firewood and charcoal. Makes an average-quality dry fence.

Acacia senegal is the leading dominant in limestone hills. It is highly regarded, as much for its domestic uses as for its browse value. It yields a lot of gum (gum arabic), eaten as a food in the dry seaon, and sold in markets. Not all nomads seem aware of this gum. Acacia senegal produces very good charcoal and is also used for implement handles and dry fencing, but not in construction. A game favorite.

One of the most ubiquitous and desirable groups of range plants are the 4 to 5 species of Grewia, medium-sized shrubs with remarkably similar distributions and more often than not found together in the same community. About equally abundant and widespread are G. penicillata, G. tembensis and G. villosa. G. tenax is ubiquitous in the west, where it is probably the commonest Grewia, but sparse on sands. G. bicolor is widespread throughout the West and in the Shebelli Valley though rare on hawd and dune sands. G. arborea and related species are common on dune sands but scarce elsewhere. All Grewia have edible fruit, that of G. penicillata being especially esteemed, and are perhaps the commonest snack-type food of nomads. Grewias are also the best source of material for arrow shafts, and are regarded as top food plants of game animals.

Commiphora albiflora/velutina, C. gurreh and C. truncata are among the commonest Commiphoras in Hiran; they are widely distributed and often codominants of bushland stands. All are palatable and important in the livestock economy though C. truncata, top-rated in palatability, is more abundant in the limestone series. These Commiphoras also have domestic uses. C. truncata is particularly valuable: the bark makes tea, the tree yields good medicinal and incense gum, and the wood is carved into utensils. C. velutina is the no.2 toothstick after Salvadora. C. gurreh makes excellent eating and drinking utensils that can last literally generations. It yields valuable gum, and may be a good sand-fixation species. Another common species, C. ellenbeckii, has a somewhat spotty distribution, and appears less palatable.

Solanum jubae, an undesirable, virtually unpalatable shrub that indicates strong disturbance, is widely distributed in Hiran though apparently rare on parts of the limestone series. It is hardly ever dominant in Hiran, but just east into Galgaduud is a strong dominant of some shallow sands.

Triumfetta actinocarpa, very similar in characteristics to Solanum, is even more abundant, especially in the Shebelli Valley where it can form the dominant cover in degraded areas.

Yet another undesirable and abundant range species is Iphionopsis rotundifolia, an aromatic dwarf shrub with a wide distribution. It is especially abundant on overgrazed sand sites, and can form a dense dominant cover. Some pastoralists say it can be eaten by stock but others indicate that it is totally shunned, and its abundance near water seems to suggest the latter. Its only value seems to be as a tea substitute, and some informants have suggested that the leaf and root are valuable medicinally.

Boscia minimifolia is widely distributed, though least frequent on the hawd. It always exhibits heavy hedging, and being evergreen, it is clearly an important dry-season browse, mainly of camel. It is also lopped for goats in dry times and produces good building poles.

4.2.3.6 Range sites

(24) The Acacia senegal - Commiphora stellatopubescens bushland range site occurs on limestone hills on both sides of the Shebelli River (Fig. 9). There are many species that dominate locally (individual stands). Among these are the two previously named as well as Acacia reficiens, A. horrida, Commiphora chiovendana and C. ellisae. Satanocrater spp. are highly regarded dry season forage plants west of the river. Evergreen shrub cover, mostly of Boscia minimifolia, is relatively high (1.3%) but there are large areas without perennial grass because of the rocky, xeric surface and overgrazing.

(25) Gypseous silt soils containing low limestone outcrops in western Hiran support the Terminalia spinosa - Commiphora spp. woodland (or woodland bushland) range site. Vegetative cover is sparse, the dwarf shrub layer is poorly developed and mostly unpalatable yet the flora is the richest of any range site in Hiran region. There are 60-70 woody species - including 13-15 species of Commiphora per 0.5 ha sample plot. Species equitibility is high so there is no clear dominance of any species. There is also a moderate cover of creeping and small, tufted grasses. Until recently, this range site supported Terminalia spinosa woodlands or woodland - bushland. However, the Terminalia has been cut out because of its high value for poles and charcoal. It may also have been excessively lopped for forage because its foliage remains green well into the dry season. There is little in the way of quality fodder offered by the present vegetation. Some intact stands of Terminalia spinosa woodland may yet remain in far western Jalalaksi.

(26) Acacia reficiens - Acacia horrida shrubland dominates pale silt flats mostly south of Jalalaksi District. Structurally, this vegetation consists of a single 2-4 meter high layer of small Acacia strongly dominated by Acacia reficiens. Shrub, dwarf shrub and herbaceous layers are poorly developed and unpalatable species predominate. The range site is probably not a particularly good producer of forage. The current vegetation is very different and much poorer than expected in the climax.

(27) Silt valleys within the limestone hills are occupied by the Acacia tortilis - Commiphora ellisae bushland range site (Fig. 9). This is a messy unit with a complex landuse history. It probably once supported dense and productive woodlands or woodland-bushland (Acacia tortilis and Commiphora ellisae are the potential climax dominants) but has since been reduced to an open bushland with approximately half the original canopy cover, half of which is made up of dwarf shrubs. There is an almost complete lack of perennial grasses. Most component plant species are undesirable.

(28) The Dalbergia commiphoroides - Satanocrater somalensis bushland range site occurs on a limestone/silt mosaic. This is the largest range site in the region, covering over 50% of western Hiran. The ground surface is a mosaic of limestone pavement alternating with silt pockets. The silt soils often support dense stands of bushland which also often contain dense clumps of two valuable perennial grasses; Schizachyrium kelleri and Chrysopogon plumulosus. The former species, which, may grow in clumps 2 meters in diameter and 2 meters tall, is used for thatching as well as forage.

This is a well watered zone. The vegetation of this range site has been greatly changed from its original (climax) condition, which is probably an unbroken bushland. The present pattern is probably being maintained by intensive use by livestock (this area supports some of the highest camel populations in the Central Rangelands), shrub cutting, cultivation and the removal of thatching material (in the latter case to destinations up to 50 km distant). Despite the intensity of use and the relatively degraded condition of the area, this range site is yet the equal of good condition hawd rangeland for stock rearing and has superior production potential.

There are three reasons for this. (a) The tall shrub - tree layer is the most valuable forage resource of all range sites in the region (although being tall, the shrubs/trees must be lopped or their leaves fall to the ground to be used).

(b) Satanocrater somalensis, a dominant evergreen to semi-evergreen browsing-tolerant shrub provides vital dry season forage (although, if eaten at the wrong growth stage, it becomes poisonous).

(c) The two perennial grasses Schizachyrium kelleri and Chrysopogon plumulosus are both high quality (when green) and productive.

(29) Much of interior western Beledweyn District consists of Terminalia orbicularis - Dalbergia commiphoroides bushland on arc silts. These show a unique pattern of alternating bands, 10-20 meters wide, of thick bush and bare areas. The latter show signs of over use.

(30) A broad swath through western Bulo Burte District contains Acacia zanzibarica - Duosperma eremophilum shrubland on basalt plains (Fig. 9). The dark brown, stony clay soils have a high production potential which probably once supported a Terminalia woodland climax (or perhaps an open bushland with a dense Sporobolus grass cover).

However, the range site has been drastically altered by shifting cultivation (Duosperma eremophilum is said to indicate cultivable land as well as being a good forage plant). The resultant post-cultivation succession is a low layer of Acacia zanzibarica - Acacia horrida which is virtually useless as forage. Acacia mellifera and Duosperma eremophilum will become more important in later successional stages.

(31) The most radically transformed of all the range sites in the region is the Acacia zanzibarica - Cordia sinensis shrubland range site on alluvial silts. Except that it is likely to be a dense woodland - bushland, the nature of the climax is not

known. A long history of shifting cultivation, heavy shrub cutting and overgrazing has resulted in a mosaic of fields and fallow, low shrub cover (rarely over 30%, very low quality vegetation and significant (though localized) amounts of wind erosion. Virtually the whole range site is in poor and very poor range condition.

(32) Acacia nilotica - Acacia zanzibarica bushland occurs on alluvial clays in the same area and is subjected to the same stock pressures as range site no 31 yet is, surprisingly, mostly in good condition. This is because of a good cover of palatable Sporobolus grass species especially S. helvolus. A woodland climax is hypothesized for this range site, possibly with Acacia nilotica and/or Balanites spp. as dominants.

(33) Suaeda micromeris - Limonium axillare dwarf shrub grassland occurs on saline plains in southern Jalalaksi District (Fig. 9). This is the only range site the original vegetation of which is not either bushland or woodland.

The low vegetation is dominated by the above evergreen salt bush species (often to the virtual exclusion of any other plant species) and by a tough endemic grass, Urochondra setulosa, which is a valuable salt forage. Dwarf shrub canopy cover is low (17%). This is not a highly rated forage habitat although it does provide salt forage periodically for livestock.

(34) Acacia robusta - Mimusops riverine forest occurs on river banks and the adjacent flood plain. This is a vegetation type rather than a range site, primarily because of the difficulty in determining the original extent of the forest. Little remains of the original forest in any case.

(35) Aristolochia rigida - Tribulocarpus dimorphanthum dwarf shrub grassland. This range site, which is too small and discontinuous to map, occurs on active sand dunes and is the poorest in range condition of all the range sites. The dunes probably result from intense cultivation with associated overgrazing and shrub cutting. Many of the colonized (invading) species comprising this vegetation stay on in the subsequent vegetation community.

(36) Loewia glutinosa - Cordia spp. bushland. Occurs on stable sand dunes (Fig. 9) and has a lower % of palatable shrubs than most other range sites. However, it is one of the more interesting floristic localities in Central Rangelands in the occurrence of rare endemic plant species.

Cordeauxia edulis (yicib) dominates three range sites, with Caesalpinia erianthera on the southern hawd sands (range site no.37), Boswellia microphylla on the much more extensive hawd sands (range site no.38) and Boswellia neglecta on shallow depressions within the hawd (range site no.39). This is the only truly dominant evergreen in the deciduous bushlands.

(37) Caesalpinia erianthera-Cordeauxia edulis bushland, is the least productive of the three hawd range sites. Other than Cordeauxia, its leading dominants (Table 9) are mediocre forage and much of the canopy is also beyond the reach of livestock. However, much of the area is distant from water so that Cordeauxia plants are vigorous and healthy.

(38 Boswellia microphylla - Cordeauxia edulis bushland on the other hand, is a particularly productive habitat because most of the vegetation is less than 1-2 meters tall (dwarf shrubs comprise 40-50% of all cover) and the leading dominants (Table 9) are highly palatable. Boswellia microphylla, being fairly tall, is lopped for forage. There is considerable compositional variation throughout the range site. This is probably of a seral (successional) nature - due to different degrees, seasons and duration of browsing, complex rain events and fire history - than to edaphic differences. Perennial grasses are relatively common (1-2% basal cover) and usually in good vigor possibly because they are of low quality and because the predominant type of livestock using the area are browsers. Open patches of grassland are probably fire-derived. This is the best all-round habitat for browsers in Hiran.

(39) The Boswellia neglecta - Cordeauxia edulis bushland, which occurs on shallow depressions within the larger hawd range site, is often too small in area to map. Depression soils are a richer red-brown than the orange-yellow/orange colored soils of the other hawd sand range sites. Grass fires have destroyed large areas (tens of km^2) of yicib, which often does not resprout. Such areas eventually become fire-maintained savanna grasslands (sometimes with low Acacia edgeworthii). However, senescent stands of yicib may also occur even where not influenced by fire.

(40) The Acacia edgeworthi - Indigofera ruspolii bushland occurs on valley sands. The larger shrubs are poor forage. Indigofera ruspolii is very abundant. Shifting cultivation occurs within the range site so that seral (successional) vegetation is present. Yicib may have been more important in the past. If so, there have been significant changes in vegetation over the past decaes.

This range site probably has more severe erosion than all the other Hiran range sites. Water flow from the escarpment and limestone hills causes severe gullying and some areas are now probably beyond hope of rehabilitation. However, overall, the silt valleys have high potential and are worth rehabilitating.

(41) The sandstone escarpment supports the Acacia senegal - Commiphora chiovendana bushland. Evergreen shrubs and perennial grasses attain and exceed 1% canopy cover and basal cover respectively, which is a bit over the average. There are also some yicib stands though mostly declining and unthrifty.

4.3 VEGETATION DYNAMICS

4.3.1 Vegetation response to type and degree of land use

Distinct changes in vegetation and soil attributes occurred along land use gradients. A ~~pattern~~ common ~~to all four gradients~~ was an increase outward from water in grass, shrub (where present), litter cover and range condition. (Herlocker & Ahmed 1986; Herlocker et al. 1987a; 1988c; Barker et al. in review) (Fig. 12). The positive relationship between range condition and distance from permanent water implied that these ~~cover~~ attributes reflected decreasing intensities of land use away from permanent water. Increasing intensity of grazing approaching water reduced grass and litter cover. Shrub cover was reduced by increased shrub cutting for fuel, fences and clearance for farms. The influence of grazing, browsing, cutting and clearing on vegetation composition and structure was apparent to 15-20 km from water in shrublands and 5-10 km in coastal plain grassland (Figs. 12, 13, 14 & 15).

Certain woody and herbaceous species clearly responded to changing intensities of use by increasing or decreasing in cover. These patterns indicated the compositional and structural nature of the stages of secondary succession and identified plant species that could be used as indicators of these successional stages and, therefore, of range condition classes. The probable nature of the final stage or "climax" vegetation was also indicated (Figs. 12, 13, 14 & 15).

Plant species that were known to be palatable or highly palatable and which demonstrated ~~their~~ ability to stand up well under moderate to heavy use - as evidenced by their relative abundance throughout much of the use gradient - were selected as probable "key" forage species. An example is Leptothrium senegalense (Fig. 15). Key forage species are the major forage support for livestock and should be emphasized in management and development activities and in the monitoring of range trends. It should noted however, that as in the case of Yicib (cordeauxia edulis) some key species do not stand up well to heavy use unless they are well managed.

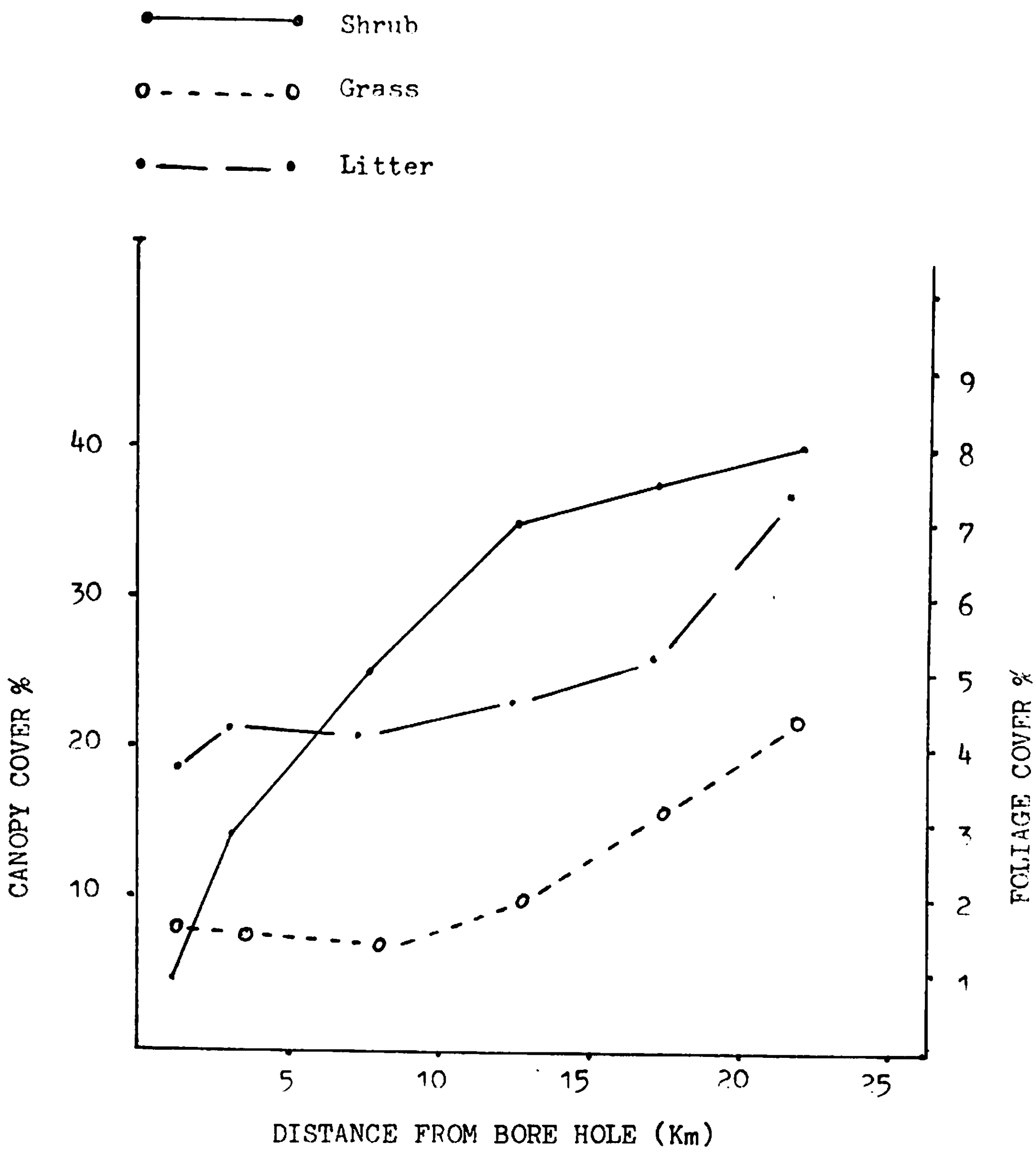


Figure 12. Changes in shrub canopy, grass and litter cover with distance from permanent water at Nooleye and Galcad villages Ceel Dhere District.

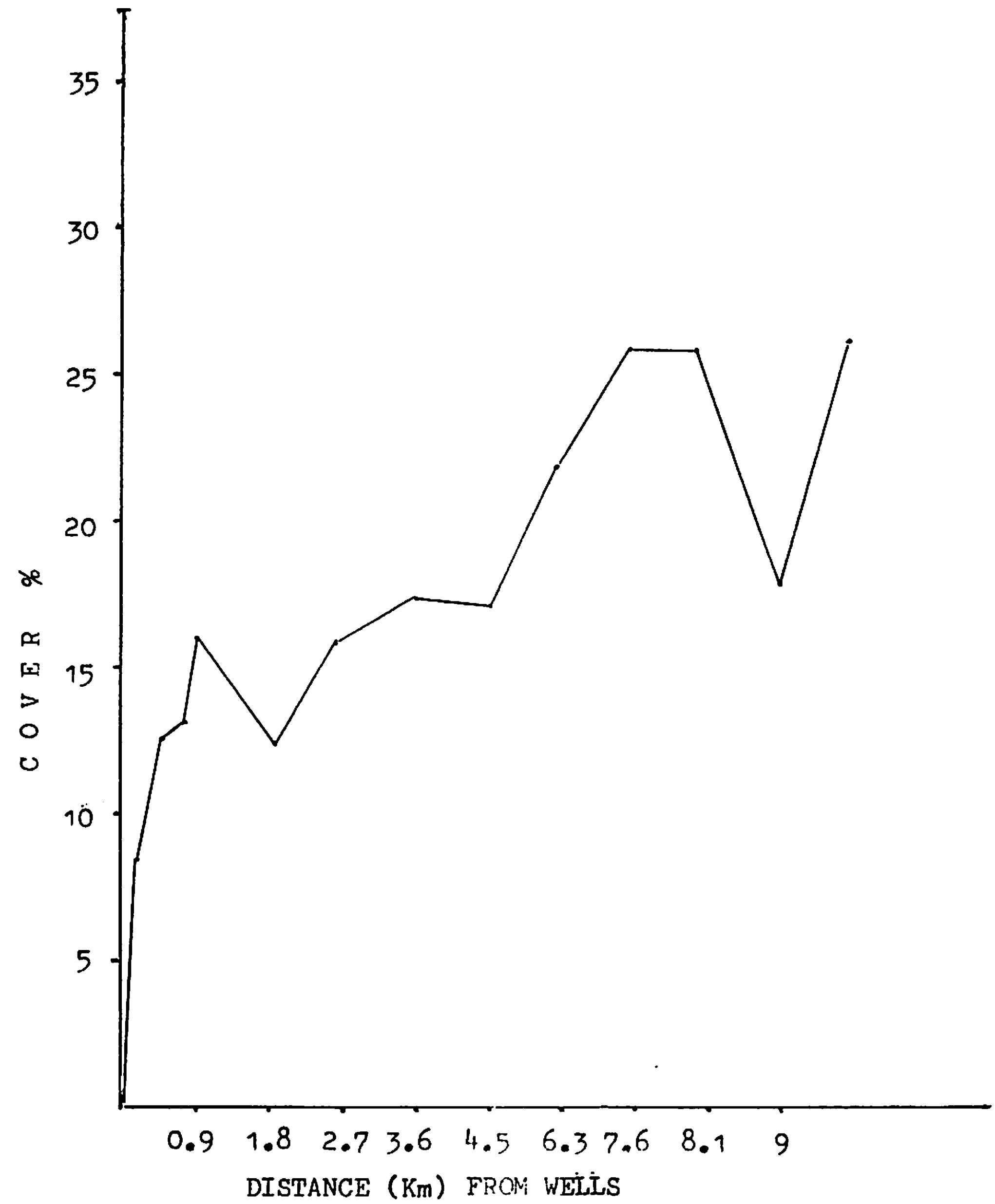


Figure 13. Variation in grass cover along a grazing gradient in coastal plain grassland

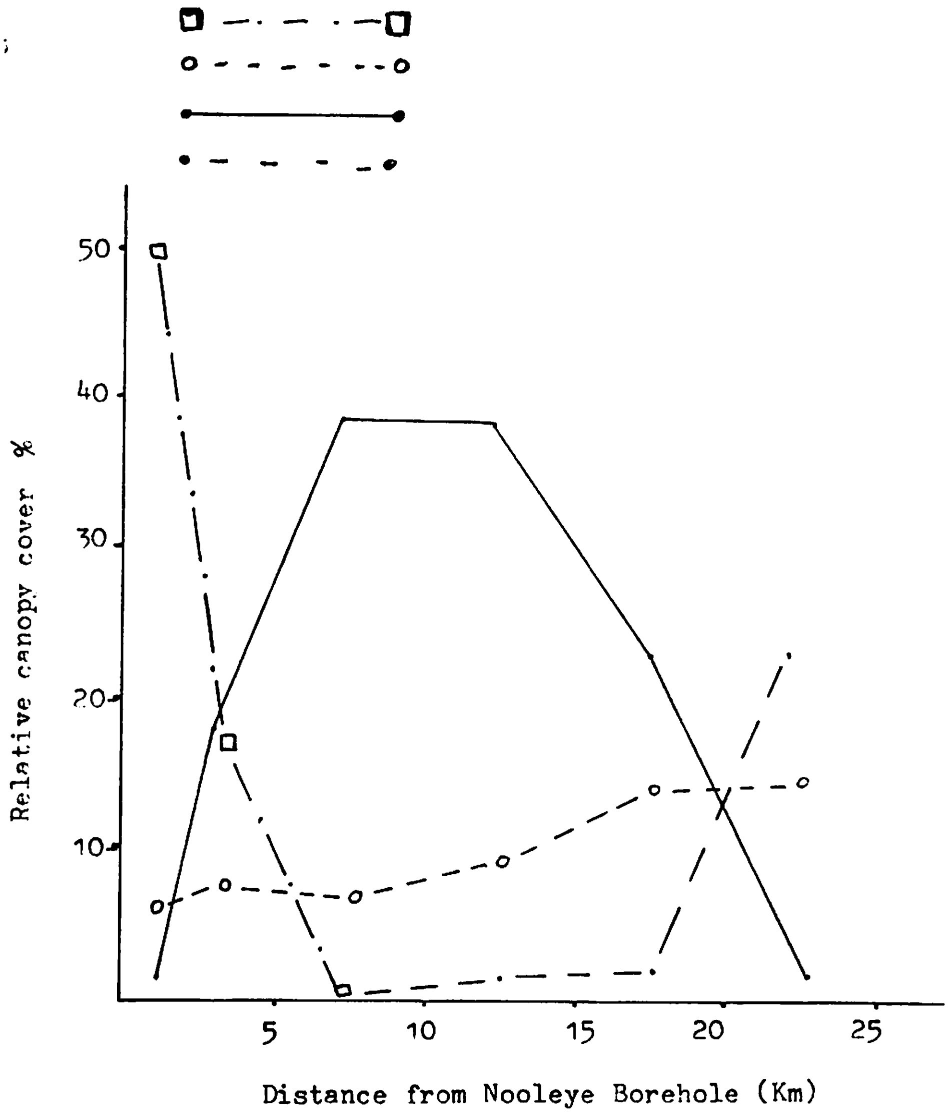


Figure 14. Changes in relative canopy cover of shrub and dwarf shrub. Species with distance from permanent water at Nooleye village, Ceel Dhere District

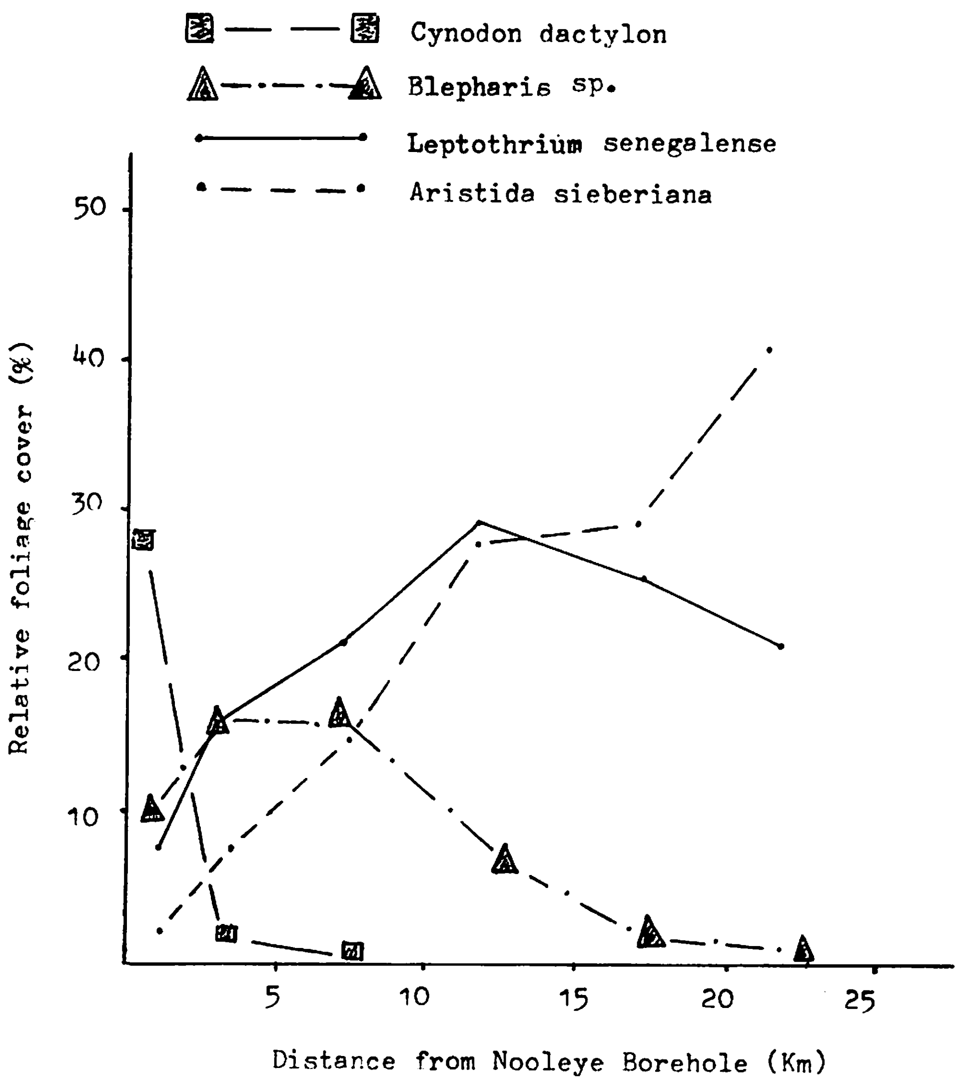


Figure 15. Changes in relative cover of herbaceous species with distance from permanent water at Nooleye village, Ceel Dhere District.

4.3.2 Yicib (*Cordeauxia edulis*)

Data from the inventory of eastern Hiran Region rangelands show the highly valuable evergreen dry season forage shrub yicib to be (a) virtually restricted in its range to the hawd sands (Fig. 16), (b) decreasing in both vigor and abundance (Kuchar et al, 1985).

Vigor, size and abundance of yicib plants are clearly related to distance from permanent water (Fig.16). Yicib stands are rare within 10 km of permanent water. Between 10-20 km there is clear evidence of heavy browsing and a decline in abundance, size and vigor of yicib plants. However, beyond 25 km yicib populations are abundant, large and vigorous and show only slight browsing impact. This pattern of yicib decline is further supported by statements of local pastoralists.

Livestock pressure seems to be more severe on yicib than on other elements of the habitat. Yicib also seems to be less resistant to livestock pressure than the habitat as a whole, which does not seem to be declining as quickly as the yicib population (Kuchar et al, 1985). In addition, even when far from water and not under heavy browse pressure, yicib is often killed by grass fires. Such areas eventually become fire-maintained grasslands which sometimes contain low *Acacia edgeworthii* shrubs (Kuchar 1989). Thus, range conservation and management measures on the hawd range sites should be directed toward preventing further loss of yicib (Kuchar, 1989).

4.3.3 Post-cultivation succession

The data obtained from the study on succession in Ceel Dheer represented 55 years of post-cultivation succession (Herlocker et al, in review). The successional stages described in this study were similar to those demonstrated by the grazing/other use gradient studied on this same range site by Herlocker et al (1988c). This study, however, allowed an estimate to be made of the time taken by the vegetation to attain each stage.

Shrub cover returned to optimal levels in 30-40 years. Herbaceous cover remained relatively constant throughout the 55 year period. However, marked changes occurred in both shrub and herbaceous composition. These indicated three main successional stages for shrubs and four stages for grasses and forbs.

Fast growing shrubs, such as *Solanum jubae*, dominated early succession and slower growing species dominated later succession. *Solanum incanum*, an invader of little value either as forage or wood, was shown to persist in significant quantities for the entire 55 year period. This indicated something of the long term impact on rangeland quality of previous (in this case agricultural) practices.

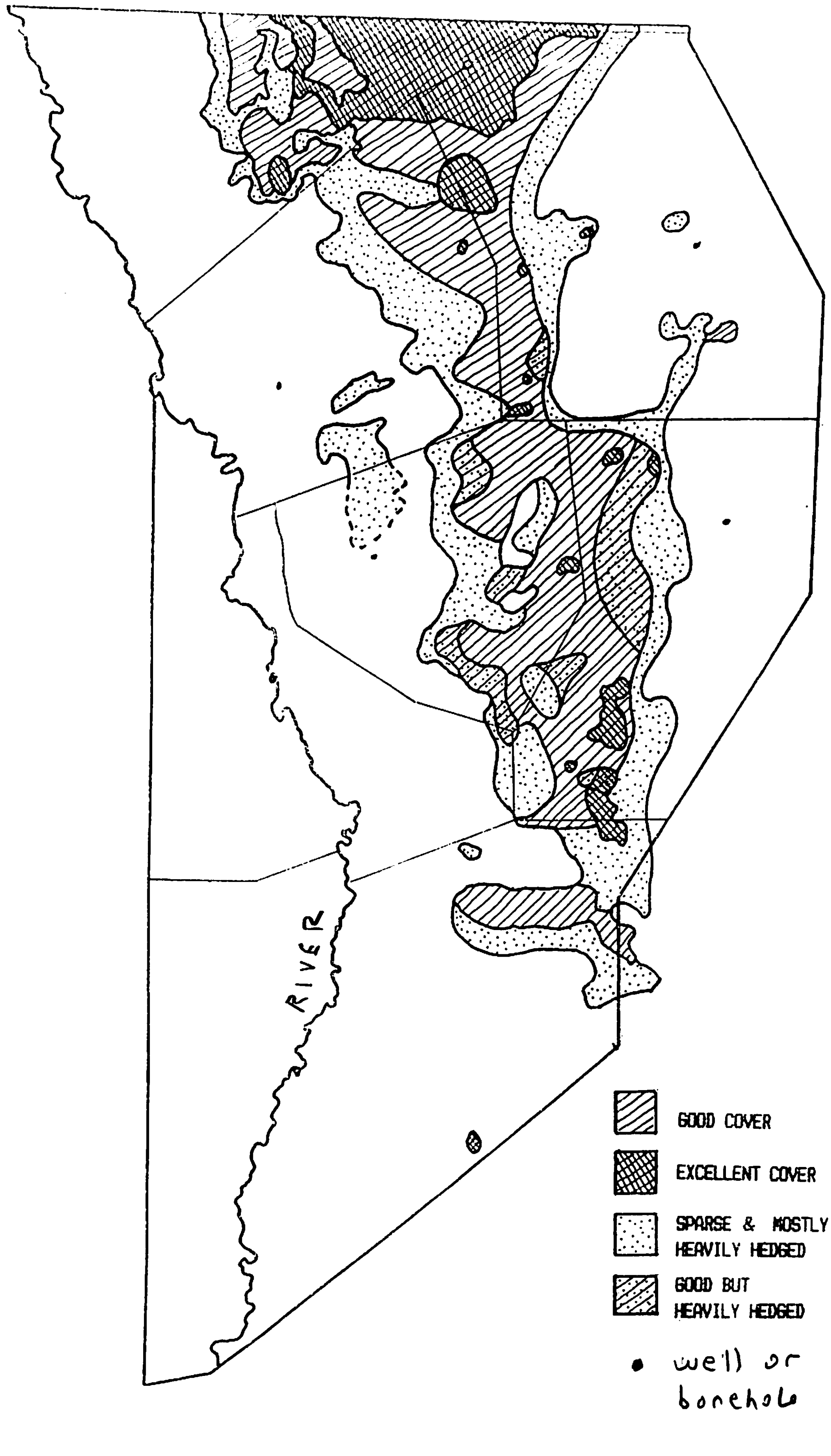


Figure 16. Yicib distribution and status

Woody vegetation would probably have entered the final stage of succession within the 55 year period except for the effect of selective cutting of Acacia reficiens, and A. nilotica, which dominate that stage, and, when these were not available, A. horrida, a dominant of the intermediate stage.

Aristida sieberiana, a perennial grass of low palatability, shown by the range inventory to dominate the herb layer over large areas of rangeland far from water, was a major, early successional, invader which, however, was quickly eradicated by grazing. This species, then, apparently persists elsewhere both because it is a good competitor and because it is only lightly grazed. This again points up the long term effect on rangeland quality by agricultural practices. Forb species were found to be very important in the first two stages of succession, giving ground to perennial grasses afterward. Continuous grazing retarded movement of succession into the final herbaceous stage.

With the exception of the addition of forbs as invaders, indicator species found in grazing gradient studies for this area (Herlocker et al. 1987a; 1988c) were confirmed.

4.3.4 Ecology and dynamics of pastoralist campsites

The coastal plain grassland contains a large number of pastoralist campsites that have been used repeatedly on a seasonal basis probably for hundreds of years. These campsites support significantly different vegetation from that on the surrounding grasslands.

Although comprising only 0.5% of the total area of coastal plain grasslands (Barker et al, in review), campsites provided a very important wet season forage resource. Livestock were seen to seek out these areas as a matter of preference (Thurow et al, in review).

Barker et al (in review) found that campsites were islands of fertility. Soil organic matter, nitrogen, phosphorus and potassium concentrations were significantly greater than on the surrounding grasslands. This reflected frequent inputs of urine and dung from livestock pastured there at night and, also possibly of heavy grazing.

Fast growing, grazing-tolerant, stoloniferous grass species, such as Cynodon dactylon, Dactyloctenium scindicum and Coelachyrum stoloniferum grow well here probably because of a combination of high soil fertility and heavy grazing by stock selecting for highly palatable, nutritious forage.

Thus, it appears that a specific form of land use, tied in this case directly to a subsistence, partly nomadic, way of life, has altered original grassland to the benefit of the users and is being maintained by this form of use. A change in this use pattern - as might occur from placement of more water points and sedenterization - might well negatively alter this system.

4.3.5 Vegetation dynamics in response to sand dune encroachment

Another important factor influencing the dynamics of coastal plain grassland is wind blown sand which may result from either overgrazing or from natural causes (Herlocker and Ahmed, 1986). The effect of sand particles being blown and deposited forward of a slowly advancing sand dune was studied by Barker and Herlocker (in review). Deposition of sand particles increased with increasing proximity to the dune. This was paralleled by an increasing mortality of the original vegetation. Most plant species were killed by relatively low rates of deposition. However, this was then followed by a peak in total vegetative cover, which was caused by the persistence and temporary increase in cover of Cenchrus ciliaris, one of the original bunch grasses, and the active colonization of the newly deposited sand by Cyperus chorrdorhizus, a strongly rhizomatous sedge.

This demonstrates the hardy survival properties of Cenchrus ciliaris, a valuable forage grass which acts here as an increaser under environmental conditions that have eradicated most of the other original species.

Cyperus chorrdorhizus is an obvious invader on newly deposited sands. This explains its frequent occurrence in elongated stands scattered here and there across the plains. These are probably deposits from blow outs caused by fire, roads, overgrazing etc., which have since stabilized. However Cyperus chorrdorhizus appears not to invade areas of active sand removal as often occurs around wells.

4.3.6 Response of degraded vegetation to protection from grazing

Two years (four growing seasons) protection from grazing by a 1 hectare fenced exclosure on coastal plain grassland in mid - fair range condition brought about rapid recovery (Herlocker et al, 1986). There were significant increases in grass and total vegetative basal cover and an improvement in range condition. Compositional changes within the exclosure occurred as expected from previous inspection of grazing gradients extending out from Ceel Dhere Village (Herlocker & Ahmed 1986; Barker et al. in review).

The results indicated a definite potential for recovery of degraded coastal plain grassland vegetation given adequate protection. Assuming a linear rate of recovery - and continued successful rainy seasons - another two years protection would have resulted in mid-good range condition.

Observations on response of vegetation following construction of a walled CRDP office compound at Ceel Dhere Village indicated a similar potential for recovery of even more highly degraded (poor condition) range on the same range site.

The ability to predict compositional changes associated with degradation or recovery of vegetation allows the identification of indicator species for use in rating range condition and monitoring trend.

Finally, it is apparent that, technically speaking, deferred grazing is of potential value in restoring and maintaining range condition and productivity on coastal plain grasslands.

4.4 FORAGE BIOMASS

Naylor and Jama (1984) estimated total and useable shrub and grass forage biomass (net standing crop) in each of the seven range sites comprising Hobbio District (Table 11).

Two estimates of net standing crop biomass of coastal plain grassland in Ceel Dhere District were made by Herlocker et al (1986), one each for the long and short rains growing seasons respectively. In addition, Herlocker et al (1987b) estimated the available palatable biomass of shrub forage of a single shrubland range site within the district (Table 11, figure 17). Wieland (1987b, c) estimated potential forage production for two degaans in Hobbio District by modifying the estimates of Naylor and Jama (1984) with those obtained from use of the rainfall - forage productivity relationship published by Lamprey (1983).

Forage biomass of Yicib (Cordeauxia edulis) was estimated for the Haud range site in Hiran Region where this valuable evergreen species primarily occurs (Kuchar et al, 1985). Kuchar (1987), also estimated the biomass of available dry season forage for the 12,500 km² of eastern Hiran Region (Table 11). Dry season forage was divided into deciduous green leaf, Yicib leaf, perennial grass and leaf litter components. Allowable dry season stocking rates were calculated from this information.

Total forage biomass ranged from 925 to 2600 kg/ha of which 50-60% (or 25% in the case of evergreen shrubs), depending on the survey, was useable (accessible, palatable and allowable) (Table 11). Two partial estimates of 200 kg/ha (for useable shrub forage only in Ceel Dhere District) and 1190 kg/ha (for Yicib shrub forage only in Bulo Burte District) and an estimate of dry season forage biomass (530 kg/ha) in eastern Hiran Region were also made. These estimates were made over a range of physiognomic vegetation types from grassland to bushland (Table 12).

Table 11: Forage biomass estimates made within the study area.

Range site No.	Forage biomass (kg/ha) Shrub	Grass	Total	Useable*
1	540	465	1005	502
2	700	450	1250	625
3	365	560	925	462
4	1900	700	2600	1300
5 (A)	1100	900	2000	1000
(B)	400	1100	1500	900
6		1260	1260	630
7	150	850	1000	500
10 ~~8~~		2600	2600	1300
16 ~~9~~	200**		---	200**
38 ~~10~~	1190**		---	595**
28 ~~11~~	530***		---	300**

* Based on 50-60% or annual productivity, depending on the sample, except in the case of dry season forage where 25% of annual growth or evergreen leaves was allowed.

** Partial biomass only

*** Dry season biomass only

Table 12: Percentage total forage biomass comprised by shrub and grass components in relation to range site physiognomic vegetation class.

Range site no.	% Total forage biomass (Shrub)	(Grass)	Physiognomic Class
1	54	46	Shrub grassland
2	~~96~~ 69	31	Shrub grassland
3	40	60	Shrub grassland
4	73	27	Shrubland
5	55	45	Bushland
6	--	100	Grassland
7	15	85	Dwarf shrub grassland

There is a clear relationship between physiognomic vegetation type and the relative contribution of shrub and grass components to total forage biomass (~~Fig. 11~~ Table 12). Such a relationship would be expected as it is the major criterion for defining physiognomic vegetation types (Pratt and Gwynne, 1977). ~~However, there is no apparent relationship between physiognomic vegetation type and useable forage biomass (Fig. 12).~~

Rainfall was not monitored during the time that forage biomass estimates were made. However, there is a noticeable relationship between useable forage biomass and average annual rainfall as obtained from RMR (1979) (Fig. 17). This shows a higher rate of forage biomass availability per unit of rainfall than does the rainfall - biomass relationship of Lamprey (1983) as quoted in Wieland (1987b,c). However, there is a close correspondence with the rainfall - biomass relationship of Deshmukh (1984).

4.4.1 Stocking rates

Allowable stocking rates were calculated from the three regressions of useable forage biomass on annual rainfall (Fig. 17) using the standard daily forage dry matter intake requirement of 2.5% of an animal's body weight (Table 13).

Figure 17. Relationship between useable forage biomas and mean annual rainfall (project estimates) and the present years rainfall as derived from the predictive equations at Deshmukh (1984) and Lamprey (1983)

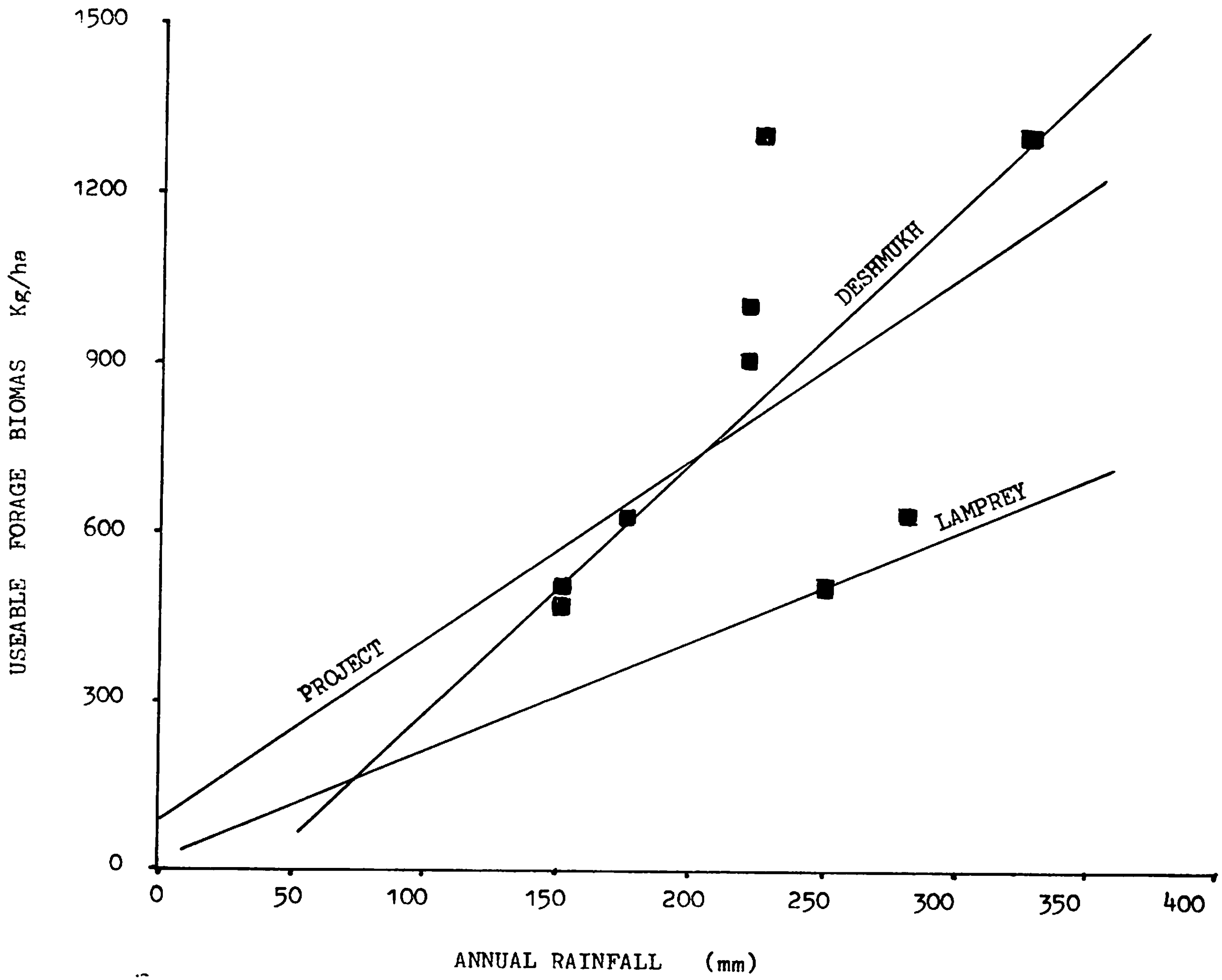


Table 13: Useable forage biomass and allowable and actual stocking rates in relation to annual rainfall.

Annual rainfall (mm)	Useable forage biomass (kg/ha) Project	Deshmukh (1984)	Lamprey (1983)	Allowable stocking rate (Ha/TLU)* Project	Deshmukh (1984)	Lamprey (1983)	Actual stocking rate(Ha/TLU) RMR 1979	MFLR 1987/1988
150	400	500	300	5.1	4.6	7.6	20.2	10.1
200	720	720	400	3.2	3.2	5.7	9.8	4.9
250	890	970	500	2.6	2.3	4.5	8.5	4.2
300	1050	1160	600	2.1	1.1	3.7	5.8	2.9

* TLU = Tropical Livestock Unit = 250 kg = 1 Cow = 0.8 Camel = 8 Sheep/Goats.

Actual stocking rates were obtained from RMR (1979) and MLFR (1987/1988) (Table 13). In the former case wet and dry season livestock biomass values were averaged for 4-9 land units occurring along each of the four major rainfall isohyths mapped for the Central Rangelands by RMR (1979). In the latter case a single mean stocking rate for all stock within the Central Rangelands was calculated for both RMR (1979) and MLFR (1987/1988). The % difference was then applied equally to each of the four original isohyth-based RMR (1979) stocking rate values.

Livestock numbers were also available from a ground census carried out over a number of years by the Non Formal Education/Extension Component. This information was not used because of doubts about its accuracy (Mascott, 1986).

Estimates of allowable stocking rates based on the forage biomass - annual rainfall relationships determined by the project and by Deshmukh (1984) were very similar (5.1/4.6 ha/TLU @150 mm annual rainfall) to 2.2-1.3 Ha/TLU at 300 mm/year (Table 13; Fig. 18). Allowable stocking rates were higher than those estimated by the relationship of Lamprey (1983) (7.6-3.7 Ha/TLU @ 150-300 mm/yr respectively). Actual stocking rates ranged from fairly low (20.2-5.8 Ha/TLU @ 150-300 mm respectively) for RMR (1979) to 10.1-2.9 Ha/TLU for MLFR (1987/1988) (Table 13; Fig.18).

A comparison of RMR (1979) actual stocking rates with all three estimates of allowable stocking rates implies that stocking rates could safely be increased somewhat throughout the range of annual rainfall. However, under rainfall exceeding 200mm/yr actual stocking rates (MLFR, 1987/1988) slightly exceed allowable stocking rates estimated by Lamprey's (1983) relationship (Fig. 18).

Thus, it would appear that the Central Rangelands is either clearly understocked, which implies large areas of lightly - moderately used fair-good condition rangeland, or (at least in those areas receiving ~~200~~ 150mm mm rainfall per year or more) is fully to slightly overstocked, which implies large areas of moderately to heavily used rangeland in fair to poor condition.

4.4.2 Dry season forage biomass

An estimate of possibly more practical significance is that made by Kuchar (1987) of dry season forage biomass for eastern Hiran Region. Accessible dry season forage totalled 300 kg/ha and consisted primarily of evergreen shrub leaves (mostly *Cordeauxia edulis*), dry perennial grass, and leaf litter.

The quantity and quality of available dry season forage is extremely important because it is the principal factor limiting year round stocking rates. In this case, there was sufficient dry

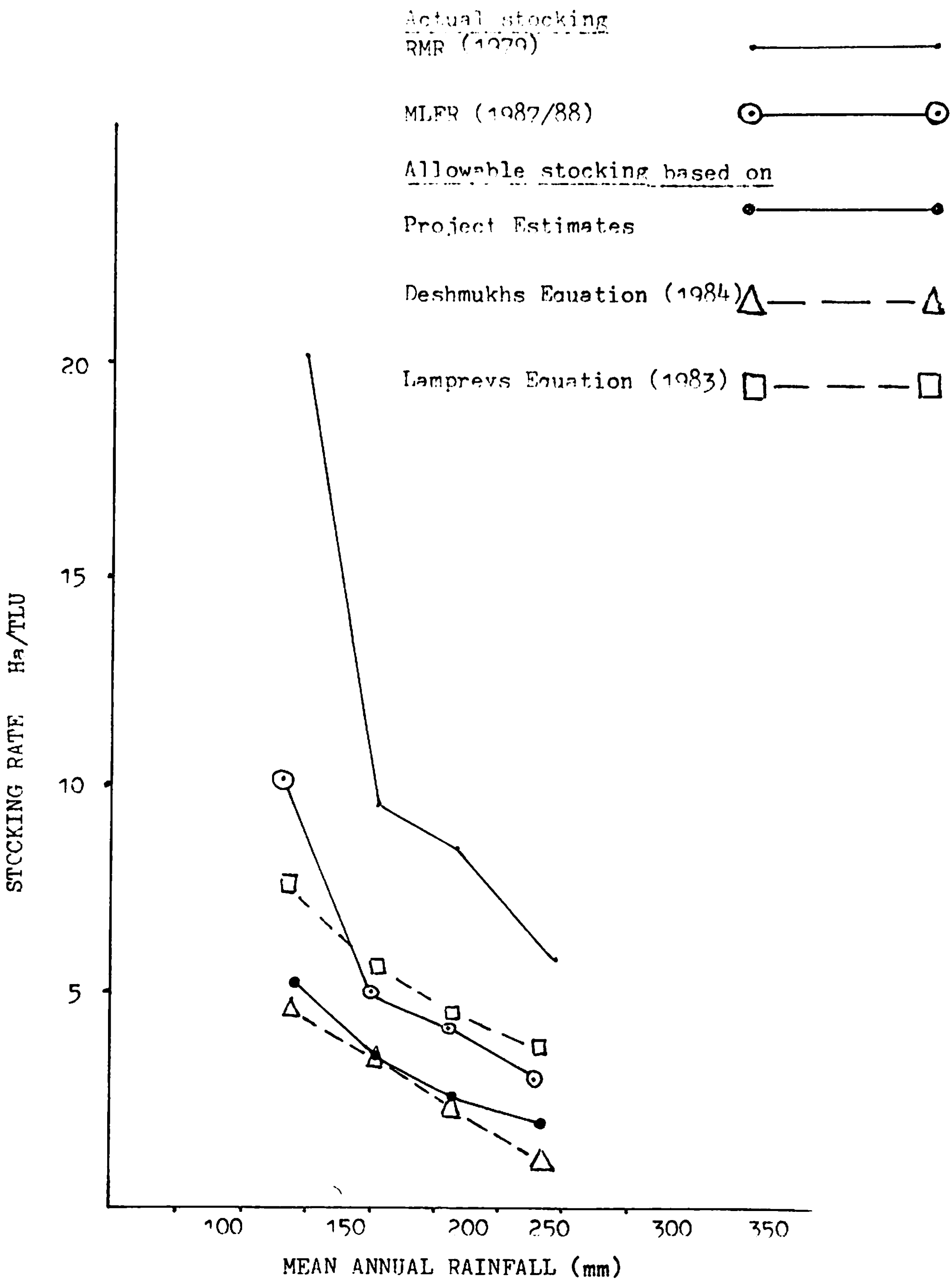


Figure 18. Allowable and actual stocking rate estimates

season forage to maintain present stocking rates plus an additional 200,000 animals over a 2-3 month dry period within this 12,500 km^2 area. Kuchar points out that the value of such estimates could be greatly improved by a knowledge of seasonal dynamics and nutrient value of litter and the feeding habits of livestock in the dry season with special reference to leaf litter and evergreen leaves.

4.5 FORAGE QUALITY

4.5.1 Palatability

Palatability ratings were obtained for 299 plant species from Ceel Dhere and Bulo Burte Districts by Herlocker and Kuchar (1985). An updated, more comprehensive list is presently being prepared for Hiran and Galgaduud Regions by Kuchar and Herlocker. This will include a minimum of 2,600 palatability ratings and 600 additional use observations, and takes in all significant range species of these two regions.

A significant amount of vegetative cover (25-30%) is of low palatability or is unpalatable. However, only a very few species exist (such as Uvaria denhardtiana in Ceel Dhere District) that are considered to be poisonous and these comprise minor amounts of cover (Herlocker and Ahmed, 1985; Herlocker et al. 1988b).

4.5.1.1 Palatability Relative to type of Livestock

A wider array of plant species and % total vegetative cover is palatable (or better) to browsers than to grazers. This is shown by a minimum of 20% and 47% of all woody cover being of low palatability to browsers and grazers respectively whereas a minimum of 18% of all herbaceous cover was of low palatability (or worse) to all stock (Herlocker et al, 1988b). Thus, the Central Rangelands (excluding the coastal plain) is probably better suited to browsers than grazers.

Minimum values are used here because a significant number of plant species were not rated for palatability - especially forb species. This of course affects subsequent estimates of the % of total cover comprised by plants of low palatability. Percentage of total cover is used here as an index of the % total forage biomass for which no useable values exist for most plant species.

4.5.1.2 Palatability Relative to range site

The amount of vegetative cover that was of low palatability or was unpalatable varied between range sites. Thus, for browsers in Ceel Dhere District, there was a range from 5-34% (minimal values) of woody cover and 1-68% of herbaceous cover that was of low palatability or worse to browsers and from 5-76% and 1-58% of woody and herbaceous cover respectively for grazers (Herlocker et al. 1988b).

4.5.1.3 Contribution by individual species

Individual plant species sometimes comprised a major proportion of low quality forage, and even a relatively large % of all woody or herbaceous cover, of a range site. For instance, on one range site in Ceel Dhere District, *Aristida sieberiana*, a perennial grass of low palatability, comprised 28.5% of all herbaceous cover whereas on another range site, *Commiphora incisa*, a shrub of low palatability, comprised 8.4% of all woody vegetative cover (Herlocker et al, 1988b).

4.5.1.4 Contribution by invader species

Where shifting agriculture is common, a significant % of the less palatable vegetative cover reflects low quality invaders that have established themselves on abandoned cultivation (Herlocker and Ahmed 1985; Herlocker, et al 1987a, 1988c, in review). For instance, in Ceel Dhere District, the shrub *Solanum jubae* and the perennial grass *Aristida sieberiana*, both of low palatability, establish early in the post-cultivation succession and persist for at least 50-60 years. *Aristida sieberiana*, however, is interestingly enough, both low in palatability and intolerant of grazing. Thus, it is eventually removed by continuous heavy use by livestock.

In contrast to agropastoral shrublands, early successional plant species of coastal plain grasslands are often preferred forage and are often maintained by continuous grazing and manuring (see section on dietary preference).

4.5.1.5 Seasons of use

In general, palatable and highly palatable ratings were usually given as wet season ratings as that is when most plants are in leaf and foliage and recently grown twigs are most tender and nutritious. However, some species were rated by pastoralists as being palatable (or better) in the dry season rather than in the wet season. Such species were then usually considered to be of low palatability in general as they are only eaten in the dry season when there is little other forage available.

It is apparent from this that being of low palatability does not necessarily remove a plant from the forage resource. Some species are both low in palatability and highly nutritious.

4.5.2 Evergreen shrubs

Evergreen shrubs (Capparids, Balanites, Cordeauxia etc) are good examples of less palatable plants that are yet heavily utilized in the dry season. The nutritive value of such plants can be high; some evergreen Capparids, for instance, have a very high leaf nitrogen content; mean leaf crude protein of 11 species of the genera Boscia, Cadaba and Maerua was 20.3% and reached highs of 35.8% (Kuchar, 1987). Leaf crude protein of some Capparids is consistently high year round (Mackay and Frandsen quoted by Kuchar, 1987), although actual feed value might be lower than expected because high tannin content may lower palatability, protein utilization and digestibility (Mc Dowell, 1984 quoted by Kuchar, 1987).

4.5.3 Dietary preferences

A study carried out on coastal plain grassland (Thurow et al, in review) demonstrated forage preferences to be largely similar between cattle, sheep, goats, Spekes gazelle and camels but especially among the former four species. During the wet season all stock (and Spekes gazelle) preferred species with rapid stoloniferous growth (Cyperus chorrdorhizus, Cynodon dactylon, Dactyloctenium scindicum and Coelachyrum stoloniferum. These species were invaders forming lawn-like sod on abandoned nomadic hut sites or on areas of recent sand deposition near sand dunes. Such sites were sought out by livestock, probably because of the high nutrient content of the forage (Barker et al, in review).

In the dry season, shifts in preference occurred with camels turning to the dwarf shrub Indigofera intricata and other stock to perennial grass "decreaser" species such as Heteropogon contortus, Afrotrichloris martinii, Digitaria nodosa, Enneapogon schimperianus and Panicum pinnifolium. Again, this was probably done to keep the intake of nutritious forage to a maximum.

Both classes of vegetation are well represented on the coastal plain so dietary shifts were not prompted by habitat shifts. The relatively low diversity of camel diet indicated camels not to be as adapted to grasslands as were the other species. This is why camels are only used as pack animals here and are kept in low numbers.

4.5.4 Salt grazing

Where natural salt licks are lacking, as is the case throughout most of the Central Rangelands, the utilization of salt bearing plants at certain times of the year is very necessary. These types of plants are usually relatively low, evergreen, succulent and grow on saline soils. Wieland (1987b) reports that salt bearing plants are preferred grazing in Hobbio District in the late dry season. This is said to invigorate stock after long dry periods.

Chenopod salt bushes, such as Suaeda micromera, often have relatively high amounts of Na, K and chloride salts, which may increase livestock water requirements (Leigh, quoted in Kuchar, 1987). However, Limonium axillare, another succulent salt bush, which occurs over large areas of western Jalalaksi District, is a highly rated forage (Kuchar, 1987).

4.6 RANGE CONDITION

Range condition is the health/productivity of a rangeland compared to its potential. Rangeland in poor condition is unhealthy, produces less forage, supports fewer livestock and is more prone to erosion than rangeland in good condition. Therefore, it is very important that a range manager know the condition of the range under his jurisdiction.

Most of the rangelands surveyed by the project were in fair condition. (%) (Fig. 19, Table 14). Most of these were in low-fair condition - a large % in Hobbio District verging on poor although this may have been caused by an extended drought prior to and during the time of survey (Naylor and Jama, 1984). However, there were also significant amounts of good (%), poor (%) and very poor (%) condition rangeland (Table 14). Hobbio District, Mudug Region, had the greatest amount of fair condition rangeland whereas the Hiran Region study area contained most of the poor as well as the good condition rangeland (Fig. 19).

Table 14: Percentage of the total survey area in different range condition classes

	Range condition class				
Region	G	G/F	F	P	VP
Mudug (Hobbio)	15.3		76.2	1.6	6.9
Galgaduud	4.7	8.2	52.1	17.4	17.5
Hiran	16.1		60.4	22.2	1.4
mean	12.1	2.8	62.8	13.5	8.7

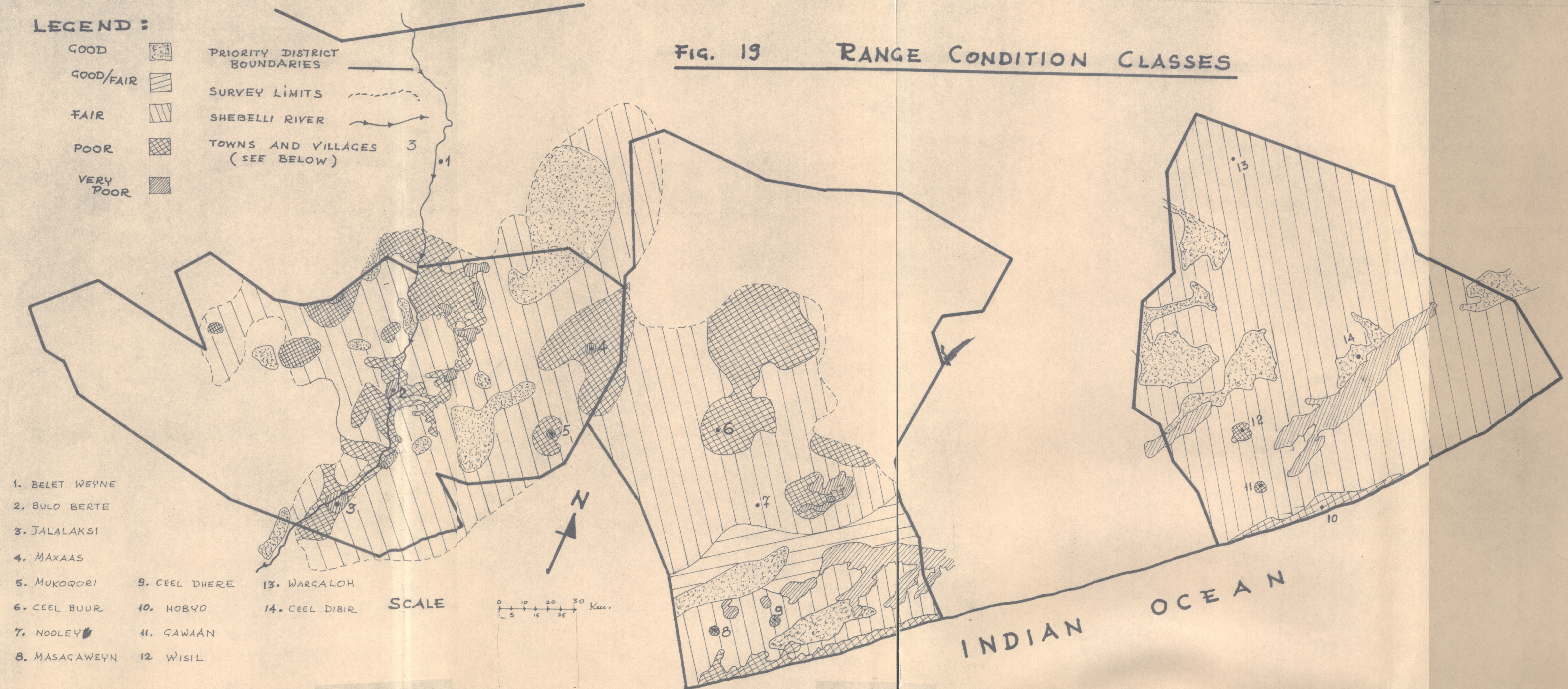


FIG. 19 RANGE CONDITION CLASSES

4.6.1 Good condition

Good condition rangelands were usually far from water (most commonly beyond 25 km) although the actual distance varied depending on, among other things, the age and productivity of the nearest permanent water source.

Areas of dense bush that support seasonal outbreaks of biting flies, known in Somali as "Ribi", were also in good condition. Use of such areas during fly outbreaks in the wet season, is unwise because of the disease factor or simple irritation from fly bites. Hence, these areas receive growing season rest from use. Most of the good condition rangeland in Ceel Dhere District is both far from water and Ribi fly habitat (Fig. 19).

Some salt bush rangelands are in good condition because they are only used briefly for short periods of time as a source of salt for stock. Such rangelands are especially common in Hobbio District where they comprise all of the good condition rangeland (Fig. 19).

Good condition rangelands may also occur on specific kinds of soils that, because of high fertility or moisture availability, compensate for moderate levels of grazing by supporting especially vigorous and productive vegetation.

4.6.2 Fair condition

Fair condition rangeland is the most widespread condition class within the survey (Fig. 19).

4.6.3 Poor condition

Poor range condition rangelands occur in a number of situations. A narrow strip of poor condition rangeland occurs along the coast. This is probably caused by seasonally high winds blowing sand inland from coastal beaches with the overall effect on vegetation and soils excaberated by the impact of livestock concentrated on numerous small wells immediately behind the beaches.

Range condition is usually poor within a few km of major villages and towns where permanent sources of water are near and grazing, browsing, shrub cutting and sometimes farming are abundant.

Rangelands on alluvial soils of the Shebelli Valley tend to be in poor condition both because they are often close to watering points along the Shebelli River and because of the large amount of relatively low quality early successional vegetation invading fallowed fields.

Shallow sands over limestone in eastern Bulo Burte District support poor range condition rangeland because of the shallowness of the soil, which decreases its ecological potential, and increases the impact of erosion, and because the area is relatively well watered by wells that are often of great age.

Rangelands on gypsic/saline soils in Ceel Bur District are in poor condition because of proximity to permanent water sources of some antiquity and of the relatively large amount of evergreen shrubs that attract and support year round use by much of the Districts' camel population (Fig. 19).

4.6.4 Very poor condition

Very poor range condition occurs in the immediate vicinity of villages and towns, on some alluvial slopes and pediments of the escarpment in eastern Hiran Region (especially where these are farmed), on the alluvial plain of the Shebelli River and on sand dunes and dune fields, which occur mostly in Ceel Dhere and Hobbio Districts (Fig. 19).

The very poor range condition rating given to dunes and dune fields reflects their present barreness -- but at the same time their potential for supporting vegetation should they ever be stabilized - rather than the effect of improper use of the surrounding rangeland.

Thus, it can be seen from Fig. 19 that, whereas the entire Central Rangelands is subject to utilization by livestock and is probably generally fully to somewhat overstocked - this is not uniform throughout but shows significant variation that reflects the history, type, intensity and timing of use.

If we exclude the large dune fields in Ceel Dhere and Hobbio Districts, which probably do not reflect the immediate effects of improper land use, Hiran Region contains the largest area of degraded rangeland. This is certainly plausible because of the relative availability of permanent water from the Shebelli River, which flows through the center of the region (and numerous shallow wells in eastern Bulo Burte District); abundance of cropping on alluvial soils; high human and livestock populations, large villages and towns and very probably, a longer history of settlement and possibly even pastoralism. Galgaduud and Mudug Regions have fewer of these attributes and are, therefore, less degraded by land use practices.

Interestingly enough Hiran Region also has the largest amount of good condition rangeland of the three Regions. This occurs because there is too little permanent water in the area concerned to support high livestock densities for more than a short time.

For the most part there is a fair degree of resilience in all range sites and degraded (poor and very poor) rangeland is capable of vigorous recovery given a few normal rainy seasons and adequate protection from use. At least this is true for rangelands on moderate to deep sands as shown by Kuchar et al (1985) and Herlocker et al (1986). Even sand dunes and dune fields are capable of supporting rangeland vegetation if they can be stabilized. This has been shown occasionally where sand dunes and small parts of some dune fields have been stabilized and the natural vegetation has been given the opportunity to establish. However, the sheer size of the dune fields makes it unlikely that stabilization will occur in the near future if ever.

Similarly, some of the most highly degraded areas, such as some slope and pediment sites below the escarpment in Bulo Burte District, would require such costly program of intensive planting and protection as to make their a potential recovery fairly uncertain (Kuchar et al. 1985).

4.6.5 Erosion and erosion hazard

The entire Central Rangelands is susceptible to erosion once the vegetative cover has been removed. Wind is probably the most widespread erosive factor although erosion by water is also locally serious, especially where soils tend to be compact and inclined. In both cases shallow soils are most endangered because of the greater chance of erosion becoming irreversible.

A 300 km^2 area between Wisil and Gawaan in Hobbio District contains active erosion gullies so deep, numerous and long that they will probably be impossible to control (Fig. 20). The productive area has been reduced by half but, due to the active recolonization of gullies by surrounding vegetation, will probably never completely become bare and unproductive (Naylor and Jama, 1984). These erosion gullies may have originated under completely natural circumstances (Wieland 1987). Naylor and Jama (1984) recommend normal range management procedures for restoring range condition but Wieland (1987) cautions that grasslands near the edge of the Gawaan plateau should not be grazed too heavily lest gully erosion encroach inward onto the top of the plateau.

An area in the lee (east) of the large dune field in Ceel Dhere District (Fig. 20), has numerous, deep, steep sided gullies undergoing accelerated erosion. This is an area far from water that is otherwise in good range condition with vigorous, productive, quality grasses and sustains only light utilization. Thus, erosion has probably been initiated by natural processes within the area or by man-induced processes outside the area and has subsequently worked its way in. The soils are compacted silty sands and easily erodible. This area should receive no development activities of any kind for fear of increasing the rate of existing erosion (Herlocker et al. 1987b).

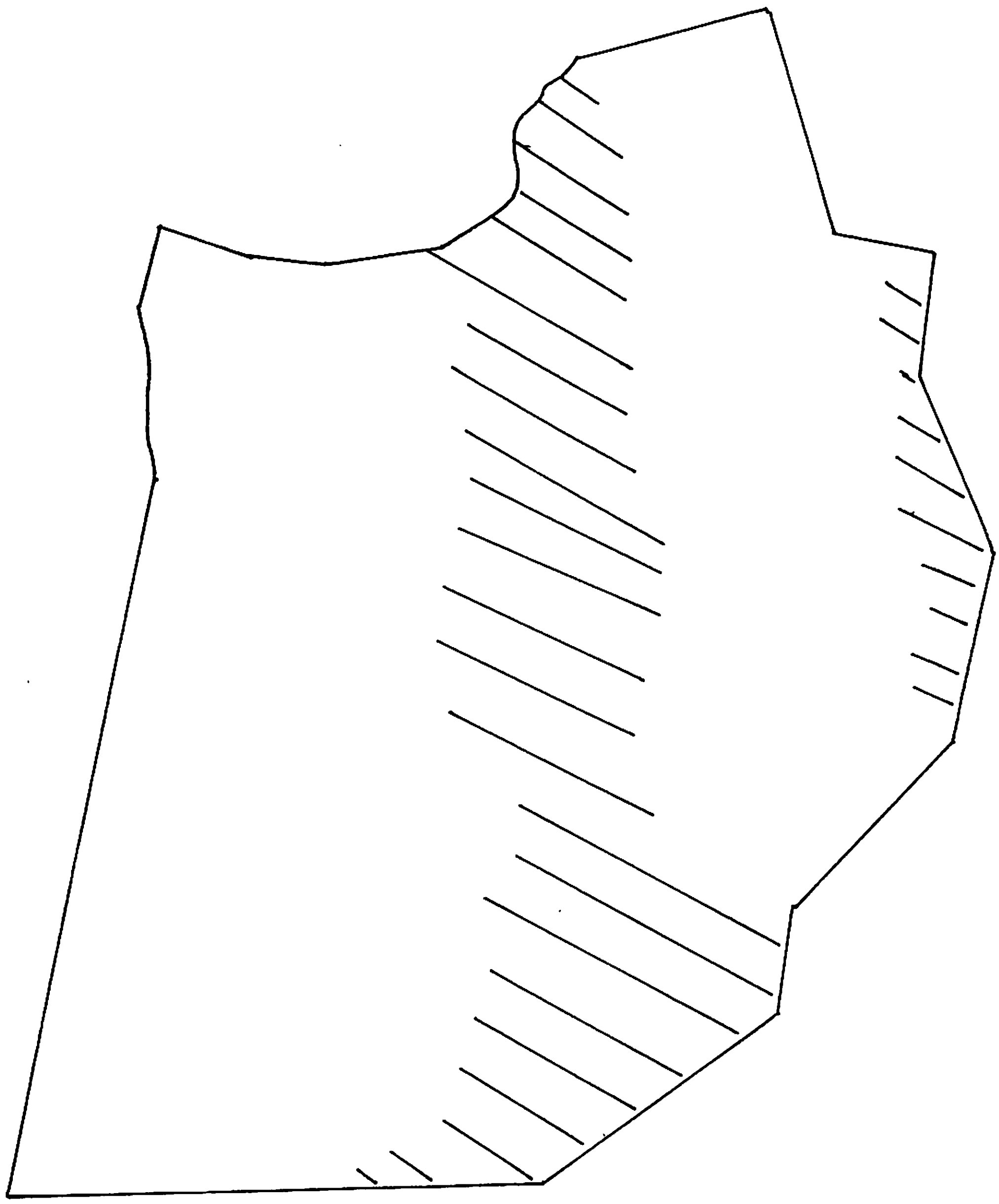


Figure 20a. Map of Soil erosion and erosion hazard, Hiran Region.

Figure 20b. Map of Soil erosion and erosion hazard. Galgaduud Region

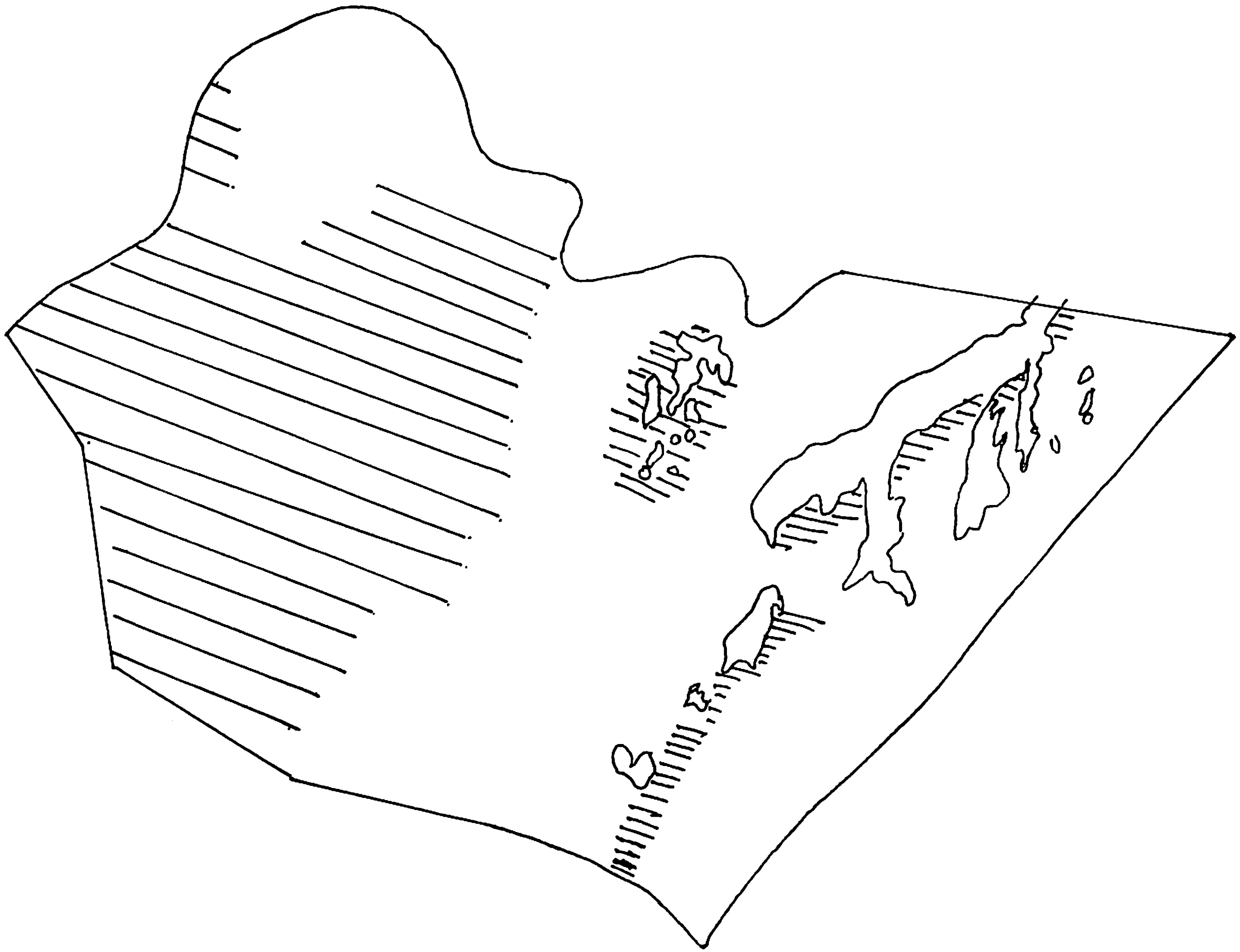
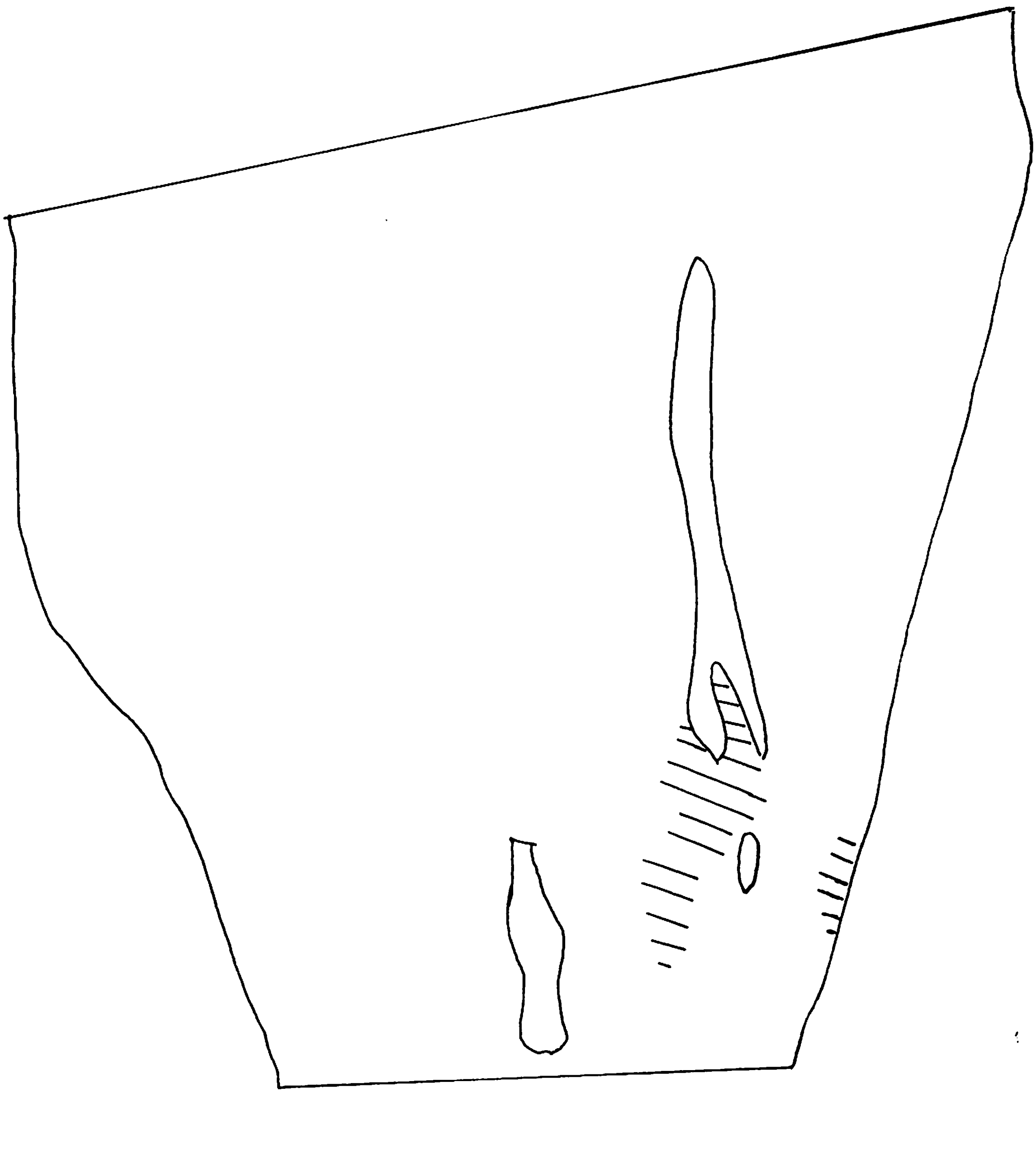


Figure 20c. Map of Soil erosion and erosion hazard, Mudug Region
(Hobbio District)



On the alluvial plain of the Shebelli River water erosion - the result of a long history of settlement and cultivation is confined to major gullies and areas within 100 meters of the river (Kuchar 1989b).

However, the most serious water erosion problems appear to be on the pediments and foot slopes of the sandsone escarpment and in the silt valleys of the limestone hills complex east of the Shebelli River. As a result of a complex history of land use considerable flow of water off the escarpment and limestone hills causes gullying. Some areas are now so badly eroded as to resemble badlands and are probably beyond hope of rehabilitation. However, the silt valleys as a whole are of high productive potential and worth rehabilitating (Kuchar 1989b).

The most visible evidences of wind erosion are sand dunes, many of those in the Central Rangelands are probably natural in origin being beach sands blown inland by high winds. However, many others have been caused by intensive cultivation, shrub cutting and overgrazing, often near villages with major water sources. Some dunes have formed only in the last decade but others are known to have originated up to 200 years ago (Holt 1985; Wieland 1987). There is a danger that the whole fore dune zone in southern Hiran may be near the threshold of destabilization due to increased pressures of utilization (Kuchar 1989). Wind erosion sometimes causes "blowouts" or areas from which soil is transported by wind. These are relatively common in coastal plain grasslands.

Deflation crusts/surfaces are produced by wind removing fine soil particles from a stony soil leaving only stones/pebbles at the surface. Deflation surfaces occur locally on the alluvial plain of the Shebelli River (Kuchar 1989b) and west of Ceel Bur on shallow sands over limestones (Herlocker et al, 1988a) (Fig. 20). Both are the result of cultivation and overgrazing and have seriously impaired the potential productivity of the land.

Large areas of unvegetated dune fields occur throughout Ceel Dhere, Haradhere and Hobbio districts (Fig. 20). The degree of their mobility is not known but probably varies from place to place. Estimates of from nil to 200 meters per year have been made by Herlocker et al (1988b), RMR (1979), Naylor and Jama (1984) and Wieland (1987b), respectively, for different locations and times.

These dunes and dune fields, for the most part, probably do not reflect overuse and degredation of the surrounding rangelands but instead hundreds of years of slow accumulation of sand blown from the beaches across the caostal plain. However, poor land use in their immediate vicinity will certainly induce their expansion whether this be by cultivation along their forward perimeter or overgrazing of grasslands to their rear.

The dune fields are generally oriented SW-NE and the major direction of movement appears to be along this axis. Thus, the most danger to roads, villages, wells etc. occurs along the relatively narrow leading edges rather than along their much longer sides. These are the most difficult parts of the dune fields to stabilize because the ultimate source areas of sand are up to 90 or more km away to the south west beyond the other end of the dune field. Stabilization measures carried out at the forward tip of a dune field will eventually be overwhelmed by the mass of sand moving up from the southwest.

The stabilization of such huge areas appears to be impractical because of the tremendous cost, man power and time required. It is worth, however, attempting to stabilize small parts of the south western (source) end of these dune fields through simple protection from use. Two relatively small, isolated dune systems in Ceel Dhere District could be used for such as trial. Success might enable a slow step by step stabilization effort to move from southwest to northwest along the dune field axis.

However, in their present unvegetated state, dune fields may provide a very useful services to the surrounding rangelands by acting as efficient sumps which allow rain fall to infiltrate quickly into the soil with a minimum of evaporation or uptake by plants. This would add significantly to the local ground water table which is tapped by boreholes and wells.

4.7 RANGE TREND

4.7.1 "Low precision" permanent trend monitoring plots

Sample plots established during range survey were used as "low precision" trend monitoring plots. The observations and measurements taken on these plots constitute the first of a series of re-measurements and/or observations to be repeated on the same plots at 3-5 year intervals. 1,200 such plots were established in Hiran Region (1 plot per 15 km^2); 502 plots in Galgaduud Region (1 plot per 22 km^2); and 247 plots over half of Hobbio District (1 plot per 48 km^2). Written descriptions of plot locations are given in Wieland et al. (1987) for Hobbio District. Hiran Region plots are located on a 1:250,000 map whereas the actual data is presented in Kuchar (1989c) but is also recorded on computer diskette. Galgaduud Region plots are on a 1:250,000 map and the data are on field sheets.

As indicated in the section on range inventory, the type of measurements and observations made on these sample/monitoring plots differed between regions and, in Galgaduud Region, between districts. This makes it hard to carry out close comparisons of these measurements/observations between regions. However, should the types of measurements/observations be the same as were initially made on each plot then the resultant trend patterns are easily comparable across all plots regardless of location or types of observations/measurements.

Forty "low precision" trend monitoring plots were resampled in Hiran Region as a training measure for counterpart officers. The results showed that further training and experience was necessary before a full resampling of existing trend plots could be carried out by counterpart staff. Therefore, as yet, no documented information on range trend exists from low precision trend monitoring plots.

4.7.2 "High precision" permanent range trend monitoring plots

Forty eight "high precision" trend monitoring plots were established in Hobbio District, eight by Naylor and Jama prior to 1985 and, following that, the remainder by Wieland (1987a). Two plots were established by Herlocker (1988b). Written descriptions of plot locations are given in Wieland et al (1987) and Herlocker (1988b). The small number of completed "high precision" trend plots reflects the care with which they must be established.

Wieland et al attempted to relocate Naylor and Jamas' plots so that they could be resampled and a trend (if any) established. None of the plots could be relocated with any degree of certainty. This points out the difficulty in establishing permanent sample plots in an essentially featureless terrain so that they may both be precisely relocated while not at the same time being so obvious to the eye that they provide temptation to vandals.

Eighteen of the plots of Wieland et al (1987d) were resampled 6 months after establishment. This was too early to detect a trend but demonstrated that the plots were, in fact, possible to relocate.

Herlocker (1988b) relocated one of the two plots established in Ceel Dhere District a few days following its establishment to determine the reliability of the data obtained from this method. The result was a difference in basal cover % of 1.1% or a relative difference of 15% between the two readings. Herlocker et al (1986) demonstrated an improvement in basal cover of 0.6% by the same grassland (in mid-fair condition) over 2 years of protection from grazing. Therefore, the rate of trend would have to continue for about 6 years before it could be demonstrated by the data. Thus, a more precisely replicable type of permanent trend monitoring plot appears to be needed.

Therefore, no trend data have been obtained yet from either the "low precision" or high precision permanent trend monitoring plots.

4.7.3 Supporting Information

4.7.3.1 Management Units

"High precision" permanent trend monitoring plots would be most effective if one or more were located within each range site. However, the length of time required to establish, record, measure and remeasure such plots makes this unrealistic even for the 41 range sites so far deliniated and described. Yet some form of extrapolation of trend results obtained from such plots is necessary.

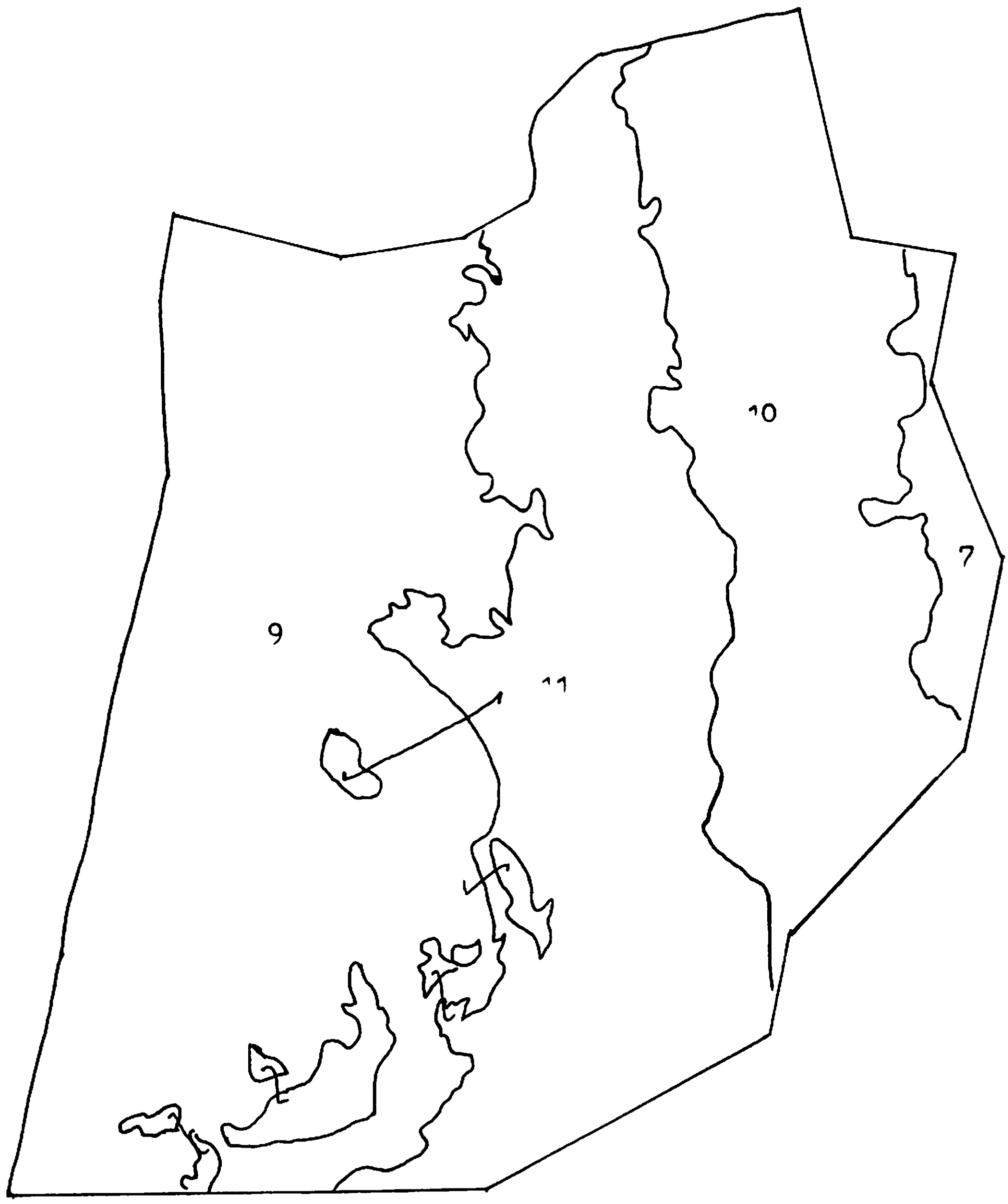
In Galgaduud Region (Ceel Dhere and Ceel Bur Districts) four large land units were identified that were environmentally uniform throughout or included an array of range sites the management of which was closely linked to that of a key range site. Each unit, called a "management unit", supported a particular type or mix of types, of land use that differed from that of adjacent management units (Fig. 21). Table 18

The grassland on coastal stabilized sand management unit supports a semi-nomadic pastoral economy based primarily on sheep. The shrublands on stabilized dunes unit supports a strongly agropastoral economy on relatively deep soils. Camels and goats are the principal livestock. Most of the land has been cleared and cropped some time in the past. Both farming and privately fenced enclosures are common. Further north, the shallow sands on limestone plains unit is a more arid and less intensive agro-pastoral system. Potential productivity is lower and the pastoralist component more nomadic and less cattle and sheep dependant. Large privately fenced enclosures for livestock are becoming common. The gypsic/saline depressions unit has heavier textured, often saline soils and supports an entirely pastoral nomadic system based on camels and goats. These management units are fully covered by "low intensity" permanent trend monitoring plots.

Any part of a management unit that later receives a differing form of management, such as the establishment of a deferred grazing system, may then be considered a separate management unit itself and be monitored accordingly.

In Hobbio District four large management units were identified (Fig. 21). The coastal plains management unit, similar to the coastal stabilized sand management unit in Galgaduud Region, supports a semi-nomadic pastoral economy based primarily on sheep. The Gawaan Ridge agropastoral shrubland management unit supports both cultivation (agropastoralism), pastoralism, emphasing camels and goats, and is susceptible to serious gully erosion. The Gawaan Ridge bushland unit has shallow soils, supports a primarily pastoral economy and is being extensively cut over for Terminalia spinosa. The interior plateau/basin shrub

Figure 21a. Map of "Management Units", Hiran Region.



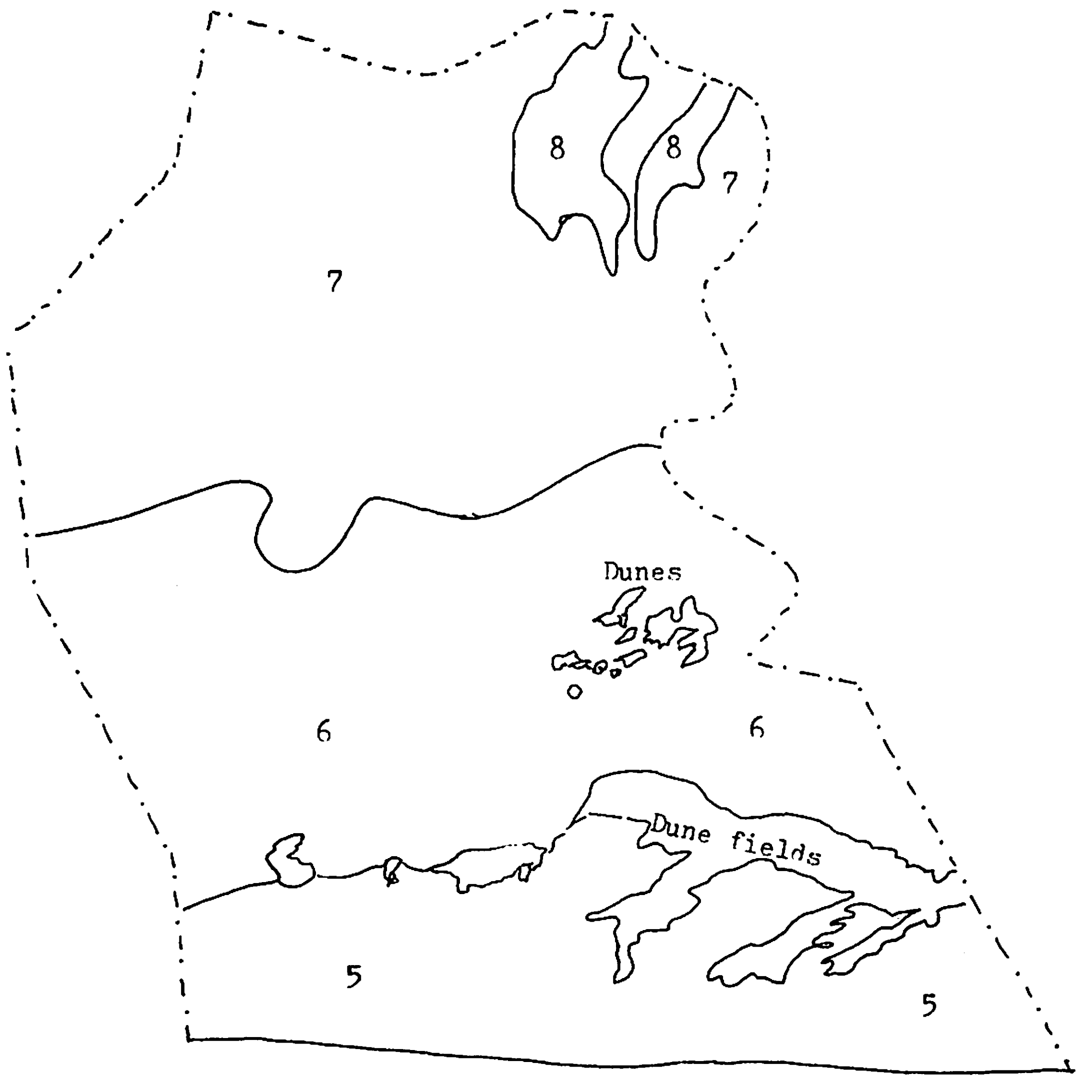
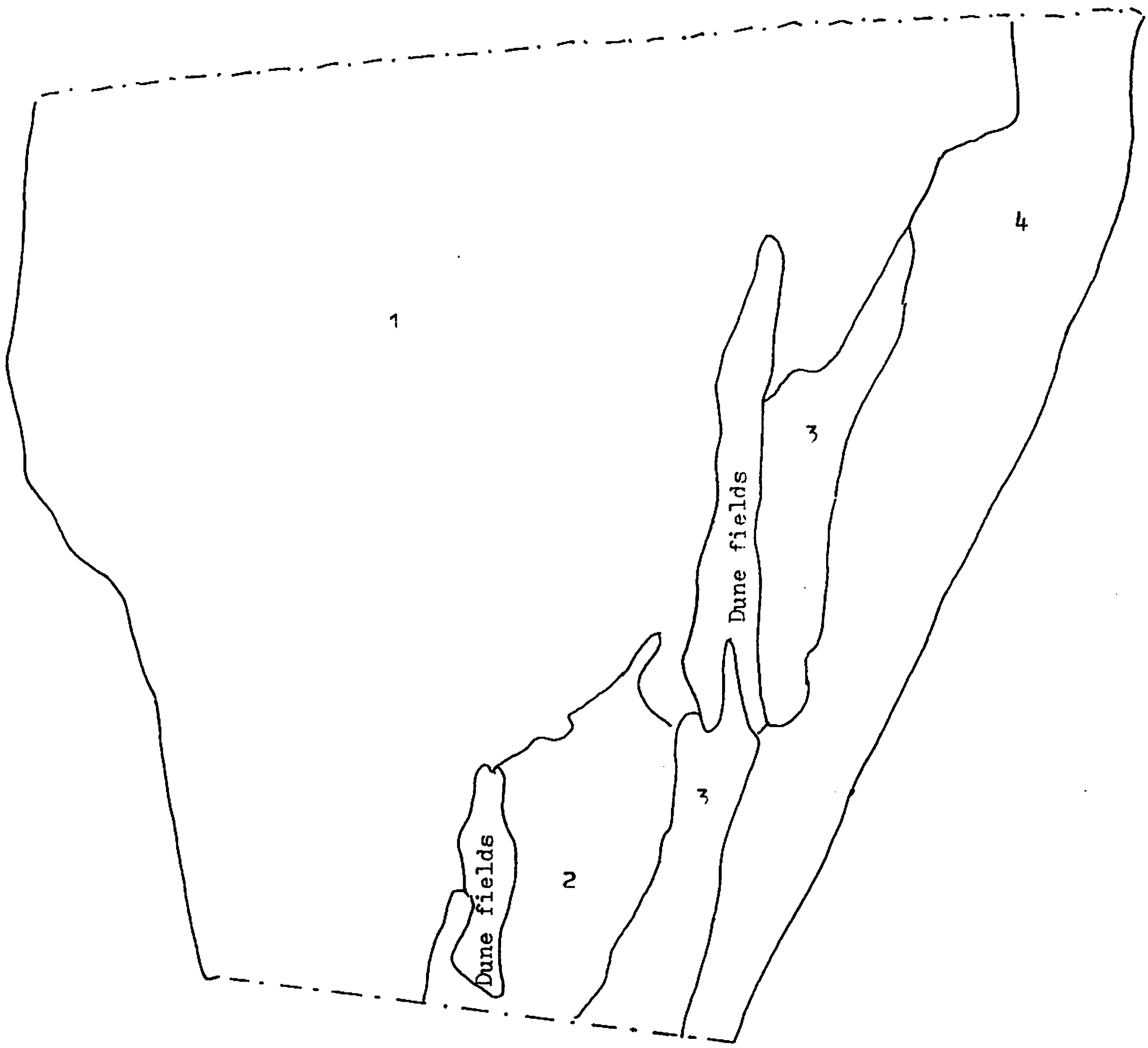


Figure 21b. Map of "Management Units" Galgadud Region.

Figure 21c. Map of "Management Units" Mudug Region (Hobbio District)



grassland management unit supports a low productivity nomadic economy based on camels and goats and is subject to frequent droughts.

There are only two major "management units" in Hiran region but they are both large (Fig. 21). The hawd sands bushland management unit in the east supports a nomadic economy based primarily on camels which relies on dry season utilization of yicib (Cordeauxia edulis). The limestone silt bushlands management unit in western Hiran is well watered, heavily used (livestock, cultivation, shrub cutting and thatch removal) so that its vegetation tends be greatly altered. Nevertheless, it remains a highly productive unit based on the dry season use of the shrub Satanocrater somalensis and the perennial grasses Chrysopogon plumulosus and Schizachyrium kelleri. This unit has the highest productive potential of any management unit in the survey area.

4.7.3.2 Climatic monitoring

RMR (1979) presents long term rainfall patterns for the Central Rangelands. However, at the start of the project, there were no longer any functioning meteorological recording stations. Collection of rainfall data by the project began in 1985 following a 2 year wait for ordered supplies to arrive in Somalia and the loss of a years data from the first rain gauge to vandalism. Subsequently, 12 rain gauges were placed within the Central Rangelands (Fig. 22). The longest period of data collection so far has been four years (Ceel Dhere Village) (Tables 15 & 16).

Solar powered automatic meteorological recording stations were placed at each of the district headquarters and at two additional sites within the six priority district (Fig. 22). These are presently recording their first set of data. All meteorological data is to be entered into a computerized data base for storage and analysis.

The present network of meteorological recording instruments is important less for the data it has provided so far, which is only for a few years, than for its long term potential should it be well maintained over the coming years.

It will be especially important to monitor rainfall. Rainfall patterns can then be compared with range trend patterns to see if the latter are a response simply to prevailing rainfall or actually reflect land use impacts.

Figure 22. Location of rainguage and automatic meteorological station sites.

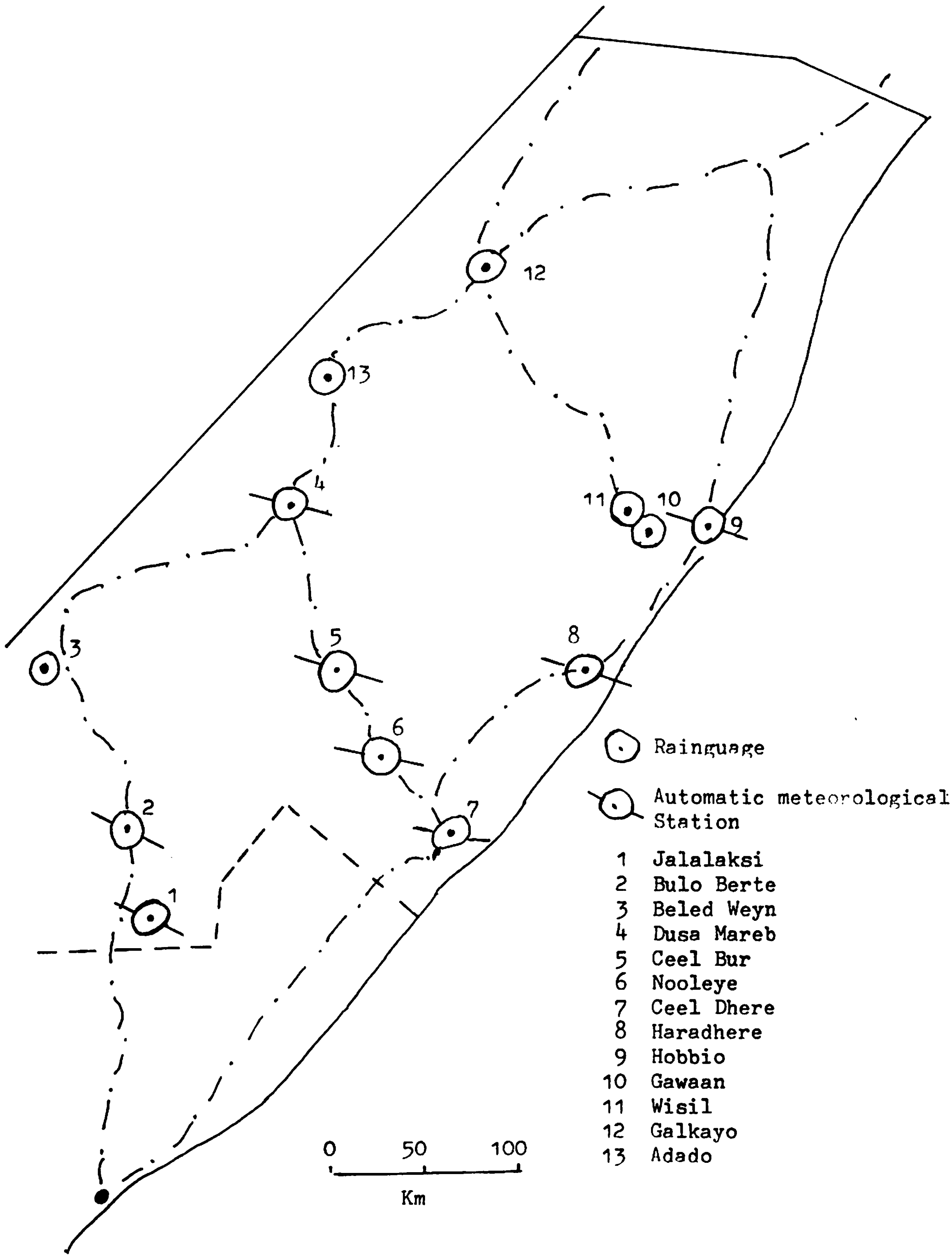


Table 15: Monthly Rainfall Records.

1987

STN	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec
Jalalaksi				--------420----------								
Bulo Burte				58	133							
Beletweyn				12	82							
Dusa Mareb					208				27	152	17	3
Adaado				(No station)								
Ceel Bur					274			65				
Nooleye										189		
Ceel Dhere				93	333			49		97	179	
Haradhere		5	30	135	190							
Hobbio				27	322					75		
Gawaan										140	35	
Wisil										112		
Galkayo					123			23				

1988

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec
Jalalaksi		19		160						120	150	
Bulo Burte				55							20	
Beletweyn				55							35	
Dusa Mareb				164							42	
Adaado				31							(no rain)	
Ceel Bur				101						59		
Nooleye			(	?		)				(	?	)
Ceel Dhere				42						50	50	
Haradhere				68						48		
Hobbio				174						6		
Gawaan				177							(no rain)	
Wisil				30						17		
Galkayo				113						60		

Table 16: Annual Rainfall Records.

STATION	1985	1986	1987	1988
Jalalaksi			420	449
Bulo Burte			191	75
Beletweyn			94	90
Dusa Mareb			407	206
Adaado			(no station)	31
Ceel Bur			339	160
Nooleye		160	189	(?)
Ceel Dhere	448	321	751	142
Haradhere			360	116
Hobbio			424	180
Gawaan			175	177
Wisil			112	47
Galkayo			146	173

4.7.3.3. Key species

Key species are usually considered to be those that provide the major forage support for livestock on either a wet or dry season basis. This report includes shrubs as key species because of their value in the provision of fuel and fencing and building materials as well as forage. Range management and development interventions should emphasize the improvement of the conservation status, quality and productivity of key species over other species because this is the most efficient way to improve the long term productivity of the community as whole. Key species should also be the principal plant species monitored on the permanent range trend monitoring plots. In this way trend monitoring is made both easier and more efficient because it monitors only the most important plant species in a rangeland community. Key species should also be given priority in future research studies.

Key species have been selected here on the basis of high relative cover, frequency of occurrence, palatability, and degree of utilization. They are presented in the context of management units (Table 17).

Table 17: Key species for the survey area

Species	"Management" Units (1)										
	1	2	3	4	5	6	7	8	9	10	11
<u>Woody</u>											
Ipomoea donaldsonii	X	X									
Indigofera ruspolii	X	X	X				X			X	X
Indigofera ogadensis			X								
Balanites orbicularis	X										
Boscia minimifolia	X										
Dalbergia uruandensii	X	X				X	X				
Limonium cylindrifolium	X										
Lagenanthus nogalensis	X										
Zygophyllum album	X										
Suaeda micromeris	X										
Terminalia spinosa			X								
Acacia horrida						X					
Dichrostachys kirkii						X					
Acacia nilotica						X					
Grewia spp.						X	X				
Tephrosia obbiadensis							X				
Commiphora truncata							X		X		X
Commiphora (Gunrey)							X				
Commiphora (Hagar)							X				
All evergreen shrub species (except unpalatable species)							X	X			
Acacia senegal								X			
Acacia mellifera								X			
Satanocrater spp.									X		X
Acacia tortilis									X		X
Duosperma eremophilium											X
Cordeauxia edulis										X	
Boswellia microphylla										X	
Dalbergia Commiphoroides									X		

Table 17: (Continued)

	1	2	3	4	5	6	7	8	9	10	11
<u>Herbaceous</u>											
Leptothrium senegalense	X	X	X	X	X	X	X				
Cenchrus ciliaris	X	X	X	X	X	X	X				
Sporobolus ruspolianus	X	X	X	X							
Heteropogon contortus			X	X							
Indigofera intricata					X						
Cyperus chorrdorhizus					X						
perennial Aristida (Xalfo)							X				
Dactyloctenium scindicum							X			X	
Sporobolus spp (variegatus/)								X			
Chrysopogon plumulosus								X	X		
Schizachyrium kelleri									X		
Sporobolus helvolus											X

1	Interior plateau/basin shrub grassland	RS 1,2,3
2	Gawaan Ridge agropastoral shrubland	4
3	Gawaan Ridge bushland	5
4	Coastal plain	6,7
5	Coastal stabilized sand	9,10,11,12,13
6	Shrublands on stabilized dunes	14,15,16,17
7	Shallow sand on limestone plains	18,19,20,21
8	Gypsic/saline depressions	22,23
9	Limestone-silt bushland	25,28,29
10	Hawd sands	37,38,39
11	Shebelli Valley	24,26,27,30,31, 32,33,34,35,36, 40,41

Further study is required of these species because little is yet known about the their quality, productivity, response to use and general ecology. An improved understanding will allow more efficent and productive management to be carried out.

A total of 27 woody and 12 herbaceous species are shown in Table 17 as "key" species. This is useful information for the support of range development and trend monitoring measures within a "management unit". However, interms of research, some further priorities must be drawn. In this case emphasis should be placed on those species providing dry season forage. These are primarily evergreen shrub species of which yicib (Cordeauxia edulis) should be given special consideration because of its apparently relatively low resilience to land use impact (browsing and fire).

Perennial grasses (probably managed) are also good sources of dry season forage. Of these, Leptothrium senegalense, Cenchrus ciliaris, Sporobolus ruspolianus and Chrysopogon plumulosus should be emphasized for further study because of their relatively ubiquity. Schizachyrium kelleri should be emphasized because of its dual value (thatching and forage).

4.7.3.4 Indicator species

Indicator species are plant species that demonstrate a marked and predictable response to grazing (and other types of utilization) pressures. There are three classes of indicator species: (a) decreasers, those that decrease in abundance under heavy grazing; (b) increasers, those that increase at first but then subsequently decrease under continued heavy grazing; and (c) invaders, not original components of the vegetation, that establish and become abundant as a result of heavy continuous grazing.

Certain combinations of decreasers, increasers, and invaders (which vary with the range site involved) are used as indicators of the occurrence of a particular level of range condition. The identification of which plant species belongs to which indicator group and the particular combination of species that indicates a particular range condition comes either from experience or specific studies directed to this purpose.

The use of indicator species increases the sensitivity of a range condition classification, indeed some classifications use only these criteria. Therefore, the identification of indicator species for certain parts of the Central Rangelands makes it possible to upgrade the present set of guidelines by Naylor and Herlocker (1987) which already include a component ready for use once indicator species have been identified.

Indicator species were determined by inspection of compositional gradients of vegetation extending out from major water sources, seasonally used permanently positioned camp sites, mobile sand dunes, an exclosure study and a post-cultivation climax study (Herlocker et al. 1986; 1987) 1988; in review; Herlocker & Ahmed, 1986; Barker & Herlocker in review; Barker et al. in review a,b).

The results are specifically applicable to range sites but, because of a general similarity in environment and vegetation composition and dynamics, are also broadly appliable within extensive "management units" (Tables 18, 19 & 20).

Table 18: Decreaser indicator species

	Management unit (1)										
Species	1	2	3	4	5	6	7	8	9	10	11
Woody											
Boscia minimifolia	X										
Balanites orbicularis	X										
Terminalia spinosa			X								
Acacia reficiens						X					
Acacia nilotica						X					
Cordeauxia edulis										X	
Herbaceous											
Leptothrium senegalense	X			X							
Cenchrus ciliaris	X			X							
Chysopogon plumulosus	X				X			X	X		
Brachiaria somalensis				X							
Afrotrichloris martinii					X						
Ennearopgon schimperianus					X						
Heteropogon contortus					X						
Panicum pinnifolium					X						
Tephrosia filiflora					X						
Aristida sieberiana						X					
Afrotrichloris hyaloptera						X	X	X			
Schizachyrium kelleri									X		
Sporobolus helvolus											X
Enneapogon cenchroides								X			

(1) See Table 17 for names of "management units"

Table 19: Increaser indicator species

Species	Management unit (1)										
	1	2	3	4	5	6	7	8	9	10	11
Woody											
Acacia horrida	X										
Acacia edgeworthii	X	X									X
Acacia reficiens										X	
Salsola bottae	X										X
Indigofera ruspolii						X				X	X
Acacia nilotica						X					
Satanocrater spp.									X		
Cordia sinensis											X
Herbaceous											
Aristida kelleri	X	X	X	X							
Dactylocterium scindicum	X						X				
Sporobolus ruspolianus		X	X								
Heteropogon contortus			X								
Leptothrium senegalense					X	X	X				
Holocolemna ineaquale					X						
Coelachryum stoloniferum			X								
Indigofera intricata					X						
Aneilema obbiadensis					X						
Blepharis sp.						X					
Perennial Aristida (Xalfo)							X				X
Perennial Aristida (Fay Fay)							X			X	
Cenchrus ciliaris							X				
Sporobolus helvolus								X			X
Dactyloctenium sp.								X			
Sporobolus (variegatus?)								X			

Table 20: Invader indicator species

Species	Management unit (1)										
	1	2	3	4	5	6	7	8	9	10	11
Woody											
Solanum jubae		X				X			X	X	X
Acacia oerfota		X									
Jatropha obbiadensis					X						X
Solanum incanum						X					
Gossypium somalense									X		X
Ocimum tomentosum											X
Triumfetta actinocrpa											X
Anisotes trisulcus											X
Jatropha arguta									X		X
Herbaceous											
Dactyloctenium aegyptium					X						
Cynodon dactylon					X						
Brachiaria ovalis					X						
Cyperus chorrdorhizus					X						
Heliotropium spp					X						X
Cymbopogon commutatus					X						
Cleome tenella					X						
Tribulus terrestris					X						
Gisekia pharnaceoides					X						
Psilotrichum sp						X					
Commelina forskalei						X					
Dactyloctenium scindicum						X					
Annual Aristida (Xalfo)							X		X		
Annual grasses & forbs								X	X	X	X

(1) See table 17 for names of management units

4.7.5 Placement of "high precision" trend monitoring sites

Because their numbers are relatively small, "high precision" permanent trend monitoring sites must be carefully placed to be most effective (Fig. 23). Optimal sites can be determined from an inspection of compositional gradients of vegetation extending outwards from major water sources.

Sites are chosen based on the assumption that the impact of increased stocking rates or other uses, such as cutting and clearing, on vegetation and soils will steadily increase through time outward from water points. This is so, at least until some

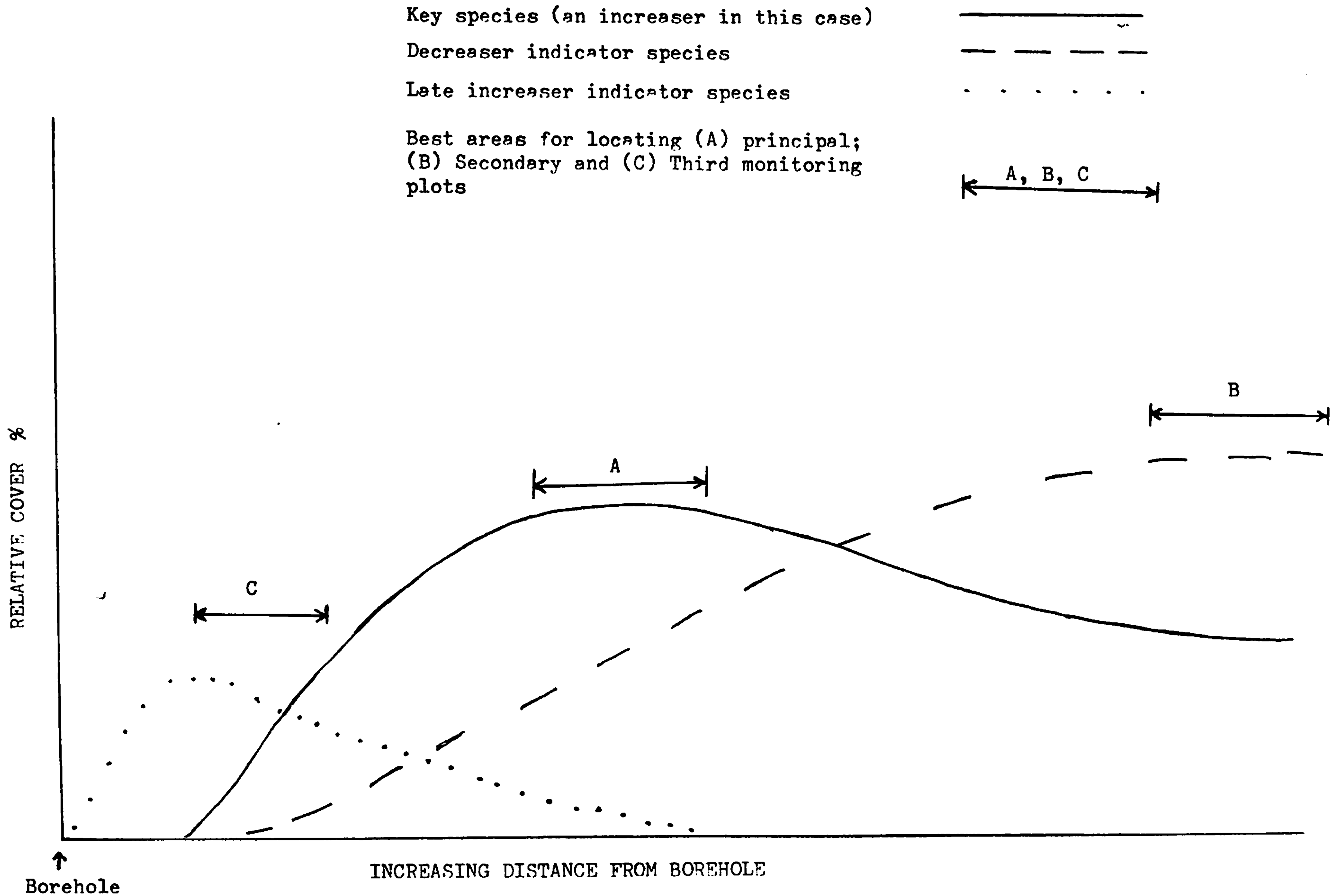


Figure 23. How to locate "High precision" permanent trend monitoring plots.

maximum distance is reached beyond which further movement of stock etc. is significantly hindered (such as the maximum distance over which an animal can repeatedly walk to water in the dry season).

The principal monitoring plot is placed where (a) the key species for that area is abundant; (b) one or more other indicator species are present and (c) trend will most quickly be reflected by compositional changes in the plot (Fig. ~~17~~ 23).

Where possible, a second "high precision" trend monitoring plot should be placed in lightly used good condition rangeland. This is so that the response over time of vegetation on both plots can be compared to see if trends noted on the first plot are due to actual land use impacts or are simply tracking variations in rainfall (Fig. ~~17~~ 23).

An improvement in range trend will show a movement or change in composition of vegetation on the plot nearest water toward that of the plot furthest from water. Decreasing trend will show the opposite movement in composition.

Where both of the "high precision" plots discussed above are far from water a third plot should be placed about halfway between the first plot and water to monitor trend within the usually accepted effective grazing radius of cattle and other livestock (Fig. ~~17~~ 23).

4.7.6 Longevity of some invader species

The longevity of the shrub *Solanum jubae* and the perennial grass *Aristida seiberiana*, both invader species of low palatability, affects their usefulness as indicators of range condition and, therefore, their use in trend monitoring.

Increasing cover over time (50-60 years or so) of *Solanum jubae* - as sometimes occurs in Ceel Dhere District - may simply reflect an increasingly older stand of larger individuals proceeding through their normal life cycle rather than a continued response to increasing environmental degredation.

Although *Aristida sieberiana* is an invader on newly abundoned farms, if it is not heavily grazed, it may persist for many years so that it eventually becomes a component of an otherwise "near climax" shrubland. Its presence, in this case, reflects a use impact many years earlier that no longer exists. For all practical purposes this species is then a decreaser.

4.7.7 Human Population Trends

In at least some parts of the Central Rangelands the human population appears to be increasing. Howze (1987) reports that, for the project area as a whole, families are quite large and the human population is apparently expanding rapidly. Increasing numbers of people are leaving the bush and settling in villages and towns. Many have been forced to do so because of loss of large numbers of stock to drought. It appears that the limits of the ability of the rangelands to support livestock may have been reached. In Ceel Dhere District, 6 new villages, 3 boreholes, at least 3 shallow wells and an unknown number of berkeds (cement-lined surface water catchments) have been established within the past 20 years. In particular, new berkeds are constructed each year, especially within the large waterless area in the center of the district. At least some of the villages have noticeably increased in size during the course of the project (Herlocker et al. (1987b). Enclosure of land for private grazing has increased 17% but especially near water (47%) (Tables 21 & 22).

Table 21: Change from 1960-1986 in % total area of private enclosures, functioning farms and obvious fallows, shrublands on stabilized dunes, Ceel Dhere District.

	% Total Area		
	Enclosures	Farms	Obvious fallow
1960	9.4	5.2	11.4
1986	36.2	3.6	20.2
Change	+26.8	-1.6	+8.8

1. Data obtained from comparison of 1:60,000 Royal Air Force (1960's) and 1:20,000 (1986) aerial photos on five 4.2 km^2 plots placed at varying distances from sites where boreholes and villages now occur.

Table 22: Change from 1960-1986 in % total area of private enclosures, functioning farms and obvious fallow near boreholes, shrublands on stabilized dunes, Ceel Dhere District.

	% Total Area		
	Enclosures	Farms	Obvious fallow
1960	7.9	3.5	11.1
1986	55.3	4.5	19.0
Change	+47.4	+0.7	+7.9

In a strongly subsistence economy such as exists within the Central Rangelands, the above pattern of use and movement implies increased numbers of livestock. Such an increase is apt to have a negative effect on range condition and trend within the district. However, Wieland (1987b,c) stressed the radical seasonal fluctuations in human population in two degaans he surveyed in Hobbio District, which were due to shortage of dry season water, and stated that the population was not excessive as long as herds were kept at a subsistence level.

5. IMPLICATIONS OF SURVEY/MONITORING RESULTS

The National Herbarium is in place but requires a professional level of maintenance and a plant species identification service to be of real value to potential user agencies such as the CRDP/NRA or other government agencies dealing with the vegetation of Somalia. The completion of a useable key to the woody flora of the Central Rangelands would also greatly assist those interested in learning the flora.

The Central Rangelands has been found to be the center (with the Ogaden) of a rich and unique floristic province. Such a discovery calls for further taxonomic and ecological studies in order to properly understand the nature of this resource. Conservation of the natural resource base is additionally important because of the need to preserve a unique genetic resource as well as to protect against degradation and maintain/increase productivity.

There is a need for laboratory analyses of forage nutrient content of selected plant species. An example is Aristida sieberiana, a perennial grass of low palatability that nevertheless acts as a decreaser when grazed. This species dominates the herb layer over large areas. Should it be established that it is nutritious, its low palatability is irrelevant because it is eaten in any case. Should it be of low nutrient content, however, this would be a reason to attempt its control in favor of a more valuable species.

Plants of low palatability (or worse) comprise a large amount of the rangeland vegetation (25-30%), much of it seral (successional) following shrub cutting and cultivation. However, much of this can still be eaten as in the case of evergreen shrubs which are of low palatability yet also valuable dry season forage. Thus, most of the vegetation of the Central Rangelands is useable forage and the quality of this has potential for further improvement through range management practices. There are few poisonous plant species. They comprise only a very small percentage of total vegetation cover, although it is conceivable that their abundance could increase should the rangelands become extensively and highly degraded.

The silt/clay soils of the Shebelli Valley and western Hiran (now highly degraded) probably have the potential of supporting woodland dominated by Terminalia spinosa, Acacia nilotica and possibly Balanites spp. It is probably impractical to attempt the rehabilitation of this type of vegetation. However, it may be possible to protect the few remaining Terminalia stands in extreme western Hiran Region as well as those growing on sands on Gawaan Ridge in Hobbio District, which are now also being cut.

It is worth investigating the feasibility of managing Terminalia stands for a sustained yield of both wood and forage products. It might be possible, for instance, to arrange deferred grazing periods so that they coincide with early regeneration stages of Terminalia following selective cutting.

Further attempts - following those initiated by the CRDP NFE/Extension Component - should be made to integrate Terminalia spinosa and other valuable trees into local agro-forestry and agro-pastoral extension activities.

Relict stands of the original thicket vegetation within Ceel Dhere District should be preserved. These few remaining stands are extremely valuable camel browse habitat as well as being unique vegetation communities of very high species diversity. Once cut for cultivation, these stands will take so long to regain their original status that it is unlikely the local agro-pastoralists will allow them to do so before clearing them again for cultivation. The same approach is probably valid for stands of original vegetation found elsewhere in the agropastoral zone of the Central Rangelands.

The relatively high land use impact (livestock, shrub cutting, farming, thatch removal), together with the inherent superior potential productivity of the area, suggests that a greater return is likely on conservation and development investments in the Shebelli Valley and western Hiran Region than elsewhere in the Central Rangelands. This area should probably then receive priority in conservation and development activities.

The significant amount of the Central Rangelands under shifting cultivation, its lowering of range condition and forage quality through the reduction of vegetation cover, increased erosion, introduction of plant species of low quality, the associated tendency towards a more sedentary privatised land tenure, increased fencing and the shortening of fallow periods, demonstrates a need to concentrate more resources on improving rangeland quality and productivity within the context of the agro pastoral system.

This can be done by introducing (a) improved farming techniques and crops, (b) soil conservation measures, (c) live fencing and (d) quality forages to replace the naturally poor quality invaders. Maintenance of soil fertility levels, which would probably result from the above activities, would assist in enabling higher quality forage species to persist on fallowed fields in the face of invading lower quality grasses and forbs.

The major effort would have to be by extension and demonstration activities directed towards individual agropastoralists for application on their privately held pieces of land.

Except perhaps for the silts and clays of the Shebelli Valley and western Hiran Region, soil fertility will have to be built up primarily through the gradual inclusion of increments of organic matter rather than by the application of fertilizer. The latter is too expensive for use in low rainfall areas, such as the Central Rangelands, and too open to failure because of frequent failure of rains.

The alternative approach to improving low quality seral (successional) rangelands, especially on communal ranges, is through simple deferred grazing programs that improve plant vigor and allow succession to progress and range condition to improve.

Even in shrubland and bushland areas management plans should provide for the rehabilitation and up-grading of the grass layer. A good example is western Hiran where the potential for improvement of palatable grass cover is high, especially on the silt pockets scattered over the limestone areas.

Salt bush areas, although not heavily used by livestock, periodically provide valuable salt forage browsing at certain times of the year. Management plans should ensure that these areas are kept open for such use by as many of the surrounding RLA's as possible.

Key species - those that provide the major forage support for livestock on either a wet or dry season basis - have been identified for the survey area. These species should now be emphasized in subsequent management/development, conservation/monitoring and research activities.

Both wet and dry season key species were identified. However, the latter are probably the most important in the prevailing, primarily subsistence pastoral economy because they are the principal support for livestock during the most difficult time of the year. The principal dry season key species are: Cordeauxia edulis (yicib), Satanocrater somalensis, Acacia tortilis, Dobera glabra, Boscia minimifolia, and Balanites orbicularis.

Palatable perennial grasses are also important dry season forages but especially: Leptothrium senegalense, Cenchrus ciliaris, Sporobolus ruspolianus, Chrysopogon plumulosus, Schizachyrium kelleri and Sporobolus helvolus.

Cordeauxia edulis and evergreen shrubs in general should be given particular attention from the viewpoint of conservation activities because they are sustaining land use impact out of all proportion to their abundance and their populations are clearly in decline. Cordeauxia edulis is especially sensitive to such pressures whereas Satanocrater spp. are least so.

Leaf litter is also a source of dry season forage for livestock but its real value is as yet unknown. More effort should be made to determine this value in terms of biomass, nutrient content, accessibility (in/out of bushes) and temporal availability.

In contrast to shrubland/bushland areas where low quality species are introduced by shifting cultivation, seral plant species in coastal plain grassland tend to be of high forage value as well as efficient colonizers and soil binders. Thus, management objectives in this system should be oriented more towards maintaining adequate vegetative cover and improving plant vigor than in modifying the composition of the vegetation.

Further extension of water supplies in coastal plain grasslands would probably result in overstocking, deterioration in range condition, increased competition for forage between different types of livestock and decreased flexibility in manipulating livestock herd ratios to respond to changing economic conditions. Therefore, no further improvement in amount or distribution of water is recommended.

Similarly, even in the face of an increasing tendency towards sedentarization focused on villages and towns, every effort should be made to encourage the maintenance of the existing system of nightly pasturing of herds on the same sites scattered across the plains that have probably been used for hundreds of years now. This will maintain the inputs of urine and feces necessary to support the unique vegetation communities on these sites that provide such a valuable wet season grazing on the coastal plains.

Overall, the Central Rangelands appear to be fully to somewhat overstocked, primarily in fair to low fair range condition with a slightly downward trend over the years. However, this pattern, which reflects the influence of a number of factors, including availability of permanent water, cultivation, shrub cutting, history of use of an area and an increase in the human population, is not uniform throughout the area but varies locally from highly overstocked and degraded to under stocked and good condition rangeland. Range trend probably varies accordingly but this is less apparent. Thus, it is possible to direct rangeland conservation, rehabilitation and development activities at specific areas of the Central Rangelands and within the context of specific methods and approaches.

It is apparent that parts of Hiran Region, such as pediment and foot slope soils of the escarpment, silt valleys within limestone hills and the alluvial silts of the Shebelli Valley, are especially in need of range rehabilitation measures.

Similarly, those areas near (within 3-10 km) of major water points (espe ally large boreholes) are more in need of rehabilitation and management than areas further away which are more lighly used and in better condition. This is especially true in agro-pastoral areas where there is a tendency to cultivate, cut shrubs and enclose land near water.

In agro-pastoral areas attempts should be made to reduce soil erosion and improve extension efforts directed at individual agro-pastoralists rather than communal efforts such as grazing reserves. Although, should the latter occasionally be appropriate, they should also be used. Soil conservation efforts should certainly be directed toward agro-pastoralists who are farming on shallow soils because of the danger of irreversibly losing this soil to erosion.

Rangelands receiving fairly continual use throughout the year, such as the saline/gypsic range sites (with evergreen shrubs) of Ceel Bur district and the transition shrub grassland range sites of Ceel Dhere District, require some form of deferred grazing in order to maintain plant vigor and productivity.

Those areas that are far from water and in good condition should not receive further water development except, perhaps, in the form of surface water dugouts.

For the most part range rehabilitation efforts can be fairly simple as well as effective - at least on sand soils. Degraded vegetation on the latter soils has demonstrated a potential for fairly fast recovery given adequate protection from use and normal rainfalls. Reduced rainfall of course results in reduced vegetative response to rest.

Although, irreversibly degraded soils occur in parts of Hiran Region, it is probable that these heavier (silt/clay) soils also will generally respond well to simple (i.e. deferred grazing) rehabilitation efforts. However, it would be very useful to have a number of fenced exclosures placed throughout this area to get a feel for the nature of vegetation response to protection.

To date sand dune stabilization efforts have been labor intensive, time consuming and expensive. As a result they have been restricted to very small dunes in high profile areas, such as near villages. It has not been practical to consider stabilizing larger areas because of the cost, time and labor involved. It is worth attempting to stabilize dunes using protection alone. The most this would involve is fencing the dune, but especially the source area of sand upwind, and the provision of guards. Should this approach work it would greatly reduce the expenses (but not the time) of dune stabilization and make it feasible to think about stabilizing larger areas.

However, the large dune fields that occur within Ceel Dhere, Haradhere and Hobbio Districts should not be viewed as environmental disasters stemming from over use of the rangelands. They are probably natural occurences and - although certainly serious when they engulf villages and wells and cut roads - do not appear to be as threatening as their sheer size and barreness make them seem. The main thrust of movement appears to be lengthwise along the dune field axis so that troubles occur at the narrow leading tips rather than along their very long sides. In fact it may be that these huge areas are efficient sumps that allow rainfall to sink quickly into the soil and recharge the ground water which is then trapped by wells and boreholes.

Plant species have been identified that demonstrate marked and predictable responses to grazing and other types of land use. The inclusion of these indicator species in the guidelines of Naylor and Herlocker (1987) will allow more sensitive and site - specific surveys of range condition to be carried out as well as ensure the sensitivity of long term monitoring of range trend using permanent sample plots.

The basis has now been established for the beginning of a long term program of monitoring range trend within that part of the Central Rangelands surveyed to date. This basis consists of (a) a large number of low precision permanent trend monitoring plots (b) mapped "management units" to set the context within which permanent trend monitoring plots are placed and analysed, (c) a climatic monitoring system and (d) identified "key" and "indicator" species the use of which will enhance the sensitivity of data taken from permanent trend monitoring plots. What is needed now is a reliably precise and repeatable method of establishing and recording permanent trend monitoring plots.

6. RANGE PLANNING

6.1 RANGE MANAGEMENT PLANS (GENERAL)

6.1.1 Guidelines and modifications

Management plans should be regarded as guidelines for use in planning and implementation rather than strict instructions which must be carried out. Much is yet unknown about the pastoral and agro-pastoral systems of the Central Rangelands and some, as yet unknown, factors, such as a particular type of animal husbandry technique, a local political problem or the impact of a future drought, could strongly influence the effectiveness of proposed interventions.

If future experience indicates that modification of a management plan would make it more effective then this should be done. A plan should be changed whenever new needs arise. Management plans should evolve over time in order to accurately reflect both development needs and the resources available to meet them.

6.1.2 Priorities

Experience with implementing its first two range management plans in Hobbio District taught the project not to rely on schedules with fixed times for beginning and completing specific interventions. Frequent logistical and financial constraints (periodic fuel shortages, short falls in funds, etc), which characterize the range managers working environment, make fixed schedules rather unrealistic for more than a few months at a time, Reliance on them beyond this point is apt to lead only to disappointment and, possibly, undue confusion.

Instead, proposed interventions should be given priorities. For instance, first priority interventions either need immediate attention and/or already possess the necessary logistical, financial and local community support to be successfully carried out. Second priority interventions are either needed less urgently or the necessary means to carry them out are not immediately available or they can be carried out only after one or more first priority interventions are completed. Third priority interventions can be postponed for some time or, even if needed, are unlikely to obtain sufficient support to be carried out in the foreseable future. In some cases, they are simply possibilities that may eventually become more feasible in the future.

6.1.3 Community support

No intervention should be put into operation until agreement has been reached with the local community as to its need, type and location as well as to who will run and maintain it and in which way. The "community" is here understood to usually be the range and livestock association which has been organized to represent pastoralists within a particular degaan. However, in some cases care should be taken to seek out the co-operation of even smaller and more localized groups of people as well. This is especially relevant regarding small "point" interventions, such as dugouts.

6.2 RANGE MANAGEMENT PLANS (SPECIFIC)

Management plans developed by the project include a description of the major physical features, environment, ecology and land use patterns of the degaan/range and livestock association concerned (Wieland 1987b,c); the entire district (Herlocker et al. 1987b); or both (Naylor and Jama, 1984). This helps the reader understand the basis for the proposed interventions and - if given-their priorities.

In most cases, interventions are proposed for a particular degaan/RLA. However, Naylor and Jama (1984) also proposed specific non-RLA related interventions for improving livestock marketing facilities in the Hobbio port area as well as more generalized range site - related interventions for areas within Hobbio District not yet surveyed for degaans.

There were a large number of types of interventions proposed. These were concerned directly with range conservation and development, as in the case of controlled grazing, or were more peripherally related, as with village-related interventions.

6.2.1 Controlled (deferred) grazing

In the first few years of the project deferred grazing - in the form of rest-rotational grazing systems - was seen as one of the range management interventions most applicable to the Central Rangelands. The first two range management plans developed by the project recommended rest-rotational grazing systems on mostly fair-poor condition coastal plain grassland in Hobbio District (Naylor and Jama, 1984). The objective was to improve grass vigor and productivity. Each degaan was divided into 8-12 blocks of which 2-4 (or 25% of the total area) were to be rested for 3 consecutive growing seasons and the intervening dry periods or about 1-1 1/2 years each. At this time they would be opened to grazing and another 2-4 blocks protected. This was to continue for 15 years at which time it was assumed that range vigor and productivity would have improved significantly and the period of rest could be shortened. Reserved blocks were to be opened to use during time of drought.

There was a great deal of resistance at first by the local pastoralists who did not understand and were not enthused about any form of grazing control. The proposed management plans were only grudgingly accepted, primarily because the District Commissioner of Hobbio District supported them so strongly.

Luckily, good rains in the first year of operation provided abundant forage and little temptation for pastoralists to trespass on the protected blocks. Therefore, when the next dry season eventually arrived the large areas of standing grass within the protected blocks were clearly visible and their obvious utility as reserves of dry season forage distinctly appreciated by the local pastoralists. Had the rains been poor or only mediocre, this situation would not have been so apparent and the value of resting rangeland less obvious.

Since that time the utility of deferred grazing has been fully accepted by the two RLA's. However, this acceptance has not extended to the reservation of 25% of the degaan for 1-/1/2 years at a time. Therefore, the approach has changed to establishing wet (growing season) season reserves on about 10% of the degaan which are than opened to grazing the following dry season. It is hoped that, as the RLA's became more familiar with the concept and usefulness of deferred grazing, they will eventually agree to further extensions of reserves both in area and time.

There were further obstacles to achieving a successful deferred grazing program. Drought is a common occurrence and often forces pastoralists to move to other degaans to find forage. Therefore, there is a natural reluctance by pastoralists of one degaan to deny use of their degaan (or part of it) to outsiders because they themselves will eventually be forced to enter other degaans when the next drought comes. Those pastoralists who served as range guards wanted some form of payment, which was given in the form of WFP food allotments. Non deliveries, late arrivals or short rations, which often occurred, caused low morale and reduced performance. Decisions by RLA committees often were not effectively transmitted to RLA members in the field. Finally, the large areas of reserved land (a few hundred km^2), their relative inaccessibility (up to 50 km from district HQ) and the usual lack of transport for range staff made supervision and enforcement of protected blocks very difficult. Despite this latter problem, however, Wieland (1987a) demonstrated that the reserved blocks were being rested significantly more than non reserved areas.

Rest-rotational deferred grazing systems were established in the next two RLA's (Ceel Dhere District). Although these range management plans were quickly agreed to by the RLA committees, they in fact, encountered all of the problems mentioned above with the addition that the rains were only poor to moderate during the first two years of operation. Therefore, as there was no immediate clearly visible evidence as to the utility of these systems, actual acceptance has come more slowly. As in Hobbio District, the emphasis has also changed to wet (growing) season reserves covering relatively small areas.

Subsequently, deferred grazing interventions have been in the form of either wet or dry season grazing reserves. These have been placed in shrubland in Bulo Burte and Ceel Buur Districts. Dry season reserves protect areas of evergreen shrub, such as Cordeauxia edulis (yicib) and Dobera glabra which provide important dry season forage for browsers.

Hobbio District includes a famine reserve established near Gawaan by the National Range Agency prior to the beginning of the project. Famine reserves are meant to be closed to grazing until the occurence of drought at which time they are opened. Therefore, they should be relatively large, productive and contain a source of dry season water. The Gawaan Reserve is, waterless although water is often trucked in at time of drought. Despite difficulties in supervising this reserve Wieland (1987a) showed that it had been rested significantly more than the surrounding area.

6.2.2 Water Development

A second major type of intervention to be carried out by the project was the drilling of 22 new boreholes for stock water supplies. Only 41% were successful. This reflected the relative lack of knowledge of the hydrogeology of the area needed to reliably predict the location of successful wells.

Boreholes can be valuable range management interventions in that they allow underutilized rangelands to be used to their full potential. However, reference to Figure 19 demonstrates that there are few such areas in the Central Rangelands so far surveyed.

There are other problems. Boreholes attract increased numbers of livestock - as they are meant to do. They also attract settlement, often including people from other degaans, shrub cutting, private enclosure of land and, where feasible, farming. The result often is increased degradation of the surrounding rangelands and significant changes in socio-economic patterns. The latter affect existing socio-political balances of power, the anticipation of which often makes it hard to obtain consensus at the local level for the exact siting of a new borehole in a waterless area. Diesal driven boreholes pumps are also difficult to maintain. Down times due to lack of fuel or mechanical break downs are often frequent and lengthy.

The above contributed to an increased interest by project staff in implementing ~~further~~, more efficient, practical, as well as ecologically and politically acceptable types of water development.

A major stockwater development intervention emphasized during the latter part of the project was the construction of surface water catchments (dugouts). Their principal purpose was to better distribute grazing by allowing livestock to remain a few weeks longer into the early dry season on unwatered rangeland than would otherwise have been possible. The low rainfall and sandy/rocky soils typical of much of the Central Rangelands restricts the size (an average of 2 million liters each), numbers and distribution of potential dugouts. Therefore, they are too small and too few to support large number of livestock or permanent settlements. Thus, they are neither sources of rangeland degradation or of political controversy.

The construction of shallow wells and berkeds (cement-lined surface water catchments) have occasionally been proposed as water development interventions. Both are already traditional activities of pastoralists so the proposals have usually stressed (a) helping to select the best sites and (b) assisting and expediting - rather than carrying out - the actual construction, such as in the provision of transport for labor etc.

Another successful water development intervention during the later years of the project was the rehabilitation of existing shallow wells. This was a highly successful, low in-put, high profile type of intervention. It required little preparatory survey, had wide spread public acceptance, could be completed fairly quickly and had almost no environmental implications. The project provided transport, materials and expert artisans and the community provided labor and their provisions.

A few access trails were improved in Hobbio District so that livestock could descend to permanent water sources at the base of a small but steep escarpment along the coast.

Improvements were recommended for the few dugouts existing at the beginning of the project.

6.2.3 Soil and Water Conservation

Soil and Water Conservation interventions, which in fact included much of the water development interventions listed above, were also included in range management plans because they either related directly to range management (as in the case of dugouts) or, if primarily village - related, were yet ultimately the responsibility of the District Range Officer to oversee and expedite. These interventions are discussed more fully in the final report of the Soil and Water Conservation Section (Kornegay 1988a) and in the Soil and Water Conservation Handbook (Kornegay 1988b). In addition to those already mentioned, interventions included:

District tree nursery programs
Sand dune stabilization
Shelter belts
Village tree planting programs
River access points for livestock
Stabilizing accelerated gully erosion

Many of these interventions were carried out at or near villages so it was possible to present them within the management plan as part of a package for the village concerned.

6.2.4 Improvement of marketing facilities

Recommendations were made for the improvement of marketing facilities for the Hobbio port area. These involved:

1. The establishment of a holding corral for dipping livestock
2. Establishment of health inspection facilities
3. Development of hay production areas for providing forage for stock on board ship in transit to market
4. Establishment of holding pastures near Hobbio Port.

Subsequently an area near Wisil, some 50 km from Hobbio port, was identified as a possible forage production site.

6.2.5 Range improvements

Recommendations were made regarding the establishment of fodder production sites in areas receiving surface water runoff. However, only a few such sites were recommended.

6.2.6 Wildlife

General proposals were made for the establishment of reserves, the control of hunting and the carrying out of surveys and studies.

6.2.7 Miscellaneous

Recommendations were made to develop a plan for the controlled harvesting of Terminalia spinosa, the maintenance and improvement of specified sections of roads and the survey of a new route for a section of another road in Hobbio District.

7. DEVELOPMENT INTERVENTIONS

7.1 DEGAANS, PLANS AND RLA's

Sixty-eight degaans (traditional grazing areas) were identified and mapped by the Non-Formal Education/Extension Component (Fig. 24, Tables 23, 24). All six priority districts were completely mapped for degaans. Degaan boundaries tend to be imprecise and often overlap, especially in the drier rangelands where the availability of forage is less predictable. Although there is usually a consensus among pastoralists as to which general area is most closely associated with which group of people, there are also, occasionally, strong disagreements between some groups.

Imprecision is also implicit in the use of land marks (given by the elders) that are often in practice inaccessible or in themselves vague ("half way from here to the second sand dune on the camel track to Wabxo"). Degaan boundaries are also liable to change over time. Villages which spring up at new major water sources are apt to become the centers of new degaans.

Range management plans were developed for 19 degaans which comprised 20,115 km^2 or 36% of the area of the six priority districts (Tables 24 & 25). the Non-Formal Education/Extension Component organized range and livestock associations for 12 of the above degaans plus another four degaans for which there are as yet no management plans. This equals 31% of the total area. Including the four above, six of the organized RLA's are, as yet, not functioning. On the other hand, to best utilize existing resources (equipment, fuel, people and time) it has occasionally been necessary to place interventions within a degaan before the preparation of a management plan.

FIG 24 PRIORITY DISTRICT DEGAANS

(a) MAPPED.
(b) WITH MANAGEMENT PLANS.
(c) WITH ORGANIZED RANGE AND LIVESTOCK ASSOCIATIONS (RLAs).

PLEASE NOTE THAT:

(A) RELATIVE PROPORTIONS of degaans WITHIN EACH DISTRICT ARE CORRECTLY SHOWN.

(BUT)

(B) RELATIVE PROPORTIONS of THE DIFFERENT DISTRICTS ARE ONLY APPROXIMATE.

Table 23: Names of degaans related to numbers given in Figure 24

Jalalaksi

1. Qobyaxaas
2. Isha raaso
3. Isha masaarule
4. Ukure
5. Qoraale
6. Buulo weyn
7. Shaw
8. Garbab
9. Fidow
10. Harar Luggle
11. Jibiley
12. Buur weyn
13. Jalalaksi
14. Qoryaale
15. Ceel ciid
16. Afcad

Bulo Burte

17. Dheriyo
18. Mukayle
19. Biyoneef
20. Buqda caqable
21. Bulo Burte
22. Jamecoshin
23. Aborey
24. Halgan
25. Muqokori
26. Maxaas

Ceel Bur

27. Dabare
28. Warxoolo
29. Wabxo
30. Dac
31. Ceel Qoxle
32. Ceel Garas
33. Xiin Dhere
34. Garabla
35. Galhareeri
36. Bergen
37. Jacar
38. Ceel Buur
39. Derri

Ceel Dhere

40. Budbud
41. Galcade
42. Nooleeye
43. Masagaweyn
44. Ceel Dhere
45. Cagacade

Haradhere

46. Ris
47. Dhalwo
48. Jawle
49. Dumaaye
50. Dabagallo
51. Camaaro
52. Caad
53. Hara Dhere
54. Ceel Huur

Hobbio District

55. Danle
56. Gawaan
57. Wisil
58. Bacaad weyne
59. Afgaduudle
60. Bajeela
61. Dawgab
62. Wargaloh
63. Dhajimaale
64. Colgula
65. Ceel Dibir
66. Xingod
67. Budbud
68. Sugule

Table 24: Summary of numbers and areas of districts, degaans, management plans, RLA's and reserves

District	Area (km²)	Degaans	Mngt plan (No)	Mngt plan (Area)	RLA's (No)	RLA's (Area)	Reserves (No)	Reserves (Area)
Hobbio	15,011	14	4	4065	4	4065	2	2335
Haradhere	7,671	9	-					
Ceel Dhere	6,952	6	5	6076	2	3197	2	1247
Ceel Bur	12,759	13	5	4192	1	1310	3	180
Bulo Burte	9,093	10	5	5782	9	8690	5	1454
Jalalaksi	3,930	16						
	55,314	68	19	20,115	16	17,262	12	5216

Table 25: Area (km²) of districts, degaans, reserves and areas for which there are management plans and organized RLA's

	Mngt Plan	RLA(1)	Area	Reserves Wet(2)	Reserves Dry	Reserves Total
Hobbio District						
Sugule	X	X	1932	1932		1932
Danle	X	X	403	403		403
Gawaan	X	X	911			
Budbud			1144			
Wisil	X	X	819			
Ceel Dibir			1015			
Xingod			895			
Dhajimale			1701			
Wargaloh			1073			
Dawgod			825			
Bajela			1548			
Afguduudle			845			
Bacaadweyne			800			
Colgula			1100			
			15,011	2335		2335
Ceel Dhere District						
Cagacade	X		1434			
Ceel Dhere	X	X	1924	699		699
Masagaweyn	X	X	1273	548		548
Galcade	X		1004			
Nooleye	X		441			
Budbud			876			
			6952	1247		1247

Table 25 (continued): Area (km²) of districts, degaans, reserves and areas for which there are management plans and organized RLA's

	Mngt Plan	RLA(1)	Area	Reserves Wet(2)	Dry	Total
Ceel Bur District						
Dac	X		582			
Wabxo	X		601			
Jacar	X		865			
Bergen			462			
Gal Hareeri			689			
Derri	X		834			
Ceel Bur	X	X	1310	160	20	180
Garable			1031			
Ceel Qoxle			563			
Xiin Dhere			2117			
Ceel Garas			1086			
Warxoolo			510			
Dabare			2209			
			=====	=====	===	=====
			12,759	160	20	180

	Mngt Plan	RLA(1)	Area	Reserves Wet(2)	Dry	Total
Bulo Burte District						
Aborey	X	X	1182	165	261	426
Maxaas	X	X	1587	243	89	332
Muqokoori	X	X	1314		365	365
Halgen	X	(-)	1168	141	409	550
Jimica shin	X	(-)	531	38	68	106
Buqda Caqable		(-)	506			
Mukayle		(-)	871			
Dharyo		(-)	611			
Biyoneef		(-)	403			
Bulo Burte			920			
			====	====	===	====
			9093	516	938	1454

Table 25 (continued): Area (km²) of districts, degaans, reserves and areas for which there are management plans and organized RLA's

	Mngt Plan	RLA(1)	Area	Reserves Wet(2)	Dry	Total
Haradhere District						
Ris			661			
Dabagallo			1512			
Tawle			590			
Caad			829			
Camaaro			991			
Dhalwo			718			
Ceel Huur			447			
Dumaaye			1119			
Haradhere			804			
			====			
			7671			
Jalalaksi District						
Afcad			397			
Ceel Ciid			407			
Qoryaale			246			
Bur weyn			235			
Buulo Weyn			206			
Gobyaxaas			428			
Isha Raso			277			
Qoraale			376			
Garbab			149			
Ukure			491			
Shaw			128			
Jibiley			71			
Fidow			103			
Jalalaksi			97			
Harar lugole			111			
Isha masarole			208			
			====			
			3930			

(1) X = RLA organized and functioning; (-) = RLA organized but not functioning
(2) Only 10% of any wet season reserve is actually rested in any one wet season.

7.2 INTERVENTIONS

Seven tree nurseries were established, one per district. These produced 176,800 tree seedlings which were used for planting 15 village shelter belts and 15 hectares of fuel wood plantations. Tree seedlings were also given out to individuals for use in 25 village tree planting programs. Eighteen small cement-lined water containers (berkeds) were constructed to hold water for nursery and tree planting activities (Figs. 25-30, Table 26).

Ninety-five hectares of sand dunes were stabilized, primarily near villages where houses, farms wells and roads were threatened. These dunes were first surrounded with 11,800 metres of live Commiphora spp. fencing. Live fencing was also used to protect small highly degraded areas near villages from further degredation.

Thirty-four dugouts were constructed in five districts to provide surface water for livestock. Only one dugout was unsuccessful. Special water harvesting systems were constructed for 10 dugouts to increase surface water flow into the dugout. Twenty-five existing shallow wells were repaired and/or upgraded in four districts. Twenty-two boreholes were drilled of which 9 were successful. The remainder either produced no water or produced water too saline for use. Two of the successful boreholes were equipped with civil works. Nine access sites were bulldozed along the Shebelle River to allow livestock access to water (Figs. 25-30, Table 26).

Two hundred eighty six km of track were constructed, primarily as access to dugout construction sites. Eighty-two km of existing roads were maintained to allow continued use by project vehicles - among other users. Six thousand eight hundred meters of fencing were constructed for a fodder farm in Bulo Burte District and an experimental range revegetation site in Ceel Bur District. An existing airstrip was maintained in Bulo Burte District and a new strip constructed in Ceel Dhere District. Control of water erosion was initiated at one site in Hobbio District (Table 26).

Nine wet season and 7 dry season grazing reserves were established in 4 and 2 districts respectively. Dry season reserves totaled 958 km^2. The area of wet season reserves was 4.258 km^2. However, only about 10% of the area of a wet season reserve is actually protected in any one season (Figs. 25-30, Tables 24, 25 & 26).

FIG. 25

HOBYO DISTRICT

DEGAANS AND INTERVENTIONS

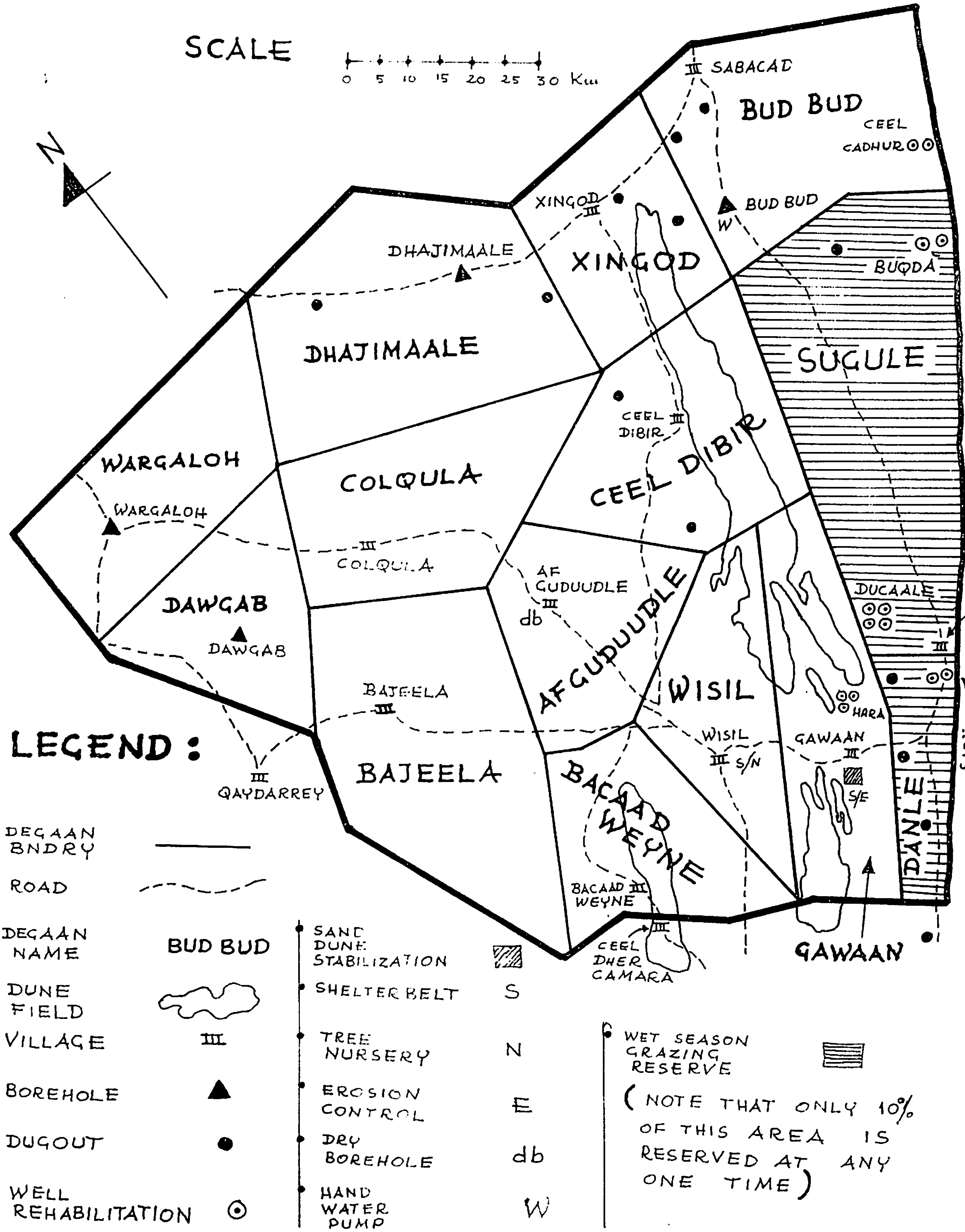


FIG. 26
HARARDHERE DISTRICT
DEGAANS AND INTERVENTIONS

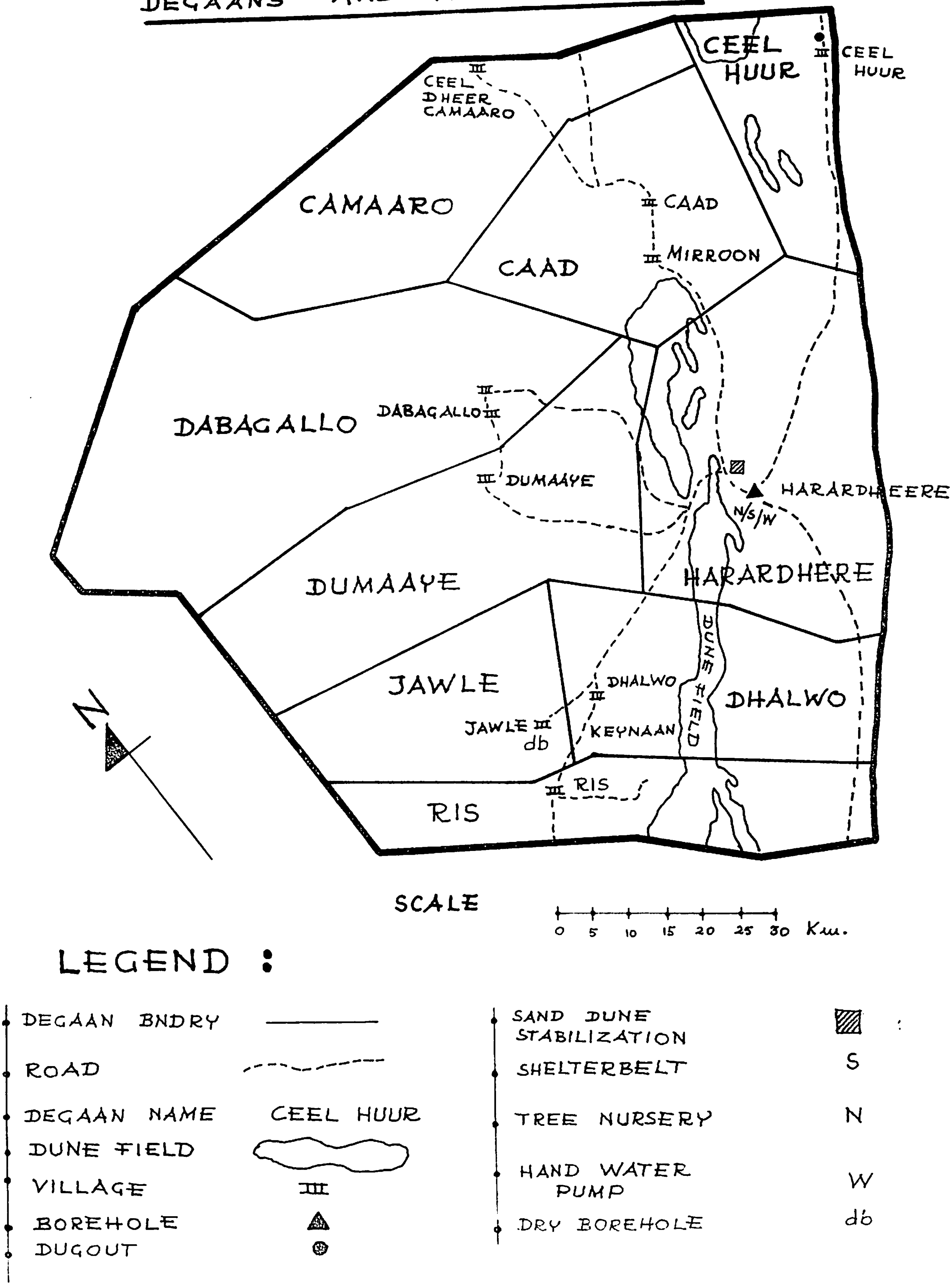


FIG. 27

CEEL DHER DISTRICT

DEGAANS AND INTERVENTIONS

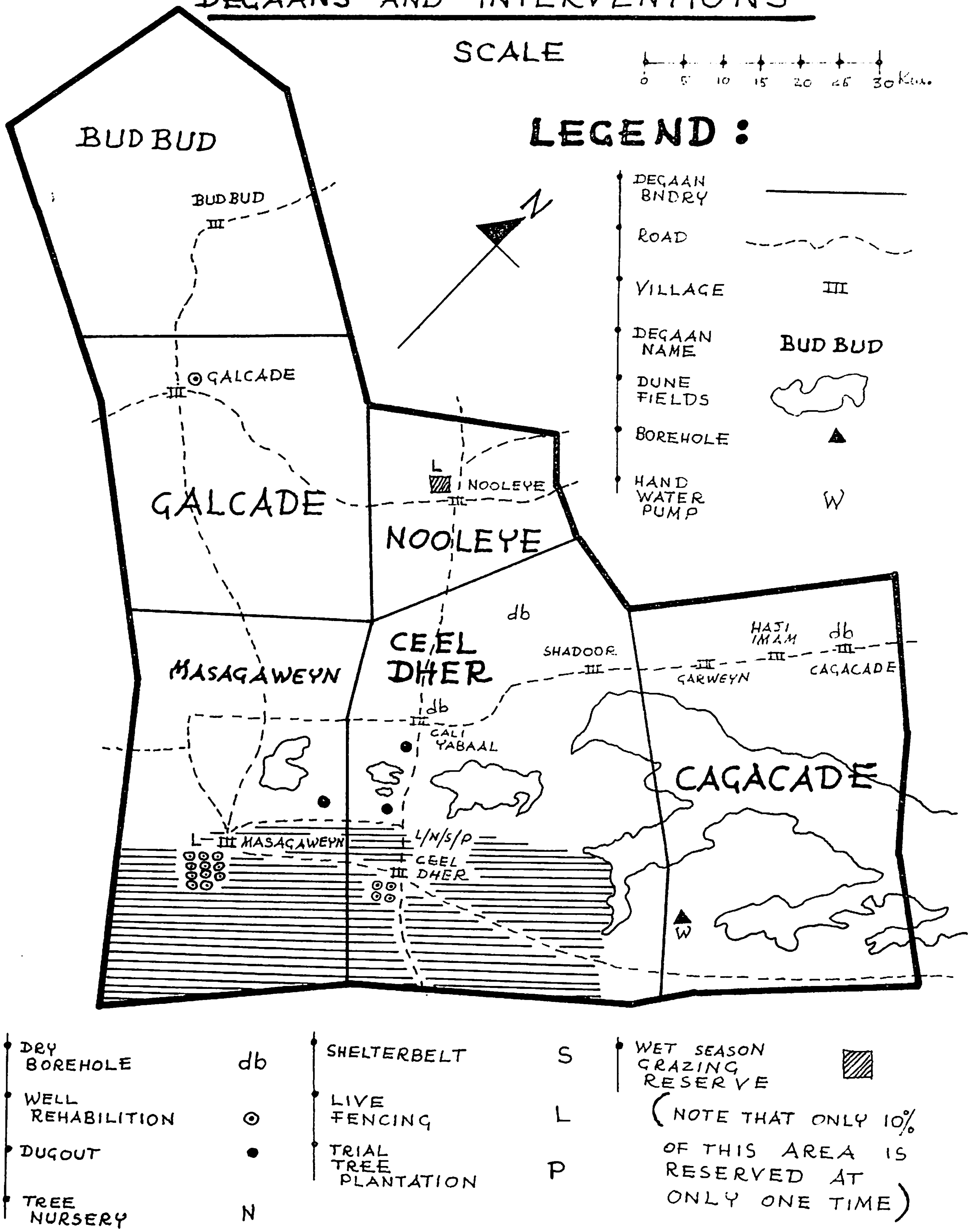


FIG. 28
CEEL BUUR DISTRICT
DEGAANS AND INTERVENTIONS

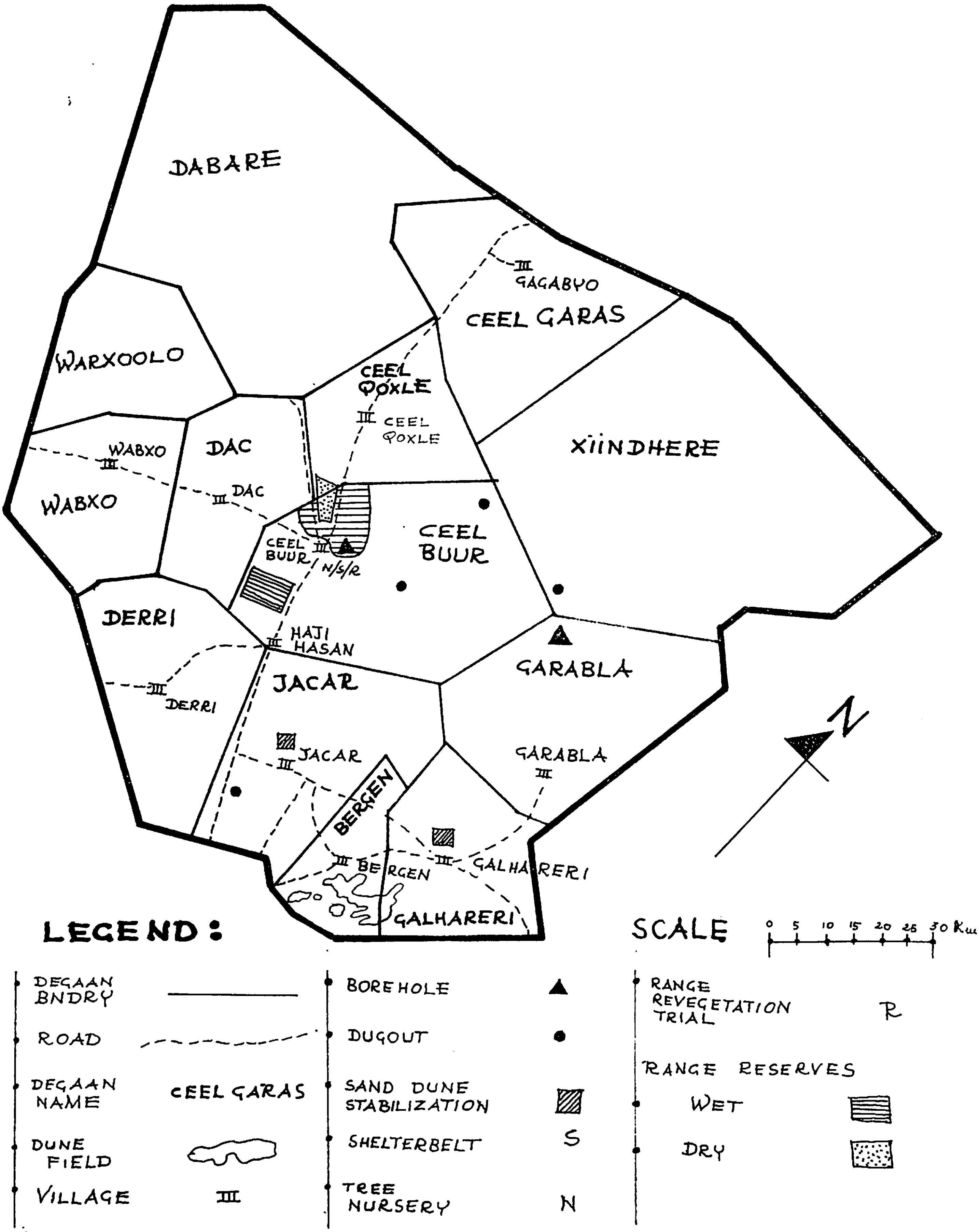


FIG. 29

BUULO BERTE DISTRICT

DEGAANS AND INTERVENTIONS

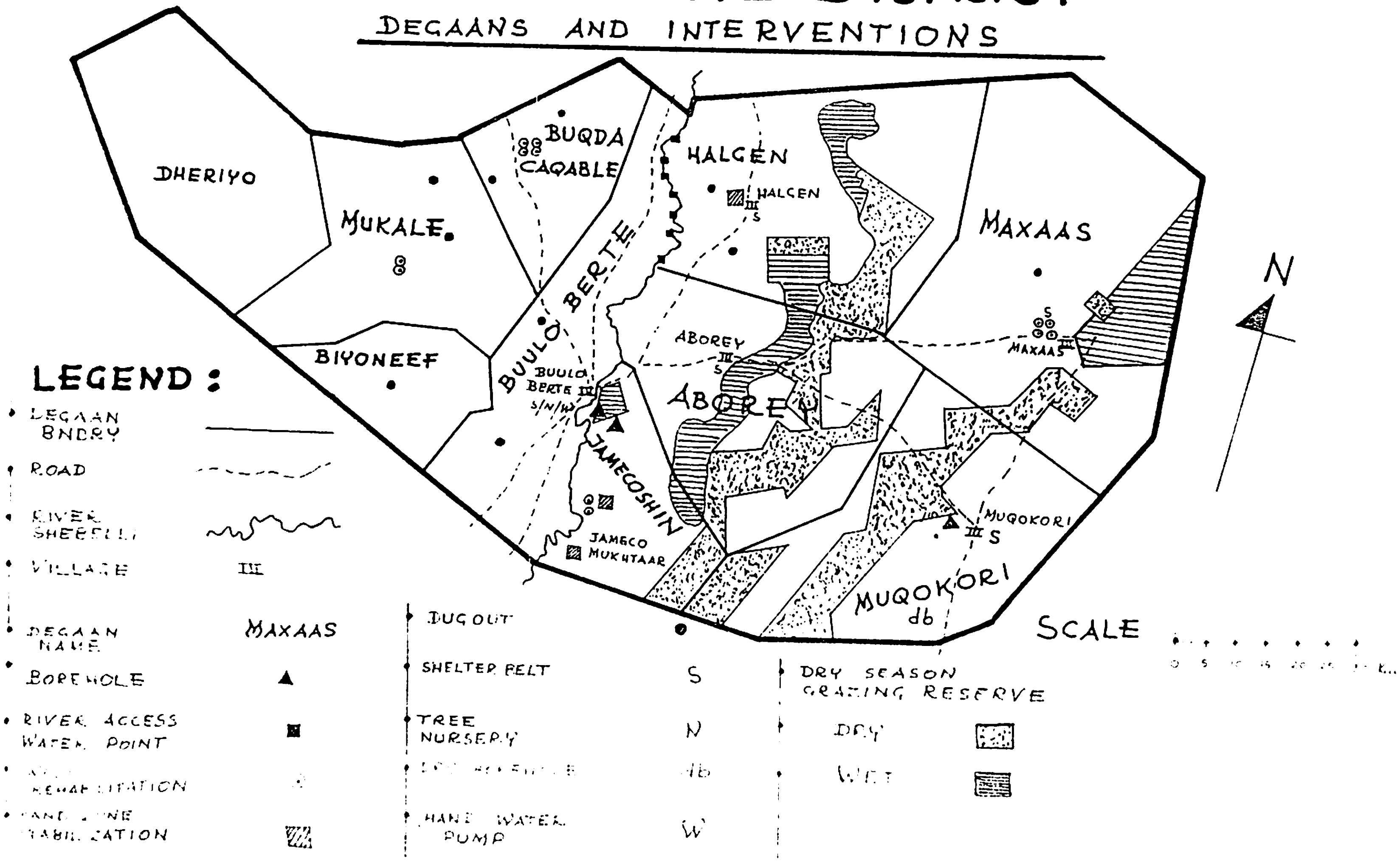


Fig. 30
JALALAKSI DISTRICT
DEGAANS AND INTERVENTIONS

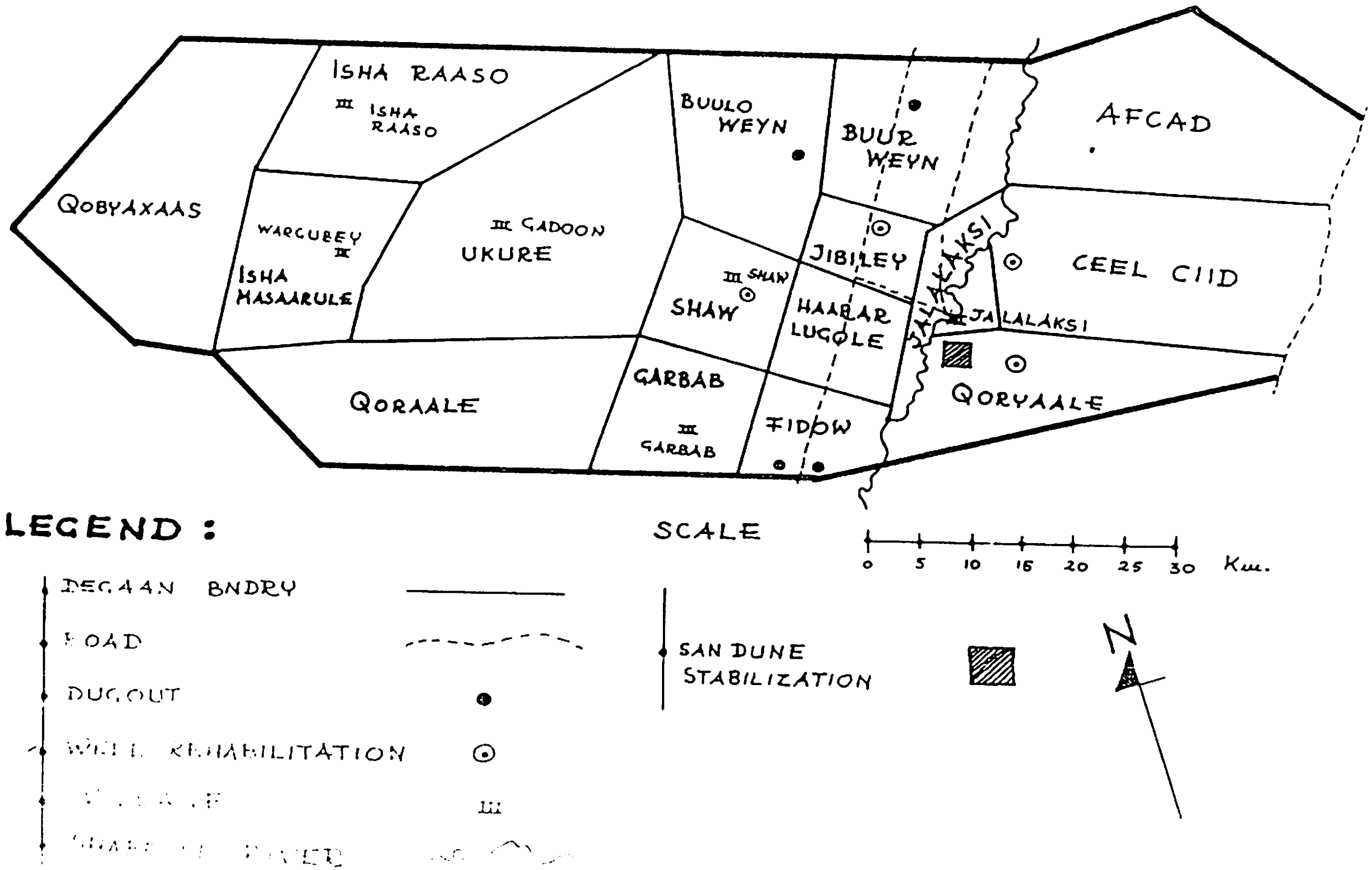


Table 26: Type and amount of range development interventions carried out by the project (1).

	Bulo Burte	Jala-laqsi	Ceel Dhere	Ceel Bur	Hobbio	Hara-Dhere	Total
Tree nurseries	1	1	1	2	1	1	7
Nursery seedlings (no)	60,000	30,000	37,500	13,500	21,300	14,500	176,800
Sand dunes stabilized (ha)	20	20	24	19	10	2	95
Sand dune fencing (m)	2,600		3,200	3,800	2,200		11,800
Shelterbelts (ha)	5	2	4	1	2	1	15
Shelterbelts fencing (m)	2,600	600	1,600	400	1,000	400	6,600
Village tree planting (no)	6	2	4	4	8	1	25
Village tree planting (km²)							
Dugouts (n)	11	1	4(3good)	4	14		34
Water harvesting dugouts (no)	5	1		4			10
Well rehabilitation	6	5	11		4		25
(no.drilled/no.good)	9/3		5/1	2/1	4/3	2/1	22/9
River access points (no)	9						9
Track construction (km)	200		54	2	30		286
Track maintenance (km)	80			2			82
Berkets (no)	5	4	3	1	4	1	18
Fuel wood plantation (ha)	12		3				15
Fodder farm fencing (m)	6,000			800			6,800
Airstrips (no)	1		1				2
Civil works (no)					2		2
Water erosion control (no)					3		3
Wet season grazing reserves(no)	4		2	1	2		9
Dry season grazing reserves (no)	6			1			7
Live fencing (no)			2				2
Range vegetation trial (no)				1			13

(1) Refer to Figures 25-30 for locations of interventions

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8. A RANGE DEVELOPMENT STRATEGY

8.1 WATER DEVELOPMENT

There should be no further development of large permanent water sources in good condition rangelands. Their chief utility should be in the supply of water in areas serving chiefly people or market livestock (Mascott, 1986). The possiblity of a borehole allowing improved use of a good condition rangeland must be carefully weighed against that of opening the area to uncontrolled use and rangeland degredation. In any case few extensive areas of good condition rangeland have yet been found.

Instead, stockwater development should emphasize the construction of relatively small, seasonal and less productive water sources, such as surface water dugouts and shallow wells. This is to better distribute livestock use through time and over area while keeping rangeland degradation to a minimum. The latter objective is insured by the low rainfall, sandy/rocky soils and generally deep and/or saline water table which restricts the size, number and distribution of potential dugouts and shallow wells. The small size of such interventions also improves the possibility that they can be maintained and administered by local groups of people.

The rehabilitation and/or upgrading of existing shallow wells should be continued. This has been a very successful, low in-put, high profile type of intervention. It requires little preparatory survey, has wide public acceptance, can be completed fairly quickly, has minimal environmental implications and can include a substantial in-put from the local community.

More appropriate technology should be introduced such as - where required - hand pumps and wind mill pumps. It is also worth attempting simple methods of clearing dugouts, such as with camel drawn scoops.

8.2 RANGE REHABILITATION

The most highly degraded rangelands should receive priority for rehabilitation measures. These include:

a. The heavy soils (silts and clays) of the Shebelli Valley and western Hiran Region.

b. Areas near major water points (usually within 3 to 10 km depending on the type and history of water supply).

c. Dry season use area, such as parts of the hawd (yicib/ Cordeauxia edulis); saline/gypsic depressions in Ceel Bur District (Dobera glabra) and transition shrub grassland in Ceel Dhere District.

d. Agro-pastoral areas

Deferred grazing is the principal method used to rehabilitate communal rangeland in order to ensure its effectiveness. It should be used primarily on degraded areas that are relatively small and accessible (and therefore manageable); with adequate project resources (people, transport, fuel and money) to establish and maintain the reserve; and a close involvement by the local RLA in the day to day operations. The results should be monitored in order to determine the degree of technical success.

There is a need to show the pastoralists a clear, practicable, useable result and to accustom them to the co-operative efforts and discipline necessary to achieve and maintain results with a minimum amount of support from the government. Success in this regard may encourage pastoralists to extend deferred grazing practices over larger areas and longer times.

The response to deferred grazing is expected to be fairly swift under normal rainfalls, at least on sands. A similar response by vegetation on heavier soils is also probable. Nevertheless it would be useful to establish fenced plots on representative sites that have been degraded to get a feel for the probable nature of response to protection.

The upgrading of agro-pastoral rangelands requires a strong extension and demonstration approach, supported by research, which is directed at individual agropastoralists. The overall program requires a number of activities including (a) crop and fodder improvement, (b) live fencing, (c) agroforestry, (d) surface water runoff trials and (e) soil conservation.

The accrued benefits are expected to be (a) improved rangeland quality and productivity; (b) improved crop productivity; (c) reduced shrub cutting and (d) reduced soil erosion.

Range inventory findings can be used to suggest plant species for possible inclusion in agro-pastoral "packages".

8.3 RANGE CONSERVATION

An attempt should be made to preserve as much of the remaining stands of "climax" (original) vegetation within agropastoral areas as possible. This is because such stands are high quality (the best in fact) browse habitat as well as sometimes also valuable producers of wood products. These stands also often have a high genetic diversity. Examples are Terminalia spinosa woodlands in western Hiran Region, *Terminalia spinosa* bushland in Hobbio District and *Commiphora* spp. shrubland thicket in Ceel Dhere District. The feasibility should be determined of managing some of the woodland and bushland stands for both forage and wood products.

8.4 VILLAGE-RELATED DEVELOPMENT

Village-related development activities should be continued. These should include the nursery raising of plant species with a wider range of possible uses (fruit trees, forage or multiple purpose shrubs and trees, live fencing species and grasses and leguminous herbs of high forage quality.

More emphasis should probably be put on village tree plantings and the provision of plants to agropastoralists for use in their fields.

Simpler methods (i.e. protection by fencing and guards) should be tried in reclaiming eroded areas near villages including locally derived (and relatively small) sand dunes. Should this approach be successful it would save a considerable amount of money and man power - although not time - for the project.

Live fencing should be the primary method used to fence sand dunes and other degraded areas near villages. Once established, such fences require little maintenance, which should reduce the need to cut shrubs in the village vicinity.

8.5 RANGE AND LIVESTOCK ASSOCIATIONS

Increased emphasis should be placed on the use of RLA's to ensure the most grass roots participation in, and benefit from, range development and management interventions. A restructuring of the RLA organization may be necessary to make it more representative of the local pastoralists, agropastoralists and villages and to allow greater local participation in range/community development. The possibility of including smaller, more localized, groups, such as sub families, villages, agropastoralists and women as basic RLA components should be investigated.

RLA's should participate in the planning, construction, administration and maintenance of range development interventions to the greatest extent possible. The scope of RLA activities should also be widened. Potential activities include water development, tree planting, road construction and repair, animal health (such as in the bare foot veterinarian (NAHA) program, education (range management practices, etc). To carry out an effective RLA program will require a considerable increase in extension activity by the project directed specifically to this end. This will not only involve initial surveys and RLA organization but also a commitment to continue a significant extension presence in each RLA over the long term.

8.6 "KEY" SPECIES

A number of plant species have been identified by the project as being of particular value for the support of livestock populations (and other types of use) within the Central Rangelands. Range management should now emphasize the conservation and improvement of these "key" species over other plant species because this is the most efficient way to improve the long term productivity of the community as a whole. Key species should also be emphasized - together with indicator species-in range trend monitoring. Finally, the biology and ecology of "key" species should be given further study so that their potentialities are better understood. Special attention should be devoted to Yicib (Cordeauxia edulis) and other evergreen shrubs because of their value as dry season forages and (at least in the case of yicib) extreme sensitivity to land use impact.

8.7 RANGE SURVEY AND MONITORING

Those plant species identified by the project as "indicator" species should be incorporated into the existing guidelines for the classification of range condition. Their presence should also be a major criteria used in selecting high precision permanent range trend monitoring plots and in the subsequent monitoring and evaluation of range trend. It should be understood, however, that their indicator value is only applicable to the present survey area until proven to be of more extensive application.

The long term range trend monitoring program should be continued based on the preliminary work of phase I of the project. The first step should be the development of a suitable "high precision" permanent range trend sample plot for placement within the mapped "management" units and the remeasureemnt of the existing "low precision" permanent range trend sample plots.

Specific monitoring programs should be established for at least one example each of wet and dry season grazing reserves to determine the effectiveness of these deferred grazing systems. Monitoring of dry season reserves should specifically emphasize the response to protection of the key, evergreen, dry season forage species.

The range inventory of the Central Rangelands should be continued. This is necessary to determine the basic nature of the rangeland resource but especially range condition, vegetation dynamics, forage value (and other uses), key and indicator species. A standardized survey format should be used, especially for the classification of range condition. The methodology should be capable of application by counterpart staff.

8.8 RANGE RESEARCH

The cooperative field research effort between the Range Ecologists and Faculty of Agriculture staff during phase I was very productive. It produced several publications, insight into the ecological processes of the Central Rangelands, and their practical implications as well as first hand material for use by instructors at the University. A similar effort should be encouraged in the future.

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