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RANGE RESOURCES AND GRAZING POTENTIALS IN SWAZILAND

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RANGE RESOURCES AND GRAZING POTENTIALS IN SWAZILAND

A INTRODUCTION

1. Background and Objectives

For a number of years there has been growing concern that Swaziland's range resources are becoming increasingly overstocked, resulting in range degradation and soil erosion. However, it has also become recognized that stocking rate recommendations designed for commercial production are not necessarily appropriate for traditional production systems in communal areas, where the management objectives differ markedly from those of commercial enterprises. A need was recognized (particularly for Swazi Nation Land) for a survey and assessment of the present status of the nation's range resources, for formulation of guidelines for reasonable stocking rates in the different ecological zones, and for recommendations on grazing management and improvement.

This study results from a request to FAO from the Government of Swaziland for provision of technical expertise to an on-going FAO project "Land Use Planning for Rational Utilisation of Land and Water Resources" to undertake a rangelands resource survey. The input was to have been provided under a planned FAO/UNDP project "Rangeland Development and Training", but it was cancelled before becoming operational. A subsequent recommendation by World Bank for a livestock sector review led to the formulation of the FAO/UNDP project TCP/SWA/2353 to combine the two requirements. This vegetation map and report forms part of the overall livestock sector review report, but is also intended to be usable as a standalone document.

The objective of the mapping exercise has not been to delineate every plant community, but to distinguish units of functional equivalence for grazing livestock. Physiographic, soil, topographic and climatic characteristics have therefore been considered as well as vegetation.

2. Methodology

Moisture zones (Map 1) and thermal zones (Map 2) for Swaziland have recently been determined and related to physiographic zones (Map 3) and soil types to produce a map of agro-ecological units (FAO; 1992, 1993). Using satellite imagery interpretation, ground truthing and previous vegetation mapping for Swaziland (I'ons, 1967) and southern Africa (Acocks, 1988), a revised vegetation map of Swaziland has been produced (Map 4), which relates vegetation types to the agro-ecological units (AEUs).

The botanical composition of Swaziland's rangelands is remarkably complex and variable, and plant communities can only be mapped at scales considerably larger than those appropriate for national or regional planning. Current land use and management influences on vegetation structure and composition often mask natural vegetation boundaries and therefore the physiognomic classification takes a broad perspective, grouping AEUs which share common characteristics of physiography, climate, soils and vegetation into units which are functionally different in respect of their grazing potential. Some of the mapped units share essentially similar species, particularly in the highveld group, but other characteristics int1uencing grazing potential (such as climate, topography, soils) warrant their separation. Similarly, there are other instances where certain key species cross their delineated boundary into an adjacent unit but physiographic or other characteristics determine the vegetation unit boundary. In order to ensure compatibility of the vegetation data with other land use data, and to meet the objective of mapping units of functional uniformity, the vegetation unit boundaries all correspond with AEU boundaries.

The study was undertaken during a five month period between January and June 1994. After a preliminary stratification for sampling purposes, fieldwork initially was based upon transects using a wheel point apparatus to record percentage cover of all species in the grass and woody layers. However this was found to be inordinately time consuming in relation to the total time available, the area to be sampled and the degree of local variation. The sampling procedure was therefore modified to visual appraisals and the compilation of species lists with subjective assessments of the relative abundance of the constituent species. Current usage, range condition and soil erosion were also noted for each sample site. Discussions were held with a range of knowledgeable people involved in livestock and wildlife management and the preliminary vegetation boundaries were gradually refined in an iterative process of mapping and verification.

It must be stressed that time did not permit detailed sampling of all the land use and management related variations within the vegetation units, and that in many instances the vegetation that could be sampled was so impacted by human intervention that assessment of the inherent vegetation type and species composition was inevitably subjective. The compilation of vegetation units sharing the broader characteristics already mentioned does however compensate for this limitation. The map attempts to portray the vegetation types that exist, or probably would exist, under moderate stocking pressures and under the periodic influence of fire such as would occur naturally. It is in reasonable agreement with that of I'ons (1967) but delineates more units owing to the inclusion of physiographic, climatic and soil features.

B THE RANGELAND RESOURCES

Swaziland occupies a total area of 17,370 sq. km of which approximately 64% has been classed as grazing land (Annual Statistical Bulletin, 1991). However considerable portions of this exist in arable/grazing/ settlement mosaics and have been drastically modified by cultivation, wood extraction and heavy grazing such that it is arguable they are no longer true rangelands supporting predominantly natural vegetation .

1. Physiographic and Agro-ecological Zones

Swaziland has long been recognized to have at least four broad agro-ecological zones (AEZs) distinguished by altitude, rainfall and geography: highveld, middleveld, lowveld and the Lubombo ridge. In terms of physiography, the middleveld and lowveld both contain two distinct zones: upper and lower middleveld (separated by altitude and g ology), and eastern and western lowveld (separated by geology). The physiography of Swaziland has recently been studied and mapped in greater detail (Map 3), resulting in some modification of previously accepted boundaries. The areas, characteristics and broad vegetation types of the six physiographic zones, which are also agro-ecological zones, are summarised in Table 1.

Table 1: Physiographic Zones of Swaziland

Physiographic Zone	Area (sq. Km)	Altitude (m)	Rainfall (mm)	Geology	Vegetation Type
Highveld (HV)	5,680	900-1400	700-1200	Granite	Short Grassland with forest patches
Upper Middleveld (UM)	2,420	600-800	700-800	Granodiorite Granite	Tall grassland with scattered trees and shrubs
Lower Middleveld (LM)	2,420	400-600	550-700	Gneiss	Broad leaved Savannah
Western Lowveld (WL)	3,410	250-400	450-550	Sandstone/ Clay-stone	Mixed Savannah
Eastern Lowveld (EL)	1,960	200-300	400-450	Basalt	Acacia Savannah
Lubombo Ridge (LR)	1,480	250-600	550-850	Ignimbrite	Hillside bush and plateau Savannah

The altitudes given are the mean ranges for each zone, not the full extremes. Moisture zones do not correspond exactly with physiographic zones and the data presented show the ranges of annual rainfall that can be expected with 80% probability for each physiographic zone, based on analysis of 30 years data from 41 rainfall stations (FAO, 1992).

2. Land Use in the Agro-Ecological Zones

Current estimates of the areas under different forms of land use in each AEZ are summarised in Table 2. The two types of grazing land usage are ranching, which is mostly on Title Deed Land (TDL) but also includes government and Tibiyo ranches on Swazi Nation Land (SNL), and communal grazing, which is essentially all on SNL. The ranch land on SNL is no longer communal but equivalent to TDL and, as an up to date land tenure map is not presently available, it has been grouped with TDL. Hence throughout this report the term TDL includes ranches on SNL, and the term SNL excludes those ranches. As stated earlier, much of the grazing land in SNL is in arable/settlement/grazing mosaics in which the different land uses cannot be separated at the mapping scale used (1:250,000), so categories with different proportions of grazing have been identified.

The designated grazing areas in SNL are available for year round grazing, while the reciprocal part of each of the grazing categories is mainly small scale arable land which becomes available to livestock from approximately May to September. The separate category of cropland comprises commercial production on TDL, including pineapples, citrus, sugar and other medium to large scale rainfed annual cropping, and is not normally available to livestock.

AEZ	Land Use Are (Square Kilometers)									Total
	Wildlife	Forestry	Urban etc.	Ranching	Grazing > 75%	Grazing 50-75%	Grazing 25-50%	Grazing < 25%	Crop Land TDL	
HV	201	1,326	32	496	3,225	266	82	30	11	**5,669**
MU	9	68	55	279	1,559	217	70	37	121	**2,415**
ML		7		580	943	615	171	44	63	**2,423**
LW	148		26	1,004	924	607	224	122	361	**3,416**
LE	147		12	642	383	119	15	190	455	**1,963**
LR	161			328	740	86	93	48	28	**1,484**
Total	**666**	**1,401**	**125**	**3,329**	**7,774**	**1,910**	**655**	**471**	**1,039**	**17,370**

Source: FAO (1994 in Prep.)

The urban category includes areas of residential, industrial and recreational use as well as major dams, but excludes rivers and small stock watering dams. It represents an insignificant proportion of total land use in the country, totalling only 0.7%. The forestry category represents plantation forests only. The wildlife category includes all wildlife and nature reserves and reserved hunting areas, from which domestic stock are prohibited. Wildlife and forestry account for 4% and 8% respectively of total area of Swaziland, and medium to large scale cropping is only 6%. Ranching land occupies 19% of the country, mainly in the lowveld. The balance is a variable mix of grazing and cropland.

Using the data from Table 2, estimates of the areas of SNL grazing land in each AEZ have been derived by multiplying the areas of each category of grazing availability by the mean value of the category, and summing them together. The individual areas were thus multiplied by 0.875, 0.625, 0.375 and 0. 125 for the four mixed use categories respectively, and the results are shown in Table 3 together with the derived estimates for TDL grazing areas and for total SNL including cropland. The TDL grazing (ranching) and SNL grazing occupy 19% and 48 % of the country respectively, while the total SNL is approximately 62%. The total SNL figure is important in that the bulk of the non-grazing part is cropland or fallow and available for dry season access by livestock; it is therefore a more appropriate figure for calculation of SNL stocking rates than the grazing area alone.

The estimates of areas available for grazing include relatively inaccessible and unutilized areas of steep slopes, ravine forest and thick bush, but these factors are considered in the delineation of vegetation units and assessment of grazing potential.

The total area of Swaziland available for livestock summer grazing, and excluding cropland and fallows, is thus estimated to be 11,630 sq. km or 67% of the country. This figure seems to be in close agreement with the 1991 Swaziland Statistical Bulletin figure of 64%, but the latter presumably included the wildlife grazing areas and so there is some discrepancy. Visual assessments during fieldwork suggest that the proportion of SNL cropland to grazing land is higher than that interpreted from satellite imagery and indicated in Table 2; however they are the best estimates available.

Table 3 Grazing and Cropping Areas Available To Livestock in Each AEZ

AEZ	TDL Grazing		SNL Grazing		Total SNL	
	Sq. Km	%	Sq. Km	%	Sq. Km	%
HV	496	8.7	3,023	53.3	3,603	63.6
MU	279	11.6	1,531	63.4	1,883	78.0
ML	580	23.9	1,279	52.8	1,773	73.2
LW	1,004	29.4	1,287	37.7	1,877	54.9
LE	642	32.7	439	22.4	707	36.0
LR	328	22.1	742	50	967	65.2
Total	**3,329**	**128.4**	**8,301**	**47.8**	**10,810**	**62.2**

3. Influence of Land Tenure

Livestock ownership objectives, stocking rates and grazing management practices, and hence the current status of the country's grazing resources, are strongly related to land tenure. In general the objectives in the communal areas (SNL) are stock accumulation and maximising production per unit area, while in the commercial ranches of the TDL the objectives are turnover and high rates of production per head; stocking rates in the former tend to be pushed to the ecological limits while in the latter they are adjusted for an economic optimum. However, there is not a simple dichotomy between SNL and TDL as the latter includes many small scale farms which are managed with traditional rather than commercial objectives.

Estimates of livestock grazing areas by land tenure and agro-ecological zone are shown in Table 3. The TDL grazing land includes a broad spectrum of management from unfenced small scale traditional to large scale fenced commercial, and includes some absentee ownership land with no enterprises at all. The satellite imagery derived estimates of SNL land inevitably include a small amount of small scale TDL, but it is thought not to exceed 10%, and is probably compensated by communal access to areas not strictly SNL. The figures in Table 3 are can therefore be taken as a close approximation of reality.

As noted earlier, livestock in the SNL also have general access to fallow lands (except where the fallows are considered too close to the croplands) and dry season access (from approximately May to September) to harvested croplands, and stocking rates expressed only in terms of grazing land are misleading.

4. Vegetation Characteristics of the Agro-ecological Zones

The highveld is the wettest and coolest part of the country, and supports a dense but short to moderately tall grassland which loses its nutritive value in the winter becoming "sour" so that the useful grazing season is only 7 to 8 months under normal management. The dry season constraint can be alleviated by very low stocking rates to permit selective grazing (as practised in the nature reserves), by provision of feed supplements (as practised by commercial farmers), by early winter burning to stimulate fresh regrowth from root reserves (as used to be practised by South Africans bringing in "trek sheep" for winter grazing), or by the use of crop residues and some late winter burning (as practised by SNL stock owners). The woody component is unsuitable for browsing by domestic stock. The highveld climate is favourable for cropping but cultivation is limited due to slope steepness; grazing areas tend to be the steeper slopes and range degradation/soil erosion is becoming locally pronounced although not yet extensive.

Under light to moderate grazing the middleveld supports tall grasses which have a high carrying capacity in the growing season and provide useful grazing for 9 to 10 months per year but become coarse and unpalatable (sour) when mature . Under heavy grazing these give way to short grasses with a lower dry matter production potential but which provide a higher degree of utilisation and livestock production potential in the dry season. The upper middleveld SNL is intensively cultivated and has the greatest grazing constraint, with locally severe range degradation and soil erosion, particularly on light erodible soils and on slopes too steep for cultivation. The woody component naturally increases in density from the upper to lower middleveld, and bush encroachment is seriously reducing herbage production in some areas of the latter. In the lower middleveld there are pronounced differences in bush density between unfenced SNL and fenced TDL; clearing for cultivation, and extraction of firewood and building material has removed the majority of trees and shrubs from the SNL, while inadequate frequency of really hot fires, heavy grazing by cattle, exclusion of browsers, and protection against cutting have resulted in problematic bush density in the majority of fenced ranches.

The lowveld is the lowest rainfall zone and supports savannah vegetation in which there is a delicate balance between the grass and woody components, such that the relative densities are highly variable. The grasses tend to be "sweet" in that they maintain reasonable nutritive value and acceptability to livestock in the winter dry season but under heavy grazing they are less resilient than those in the moister middleveld and highveld regions, and give way to less palatable and less productive species. A high proportion of the woody species provide useful browse, and browsing animals can play a useful role in containing bush encroachment. As with the lower middleveld, there are pronounced differences in woody density between SNL and TDL (including nature reserves) and for the same reasons. Where periodic hot fires do occur, the savannah is noticeably more open and the best grazing conditions are to be found in the fire-derived stretches of Acacia nigrescens/ Panicum maximum parkland savannah on the basalt plains of the eastern lowveld.

The Lubombo ridge is the smallest physiographic unit and is predominantly a rugged plateau supporting a broadleaf savannah with similar species to the lower middleveld and the grazing is moderately sour. The western part of the ridge is a steep and rocky escarpment with dense bush but the lower slopes provide useful grazing with sweetveld grasses.

5. Vegetation Units and Grazing Areas

A total of 22 vegetation units have been mapped and described (see Section F). The total areas of each unit and the percentages under different forms of land use are summarised in Table 4. The prefix letters of the vegetation units correspond to the AEZ in which the units predominantly occur. The category of urban and water has been omitted as it is an insignificant part of land use, but otherwise the categories are the same as in Table 2 for the AEZs.

The units with the largest proportions of non-grazing forms of land use are H1 (wildlife and forestry), H2 (forestry), H5 (forestry), UM4 (pineapples), UM5 (forestry), WL2 (sugar and wildlife) and EL2 (sugar and wildlife). Estimates of the areas of SNL grazing, total grazing and total SNL can be derived for the vegetation units as in Table 3 for the AEZs.

Table 4 Land Use In Vegetation Units

Vegetation Unit	Area of Unit (Sq. km)	Percentage of Area Under Each Form of Land Use								Total
		Wildlife	Forestry	Ranching	Grazing >75%	Grazing 50-75%	Grazing 25-50%	Grazing <25%	Crop Land TDL	
H1	838	21.7	12.9	0.1	64.5	0.4	0.0	0.0	0.0	100
H2	1,695	1.1	40.2	5.2	48.5	2.4	0.9	0.0	0.0	100
H3	1,484	0	15.9	20.5	59.9	3.0	0.6	0.0	0.0	100
H4	211	0	0	1.5	61.4	37.1	0.0	0.0	0.0	100
H5	1,441	0	20.9	6.9	58.5	6.8	4.0	2.1	0.8	100
UM1	346	0	0	0	96.3	3.7	0.0	0.0	0.0	100
UM2	333	0	0	0	96.6	3.4	0.0	0.0	0.0	100
UM3	922	0	0	25.1	55.6	13.1	1.6	0.0	2.1	100
UM4	469	1.8	1.9	3.3	35.7	11.2	10.4	7.2	21.7	100
UM5	224	0	25.7	0	70.1	0.0	2.8	1.3	0.0	100
UM6	155	0	0.8	21.2	64.3	13.7	0.0	0.0	0.0	100
LM1	1,502	0	0.4	25.8	22.5	33.9	10.7	2.7	4.0	100
LM2	531	0	0	39.2	51.4	5.5	1.4	1.1	1.5	100
LM3	423	0	0	0.3	80.6	18.0	1.0	0.1	0.0	100
WL1	1,159	0.8	0	30.9	31.1	23.6	2.0	7.1	2.2	100
WL2	1,345	10.3	0	26.9	24.8	11.7	7.0	1.8	17.6	100
WL3	913	0	0	31.2	25.1	19.3	11.8	1.8	10.9	100
EL1	1,005	0	0	40.2	29.9	8.4	1.5	5.1	14.2	100
EL2	1,098	17.2	0	25.7	8.8	3.2	1.7	13.6	29.4	100
L1	195	0	0	29.4	62.7	0.3	4.3	2.7	0.6	100
L2	418	0.5	0	24	33.8	18.7	15.8	6.1	1.1	100
L3	663	17.6	0	16.4	63.2	1.1	0.0	0.6	1.0	100
Total	**17,370**	**3.8**	**8.1**	**19.2**	**44.7**	**11.0**	**3.8**	**2.7**	**6.0**	**100**

For the purposes of stocking rate and carrying capacity assessments, all non-grazing areas of SNL are considered to be crop or fallow land equivalent to grazing land available in winter. However, the proportions of each community area that are under cultivation and grazing are important in determining whether feed availability is more likely to be a constraint in summer or winter, and whether overgrazing of the summer grazing can be expected. On the basis of a maximum of 4 months useful access to crop residues, fallow lands and interstitial grassy patches within the cropping areas, the ratio of summer grazing area to winter cropping area should be at least 2:1, or 66% to 33%. The percentages of SNL grazing and arable areas in each vegetation unit are given in Table 5 which shows that a massive 56% of EL2 SNL is already cultivated and that a further five units are at the limit of the 2:1 ratio . These percentages are the averages for each unit, so there must already be a number of chiefdoms within these units that are experiencing problems of summer grazing shortage.

Vegetation Unit	Grazing % of SNL	Cropping % of SNL
H1	87.3	12.7
H2	85.5	14.5
H3	85.8	14.2
H4	78.1	21.9
H5	80.1	19.9
UM1	86.6	13.4
UM2	86.6	13.4
UM3	81.7	18.3
UM4	66.7	33.3
UM5	84.2	15.8
UM6	83.1	16.9
LM1	64.8	35.2
LM2	82.7	17.3
LM3	82.4	17.6
WL1	68.4	31.6
WL2	70.3	29.7
WL3	66.7	33.3
EL1	72.6	27.4
EL2	44.1	55.9
L1	81.4	18.6
L2	64.5	35.5
L3	86.3	13.7
Total	76.8	23.2

6. Stock Distribution by Ecological Zone

The proportional distribution of livestock by land tenure in the major ecological zones is summarised in Table 6. These figures represent the situation after the 1991/92 drought in which there were considerable mortalities, particularly in the lowveld SNL. The lowveld normally supports the majority of livestock and prior to the drought the percentages of SNL cattle in the lowveld and middleveld were 44% and 31 % respectively.

The major livestock enterprise in Swaziland is beef production and the majority of holdings are in the lower middleveld and the lowveld. The highveld has the largest land area but only 50-60% of the livestock population size of the middleveld and lowveld, due partly to less favourable winter grazing but mainly to the low settlement density. The Lubombo is also relatively lightly stocked, due to being behind the foot-and-mouth barrier, which constrains stock movements and sales. The larger TDL enterprises tend to be run on a commercial basis and implement lenient stocking rates which permit high rates of individual animal liveweight gain, but the objectives and management practices in many of the smaller TDL holdings are little different to those in the SNL.

Table 6 Swazi Nation Land (SNL) and Title Deed Land (TDL) Livestock Distribution by Agro-Ecological Zone

Zone	Area %	Cattle (%)		Sheep (%)		Goats (%)		Total LSU (%)	
		SNL	TDL	SNL	TDL	SNL	TDL	SNL	TDL
Highveld	33	24	21	38	24	18	31	23	21
Middleveld	28	38	44	32	35	30	37	38	44
Lowveld	31	333	30	27	32	49	28	35	30
Lubombo	8	5	5	4	9	3	4	4	5

Source: Analysis of 1993 Dip-tank data

7. Range Condition and Soil Erosion Range Condition

Range Conditions

Stocking rates in the SNL tend to be higher than those in commercial enterprises but they are not necessarily unsustainable, and both carrying capacity and range condition assessments should be qualified in terms of the production objectives. The botanical composition in the communal areas might no longer satisfy commercial livestock production objectives but it does generally meet the SNL requirements. Carrying capacity determinations for SNL rangelands are further complicated by the significant contribution of crop residues to the livestock diets during the winter months. This aspect is considered further in the assessment of grazing potential in Section C.

Owing to the moderate stocking rates applied in the commercial ranches, the range condition in context of the herbaceous layer is generally fair to good considering that the country has just come through a serious drought. However, bush encroachment is seriously problematic on the majority of fenced ranches in the lower middleveld and lowveld, due to exclusion of fire and browsing animals. In SNL there is more variability due to localised settlement, cultivation and grazing pressure. There are substantial areas in fair condition, particularly in the highveld, but there are also substantial parts of SNL in poor condition and areas of severe localised erosion, although there are now fewer animals than before the drought. Bush density is generally less of a constraint in SNL than in TDL due to cutting and browsing.

Soil Erosion

In a geomorphological context of soil erosion there are three distinct areas in Swaziland. The highveld is essentially rock and therefore resistant to erosion, the lowveld has only gentle slopes and has been through the evolutionary process of erosion, but the middleveld is largely characterised by moderately steep slopes and deep soils which have yet to be eroded, and is therefore the physiographic unit at most risk. Sheet and gully erosion are locally problematic and tend to be related to interactions of the four factors of a) slope steepness, b) soil depth and erodibility, c) grazing pressure, and d) regular animal tracks or animal concentrations. Poor road and road drainage design in hilly areas is a contributory factor to gully erosion. Swaziland is unusual for a hilly country in that cultivation related soil erosion has been virtually eliminated by the establishment of grass strips within fields, and hence the current erosion problem is primarily livestock related. It is also confined almost exclusively to SNL.

Overgrazing of hillsides leads to depletion of vegetative cover and then to sheet, and sometimes gully, erosion. Similarly, dip tanks on slopes tend to be characterised by bare ground and sheet erosion at the entrances and exits. Cattle tracks, however, can become drainage channels and are more likely to lead to gully erosion. The deep red loams are particularly vulnerable to deep gullying, while the interaction of soil texture and slope determine the erosion hazard under grazing. For each soil type there appears to be a critical slope on which dip tanks, cattle tracks or heavy grazing are likely to become problematic. In the sandier and flatter parts of the lowveld, cattle tracks and narrow bands of erosion become prominent along the drainage lines.

The Swazi people do not customarily maintain separate households for livestock and for cropping, nor split their herds and households for herding purposes, as in other parts of Africa, hence livestock are closely linked to areas suitable for cultivation. Areas with more arable potential support more households and hence more livestock, and the erosion problems are most pronounced in, or adjacent to, the fertile soils of the upper middleveld SNL, and in those chiefdoms of the highveld with the most cultivable land. In hilly locations the grazing areas tend to be confined to the steeper slopes, however some of the most severe degradation and erosion problems occur on the deeper soils of the flatter areas. The chiefdom boundaries appear strong, and eroded areas in one chiefdom are sometimes located within a few kilometres of more than adequate grazing in another. Overgrazing leading to erosion is also conspicuous on some of the steep hillsides of the highveld and upper middleveld bordering intensely cultivated areas of the lower middleveld or lowveld. The Lubombo plateau has steep slopes and erodible soils but the stocking pressures are lower than in the middleveld and there is little sign of erosion.

The main areas where range depletion and/or soil erosion is serious are the western slopes of the Ponjwane Hills (H2), the western slopes above the Grand Valley (H3), the Kapunga plateau (UM2) , the Mhlosheni and Sigombeni/Emangicineni areas (UM3) , the Lukonde plateau (UM5), much of unit WL3, and the north-western part of unit EL1.

C ASSESSMENT OF GRAZING POTENTIAL

1. Factors Influencing Grazing Potential

Grazing (and browsing) potential is dependent upon the quantity and quality of the vegetation on offer. The principal determinants of inherent floristic composition and primary production are climate (mainly rainfall) and soils (texture, depth and fertility), although slope exerts an influence on soil depth and rainfall run-off/infiltration.

The major modifying influences on vegetation structure and composition are fire, domestic stock and man. Thus a particular vegetation type may exist in a number of markedly different states, or conditions, with different grazing potentials. Different states or conditions may be required for different purposes; for example a nature reserve with a lot of browsing animals requires a greater woody component than a cattle or sheep enterprise. In Swaziland cattle is the main livestock species and hence grazing potential is considered primarily for cattle.

Poor range condition implies that there has been an unfavourable shift in botanical composition and plant vigour in respect of the intended usage, SNL grazing tends to be regarded as being in poorer condition than TDL grazing, however the management objectives are different from those in TDL and the productivity of the range is more important than simply the botanical composition. As demonstrated at Frankenwald Pasture Research Station in the 1950s (Roux , 1969), heavy grazing can cause a more rapid circulation of nitrogen from dung and urine into plant growth and back into dung and urine than in lightly grazed veld. This maintains a higher proportion of young and nutritious material, and hence more beef can be produced, despite a change in botanical composition that is normally considered adverse.

Taking note of the number of variables that influence grazing capacity, it becomes clear that there can be no single optimum value for all conditions, all objectives or all seasons. All stocking rate recommendations should therefore be used with common sense, and adjusted according to prevailing circumstances.

It is impossible from only a single season's observations to make reliable long term recommendations of stocking rates for all the vegetation types mapped. Therefore the approach used is to review previous carrying capacity estimates for Swaziland; to consider empirical relationships of primary production with rainfall, to analyse stocking rate data for the country , and to develop a simple formula that appears to give satisfactory results.

2. Previous Estimates of Carrying Capacity

Carrying capacity estimates should include an assessment of browse availability as well as of grazing availability, but the former is more difficult and often ignored. Where it is not taken into account the estimates should more strictly be called grazing capacity estimates. A number of people have made carrying capacity (grazing capacity) estimates for Swaziland, which are summarised in Table 7. All have been largely subjective and they show a high degree of variation, both in absolute values for each zone and in the relative carrying capacities of the zones. None make adequate allowance for local site conditions variability.

The I'ons and Kidner estimate was based on 6 months grazing for the highveld, 9 months for the middleveld and 12 months for the lowveld. The other estimates appear to be based on year round grazing. Estimates for Lubombo tend to have been omitted or assumed to be as for the middleveld. In all cases a livestock unit of 450 kg liveweight is stated or assumed.

These estimates can he compared to stocking rate recommendations (ha/LSU) of 1-2 (8 months grazing), 2-3 (10 months grazing), and 3-5 {12 months grazing) for reasonably comparable high, middle and lowveld areas across the border in South Africa.

Table 7 Previous Carrying Capacity Estimates (Ha/LSU) For Swaziland

Author	Year	Agro -Ecological Zones			
		HV	MV	LV	LR
Hall[1]	1952	-	3.5	5.2	3.2
Economic Mission[1]	1960	3.6	3.0	3.6	3.0
I'ons & Kidner[2]	1967	1.0 -1.8	1.2 - 2.4	4.0 - 4.8	-
World Bank[1]	1977	2.7	2.7	4.0	-
Spargaaren[1]	1977	2.8	2.9	2.9	3.6
Hunting Technical Services[2]	1983	4.5 - 4.7	3.3 - 4.9	3.0 - 3.6	-

Sources: [1] FAO (1989); [2] as referred

3. Analysis of Stocking Rate Data

Swaziland has approximately 800 registered dip tanks (plunge dips or spray races) at which all cattle in the country are mandatorily dipped once a week in summer and once a fortnight in winter. All ruminant and equine livestock within each dip tank area are supposed to be recorded, and these records provide a valuable data base for compiling livestock statistics including stocking rates.

Previously the dip tanks have been grouped according to administrative rather than agro-ecological regions, however with the help of the dip tank inspectors the dips have now been allocated to the four broad AEZs of highveld, middleveld, lowveld and Lubombo, and to SNL or TDL usage. Data have been compiled for August 1992 (peak numbers before the drought mortality), August 1993 (post drought remainder) and August 1982 (an arbitrary ten years previous). It has not been possible in the time available to map the positions of the dip tanks in order to locate them within the more precise six AEZs, or in the newly mapped vegetation units, but this work has commenced.

The returns are almost complete for SNL but data are missing for more than 100 TDL dip tanks. It can be assumed that some of these are not in use and that the others belong to smaller holdings and account for only a small number of livestock, however the TDL livestock population is apparently under-represented to some extent.

The numbers of cattle, sheep, goats, horses and donkeys have been converted into livestock units (LSU) of 450 kg liveweight using standard Comparison factors to enable comparison of overall stocking rates between years and between AEZs. The area estimates are derived from Table 3 and the results of the stocking rate calculations are shown in Table 8. It is assumed for this comparison that the areas available to livestock were not significantly different in 1982.

As explained in Section 13, the SNL livestock have dry season access to cropping areas and so the total SNL areas are more appropriate figures for calculation of stocking rates than the summer grazing areas alone. For completeness the SNL stocking rates have been calculated for the grazing areas only and for the entire areas available, whereas for TDL the grazing areas only are used.

Table 8 Stocking rates by land tenure in the Agro-Ecological Zones

AEZ	Tenure	Area (Sq. km)	1993		1992		1982	
			LSU ('000)	Ha/LSU	LSU ('000)	Ha/LSU	LSU ('000)	Ha/LSU
HV	TDL	496	28.6	1.7	24.3	2.0	13.6	3.7
	SNL	3,023	93.4	3.2	101.4	3.0	81.2	3.7
	SNL+	3,603	93.4	3.9	101.4	3.6	81.2	4.4
MV	TDL	859	55.6	1.5	46.7	1.8	36.1	2.4
	SNL	2,810	154.2	1.8	167.8	1.7	144.0	2.0
	SNL+	3,656	154.2	2.4	167.8	2.2	144.0	2.5
LV	TDL	1,646	38.6	4.3	35.7	4.6	37.2	4.4
	SNL	1,726	147.5	1.2	234.1	0.7	128.1	1.3
	SNL+	2,584	147.5	1.8	234.1	1.1	128.1	2.0
LR	TDL	328	7.7	4.2	5.0	6.5	4.3	7.7
	SNL	742	18.3	4.1	29.1	2.5	23.5	3.2
	SNL+	967	18.3	5.3	29.1	3.3	23.5	4.1
Total	TDL	3,329	130.5	2.6	111.8	3.0	91.1	3.7
	SNL	8,301	413.3	2.0	532.4	1.6	376.7	2.2
	SNL+	10,810	413.3	2.6	532.4	2.0	376.7	2.9

TDL: Grazing area only SNL: grazing area only SNL+: Total SNL area

The data have some surprises and indicate that the SNL stocking rates are considerably lighter than for TDL in the highveld, slightly lighter in the middleveld, and similar in Lubombo. However no allowances have been made for topographic variation or uneven stock distribution, and furthermore the missing TDL dip tank data might be causing the TDL stocking rates to be under -estimated. The major tenure related difference is in the lowveld, where SNL stocking rates are twice as high as TDL ones, and before the drought the difference was even more pronounced. However the SNL stocking rates across the zones are generally little different now compared to their 1982 values. The comparison of SNL and TDL stocking rates based on total areas of all the zones should be regarded with caution because of the different sizes of the zones and the unequal distribution of SNL and TDL livestock in them, but between year comparisons are valid.

The main conclusion from these data is that the present overall livestock populations in the SNL and TDL sectors should be sustainable but that there are problems of distribution, i.e. there are localised areas of over-utilisation and others of under-utilisation. The AEZ where overgrazing problems appear most likely is the lowveld SNL, while the highveld and the Lubombo plateau are understocked on aggregate. The analysis should be repeated in more detail, using the vegetation unit boundaries or even the six AEZs, because major variations in stocking rates and grazing potential are being masked within the present groupings.

4. Empirical Models of Primary Production and Carrying Capacity

Estimates of carrying (or grazing) capacity are normally based upon estimates of annual production of herbage dry matter, an acceptable usage (removal) factor for the herbage, and an estimated daily dry matter intake requirement per animal. As stated earlier, rainfall is the key variable determining primary production, hence many workers have attempted to develop predictive relationships of carrying capacity to rainfall.

Linear relationships have been demonstrated between annual forage production and annual rainfall, particularly in more arid regions (<500-600mm annual rainfall), but there are departures from linearity at higher rainfalls (> 800-1OOOmm). The relationships are strongly influenced by vegetation type and also by soil fertility. The majority of derived relationships are of the form:

$$y = a + bx$$

Where: y is the herbage annual dry mater production (kg/ha)
x is the annual rainfall (mm)
a and b are constants

but they can he simplified to straightforward expressions of kg of annual dry matter production per mm of annual rainfall (the water use efficiency) . The use of a single linear model for the full rainfall and vegetation range of Swaziland is not ideal but, in the absence of quantitative production data from the different rainfall zones of the country, complex models would not necessarily be more accurate and so simplicity is favoured. Extension recommendations in Natal are based on production of 3kg/mm from veld in average condition (Camp and Smith, 1991).

5. A Stocking Rate Model for Swaziland

In the absence of established rainfall/primary production relationships for Swaziland, the approach adopted has been to use the Natal recommendations as a starting point and to make adjustments until the results are in reasonable agreement with known sustainable stocking rates on selected TDL ranches in the different zones.

Since the required output of the model is a direct relationship between annual rainfall and recommended stocking rates, the intermediate steps of estimating primary production, acceptable plant removal factors and individual animal requirements can be omitted. In order to make allowance for annual rainfall variability, the recommendations are based on the minimum annual rainfall that can be expected with 80% probability. The model that appears to give acceptable results is based on a water use efficiency (WUE) of 0.00065 LSU/ha'/mm of dependable rainfall, and can be written as follows:

Recommended Stocking Rate (ha/LSU) = 1/ (mm Rainfall x 0.00065)

Use of the reciprocal is necessary to express the stocking rates in ha/LSU rather than LSU/ha.

Allowances should be made for prevailing conditions of soil, slope, woody cover and range condition. These can best be accommodated by applying correction factors to the rainfall-derived stocking rate Recommendations. Proposed site correction factors for Swaziland are given below, but can be modified with experience.

Constraint	Correction Factor
Slopes 15-30%	0.15
Slopes > 30%	0.30
Moderately stony, sandy or erodible soils	0.15
Very stony, sandy or erodible soils	0.30
Moderately dense bush (30-40% cover)	0.30
Dense bush (40-60% cover)	0.50
Range condition poor	0.25
Range condition very poor	0.50

The slopes and soils are permanent features, so the appropriate corrections can be applied uniformly to the whole of each vegetation unit. The rock and boulder outcrops of the highveld are not a sufficiently uniform feature to warrant a standard correction factor but, where they are common, additional correction factors can be applied according to the proportion of the surface area estimated to be rock. Range condition is assumed to be fair and bush density to be low (< 30% cover), therefore corrections for the present status of bush density and range condition should be applied to specific grazing areas and revised as conditions change. Converse correction for above average range condition is not recommended except where there are adequate data to be sure that the recommended stocking rates are conservative. The correction factors increase the area required per animal and are additive so that, for example, the area required per LSU for a particular rainfall zone would be increased by 80% (0.30 + 0.50) for sites with steep slopes and dense bush.

The correction factors are applied by multiplying the number of ha per LSU by [1 + the sum of the correction factors], as shown below:

E.g. applying a total correction factor of 0.6 to a standard stocking rate of 2ha/LSU

Adjusted SR = Standard SR x (1 + correction factor)
= 2 X 1.6
= 3.2 ha/LSU

The rainfall-related stocking rates and the stocking rate recommendations adjusted for the permanent characteristics of each vegetation unit are given in Table 9. In all cases the recommendations in the table are only applicable to range in fair condition. Corrections for bush cover have been included only for the few units where the density is a fairly stable and uniform feature of the vegetation type, but in most middleveld

and lowveld units the bush density is highly variable and corrections should be included as appropriate for the areas under consideration. This means that for almost every ranch in the savannah areas, correction factors of at least 0.3 - 0.5 will be applicable . The corrections for range condition and bush density can be applied directly to the preliminary adjusted stocking rates in the table, or summed with the corrections for slopes and soils and applied to the rainfall-related stocking rates. Where a grazing area overlaps two or more vegetation units, the overall stocking rate (total number of livestock recommended) can be determined using a pro rata allocation.

Table 9 Stocking Rate (SR) Recommendation for Each Vegetation Unit

Vegetation Unit	Reliable Rainfall (mm)	Rainfall Related SR (Ha/LSU)	Correction Factors				Preliminary Adjusted SR (Ha/LSU)
			Slope	Soil	Bush	RC	
H1	850 - 1000	1.5 - 1.8	0.30	-			2.0 - 2.3
H2	850 - 1000	1.5 - 1.8	0.15	-			1.7 - 2.1
H3	700 - 850	1.8 - 2.2	0.30	-			2.3 - 2.9
H4	700 - 850	1.8 - 2.2	-	0.30			2.3 - 2.9
H5	700 - 850	1.8 - 2.2	-	-			1.8 - 2.2
UM1	700 - 850	1.8 - 2.2	0.30	0.15	0.50		3.5 - 4.3
UM2	600 - 800	1.9 - 2.6	0.15	0.15			2.5 - 3.4
UM3	600 - 800	1.9 - 2.6	0.15	0.30			2.8 - 3.8
UM4	700 - 850	1.8 - 2.2	-	0.30			2.3 - 2.9
UM5	700 - 850	1.8 - 2.2	0.30	0.30			2.9 - 3.5
UM6	800 - 1000	1.5 -1.9	0.30	-			2.0 - 2.5
LM1	500 - 700	2.2 - 3.1	-	-			2.2 - 3.1
LM2	450 - 550	2.2 - 3.4	-	0.30	0.30		3.5 - 5.4
LM3	550 - 750	2.1 - 2.8	0.15	-			2.4 - 3.2
WL1	450 - 550	2.8 - 3.4	-	0.30			3.6 - 4.4
WL2	450 - 550	2.8 - 3.4	-	-			2.8 - 3.4
WL3	400 - 550	2.8 - 3.8	-	0.15			3.2 - 4.4
EL1	400 - 450	3.4 - 3.8	-	-			3.4 - 3.8
EL2	450 - 550	2.8 - 3.4	-	-			2.8 - 3.4
L1	450 - 550	2.8 - 3.4	0.30	0.30	0.50		5.9 - 7.1
L2	600 - 800	1.9 - 2.6	-	-			1.9 - 2.6
L3	550 - 700	2.2 - 2.8	0.15	0.15			2.9 - 3.6

Correction factors for the local site conditions of current range condition (RC) and bush density must be included for the final adjusted stocking rate recommendations.

When appropriate bush density correction factors are included, the recommended stocking rates bear good relation to those applied on selected ranches in different zones and soil types, and are thus validated as far as possible with the information available. Sustainable stocking rates in SNL can be expected to be 30-50% higher than in TDL, particularly in savannah areas due to differences in bush density, but no suitable data are available for validation in SNL. The range of stocking rates within each category is related to the range of rainfall within the vegetation unit, but the higher rates will also tend to be those more applicable to SNL, and the lower ones to TDL.

The terms grazing capacity and carrying capacity have been deliberately avoided as there are insufficient data from which to derive accurate estimates for the vegetation units, and it must be clearly understood that the stocking rate recommendations are indicative rather than absolute. However, they should provide an adequate basis for planning purposes until more accurate data become available. The important principle that has been introduced is that stocking rate recommendations must take into consideration local site conditions which influence grazing potential, and that single values for each ecological zone are spurious. The WUE factor and the correction factors can readily be adjusted through experience to improve the recommendations.

D RANGE RESOURCES DATA BASE

A data base has been established for range and livestock data within the computerised information system developed by the FAO Land Use Planning project in the MOAC. There are two main components:

a) A data base management system (DBMS) for entry, storage, processing and retrieval of data, and presentation in tabular form. All data bases are DBase III+ compatible. The range and livestock data bases established include:

- allocation of AEUs to VUs
- characteristic grasses, trees and shrubs of each VU increaser grasses in each VU
- present range condition assessment in SNL and TDL in each VU present bush density assessment in SNL and TDL in each VU allocation of dip tanks to AEZ and to tenure
- dip tank data for all domestic livestock for the years 1982, 1992 and 1993, with totals
- For each species and for total livestock units, according to tenure and AEZ.
- stocking rates by tenure for each main AEZ
- A rainfall dependent stocking rate model with correction factors for slopes, soils, woody cover and range condition, and stocking rate recommendations for each VU.

b) A geographic information system (GIS) for spatial analysis and map production. The GIS enables interactive processing of more than one thematic layer, for example land tenure and vegetation type can be combined to produce tabular or map data of the areas of each vegetation type in SNL and TDL. A raster based package, IDRISI, is used. The following thematic layers relevant to range resources are available:

- moisture zones (rainfall, length of growing period) thermal zones (mean temperatures)
- physiography (slope, soil characteristics)
- agro-ecological units (combinations of moisture, thermal and physiographical layers) vegetation units (combinations of climatic, physiographic and vegetation characteristics)
- present land use
- land tenure (in preparation)

E RECOMMENDATIONS FOR GRAZING MANAGEMENT AND IMPROVEMENT

1. Grazing Management

Grazing management may be summarised as the art of manipulating the spatial and temporal distribution of grazing (and browsing) livestock to maximise the animal production objectives while maintaining an appropriate plant composition, density and structure to meet those objectives. The management tools required are stocking rates, grazing systems and the use of fire.

Stocking Rates

Stocking within the carrying capacity of the available grazing area is the fundamental principle of grazing management. Where this is exercised all other management practices are of secondary importance, and where it is not no other management practices (except feed supplementation) can compensate.

The point has been made earlier that higher stocking rates than desirable for commercial production may be appropriate and sustainable in SNL at a different botanical composition. However the differences have never been quantified, and data on stocking rates in relation to range condition in communal areas should be collected. Guidelines for stocking rates in the different vegetation units of the country have now been formulated, together with a simple methodology for adjusting them according to local site conditions. These recommendations can gradually be refined by assessments of range condition in context of the present and proposed stocking rates, where the present stocking rates can be calculated.

The determination of existing stocking rates, or the purposeful implementation of a stocking rate by regulating stock numbers, pre-supposes a defined grazing area. However none of the traditional grazing areas of SNL have been quantified and few have incontrovertible boundaries. Until the areas available to each community and the proportional grazing rights of each member of the community are clarified, the subject of carrying capacities and stocking rates remains largely academic. Range planning must be implemented at the level of the basic land/livestock resource unit, which in TDL is the farm or ranch, and in SNL is the chiefdom or the dip tank area.

Grazing Systems and Rest Periods

Many variations of rotational grazing have been developed and recommended for different purposes, however the claimed advantages over continuous grazing are not always readily apparent. In a detailed analysis of grazing experiments conducted over the last 60 years in southern Africa, O'Reagain & Turner (1991) concluded that continuous grazing is not necessarily inferior to rotational grazing in terms of its long term effects on either animal production or on plant species composition.

However, periodic rests are of great importance for seed set and for replenishment of root reserves; and the heavier the grazing pressure, the greater the need for rest periods. Rest periods are the operating principle of rotational grazing systems but can adequately, more simply and more flexibly be incorporated into grazing management without formal grazing systems. This is particularly so for communal grazing SNL, where paddocking and fencing are impractical but selected areas can be given periodic rest by communal consent.

It must be understood that rest periods are only beneficial when applied during the active growth phase of the forage plants, i.e. during the summer months. Once dormant, grass plants can be heavily grazed, cut or burned with little detriment but, conversely, they are most susceptible to excessive defoliation while making active growth.

Rest periods can readily be implemented on paddocked TDL ranches, and combined with herbage accumulation for hay, dry season reserve, or burning. In SNL the logistics may be a little more complicated, depending on the distribution of crop and grazing land, and community cooperation is required for successful implementation. The appropriate length and frequency of rest periods depends upon the condition of the grazing land; full growing season rests should be applied to land in very poor condition until the condition has improved, while late wet season rests of about 6 weeks for seed set every 3-4 years should be sufficient to maintain condition for areas correctly stocked. The areas rested are not lost to grazing, the grazing is merely deferred for a while; thus rest periods per se do not necessitate reductions in stocking rates.

A problem that seems to be faced in the more intensively cultivated parts of SNL is that, although the stocking rates based on total SNL may appear acceptable, the areas available for summer grazing are inadequate and degradation is resulting : As explained in Section B, a ratio of 2:1 for grazing area to cropping area is recommended from the grazing/livestock point of view but estimates of cropping areas in SNL (Table 5) show that grazing is already very scarce in vegetation unit EL2 and that it is becoming marginal in five other units . Data are required for individual chiefdoms, but there appears to be a strong correlation between erosion sites and cultivation intensity. The implications are that chiefdoms with more arable potential will have to start making choices between crops and livestock.

Burning

The main justifications for burning rangeland are the removal of coarse unpalatable herbage, the stimulation of new grass growth, and the control of invading woody species. Tick control can be a subsidiary benefit.

In the sourveld grassland areas of South Africa controlled burning is an accepted management practice. Burning should only be applied in late autumn or winter while the grass is dormant, as burning during the growing season, particularly when followed by grazing, is distinctly harmful. Conventional wisdom in southern Africa has been that stocking too early" after burning is a major cause of range degradation, and that grazing after burning should be deferred until the grass has reached a height of 10-15cm. However, recent research work (Barnes, 1992) has shown that deferring grazing for even 2-3 weeks after there is sufficient growth to carry stock has a severe negative effect on animal performance. The conclusions are that burning in winter does not damage the range, and can be beneficial, and that sourveld grasses should be utilised in as young and nutritious state as possible.

An alternative to burning to remove unpalatable material is to maintain a sufficiently high stocking pressure to maintain a leafy sward, and so avoid the need to burn. This is the practice in most SNL and is arguably more efficient. On the lower slopes of the highveld, where there is a greater propensity for woody species development, occasional burns are likely to be beneficial to control bush encroachment. Burning for removal of surplus grass should be accomplished with "cool" burns, while the control of bush encroachment requires hot fires as for the savannah areas. Periodic burning is likely to encourage Themeda triandra, which is normally desirable.

The savannah areas in Swaziland are fire climax vegetation states and the exclusion of fire leads to an increase in woody density causing a progressive reduction in grazing capacity. In a natural ecosystem there are synergistic effects of fire and browsing animals in controlling bush development, and where one element is removed the other becomes more important. Hence in the majority of TDL cattle ranches in Swaziland bush encroachment is a serious problem. Fire can be expected to effect top kill on trees and shrubs up to a height of about 2m, which means that the frequency of burning is determined by the rate of regrowth of the basal coppice. In order to accumulate sufficient grass fuel for an effective fire, a rest period of at least half the growing season is normally necessary, and the burned grass is lost to grazing. Ranchers must therefore weigh up the economics of stocking leniently to permit fairly regular burning, or facing a bush infestation problem that requires mechanical or chemical intervention.

Burning for bush control should be conducted as late as possible before the spring rains but while the grass is still dry and dormant and in conditions of high air temperatures and low humidity. These conditions obviously carry the greatest risk of a runaway fire, and stringent fire control procedures are essential. Burning in the lowveld encourages Themeda triandra, which is less prone to leaf shatter than Panicum maximum, and tends to be preferred by ranchers.

Feed Supplementation

Sourveld grasses become unpalatable and of low nutritional value when mature, such that grazing animals lose weight and condition. The principal limiting factors are protein and digestibility, hence protein supplements improve the utilisation of winter pasture. In SNL the feed supplementation takes the form of access to crop residues as an alternative feed supply, and the use of purchased feed is extremely rare, while in commercial enterprises it is common practice. Ruminant livestock are able to redress modest weight losses while on a low nutritional plane by compensatory weight gain when the plane of nutrition is restored, without any overall reduction in performance. South African research work suggests that winter weight losses up to 12% of initial body weight can be readily compensated during the following summer , hence winter feed supplementation is only economic where it prevents weight losses exceeding this amount. Obvious exceptions are pregnant and lactating females, and working oxen that need to be in good condition for ploughing early in spring.

Sweetveld grasses remain acceptable to stock throughout the year even though the overall protein and digestibility levels drop below maintenance requirements and selective grazing becomes necessary. By the same virtue of compensatory gain mentioned above, winter feed supplementation of growing stock is seldom economic or necessary provided there is adequate grazing available. The principal need for feed supplementation in sweetveld areas is to correct for mineral deficiencies such as calcium and phosphorus.

2. Pasture Improvement

Pasture improvement can be effected to some extent by grazing management but normally also implies the artificial modification of plant structure or composition, for example by bush eradication or plant introduction.

Bush control

The control of bush encroachment should ideally be implemented through a strategic burning programme, but where established stands are too dense to support an adequate fuel load, or have grown up beyond the reach of fire, radical control measures become necessary. These circumstances apply principally to the lowveld and lower middleveld, which are the savannah areas of the country. The predominant encroaching woody plant in these areas is *Dichrostachys cinerea* (lusekwane), although *Acacia tortilis*, *Acacia nilotica*, *Maytenus* spp. and *Euclea* spp. can be problematic.

One option is to do nothing and to let the stands live out their natural life spans. The germination and establishment of woody plants tends to be episodic rather than continuous, hence many of the problematic stands are even aged. *Dichrostachys cinerea* is relatively short lived (probably 30-40 years) and it is possible that another drought as the stands approach that age would cause a significant die off, as has been observed with *Acacia mellifera* in Botswana.

The intervention alternatives are limited to mechanical or chemical means of bush clearing. Bulldozer blade clearing should be avoided except where cultivation or re-seeding is planned, because the soil disturbance causes proliferation of weeds and pioneer grasses. Chaining, using a weighted ship's anchor chain (the Ely chain) towed between two bulldozers can be very effective with a predominance of single stemmed trees and sandy soil so that the majority of trees are uprooted, but in heavier soils and/or with stands of supple multi-stemmed shrubs and trees the stems merely break or bend, and regrowth can be prolific. If there is not an adequate follow-up burning programme, the situation can end up worse than it was originally; such has been the experience of the 1970's chaining operations in Swaziland.

A number of ranchers in Swaziland are selectively cutting out unwanted trees and shrubs, and covering their costs by charcoal manufacture. However, there is a strong probability of basal coppicing unless the stumps are removed or treated with arboricides.

Various soil-applied and plant-applied arboricides are on the market, and they can be applied by hand, machine or aeroplane according to the scale of operation. The range of products on offer changes with time, and potential users should ask the suppliers for product information and trial results. The costs of chemical control are likely to be high, but the effects should be longer lasting than with other methods of control. It must be understood that bush encroachment is a natural phenomenon and that bush control cannot be regarded as a one-off operation.

SNL is atypical in that there is heavy pressure on the wood resources for building and for fuel, hence bush density is rarely a problem. TDL ranchers could attend to their own problem while accommodating the needs in SNL by permitting controlled wood extraction. Woody cover can significantly reduce grass production and grazing capacity, hence the more open SNL grazing areas are in that respect more efficient than the bush encroached TDL ones .

Range Reinforcement

The quality of natural rangeland can sometimes be improved by the introduction of superior grasses or legumes, however difficulties of establishment and problems with persistence tend to limit its usefulness. South African research work in highveld bordering Swaziland (Barnes *et al*, 1986) has concluded that intensification of highland sourveld is better achieved through development of improved pastures for use in conjunction with the range, rather than by means of range reinforcement.

In the lowveld the low rainfall is a constraint to legume introduction, however the native grasses maintain a higher nutritive value in winter than in the highveld, and there is less need for range reinforcement. The agro-ecological zone with the greatest potential for legume introduction and range reinforcement is the middleveld, which combines good soils with adequate rainfall. Numerous tropical grass and legume species were screened at Malkerns Research Station, and the promising ones field tested, in the 1960's and 1970's (e.g. I'ons & Kidner; 1967; I'ons , 1968) and these results still remain valid. New species and cultivars have since become available but, rather than embarking on a new screening programme, interested parties should refer to trials conducted in similar areas of South Africa and Zimbabwe.

Undoubtedly range reinforcement with legumes could improve pasture and livestock productivity in the Swaziland middleveld but the economics as well as the establishment and management practicalities must be given due consideration.

Reseeding

Reseeding implies a virtual replacement of the original plant cover, and is more intensive than reinforcement. The need for reseeding is normally limited to revegetation of areas which have become denuded, and the seed replacement can either be one or more of the original grass species or new introductions. It must be clearly understood that there is little chance of successful establishment or persistence of reseeded areas if the conditions which gave rise to their denudation still prevail.

Swaziland's rangeland exhibits remarkable recuperative powers when afforded wet season rest periods and the approach to improvement of degraded areas should be to reduce the grazing pressure, at least during the growth period. Reseeding of rangeland should be limited to the treatment of badly eroded areas, which should first be fenced or barricaded against stock access.

The other case for reseeding is the establishment of special purpose pastures. A possibility for combatting erosion where the grazing areas are of slopes and soil types suitable for cultivation, could be to implement a switch of grazing land with crop land. The establishment of grass strips in the ex- grazing areas would control erosion and they would gradually stabilise; in order to boost the grazing potential of the abandoned cropland, it could be reseeded to suitable grass/legume mixtures.

3. The Future for Swaziland's Rangelands and Livestock

The question of just how large a national herd can be sustained in Swaziland is not easy to answer from a single season's observations, and there are many variables involved. This report has attempted to formulate stocking rate recommendations appropriate for the different vegetation units which have been mapped and described, however there are no mechanisms in place for implementing control of stock numbers in SNL.

What is certain is that human and livestock population pressures on a non-expandable resource are increasing and so are the areas of range degradation and soil erosion. There is a strong correlation between cultivation intensity and overgrazing and, while the present overall livestock population is believed to be sustainable, there are problems of distribution. Communities must start to face the harsh reality that as the number of households' increases fewer of them will be able to maintain livestock and/or the numbers of livestock per household will have to be reduced.

Government imposed stock control in SNL would be unpopular and probably ineffective. The only long term solution is for communities to accept responsibility for management of their own resources. The pre-requisites for community action are:

1. Recognition of the need for stock control. Action can only be expected when communities recognize that they have a serious, or potentially serious, problem that must be addressed.

2. Boundary recognition. Recommended stocking rates cannot be implemented until areas are defined, and there is no incentive to control stock numbers unless the limits of the grazing area are recognized - both by the resident community and the neighbouring communities.

3. Defined communities. The communities sharing the grazing resources must be defined in terms of the households or individuals with grazing rights within the boundaries of the community. Consensus on sensitive issues, such as stock control, is more likely in cohesive communities.

F DESCRIPTION OF VEGETATION UNITS

1. Terminology

The principal terms used in the vegetation descriptions are defined below. The definitions are not necessarily applicable outside the context in this report.

Plant Forms

Grass – rooted, non-woody plants of the family Gramineae

Forb – rooted, non-woody, non-grass like plants

Shrub – rooted, wooded, multi-stemmed plants up to 5m high, or single stemmed 2-5cm high.

Tree – rooted, woody, single stemmed plants more than 2m high, or multi stemmed more than 5cm high.

Vegetation Types

Grassland – Open grassy area with less the 2% woody cover. Levels of woody cover from approximately 2% to 15% are classed as wooded grassland. Most of the highveld of Swaziland is in fact wooded grassland, but the woody component is aggregated rather than evenly dispersed.

Savannah – An extensive stand of trees and shrubs with a conspicuous grass component. The woody cover can range from about 15% to 40% (open savannah) to 40-60% (dense savannah), beyond which it assumes the characteristics of thicket or forest.

Bush – a moderately dense to dense stands of trees and shrubs growing on rocky slopes in units too small to be classed as savannah; also used as a general term for trees and shrubs when expressing cover or density.

Thicket – A dense (>60%) cover of woody plants, usually shrubs, which has developed due to local edaphic or management conditions.

Forest – A closed canopy (>80%) of woody plants, mainly trees, in a natural stand.

Botanical Name Changes

The commonly occurring species, whose names have been changed in recent years are as follows:

Vegetation	Old Name	New Name
Grasses	*Andropogon amplectens*	*Diheteropogon amplectens*
	Apochaete hispida	*Tristachya leucothrix*
	Axonopus comressus	*Axonopus affinis*
	Digitaria pentsii, D. smutsii	*Digitaria eriantha*
	Eustachys mutica	*Eustachys paspaloides*
	Hyparrhenia dissoluta	*Hyperthelia dissoluta*
	Rhynchelytrum repens	*Melinis repens*
Trees & Shrubs	*Adina microcephala*	*Breonadia salicina*
	Fagara capense	*Zanthoxylum capense*
	Rhus dura	*Rhus tumulicala*
	Sclerocarya caffra	*Sclerocarya birrea* subsp. *Caffra*

Sweet and Sour

These terms refer to the physiological status of the grasses in context of their palatability, digestibility and nutritive value. In simple terms, sweet grasses (sweet veld) remain acceptable to stock throughout the year, and with reasonable stocking rates are able to sustain animals with minimal weight loss in the dry season. Sour grasses (sour veld) become unpalatable and low in feed value when the grasses mature in autumn, and feed supplements are required to avoid dry season weight loss.

The physiology of "sweet and sour" is poorly understood and, although a number of contributory factors are known, there are no rigidly set levels at which they come into play. In general, the tendency for sourness increases with rainfall and soil acidity (factors which contribute to leaching out of plant nutrients). In Swaziland there is a correlation between altitude and rainfall, hence there is a gradation from sweet grasses in the lowveld through moderately sour, or mixed, grasses in the middleveld, to predominantly sour grasses in the highveld. In general sourveld occurs in southern African grasslands at rainfalls above 800mm, and on acid, sandy soils at lower (> 600mrn) rainfalls. Some grass species (e.g. *Cymbopogon excavatus*) are inherently sour, while others (e.g. *Themeda triandra*) vary considerably in palatability and feed value according to the local soil type and climate. As a rule of thumb in Swaziland, the highveld provides 7-8 months of adequate quality grazing per year, the middleveld 9-10 months, and the lowveld a full 12 months.

Soil Types

The soil set nomenclature used is that of Murdoch (1970). The characteristics of the soil types listed in the summary table and used in the vegetation unit descriptions are summarised below.

Soil Type	Set	Description
Deep sand	JL	Deep pale red sand
	E	Deep pale grey sand on clay or iron pan
Sandy loam	G	Grey sandy loam on hard iron pan
	H	Grey sandy loam on mottled clay pan
	O	Shallow grey sand to sandy loam on hard rock
	ZL	Dark grey sandy loam on clay pan
	TH	Pale red sandy loam on rotten rock
Loam	JH	Grey loam on thick stone line on red loam
	Q	Grey or orange gravelly loam
	W	Deep orange loamy old alluvium
	ZH	Shallow red loam, acidic
	L	Deep red loam, slightly acidic
	M	Deep red loam, very acidic
	N	Deep yellow or red loam, very acidic
	A	Deep yellow loam, very acidic
	SL	Shallow brown/black loam to clay
Clay	CL	Dark brown clay
	K	Black clay, calcareous
	R	Red clay, slightly acidic
	SH	Dark brown clay, acidic
Marsh Soil	I	Marsh soil, mottled sand to clay, acidic
	V	Marsh soil, deep calcareous clay
Rock	U	Rock outcrops & stony ground

Moisture Zones and Thermal Zones

In order to conform to the climatic descriptions used by the Land Use Planning section of the MOAC for determining crop potentials in different parts of the country, the vegetation units have been characterised according to moisture zones and thermal zones rather than simply to mean annual rainfall. The moisture zones show the minimum length of growing period and minimum annual rainfall that can be expected with 80% probability, while the thermal zones are related to altitude and indicate the range of mean decadal temperatures that can be expected.

Moisture Zone	Dependable Length of Growing Period (Days)	Dependable Annual Rainfall (mm)
H	270 - 360	1000 - 1200
SH2	225 - 270	850 - 1000
SH1	180 - 225	700 - 850
MSA2	150 - 180	550 - 700
MSA1	120 - 150	450 - 550
DSA	100 - 120	400 - 450

Thermal Zone	Altitude (m)	Mean Decadal Temperatures (°C)		
		Average	Highest	Lowest
MW1	< 625	20.0 – 22.5	25.0 – 27.5	15.0 – 20.0
MW2	625 - 950	17.5 – 20.0	20.0 – 25.0	12.5 – 15.0
MC1	950 - 1300	15.0 – 17.5	17.5 – 20.0	10.0 – 15.0
MC2	1300 - 1700	14.0 – 16.0	15.0 – 17.5	10.0 – 12.5
C	> 1700	< 14.0	< 15.0	< 10.0

2. Encroachment of Alien Woody Species

A number of introduced woody species are becoming increasingly widespread and locally problematic in Swaziland. The principal ones are:

1. **Guava (*Psidium guajava*)** - Introduced as a fruit tree, now widely found in highveld and upper middleveld areas near to settlements and along rivers. Seed dispersal from human, animal and bird consumption; thick infestations common, seems to be spreading quite rapidly. Although the fruit is palatable the plant is becoming problematic.

2. **Lantana (Lantana camara)** - Probably introduced as an ornamental shrub. Since the cyclone Demoina this plant has begun to appear widely in the middleveld, particularly in the vicinity of major water courses. Unpalatable and toxic to stock, but with the seeds dispersed by birds, lantana is encroaching on grazing land and has a propensity to form dense thickets.

3. **Mauritius thorn (*Caesalpinia decapetala*)**- Introduced as a living fence plant, this thorny scrambler is now infesting parts of the Northern RDA and reducing the grazing potential.

4. **Wattle (*Acacia meamsii, A. decurrens, and A. dealbata*)** - Introduced as a fuel-wood and as a source of tannin, this is the most widespread alien and is found widely throughout the highveld, particularly near settlements. Although said to be increasing, this species is often the major, or only, source of fuel-wood in the highveld. It alleviates the pressure on indigenous woods where they do occur and is therefore to be encouraged within reasonable limits.

3. Vegetation Unit Summary and Detailed Descriptions

A summary of the characteristics of the vegetation units is presented in Table 10 and more detailed descriptions follow in the ensuing pages. Actual vegetation boundaries are seldom precise, as there is usually a gradation from one type to the next, and the vegetation unit boundaries are set at the nearest appropriate agro-ecological unit boundary (Map 4). The objective is to delineate functionally different units in respect of their grazing potential rather than only their botanical composition. As stated in Section A, the vegetation units are based on topographic, climatic and soil characteristics as well as on vegetation, and the same plant species may occur in more than one vegetation type. For example, most of the highveld units have similar species compositions but their grazing potentials differ owing to differences in rainfall, slope and/or soils. The total of 22 units may provide more detail than required for some planning purposes, in which case suitable aggregations of similar units can readily be used.

It has not been generally possible to classify the vegetation units according to characteristic grass and woody species, owing to the occurrence of the same species in more than one unit. Similarly, the same structural vegetation types occur in more than one unit. Therefore a procedure has been adopted of incorporating the physiographic zone and the topography with the structural vegetation type in the classification. The structural classifications are further qualified physiognomically to distinguish different types of savannah.

The descriptions include a brief list of characteristic grasses, trees and shrubs, and note the changes in grass composition that tend to occur due to overgrazing. The present status of each unit is described in context of land use, land tenure and range condition, and the observed trends are recorded. Finally, the grazing and browsing potential are summarised in context of the unit's inherent potential and present condition, and the number of months of good quality grazing that can be expected. It is essential to note that the stocking rate recommendations are applicable to range in fair condition and (except for units UM1, LM2 and L1) with reasonably open woody cover. Correction factors for range condition and bush density should be applied as appropriate.

The botanical names of the plant species are used throughout but in the case of *Dichrostachys cinerea* there are two distinct subspecies which occur commonly, but with different habitat ranges, in Swaziland. For simplicity and for local benefit the SiSwati names lusekwane and mzilazembe are used for subsp. *africana* and subsp. *nyassana* respectively.

Table 10 Summary of Vegetation Units

Vegetation Unit	Dependable Rainfall (mm)	Topography	Slope	Soils	Classification
H1	850 - 1000	Steeply dissected, rock outcrops, part mountainous	> 30%	**U, TH, N** Rocky outcrops with sandy loam	Highveld steep hill and mountain grassland
H2	850 - 1000	Hilly to undulating	10 - 30%	**U, N, SH, M, V** Acidic loams & clays with rock outcrops	Highveld hill grassland
H3	700 - 850	Steep Hills	> 30%	**U, O, N, TH** Shallow sandy loams with rock outcrops	Highveld steep hill grassland
H4	700 - 850	Undulating valley	< 15%	**O, JH, M, U** Sandy loam to clay, very stony	Highveld valley grassland
H5	700 - 850	Undulating to rolling	5 - 15%	**U, O, M, SH** Shallow sandy loam with rock outcrops. Acidic loams or clays on plateaus	Highveld plateau grassland
UM1	700 - 850	Rocky hillsides	> 30%	**U, O** Shallow sand to sandy loam, stony with rock outcrops	Upper middleveld hillside bush
UM2	600 - 800	Rolling to hilly eroded plateau & plain	15 - 30%	**O, U, Q** Sandy to gravel loam with rock outcrops	Upper middleveld plateau wooded grassland
UM3	600 - 800	Rolling to hilly	15 - 30%	**O, N, M, TH, U, O** Sandy loams with patches of acid clay	Upper middleveld hill grassland
UM4	700 -850	Undulating basin	5 - 10%	**M** Deep red loams, very acidic	Upper middleveld basin grassland
UM5	700 - 850	Steeply dissected escarpment & hilly plateau	> 30%	**U, O, Q, M** Sandy to gravelly loam with rock outcrops. Very acid deep red loam on plateau	Upper middleveld forest with clearings
UM6	800 - 1000	Steeply dissected river valley, rocky outcrops	> 30%	**U, Q, O** Sandy to gravelly loam with rock outcrops	Upper middleveld valley broadleaf savannah

Table 10 (continued) Summary of vegetation Units

Vegetation Unit	Dependable Rainfall (mm)	Topography	Slope	Soils	Classification
LM1	500 - 700	Undulating to rolling	5 - 15%	**O, U, H,L** Sandy loam to loan with few rock outcrops	Lower middleveld plains broad leaf savannah
LM2	450 - 700	Low hill and foot slopes	5 - 15%	**U,O** Shallow sand to sandy loam, stony with rock outcrops	Lower middleveld & Lubombo foot slope bush
LM3	550 - 750	Hilly, part undulating	10 - 30%	**U,O** Shallow sandy loam with rock outcrops	Lower middleveld hilly broadleaf savannah
WL1	450 - 550	Undulating to rolling plain	5 - 15%	**JL, E** Deep sand	Western lowveld Combretum/Terminalia savannah
WL2	450 - 550	Undulating plain	5 - 10%	**H, ZL, SL** Sandy loam to loamy clay	Western lowveld broadleaf & microphyllous savannah
WL3	450 - 550	Undulating to rolling plain	5 - 15%	**O, H** Shallow sand to sandy loam	Western lowveld dry broadleaf microphyllous savannah
EL1	400 - 450	Gently undulating to rolling	< 15%	**SL, CL, R, K, U** Clays & loams, with some rocky outcrops	Eastern lowveld dry Acacia shrub savannah
EL2	450 - 550	Gently undulating to undulating	< 10%	**SL, CL, R, K** Clays and loams	Eastern lowveld Acacia nigrescens tree savannah
L1	450 - 550	Steeply dissected escarpment	> 30%	**U** Stony ground with rock outcrops	Lubombo steep escarpment bush
L2	600 - 800	Undulating plateau	5 - 10%	**L, O, U** Slightly acid deep red loam, some sandy loam and rock outcrops	Lubombo plateau bush clump savannah
L3	550 - 700	Hilly eroded plateau	15 - 30%	**U, O** Shallow sand to sandy loam, stony and rocky	Lubombo plateau broadleaf savannah

Vegetation Unit: H1

Classification: Highveld steep hill and mountain grassland

Description: A short dense grassland in very rugged terrain. Generally open but patches of evergreen forest occur in the ravines and river valleys, and some of the lower slopes are densely wooded. The mountains of Ngwenya and Bulembu could be regarded as sub-units but are too small to map separately.

Location: Northwest Swaziland including the Ngwenya Hills and Bulembu, the highest point in Swaziland. Extending southeast in a tongue to the Mdzimba Hills.

Climatic zones: MC1 to C, SH2 to H

Altitude, topography and soils: 1000-1800m, steeply dissected with rock outcrops, part mountainous, slopes > 30%, shallow sandy loams, often stony.

Characteristic grasses: A wide variety of grasses occur including *Hyparrhenia hirta*, *Diheteropogon amplectens, Monocymbium ceresiiforme, Loudetia simplex, Ctenium concinnum, Eulalia villosa, Trachypogon spicatus, Themeda triandra, Koelaria capensis, Michrochloa caffra* and *Rendlia altera*. Under heavy grazing these give way to *Sporobolus* species. At the higher altitudes *Schizachyrium sanguineum* and *Axonopus ajfinus* are common, the latter increasing in overgrazed areas.

A wide variety of forbs also occur in the grassland. They are not normally selected by stock but many are eaten accidentally.

Characteristic trees and shrubs: *Bequaertiodendron magalismontanum, Syzygium cordatum, Vangueria infausta, Maesa lanceolata, Psychotria capensis*, and *Diospyros whyteana* occur at rock outcrops. Bracken (*Pteridium aquilinum*) occurs on more acid soils, *Helichrysum* and *Protea* species are locally common at higher altitudes.

Present status: Nearly a quarter of the unit is nature reserve and a further 13% is under forestry. The rest is mainly SNL grazing. Range condition is generally fair to good but there is some erosion resulting from cattle tracks up and across hillsides near to settlements and dip tanks in SNL. Overall woody cover is very low.

Present trend: Generally stable, but some areas of over utilisation in SNL.

Grazing and browsing potential: Grazing potential limited by steep slopes, shallow soils and rock outcrops. Sour veld with 7-8 months good quality grazing. Very low browse potential.

Recommended stocking rates: 2.0- 2.3 ha/LSU

Vegetation Unit: H2

Classification: Highveld hill grassland

Description: Open grassland with forest patches in hillside ravines and woody clumps at rock outcrops. Broadly similar to H1 but with gentler slopes.

Location: Mainly in a large block in the western side of the country incorporating most of the commercial forest plantations. Smaller units east and northeast of Mbabane.

Climatic zones: Mainly MC2, SH2 but some MC1 and H.

Altitude, topography and soils: Mainly 1000-1500m, hilly to undulating, slopes 10-30%, very acidic loams and clays with rock outcrops.

Characteristic grasses: *Hyparrhenia hirta, Themeda triandra, Loudetia simplex, Diheteropogon amplectens, Tristachya leucothrix, Eulalia villosa, Monocymbium ceresiiforme* and *Cymbopogon excavatus.* Overgrazing leads to *Eragrostis spp.* and then to *Sporobolus spp.*

Berkheya setifera is a common forb.

Characteristic trees and shrubs: The trees *Bequaertiodendron magalismontanum, Cussonia spp.* and *Maesa laneeolata,* and shrubs *Diospyros whyteana, Cephalanthus natalensis, Psychotria capensis* and *Rhoicissus tridentata* are common at the rock outcrops.

Present status: 40% of the unit is under forestry, 5% is TDL grazing and the balance is mainly SNL grazing with scattered cultivation. Range condition is variable, with areas of overutilization and degradation near to settlements but good grazing in sparsely populated areas. Range depletion leading to erosion is locally pronounced, particularly on western side of the Ponjwane Hills and along the slopes down to UM3. Wattle plantations have been established along the Motjane- Piggs Peak road as far as the Monyakane junction.

Present trend: Range condition would seem to be deteriorating in the more populated parts of the SNL.

Grazing and browsing potential: Medium potential grazing for highveld due to slopes and strong tendency to being sour owing to high rainfall and high soil acidity. 7-8 months good quality grazing. Very low browse potential.

Recommended stocking rates: 1.7 - 2 .1 ha/LSU

Vegetation Unit: H3

Classification: Highveld steep hill grassland.

Description: Open grassland with stony hills and rock outcrops. Broadly similar to Hl but at lower altitude and rainfall; slopes steeper than H2. Some slopes wooded, others with scattered shrubs; woody clumps occur mainly at rock outcrops and along drainage lines.

Location: A horseshoe belt from Bhunya and Mankayane curving round to the upper reaches of the Mkhonvdo River, with a tongue extending east from Hlatikulu. It also includes the Mtombe plateau and the Luqolweni hills.

Climatic zones: Mainly MC1, SH1; but slightly warmer (MW2) around the Mkhondvo.

Altitude, topography and soils: Mainly 900-1200m but down to 700m, steep hills with slopes > 30%, shallow sandy loams with rock outcrops.

Characteristic grasses: *Hyparrhenia hirta, Themeda triandra, Eulalia villosa, Eragrostis curvula, Diheteropogon amplectens, Loudetia simplex* and *Cymbopogon excavatus* are common. *Eragrostis spp., Melinis repens, Sporobolus spp., Cynodon dactylon* and sometimes *Paspalum spp*. come in with overgrazing.

Characteristic trees and shrubs: Trees include *Syzygium cordatum, Ficus ingens, Acacia ataxacantha, Bequaertiodendron magalismontanum, Dombeya rotundifolia and Vangueria infausta.* Shrubs include *Dalbergia armata, Diospyros lyciodes, D. whyteana, Clerodendron glabrum, Rhus spp.* (mainly *R. rehmanniana),* and *Euclea spp. (E. crispa, E. divinorum).*

Present status: About 16% of the unit is under forestry, 21% is TDL grazing, and the balance is mainly SNL grazing and scattered cultivation. Range condition generally fair with little sign of erosion except on the slopes leading down to the western side of the Grand Valley.

Present trend: Reasonably stable.

Grazing potential: Medium; limited by the steep slopes but has strong grass cover. About 8 months good quality grazing.

Recommended stocking rates: 2.3 - 2.9 ha/LSU

Vegetation Unit: H4

Classification: Highveld valley grassland

Description: Broad river valley sloping gently up either side of river then rising steeply on thickly wooded hillsides. Valley vegetation predominantly grassland or wooded grassland. Warmer than most of the highveld, and tending climatically toward upper middleveld.

Location: Ngwempisi river valley Climatic zones: MW1 to MC1, SH1
Altitude, topography and soils: 900-lOOOm, undulating valley, slopes < 15%, sandy loam to clay, very stony.

Characteristic grasses: Variable species composition including *Hyparrhenia hirta, Heteropogon contortus, Hyperthelia dissoluta, Trachypogon spicatus* and *Cymbopogon excavatus.* Other typical highveld grasses including *Loudetia simplex, Eulalia villosa, Diheteropogon amplectens* and *Monocymbium ceresiiforme* occur in the cooler western end of the valley. Overgrazed areas are characterised by *Cynodon dactylon, Sporobolus ajricanus* and *Paspalum scrobiculatum.*

Characteristic trees and shrubs: There are few trees or shrubs in the valley but scattered *Acacia caffra* and *A. tortilis* occur lower down, while *Euclea divinorum, Cussonia spicata, Diospyros whyteana, D. dichrophylla* and *Rhus dentata* are found further up the slopes.

Present status: The unit is mainly SNL grazing, with a considerable amount of cultivation. Range condition is generally poor with widespread overgrazing and considerable localised gulley erosion.

Present trend: Range condition seems to be deteriorating.

Grazing potential: Low potential in its present condition but fairly high inherent potential; moderately sour with 8-9 months good quality grazing.

Recommended stocking rates: 2.3 - 2.9 ha/LSU

Vegetation Unit: H5

Classification: Highveld plateau grassland

Description: Undulating plateau grassland with woody clumps at rock outcrops

Location: A large unit in the southwest of the country extending from Sicunusa and Mahlangatsa to Nhlangano, and a small area east of Hlatikulu.

Climatic zones: MC1, SH1

Altitude, topography and soils: 900-1300m, undulating to rolling, slopes 5-15%, shallow sandy loam with rock outcrops; acidic loams or clays on plateaus.

Characteristic grasses: *Hyparrhenia hirta, Cymbopogon excavatus, Loudetia simplex, Eragrostis curvula*, and Themeda triandra, giving way to *Eragrostis spp., Melinis repens, Sporobolus spp.* and *Aristida spp*. with overgrazing .

Characteristic trees and shrubs: *Diospyros whyteana* occurs sporadically on the stony slopes and together with *D. dichrophylla* and *Bequaertiodendron magalismontanum, Dombeya rotundifolia* and *Vangueria injausta* at the boulder outcrops. Wattle has become quite wide spread in small clumps, in addition to managed plantations, particularly in Nhlangano area.

Present status: 21% of the unit is under forestry and 7% is TDL grazing; the balance is SNL grazing with cultivation. Widely overgrazed due to intensive settlement, range condition generally poor but little erosion. Natural woody cover very low.

Present trend: Range condition probably deteriorating. Wattle and eucalypts increasing near settlements.

Grazing potential: Inherent potential high but reduced by present condition. About 8 months good quality grazing.

Recommended stocking rates: 1.8- 2 .2 ha/LSU

Vegetation Unit: UM1

Classification: Upper middleveld hillside bush

Description: Steep rocky slopes with a dense cover of shrubs and trees and relatively sparse grass cover. The Bulunga mountains include an area of open plateau corresponding to MU2 but too small to warrant mapping separately as has been done for Kapunga.

Location: Slopes of the Kapunga plateau, Bulunga Mountains, Nkambeni hills and Ntabinezimpisi hill.

Climatic zones: MW2, SH1 except for the Nkambeni and Ntabainezmpisi hills which are MSA2. Altitude, topography and soils: The northern hills 350-700m, the rest 600-900m. Slopes > 30%. Shallow sand to sandy loam, stony and with rock outcrops.

Characteristic grasses: *Heteropogon contortus, Aristida congesta, Digitaria ternata* and *Themeda triandra*. With overgrazing *Aristida spp., Sporobolus spp., Melinis repens, Tragus berteronianus* and *Cynodon dactylon* come in.

Characteristic trees and shrubs: *Combretum* spp. (inc. *C. molle*, *C. apiculatum*), *Peltophorum africanum, Lannea discolor, Acacia nilotica, Berchemia zeyheri* and *Sclerocarya birrea.* Shrubs include *Diospyros dichrophylla, Bauhinia galpinii, Rhus gueinzii, Dichrostachys cinerea* (Lusekwane), *Cassine eucleiformis, Plectroniella armata, Euclea* spp. and *Dalbergia armata*. Aloes are also locally common.

Present status: The unit is almost entirely available as SNL grazing. Range condition is generally fair due to protection by the slopes and woody density.

Present trend: Range condition is generally stable.

Grazing potential: Grazing potential is low due to steepness, stoniness and woody density, but browsing potential is high.

Recommended stocking rates: 3.5- 4.3 ha/LSU

Vegetation Unit: UM2

Classification: Upper middleveld plateau wooded grassland

Description: Rolling plateau grassland with scattered trees and shrubs, and some dense forest patches.

Locations: The Kapunga plateau and the locality around Hluti. Climatic zones: MW1-MW2, MSA1-SH1 Altitude, topography and soils: 600-900m, rolling to hilly eroded plateau and plain, slopes 15-30%, sandy to gravelly loam with rock outcrops.

Characteristic grasses: *Hyparrhenia hirta, Cymbopogon excavatus, Diheteropogon amplectans, Eragrostis spp. (inc. E. curvula), Sporobolus africanus, Paspalum spp.* (inc. *P. scrobiculatum).* Abandoned cultivation areas are colonised by *Cynodon dactylon* and *Melinis repens* followed by *Sporobolus spp.* and ultimately back to *Hyparrhenia hirta* and *Cymbopogon excavatus.*

Characteristic trees and shrubs: Trees include *Syzygium cordatum, Canthium inerme*, *Maesa lanceolata, Dombeya rotundifolia, Pterocarpus angolensis, Combretum* spp. (inc. *C. heterophyllum*) and *Zizyphus mucronata*; shrubs include *Diospyros whyteana*, *Euclea* spp. (inc. *E. divinorum*) and *Dalbergia armata*.

Present status: Entirely SNL. Range condition is poor due to cultivation limiting grazing areas to steeper and rockier slopes, particularly on the Kapunga plateau, where the original woody vegetation only remains in less accessible areas such as slopes and narrow stream valleys. Vegetation depletion and the commencement of soil erosion are quite widely evident and have become severe on the eastern side of the Kapunga plateau, where harvester termites (*Hotodermes* spp.) are a contributory factor.

Present trend: Range condition in terms of grass cover and composition is deteriorating. *Lantana camara*, an alien, is encroaching.

Grazing potential: The non-cultivation areas left for grazing have fairly low potential due to steep slopes and, in some instances, to woody cover; the potential is further reduced by the presently poor range condition. Browsing potential is fairly low due to the woody species composition.

Recommended stocking rates: 2.5- 3.4 ha/LSU

Vegetation Unit: UM3

Classification: Upper middleveld hill grassland
Description: Open rolling grassland with scattered trees in drainage lines and on some slopes. Locations: This is the largest unit in the upper middleveld and occurs mainly in a central block north from the Little Usutu River through Manzini to the Malandzela foothills. Two smaller locations occur in the south between Shiselweni Nkundla and the Ngwavuma River, and in the locality of Nzila.

Climatic zones: Mainly MW2, SH 1; but MSA2 in the southern unit.

Altitude, topography and soils: 600-800m, rolling to hilly, slopes 15-30%. The soils are variable from loamy sands to sandy loams and patches of acid clay. The sandier soils, occurring mainly in the southern units, are highly erodible.

Characteristic grasses: *Hyparrhenia hirta* on the loamier soils, *Hyperthelia dissoluta* on the sandy soils; also in the associations are *Heteropogon contortus and Cymbopogon excavatus.* With overgrazing *Sporobolus africanus. Aristida spp., Melinis repens* and *Cynodon dactylon* come in.

Characteristic trees and shrubs: *Acacia davyi, A. gerrardii, A. sieberana, Sclerocarya birrea* and *Vangueria injausta* on the loamier soils; on the slopes *Combretum* spp. (inc. *C. zeyheri* and *C. apiculatum*), *Bequaertiodendron magalismontanum, Syzygium cordatum* and *Canthium inerme*. Shrubs include *Clerodendron glabrum, Maytenus heterophylla, Dichrostachys cinerea* (mzilazembe), *Rhus* spp. (inc. *R. rehmanniana* and *R. tomentosa*), *Rhoicissus tridentata, Lannea discolor* and *L. edulis*.

Present status: 25% of the unit is TDL grazing and 2% is TDL cropland. The balance is SNL where, owing to high cropping intensity, grazing tends to be confined to the steeper areas. Range condition generally fair to poor, with localised severe sheet and gulley erosion in the Mhlosheni and Sigombeni/Emangcineni areas. Less severe sheet erosion is also evident in the north west of the unit on the slopes forming the transition to H2. Overall woody cover is very low.

Present trend: The extent of range depletion and soil erosion appears to be increasing. Guava and wattle trees are encroaching in some parts.

Grazing potential: High grazing potential in good range condition, but currently reduced. Low browsing potential.

Recommended stocking rates: 2.8 - 3.8 ha/LSU

Vegetation Unit: UM4

Classification: Upper middleveld basin grassland

Description: Inherently a grassland, or an open savannah with a vigorous grass component, but now largely cleared for cultivation and settlement due to the deep red soils.

Locations: A continuous unit including the Malkerns, Ezulwini and Mtilane River valleys, a small unit in the northwest at Ntfonjeni, and two further small pieces in the south at Mbulungwane and Nzila.

Climatic zones: MW1 to MW2, SH1

Altitude, topography and soils: 500-700m, undulating basin, slopes 5-10%, deep red loams, very acidic.

Characteristic grasses: *Hyparrhenia hirta, Themeda triandra, Panicum maximum, Heteropogon contortus, Loudetia simplex* and *Cymbopogon excavatus*; giving way to *Sporobolus* spp., *Aristida* spp., *Paspalum notatum, Axonopus affinus* and *Cynodon dactylon* with overgrazing.

Characteristic trees and shrubs: The few trees include *Acacia sieberana, Sclerocarya birrea, Combretum zeyheri, Vangueria injausta, Trichilia emetica* and *Ficus* spp. The shrubs include *Annona senegalensis, Dichrostachys cinerea* (mzilazembe), *Maytenus senegalensis, Dalbergia armata, Rhoicissus tridentata, Rhus pyroides, Euclea divinorum* and *Acacia ataxacantha*.

Present status: The unit is intensively cultivated, including 22% TDL cropland, leaving little area for grazing and consequently much of the SNL is in poor condition. Severe sheet and gulley erosion is evident along the Little Usutu River, and serious overgrazing on the grazing slopes serving the northern unit. Guava encroachment is rampant in the northern unit, where it is advancing up the hillside toward H 1, but also near the Tibiyo headquarters in the Ezulwini valley. A strongly thorny scrambling alien shrub, *Caesalpinia decapetala*, is also encroaching widely into grazing areas of the northern unit, particularly in the Northern RDA.

Present trend: The erosion in lower Ezulwini is likely to accelerate unless preventive measures are taken. The active encroachment of guava, *Annona senegalensis* and *Caesalpinia decapetala* is seriously problematic in the northern unit.

Grazing and browsing potential: Inherent grazing potential in the valleys is very high but SNL grazing tends to be confined by cultivation to the slopes where the potential is lower.

Recommended stocking rates: 2.3 - 2 .9 ha/LSU

Vegetation Unit: UM5

Classification: Upper middleveld forest with Clearings

Description: A steep escarpment rising up from the LM1 plains to a rugged and steeply hilly plateau. Much of the unit is thickly wooded with natural forest and thicket, particularly on the slopes, but areas of open grassland occur on the plateau.

Locations: A single unit stretching from Mayiwane to the Mzimnene River in the Lukonde area in the north of the country.

Climatic zones: MW2, SH1

Altitude, topography and soils: 600-900m, steeply dissected escarpment and hilly plateau; escarpment slopes > 30%, plateau 15-30%. Sandy to gravelly loam with rock outcrops, very acid deep red loam on plateau.

Characteristic grasses: The open areas that could be accessed were former settlement or cultivation sites abandoned due to resettlement in the 1960s, and no undisturbed grassland was sampled. *Hyparrhenia hirta* would have been expected to dominate but the two major species now in evidence are *Cynodon dactylon* and *Axonopus affinis*, with smaller amounts of *Melinis repens, Pogonarthria squarrosa, Heteropogon contortus, Eragrostis* spp. and *Aristida* spp.

Characteristic trees and shrubs: Trees include *Combretum erythrophyllum, Syzygium cordatum, Maesa lanceolata, Clerodendron glabrum* and *Ficus* spp. Shrubs include *Diospyros whyteana, Euclea* spp., *Dalbergia armata,* and *Acacia ataxacantha*. Bracken (*Pteridium aquilinum*) is locally abundant in the clearings.

Present status: A quarter of the unit is under plantation forest and the natural forest is dense (> 60% cover), leaving only about 20% of the unit as grassland clearings. Aerial reconnaissance shows that some of the clearings are cultivated while nearly all the others are intensively grazed and severely eroded. Although sparsely populated itself, the unit is grazed by livestock from the intensively cultivated adjacent lower middleveld.

Present trend: Range condition is deteriorating in the open grassland areas, and the amount of cultivation in the unit seems to be increasing.

Grazing and browsing potential: The open areas suitable for grazing are limited in extent and a long way from the settlements below. Overall grazing potential of the unit is very low. Browsing potential is also fairly low due to a lack of good browse species in the woody component.

Recommended stocking rates: 2 .9- 3.5 ha/LSU in the grassland areas, nil in the forest areas.

Vegetation Unit: UM6

Classification: Upper middleveld valley broadleaf savannah

Description: Moderately dense bushveld, predominantly broadleaved but with a very wide botanical composition, in a rugged valley with steep and stony sides and a narrow band of dense riverine forest running centrally.

Locations: A single location in the upper reaches of the Komati River in the northwest of the country.

Climatic zones: MW2, SH1 to SH2

Altitude, topography and soils: 600-800m, steeply dissected river valley with rocky slopes > 30%, sandy to gravelly loam.

Characteristic grasses: A wide range of grasses characterised by *Hyparrhenia hirta, Hyperthelia dissoluta, Loudetia simplex, Themeda triandra, Heteropogon contortus, Eragrostis* spp. (inc. *E. superba* and *E. heteromera), Aristida* spp. (inc*. A. congesta and A. sciurus*), *Pogonarthria squarrosa* and *Setaria sphacelata* occurs. With overgrazing the *Aristida* and *Pogonarthria* increase and in areas of higher fertility (e.g. near kraals and dip tanks) *Cynodon dactylon* dominates.

Characteristic trees and shrubs: *Syzygium cordatum, Breonadia salicina, Ficus sycomorus* and the scrambling shrub *Dalbergia armata* occur along the river. On the slopes *Trichilia emetica* and *Acacia karroo* are common, giving way up the slopes to *Combretum collinum*, *Lannea discolor*, *Annona senegalensis*, *Dombeya rotundifolia, Peltophorum africanum, Faurea speciosa*, and Cussonia spicata. The shrubs include *Vangueria infausta, Euclea divinorum, Rhus* spp. (inc. *R. tumulicala* and *R. lancea*), *Ximenia caffra, Acacia cajfra, Lannea edulis* and *Maytenus heterophylla*. Among the rock outcrops *Bequaertiodendron magalismontanum, Heteropyxis natalensis, Diospyros whyteana* and *Rhoicissus tridentata* occur.

Present status: 22% of the unit is TDL ranching. In the SNL there is some cultivation on lower slopes but the unit is mainly used for grazing: Present condition is generally fair to poor with considerable weed encroachment in some parts and slight erosion resulting from steep cattle tracks.

Present trend: Fairly stable.

Grazing and browsing potential: The western end of the valley has sandier soil with poorer grass cover, but the eastern end has better soils and grasses limited by only by rockiness. The great species diversity offers good potential for grazing and browsing but the steep slopes pose an erosion hazard.

Recommended stocking rates: 2 .0 - 2.5 ha/LSU

Vegetation Unit: LM1

Classification: Lower middleveld plains broadleaf savannah

Description: Inherently a predominantly tall grass and broadleaf tree and shrub savannah plain but showing a wide variation in woody cover, having been modified by land use and tenure. The Grand Valley is a sub-unit which could arguably be mapped separately but is sufficiently similar to the bulk of LM 1 to be grouped with it.

Locations: This is the largest of the lower middleveld vegetation types and occurs as a wavy band stretching from the head of the Grand Valley in the south up to Mandlangampisi, where it is interrupted by the lower Komati valley unit LM2, and then continues on to the northern border at Jeppe's Reef and curves round to include Ngononi.

Climatic zones: MW1, MSA1 to MSA2

Altitude, topography and soils: 300-600m, undulating to rolling, with isolated hills and rock outcrops, slopes 5-15%. The soils are predominantly sandy but tend towards sandy loam to loam on the western side of the central part bordering with UM3.

Characteristic grasses: *Hyparrhenia hirta* and *Panicum maximum* occur on the heavier soils but *Hyperthelia dissoluta, Heteropogon contortus, Eragrostis* spp. (inc. *E. rigidior* and *E. superba*), and *Cymbopogon excavatus* are more typical of the unit. Under heavy grazing *Eragrostis pallens, Aristida congesta, Pogonarthria squarrosa, Perotis patens, Sporobolus africanus* and *Urochloa mosambicensis* come in.

Characteristic trees and shrubs: A wide variety of woody plants occur. Common trees include *Combretum* spp. (*C. molle* and *C. apiculatum, C. collinum, C. zeyheri*), *Sclero carya birrea, Acacia* spp. (*A. sieberana, A. nilotica, A. karroo), Ficus sycomorus, Peltophorum africanum, Lannea discolor, Berchemia zeyheri* and *Albizia versicolor*. *Terminalia sericea* is conspicuous on patches of deeper sand. *Olea africana* and *Spirostachys africana* occur on heavier soils. Characteristic shrubs include *Dichrostachys cinerea* (lusekwane), *Euclea* spp. (inc. *E. divinorum* and *E. schimperi*), *Maytenus senegalensis, Xeromphis rudis, Rhus* spp. (mainly *R. gueinzii*), *Annona senegalensis, Lippia javanica* and *Zanthoxylum capense*.

Present status: 26% of the unit is TDL ranching. The SNL land is heavily settled and largely devoid of woody cover, except on isolated hills, while much of the TDL ranch land is thickly bushed. Grass cover and composition on TDL land is mostly fair to good but the range condition is reduced by the woody density. In SNL the cultivation intensity limits the areas available for grazing but overall condition is generally fair except for considerable erosion along the Mzimphofu River and its stream lines. The northern unit is intensively cultivated, causing heavy grazing pressure on the grassland patches of the adjacent UM5 plateau.

Present trend: The SNL appears fairly stable but there is a long running problem of bush encroachment in the TDL ranches. Lusekwane is the principal species responsible for bush encroachment in this vegetation unit and throughout the middleveld and lowveld. Some erosion gullies are visible in the Grand Valley but they are mostly old and stable.

Grazing and browsing potential: This unit is high potential grazing land but the carrying capacity in the bush encroached areas has been considerably reduced.

Recommended stocking rates: 2.2 - 3. 1 ha/LSU

Vegetation Unit: LM2

Classification: Lower middleveld and Lubombo foot slope bush

Description: A fairly open to moderately dense but rather short stand of predominantly broadleaved trees and shrubs (characterised by Combretum spp.) on low rocky hills and the foot slopes of steeper ones.

Locations: This unit includes a most of the hills throughout the middleveld and lowveld, the Komati valley between Mlambongwenya and Madlangampisi, and the lower ledge of the Lubombo ridge running from Sivunga to the southern border.

Climatic zones: Mainly MW1, MSA1 to MSA2

Altitude, topography and soils: 400-600m, low hills and foot slopes, slopes 5-15%, shallow sand to sandy loam with rock outcrops.

Characteristic grasses: *Themeda triandra, Heteropogon contortus, Panicum maximum, Panicum deustum, Eustachys paspaloides, Diplachne eleusine, Eragrostis* spp. (inc. *E. rigidior, E. superba*) and *Aristida* spp. (mainly A. congesta). With overgrazing the Themeda and Panicum disappear and the Aristida spp. become dominant. *Hyperthelia dissoluta* is common on the sandier soils of the Komati valley, and with overuse this gives way to first *Sporobolus* spp. and then to *Cynodon dactylon*.

Characteristic trees and shrubs: *Combretum* spp. (inc. *C. apiculatum*, *C. collinum*, *C. zeyheri* and *C. hereroense*) are typical of the unit. *Zizyphus mucronata, Peltophorum africanum, Vangueria injausta* and *Berchemia zeyheri* are common trees, and *Acacia nigrescens* on the Lubombo ledge. The main shrubs *include Euclea spp. (inc. E divinorum, E. schimperi and E. natalensis), Rhus spp. (mainly R. gueinzii), Dichrostachys cinerea* (lusekwane and mzilazembe), *Dombeya rotundifolia*, *Maytenus senegalensis*, *Plectroniella armata* and *Grewia* spp. (inc. G. *monticola, G. flavescens, G hexamita* and *G. inaequilatera)*. Aloes (*A. marlothii*) are also common.

Present status: These areas are used exclusively for grazing, as they are unsuitable for cultivation. 40% of the unit is TDL. Present condition is generally fair but with some variation.

Present trend: Stable.

Grazing and browsing potential: Intermediate grazing potential due to the slopes, stoniness and woody cover; high browsing potential.

Recommended stocking rates: 3.5 - 5.4 ha/LSU

Vegetation Unit: LM3

Classification: Lower middleveld hilly broadleaf savannah

Description: A hilly unit that is transitional between the plains of the lowveld on the eastern side and the steep slopes up to the highveld and upper middleveld units on the western side. The vegetation is a variable broadleaf savannah with the steeper slopes thickly wooded and intermediate between vegetation units LM2 and UMI but the gentler slopes more open.

Locations: A fairly narrow unit extending south from Kubutsa/Madubeni to Salitje and the border. Climatic zones: MW 1, MSA2

Altitude, topography and soils: 400-600m, hilly, part undulating, slopes 10-30%, shallow sandy loam with rock outcrops.

Characteristic grasses: *Hyperthelia dissoluta, Heteropogon contortus* and *Themeda triandra. Hyparrhenia hirta* occurs on the upper slopes of the western side, while *Eustachys paspaloides* and *Eragrostis* spp. come in on the lower eastern side. The *Eragrostis* spp. increase and *Aristida* spp. come in with overgrazing.

Characteristic trees and shrubs: *Combretuin* spp. (*C. molle, C. zeyheri*), *Sclerocarya birrea, Peltophorum africanum, Pterocarpus angolensis, Dombeya rotundifolia, Olea africana* and *Acacia tortilis*, with a shift from *Combretums* to *Acacia tortilis* and *Acacia nilotica* towards the lowveld. Common shrubs include *Euclea* spp. (*E. divinorum*), *Maytenus senegalensis, Rhus* spp. (*R. pentheri*), *Acacia ataxacantha, Bauhinia galpinii*, *Dichrostachys cinerea* (lusekwane), *Plectroniella armata, Diospyros lyciodes* and *Grewia* spp. (*G. occidentalis*). Aloes (*A. marlothii*) are locally common.

Present status: Almost entirely SNL. Some of the gentler slopes are cultivated but the major part is used for grazing. Present condition is fair to poor; with erosion is developing along the drainage lines and severe gullying in places.

Present trend: Generally stable except in the Salitje area.

Grazing and browsing potential: The grazing potential is intermediate due to the slopes, soils and woody cover. Browsing potential is high. The soils are more erodible than in LM 1.

Recommended stocking rates: 2.4- 3.2 ha/LSU

Vegetation Unit: WL1

Classification: Western lowveld Combretum/Terminalia savannah

Description: A predominantly broadleaf tree and shrub savannah on sandy soils and characterised by Combretum *spp*. and *Terminalia sericea*. A sub-unit is the band of alluvial soils 1-2 km wide either side of the Komati River, which does not warrant mapping separately.

Locations: Tapers down the western side of the western lowveld from Ntabinezimpisi and Border gate down to just south of the Usutu River.

Climatic zones: MW1, MSA1

Altitude, topography and soils: 300-400m, undulating to rolling plain, slopes 1-15%, sandy soils varying from shallow sandy loams to deep sands, apart from an alluvial band along the Komati River.

Characteristic grasses: *Themeda triandra, Panicum maximum, Eragrostis spp.* (a wide variety inc. *E. superba, E. rigidior, E. heteromera* and *E. gummiflua*), *Eustachys paspaloides, Digitaria spp*. (inc. *D. eriantha, D. ternata, D. sanguinalis), Setaria sphacelata, Hyperthelia dissoluta* and *Heteropogon contortus* are common on the more sandy soils. With overgrazing *the Eragrostis spp., Aristida spp*., *Pogonanhria squarrosa* and *Perotis patens* come in.

Characteristic trees and shrubs: The trees include *Terminalia sericea, Combretum spp.* (inc. *C. apiculatum. C. collinum, C. molle, C. zeyheri, C. hereroense), Peltophorum africanum, Acacia spp*., (inc. *A. nigrescens, A. nilotica, A. gerrardii, A. senegal*), *Zizyphus mucronata, Pterocarpus angolensis* and *Strychnos madagascariensis*. The shrub layer includes *Dichrostachys cinerea* (lusekwane), *Euclea divinorum*, *Maytenus senegalensis, Rhus spp*. and *Grewia spp*. Along the Komati River the main trees are *Ficus sycomorus, Trichilia emetica, Acacia sieberana, Lonchocarpus capassa* and *Sclerocarya birrea*, and the shrubs *Maytenus senegalensis, Acacia tortilis* and *Dichrostachys cinerea* (lusekwane).

Present status: 31% of the unit is TDL ranching, and the SNL is intensively settled and cultivated. The fenced ranches are seriously bush encroached, particularly by Lusekwane, but their grazing is mainly fair to good. In the SNL the woody layer has been drastically modified by selective extraction of *Combretums* and *Terminalia* for housing, fencing and kraals, and by clearing for cultivation, and range condition is fair to poor with patches of severe overgrazing. Narrow bands of erosion, related to cattle tracks, are evident along stream lines. The alluvial band along the Komati is intensively cultivated and little of the original vegetation remains.

Present trend: Fairly stable in SNL but bush encroachment is advancing in TDL and in the uncultivated parts of the alluvial band.

Grazing and browsing potential: Moderately high grazing potential, good browse potential. The alluvial band has excellent cropping potential.

Recommended stocking rates: 3.6- 4.4 ha/LSU

Vegetation Unit: WL2

Classification: Western lowveld broadleaf & microphyllous savannah

Description: A mixed broad leaf and microphyllous savannah that is transitional between the broadleaf savannah of the lower middleveld and the acacia savannah of the eastern lowveld. The vegetation boundaries are not precise, particularly on the eastern side where there is often a gradual merging into the predominantly acacia savannah of the eastern lowveld, but the eastern boundary is taken as the line separating the basalt from the sandstones and claystones. There is also a gradual merging of the southern part of the unit into the more arid WL3 south of the Usutu River.

Locations: A band running from the northern border east of Border-gate down the western side of the basalt line to the Mhlatuzane and Usutu rivers.

Climatic zones: Mainly MW 1, MSA 1; but slightly drier (DSA) in the southern part.

Altitude, topography and soils: 200-350m, undulating plain, slopes 5-10%, sandy loam to loamy clay.

Characteristic grasses: *Panicum maximum, Panicum deustum, Themeda triandra, Urochloa mosambicensis, Setaria sphacelata, Enteropogon monostachyus, Eragrostis spp*. (*E. rigidior*) and *Digitaria spp*. (inc. *D sanguinalis, D. ternata*). Burning tends to shift the balance from *Panicums* to *Themeda*. With overgrazing, and in ex-cultivation areas, *Sporobolus spp*. (*S. nitens*) and *Urochloa mosambicensis* are more common.

Characteristic trees and shrubs: Acacia spp. (inc. *A. nigrescens*, *A. nilotica*, *A. senegal, A. gerrardii*, *A . borleae), Sclerocarya birrea, Zizyphus mucronata* and *Peltophorum africanum* occur throughout; *Spirostachys africana* is a more common constituent in the southern part. The shrub layer is composed mainly of *Dichrostachys cinerea* (lusekwane) and to a lesser extent *Euclea divinorum* (which also occurs as a tree), but *Maytenus senegalensis, Acacia senegal, Ormocarpum trichocarpum, Rhus spp*. and *Grewia spp*. are also common.

Present status: Much of the unit is intensively cultivated, with irrigated sugar plantations in the north from Ngomane to the border (18% of the unit), and SNL rainfed arable in the middle section. The southern part is primarily TDL ranching (27% of the unit) and nature reserve (10%). In TDL the grazing condition is generally fair but bush density is problematic; in SNL range condition varies from poor to fair.

Present trend: The grazing still shows the effect of the 1992 drought but also demonstrates remarkable resilience and is recovering well due to the now lower stocking pressures. Bush encroachment is continuing in the TDL; Dichrostachys cinerea (lusekwane) is the primary species responsible and virtually pure stands can be seen in areas previously cleared.

Grazing and browsing potential: The grazing potential is high, with year round palatability of the grass species. Browsing potential is also high in uncleared areas.

Recommended stocking rates: 2 .8 - 3.4 ha/LSU

Vegetation Unit: WL3

Classification: Western lowveld dry broadleaf & microphyllous savannah

Description: A mixed broad leaf and microphyllous savannah that is similar to the unit WL2, but with sandier soils and more arid so that the woody vegetation tends to be less developed and more open. Like WL2, it is transitional to the acacia savannah of the eastern lowveld, and the vegetation boundaries with the units WL2 and EL1 are not clearly defined.

Locations: A block from the Mhlatuzane and Usutu rivers to the southern border between Salitje and the Nkondolo Hills.

Climatic zones: Mainly MW1, MSA1; but slightly drier (DSA) in the north-eastern part of the unit. Altitude, topography and soils: 250-400m, undulating to rolling plain, slopes 5-15%, shallow sand to sandy loam overlying rock or clay pans.

Characteristic grasses: *Eragrostis spp*. (inc. *E. rigidior*, *E. superba*, *E. racemosa, E. pallens*) predominate. *Eustachys paspaloides*, *Digitaria eriantha, Heteropogon contortus, Themeda triandra, Panicum maximum, Enneapogon cenchroides* and *Urochloa mosambicensis* are also common. Overgrazed and disturbed areas become characterised by *Pogonarthria squarrosa*, *Perotis patens* and *Aristida congesta*.

Characteristic trees and shrubs: The common trees include
Combretum apiculatum, Zizyphus mucronata, Peltophorum africanum, Sclerocarya birrea, Bolusanthus speciosus and Acacia spp. (inc. *A. nigrescens, A. nilotica, A. tortilis*). Shrubs include *Dichrostachys cinerea* (lusekwane), *Maytenus senegalensis*, *Euclea spp*. (*E. divinorum*), *Grewia spp*. (*G. flavescens, G. monticola, and G. caffra*) and *Carissa bispinosa*. *Croton gratissimus* and *Spirostachys ajricana* are locally common on more sandy and more clayey soils respectively.

Present status: 31% of the unit is TDL ranching and a further 11% TDL cropland. Range condition is poor in SNL, with considerable erosion. In TDL range condition is fair to poor and bush encroachment is a serious problem, with Lusekwane as the main invader but in some poorly drained areas Tambuti (*Spirostachys africana*) is also an invader. In the northern part of the unit there are some old cotton lands now carrying almost pure stands of Lusekwane 2-3m high. The secondary growth areas of Dichrostachys and Acacia tortilis give a misleading impression of an acacia savannah. Patches of sheet and gulley erosion are common in the SNL, and erosion is severe east of Sitobela.

Present trend: Recovery from the 1992 drought is less pronounced than in the more mesic WL2. Grazing and browsing potential: The inherent grazing potential is intermediate (a little lower than LW2) but the browsing potential is high. Current grazing potential is reduced by the drought effect throughout and by bush encroachment in TDL.

Recommended stocking rates: 3.2 - 4.4 ha/LSU

Vegetation Unit: EL1

Classification: Eastern lowveld dry acacia shrub savannah

Description: A relatively arid and somewhat stunted savannah characterised by Acacias, but with gradual boundaries to the adjoining dry mixed savannah (WL3) on the western side and the *Acacia nigrescens* tree savannah (WL2) on the northern end.

Locations: A band from Big Bend down to Lavumisa, between the Lubombo ridge and the Nkondolo Hills.

Climatic zones: MW1, DSA. This is the driest and hottest part of the country and includes the rain shadow along the Usutu River.

Altitude, topography and soils: 100-300m, gently undulating to rolling plain, slopes mainly < 10%, clays and loams with some rocky outcrops.

Characteristic grasses: *Panicum maximum* and *Themeda triandra* are the two major grasses; other common ones include *Cenchrus ciliaris*, *Eragrostis spp.* (*E. rigidior, E. superba*), *Digitaria eriantha, Urochloa mosambicensis, Sehima galpinii* and *Panicum deustum*. With overgrazing Aristida spp. (A. congesta) and *Sporobolus spp*. (*S. nitens*) predominate on both the red loams and the dark clays along the water courses.

Characteristic trees and shrubs: *Acacia spp*. (inc. *A tortilis, A. nilotica, A. nigrescens*), *Sclerocarya birrea* and *Zizyphus mucronata*. *Acacia tortilis* is the dominant species through much of the unit but gives way to *Acacia nigrescens* in the transition to EL2. *Spirostachys ajricana* can form dense thickets on black clays, particularly where saline. Shrubs include *Dichrostachys cinerea* (lusekwane), *Maytenus spp*. (*M. heterophylla, M. senegalensis), Euclea spp.* (*E. divinorum, E. natalense*), *Rhus gueinzii* and *Ozoroa engleri*.

Present status: There are large irrigated sugar plantations at Big Bend, Nsoko and Lavumisa (14% of the unit), and a further 40% is TDL ranching; the balance is SNL with scattered cultivation. Range condition is fair on TDL but with some encroachment of Acacia tortilis and Dichrostachys cinerea. On SNL range condition varies from fair to poor, with areas of marked grass depletion particularly west of the Incandu Hills.

Present trend: Generally stable.

Grazing and browsing potential: Good grazing and browsing potential, limited only by rainfall.

Recommended stocking rates: 3.4 - 3.8 ha/LSU

Vegetation Unit: EL2

Classification: Eastern lowveld Acacia nigrescens tree savannah

Description: A tree savannah dominated by *Acacia nigrescens* and with a variable understorey dependent upon management. With moderate grazing and periodic burning this becomes a classic parkland savannah. The south of the unit has a gradual transition into the more arid dry acacia savannah (EL1) and the north-western part merges with the better soils of WL2 around Ngomane.

Locations: A single band on the basalt plains north of the Usutu River. Climatic zones: MW1, MSA1 to DSA Altitude, topography and soils: 100-300m, gently undulating to undulating plain, slopes < 10%, clays and loams.

Characteristic grasses: *Panicum maximum, Panicum deustum, Themeda triandra, Urochloa mosambicensis, Eragrostis spp. (inc. E. rigidior, E. superba), Enneapogon cenchroides, Heteropogon contortus, Bothriochloa insculpta, Digitaria eriantha, Eustachy s paspaloides* and *Cenchrus ciliaris.* Fire encourages the Themeda over the Panicums but with overgrazing the Panicums and Themeda decrease, Aristida spp. and miscellaneous forbs come in and Urochloa may increase. Under greater pressure in locations of high fertility (dunging areas) *Cynodon dactylon* forms a dense sward .

Characteristic trees and shrubs: Acacia nigrescens is often dominant and can form almost pure stands. Other characteristic trees include *Zizyphus mucronata, Sclerocarya birrea*, other *Acacia spp.* (inc. *A. burkei, A. gerrardii, A. nilotica, A. tortilis), Bolusanthus speciosus, Combretum imberbe* and *Albizia harveyi.* Shrubs include *Dichrostachys cinerea* (lusekwane), *Grewia spp.* (inc. *G. hexamita, G. bicolor*), *Ormocarpum trichocarpum, Euclea spp*. (*E. divinorum, E. schimperi*), *Balanite smaughamii* and *Rhoicissus tridentata*.

Present status: 30% of the unit, on the best soils, is under large scale irrigated sugar and citrus, 26% is TDL grazing and 17% is nature reserve and reserved hunting area. In these areas range condition is generally good, and in some parts excellent, however bush encroachment is problematic in some parts of TDL and the nature reserve. The SNL is intensely cultivated and little rangeland remains; condition is fair to poor.
Present trend: Effects of the drought are still evident but the unit is showing good recovery.

Grazing and browsing potential: Very good year round grazing and brow sing potential, but is particularly prone to bush encroachment in the absence of periodic hot fires.

Recommended stocking rates: 2.8- 3.4 ha/LSU

Vegetation Unit: L1

Classification: Lubombo steep escarpment bush

Description: A narrow, steep and rocky escarpment from the lowveld plains to the Lubombo plateau, supporting a moderately dense tree and shrub cover similar to that of UM 1.

Locations: A narrow line along the western side of the Lubombo ridge. Climatic zones: MW1, MSA2 Altitude, topography and soils: 300-600m, steeply dissected escarpment, slopes > 30%, stony ground with rocky outcrops.

Characteristic grasses: *Panicum maximum, Themeda triandra, Cymbopogon excavatus, Aristida spp.* (*A. congesta*), *Bothrio chloa insculpta, Heteropogon contortus, Hyperthelia dissoluta a*nd *Setaria sphacelata.* The *Aristida spp.* increase with overgrazing.

Characteristic trees and shrubs: A wide range of woody species occur including the trees *Berchemia zeyheri, Olea africana, Peltophorum africanum, Combretum spp*. (inc. *C. apiculatum, C. molle, C. collinum, C. hereroense*), *Acacia spp*. (inc*. A. tortilis, A. nilotica, A. gerrardii, A. swazica*), *Sclerocarya birrea* and *Vangueria infausta*. Shrubs include Dichrostachys cinerea (lusekwane and mzilaszembe), *Maytenus senegalensis, Rhus tumulicala, Clerodendron glabrum, Lippia javanica, Plectroniella armata* and *Ximenia caffra*.

Present status: 30 % of the unit is TDL and the balance SNL. Owing to the steepness the unit is used only for limited grazing and the condition is fair to good. Bush cover is high (60-80%).

Present trend: Stable.

Grazing and browsing potential: Desirable sweetveld grasses occur but their cover is poor. The combination with steep slopes, stoniness and woody density makes the grazing potential very low except on less steep slopes.

Recommended stocking rates: 5.9- 7.1 ha/LSU

Vegetation Unit: L2

Classification: Lubombo plateau bush clump savannah

Description: Tall grass veld with the woody component occurring in small dense clumps on old termitaria and comprised mainly of broad leaved species.

Location: Lubombo plateau, mainly in a band centred on Siteki, and in smaller locations at the north and south ends of the plateau.

Climatic zones: Siteki band in MW2, SH 1, the outlying areas slightly warmer and drier in MW 1, MSA2.

Altitude, Topography and Soils: 500-650m, undulating plateau, slightly acid deep red loam with some sandy loam and rock outcrops.

Characteristic grasses: *Hyparrhenia hirta, Trachypogon spicatus* and *Themeda triandra* are generally dominant in moderately grazed areas, although in some parts *Cymbopogon excavatus* is locally dominant. Other characteristic grasses include *Diheteropogon amplectens, Loudetia simplex*, *Eragrostis curvula* and *Tristachya Leucothrix*. Under heavy grazing these give way through *Digitaria eriantha* and *Eragrostis spp.*, then to *Sporobolus ajricanus, S. nitens*, miscellaneous forbs, *Paspalum scrobiculatum* and *Cynodon dactylon*.

Characteristic trees and shrubs: The tree layer of the termitaria clumps comprises mainly *Combretum molle*, *C. zeyheri*, *Sideroxylon inerme*, *Cadaba natalensis*, *Schotia brachypetala*, *Olea ajricana* and *Brachylaena huillensis*. Characteristic shrubs include *Galpinia transvaalica*, *Plectroniella armata*, *Diospyros* (*D. dichrophylla* and *D. Lyciodes*), *Dichrostachys cinerea* (mzilazembe), *Maytenus undata* and *M. senegalensis*. Other trees and shrubs occurring include *Acacia burkei*, *A. gerrardii, A. ataxacantha*, *Zizyphus mucronata*, *Sclerocarya birrea, Vangueria infausta, Grewia spp*. (inc. *G. caffra, G. flavescens*), *Lippia javanica, Ximenia caffra and Rhus spp*. (inc. *R. tumulicala*).

Present status: 24% of the unit is TDL grazing, and the SNL balance is intensely cultivated. Range condition is generally fair to good, and soil erosion is not evident. Overall bush cover is low, at about 10%. Present trend: Generally stable, no obvious signs of the bush clumps increasing in size or number.

Grazing potential: High but moderately sour , about 10 months useful grazing. Low browse potential.

Recommended stocking rates: 1.9- 2.6 ha/LSU

Vegetation Unit: L3

Classification: Lubombo plateau broadleaf savannah

Description: Moderately open savannah with tendency for termitaria related bush clumping particularly adjoining unit L2, but becoming more evenly dispersed on eastern sides. Variations within the unit include the Umbuluzi valley, the *Androstachys* forests of the stream and river valleys, and the Mlawula nature reserve which includes areas more typical of L1 and L2.

Location: Eastern side of the Lubombo plateau.

Climatic zones: MW1, MSA2

Altitude, topography and soils: 250-500m, hilly and moderately rugged eroded plateau, slopes 15- 30%, rocky and stony, shallow sand to sandy loam.

Characteristic grasses: *Cymbopogon excavatus* strongly dominant. Other species include *Hyparrhenia hirta*, *Diheteropogon amplectans*, *D. filifolius*, *Themeda triandra*, *Heteropogon contortus*, *Setaria sphacelata* and *Sporobolus* species. The *Sporobolus* increase with overgrazing. On the lower slopes of the Umbuluzi valley *Panicum maximum* and *Themeda triandra* are common.

Characteristic trees and shrubs: *Combretum spp*. (*C. apiculatum, C. molle, C. zeyheri*) are widely common but *Olea ajricana* and *Berchemia zeyheri* are local dominants. *Acacia karroo, Cassine transvaalensis*, *Heteropyxis natalensis* and *Vanguaria injausta* are also characteristic trees. *Rhus spp*. (*R. microcarpa* and *R. leptodictia*), Dichrostachys cinerea (mzilazembe), Euclea schimperi and Maytenus heterophylla are common shrubs in the woody component, while *Lippia javanica* and *Diospyros lyciodes* are abundant in the grass layer. *Androstachys johnsonii* forms patches of forest in the river valleys.

Present status: Apart from the Mlaula nature reserve (18% of the unit), which is slightly atypical, the unit is used almost entirely for grazing and is predominantly SNL, but includes 16% TDL. Range condition is generally fair to good but some degradation and soil erosion are evident on a small and localised scale around settlements or dip tanks. The nature reserve is showing drought effect particularly in the Mbuluzi valley. The woody cover is locally dense but overall moderately open (<40%).

Present trend: Generally stable.

Grazing potential: The unit is quite sour, with 9-10 months of reasonable quality grazing. Stoniness, poor soils and moderately steep slopes limit the grazing potential to intermediate. Browsing potential is also intermediate.

Recommended stocking rates: 2.9- 3.6 ha/LSU

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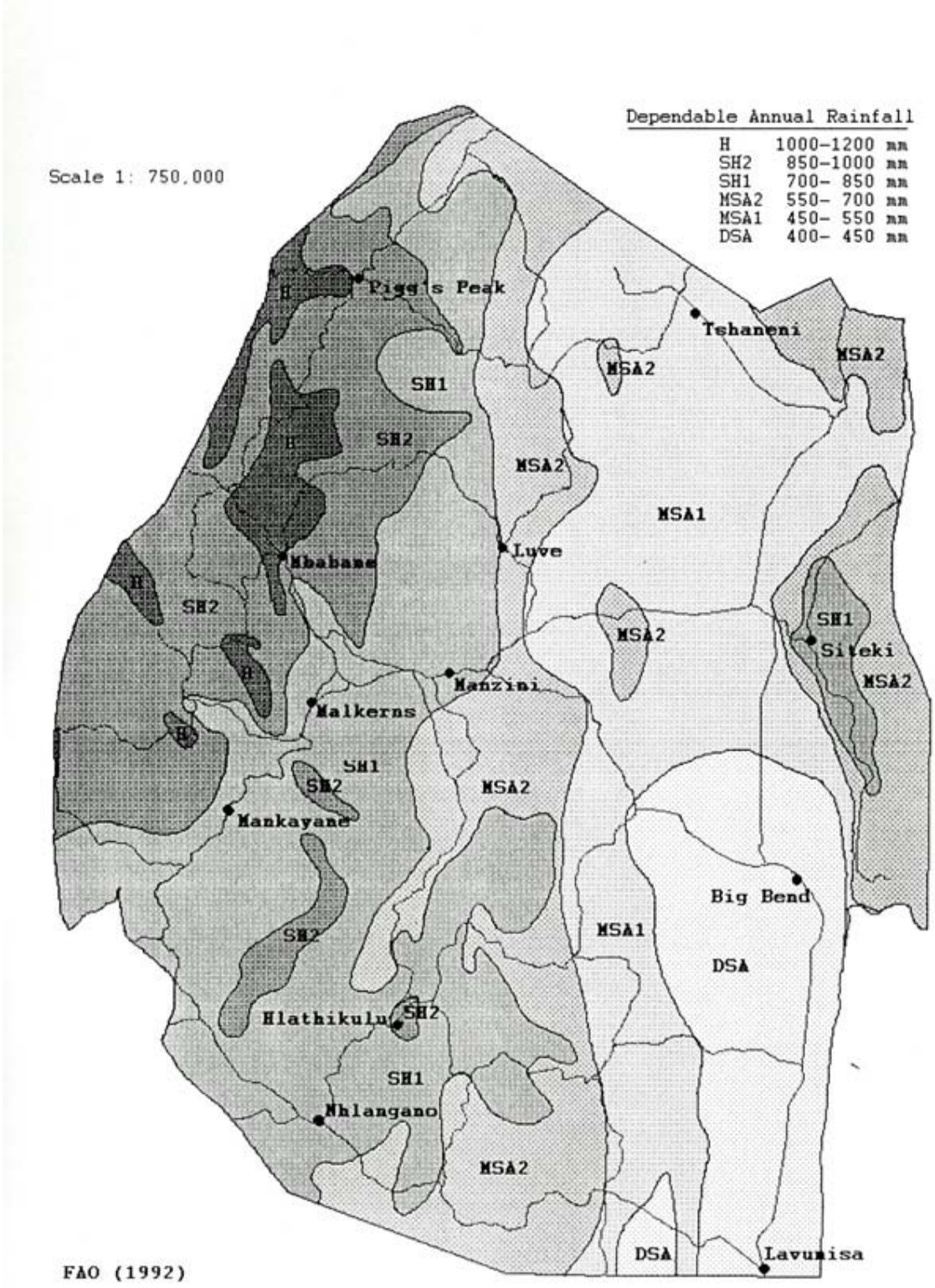
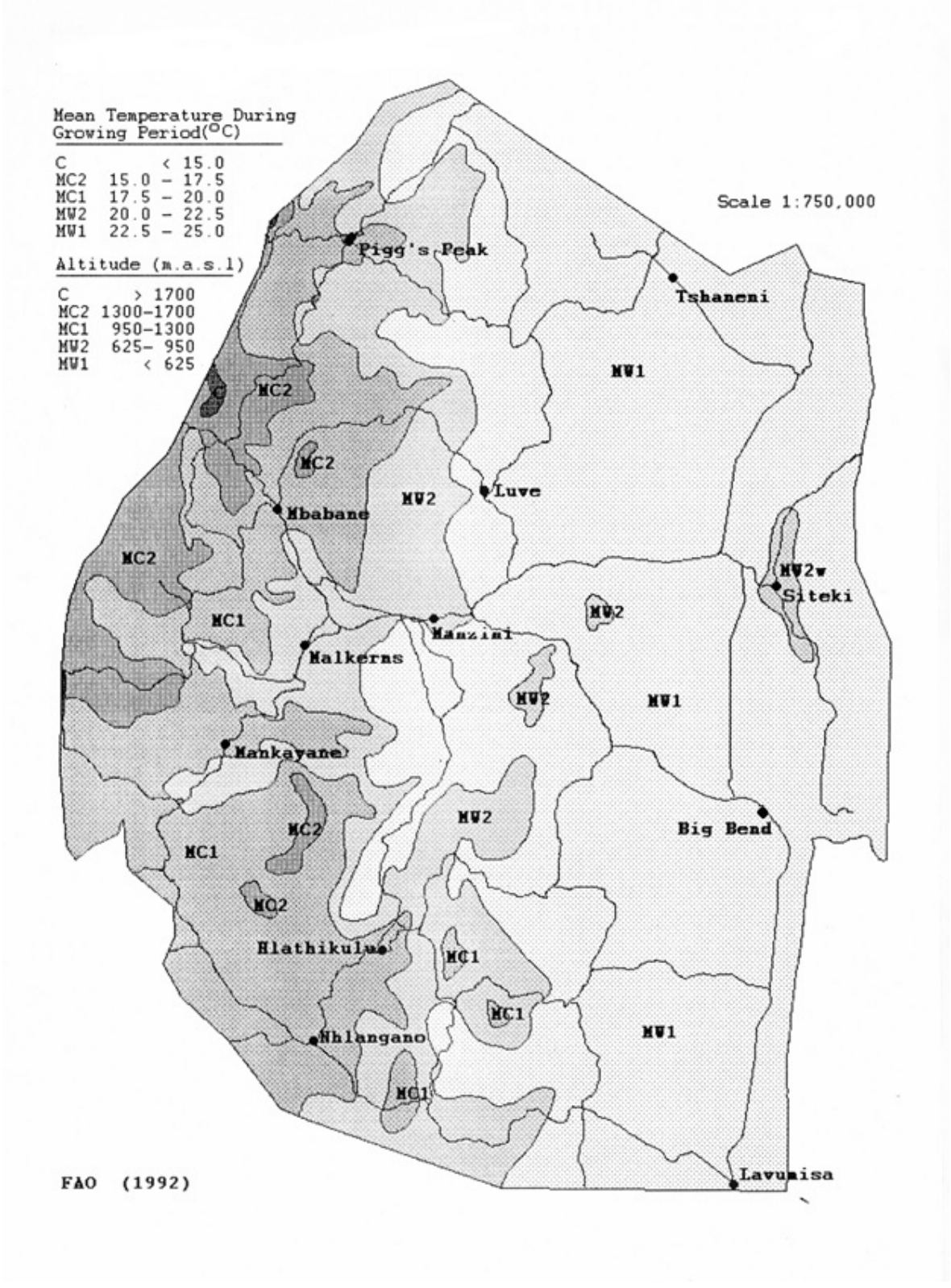
Map 1. Moisture Zones of Swaziland

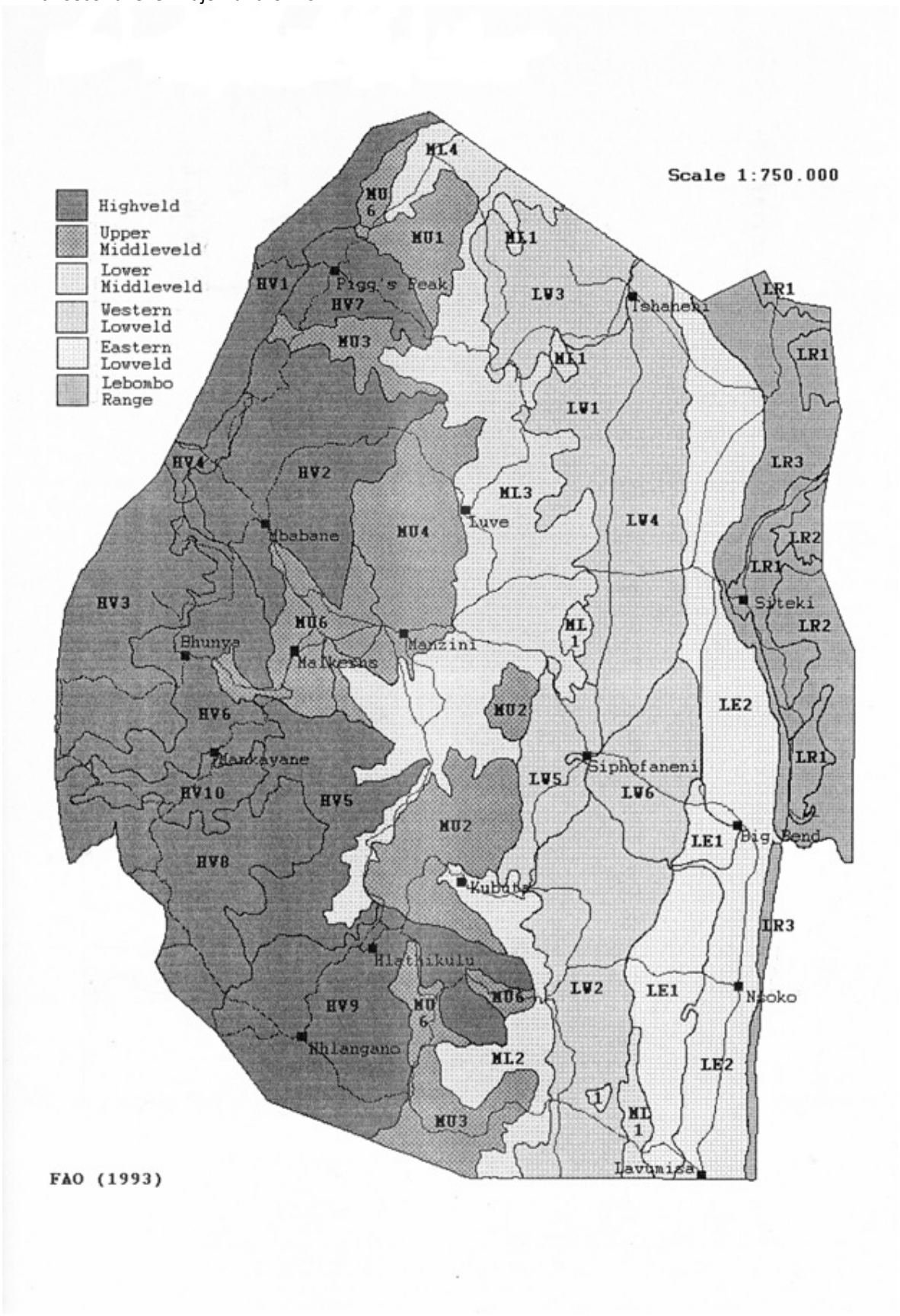


Map 2. Thermal Zones of Swaziland



Map 3. Physiographic Zones of Swaziland

With second level major landforms



Map 4. Vegetation Units of Swaziland