

THE THREE RIVERS REGION

A VEGETATION STUDY

NATAL TOWN AND REGIONAL PLANNING REPORTS

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**THE VEGETATION OF THE THREE RIVERS
REGION, NATAL**

by

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Introduction

The Three Rivers Region is that portion of Natal lying between the Tugela River and the Mkomanzi River catchments. It is approximately 11 400 sq.km (4 400 sq. miles) in extent, about one eighth of Natal (Fig. 1). It is the most

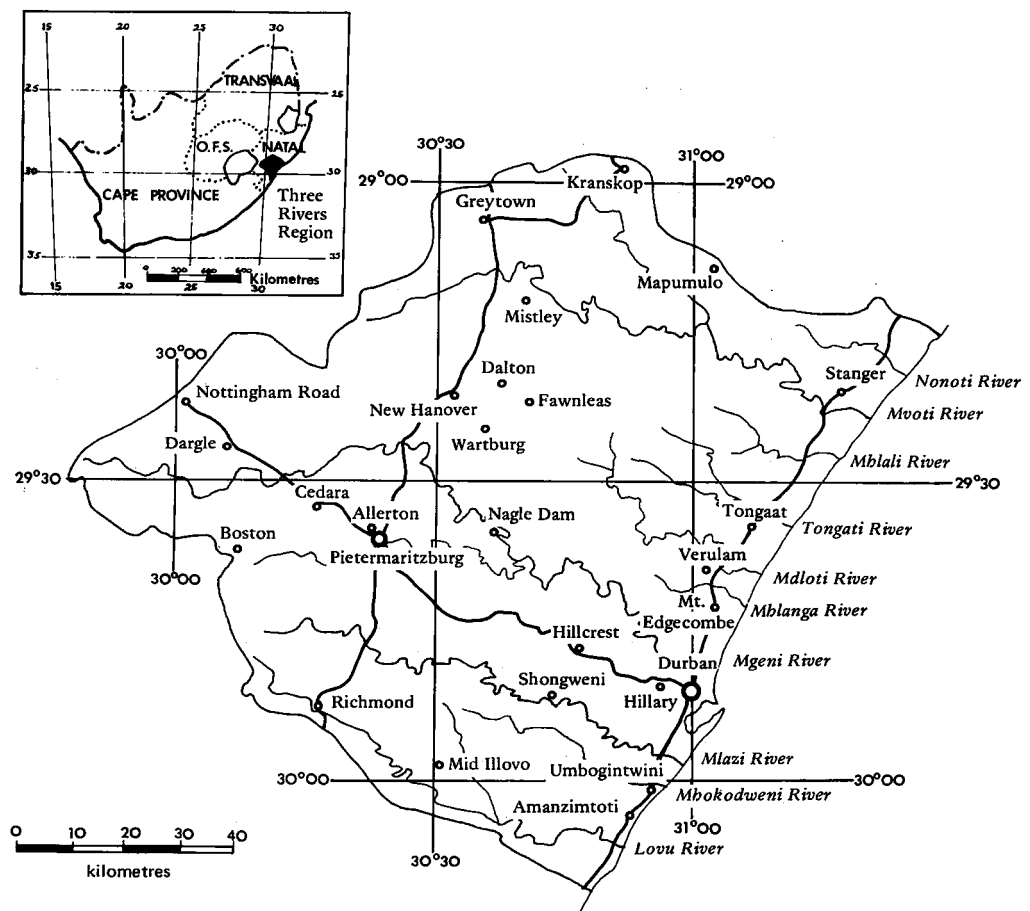


FIG. 1: The Three Rivers Region. The inset gives its position in the Republic of South Africa.

densely populated part of Natal, containing half of the Province's total population of approximately four million people and some 70 per cent of the industrial and commercial development. Durban and Pietermaritzburg, the two largest cities in Natal, lie within the Region.

The study of the plant ecology of the Three Rivers Region was undertaken from 1966 to 1968, after completion of a preliminary investigation of the vegetation of the Upper Mgeni Catchment (Moll, 1965). Seven vegetation types have been recognised in the region and these have been mapped at 1:250 000 scale. For present purposes a *vegetation type* is considered as an assemblage of plant communities that occupy a single bio-climatic area. It is also considered that similar vegetation types indicate similar bio-climatic areas with similar agro-economic potentials.

This plant ecological study has been aimed not only at increasing knowledge of the vegetation of Natal, but also to assist town and regional planners and agriculturalists in planning the development of the Three Rivers Region. It is anticipated that many of the users of this report will be non-botanists, and an attempt has been made to produce a report that will be comprehensible to all possible users.

The report has been divided into three parts: the first includes the most significant environmental factors; the second describes the vegetation, discusses previous literature on the vegetation, and has a brief summary which includes plant indicators of each vegetation type; the third summarises the more important practical implications and recommendations. Possibly the most significant departure from the more usual ecological accounts is the order in which the plant communities of each vegetation type are discussed, and the omission of any detailed description of plant succession.

Acknowledgements

This account is partly a summary of a plant ecological study submitted as a thesis for the Ph.D. degree (Moll, 1971) in the Botany Department, University of Natal, Pietermaritzburg, while I was employed by the Botanical Research Institute.

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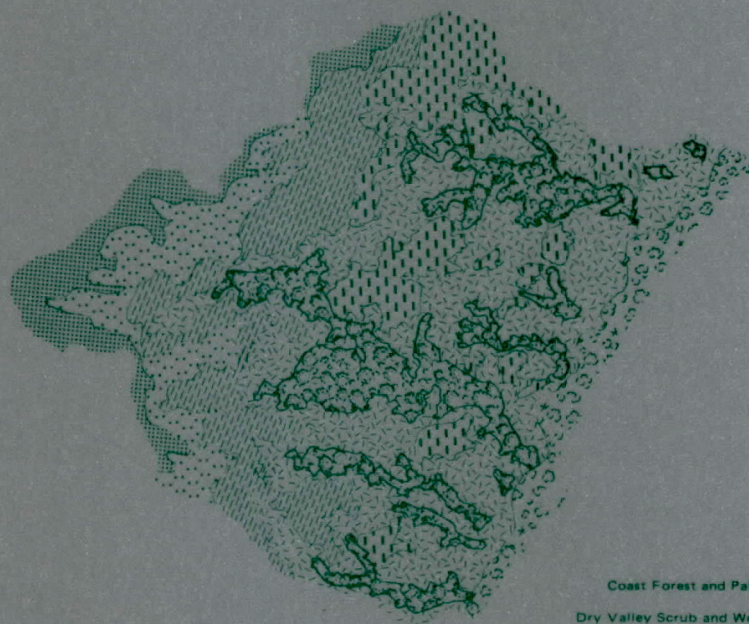
I am also extremely grateful to Mrs. A. Breytenbach who willingly and cheerfully typed and retyped the manuscript.

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



PART I

Environmental Factors

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A simplified Vegetation Map of the Three Rivers Region (Moll, 1968)

- Coast Forest and Palm Veld 
- Dry Valley Scrub and Woodland Mosaic 
- Acacia Sieberana Savanna 
- Secondary *Aristida junciformis* Grassland 
- Moist Transitional *Themeda-Hyparrhenia* Grassland 
- Mistbelt *Themeda-Aristida* Grassland 
- Highland Grassland 

CHAPTER 1

Physiography

1.1 TOPOGRAPHY

The land surface of the Three Rivers Region rises from sea level to over 1 829m (6 000ft) in approximately 105km (65 miles). It has been deeply incised by many rivers, the largest of which run more-or-less at right angles to the coastline. The general topography of the region is shown in Fig. 2.

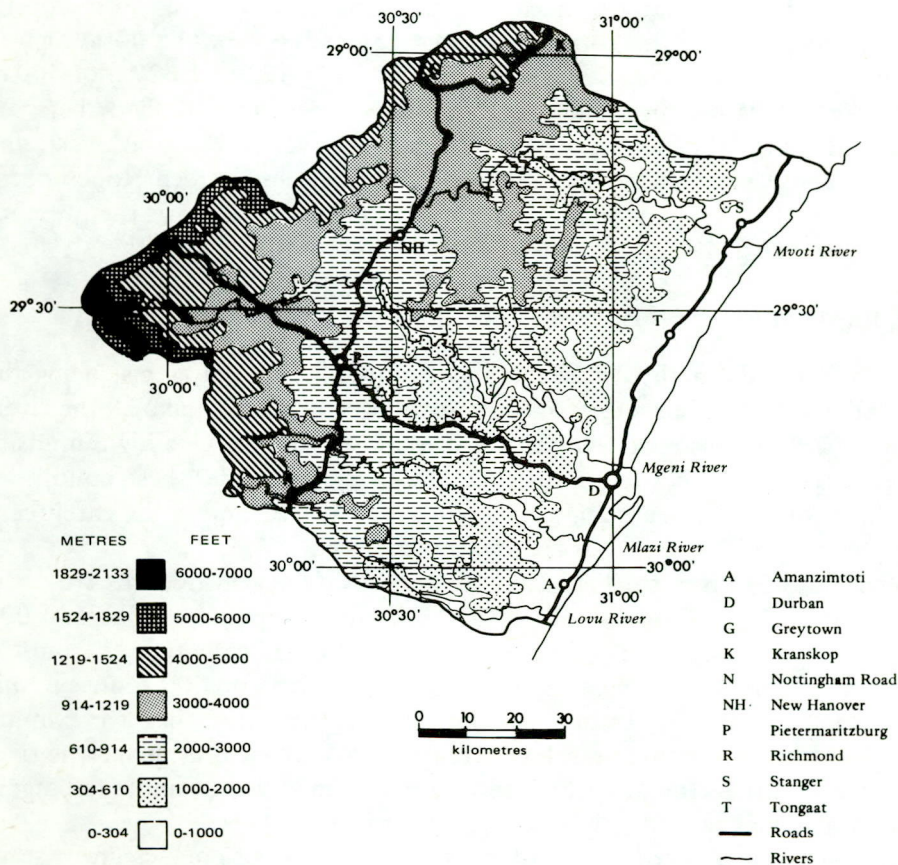


FIG. 2: Topography of the Three Rivers Region (after 1:500 000 Topographic Series Map, 1950).

Along the coast, to an altitude of some 304m (1 000ft), there is a narrow belt of low rolling hills, about 16km (10 miles) wide. An occasional steep river valley cuts across this strip, and along the shore there is a narrow belt of low coast sand dunes, less than 0,4km (0,25 miles) wide and 15 to 61m (60 to 200ft) high.

Behind the belt of low rolling hills lies the most highly dissected terrain of the Region, for example "The Valley of a Thousand Hills". This highly dissected coast hinterland, which extends in a 32km (20 mile) wide belt behind the coast hills, has been incised by numerous rivers and streams. Between the steep-sided river valleys, finger-like spurs of remnant tableland extend towards the sea. Near the sea the spurs become narrow, flat-topped ridges whilst further inland they are more extensive, for example the area between Cato Ridge and Camperdown. The altitude varies from 152m (500ft) in the valleys, to 914 m (3 000ft) on the ridges.

Beyond the highly dissected coast hinterland the river valleys are not as steep, and fairly large river basins are formed. The topography here is flat, as in the Dalton—Wartburg—Fawnleas triangle, or undulating, as in the vicinity of Merrivale and Crammond. The altitude varies from 610m (2 000ft) in the river basins, to 1 067m (3 500ft) on the hills.

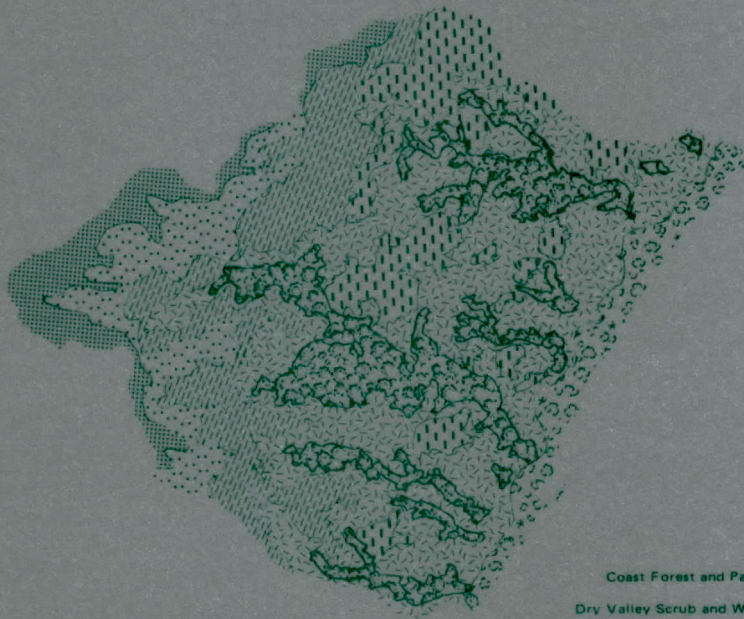
Rising steeply out of this gently undulating country is the highland area. Escarpments are particularly noticeable along the Karkloof Range in the north, and near Richmond in the south. This escarpment is 304m (1 000ft) high in parts, giving way to the relatively flat highland area, 1 372 to 1 829m (4 500 to 6 000ft) high. It is the highland area that forms the watershed divide between the Mooi River to the northeast, the Mkomanzi River to the southwest, and the Mvoti and Mgeni Rivers to the southeast. Occasional steep slopes occur within the highlands and a characteristic feature of these slopes is the presence of terracettes (King, 1951), forming almost continuous contour paths.

1.2 DRAINAGE








Numerous rivers drain the Three Rivers Region (Fig. 1), the largest being the Mgeni and Mvoti. The effects of the steep topography is to make all the rivers flow swiftly. Rainfall is seasonal, and storms are often of such a high intensity that the rivers are subject to flash floods. As expected, under these conditions the silt loads of the rivers are abnormally high, and where land in the catchment is poorly conserved the silt loads are greatly increased.

Wylie (1965) gives silt load data for some Natal rivers. Figures from the Mgeni River at Nagle Dam show that in the rainy season as much as 150 000 tonnes of silt were carried in one month (January 1959), while figures from the Mvoti River mouth show that this river may carry over 100 000 tonnes in one month (December 1964). Even a small river like the Mdloti has a maximum load of 4 800 tonnes in one month (December 1964). In winter, when the river flow is very low, the silt loads are correspondingly small, for example the Mgeni River at Nagle Dam carried only 4 tonnes of silt in June 1960.

The presence of hard bands of rock across the river courses give rise to numerous rapids and waterfalls. In the highlands, where numerous dolerite dykes and sills obstruct the flow of the rivers, they are mature above the obstructions and youthful below, becoming mature near the coast.



A simplified Vegetation Map of the Three Rivers Region (Moll, 1968)

- Coast Forest and Palm Veld 
- Dry Valley Scrub and Woodland Mosaic 
- Acacia Sieberana Savanna 
- Secondary Aristida junciformis Grassland 
- Moist Transitional Themeda-Hyparrhenia Grassland 
- Mistbelt Themeda-Aristida Grassland 
- Highland Grassland 

1.3 GEOLOGY

A geological map of the region is shown in Fig. 3. The geology west of a line running south-southwest from Kranskop to Richmond is fairly simple. It consists of horizontally-bedded sandstones, shales and mudstones belonging to Beaufort and Ecca Series of the Upper Karroo System. Most of the Upper Karroo System has been intruded by dolerite dykes and sills.

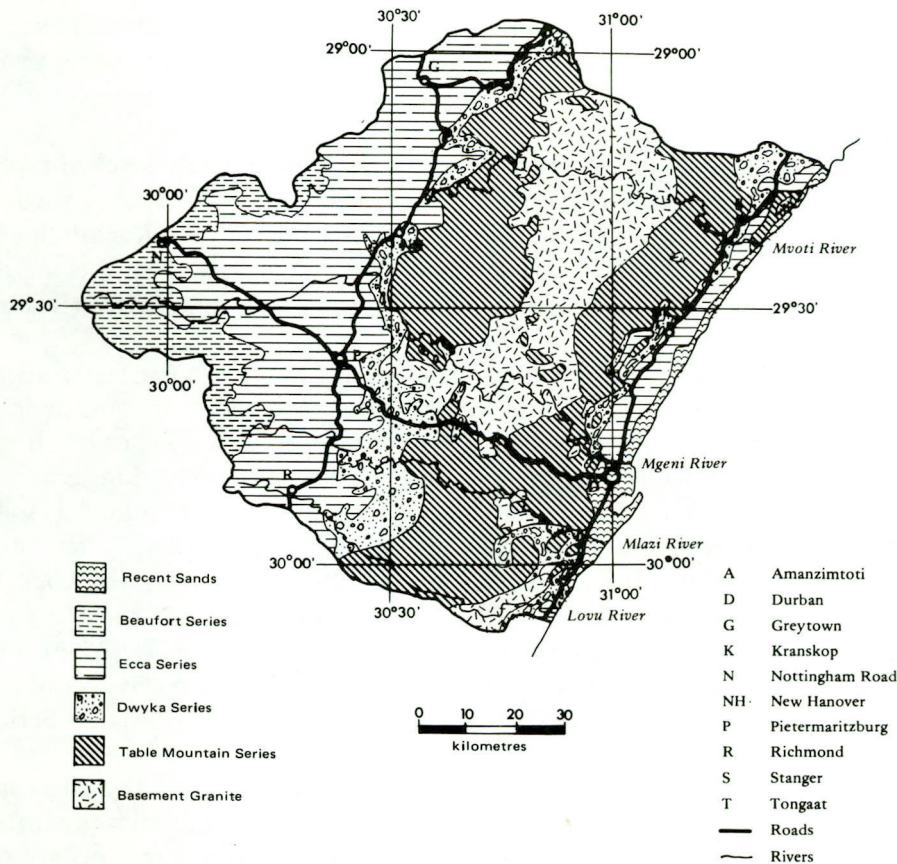


FIG. 3: Geology of the Three Rivers Region (Geological Survey, 1955).

East of the line the geology is complex, the area having been subjected to considerable tectonic movement. The structure through this area is a broad monocline, almost parallel to the coastline, which involved the Karroo System. Subsequent erosion of the "hinge" has produced a double belt of the relevant geological series (du Toit, 1954), which has resulted in the exposure of the Basement Granite on the "hinge". To the west of this "hinge" the Table Mountain Sandstone and Dwyka Tillite of the Lower Karroo System are nearly horizontal, while to the east there is a dip to the sea and the Table Mountain Sandstone, Dwyka Tillite and Ecca Shales are again exposed.

One of the most recent movements along the coast has been the submergence of the coastline, drowning the river mouths. The subsequent deposition

of sand-bars across the river mouths has resulted in the formation of characteristic sea-shore lagoons (Photo 1) common in the Three Rivers Region, and the "northward, longshore drift of sand" (King, 1951) has resulted in the deposition of Recent Sands along the coastline.

1.4 SOILS

Little detailed work has been done on the soils of the Three Rivers Region. Beater (1957) mapped the soils of the "Sugar Belt" according to parent material, and Scotney (MS) is working on the soils of the Upper Mgeni Catchment (Moll, 1965). However, van der Eyk (1965) wrote a short paper on soil classification, and his criteria have been used in this report, with the exception of those areas covered by Beater.

Near the coast most of the soils are deep, sandy, moderately leached types derived from Recent Sands; belonging to the Clansthal, Lytton and Fernwood Series (Beater, 1957). Those coast soils that are derived from the Karroo shales and Dwyka Tillite tend to be shallow, clayey and moderately deep, belonging to the Milkwood Kraal, Windermere, Williamson and Waldene Series (Beater, 1957).

In the highly dissected coast hinterland where the valleys are steep-sided, the soils are shallow, rocky and slightly to moderately leached; belonging mainly to the Glen Rosa Series (Beater, 1957). Where the vegetation cover has been excessively reduced, erosion has led to the formation of gullies or "dongas", and along the bottomlands there are usually deep alluvial and colluvial soils (Photo 2) which vary from clays, to loams and to sand of varying fertility. On the ridges and flat tableland between the valleys, where the bedrock is Table Mountain Sandstone, the moderately deep sandy soils are considerably to highly leached; belonging to the Cartref Series (Beater, 1957). Where the bedrock is Ecca Shale or Dolerite the moderately deep soils are clayey and are moderately to considerably leached; belonging mainly to the Shortlands Series (van der Eyk, 1965).

Further inland where the river valleys are shallow basins the soils are shallow to moderately deep and are moderately to considerably leached; the upland soils belong to the Viny, Avalon and Bergville Series, hardpans are of the Glencoe Series, and the bottomlands belong to the Killarney Series (van der Eyk, 1965);

At even higher altitudes, above 1 219m (4 000ft), the soils are of varying depth and highly leached; the uplands belong to the Griffin, Clovelly, Balmoral and Farningham Series and the bottomlands belong to the Katspruit Series (van der Eyk, 1965).

CHAPTER 2

Climate

This discussion of the climate is limited to components which are known to be of most significance in determining the pattern of the vegetation.

2.1 INSOLATION

Average sunshine data recorded over a ten year period are available only from Durban and Cedara (Weather Bureau, 1965). These data allow for a rough comparison of the coast belt and the interior, and are plotted in Figs. 4 and 5.

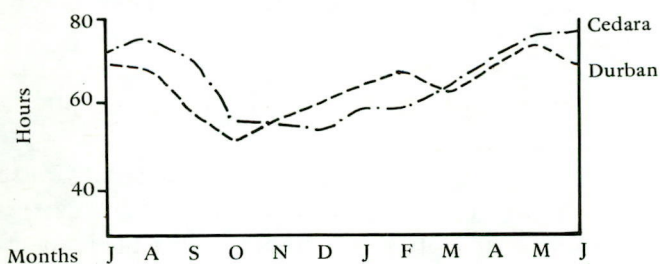


FIG. 4: Percentage of possible sunshine duration at Durban and Cedara (Weather Bureau, 1965).

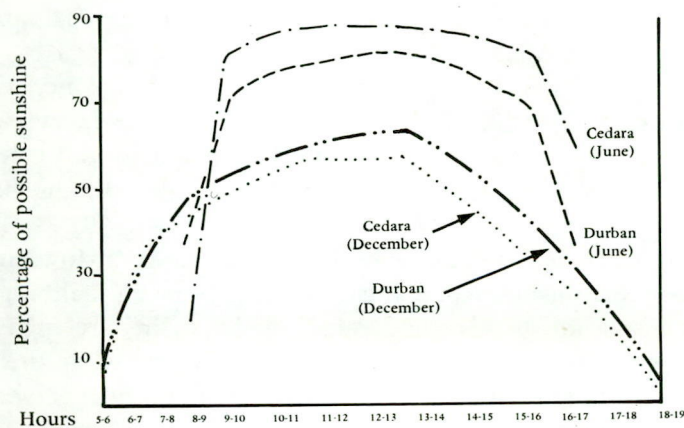


FIG. 5: Diurnal variation of sunshine duration during June and December at Durban and Cedara (Weather Bureau, 1965).

The percentage of possible sunshine at Cedara in winter is higher than at Durban, but in summer the position is reversed (Fig. 4). Comparing the diurnal variation of sunshine duration in June, it is observed that Cedara receives a greater percentage of possible sunshine than does Durban (Fig. 5), particularly in the afternoons. It can be inferred, therefore, that there are fewer clouds over the interior in winter than over the coast, particularly in the afternoons. Consequently heat loss by radiation during winter nights will be greater in the interior than at the coast. This factor, combined with the phenomenon of cold air drainage, is responsible for the heavy ground frost experienced inland. In summer the skies at the coast are clearer than the skies over the interior, but because the atmosphere further inland is thinner, sunshine intensity can be greater at higher altitudes. Taking the year as a whole, therefore, the interior probably receives more insolation than does the coast belt.

Another important consideration in Natal is that north-facing slopes receive more insolation than do south-facing slopes. The former are, therefore, warmer and drier than the latter. In the Mvoti valley, for example, patches of forest may occur on the southeast-facing slopes, while dry succulent vegetation occurs on the northwest-facing slopes of the same hill.

2.2 TEMPERATURE

Temperature data are available from few stations in the Three Rivers Region. Figures for mean daily temperature ranges, absolute maximum and absolute minimum temperatures are given in Tables 1 to 3. The stations are listed according to altitude, from highest to lowest.

Along the coast, below 304m (1 000ft), the mean annual temperatures are highest, for example at Hillary, Stanger, Verulam, Mt. Edgecombe, Umbogintwini and Durban (Table 1).

Records are available from four stations in the highly dissected coast hinterland. The high temperatures at Shongweni Dam and Nagle Dam indicate that the deep river valleys are hotter than the cooler table-land of Mid-Illovo and Hillcrest. Further inland, the stations in the shallow river basins, for example at Allerton, Pietermaritzburg and New Hanover, have higher temperatures than stations on flat ridges, for example at Mistley, Dalton and Greytown. The lowest mean temperatures are recorded in the highland region, for example at Howick, Cedara and Nottingham Road.

With increasing altitude there is a tendency towards an increase in the diurnal temperature range (Table 2). Exceptions are the river valleys where the diurnal temperature range is high even though the altitude is relatively low. To illustrate these changes in diurnal range data from five stations have been plotted in Fig. 6.

The data for Durban illustrate that the diurnal range at low altitudes is small. The data for Nottingham Road illustrate the greater diurnal range at high altitudes is that insolation by day and radiation by night, are higher in the highlands than at the coast. This is particularly so in winter when the highland area receives more sunshine than does the coast, and when heat loss by radiation on clear, calm nights is at its greatest. Thus exposed surfaces warm up rapidly during the day and cool down rapidly at night. Nagle Dam is exceptional, because, even though it is at a lower altitude than are Mid Illovo and Dalton, it

TABLE 1
MEAN DAILY TEMPERATURES RECORDED IN THE THREE RIVERS REGION IN °C (WEATHER BUREAU, 1954).
IN ALL CASES RECORDS ARE FOR TEN OR MORE YEARS.

STATION	ALTITUDE IN M (FT)	MONTHS												YEAR
		J	F	M	A	M	J	J	A	S	O	N	D	
Nottingham Road	1438 (1718)	18,0	17,9	16,6	14,0	10,5	7,5	7,3	10,3	13,3	15,3	16,3	17,5	13,7
Greytown	1109 (3643)	20,4	20,4	19,3	17,6	15,3	12,9	12,4	14,7	16,2	17,8	18,7	20,1	17,2
Cedara	1079 (3540)	19,6	19,7	18,7	16,9	14,2	11,8	11,6	14,1	15,7	16,8	17,9	19,1	16,3
Howick	1052 (3453)	20,7	20,7	19,5	17,2	13,8	10,7	10,5	13,2	15,6	17,6	18,4	19,5	16,5
Dalton	3430 (1045)	19,6	19,5	19,3	17,5	15,4	12,8	12,4	14,4	16,1	17,3	18,1	19,4	16,8
Mistley	975 (3200)	19,1	19,3	18,5	16,7	14,1	11,7	11,7	13,5	15,5	16,8	17,5	18,9	16,1
New Hanover	789 (2596)	22,6	22,3	21,2	19,1	15,9	13,3	13,1	15,8	17,8	19,5	20,5	21,9	18,6
Mid Illovo	701 (2300)	20,4	20,8	20,1	19,0	17,2	15,5	15,1	16,2	16,7	17,7	18,6	19,7	18,1
Hillcrest	695 (2283)	20,4	20,9	19,8	18,7	16,7	14,4	14,3	15,3	16,3	17,9	18,6	20,1	17,8
Pietermaritzburg (Mental Hospital)	2244 (684)	21,9	22,1	21,1	19,3	16,5	13,7	13,3	15,9	17,7	19,1	20,1	21,3	18,5
Allerton	640 (2100)	21,4	21,4	20,1	18,4	15,1	12,3	12,3	14,4	16,3	18,4	19,3	20,8	17,5
Shongweni	1500 (457)	22,5	22,6	22,3	20,8	18,4	16,0	15,5	16,5	18,2	19,7	21,2	22,0	19,7
Nagle Dam	442 (1450)	22,7	23,6	22,5	19,8	17,4	15,9	15,5	17,1	19,6	20,1	21,1	22,3	19,8
Hillary	137 (450)	23,2	23,5	22,7	21,2	19,3	17,4	19,6	17,7	18,7	19,9	21,2	22,5	20,3
Stanger	122 (400)	23,7	24,6	23,8	22,2	20,1	18,4	17,8	18,8	20,1	21,4	22,3	23,5	21,4
Verulam	122 (400)	24,2	24,5	23,7	21,7	19,4	16,9	16,4	17,6	19,2	20,8	22,4	23,7	20,9
Mt. Edgecombe	104 (340)	23,5	23,7	22,9	21,4	19,3	17,1	16,7	17,7	19,0	20,3	21,5	22,7	20,5
Umbogintwini	67 (220)	23,4	23,6	22,8	21,2	18,7	16,7	16,2	17,2	18,4	19,8	21,2	22,6	20,2
Durban	5 (16)	23,9	24,1	23,3	21,6	19,1	17,0	16,5	17,5	18,8	20,1	21,5	22,9	20,5

TABLE 2 MEAN DAILY TEMPERATURE RANGE RECORDED IN THE THREE RIVERS REGION IN °C (WEATHER BUREAU, 1954). IN ALL CASES RECORDS ARE FOR TEN OR MORE YEARS.

STATION	ALTITUDE IN M (FT)	MONTHS												YEAR
		J	F	M	A	M	J	J	A	S	O	N	D	
Nottingham Road	1438 (4718)	11,4	11,5	12,2	14,6	17,9	19,5	19,6	19,1	16,9	14,3	13,0	12,4	15,2
Greytown	1109 (3643)	11,2	10,7	10,0	14,4	11,9	11,6	12,3	12,9	12,5	11,7	11,8	11,2	11,6
Cedara	1079 (3540)	10,6	10,4	10,5	11,8	13,6	14,6	14,8	14,7	14,1	12,4	11,5	11,3	12,5
Howick	1052 (3453)	12,8	12,9	12,8	14,9	16,7	17,6	17,4	17,2	15,7	13,9	14,0	12,4	14,8
Dalton	1045 (3430)	10,1	10,2	10,3	11,1	11,5	11,5	12,5	12,3	12,0	11,8	11,6	11,1	11,3
Mistley	975 (3200)	10,7	10,5	10,3	11,3	12,1	12,4	12,3	12,9	13,1	12,4	11,8	11,5	11,8
New Hanover	789 (2596)	12,9	12,6	12,5	14,6	15,7	16,7	15,8	15,1	15,2	13,7	13,2	12,6	14,3
Mid Illovo	701 (2300)	8,6	8,7	8,6	9,8	10,3	11,2	11,8	11,1	10,5	9,8	9,3	8,8	9,9
Hillcrest	695 (2283)	8,5	8,8	8,9	9,0	10,9	10,9	10,2	10,7	10,3	10,4	9,5	8,9	9,8
Pietermaritzburg (Mental Hospital)	684 (2244)	10,5	10,3	10,5	12,1	14,2	15,7	15,2	14,6	13,5	11,9	11,1	10,8	12,5
Allerton	640 (2100)	11,2	11,5	11,0	13,6	16,2	17,1	16,9	15,0	14,4	11,8	11,5	11,2	13,4
Shongweni	457 (1500)	8,2	8,1	8,7	10,2	11,6	12,2	12,4	11,4	10,5	9,5	9,1	8,8	10,1
Nagle Dam	442 (1450)	9,4	10,2	10,4	11,1	12,9	13,4	13,5	13,9	13,5	9,7	8,8	10,2	11,4
Hillary	137 (450)	7,0	7,9	7,3	8,1	9,0	9,9	9,8	9,4	8,4	7,5	7,2	7,1	8,1
Stanger	122 (400)	8,9	9,4	8,3	10,5	10,5	11,3	11,2	11,5	10,9	10,3	9,3	9,6	10,3
Verulam	122 (400)	9,5	9,8	10,1	10,9	12,2	14,3	14,3	13,5	12,1	10,4	10,0	10,0	11,4
Mt. Edgcombe	104 (340)	7,9	7,9	8,1	9,0	10,5	11,3	11,5	10,7	9,8	8,6	8,3	8,0	9,3
Umbogintwini	67 (220)	8,6	9,1	9,0	10,3	11,6	12,8	12,7	11,9	10,6	9,1	8,6	8,4	10,2
Durban	5 (16)	6,7	6,9	7,1	8,0	10,0	11,0	11,1	9,9	8,2	6,9	6,8	6,7	8,3

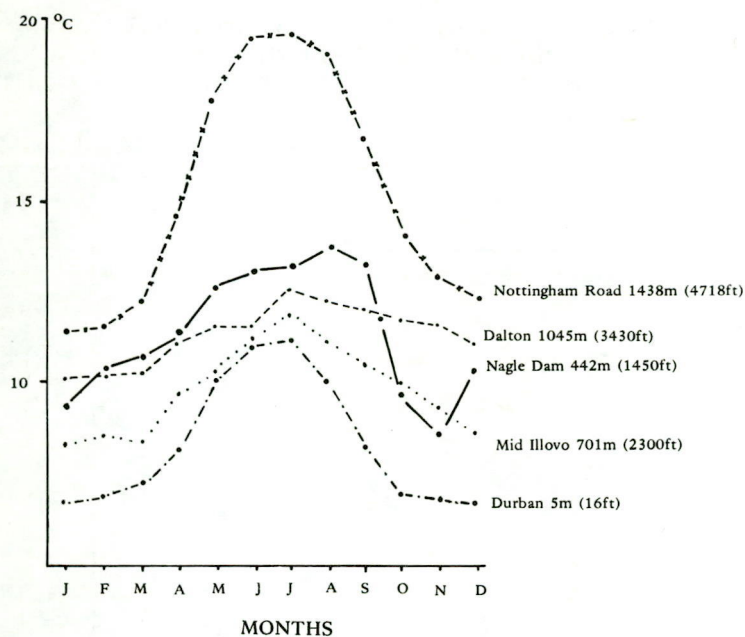


FIG. 6: Diurnal temperature range from five stations in the Three Rivers Region (Weather Bureau, 1954).

has a large diurnal temperature range. This is because in the deep river valleys day temperatures are affected by reflected heat as well as by direct radiation, and night temperatures are low because of cold air drainage into the valleys. Cold air drainage, especially in winter, often results in heavy dew and fog formation in the otherwise dry river valleys, and is probably an important additional source of moisture for many plants (Section 2.4.3.).

Screen temperature from 2,8 to 0,1°C (37,0 to 32,1°F) indicate light ground frost, from 0,0 to -2,8°C (32,0 to 28°F) indicate severe frost (Weather Bureau, 1942). Considering the data given in Table 3, it is seen that generally the coast area is frost free (Durban, Mt. Edgecombe, Stanger and Hillary). The river valleys of the deeply dissected coast hinterland, below about 304m (1 000ft), may receive light frost (Shongweni and Nagle Dam), yet moderately severe frosts may occur on the ridges between the valleys, due to rapid cooling at night (Hillcrest and Mid Illovo). Further inland the river valleys above about 610m (2 000ft) receive more severe frost than do the surrounding ridges (cf. Allerton in a valley and Pietermaritzburg Mental Hospital on a nearby ridge). The severe frost is caused by cold air drainage into the low lying areas on clear winter nights. Another good example of cold air drainage causing very low minimum temperatures is Howick.

Above 1 067m (3 500ft) frosts may be severe over the whole land surface (Nottingham Road and Cedara), and frost erosion (Killick, 1963) is fairly widespread (Photo 3).

The occurrence and intensity of frost is an important factor affecting the vegetation.

Absolute maximum temperatures are also important ecologically, especially if they are associated with low atmospheric humidity. This is discussed in Section 2.5

TABLE 3 ABSOLUTE MAXIMUM AND MINIMUM TEMPERATURES, IN °C, RECORDED IN THE THREE RIVERS REGION (WEATHER BUREAU, 1954). IN ALL CASES RECORDS ARE FOR TEN OR MORE YEARS.

STATION	ALTITUDE IN FT(M)	ABS. MAX.	ABS. MIN.
Nottingham Road	1438 (4718)	35,0	-10,0
Greytown	1109 (3643)	37,9	- 2,1
Cedara	1079 (3450)	38,3	- 5,8
Howick	1052 (3453)	40,6	- 6,6
Dalton	1045 (3430)	38,1	- 1,2
Mistley	975 (3200)	38,3	- 2,8
New Hanover	789 (259)	41,7	- 3,6
Mid Illovo	701 (2300)	41,7	- 0,6
Hillcrest	695 (2283)	40,1	- 0,1
Pietermaritzburg (Mental Hospital)	684 (2244)	40,6	- 1,4
Allerton	640 (2100)	40,0	- 3,3
Shongweni	457 (1500)	43,9	2,8
Nagle Dam	442 (1450)	41,5	2,1
Hillary	137 (450)	44,3	6,3
Stanger	122 (400)	43,9	5,0
Verulam	122 (400)	44,4	0,0
Mt. Edgecombe	104 (340)	45,0	5,0
Umbogintwini	67 (220)	43,3	1,7
Durban	5 (16)	41,9	4,1

2.3 WIND

Wind data are available from Durban, Pietermaritzburg, Cedara and Mistley, and are plotted as wind roses in Fig. 7. The data for Durban include yearly averages of wind speed and direction. Monthly data are also available for January and July. Data for other stations are less comprehensive, but sufficient to indicate important wind directions.

The wind along the coast blows most frequently and strongly from the southwest and northeast quarters, particularly in summer. Further inland winds are most frequent from the southeast and northwest quarters, the strongest winds blowing from the northwest.

An important consequence of air movement is the transportation of moist air over the Three Rivers Region. Most of the rain is frontal, the fronts sweeping up along the east coast of South Africa from the Cape (Jackson; 1952; Weather

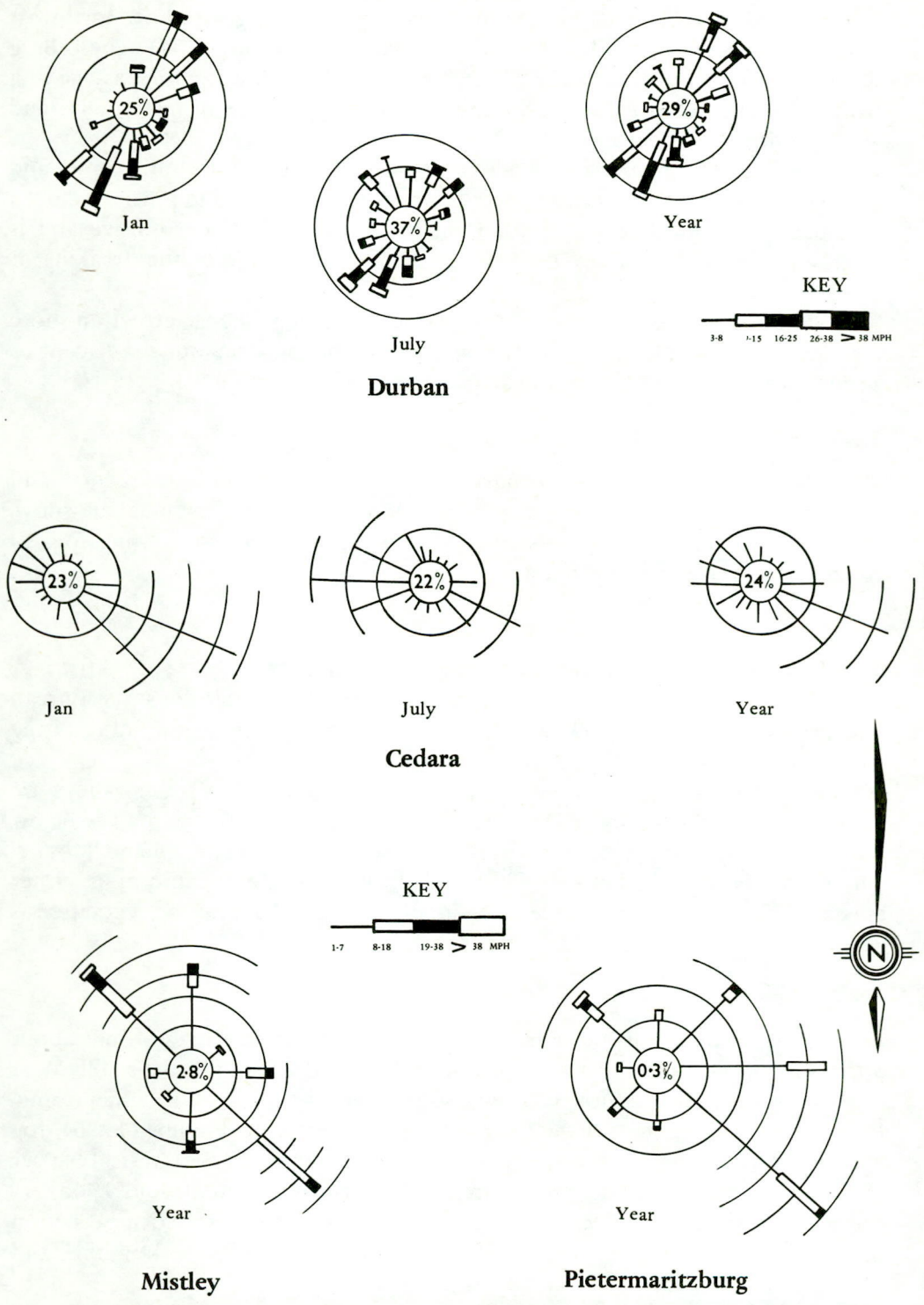


FIG. 7: Wind roses from four stations in the Three Rivers Region — arcs represent 5 per cent intervals (Weather Bureau, 1960).

Bureau, 1965). The fronts may be preceded by strong, gusty, hot, northwest Berg winds which may blow for up to three days (Tyson, 1964). These Berg winds have a strong desiccating effect (Section 2.5). Following the passage of a front, the wind changes to the southwest, the temperature drops rapidly, and gentle continuous rain may fall.

Apart from bringing rain, winds cause some damage by uprooting trees and tearing off branches. In Durban gusts of up to 125 k.p.h. (78 m.p.h.) have been recorded (Weather Bureau, 1960). Damage, however, is not extensive and is usually limited to the occasional uprooting of a forest tree or the breaking of branches.

Windborne salt-spray from the sea causes the clipped-hedge effect on shore vegetation (Photo 4). This is particularly noticeable on steep dunes adjacent to a rocky seashore, as at Isipingo Beach.

2.4 PRECIPITATION

Most precipitation in Natal occurs as rain which, in both frequency and quantity, exceeds other forms of precipitation. Other types include hail, snow, dew and fog. Little or no systematic observations exist concerning fog, so conclusions are necessarily tentative.

2.4.1. Rainfall

The Three Rivers Region lies in the summer rainfall area of South Africa. A rainfall map (Fig. 8) has been compiled from all available Weather Bureau data. This presents a relatively accurate picture of mean annual rainfall resulting from both frontal activity and thunderstorms.

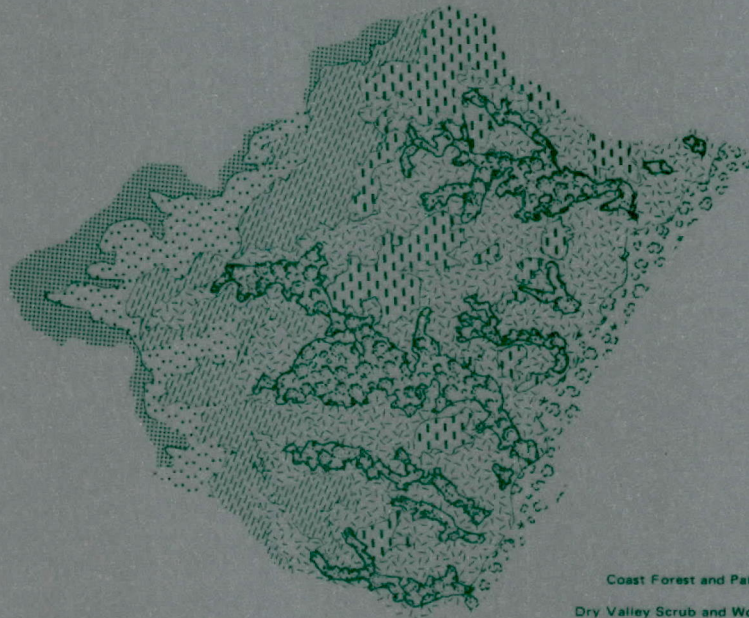
Mean annual rainfall varies from 600 to 1 200mm. The larger valleys are driest, whilst highland and coast areas are wettest. Where the rainfall is below 800mm the vegetation consists of Dry Valley Scrub and Woodland Mosaic; where the rainfall is between 800 and 1 000mm the vegetation is either grassland or savanna; and where the rainfall exceeds 1 100mm the vegetation is grassland or, if protected from fire, forest.








2.4.2. Fog

Fog, or low cloud, occurs quite frequently on ridges and on ranges of hills above 305m (1 000ft), as at the Karkloof Range, Hilton Road and Botha's Hill. Most fog occurs in summer, although heavy fogs may occur also in spring and autumn. In winter, fog is limited to the river valleys. According to Phillips (1926), fog is an important source of precipitation, particularly where some physical barrier obstructs its passage, and in such areas forest usually occurs (Moll, 1965). A fine example in the Three Rivers Region is the Karkloof Forest which occurs on the Karkloof Range. Other examples are on the Hilton and Swartkop hills, and the hills west of Richmond (see Vegetation Map).

2.4.3. Dew

Dew is most frequent and heavy in summer and autumn. Its importance is unknown, but it is probably important in the dry river valleys since cuticular absorption of water has been demonstrated for a number of plants (Gallwey, 1956).



- Coast Forest and Palm Veld 
- Dry Valley Scrub and Woodland Mosaic 
- Acacia Sieberana Savanna 
- Secondary *Aristida junciformis* Grassland 
- Moist Transitional *Themeda-Hyparrhenia* Grassland 
- Mistbelt *Themeda Aristida* Grassland 
- Highland Grassland 

A simplified Vegetation Map of the Three Rivers Region (Moll, 1968)

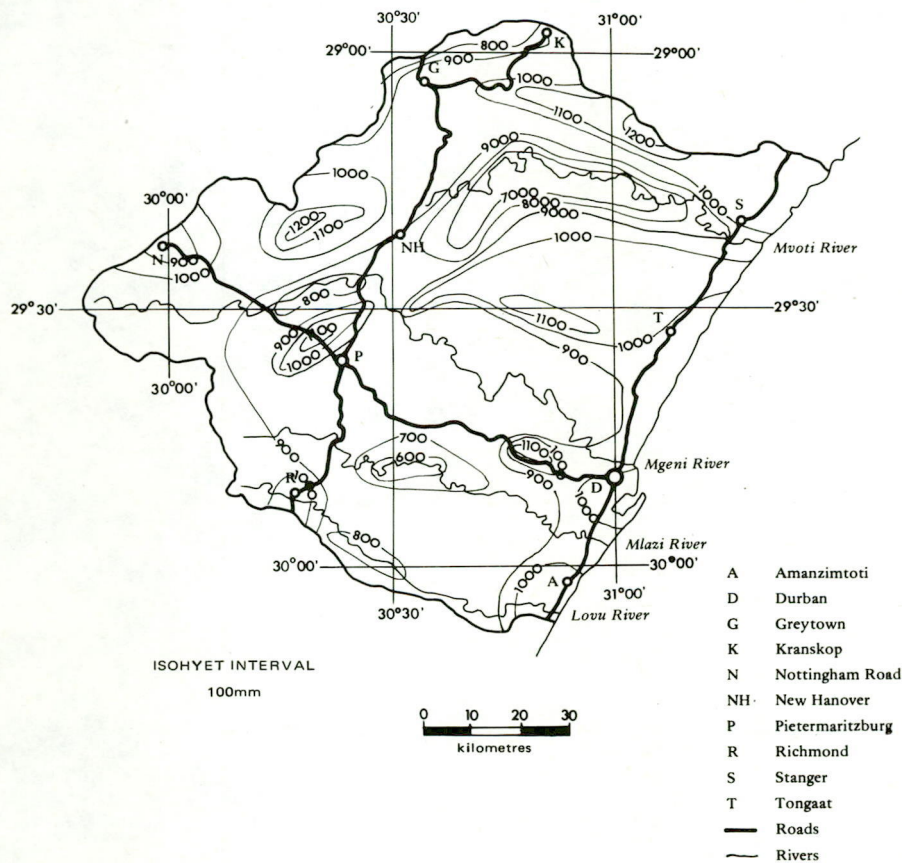


FIG. 8: Rainfall map of the Three Rivers Region.

2.4.4. Hail

Hail, which usually falls in summer and autumn (Weather Bureau, 1954), is not an important source of moisture but can cause great destruction, especially to woody vegetation, small twigs being broken off and even bark stripped, as was witnessed after exceptionally heavy hail at Howick in November, 1965. Fortunately hail is only occasional and the damage is usually restricted to localized belts. Most damage occurs in areas above about 1 067m (3 500ft).

2.4.5. Snow

Snow is mainly limited to areas over 1 067m (3 500ft) and may occur periodically from May to September (Moll 1965), but below 1 219m (4 000ft) snowfalls are rare. It falls fairly regularly (every two or three years) only in areas above 1 524m (5 000ft) heavy falls being experienced every three to five years (Moll, 1965), when the ground may be covered by about 0,3m (1ft) of snow. On rare occasions exceptionally heavy falls with a depth of snow up to 0,9m (three feet) have been recorded (July 1905, 1964 and 1967).

Snow may also be destructive causing considerable damage to woody

TABLE 4
 MEAN DAILY RELATIVE HUMIDITY AT 0800 HOURS AND 1400 HOURS RECORDED IN THE
 THREE RIVERS REGION IN °C (WEATHER BUREAU, 1954). IN ALL CASES RECORDS ARE
 FOR TEN OR MORE YEARS.

STATION	ALTITUDE IN FT(M)	TIME	MONTHS												YEAR
			J	F	M	A	M	J	J	A	S	O	N	D	
Nottingham Road	4718 (1438)	0800	84	87	87	88	83	81	82	80	77	79	78	81	82
Cedara	3540 (1079)	0800	80	83	85	82	78	75	72	71	59	73	76	77	77
Mistley	3200 (975)	0800	81	85	85	83	87	73	72	70	68	72	74	78	77
		1400	67	64	65	57	50	44	41	41	46	54	61	64	55
Pietermaritzburg (Mental Hospital)	2244 (684)	0800	80	82	85	84	82	81	78	76	71	73	76	77	79
		1400	64	63	62	54	44	40	39	42	44	56	62	62	53
Mt. Edgecombe	340 (104)	0800	73	77	80	80	74	71	70	75	71	70	69	75	73
Durban	16 (5)	0800	77	79	80	78	72	69	71	75	74	75	76	75	75
		1400	72	73	74	71	66	61	61	68	71	73	74	73	70

plants, particularly forest trees (Moll, 1965). Water from melted snow may cause erosion on steep slopes by saturating the upper soil layers causing soil slips (Photo 5).

2.5 RELATIVE HUMIDITY

Very little humidity data are available from the Three Rivers Region. Mean daily values recorded at 08h00 are available from Cedara, Mt. Edgecombe and Nottingham Road, and mean daily values at 08h00 and 14h00 are available from Durban, Pietermaritzburg and Mistleley (Weather Bureau, 1954). These data are given in Table 4, and it is apparent that at 08h00 there is very little difference in the relative humidity from the coast to the interior, although values at the coast are a little lower than those of the interior. At 14h00, however, there is a much greater difference, the relative humidity at the coast is high, while that of the interior is much lower (Table 4).

The relative humidity is important ecologically because it influences the rate of evapotranspiration. It can be very low during Berg wind conditions; these conditions are particularly severe in the deep river valleys. Records show that the relative humidity under these Berg wind conditions can be as low as 5 per cent, with an associated air temperature of 40°C (104°F), measured at 13h00 at Pietermaritzburg (Bayer and Coutts, 1938). The ecological significance of these occasional extreme conditions is that they operate as a limiting factor for the growth of sensitive plants.

2.6 EVAPOTRANSPIRATION

Data for evapotranspiration (Thorntwaite and Mather, 1962) are available only for Durban, Pietermaritzburg, Cedara, Nottingham Road, New Hanover and Weenen.* These data have been plotted in Fig. 9.

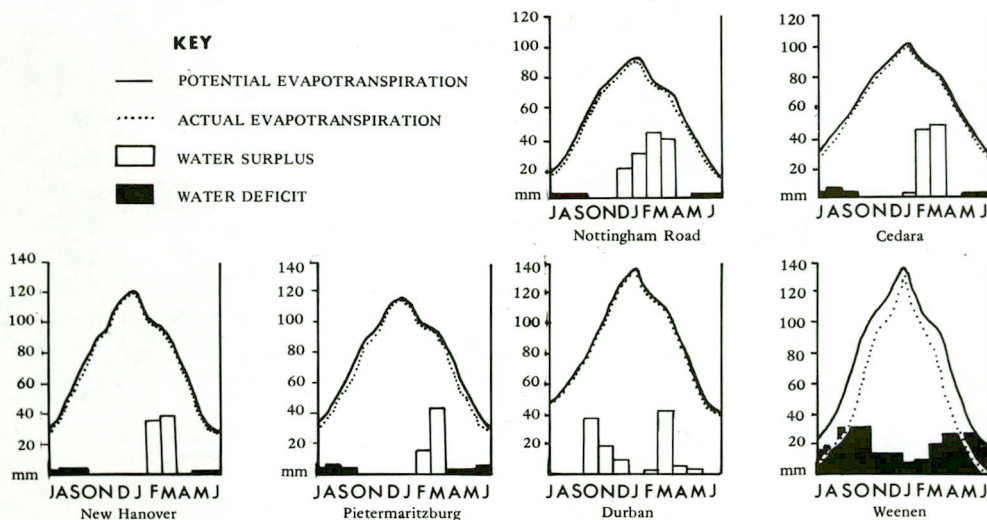


FIG. 9: Available water at five stations in the Three Rivers Region and one station (Weenen), just outside the region (Thorntwaite & Mather, 1962).

* Weenen, although outside the region in the adjacent Tugela River basin, has been included as an example from an extremely dry river valley. Weenen, with a similar vegetation to that of the Mgeni River valley, is the only comparable station for which evapotranspiration data are available. Conditions at Weenen are, however, more extreme than in the Mgeni River valley, as frosts are more severe and the rainfall is only 670mm per annum. But the data do give an indication of the extreme conditions prevailing in a dry river valley, and have been included for comparative purposes.

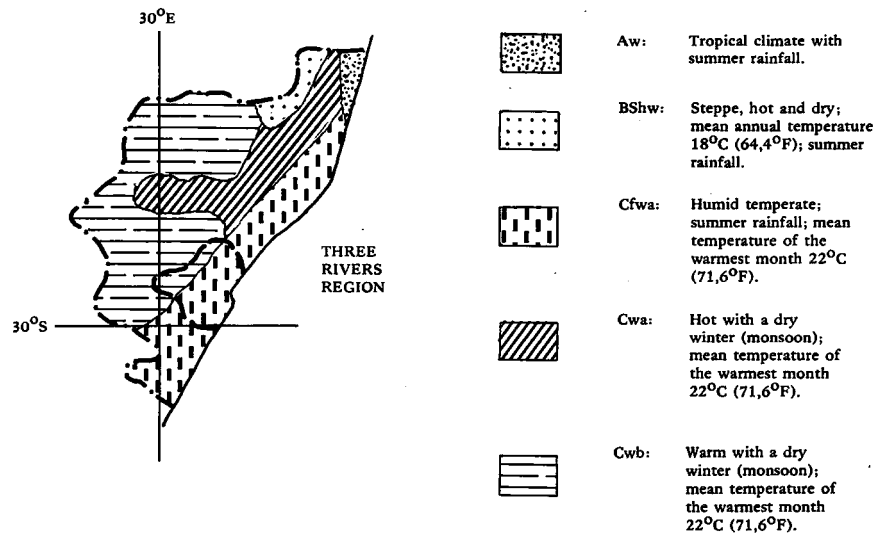


FIG. 10: The climates of Natal according to Köppen's classification (Schulze, 1947).

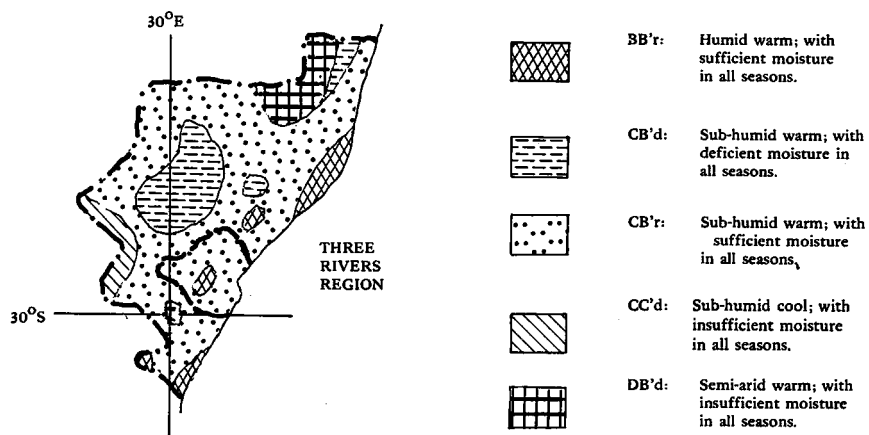


FIG. 11: The climates of Natal according to Thornthwaite's classification (Schulze, 1947).

These data are important as they give an indication of the water available to the plants. In an average year in Durban there is a water surplus for most of the year, and the potential and the actual evapotranspiration are the highest of the six stations. Further inland, the potential and the actual evapotranspiration decrease, corresponding to a decrease in temperature. At Weenen which is in a dry river valley, the potential evapotranspiration and the actual evapotranspiration are high, and there is an apparent water deficit throughout the year.

2.7 CLIMATE CLASSIFICATION

It is interesting to compare the climate of the Three Rivers Region with some world schemes of climate classification. Figs 10 and 11, on which the extent of the Three Rivers Region is given, show Natal's climate divided into regions after Thornthwaite's, and Köppen's classification (Schulze, 1947).

Köppen's classification is a widely used, strictly empirical scheme in which each climate is defined according to fixed values of temperature and precipitation. Thornthwaite's classification on the other hand takes into account differences of vegetation, soil and drainage features, and is based on the seasonal concentration of effective precipitation, and thermal efficiency.

In both these classifications the climate of the Three Rivers Region is classified as being warm and humid with a wet summer season. Sufficient moisture is available throughout the year. Köppen's classification separates the highlands from the rest of the region on the basis that the highlands are less humid than elsewhere and have drier winters. Thornthwaite classifies the whole region, except for a moist area in the vicinity of the Karkloof Forest, as being sub-humid and warm with sufficient moisture in all seasons.

A more comprehensive picture of the climate, in my opinion, is that the region contains a mosaic of bio-climatic areas as indicated by the main vegetation types. The sub-tropical vegetation of the coast is an expression of the prevailing warm, humid climate; the bushland and shrub vegetation of the deep river valleys are an expression of the prevailing warm, drier climate; and the temperate grassland and forest of the highlands is an expression of the prevailing cool, moist climate. Thus the vegetation clearly illustrates the climatic complexity of the Three Rivers Region.

CHAPTER 3

Fire

Fire owes its significant rôle in the ecology of the Three Rivers Region to the seasonal distribution of rainfall. Because the summers are warm and moist, and the winters are dry, the grasslands at the end of winter are highly inflammable. The occurrence of occasional droughts increases the fire hazard considerably, as do the Berg winds which blow in late winter and early spring. Thus, climatically, conditions are ideal for late winter or early spring fires.

3.1 NATURAL FIRES

Fire is considered a natural factor of the environment and West (1965) gives an excellent summary of the literature supporting this view. But, since early historical times, fire has been used by man as a tool to manipulate his environment. Today natural fires are not important, as practically all fires are caused by man.

Natural fires were probably mainly caused by lightning strikes during thunderstorms in spring. These fires still occur and have been witnessed by many farmers. Mr. Spiers of Dargle (personal communication) extinguished three lightning fires in one day in October, 1953. I have witnessed the devastation caused by a lightning fire in sugarcane on Hulett's Estate near the Tugela River mouth, in September, 1965. These examples show that lightning fires can occur from the coast to the highland area in the Three Rivers Region.

It is logical to assume that, before the arrival of the Europeans, natural fires burned large tracts of land since the only barriers were the natural ones of rivers and mountain ranges, and rain the only extinguisher. Brown (1877) gives an account of a fire which razed many square miles of Natal vegetation, and which burned from the Drakensberg to the coast. Since the turn of the century, however, the size of the areas burned has been restricted by the construction of a network of fire breaks.

Grassland, above 1 067m (3 500ft), in the Three Rivers Region is fire maintained. Where areas have been protected from burning for any length of time the grasses have become moribund, and the areas are often invaded by woody plants. Examples of this can be seen at the Cedara and Pietermaritzburg Agricultural Research Stations, at Giant's Castle Game Reserve and at Draycot near Estcourt. The last two places are both just outside the region. That

grassland is fire maintained in much of Natal has been accepted by Bews (1917 and 1918), West (1951), Scott (1952), Bayer (1955), Killick (1959 and 1963), Moll (1965) and Edwards (1967).

The most contentious points concerning natural fires are the season of their occurrence and their frequency. Both these points have been satisfactorily explained for Natal, where below about 2 438m (8 000ft), *Themeda triandra* Grassland is considered the climatic climax grassland type (Bayer 1955; Killick, 1963). At Cedara Staples (1926 and 1930) found that *T. triandra* was encouraged by winter burns. At Tabamhlope and Estcourt Scott (1952) found that burning after the first spring rains gave the best *T. triandra* cover. Both Staples and Scott found that annual or biennial burns gave the best *T. triandra* grass cover, and that triennial burns produced a decrease in the amount of *T. triandra* because the accumulation of litter gave rise to hot, destructive fires. These results indicate that fires must have burned annually, or biennially in spring to maintain *T. triandra* grassland. Furthermore, that spring fires were a natural factor is supported by presence of many herbaceous grassland species, or "forbs", which are adapted to escape the fire. For so many species to have become adapted to conditions of short grass in spring suggests that spring fires must have been a factor of the environment for many thousands of years (Bayer, 1955), long before the arrival of man.

Below 1 067m (3 500ft) it is not clear whether grassland was climax, because, with the exception of the grass-burning experiments at Pietermaritzburg, no experimental work has been conducted below this altitude. Killick (1959), however, recognised *T. triandra* Grassland as the fire maintained sub-climax on Table Mountain. By extrapolation one can assume that all the tableland area of about 610m (2 000ft), is similar. Below this level the topography is rugged in the valleys to undulating on the coast. In the valleys much of the soil is shallow and consequently the grass cover is poor and could not readily have supported a burn. Thus it is apparent that the valley vegetation has always been a mixture of woody and herbaceous species. Along the coast belt, where the climate is more moist and warm, some of the vegetation is always fairly green. Although lightning fires occur in the coast belt, it is unlikely that they would burn large areas because of the lack of sufficient dry fuel.

3.2 MAN-MADE FIRES

Man's changing of the natural fire régime has had considerable impact on the vegetation. Along the coast belt and in the hot river valleys the Bantu used fire to clear the woody vegetation and to supply green grazing for their stock in late summer and winter. This practice was continued by the Europeans, with the result that most of the remaining natural vegetation is secondary. Unnatural burns combined with selective over-grazing have resulted in an alteration of the species composition of the grassland, *T. triandra* a good grazing grass having been replaced by the unpalatable *Eragrostis* spp., *Sporobolus* spp. and *Aristida junciformis*.

In addition the grasslands of the interior have expanded at the expense of woody plant communities, changing the whole character of the vegetation. This change has been from closed forest, to open grassland with relic patches of

forest. On the other hand in the dry river valleys and basins the reverse holds true, the mis-management of the vegetation with consequent depletion of grass-cover has contributed to scrub encroachment by *Acacia* spp.

CHAPTER 4

Historical Background

To assist in the understanding of current vegetation patterns in the Three Rivers Region, some knowledge of the history is necessary. This knowledge is of particular importance as the general methods of land-use have changed from primitive to modern within the last century. Some difficulties have been experienced in compiling this historical chapter, however, for although much has been written about the history of Natal and Zululand, it is difficult to ascertain just how much is relevant to the Three Rivers Region.

The history of man's influence on the vegetation of the Three Rivers Region is best divided into three periods.

4.1 PRE-BANTU TIMES

As far as is known the only inhabitants of Natal prior to the Bantu were the Bushmen (Wilson, 1959). The Bushmen were a nomadic people, roaming the country in small clans. They lived mainly by hunting and eating wild fruits (Clark, 1959). The most important influence of the Bushmen upon the vegetation was probably their practice of firing the vegetation as an aid to hunting (Bartlett, 1957). It, therefore, seems logical to assume that their effect on the vegetation was to maintain open grassland at the expense of woody plant communities such as forest.

In these early times a variety of species of herbivorous animals roamed freely over the country (Roberts, 1951). Many of these animals travelled in large herds, so that if overgrazing occurred it was either localized or transitory.

4.2 THE ARRIVAL AND SPREAD OF THE BANTU

According to Bryant (1929) the Bantu arrived in Natal in the fifteenth and sixteenth centuries, but modern historians believe that they may have arrived in the fourteenth century or earlier (Brookes and Webb, 1965). The first Bantu settled mainly in the warmer areas of the Three Rivers Region, below about 1 372m (4 500ft). They were fairly peaceful people (Bryant, 1929), and their culture revolved around cattle and a primitive system of shifting agriculture. They lived in permanent villages, in huts of wattle and grass which encircled a central cattle kraal. The whole village was surrounded by a fence (Bryant, 1929).

It has been estimated that approximately 1 000 saplings were required for the construction of a single hut (Fourcade, 1889). Thus, when it is realized that some of these villages (particularly further north) contained many hundreds of huts, some indication is given of the great quantity of woody plants that the Bantu must have destroyed for construction purposes alone.

The Bantu burned the vegetation in late summer or in autumn, as well as in winter, to supply green grazing for their stock and by so doing changed the natural fire régime. This initiated a change in the grassland composition, *Themeda triandra* being replaced by *Aristida junciformis* (Staples, 1926 and 1930; and Scott, 1952). Furthermore, "they often changed their garden sites, for under their treatment the land soon wears out" (Holden, 1955). This resulted in the continual clearing of small patches of primary vegetation and of its gradual replacement by secondary vegetation. Such a practice would encourage *A. junciformis*, *Eragrostis curvula* and *Hyparrhènia birta* grassland formation, and *Acacia* scrub development.

The Bantu population of Natal was sparse (Bryant, 1929), but nevertheless their way of life must have caused a considerable change in the vegetation, notably the destruction of woody plant communities and a change in grassland composition.

4.3 THE EUROPEAN SETTLEMENT OF NATAL

The first permanent settlement in Natal was established in Durban in 1824. In 1837 the Voortrekkers entered Natal, and settled mainly in the foothills of the Drakensberg and in the Pietermaritzburg area (Fannin, 1932; Brookes and Webb, 1965). These early European settlers tended to avoid the more rugged areas and the deep river valleys.

It is from 1824 that we begin to get fairly numerous, though rather vague, accounts of the vegetation as it was in those early days. The coast belt was described by Mann (1859) as being 19 to 24km (12 to 15 miles) wide, with many places densely covered by small, evergreen trees. Barter (1952) described the Berea in Durban as being "covered by a dense tangle of vegetation, beyond which the bushy country is free". Holden (1844) stated that "scarcely any timber valuable for building purposes is found near the coast except the red mangrove, which abounds at the mouths of some of the larger rivers." He noted too that forest occurred from the shore to distances of many miles inland, and, where there was no forest, the coast plain was "rolling grass almost devoid of trees, except in the ravines".

Holden made special mention of the numerous streams of pure water in Natal, especially at the coast, and wrote, "seldom does one travel an hour along the coast country, without crossing rivulets of transparent water", though he did say that after a torrential downpour the waters become muddy.

One of the earliest descriptions of the inland of Natal was by Perestrello in 1575 (McKeurtan, 1930), who wrote that the interior consisted of green ridges and many patches of forest. Holden (1855) stated that leaving the coast plain the land was rugged, with bush in the valleys and grassland on the flat ridges, and that this gave way to a broad tableland "almost wholly destitute of trees", though the mountain sides were forested. Mann (1859) noted that the forests of the midlands were known for their yellowwood timber, with beams

12 x 1,5m (40 x 5ft) being common. He also wrote of sneezewood beams being 24 x 1,2m (80 x 8ft).

This picture was soon changed when the vegetation was subjected to man's influence. The early European settlers, like the Bantu, burned the veld to supply green grazing for their stock, and "nearly the whole surface of the country is burnt over once or twice a year; not all at once, but in sections" (Holden, 1855). Along the coast numerous tropical plants were cultivated, such as bananas, pineapples, oranges, lemons, pawpaws, tea, coffee, arrowroot and sugarcane. In 1951 Mr. Morwood at Compensation had a successful sugar farm and small mill (Mann, 1959). But it was not until the early 1900's, when the steam plough was used on an extensive scale, that large acreages were planted to sugar and other crops. Further inland the early settlers farmed with sheep and cattle, planting small acreages of crops such as maize. The Black Wattle industry (*Acacia mearnsii*) was fairly well established by 1904, with approximately 10 000 hectares (25 000 acres) in Natal, most of which was in the Three Rivers Region (Sim, 1904).

In 1883 the Governor of the Natal Colony, Sir Henry Bulwer, was so concerned about the state of the Natal forests that he appointed a commission to enquire into the extent of the destruction, for it was feared that it would affect both the climate and the water supply. The Commission appointed Fourcade, then Survey Officer with the Department of Forestry in the Cape Colony, to report on the Natal Forests.

Fourcade (1889) reported that considerable damage to forests of the interior had resulted from exploitation for timber, and that the forests at the coast had been extensively cleared for agriculture. The former was mainly due to the European settlers since 1837, and the latter due first to the Bantu, and later to the Europeans. Fourcade gave the Forest Commission's estimate of the size of the Karkloof in 1880 as 32 500 hectares (80 000 acres) and Rycroft (1942) gave it as 6 000 to 8 000 hectares (15 000 to 20 000 acres). Fourcade also gave the size of the forest around Zwartkop as 3 250 hectares (8 000 acres), and Taylor (1963) gave it as 600 hectares (1 500 acres). No records are available for the extent of damage to the forests at the coast, but Fourcade states that nearly all cultivated land below 304m (1 000ft) was once wooded. This means that thousands of acres of forest had been cleared by 1889, and even more has been cleared or badly damaged since then.

The effects of these early European settlers on the vegetation are best summarized as follows:

- (i) The whole system of land-use changed from a shifting form of agriculture, to a stable farming community with much larger areas being cultivated.
- (ii) The pattern of grazing changed from the wandering unselective grazing of the herds of antelope that once roamed freely over the country, to the selective grazing of domestic stock (Photo 6).
- (iii) Natural fires in late winter or spring, which once burned large tracts of land, particularly in the predominantly pure grassland areas of Natal above 910m (3 000ft), were restricted. The practice of burning in late summer or autumn, learned from the Bantu, was continued. This, combined with

selective grazing habits of domestic stock, led to a deterioration of the grassland and the suppression of good grazing grasses, such as *Themeda triandra*, and the influx over large areas of poor grazing grasses, such as *Aristida junciformis*. In recent years many farmers have returned to the natural burning period of early spring (Scott, 1952).

- (iv) Much indigenous forest in the Three Rivers Region was either cleared or exploited (Photo 7). Sugar was introduced in 1847 (Bulpin, 1954) and vast areas of coast forest were cleared. Today about 60 per cent of the coast area is cultivated for sugarcane. The forests of the interior, where *Podocarpus* spp. were common, were exploited for their timber (Hattersley, 1940), first by the Voortrekkers in 1838, and later by the other European settlers from 1850 until about 1945. Also, since about 1850, there has been an ever increasing establishment of plantations of exotic timbers such as *Acacia* spp., *Eucalyptus* spp. and *Pinus* spp.
- (v) Rivers have become silted, and many are now seasonal due to bad usage of the vegetation, *viz.* burning at the wrong time of the year, the clearing of riverine vegetation, the draining of swampy areas, over-stocking and subsequent over-grazing, and the clearing of land for cultivation without ensuring that the bared soil is protected from soil erosion.

CHAPTER 5

A Summary of Environmental Factors

Climatographs (modified after Walter, 1963), where 20mm of rainfall is equated with 10°C, give a rapid visual assessment of the interaction of temperature and rainfall (Fig. 12). A dry period is indicated when the rainfall curve is below the temperature curve, and a humid period is indicated when the rainfall curve is above the temperature curve. The horizontal extension of the intersecting area indicates the duration of the dry or wet periods, whilst the vertical extension gives an appreciation of the intensity of either the wetness or the dryness. By studying Fig. 12, where mean daily temperature and rainfall data are plotted, it is possible to appreciate the average duration and intensity of wet and dry periods at selected stations. When these climatographs are studied in conjunction with the other physical factors, with fire, and with the biotic influences such as grazing and clearing of natural vegetation for cultivation, a brief appraisal of the prevailing environmental factors is obtained.

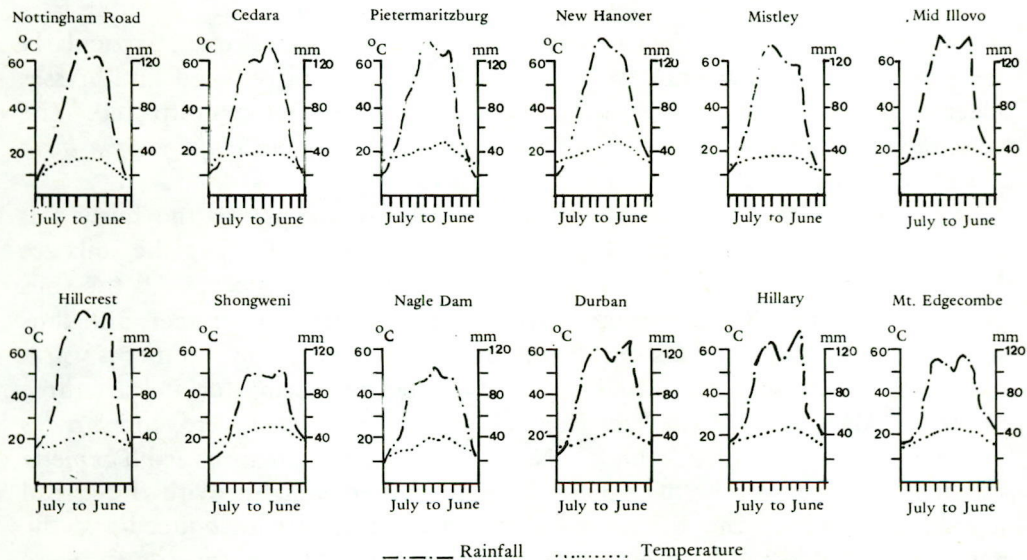


FIG. 12: Climatographs showing the duration and intensity of the wet and dry periods (after Walter, 1963).

The rolling countryside of the coast belt, below about 304m (1 000ft), with its moderately leached, sandy soils, has a hot humid climate in summer. Winters are mild with adequate moisture (Durban, Hillary and Mt. Edgecombe, Fig. 12). No frost, or only extremely light frost occurs. Natural fires were probably infrequent and when they occurred they were probably of limited extent. But, with the arrival of the Bantu and later the Europeans, fire was used to maintain and enlarge grassy areas. Man has, therefore, been responsible for the clearing of much of the woody vegetation in the area.

In that section of the coast hinterland, between 152 and 610m (500 and 2 000ft), where the highly dissected terrain consists of deep river valleys and narrow ridges the soils are generally shallow, and slightly to moderately leached. A large range of local climates are found in this area. The valleys are generally hot and moist in summer, whilst the ridges tend to be cooler and wetter. Winters in the valleys are cool and dry, the dry period lasting for at least three months (Shongweni Dam and Nagle Dam, Fig. 12), and only light frosts occur. The ridges are also dry in winter, and temperatures are lower than in the valleys, with moderately severe frosts occurring. The dry period is, however, shorter on the ridges than in the valleys (Hillcrest and Mid Illovo, Fig. 12). Natural fires were probably rare in this lower section of the coast hinterland, but, with the arrival of the Bantu and later the Europeans, fire was used by man to maintain areas of grassland. Clearing of indigenous vegetation for cultivation has been mainly by the Bantu, who typically still follow the traditional system of shifting cultivation. In addition considerable overgrazing occurs in this area.

At altitudes between 610 and 1 106m (2 000 and 3 500ft), where the river valleys are broader and the ridges between the valleys are more extensive, the soils throughout are generally fairly deep, considerably leached types. The climate in summer is warm and wet, and winters are cool to cold and dry (Mistley, New Hanover and Pietermaritzburg, Fig. 12), there being a two to three month dry period. Frosts may be moderate to severe. Natural fires maintained *Themeda triandra* Grassland, but with the arrival of man, particularly the Europeans, the practice of autumn burning was introduced and grasses selectively grazed. In addition large areas of land were cultivated. The subsequent effect on the grassland has been an increase in *Hyparrhenia birta* and of increased scrub encroachment by *Acacia* spp.

Above 1 106m (3 500ft) the land rises fairly steeply to the fairly flat highland area above 1 372m (4 500ft). Where the slope is steep the soils are shallow and where the land is fairly flat the soils are fairly deep. All the soils are highly leached. The escarpment is often fog covered in summer, and thus forest is often a feature on south-facing slopes. The climate in summer is warm and moist. Winters are cold and dry, the dry period lasting for at least three months (Cedara and Nottingham Road, Fig. 11). Frosts are severe, and snow is frequent above 1 524m (5 000ft). Natural fires, which maintained *Themeda triandra* Grassland, probably occurred annually or biennially. With the arrival of man, particularly the Europeans, autumn burning was introduced and the grasses were subjected to selective over-grazing. In addition the forests were exploited for their timber. Under these changed environmental conditions there was a change in grass composition, particularly on the wet escarpment, where *T. triandra* has been almost completely replaced by *Aristida junciformis*, and in the forests most of the good timber trees such as *Podocarpus* spp. have been exploited. Only small areas of this region have been cultivated.

PART II

General Plant Ecology

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CHAPTER 6

The Vegetation

The vegetation of the Three Rivers Region consists of a complex mosaic of different plant communities, which are an expression of the range of prevailing environmental factors. Seven basic vegetation types, which correspond to seven bioclimatic areas, are recognised in the region (see Vegetation Map). These range from the sub-tropical vegetation of the coast, through the dry scrub and succulent vegetation of the deep river valleys, to the more temperate grasslands and montane forests at higher altitudes.

There are few sharp boundaries between the various vegetation types, particularly in gently sloping country where there is a gradual transition from one vegetation type to another. Nevertheless lines, representing boundaries, have been drawn on the Vegetation Map, and these boundary lines have mostly been drawn through the ecotones. These ecotones require careful consideration when interpreting marginal areas. A notable exception is the boundary of the Dry Valley Scrub and Bushland Mosaic which is usually very sharp, because of the abrupt topographic changes between the steep river valleys and the more gently sloping river basins.

Once the main vegetation types had been defined these were delimited on 1:100 000 scale field maps and on aerial photographs. The data were subsequently transferred on to a base map of the 1:250 000 Scale Topocadastral Series (1953). Isolated pockets of one vegetation type occurring within the area of another required careful consideration. If the pockets were sufficiently large, at least 13 sq. km (5 sq. miles), they were mapped; if the pockets were small they were neglected.

Since large areas have been cultivated at one time or another during the last 50 years, and since veld deterioration and soil erosion have been greatly accelerated in the last 100 years, the resultant secondary vegetation tends to obscure the primary vegetation types. In some areas these secondary influences are extensive.

On the coast belt, 95 per cent of the indigenous vegetation has been cleared for cultivation, the little indigenous vegetation that remains is, almost without exception, secondary.

In the steep river valleys, 60 per cent of the vegetation has been cleared

at one time or another by the shifting agricultural practices of the Bantu, the small areas of grassland present on the ridges, or on the flat spurs between the river valleys, have been subjected to frequent burning by man and to heavy grazing pressures by his domestic stock. This grassland is now, almost without exception, secondary.

In the forests of the highland region, virtually all the good timber has been exploited and much of the grassland of this region is secondary.

In spite of these various influences, as accurate as possible an assessment of the natural vegetation has been made by extrapolation where necessary. Only the most important and extensive communities occurring within each vegetation type are discussed in the text. Simple diagrams showing the successful relationships between the major communities are given. Lists of species occurring in each community have been kept as short as possible, with only the dominant species being listed. The sequence of the species enumerated is in order of importance, as determined by a somewhat arbitrary assessment of dominance and fidelity, based on lists from various sample sites.

A simplified Vegetation Map, which is used as an overlay on the other maps in the text, has been prepared. This transparent overlay is intended to assist the reader to appreciate the relationships between the topography, geology and rainfall and the vegetation types. In addition the transparent overlay is used to compare my vegetation map with the maps of earlier workers such as Pentz (1945) and Acocks (1953).

Unfortunately insufficient temperature, insolation and soil data are available to construct separate maps for these important climatic factors.

6.1 COAST FOREST AND PALM VELD

The Coast Forest and Palm Veld forms a narrow belt along the coast, about 8km (5 miles) wide. It is approximately 653 sq. km (252 square miles) in extent, or 6 per cent of the Three Rivers Region (see Vegetation Map).

The topography of the area is gently undulating, from 0 to 152m (0 to 500ft) above sea level. The summers are hot, the December mean temperature is 23°C (73°F), with absolute maximum temperatures in the region of 45°C (113°F). Summers are moist, the October to March rainfall being approximately 700mm. The winters are cooler, the July mean temperature being 17°C (63°F), with absolute minimum temperatures of 4°C (39°F) having been recorded. Winters are dry, the April to September rainfall being approximately 300mm. No frost occurs.

The vegetation is sub-tropical, but much of the primary vegetation, at least 95 per cent, has been cleared for cultivation. The following description of the major plant communities is based on a study of the few remaining relics.

Coast Forest occurs on the deep sandy soils. On the shallower, drier soils the forest is shorter with a greater percentage of marginal forest tree species occurring. On the sea-facing slopes, close to the seashore, a dense, short Dune Forest, with a salt-spray pruned canopy, occurs. On the shallow clay soils, particularly overlying Dwyka Tillite, where the drainage is poor, a Palm Veld community is developed. Swamp Forest occurs where there are deep soils and a

high water-table. Mangroves and other halophytic communities occur in shallow, saline estuaries.

6.1.1. Forest Communities

The forest communities of the coast belt are diverse, but these can be separated into three types.

- (i) DUNE FOREST occurs in the salt-spray zone of the sea shore. Dune pioneers such as *Scaevola thunbergii*, *Ipomoea pes-carprae*, *Canavalia bonariensis* and *Sporobolus virginicus* are the most important species which initiate the stabilization of the dunes (Photo 8). This pioneer community is invaded by shrubs, small trees and woody lianes, such as *Eugenia capensis*, *Allophylus natalensis*, *Mimusops caffra*, *Passerina rigida*, *Scutia myrtina* and *Ficus burtt-davyi*, which usually form a dense community with a generally smooth, salt-spray pruned canopy.

Eventually Dune Forest trees grow up through the canopy, shading out the shrubs (Photo 4). Dune forest is limited to a very narrow belt fringing the coast. It is a dense, short, tangled forest, usually 4 to 7,6m (15 to 25ft) high, but up to 12m (40ft) in parts. The characteristic canopy species is *Mimusops caffra*, though in some areas *Canthium obovatum*, *Euclea natalensis*, *Dovyalis longispina*, *Chaetacme aristate* and *Cordia caffra* may be common.

Isoglossa woodii is a characteristic shrub of the undergrowth, sometimes forming very dense stands, usually 1,2 to 1,8m (4 to 6ft) high, but which may be up to 2,4m (8ft) high in parts.

A feature of the Dune Forest is the abundance of lianes. A few of the more common lianes are *Flagellaria guineensis*, *Scutia myrtina*, *Dalbergia armata*, *Acacia kraussiana*, *Rhoicissus* spp., *Ficus burtt-davyi* and *Grewia caffra*. Much of the high density of these lianes can be attributed to recent disturbance, particularly where *Flagellaria* is present.

Where the Dune Forest has been badly damaged, as is the case over large areas today, *Brachylaena discolor* is dominant.

The Dune Forest serves the extremely important function of stabilizing the soft sand of the sea dunes, which otherwise would be subject to erosion by wind and rain.

- (ii) COAST FOREST Behind the Dune Forest, protected from the full blast of the salt-spray, there was a much more extensive forested area which, on the more favourable sites, extended about 5 miles inland. Ninety-nine per cent of this Coast Forest has been cleared (Photo 9), and only three areas of good forest remain in the Three Rivers Region, namely Hlogwene Forest just south of the Tugela River mouth (Moll and Cooper, 1966), Hawaan Forest just south of the Mhlanga River mouth (Moll and Cooper, 1967; Moll, 1968a), and in the Stainbank Nature Reserve just south of Durban (Rogers and Moll, 1975).

The height of the canopy is from 10 to 21m (30 to 70ft). The composition is very mixed and depends upon local environmental conditions. Some of the more frequent canopy species are *Trichilia dregeana*, *Celtis africana*, *Strychnos innocua*, *Cola natalensis*, *Chaetacme aristata*, *Apodytes dimidiata*, *Ekebergia capensis*, *Chrysophyllum viridiflorum*, *Protorbus longifloia*, *Strychnos decussata*, *Vepris lanceolata*, *Croton sylvaticus*, *Canthium obovatum*, *Ziziphus mucronata*, *Millettia grandis*, *Linociera peglerae*, *Cussonia chartacea*, *Dovyalis longispina*, *Euclea natalensis*, *Harpephyllum caffrum* and *Cavacoa aurea*.

In mature forest there is usually a well developed layer of subcanopy trees, from 9 to 15m (30 to 50ft) high. Some common trees that occur in this layer are *Bequaertiodendron natalense*, *Drypetes arguta*, *D. natalensis*, *Rothmannia globosa*, *Deinbollia oblongifolia*, *Xylotheba kraussiana*, *Teclea gerrardii*, *Diospyros natalensis*, *Baphia racemosa* and *Oxyanthus gerrardii* (Photo 10).

The forest has a poorly developed shrub and herbaceous layer. The forest floor is usually covered by a thick leaf litter. Some common shrubs are *Erythroxylum emarginatum*, *Peddiea africana*, *Carissa bispinosa*, *Tricalysia capensis*, *T. sonderiana*, *Popowia caffra*, *Dracaena bookeriana* and *Buxus natalensis*.

Herbaceous species are not common in the forest fieldlayer. Some of the more common herbs are *Oplismenus hirtellus*, *Digitaria diversinervis*, *Panicum deustum*, *Cyperus albostriatus*, *Diets vegeta*, *Sansevieria thyrsiflora*, *Commelina benghalensis*, *Justicia* spp., *Dicliptera* spp., *Chlorophytum modestum*, *Celosia trigyna* and *Phaulopsis imbricata*.

Lianes are common in the forest, the species being similar to those that occur in Dune Forest. Some of the most common are *Dalbergia armata*, *D. obovata*, *Capparis* spp., *Acacia kraussiana*, *Secamone* spp., *Cyphostemma hypoleuca*, *Rhoicissus* spp., *Scutia myrtina*, *Flagellaria guineensis*, *Urera woodii*, *Uvaria caffra*, *Grewia caffra* and *Oncinotis inandensis*.

- ii) SWAMP FOREST In low-lying swampy areas *Phragmites australis* and/or *Typha capensis*, and other tall associated species of Cyperaceae form very dense communities up to 2,7m (9ft) high. These reed-beds play an important rôle in the succession to Swamp Forest as they impede the flow of flood waters, causing the deposition of silt. Such areas develop into fertile flats with deep alluvial soils. When the level of the ground has risen above the permanent water level, Swamp Forest trees are able, in the absence of fire, to invade. This succession is not usual today, however, as the silt loads of rivers have been so increased that river beds have become vast, unstable sandy wastes; for example the Mvoti River mouth.

On the periphery of reed-beds certain Swamp Forest trees, or forest initials, may grow. These trees, in the absence of fire, eventually invade the reed-beds. Common trees are *Syzygium cordatum*, *Myrica conifera*, *Rauvolfia caffra*, *Macaranga capensis*, *Voacanga thoursii*, *Schefflera umbellifera* and *Phoenix reclinata*. Most of these tree species are also

often found along river courses in the drier areas further inland (Photo 11).

In mature Swamp Forest the height of the canopy varies from 12 to 21m (40 to 70ft). The most common canopy species are *Syzygium cordatum*, *Voacanga thouarsii*, *Bridelia micrantha*, *Macaranga capensis*, *Ficus capensis*, *F. hippopotami*, *Rauvolfia caffra* and *Schefflera umbellifera*.

Below the canopy there is usually a rather badly defined layer of shrubs and small trees, and most frequent species that occur are *Peddiea africana*, *Psychotria capensis*, *Burchellia bubalina*, *Tabernaemontana ventricosa*, *Tarenna pavettoides*, *Phoenix reclinata* and *Strelitzia nicolai*.

The herbaceous ground layer is usually fairly well developed, various species of ferns, grasses and sedges being common. The characteristic feature of this type of forest is the presence of climbing ferns, particularly *Stenochlaena tenuifolia* (Photo 12) and *Microgramma lycopodioides*, which grow prolifically on the forest floor and festoon the tree boles to a height of 6m (20ft). In addition there are numerous liane species which grow in profusion on the forest margin and also fill gaps in the canopy. Some of the more frequent lianes are *Convolvulus* spp., *Dalbergia armata*, *D. obovata*, *Asparagus falcatus* and *Urera woodii*.

Epiphytes, notably *Rhipsalis baccifera* and species of orchids and ferns, are fairly common on some trees, particularly on *S. cordatum* which has a rough, fissured bark.

Today extremely few relics of Swamp Forest remain, as most of the areas where it once thrived have been drained and cleared; to control the breeding of mosquitoes or for cultivation.

6.1.2. Mangrove Swamp and allied communities

In saline estuaries a closed woodland community of mangroves may occur (Photo 13). This community usually consists of a single layer of trees with little or no understorey. The height of the canopy, which is usually closed, is about 6 to 9m (20 to 30ft). Only three species of mangrove occur, *Avicennia marina*, *Bruguiera gymnorhiza* and *Rhizophora mucronata*. The most common species, which once covered extensive areas in Durban Bay and Isipingo Lagoon, are *A. marina* and *B. gymnorhiza* (Photo 14). *A. marina* is still common in the Mgeni River estuary at Beachwood.

Allied salt tolerant communities, such as beds of *Phragmites australis*, and *Hibiscus tiliaceus* fringing woodland, occur in some of the less saline lagoons. *P. australis* beds are now limited to the smaller river mouths, such as the Mhlanga, Tongati, Nonoti, Mdloti and Lovu Rivers. The *H. tiliaceus* communities have been reduced to such an extent that only scattered remnants remain.

Where the water is almost fresh, a fringing *Barringtonia racemosa*-*Hibiscus tiliaceus* fringing woodland occurs. Most of this vegetation has been destroyed, and the best example in the Three Rivers Region is in the Ndlolane Lagoon.

Factors which have contributed to the disappearance of these halophytic communities, apart from physical draining and clearing at Durban Bay and Isipingo Beach, are the increased silt loads in rivers which have clogged the river mouths burying the mangroves and reed-beds. Consequently, since the turn of the century, these communities have been greatly reduced.

6.1.3. Palm Veld

Palm Veld (Photo 15) occurs on areas where the soil is clayey and drainage is poor. The palms occur in clumps wherever there is a slight rise in otherwise level terrain, notably on old termitaria. Grassland covers the ground between the palm clumps. This community, of palm clumps in a grassland matrix, is fire maintained.

Prior to the arrival of man it is possible that the grassland was dominated by *Themeda triandra*. With the arrival of the Bantu and later the Europeans, the fire régime was altered (Chapter 3) and the grass was subjected to almost continuous selective grazing. These factors have resulted in a change in grass composition with *Aristida junciformis* becoming dominant. Common associated grass species are *Eragrostis* spp., *Sporobolus* spp., *Hyparrhenia filipendula*, *Tristachya hispida*, *Digitaria setifolia* and *Cymbopogon* spp.

There are numerous species of associated forbs, some of the more common families are Cyperaceae, Compositae, Leguminosae, Liliaceae, Acanthaceae, Orchidaceae, Commelinaceae, Asclepiadaceae, Labitae, Scrophulariaceae and Amaryllidaceae.

The characteristic plant of the Palm Veld is *Phoenix reclinata*, and it is usually the first to invade suitable sites. With the increased shade and protection from fire, provided by *P. reclinata*, other woody plants soon invade the site and a mixed community of woody plants, or a bush clump, results. These clumps are usually from 30 to 90m (100 to 300ft) apart, and up to 30m (100ft) in diameter. The height of the trees in the clumps varies from 3 to 6m (9 to 20ft). Some of the common trees, in addition to *P. reclinata*, are *Antidesma venosum*, *Euclea natalensis*, *Cussonia spicata*, *Albizia adianthifolia*, *Sapium integerrimum*, *Strelitzia nicolai* and *Ficus natalensis*. On more xeric sites *Acacia nilotica*, *Sclerocarya caffra*, *Euphorbia ingens*, *Acacia robusta* and *Trichilia emetica* are more common. The bush clumps are surrounded by numerous small shrubs and trees such as *Maytenus senegalensis*, *Pavetta lanceolata*, *Grewia occidentalis*, *Hippobromus pauciflorus*, *Ebretia rigida*, *Maytenus heterophylla* and *Xeromphis rudis*.

Lianes are fairly frequent, and the more common species that occur are *Dalbergia obovata*, *Scutia myrtina*, *Asparagus falcatus*, *Acacia kraussiana* and *Dalbergia armata*.

Beneath the rather dense tangle of woody vegetation there are a variety of herbaceous sciophytes, similar to those occurring in Coast Forest.

Today this Palm Veld is limited to two small areas, one just south of Stanger at Groutville, and the other inland of Umbogintwini near Mfume. Fairly numerous secondary remnants do exist, but these are all either too damaged or too small to warrant study.

The successful relationships between the communities occurring in the Coast Forest and Palm Veld are illustrated diagrammatically in Fig. 13.

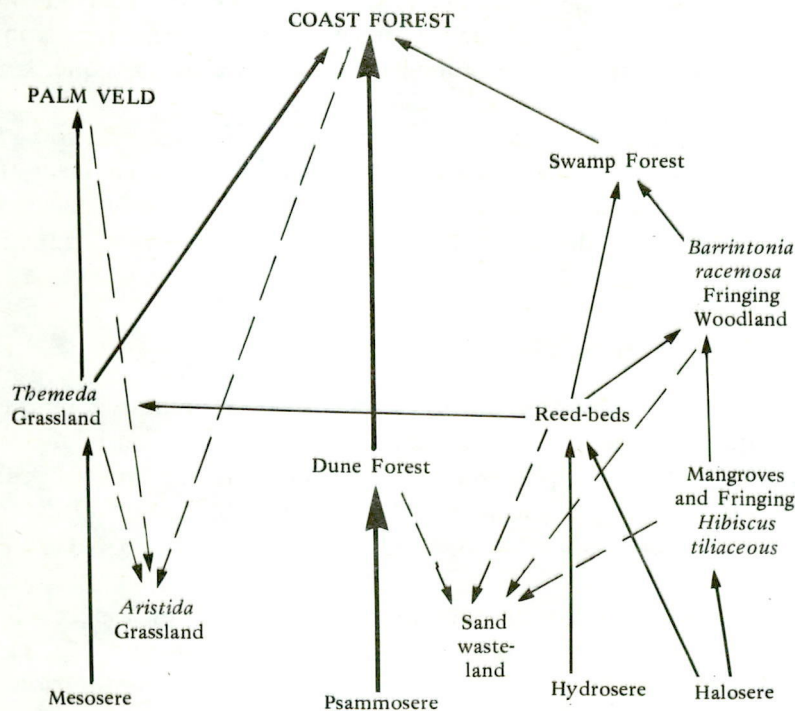


FIG. 13: A greatly simplified diagrammatic representation of the most extensive communities of the Coast Forest and Palm Veld. Solid arrows indicate primary succession, broken arrows indicate secondary succession, the thickness of the arrows gives an indication of the successional trends, and the most obvious climax communities occurring have been capitalized.

6.2 DRY VALLEY SCRUB AND BUSHLAND MOSAIC

The Dry Valley Scrub and Bushland Mosaic vegetation type is found in the deep river valleys forming the highly dissected terrain west of the Coast Forest and Palm Veld. It is approximately 1 634 sq. km (631 square miles) in extent, or 14 per cent of the Three Rivers Region (See Vegetation Map).

The topography of the area is generally very steep and rugged with many prominent cliffs, particularly in the Mgeni River Valley. The country extends from about 30m (100ft) near the coast to 914m (3 000ft) further inland near Pietermaritzburg and Richmond. The summers are hot, the December mean temperature is 24°C (75°F), with absolute maximum temperature in the region of 44°C (111°F). Summers are fairly moist, the October to March rainfall being approximately 575mm. The winters are cool, the July mean temperature being 15°C (59°F), with absolute minimum temperatures of 0°C (32°F) having been recorded. Winters are dry, the April to September rainfall being approximately 175mm. Only light frosts occur, although at upper altitudinal limits the frosts may be moderately severe in depressions. Unfortunately there are no data from such low lying areas at higher altitudes.

Most of the country covered by the Dry Valley Scrub and Bushland Mosaic is occupied by Bantu. Their effect on the vegetation has been marked because, as a result of overstocking and general mismanagement of the vegetation there

has been extensive surface and gully erosion and wholesale destruction of trees. Thus a naturally complex vegetation pattern, resulting primarily from the inherent heterogeneity of the environmental factors of aspects, slope, soil and climate, is further complicated by secondary influences.

The climax vegetation on the flatter terrain, where soils tend to be fairly deep, is either grassland, wooded grassland, or closed bushland. On steep slopes, where the soil is very shallow, the vegetation varies from a fairly dense scrub, on the drier north-facing slopes, to forest patches, in the moist south-facing kloofs.

6.2.1. Semi-Deciduous Scrub

Semi-Deciduous Scrub is one of the most extensive communities of the Dry Valley Scrub and Bushland Mosaic, covering roughly 50 per cent of the region. It occurs on moderately steep ground on both north-facing and south-facing slopes where the soil is fairly deep. It is found up to 872m (2 500ft) on the drier-north-facing slopes, while on the wetter slopes it seldom occurs above 610m (2 000ft).

Numerous local variations in composition, depending on aspect, climate, and the type and degree of disturbance, occur (Photos 16 and 17). Certain species, typical of the community, occur under almost all these conditions, and these species were used as indicators of the community.

Generally the community is very mixed, occurring as a dense, almost impenetrable scrub from 2 to 5m (6 to 16ft) tall. This is often mixed with succulents to form a complex mosaic of minor communities, some species being common to both the Mixed Succulent Communities (Section 6.2.3.) and the Semi-Deciduous Scrub. Typical tree or tall scrub species which are common in the Semi-Deciduous Scrub are *Acacia nilotica*, *A. karroo*, *Dichrostachys cinerea*, *Hippobromus pauciflorus*, *Calpurnia aurea*, *Ebretia rigida*, *Grewia occidentalis*, *Maytenus heterophylla*, *Euclea crispa*, *Cussonia spicata*, *Dombeya rotundifolia*, *Boscia albitrunca*, *Acacia caffra*, *Aloe candelabrum* and *Olea africana* (Photo 18).

Where overgrazing has reduced the grass cover there is an increase of herbaceous and shrub understorey species. In such areas the common understorey species are *Peristrophe natalensis*, *Xeromphis rudis*, *Aloe saponaria*, *Lippia javanica* and ruderal grasses such as *Rhynchelytrum repens* and *Aristida barbicollis*.

In areas where the soil is deeper, frequently on old termitaria, a much better grass cover is developed with such species as *Eragrostis* spp., *Hyparrhenia hirta*, *Panicum maximum*, *Setaria sphacelata*, *Sporobolus* spp., *Cymbopogon plurinodis*, *Meteropogon contortus* and *Themeda triandra* being the most common.

6.2.2. Acacia Wooded Grassland and Scrub

The other most extensive community of the Dry Valley Scrub and Bushland Mosaic, covering approximately 30 per cent, is the *Acacia* Wooded Grassland and Scrub community. It occurs on the flatter land, from 61 to 1 067m (200 to 3 500ft), where the soils are fairly deep. It has increased in size in the last

century, having encroached into adjacent grasslands. Typically this community occupies the shallow inland river basins, such as the Mgeni basin between Albert Falls and Otto's Bluff and the Mlazi basin between Mid Illovo and Eston (Photo 19).

The primary, undamaged community is an open wooded grassland of small trees 3 to 6m (10 to 20ft) high, common species being *Acacia nilotica*, *A. karroo*, *A. caffra*, *Ziziphus mucronata*, *Acacia gerrardii*, *Cussonia spicata*, *Euphorbia ingens*, *Aloe candelabrum*, *Rhus pentheri*, *Grewia occidentalis* and *Buddleia saligna*. The grass understorey, up to 1m (3ft) high, consisted primarily of *Themeda triandra* (Bews, 1913). Today, however, this picture is radically changed and only secondary communities occur. These secondary communities vary from site to site, but an overall appreciation is one of an increase in woody plants to form dense thickets, and a change in grass composition. The height of the woody species varies from 1 to 6m (3 to 20ft). In secondary communities, in addition to those woody species already listed, the following species are fairly common: *Acacia tortilis*, *Hippobromus pauciflorus*, *Calpurnia aurea* and *Acacia brevispica*.

Some common grasses occurring in this Secondary *Acacia* Scrub community are *Eragrostis* spp., *Sporobolus* spp., *Hyparrhenia hirta*, *Cymbopogon plurinodis*, *C. excavatus*, *Aristida barbicollis* and *A. junciformis* (Photo 20).

The change in structure and composition of the *Acacia* Wooded Grassland and Scrub community can be attributed to a number of factors. For example, where there has been an increase in the density of the woody plant species, or where scrub encroachment has occurred, it is usually the result of either the invasion of old cultivation sites, or of reduced intensity of grass-fires due to overgrazing and soil erosion. These factors have been subjected to trampling and continuous selective overgrazing. The resulting encroachment of woody species, mainly *Acacia* spp. (Photo 21), has seriously reduced the grazing potential of this community.

6.2.3. Mixed Succulent Communities

Mixed Succulent Communities occur on the driest, north-facing slopes where the soils are generally shallow and rocky, they cover approximately 10 per cent of the Dry Valley Scrub and Bushland Mosaic. Outliers of this community occur from almost sea level to about 510m (2 000ft).

Many facies of the Mixed Succulent Communities occur and these vary greatly in density and height, from a short, impenetrable, thorny tangle 3m (10ft) tall, to a fairly open community, 6 to 9m (20 to 30ft) high. These communities are, however, always characterised by the presence of *Euphorbia* spp. and *Aloe* spp.

On the steepest sites a mixed community of *Dichrostachys cinerea*, *Euphorbia triangularis*, *E. tirucalli* and *Acacia brevispica* occurs. On flatter sites *Acacia tortilis*, *Euphorbia triangularis*, *Aloe candelabrum*, *Sclerocarya caffra*, *Euphorbia ingens*, *Aloe spectabilis* and many other species are found. On very rocky areas *Aloe arborescens* and *Portulacaria afra* are the dominant species, and on old kraal sites and in abandoned fields *E. tirucalli* forms a dense, closed community up to 4,6m (15ft) high.

The understorey of the above communities consists almost entirely of

scattered woody shrubs such as *Xeromphis rudis*, herbs such as *Hypoestes verticillaris*, *Lippia javanica* and *Peristrophe natalensis*, and ruderal grasses such as *Rhynchelytrum repens*, *Brachiaria* spp., *Aristida barbiocollis*, *Urochloa* spp. and *Perotis patens*.

6.2.4. *Spirostachys africana* Woodland

Spirostachys africana Woodland in the Three Rivers Region is limited to small localized patches, covering roughly 5 per cent of the Dry Valley Scrub and Bushland Mosaic. It occurs mainly on dry northwest-facing slopes at altitudes between 152 and 457m (500 and 1 500ft), and also on the alluvial soils of the valley floor, below 305m (1 000ft). It is particularly extensive in the Mgeni and Mvoti River valleys.

The dominant tree of this closed Woodland, 4,6 to 6m (15 to 20ft) high, is *Spirostachys africana*. Other trees that were fairly common are *Combretum molle*, *Acacia robusta*, *Schotia brachypetala* and *Sclerocarya caffra*. Man, however, has completely altered the character of the Woodland, and nowhere in the Three Rivers Region is there an undamaged example of this Woodland which has been converted into Scrub. Common scrub species are *Spirostachys africana*, *Acacia tortilis*, *Dichrostachys cinerea*, *Calpurnia aurea*, *Clerodendrum glabrum*, *Maytenus heterophylla*, *Acacia karroo* and *Euphorbia tirucalli*. This scrub usually forms a dense tangle 1,2 to 2,4m (5 to 8ft) high. The field layer is generally sparse, and where present includes a mixture of numerous species of secondary grasses and herbs.

6.2.5. *Combretum molle* Bushland

The *Combretum molle* Bushland occurs along the upper margin of the Dry Valley Scrub and Bushland Mosaic, occupying roughly 4 per cent of the area. It has a fairly wide distribution, usually occurring on dry north-facing slopes where the bedrock is Table Mountain Sandstone. It occurs between 304 and 762m (1 000 and 2 500ft) above sea level.

Structurally the community is an open or a closed bushland with a grass understorey. The small trees are usually of a fairly uniform height, 3 to 4m (10 to 13ft) high. Most of the species are deciduous or semi-deciduous in winter, the most common species is *Combretum molle*, but others such as *Acacia caffra*, *Dombeya rotundifolia*, *Acacia nilotica*, *Ficus ingens*, *Acacia gerrardii*, *Cussonia spicata*, *Ziziphus mucronata* and *Sclerocarya caffra* (Photo 22), may be associated with *C. molle* (Molle and Morris, 1968). Below about 457m (1 500ft) additional associated tree species which frequently occur are *Albizia adianthifolia*, *Acacia robusta*, *Antidesma venosum*, *Millettia grandis*, *Acacia sieberana* and *Heterophyxis natalensis*.

The grass understorey is usually dominated by the secondary grass *Aristida junciformis*; which may be up to 0,5m (1,5ft) tall. Numerous other species are often associated with *A. junciformis*, the most common being *Hyparrhenia filipendula*, *Heteropogon contortus*, *Themeda triandra*, *Tristachya bispida*, *Digitaria* spp. and *Hyparrhenia birta*.

6.2.6. *Aloe candelabrum* Communities

Aloe candelabrum Communities usually occur on north-facing, rocky slopes

where the soil is shallow and where there is partial protection from fire. The community can tolerate moderately severe frosts and outliers occur to 1 219m (4 000ft) on north-facing slopes (Moll, 1965). The community is not extensive and probably occupies 0,6 per cent of the Dry Valley Scrub and Bushland Mosaic.

The community usually consists of an almost pure stand of *Aloe candela-brum*, individuals of which may reach a height of 6m (20ft). In some areas there are a limited number of associated woody species such as *Ebretia rigida*, *Rhus pentheri*, *Maytenus heterophylla*, *Cussonia spicata*, *Ziziphus mucronata* and *Erythrina latissima* (Photo 23). The understorey is usually secondary *Aristida junciformis*.

6.2.7. *Faurea saligna* Woodland

In certain areas at the upper altitudinal boundary of the Dry Valley Scrub and Bushland Mosaic, usually between 457 to 762m (1 500 to 2 500ft), *Faurea saligna* Woodland occurs. This Woodland is usually found on gently sloping, south-facing slopes, in soils overlying Table Mountain Sandstone. In such areas the climate is cooler in summer and warmer in winter with more fog than in the valley. No exact climatic data are available for this vegetation type, however, and the only reason I have for suggesting that the climate is cooler is that Professor A.W. Bayer (personal communication) has made this observation. From my own observations in the Mvoti River valley, *F. saligna* Woodland usually occurs at the lower limit of the low clouds that sometimes bring soft rain to the ridge on the Mvoti–Tugela watershed divide in summer.

Structurally the community is an open woodland, the trees being 17 to 23m (50 to 70ft) apart, with an orchard-like appearance. There is very little tendency towards clump development. The trees are usually 6 to 11m (20 to 30ft) high, and usually occur in pure stands. There are few associated trees, however, except on the margins where such species as *Acacia caffra*, *Combretum molle*, *Dombeya rotundifolia* and *Cussonia spicata* are found.

Today this community is very limited in size, and what remains is rather depauperate, consisting of a few relic trees. In some places multiple-stemmed coppice shoots are all that remain, the result of irregular burning and tree chopping for the excellent figure wood obtained from the dry wood (Bews, 1921; Comins, 1953). The grass understorey consists of secondary *Aristida junciformis*.

6.2.8. Kloof Forest

Where there is sufficient moisture, and protection from hot winds and fire, Kloof Forest occurs. In the Dry Valley Scrub and Bushland Mosaic such areas are rare, but do occur along water courses, in deep gullies, and on steep southeast-facing slopes (Photo 24). These forest patches are outliers of Coast Forest.

Because these communities are not extensive and have been subjected to considerable disturbance, it is difficult to assess their structure and composition. From the scattered relics that remain, however, it is apparent that the height and composition of the canopy varied greatly from site to site, depending on soil moisture, soil depth, amount of protection and aspect. Some of the more

common trees occurring in relics of Kloof Forest are *Anastrabe integerrima*, *Combretum kraussii*, *Celtis africana*, *Canthium ventosum*, *Bequaertiodendron natalense*, *Albizia adianthifolia*, *Clausena anisata*, *Cryptocarya woodii*, *Ficus petersii*, *Rothmannia globosa*, *Rhus chirindensis*, *Fagara capensis*, *Ficus natalensis*, *Cordia caffra*, *Combretum erythrophyllum* and *Commiphora harveyi*. The trees usually form a closed canopy 6 to 18m (20 to 60ft) high.

The various lower strata present beneath the canopy are not well defined. A great number of short tree and shrub species occur in Kloof Forest, and these vary considerably with differences in the local environments. Because this type of forest has suffered such great interference it is impossible to assess which short tree, shrub and herb species were common in undisturbed forest.

6.2.9. Cliff Communities

Cliffs are a fairly common topographic feature in the steep valleys, particularly in the Mgeni River valley. Because of the variety of aspects, differences in substrate, and in moisture, innumerable facies occur. In fact every stand seems to have some unique feature. For present purposes, however, it is sufficient to give a brief outline of only two types.

- (i) **THE CLIFF COMMUNITIES OF MESIC SITES** The mesic sites are, almost without exception, on south-facing cliffs. The communities are seldom well developed and consist of scattered woody and herbaceous plants, clinging to any available ledge or crevice. Perhaps the best way of listing species is to list some of the larger, usually woody plants, followed by some of the smaller, usually herbaceous plants.

Larger plants that grow on the mesic cliffs are *Ficus craterostoma*, *Strelitzia nicolai*, *Ficus burtt-davyi*, *Encephalartos natalensis*, *Pterocelastrus echinatus*, *Schrebera alata*, *Canthium mundianum*, *Seemanneralia gerrardii*, *Duvernoia adhatodiodes* and *Passerina filifolius*.

Lianes such as *Oncinotis inandensis*, *Cissus hypoleuca*, *Rhoicissus capensis* and *Acridocarpus natalitius* are fairly common.

Some of the smaller, herbaceous plants that occur are ferns such as *Vittaria isoetifolia*, *Oleandra distenta*, *Pellaea viridis*, *Gleichenia poly-podioides* and *Cheilantes birta*, grasses such as *Danthonia macowanii*, *Setaria sphacelata* and *Cymbopogon* spp., other monocotyledons such as *Carex* spp., *Ficinia* sp., *Vellozia talbotii*, *Agapanthus umbellatus*, *Aneilema dregeanum*, *Haemanthus natalensis*, *Clivia miniata*, *Watsonia densiflora* and *Gladiolus* spp., and dicotyledons such as *Crassula* spp., *Streptocarpus* spp., *Helicbrysum* spp., *Stoebe vulgaris*, *Centella coriacea*, *Plectranthus* spp. and many others.

- (ii) **THE CLIFF COMMUNITIES OF XERIC SITES** These xeric sites are, almost without exception, on north-facing cliffs. The plant communities are always poorly developed, and, as with the Cliff Communities on mesic sites, it is impracticable to list species in any order of occurrence.

Some of the larger plants that occur are *Urera tenax*, *Euphorbia tirucalli*,

the comparative flat ridges between the steep-sided river valleys (see Vegetation Map).

The summers are hot. The December mean temperature is 21°C (70°F), with absolute maximum temperature in the region of 41°C (106°F). Summers are fairly moist, the October to March rainfall being approximately 650mm. The winters are cool, the July mean temperature being 13°C (55°F), with absolute minimum temperatures of 0°C (32°F) near the coast (Verulam) and -2°C (28°F) further inland (Pietermaritzburg). Winters are dry, the April to September rainfall being approximately 200mm. Frosts can be moderately severe, particularly above 610m (2 000ft) where there is cold air drainage into the valleys. The soils of the area are moderately deep, well drained and moderately to considerably leached. At altitudes below about 762 to 914m (2 500 to 3 000ft) the soils are derived from Basement Granite and Table Mountain Sandstone, and at higher altitudes the soils are derived from Ecca Shales.

The vegetation over most of the area is a fire-maintained wooded grassland, but, where there is partial or total protection from fire, woody communities develop.

Today most of the *Acacia sieberana* Wooded Grassland is secondary. The most important changes have been the clearing of large areas for cultivation and for afforestation with *Acacia mearnsii*, *Pinus* spp. and *Eucalyptus* spp., the removal of many of the woody species for firewood, and a change in grass composition from *Themeda triandra* (Bews, 1918 and 1921) to either *Aristida junciformis* or *Hyparrhenia birta*.

Two major faciatis occur within the *Acacia sieberana* Wooded Grassland. Below about 762 to 914m (2 500ft to 3 000ft), on soils derived from Basement Granite and Table Mountain Sandstone the grass understorey is mainly *Aristida junciformis*. Above this altitude the grass composition is mainly a mixture of *Themeda triandra* and *Hyparrhenia birta*, and the soils are derived from Ecca Shales.

6.3.1. *Acacia sieberana* Wooded Grassland with Secondary *Aristida junciformis* understorey.

Of the two faciatis of the *Acacia sieberana* Wooded Grassland, that which has an understorey of *Aristida junciformis*, occurs at lower altitudes on a different geological series, and because of its proximity to the sea, has a slightly warmer and more humid climate with little frost. It is also the more extensive, occupying 70 to 80 per cent of the area. At its lower altitudinal boundary it abutts on to the Coast Forest and Palm Veld, consequently there is some mixing of the two types at lower altitudes. This mixing is most noticeable where there is a gradual topographic change and where climatic changes are correspondingly small. The boundary between the *Acacia sieberana* Wooded Grassland and Dry Valley Scrub and Bushland Mosaic is fairly distinct, however, because the latter is confined to steep river valleys.

The vegetation is mainly *Acacia sieberana* Wooded Grassland with a grass understorey of predominantly *Aristida junciformis* (Photo 25). Prior to the arrival of man *Themeda triandra* was the chief grass. However, with man's arrival, the effect of burning in either late summer or autumn, instead of in

early spring, and the continuous selective grazing of domestic stock, caused a change in grass composition, which has been rapidly accelerated in the last 60 years (Photo 26). Today *A. junciformis* is the common grass.

In areas where there is partial protection from fire, such as on old termitaria, on rock outcrops, and on south-facing mesoclines, the climax vegetation is a mixed woody community.

There are a number of distinct communities in this lower faciation of the *Acacia sieberana* Wooded Grassland.

- (i) **WOODED GRASSLAND** This is the most extensive community by far. It occurs on the flatter terrain where the soils are moderately deep.

The Wooded Grassland consists of widely spaced trees, up to 7,6m (25ft) high, with a grass understorey. The most common tree is *Acacia sieberana*. Other trees often present are *Sclerocarya caffra*, *Erythrina lysistemon*, *Ficus petersii*, *Albizia adianthifolia* and *Ekebergia capensis*.

The dominant understorey grass is *Aristida junciformis*. Other common grasses of the understorey are *Sporobolus capensis*, *Eragrostis curvula*, *Paspalum commersonii*, *Hyparrhenia filipendula*, *H. birta*, *Alloteropsis semialata*, *Eulalia villosa*, *Tristachya hispida*, *Digitaria* spp., *Cymbopogon* spp. and *Panicum aequinerve*. Usually these species form a heterogeneous community up to 1m (3ft) high. Sometimes one or another of the grass species may be locally common.

Unlike the grasslands further inland (Sections 6,5 6,6 and 6,7) there are relatively few forb species present. The most common associated plants in the grass understorey in this faciation are sedges such as *Bulbostylis* spp., *Cyperus* spp., *Fimbristylis* spp. and *Mariscus* spp. Other genera that occur are *Helichyrum*, *Indigofera*, *Hypoxis*, *Becium*, *Tephrosia*, *Senecio*, *Pentanisia*, *Cyanotis*, *Eriosema*, *Plectranthus*, *Cassia*, *Gladiolus*, *Eulophia*, *Desmodium*, *Lasiosiphon* and *Berkhaya*.

- (ii) **CLOSED WOODY COMMUNITIES** Where there is partial protection from fire, woody plants are better able to survive. Some of the most favourable sites are old termitaria, which are common in some parts and appear to be associated with a relatively high water-table and a Basement Granite substrate. Where these termitaria occur, the vegetation consists of scattered clumps of woody plants surrounded by grasses. This bush clump community is a discontinuous thicket vegetation, the thickets being limited to the scattered termitaria. Today, however, it is a relic community because most of the clumps have been cleared for cultivation by the Bantu as the old termitaria are more fertile than the surrounding soils. Nevertheless, undamaged clumps are still present in some areas. In these the trees are up to 9m (30ft) high, forming a dense, closed community no more than 6 to 12m (20 to 40ft) in diameter. Some of the common tree species are *Acacia sieberana*, *Apodytes dimidiata*, *Fagara capensis*, *Rhus chirindensis*, *Cussonia spicata*, *Albizia adianthifolia*, *Croton sylvaticus*, *Turraea floribunda*, *Sclerocarya caffra*, *Acacia gerrardii*, *Ekebergia capensis*, *Erythrina caffra*, *Ficus capensis*, *Ziziphus mucronata* and *Millettia grandis*.

Beneath the canopy, which is usually laced together by lianes such as *Dalbergia armata*, *Rhoicissus* spp., *Scutia myrtina*, *Grewia lasiocarpa*, *Uvaria caffra*, *Acacia kraussiana*, *Entada spicata* and *Dalbergia obovata*, is a poorly developed layer of woody shrubs. Most of the shrub species are either common forest shrubs, or forest marginal species, such as *Maesa lanceolata*, *Tricalysia* spp., *Pavetta* spp., *Grewia occidentalis*, *Hippobromus pauciflorus*, *Maytenus* spp., *Chrysanthemoides monilifera*, *Canthium* spp., *Xeromphis rudis* and *Clausena anisata*.

The lowest stratum of the bush clumps is a herbaceous layer, the dominant plants being grasses. The species occurring are the same as those that occur in the forest communities discussed below.

Other fire protected sites are steep south-facing slopes, rocky areas, and along watercourses. In most of these areas, additional soil moisture is available and in addition, on the steep south-facing slopes there is some protection from hot winds and insolation. In such areas a forest community develops. These forests are considered outliers of Coast Forest. They have been heavily exploited and are considerably reduced in size. In most cases only fragments remain.

FRINGING FOREST Along river courses or drainage lines there is usually a discontinuous woody fringing community 6 to 12m (20 to 40ft) high. Some typical trees present are *Celtis africana*, *Ficus capensis*, *Bridelia micrantha*, *Combretum erythrophyllum*, *Syzygium cordatum*, *Combretum kraussii*, *Macaranga capensis* and *Rauwolfia caffra*. Where the soils are deep and continuous the communities are most extensive, and a taller, continuous canopy is developed. This canopy may be up to 24m (80ft) high, such as the forest on Table Mountain (Killick, 1968) and in Krantzklouf Nature Reserve (Moll, 1968b). Some common canopy species that occur are *Bequaertiodendron natalense*, *Albizia adianthifolia*, *Protobus longifolia*, *Xymalos monospora*, *Nuxia floribunda*, *Drypetes gerrardii*, *Harpephyllum caffrum*, *Combretum kraussii*, *Celtis africana*, *Anastrabe integerrima*, *Cryptocarya woodii*, *Trema orientalis*, *Ficus capensis*, *Ekebergia capensis*, *Maytenus peduncularis*, *Mimusops obovata*, *Rhus chirindensis*, *Syzygium gerrardii*, *Bridelia micrantha* and *Celtis gomphophylla* (Photo 27).

A variety of shrubs and herbs are present in the undergrowth. Their density, composition, and distribution depend on a great number of environmental factors, such as density of shade, soil moisture, and amount of disturbance. A few of the more common shrubs are *Tricalysia capensis*, *Carissa bispinosa*, *Encephalartos villosus*, *Popowia caffra*, *Uvaria caffra*, *Dracaena hookeriana*, *Gardenia neuberia*, *Piper capensis* and *Peddiea africana*.

Few herbs occur. Some of the more common species are *Oplismenus birtellus*, *Panicum* spp., *Cyperus albostriatus*, *Commelina* spp., *Dactyloctenium* and *Plectranthus* spp.

Lianes are a common feature of this forest and numerous species are present. Some of the most common lianes are *Rhoicissus cuneifolius*, *R. tomentosa*, *Scutia myrtina*, *Acacia ataxacantha*, *Senecio tamoides*, *Cnestis natalensis*, *Dalbergia obovata* and *Capparis tomentosa*.

6.3.2. *Acacia sieberana* Wooded Grassland with Secondary *Themeda-Hyparrhenia* understorey.

The faciation of *Acacia sieberana* Wooded Grassland, which today has an understorey of *Themeda triandra* and *Hyparrhenia hirta*, occurs at a slightly higher altitude than does that with *Aristida junciformis* understorey, and on moderately leached soils derived from Ecca Shales. The climate is slightly cooler and drier than that of the lower faciation, and frosts are moderately severe.

In general this upper faciation of the *Acacia sieberana* Wooded Grassland is floristically poorer than the lower faciation, and the trees are more sparse. Most of the area is, or was, an open savanna, with *Acacia sieberana* being the characteristic tree (Photo 28). These trees may grow to a height of about 7,6m (25ft) and some of the more common, although widely scattered, associated trees which are especially common towards the adjacent Dry Valley Scrub and Bushland Mosaic and on rock outcrops, are: *Rhus chirindensis*, *Hippobromus pauciflorus*, *Dais cotinifolia*, *Cussonia spicata*, *Ziziphus mucronata* and *Acacia caffra*.

The grass understorey is usually a mixture of *T. triandra* and *H. hirta*. Species which may also occur fairly frequently are *Eragrostis capensis*, *E. chloromelas*, *E. curvula*, *E. racemosa*, *Sporobolus africanus*, *Cymbopogon* spp., *Heteropogon contortus*, *Tristachya hispida*, *Harpechloa falx* and *Brachiaria serrata* (Moll 1965 and 1968c). This grass community may be up to 1,5m (5ft) tall.

Numerous forbs are associated with the grasses and some of the more common genera are *Thesium*, *Helichrysum*, *Becium*, *Acalypha*, *Bulbostylis*, *Fimbristylis*, *Lasiosiphon*, *Gerbera*, *Indigofera*, *Hypoxis*, *Rhynchosia*, *Gazania*, *Anthericum*, *Eriospermum*, *Hypericum*, *Chaetacanthus*, *Albuca* and *Argyrolobium* (Photo 29).

Closed woody communities are not common in the upper faciation of the *Acacia sieberana* Wooded Grassland but, where there is some protection from fire, more woody species are able to grow and small patches of shrubby vegetation may occur, usually on boulder strewn slopes. Common woody species in these areas are *Rhus pentheri*, *Cussonia spicata*, *Maytenus heterophylla*, *Canthium mundianum*, *Brachylaena elliptica*, *Ochna atropurpurea*, *Ebretia rigida*, *Acacia sieberana*, *Grewia occidentalis* and *Ziziphus mucronata*.

Like most of the vegetation discussed so far, vast areas of this upper faciation have been cultivated. Even where there is no cultivation most of the trees have been removed. The grass composition has also been altered, from *T. triandra* to a mixture of *T. triandra* and *H. hirta*.

The successional relationships between the communities occurring in the *Acacia sieberana* Wooded Grassland are illustrated diagrammatically in Fig. 15.

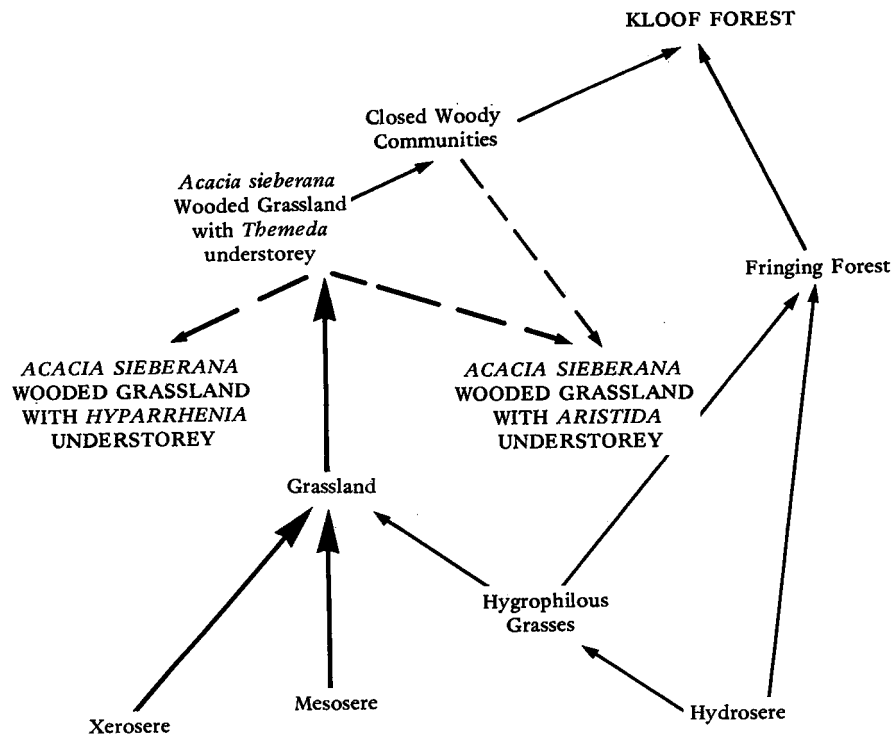


FIG. 15: A greatly simplified diagrammatic representation of the successional relationships of the most extensive communities of the *Acacia sieberana* Wooded Grassland. Solid arrows indicate primary succession, broken arrows indicate secondary succession, the thickness of the arrows gives an indication of the successional trends, and the most obvious communities occurring have been capitalized.

6.4 SECONDARY *ARISTIDA JUNCIFORMIS* GRASSLAND

Secondary *Aristida junciformis* Grassland occupies approximately 1 308 sq. km (505 square miles) or 12 per cent of the Three Rivers Region. It occurs on the relative flat areas of Table Mountain Sandstone which rise above the deep river valleys (Photo 30). It is the most discontinuous vegetation type in the Three Rivers Region. Scattered outliers can be found throughout the *Acacia sieberana* Wooded Grassland on the crests of ridges and on tiny, isolated buttes (Photo 31). In some parts it covers appreciable areas, sufficiently large to be mapped (see Vegetation Map). These areas occur from about 152 to 1 219m (500 to 4 000ft) above sea level and are as little as 12km (7 miles) from the sea, or as much as 64km (40 miles) inland.

The summers are warm, the December mean temperature is 20°C (68°F), with absolute maximum temperatures in the region of 40°C (104°F). Summers are moist, the October to March rainfall being approximately 800mm. The winters are cooler, the July mean temperature being 12 to 13°C (54 to 55°F), with absolute minimum temperatures of -0,1°C (32°F) near the coast (Hillcrest) and probably -2 or -3°C (28 to 27°F) further inland (Kranskop). Winters are drier, the April to September rainfall being approximately 200mm. Frosts may be light to moderately severe, especially in low lying areas. The soils

are sandy, well drained and considerably to highly leached.

The vegetation, as the name implies, is secondary. Grassland is the climax, fire-maintained community on the comparatively flat terrain. The dominant grass was once *Themeda triandra*, but since about 1910 a radical change in the floristic composition has occurred. From being almost pure *T. triandra*, the grass composition has changed to almost pure *A. junciformis*, caused by burning in late summer or autumn, increased frequency of burns, and overgrazing by stock. (Killick, 1958) Today much of this vegetation has been cleared, particularly in the northern half of the Three Rivers Region where trees or sugarcane have been planted.

Within the Secondary *Aristida junciformis* Grassland three distinct communities can be distinguished.

- (i) GRASSLAND This is by far the most extensive community. It appears to consist almost entirely of *Aristida junciformis* tussocked grassland, but on close inspection, other grass species are found, often in fair quantities. Their presence, is however, almost hidden by the *A. junciformis*. The common associated grass species, which may form a mixed community about 0,6m (2,5ft) high, are *Hyparrhenia filipendula*, *H. birta*, *Paspalum commersonii*, *Eragrostis capensis*, *E. racemosa*, *E. plana*, *E. curvula*, *Heteropogon contortus*, *Themeda triandra*, *Alloteropsis semialata*, *Tristachya hispida*, *Brachiaria serrata*, *Monocymbium ceresiiforme*, *Trachypogon spicatus* and *Sporobolus centrifugus*.

Various sedges are fairly common in the grassland and it is usual to find many species of *Bulbostylis*, *Fimbristylis*, *Kyllinga*, *Cyperus*, *Scleria*, *Mariscus* and *Ficinia*. The grassland is, however, rather unusual in Natal as, except on rocky or locally moist areas, the frequency of forbs is low. Genera that occur are *Gerbera*, *Helichrysum*, *Pteridium*, *Selago*, *Pentania*, *Lasiosiphon*, *Argyrolobium*, *Dierama*, *Eriosema*, *Watsonia* and many more (Killick, 1958; Moll and Morris, 1968).

- (ii) PROTEA ROUPELLIAE WOODED GRASSLAND This occurs in very small isolated patches above 610m (2 000ft) where the rainfall is at least 1 000mm. It generally occurs on sites where shallow soil limits the grass cover and hence the intensity of fires. The communities consist of a pure and fairly dense stand of *Protea roupelliae* which may be 3 to 4,5m (10 to 15ft) high. Regeneration is poor, and it is possible that the community may be a relic of a once more extensive Protea Community (see also Edwards, 1967).

- (iii) KLOOF FOREST On steep south-facing slopes, where there is partial or total protection from fire, Kloof Forest develops. These forest communities occur only in small localized patches, all of which are mere remnants of what were once probably fairly large areas of closed forest.

The floristic composition of the forests is similar to the areas of Kloof Forest that occur in the *Acacia sieberana* Wooded Grassland. The height of the continuous canopy varies considerably and may be up to 24m

(80ft). Common species are *Protobus longifolia*, *Anastrabe integerrima*, *Nuxia floribunda*, *Drypetes gerrardii*, *Celtis africana*, *Combretum kraussii*, *Podocarpus latifolius*, *Trichilia dregeana*, *Harpephyllum caffrum*, *Sapium ellipticum*, *Rauwolfia caffra*, *Rhus chirindensis*, *Vepris undulata*, *Xymalos monospora*, *Erythroxylum pictum* and *Celtis gomphophylla* (Photo 32).

Below the canopy there is a discontinuous subordinate tree layer, from 4,5 to 18m (15 to 60ft) high. Some common species are *Bequaertiodendron natalense*, *Cryptocarya woodii*, *Eugenia natalitia*, *Tricalysia capensis*, *Rothmannia globosa*, *Ochna arborea*, *Drypetes arguta*, *Cassipourea gerrardii*, *C. gummiflua* and *Oxyanthus gerrardii*.

A third stratum of woody shrubs, forming a discontinuous layer from 1,2 to 3m (4 to 10ft) high is also present. Common species are *Carissa bispinosa*, *Popowia caffra*, *Dracaena hookeriana*, *Peddiea africana*, *Gardenia neuberia*, *Encephalartos villosus*, *Canthium ciliatum*, *Maerua racemulosa*, *Piper capense* and *Maytenus mossambicensis*.

Beneath these three woody layers there is a herbaceous field-layer which is not very well developed, because the soil is usually well drained and therefore fairly dry. Some species that do occur, however, are *Oplismenus hirtellus*, *Cyperus albostriatus*, *Celosia trigyna*, *Fleurya mitis* and *Clivia miniata*.

Lianes are not common but, once the canopy is disturbed, they increase in frequency and many species occur (see Section 6.3).

The successional relationships between the communities occurring in the Secondary *Aristida junciformis* Grassland are illustrated diagrammatically in Fig. 16.

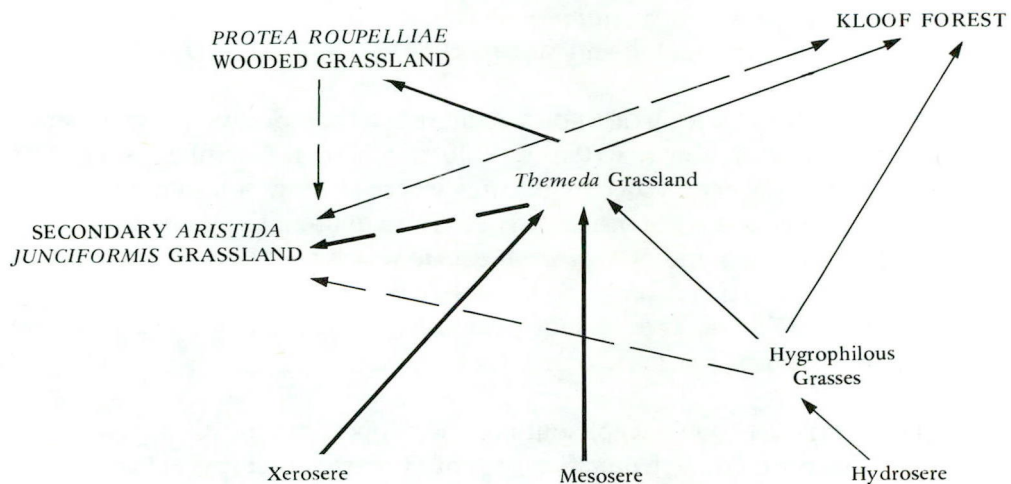


FIG. 16: A greatly simplified diagrammatic representation of the successional relationships of the most extensive communities of the Secondary *Aristida junciformis* Grassland. Solid arrows indicate primary succession, broken arrows indicate secondary succession, the thickness of the arrows gives an indication of the successional trends, and the most obvious communities occurring have been capitalized.

6.5 MOIST TRANSITIONAL THEMEDA-HYPARRHENIA GRASSLAND

Moist Transitional *Themeda-Hyparrhenia* Grassland occupies 1 650km² (637 square miles). It occurs in the ecotone between either the *Acacia sieberana* Wooded Grassland or the Secondary *Aristida junciformis* Grassland, and the Mistbelt *Themeda-Aristida* Grassland (see Vegetation Map), between 610 to 1 219m (2 000 and 4 000ft).

The topography of the area is generally fairly gentle, consisting of shallow river basins and low hills at the base of the highland escarpment. The summers are warm, the December mean temperature is 12°C (70°F), with absolute maximum temperatures in the region of 40°C (104°F). Summers are moist, the October to March rainfall being approximately 750mm. The winters are cool, the July mean temperature being 13°C (55°F), with absolute minimum temperatures of -3°C (27°F) having been recorded. Winters are dry, the April to September rainfall being approximately 250mm. Frosts may be moderately severe to severe. Soils are considerably leached.

Grassland is the most extensive community by far. Large areas have been cleared for cultivation and few areas of natural grassland still remain. Today the dominant grasses are *Hyparrhenia birta* and *Themeda triandra*. Previously *T. triandra* was dominant (Bews, 1918), but as with the other grasslands discussed above, the species composition has been altered as a result of farming activities. Other grass species, which are frequently associated with the two dominant species, are *Eragrostis* spp., *Heteropogon contortus*, *Sporobolus* spp., *Tristachya hispida*, *Aristida junciformis*, *Panicum natalense*, *Setaria woodii*, *Monocymbium ceresiiforme* and *Harpechloa falx*. This grass community is usually about 1,2m (4ft) tall.

Numerous associated species occur, and some common genera are *Bulbostylis*, *Acalypha*, *Fimbristylis*, *Gerbera*, *Helicbrysum*, *Hypoxis*, *Scabiosa*, *Scilla*, *Senecio*, *Indigofera*, *Rhynchosia*, *Gazania*, *Thesium*, *Pentanisia*, *Cyrtanthus*, *Lasiosiphon*, *Lotononis*, *Thunbergia*, *Tephrosia*, *Vernonia*, *Tulbaghia*, *Euryops*, *Vigna*, *Hypericum*, *Alysicarpus*, *Aster*, *Crabbea*, *Boopane* and *Satyrium*.

On south-facing slopes, where there is protection from fire, a poorly developed Scrub Forest occurs. Only three strata are represented in these forest communities and are often difficult to distinguish. Common canopy trees, which may be up to 9m (30ft) high are *Canthium mundianum*, *Cryptocarya woodii*, *Apodytes dimidiata*, *Fagara davyi*, *Cassine* spp., *Brachylaena elliptica*, *Cussonia spicata*, *Dais cotinifolia*, *Hippobromus pauciflorus*, *Maytenus* spp., *Pittosporum viridiflorum*, *Ziziphus mucronata* and *Ficus capensis*. These trees may form a closed canopy, the density of which is increased by the presence of numerous lianes, such as *Acacia ataxacantha*, *Rhoicissus* spp., *Scutia myrtina*, *Senecio* spp. and *Dalbergia obovata*.

Shrubs are very common in the forest community. A large number of species are present, some of the most common being *Maytenus mossambicensis*, *Carissa bispinosa*, *Canthium* spp., *Clausena anisata*, *Calpurnia aurea*, *Dovyalis* spp., *Dracaena hookeriana*, *Peddiea africana*, *Ochna atropurpurea* and *Grewia occidentalis*.

Herbs are not usually common in the forest community. Some species are *Cyperus albostriatus*, *Oplismenus hirtellus*, *Dietes vegeta*, *Setaria chevalieri*,

Plectranthus spp. and *Clivia miniata*.

The successful relationships between the communities occurring in the Moist Transitional *Themeda-Hyparrhenia* Grassland are illustrated diagrammatically in Figure 17.

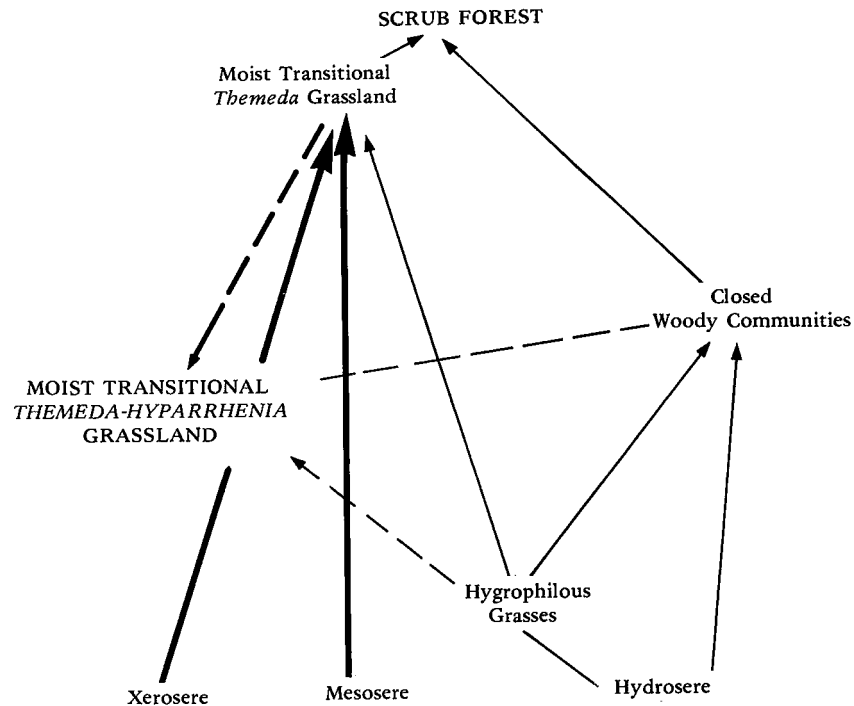


FIG. 17: A greatly simplified diagrammatic representation of the successional relationships of the most extensive communities of the Moist Transitional *Themeda-Hyparrhenia* Grassland. Solid arrows indicate primary succession, broken arrows indicate secondary succession, the thickness of the arrows gives an indication of the successional trends, and the most obvious communities occurring have been capitalized.

6.6 MISTBELT *THEMEDA-ARISTIDA* GRASSLAND AND MIXED *PODOCARPUS* FOREST

Mistbelt *Themeda-Aristida* Grassland and Mixed *Podocarpus* Forest occupies 1 225 sq. km (473 square miles), or 11 per cent of the Three Rivers Region. It occurs between 1 067 and 1 372m (3 500 and 4 500ft) on the highland escarpment, where the terrain is fairly steep.

The summers are warm, the December mean temperature being 19,5°C (67° F), with absolute maximum temperatures in the region of 40°C (104° F). Summers are wet, the October to March rainfall being approximately 700 to 900mm. The winters are cool, the June mean temperature being 12°C (54° F), with absolute minimum temperatures of -4 to -5°C (25 to 23° F). Frosts may be severe. A characteristic feature of this area is the frequency of fog which is an important additional source of moisture, particularly to forest. The soils are highly leached.

This type grassland, which is fire maintained, is by far the most extensive community occupying 1 145 sq. km (442 square miles). Large forest patches also occur, particularly on the steep south-facing slopes (see Vegetation Map), such as the Karkloof Forest (Rycroft, 1942; Moll and Cooper, 1968), the forests near Richmond and the forests near Dargle (Moll, 1965).

Like most of the vegetation of the Three Rivers Region the vegetation of the area has been greatly affected by man. The grassland which was once dominated by *Themeda triandra* is now dominated by *Aristida junciformis*, and the forest patches have been reduced to remnants by timber cutting (Photo 7) and frequent fires which burn into the forest margins (Photo 33).

6.6.1. Themeda-Aristida Grassland

Although *Aristida junciformis* is a secondary species, it is one of the most abundant grasses. *Themeda triandra* is still, however, fairly common over large areas. Usually a variety of grass species occur, and some of the more common are *Andropogon filifolius*, *Eragrostis capensis*, *Tristachya hispida*, *Heteropogon contortus*, *Microchloa caffra*, *Rendlia altera*, *Loudetia simplex*, *Eragrostis racemosa*, *Panicum ekklonii*, *Sporobolus capensis*, *Trachypogon spicatus*, *Alloteropsis semialata*, *Andropogon amplexans*, *Hyparrhenia hirta*, *Monocymbium cerasiiforme*, *Festuca caprina*, *Setaria nigrirostris* and *Harpechloa falx*. This grass community is usually about 0,6m (2ft) high.

In addition to the numerous species of grasses present, there are also many forbs, although their frequency is not as high as in the Highland Grassland (Section 6.7). They are most common on shallow soils and in disturbed areas. Some of the more common genera are *Helichrysum*, *Aristea*, *Cyperus*, *Bulbostylis*, *Pentanisia*, *Lotononis*, *Acalypha*, *Gerbera*, *Anthericum*, *Scilla*, *Hypericum*, *Cyrtanthus*, *Lasiosiphon*, *Dierama*, *Indigofera*, *Mariscus*, *Rhynchosia*, *Satyrium*, *Thunbergia*, *Polygala*, *Barleria*, *Hypoxis*, *Tulbaghia*, *Senecio*, *Kyllinga*, *Leonotis*, *Gladiolus*, *Hebenstraita*, *Aster*, *Becium*, *Apodolirion*, *Tritonia*, *Schizoglossum* and *Urginea*.

6.6.2. Mistbelt Mixed Podocarpus Forest

Where there is protection from fire, Mistbelt Mixed *Podocarpus* Forest develops. This forest usually occurs in patches on south-facing slopes, and it is the presence of this type of forest that can be used to indicate this vegetation type.

The forest patches have been extensively exploited and greatly reduced in size. Taylor (1961; and 1963) gives an estimate of forest reduction since about 1900 of between 25 and 75 per cent. Similar evidence of destruction has been recorded by Fourcade (1889) and Rycroft (1942). Nevertheless, certain small areas have been afforded greater protection than others. From these areas it is possible to gain an appreciation of the forest structure and composition.

The height of the canopy varies from 14 to 27m (45 to 90ft). Composition is very mixed and varies from patch to patch. The Karkloof Forest is the most extensive, consisting of one big block of forest with numerous small outliers. On the warmer aspects common species are *Combretum kraussii*, *Casearia junodii*, *Syzygium gerrardii*, *Trichilia dregeana*, *Harpephyllum caffrum*, *Cassipourea gerrardii* and *Croton sylvaticus*. These species also occur in forested areas

much nearer the coast. On the cooler aspects the common species are characteristic of the more temperate or montane forests of South Africa, and not of the Coast Forest or sub-tropical forests. Common species on the cooler aspects are *Kiggerlaria africana*, *Cryptocarya myrtifolia*, *Podocarpus falcatus*, *P. henkelii*, *Scolopia mundii*, *Ilex mitis*, *Rothmannia capensis* and *Ocotea bullata*. Other common canopy tree species are *Xymalos monospora*, *Celtis africana*, *Calodendrum capense*, *Cussonia sphaerocephala*, *Podocarpus latifolius*, *Halleria lucida*, *Apodytes dimidiata*, *Ptaeroxylon obliquum*; *Linociera peglerae*, *Ficus craterostoma*, *F. natalensis*, *Maytenus peduncularis*, *Prunus africanus*, *Vepris undulata*, *Ekebergia capensis* and *Scolopia zeyheri* (Photo 34).

A feature of the Mistbelt Mixed *Podocarpus* Forest is that occasional large trees pierce the continuous upper canopy. These emergents may be up to 34m (110ft) tall. The most common emergent species are *Cussonia Sphaerocephala*, *Podocarpus falcatus*, *Cryptocarya myrtifolia*, *Calodendrum capense*, *Podocarpus henkelii* and *Ptaeroxylon obliquum*. Unfortunately the best specimens have been exploited and few remain.

Below the canopy is a discontinuous layer of subordinant trees. Common species are *Rinorea angustifolia*, *Ochna arborea*, *Trimeria rotundifolia*, *Fagara davyi*, *Rothmannia globosa*, *Pavetta lanceolata*, *Tricalysia lanceolata*, *Cryptocarya woodii* and *Dombeya tiliacea*.

Common shrub species, some of which may be up to 6m (20ft) high, are *Peddiea africana*, *Carissa bispinosa*, *Eugenia zuluensis*, *Diospyros whyteana*, *Dovyalis* spp., *Cassine papillosa*, *Ochna serrulata*, *Canthium ciliatum*, *Maytenus undata*, *Englerodaphne pilosa*, *Indigofera natalensis* and *Excoecaria simii*.

Beneath the shrub layer there is usually a well developed field-layer of grasses and sedges, such as *Oplismenus birtellus*, *Brachypodium flexum*, *Stipa dregeanus*, *Cyperus albostriatus*, *Panicum aequinerve*, *Schoenoxiphium caricoides* and *Carex* spp. Scattered through the field-layer are also a number of other herbs such as *Impatiens dutchieae*, *Streptocarpus* spp., *Dietes vegeta*, *Centella coriacea*, *Justicia campylocantha*, *Fleurya* spp., *Plectranthus* spp., *Begonia* spp., *Clivia miniata*, *Crocoshmia aurea* and *Disperis fanninia*. Sometimes *Selaginella kraussiana* forms dense, local swards.

A fairly common feature of the forest, particularly in disturbed areas, are numerous lianes. Some of the most frequent species are *Strophanthus speciosus*, *Scutia myrtina*, *Dalbergia obovata*, *Combretum edwardsii* and *Cnestis natalensis*.

A characteristic feature of the forest is the large number of epiphytes, which include many species of Bryophytes, Lichens, Ferns such as *Asplenium* spp. and *Pleiopheltis* spp., and Angiosperms such as *Streptocarpus* spp., *Peperomia reflexa*, *Mystacidium* spp. and *Polystachya* spp.

The successional relationships between the communities occurring in the Mistbelt *Themeda-Aristida* Grassland and Mixed *Podocarpus* Forest are illustrated in Fig. 18.

6.7 HIGHLAND GRASSLAND AND MONTANE PODOCARPUS FOREST

The Highland Grassland and Montane *Podocarpus* Forest occupies 720 sq. km (278 square miles), or 6 per cent of the Three Rivers Region. It occurs on the highland plateau, above 1 372m (4 500ft), where the terrain is generally flat with few steep slopes.

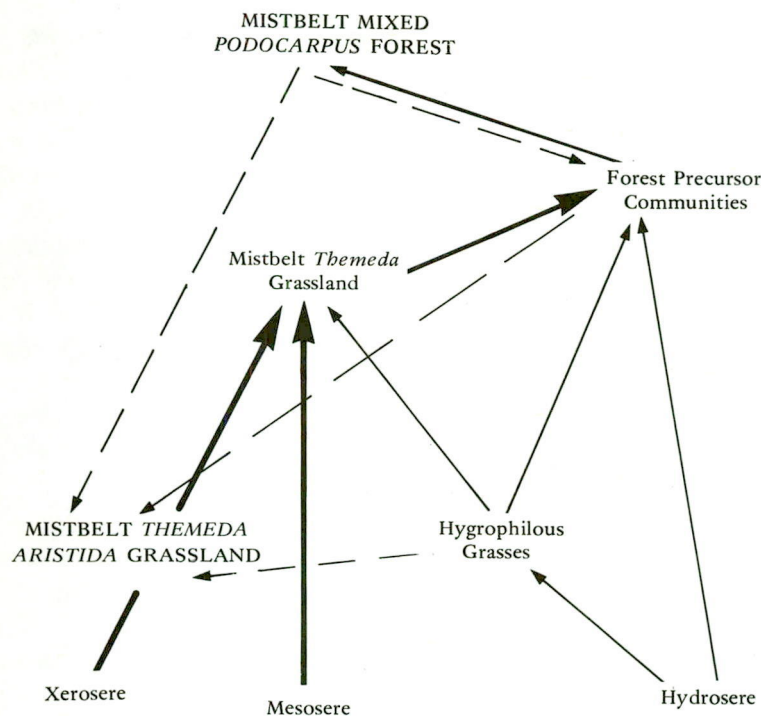


FIG. 18: A greatly simplified diagrammatic representation of the successional relationships of the most extensive communities of the Mistbelt Themeda-Aristida Grassland and Mixed Podocarpus Forest. Solid arrows indicate primary succession, broken arrows indicate secondary succession, the thickness of the arrows gives an indication of the successional trends, and the most obvious communities occurring have been capitalized.

The summers are moderately warm, the December mean temperature is 18°C (64°F), with absolute maximum temperatures in the region of 35°C (95°F). Summers are moist, the October to March rainfall being approximately 760mm. The winters are cold, the July mean temperature being 7°C (45°F), with an absolute minimum temperature of -10°C (14°F) having been recorded. Winters are dry, the April to September rainfall being approximately 200mm. Frosts are severe and snow falls almost every winter. The soils are highly leached.

The Highland Grassland, which is fire maintained, is the most extensive community occupying 707 sq. km (267 square miles) of the area. Small patches of forest occur where there is adequate protection from fire and wind, usually on southeast-facing slopes (see Vegetation Map).

The primary vegetation of the area is not as disturbed as the vegetation of other parts of the Three Rivers Region, though in some parts the natural vegetation has been cleared for cultivation.

6.7.1. Highland Grassland

The grass composition is very mixed. The great majority of the more common grass species belong to the Andropogoneae, such as *Themeda triandra*,

Andropogon filifolius, *Heteropogon contortus*, *Trachypogon spicatus*, *Monocymbium ceresiiforme*, *Andropogon amplexans*, *A. appendiculatus*, *Elyonurus argenteus*, *Cymbopogon excavatus*, *Eulalia villosa* and *Hyparrhenia birta*. Other common grasses are *Tristachya bispida*, *Eragrostis racemosa*, *Rendlia altera*, *Microchloa caffra*, *Eragrostis plana*, *Panicum natalensis*, *Alloteropsis semialata*, *Harpechloa falx*, *Setaria nigrirostris*, *Stiburus alopecuroides*, *Loudetia simplex*, *Festuca scabra*, *Sporobolus capensis*, *S. centrifugus* and *Danthonia stricta*. Owing to the variety of microhabitat factors, various grass species are common in certain areas and rare in others. An overall appreciation is difficult, but in most primary grassland areas *T. triandra*, *A. filifolius*, *T. bispida*, *H. contortus*, *E. racemosa*, *R. altera*, *M. caffra*, *E. capensis*, *T. spicatus*, *P. ecklonii* and *A. amplexans* are the dominant species, forming a community up to 0,5m (1,5ft) tall.

A feature of the grassland is the great variety of forbs. These are particularly common on rocky outcrops, in shallow soil and in disturbed areas where the competition from the grasses is reduced. Because of the great number of species only some of the most common genera present are listed, these are *Helichrysum*, *Gerbera*, *Leontonyx*, *Gnidia*, *Senecio*, *Watsonia*, *Acalypha*, *Erica*, *Indigofera*, *Hypoxis*, *Moraea*, *Rhodohypoxis*, *Rhynchosia*, *Schizoglossum*, *Scilla*, *Pachycarpus*, *Cyperus*, *Chrysocoma*, *Dierama*, *Tulbaghia*, *Apodolirion*, *Agapanthus*, *Anthericum*, *Ficinia*, *Eriosema*, *Drimia*, *Kniphofia*, *Gladiolus*, *Urginea*, *Tritonia*, *Ajuga*, *Aristea* and *Barleria*.

6.7.2. Montane Podocarpus Forest

On south-east facing slopes which are partly protected from fire and wind, patches of Montane *Podocarpus* Forest occur. Most of these forest patches have been exploited and only remnants remain.

Floristically and structurally the forest is a depauperate form of Mistbelt Mixed *Podocarpus* Forest. Fewer species are present and the trees are shorter. Only three well defined strata may be distinguished. In general the leaves are smaller than in Mistbelt Mixed *Podocarpus* Forest, probably a reaction to the colder, drier climate.

The canopy is from 14 to 18m (45 to 60ft) high and is seldom pierced by emergent species. *Podocarpus latifolius* is the dominant species. Other common species are *Euclea crispa*, *Celtis africana*, *Ptaeroxylon obliquum*, *Scolopia* spp., *Olinia emarginata*, *Linociera foveolata*, *Apodytes dimidata*, *Fagara davyi* and *Halliera lucida*.

Below the canopy there is no definite layer of shorter trees. The woody plants that do occur vary in height from 3 to 12m (9 to 40ft), and in density. Common species are *Diospyros whyteana*, *Maytenus mossambicensis*, *Carissa bispinosa*, *Eugenia zuluensis*, *Dovyalis lucida*, *Maytenus undata* and *Canthium ciliatum*.

The herbaceous field layer is well developed and is mainly a dense sward of *Brachypodium flexum* and *Oplismenus hirtellus* (Photo 35). Scattered through the field layer are a few other herbs, such as *Stipa dregeana*, *Dietes vegeta*, *Streptocarpus* spp., *Plectranthus* spp., *Impatiens duthieae* and *Begonia* spp.

Epiphytes are not as common as in Mistbelt *Podocarpus* Forest, but the

species are similar. The trees on the upper forest margin are frequently festooned with a lichen (*Usnea* sp.)

Lianes are not common. Species that do occur are *Clematis brachiata*, *Strophanthus speciosa*, *Cassinopsis ilicifolia*, *Choristylis rhamnoides*, *Scutia myrtina* and *Dalbergia obovata*.

The successional relationships between the communities occurring in the Highland Grassland and Montane *Podocarpus* Forest are illustrated diagrammatically in Fig. 19.

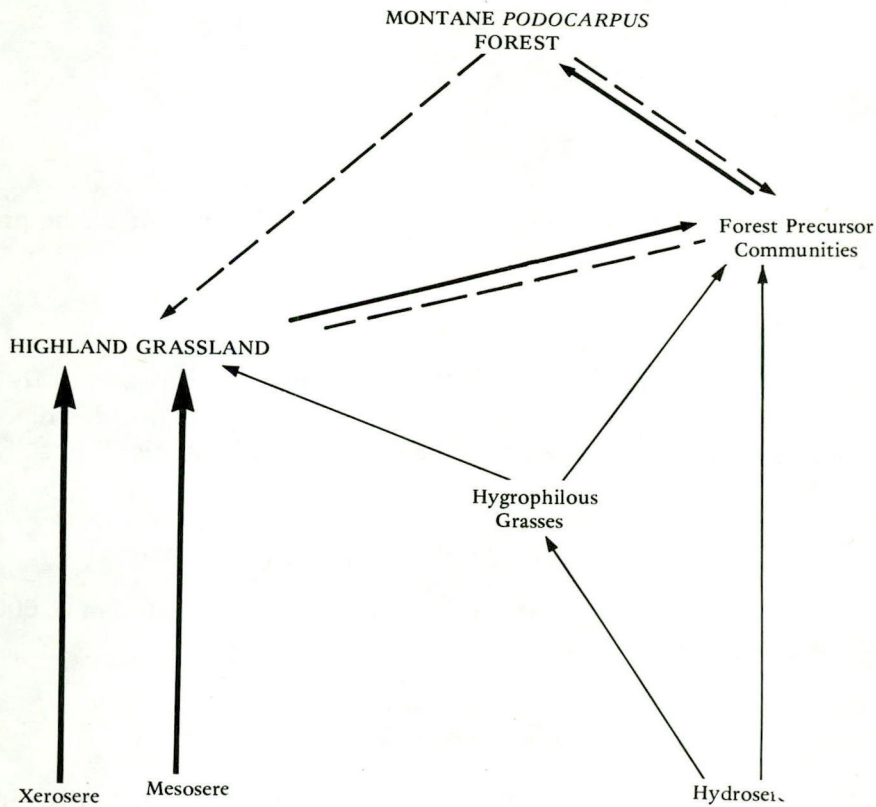


FIG. 19: A greatly simplified diagrammatic representation of the successional relationships of the most extensive communities of the Highland Grassland and Montane Podocarpus Forest. Solid arrows indicate primary succession, broken arrows indicate secondary succession, the thickness of the arrows gives an indication of the successional trends, and the most obvious communities occurring have been capitalized.

CHAPTER 7

Literature Review

The following is a brief review of published literature relevant to the present survey.

7.1 FOURCADE (1889)

Fourcade, who was Conservator of Forests in the Cape, was invited to Natal by the Colonial Government to report on the Natal Forests. In his report he separated the forests "according to their nature and distribution" into:

- (i) High Timber, distributed in patches on south-facing slopes, from 1 067 to 1 829m (3 500 to 6 000ft), with *Podocarpus* spp. dominant.
- (ii) Thorn-Bush, in the deep river valleys between 304 to 1 067m (1 000 and 3 500ft), mainly of *Acacia* spp.
- (iii) Coast Forest, stretching in a band along the coast, with *Mimusops caffra* and *Albizia adianthifolia* being characteristic species.

Fourcade's work is of considerable interest. Many of his High Timber Forests are no longer dominated by *Podocarpus* spp., because most of these trees have been cut for timber, and most of the Coast Forest has been cleared for agriculture. *Acacia* spp. are still dominant in the deep river valleys and have also encroached into adjacent grassland areas.

7.2 THODE (1901)

Thode defined the botanical regions of Natal on the basis of "floristic composition". He recognised three botanical regions which he separated according to altitude.

- (i) A Semi Tropical Coast Region, from 0 to 457m (0 to 1 500ft), characterised by *Phoenix reclinata* and *Strelitzia nicolai*.
- (ii) A large Central Savannah Region, from 457 to 1 372m (1 500ft to 4 500ft), characterised by *Acacia* spp., *Aloe* spp. and numerous grasses, especially *Hyparrhenia* spp. In this region forest occurred on south-facing slopes.

- (iii) A Mountain Region, from 1 372 to 3 048m (4 500 to 10 000ft), characterised by *Leucosidea sericea*, *Protea* spp. and *Cyathea dregei*, with forest in sheltered kloofs and grassland, or savanna, on exposed areas.

Thode's work is of historical interest mainly, but it is surprising how accurate his knowledge was.

7.3 BEWS (1912, 1913, 1916, 1917a, 1917b, 1918, 1920 and 1921).

Bews made major contributions to our understanding of the vegetation of Southern Africa. He was the first South African ecologist to show an appreciation of the dynamic nature of the vegetation. He considered climate to be of major importance in determining the climax vegetation, and to illustrate his argument he used comparisons of vegetation and aspect. He emphasised the phenomenon of plant succession and subsequent ecologists have built on the foundation he laid.

Bews was the first Professor of Botany at what is now Natal University. He founded what might be called a Natal school of plant ecology, and many of the ideas in the present work are based on Bews' concepts.

7.4 BAYER (1933, 1938, 1952, 1953 and 1955)

Bayer was not only a student of Bews, but his assistant and successor in the Chair of Botany. He published accounts of the plant ecology of the coast vegetation and thornveld, though most of his work was done on the vegetation of northern Zululand.

Bayer (1955) subscribed to the view that fires in late winter or early spring have been a factor in the vegetation for a very long time. He discussed how this factor has been responsible for the evolution of the great variety of vernal aspect forbs present in our grassland.

Many of the more recent investigations of the plant ecology of Natal have been by students of Bayer, such as Rycroft (1942), Hillary (1947), Comins (1953), Killick (1958; 1963), Wells (1959), Moll (1965), Downing (1966), Edwards (1967) and Morris (1967).

7.5 POLE EVANS (1936)

Pole Evans produced a vegetation map of South Africa. He recognised the following types in the Three Rivers Region:

- (i) Evergreen and Deciduous Bush, with patches of subtropical forest, occurring in a narrow belt along the coast, to 305m (1 000ft). This consisted of mangroves, palms, *Acacia* spp., streambank bush, and evergreen forest.
- (ii) A small area of Temperate Evergreen Forest, with *Podocarpus* spp., situated near Howick.
- (iii) Tall Grass, the most extensive community, with *Acacia* spp. in the sheltered, drier valleys at lower altitudes, with *Hyparrhenia* spp. grassland below 1 524m (5 000ft).

Pole Evans' work covered the whole of South Africa so it is hardly fair to compare his results with those of the present, detailed study. His conclusions are given, however, as they are of general interest. He recognised that the forest at the coast was sub-tropical, and that the *Podocarpus* spp. Forest at higher altitudes was temperate.

7.6 ADAMSON (1938)

Another vegetation map of South Africa was compiled by Adamson, who gave the following sub-divisions for the Three Rivers Region.

- (i) A sub-tropical Forest region extending in a belt along the coast, to almost 305m (1 000ft).
- (ii) A Temperate Savanna and Warm Temperate Forest Region, with *Acacia* spp. in the dry valleys and grassland over most of the remaining area, except for small patches of forest at higher altitudes.
- (iii) A Grassland region above about 1 219m (4 000ft), with mainly *Themeda triandra*.

Adamson's work, like that of Pole Evans, was on the whole of South Africa. It is interesting to note, however, that Adamson also called the forest at the coast sub-tropical. Adamson went one step further than Pole Evans, and called the vegetation of the dry valley region a Temperate Savanna.

7.7 BAYER AND COUTTS (1938)

In a short paper on morning and midday relative humidities measured at Pietermaritzburg, it was shown that in Berg wind conditions the relative humidity can be as low as 5 per cent at 13h00; the associated temperature being as high as 40,7°C (105°F). This gives an indication of some of the extreme conditions plants must be able to survive.

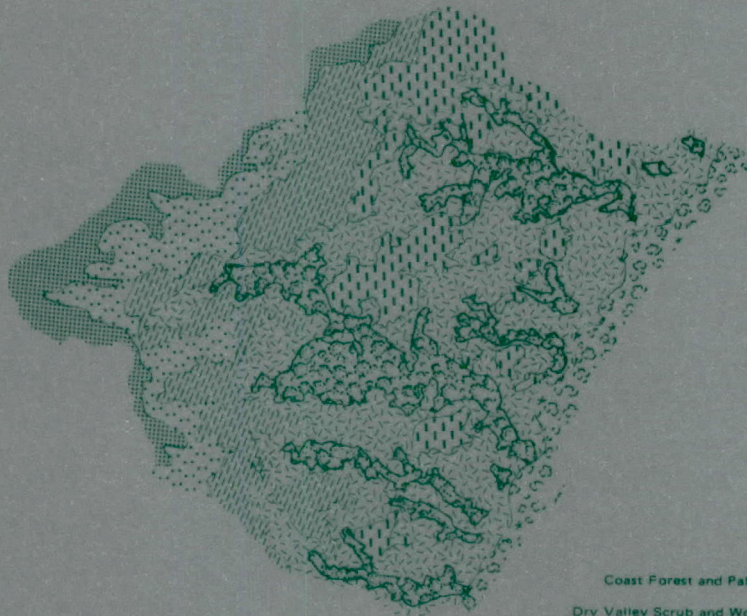
7.8 RYCROFT (1942)








A detailed account of the ecology of the Karkloof, the largest forest in the Three Rivers Region, was given by Rycroft. He described the various seral stages and gives a comprehensive appreciation of the general forest ecology, structure and composition. A thorough examination of the exploitation and mis-use of forest is also given. Figures given for the Karkloof show that since about 1880 it has been reduced from about 8 094 to 6 070 hectare (20 000 to 15 000 acres).

Rycroft's work has been of importance in the present survey because his conclusions have greatly assisted in the final understanding of the present status of Mistbelt Mixed *Podocarpus* Forest.

7.9 PENTZ (1945)

Pentz was concerned about land-use, and in his Agro-Ecological map of Natal



- Coast Forest and Palm Veld 
- Dry Valley Scrub and Woodland Mosaic 
- Acacia Sieberana Savanna 
- Secondary *Aristida junciformis* Grassland 
- Moist Transitional *Themeda-Hyparrhenia* Grassland 
- Mistbelt *Themeda-Aristida* Grassland 
- Highland Grassland 

A simplified Vegetation Map of the Three Rivers Region (Moll, 1968)

he divided the vegetation of the Three Rivers Region into six types (Fig. 20).

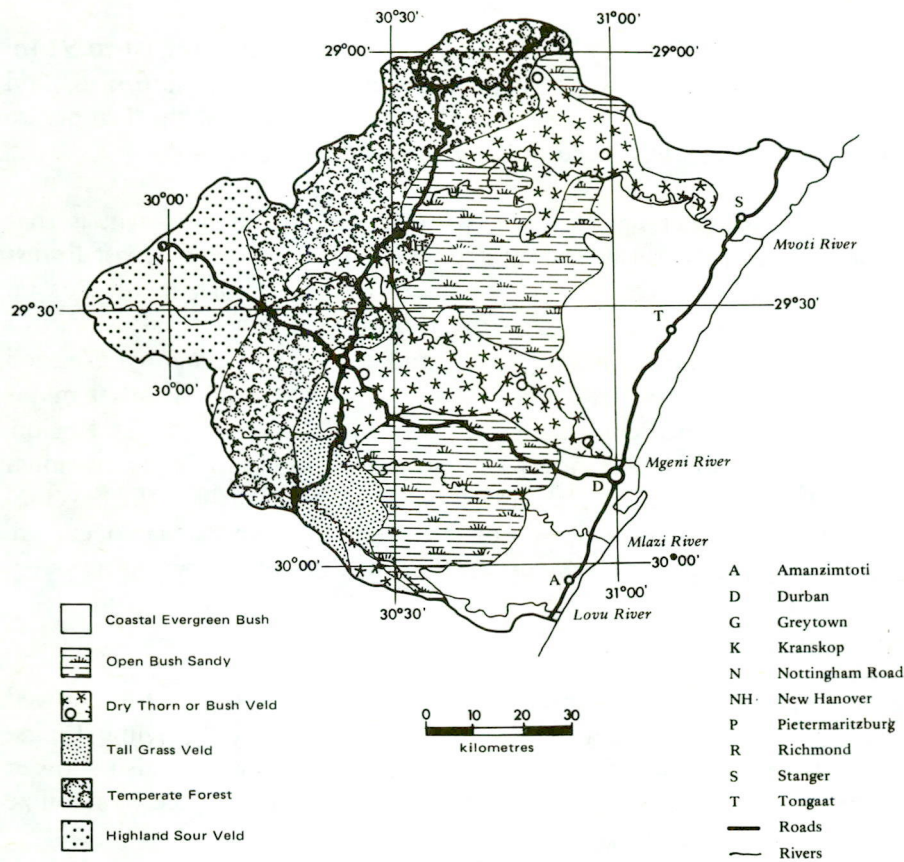


FIG. 20: The vegetation types of the Three Rivers Region (after Pentz, 1945).

These are:

- (i) Coastal Evergreen Bush, occurring up to 457m (1 500ft), of Forest, and Coastal Thorn in the dry river valleys.
- (ii) Dry Thorn or Bush Veld, distinct from the Coastal Thorn Bush, following the river valleys to just over 914m (3 000ft). It comprises many different plant communities with species of *Acacia*, *Boscia*, *Euphorbia* and *Aloe* being the most common.
- (iii) Tall Grass Veld, occurring from 1 067 to 1 372m (3 500 to 4 500ft), with grasses such as *Hyparrhenia* spp., *Sporobolus* spp., *Setaria* spp., *Tristachya hispida* and *Themeda triandra*, and trees such as *Acacia sieberana* and *Acacia caffra*.
- (iv) Highland Sourveld, occurring from 1 372 to 1 829m (4 500 to 6 000ft), with very mixed grassland, *Podocarpus* spp. temperate forest and *Leucosidea sericea* scrub-forest.

- (v) Temperate Forest ("Kongoni" veld), occurring between 914 to 1 219m (3 000 to 4 000ft) on undulating country, with forest of mixed composition, and *Aristida junciformis* grassland.
- (vi) Open Bush Sandy Country, stretching in patches between 610 to 914m (2 000 and 3 000ft). The grassland is mainly *Aristida junciformis*, and the woody plants in the kloofs are related to the species of the Temperate Forest, while Thornbush predominates on undulating sites.

The basic differences between the work of Pentz and my own, is that Pentz's Coastal Evergreen Bush is more extensive than my narrow Coast Forest and Palm Veld. This is because Pentz included Coastal Thorn in his Coastal Region, whereas I have considered that the thornveld near the coast is part of the Dry Valley Scrub and Bushland Mosaic and the *Acacia sieberana* Wooded Grassland, thus keeping the dry types of vegetation together. Another major difference is that I have included part of Pentz's Temperate Forest Region, namely in the vicinity of New Hanover and Greytown, in my Moist Transitional *Themeda Hyparrhenia* Grassland, because this region is too dry for the development of Mistbelt Mixed *Podocarpus* Forest. Other differences that occur are unimportant, being attributed to the differences in scales of the two surveys.

7.10 HILLARY (1947)

Hillary gave an account of the dune succession at Tongaat Beach. She showed that the clipped-hedge effect, which is characteristic of all the Dune Forest in the Three Rivers Region, is a result of salt-spray pruning. She also showed that the pioneer dune plants, such as *Scaevola thunbergii*, are able to stabilize the shifting sand very effectively.

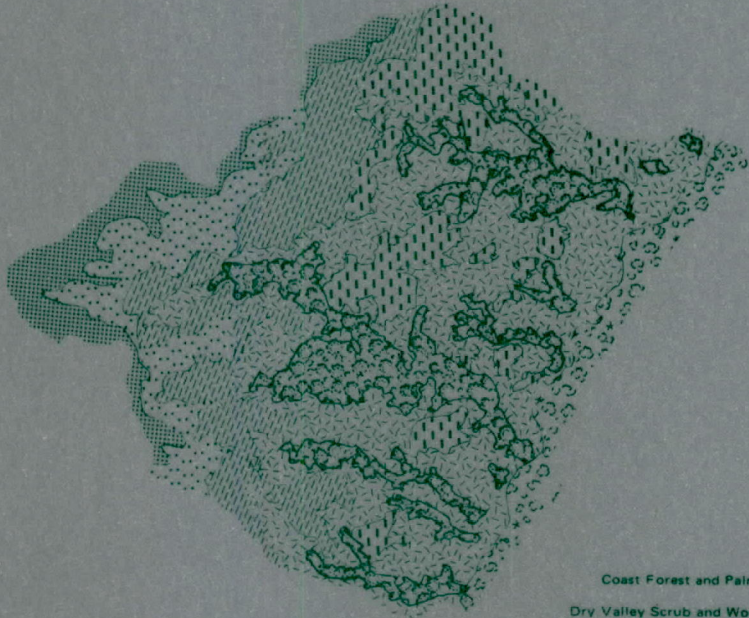
7.11 COMINS (1953)








Comins studied the plant ecology of the Albert Falls area and mapped the vegetation. He was particularly concerned with the effect of the European settlers on the vegetation. Their main effect was on the grassland, where there was a decrease in the amount of *Themeda triandra*, which was replaced by secondary species, particularly *Hyparrhenia birta*. He also noted that there has been increased *Acacia* scrub encroachment (Photo 36). Extrapolating from Comins's conclusions it is evident that there has been considerable replacement of *T. triandra* by *H. birta*, particularly in the *Acacia sieberana* Wooded Grassland and in the Moist Transitional *Themeda-Hyparrhenia* Grassland and considerable *Acacia* scrub encroachment.

7.12 ACOCKS (1953)

Acocks's Veld Types of South Africa is the most recent report that incorporates all the vegetation of the Three Rivers Region. He divided the vegetation of the Region into six basic Veld Types (Fig. 21).

- (i) Coastal Forest and Thornveld, up to 457m (1 500ft). Much of the forest has been reduced and replaced by thornveld. Four sub-types occur in the Three Rivers Region:



- Coast Forest and Palm Veld 
- Dry Valley Scrub and Woodland Mosaic 
- Acacia Sieberana Savanna 
- Secondary Aristida junciformis Grassland 
- Moist Transitional Themeda-Hyparrhenia Grassland 
- Mistbelt Themeda Aristida Grassland 
- Highland Grassland 

A simplified Vegetation Map of the Three Rivers Region (Moll, 1968)

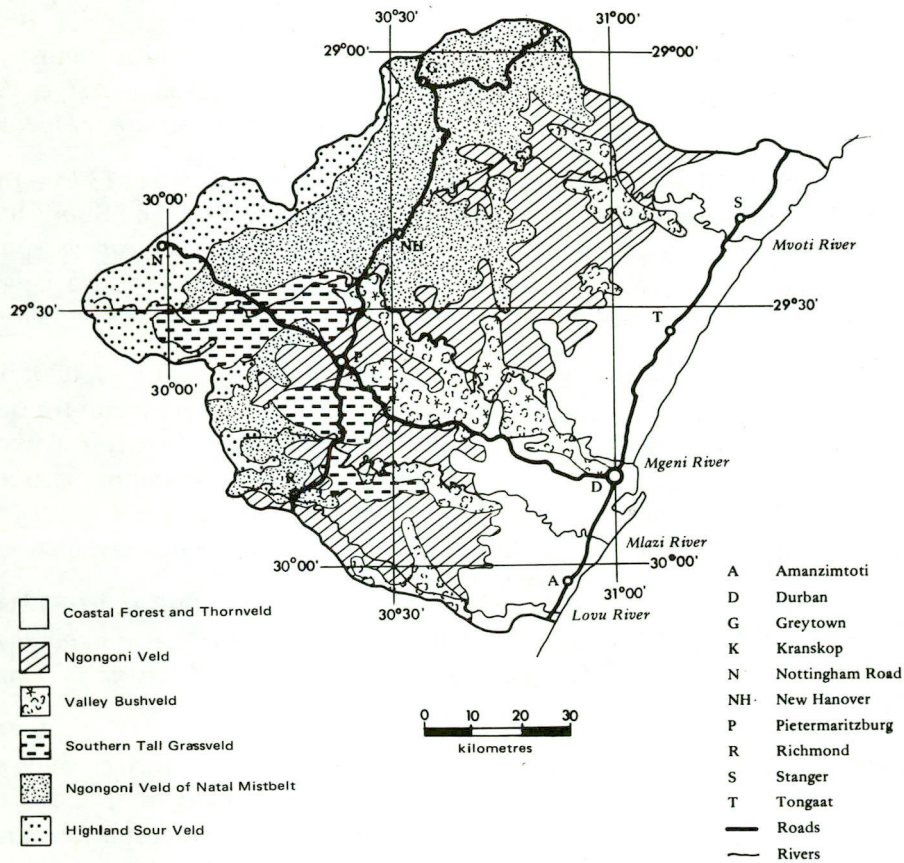


FIG. 21: The vegetation types of the Three Rivers Region (after Acocks, 1953).

- (a) Typical forest, the dominant trees being *Millettia grandis* and *Protorbus longifolia*. The thornveld replacing forest is scrubby, usually full of bush clumps separated by Secondary *Aristida junci-formis* grassland.
- (b) Zululand Palm Veld, only outliers occur south of the Tugela, conspicuous species are *Phoenix reclinata*, *Hyphaene crinita* and *Strelitzia nicolai*.
- (c) Dune Forest, the principal trees include *Minusops caffra*, *Euclea natalensis* and *Brachylaena discolor*.

- (d) Mangrove Forest, typical trees include *Avicennia marina* and *Bru-guiera gymnorrhiza*.
- (ii) The 'Ngongoni Veld, stretching in a belt between 457 and 914m (1 500 and 3 000ft). The vegetation should be forest, but it consists mostly of secondary *Aristida junciformis* Grassland. Most common forest trees are *Trimeria rotundifolia*, *Combretum kraussii* and *Rapanea melanophloeos*.
- (iii) Natal Mistbelt 'Ngongoni Veld, occurring from 914 to 1 372m (3 000 to 4 500ft). It is transitional between 'Ngongoni Veld and Highland Sourveld. Little forest survives except at the upper margin where *Podocarpus* spp. are the dominants. In the grassland *Aristida junciformis* has to a large extent replaced *Themeda triandra*.
- (iv) Highland Sourveld, occurring from 1 372 to 2 134m (4 500 to 7 000ft). It is probable that the whole area was originally forest and scrub-forest, but relics are few, small and badly mutilated. The dominant forest tree is *Podocarpus latifolius*, and *Leucosidea sericea* is the commonest tree in scrub-forest. The grassland is mixed, *Themeda triandra* and *Tristachya hispidula* being most common, with occasional patches of *Protea* savanna.
- (v) Southern Tall Grassveld, occurring in patches between 1 067 and 1 372m (3 500 and 4 000ft). It is usually an open savanna with *Acacia sieberana* being the common tree, and *Hyparrhenia birta* and *Themeda triandra* being the common grasses.
- (vi) Northern varieties of Valley Bushveld, occurring in the deep river valleys between 152 and 914m (500 and 3 000ft). Large numbers of species are present and typical trees are *Dichrostachys cinerea*, *Euphorbia* spp., *Acacia* spp. and *Spirostachys africana*. Common grasses are *Themeda triandra*, *Panicum maximum*, *Eragrostis* spp. and *Sporobolus* spp.

The basic differences between the work of Acocks and my own is that Acocks's Coastal Forest and Thornveld Type, like that of Pentz, is more extensive than my Coast Forest and Palm Veld. Another major difference is my recognition of part of the 'Ngongoni Veld of the Natal Mist Belt, in the vicinity of New Hanover and Greytown, as Moist Transitional *Themeda-Hyparrhenia* Grassland. Other differences are unimportant, resulting merely from the differences in scales of the two surveys. My reasons for recognising the two major differences were explained above (see Section 7.9).

7.13 KILLICK (1959)

Killick studied the Table Mountain area near Pietermaritzburg. In his excellent report on the plant ecology he gave an account of the various seral stages, discussed the secondary nature of the *Aristida junciformis* Grassland which he attributed to overgrazing and autumn burning, and divided the woody communities into Treeveld, on the drier slopes, and Kloof Forest on the more moist, protected sites. Killick also mapped the vegetation of the area.

The work of Killick was important for this present survey, as many of the

conclusions regarding the Secondary *Aristida junciformis* Grassland region are based on his work.

7.14 WELLS (1959)

Wells gave a very detailed account of the seral stages, climax communities, and secondary vegetation types of the Nagle Dam area in the Mgeni River valley near Pietermaritzburg. He described the dry valley vegetation and indicated the vast degree of secondary interference. Wells also produced a very detailed vegetation map of the area. His work is significant since it indicates the complex nature of the vegetation of the deep, dry river valleys which he attributed to local differences in temperature and insolation, directly related to aspect.

Wells's work was important for this present survey, but because the Mgeni River valley is the driest in the Three Rivers Region, the usefulness of his conclusions are fairly limited.

7.15 TAYLOR (1963)

Taylor gave an indication of Natal Mistbelt Forest destruction, and reported that since about 1880 the Nxamalala Forest had been reduced from 3 237 to 607 hectare (8 000 to 1 500 acres). A reduction of 2 630 hectare (6 500 acres). Taylor's conclusions give an indication of the extent of damage to Mistbelt Mixed *Podocarpus* Forest.

7.16 MOLL (1965, 1968a, 1968b and 1968c)

Moll gave an account of the plant ecology of the Upper Mgeni Catchment (1965), an area of land between 1 069 and 1 981m (3 500 and 6 500ft). He also produced a vegetation map of the area. The results of his survey have been incorporated into the present report.

7.17 EDWARDS (1967)

The most recent comprehensive plant ecological survey of Natal vegetation is of the Tugela Basin, which abutts on the northern boundary of the Three Rivers Region. In his report, Edwards discussed the plant ecology of the various communities present, and also compiled a 1:250 000 scale Vegetation Map. As the nature of the Tugela Basin survey and scale of the vegetation map is similar to that of the Three Rivers Region, a fairly detailed comparison between the two surveys is desirable. Possibly the best way of accomplishing this is a direct analysis of the similarity and differences between the vegetation types delimited in the Three Rivers Region, with those given by Edwards for the Tugela Basin.

(a) COAST FOREST AND PALM VELD

The Tugela River Valley is a much drier valley than any of the much smaller river valleys in the Three Rivers Region. This accounts for the difference in vegetation between the Tugela Basin and the Region.

(b) DRY VALLEY SCRUB AND BUSHLAND MOSAIC

This is analogous to Edwards's Dry Valley Vegetation. This vegetation type is not as well developed in the Three Rivers Region as it is in the Tugela Basin, because the valleys in the former are not as large, nor as dry as the Tugela Basin. Therefore, the dry valley communities in the Three Rivers Region are less clearly defined. No *Acacia burkei* and very little *Combretum apiculatum* occurs south of the Tugela Basin.

(c) ACACIA SIEBERANA WOODED GRASSLAND

This is broadly analogous to Edwards's *Themeda-Hyparrhenia* Grassland of the Interior Basin Region. A fairly big difference in interpretation exists, as I have preferred to distinguish two faciations of *Acacia sieberana* Wooded Grassland. The one faciation, on the Karroo Series, is very similar to Edwards' *Themeda-Hyparrhenia* Grassland, and the upper boundary on the vegetation map of the Three Rivers Region almost coincides with the boundary of Edwards' *Themeda-Hyparrhenia* Grassland. The other faciation of *Acacia sieberana* Wooded Grassland on Table Mountain Sandstone, corresponds partly to Edwards' Moist Coast *Acacia karroo-A. nilotica-A. robusta* Thorn Scrub, to his Semi-Coast Bush Clump-Grassland Mosaic and partly to his Semi-Coast *Aristida junciformis* Grassland.

(d) SECONDARY ARISTIDA JUNCIFORMIS GRASSLAND

This is analogous to Edwards' Semi-coast Secondary *Aristida junciformis* Grassland, but is much more extensive in the Three Rivers Region than in the Tugela Basin.

(e) MOIST TRANSITIONAL THEMEDA-HYPARRHENIA GRASSLAND

This corresponds almost exactly to Edwards' type of the same name, and the boundary on my map meets his almost exactly.

(f) MISTBELT THEMEDA-ARISTIDA GRASSLAND AND MIXED PODOCARPUS FOREST

This corresponds almost exactly to both Edwards' Mistbelt Secondary *Aristida junciformis* Grassland and Mistbelt Mixed *Podocarpus* Forest. On this basis our boundaries coincide almost exactly.

(g) HIGHLAND GRASSLAND AND MONTANE PODOCARPUS FOREST

This corresponds almost exactly to Edwards' *Themeda-Trachypogon* Highland Grassland and Montane *Podocarpus* Forest, and my boundary meets his almost exactly. The difference in terminology exists because in the Three Rivers Region the grassland is very mixed with no clear dominance of any particular species.

CHAPTER 8

A Summary of the General Plant Ecology

8.1 SUMMARY OF THE VEGETATION TYPES

The salient features of the seven vegetation types recognised and the plant species indicative of each vegetation type are summarized below.

8.1.1. Coast Forest and Palm Veld

AREA: 653 sq. km (252 square miles).

ALTITUDE: 0 to 152m (0 to 500ft).

TOPOGRAPHY: Gently undulating.

GEOLOGY: Mainly Recent Sands and Ecca Shales, with a little Table Mountain Sandstone in the north.

SOILS: Mainly deep and sandy; moderately leached. Some rather clayey soils occur where the substrate is Ecca shale.

CLIMATE: Hot and humid in summer, cool to warm and moderately humid in winter. Temperatures: mean daily 20°C (68°F); extremes 45°C (113°F) and 4°C (39°F). Mean annual rainfall is approximately 1 000mm. Mean daily relative humidity at 08h00 and 14h00 usually 70 per cent. No frost occurs.

PRIMARY VEGETATION: The climatic climax is Coast Forest. Palm Veld occurred as an edaphic climax in limited areas on Dwyka Tillite. Mangroves occurred in saline estuaries. Swamp Forest occurred on swampy ground.

PRESENT VEGETATION: At least 95 per cent has been cleared for cultivation, particularly for sugarcane. Swamps have been drained and Mangroves destroyed, except for the small area of Mangroves at the Beachwood backwater of Mgeni River (Cooper 1968).

PLANT INDICATORS: The various Coast Forest communities are indicated by *Mimusops caffra*, *Brachylaena discolor*, *Millettia grandis*, *Strychnos innocua*, *Strelitzia nicolai* and *Chaetacme aristata*. Palm Veld is indicated by *Phoenix reclinata*, with the following species present in bush clumps, *Sapium integrimum*, *Antidesma venosum* and *Albizia adianthifolia*. *Aristida junciformis*

is the most frequent species in the grassland matrix of Palm Veld. Mangroves and allied halophytic communities are indicated by *Avicennia marina*, *Bruguiera gymnorrhiza*, *Barringtonia racemosa* and *Hibiscus tiliaceus*. Swamp Forest indicators are *Ficus hippopotamii*, *Stenochlaena tenuifolia*, *Macaranga capensis*, *Voacanga thouarsii* and *Syzygium cordatum*, the last three species often grow on dry land where the water-table is high.

8.1.2. Dry Valley Scrub and Bushland Mosaic

AREA: 1 634 sq. km (631 square miles).

ALTITUDE: 30 to 914m (100 to 300ft).

TOPOGRAPHY: Steep and rugged.

GEOLOGY: Mainly Basement Granite and Table Mountain Sandstone, and limited areas on Dwyka and Ecca Series.

SOILS: Mainly shallow, except in limited areas; slightly to moderately leached and tending to be considerably leached towards the upper margin.

CLIMATE: Hot and moist in summer, cool and dry in winter. Temperatures: mean daily 21,5°C (71°F); extremes 44°C (111°F) and 0°C (32°F). Mean annual rainfall 700 to 800mm; in some localised areas as much as 900mm. Occasional light frosts occur.

PRIMARY VEGETATION: The climax vegetation of the area was a mixed woody community, ranging from woodland to savanna, with a *Themeda triandra* understorey. Examples are, *Spirostachys africana* Woodland on deep alluvial soils of the valley floor; Riverine Woodland; Mixed Deciduous Communities with *Acacia* spp., *Aloe* spp. and *Euphorbia* spp. on the steep, dry sites; *Combretum molle* Bushland; *Faurea saligna* Woodland; and *Acacia* Wooded Grassland. Various Cliff Communities occurred, with Kloof Forest in localized, small areas having additional soil moisture and protection from extreme temperatures.

PRESENT VEGETATION: Secondary scrub communities occur in most of the area. There has been almost total destruction of the Kloof Forest communities. An important economic factor is the scrub encroachment of *Acacia* spp., and the change in grass composition from *T. triandra* to *Sporobolus-Eragrostis*. Ninety per cent of indigenous vegetation is secondary.

PLANT INDICATORS: The Mixed Deciduous Communities are indicated by *Euphorbia triangularis*, *E. tirucalli*, *Dichrostachys cinerea*, *Sclerocarya caffra*, *Aloe candelabrum*, *Calpurnia aurea* and *Boscia albitrunca*. The *Acacia* Wooded Grassland is indicated by *Acacia karroo*, *A. nilotica*, *A. tortilis* and *Rhus pentheri*, with *Sporobolus pyramidalis*, *Eragrostis curvula* and *Themeda triandra* as the common understorey grasses. *Spirostachys africana* occurs as a specific community type, as does *Combretum molle* and *Faurea saligna*. Kloof Forest communities are outliers of Coast Forest, indicator species are *Anastrabe integerrima*, *Commiphora harveyi*, *Combretum kraussii* and *Clerodendrum glabrum*. Cliff communities have an exceedingly variable species

composition, indicators are *Encephalartos natalensis*, *Schrebera alata*, *Seemanea gerrardii*, *Urera tenax*, *Ekebergia pterophylla* and *Ficus ingens*.

8.1.3. *Acacia sieberana* Wooded Grassland

AREA: 4 126 sq. km (1 593 square miles).

ALTITUDE: 152 to 1 067m (500 to 3 500ft).

TOPOGRAPHY: Undulating to fairly steep and rugged.

GEOLOGY: Mainly Basement Granite, Table Mountain Sandstone and limited areas of Dwyka and Ecca Series.

SOILS: Mainly moderately deep, clayey to sandy; moderately to considerably leached.

CLIMATE: Warm and moist in summer. Temperatures: mean daily 18,5°C (65°F); extremes 41°C (106°F) and 0°C (32°F) near the coast with minima to -2°C (28°F) in river valleys further inland. Mean annual rainfall 800 to 900mm.

PRIMARY VEGETATION: *Acacia sieberana* Wooded Grassland with a grass understorey of *Themeda triandra*. Below 610m (2 000ft) Bush Clumps developed on sites protected from fire. Kloof Forest occurred on most mesic, usually south-facing slopes.

PRESENT VEGETATION: Thirty to 40 per cent of the vegetation has been cleared for cultivation. The remaining vegetation is almost all secondary; many of the trees have been removed, and the grass composition has changed from *T. triandra* to either *Aristida junciformis* or *Hyparrhenia birta*.

PLANT INDICATORS: *Acacia sieberana* with a mixed *Aristida junciformis*, *Hyparrhenia birta* and *Themeda triandra* understorey. Closed woody communities occasionally occur below 760m indicator species are *A. sieberana*, *Maesa lanceolata*, *Albizia adianthifolia*, *Dais cotinifolia* and *Ficus petersii*. Where these woody communities develop into forest, indicators are *Protobus longifolia*, *Drypetes gerrardii*, and *Combretum kraussii*.

8.1.4. Secondary *Aristida junciformis* Grassland

AREA: 1 308 sq. km (505 square miles).

ALTITUDE: 152 to 1 219 km (500 to 4 000ft).

TOPOGRAPHY: Flat to gently undulating with very occasional steep slopes.

GEOLOGY: Mainly Table Mountain Sandstone, with very limited areas of Basement Granite.

SOILS: Mainly moderately deep sandy soils; highly leached.

CLIMATE: Warm and moist in summer, cool and dry in winter. Temperatures: mean daily 18°C (64°F); extremes 40°C (104°F), and -0,2°C (31,5°F) near the coast with minima to -2 to -3°C (28 to 26°F) further inland. Mean annual

rainfall 1 000 to 1 100mm. Fog common in summer. Frosts light to moderately severe.

PRIMARY VEGETATION: *Themeda triandra* Grassland maintained by fire. On shallow soils and rainfall approximately 1 100mm, *Protea roupelliae* Wooded Grassland occurred. Kloof Forest occurred on moist south-facing slopes.

PRESENT VEGETATION: Sixty to 70 per cent of the vegetation has been cleared for cultivation. The remaining vegetation is almost all secondary. Grassland is now Secondary *Aristida junciformis* Grassland. Most of the *Protea roupelliae* has been cleared, and most forests have been reduced to small relic patches.

PLANT INDICATORS: Secondary *Aristida junciformis* Grassland on sandy soils. Some associated plant species which are fairly good indicators are *Paspalum commersonii*, *Hyparrhenia filipendula*, *Selago natalensis*, *Watsonia densiflora* and *Protea roupelliae*. Kloof Forest communities are related to the Kloof Forest communities of the *Acacia sieberana* Wooded Grassland and the Coast Forests, indicator species are *Protorbis longifolia*, *Nuxia floribunda*, *Ochna arborea*, *Combretum kraussii* and *Drypetes gerrardii*.

8.1.5. Moist Transitional Themeda-Hyparrhenia Grassland

AREA: 1 650 sq. km (637 square miles)

ALTITUDE: 610 to 1 219m (2 000 to 4 000ft)

TOPOGRAPHY: Fairly flat undulating country.

GEOLOGY: Mainly Ecca Series with limited areas of the Dwyka Series.

SOILS: Fairly deep to shallow clays and loams; moderately to considerably leached.

CLIMATE: Warm and fairly moist in summer, cool and dry in winter. Temperatures: mean daily 18°C (64°F); extremes 40°C (104°F) and -3°C (27°F). Mean annual rainfall 800 to 1 000mm, but usually about 950mm. Frosts moderately severe.

PRIMARY VEGETATION: *Themeda triandra* Grassland maintained by fire, with small areas of short Scrub Forest on fire protected sites.

PRESENT VEGETATION: Seventy to 80 per cent of the vegetation has been cleared for cultivation. The remaining vegetation is almost all secondary *Themeda-Hyparrhenia* Grassland.

PLANT INDICATORS: Because this vegetation type occupies an ecotone, no species are truly indicative. The grassland is dominated by *Themeda triandra* and *Hyparrhenia hirta*, and in occasional Scrub Forest communities *Cantbium mundianum*, *Cryptocarya woodii*, *Dais cotinifolia* and *Brachylaena elliptica* are fairly characteristic.

8.1.6. Mistbelt Themeda-Aristida Grassland and Mixed Podocarpus Forest

AREA: 1 225 sq. km (473 square miles)

ALTITUDE: 1 067 to 1 372m (3 500 to 4 500ft)

TOPOGRAPHY: Fairly steep and undulating.

GEOLOGY: Mainly Ecca Series, with limited areas of the Beaufort Series.

SOILS: Highly leached, fairly deep.

CLIMATE: Fairly warm and wet in summer; cool to cold, and dry, in winter. Temperatures: mean daily 17°C (63°F); extremes 40°C (104°F) and -6°C (21°F). Mean annual rainfall usually 1 000 to 1 200mm. Fog frequent in summer.

PRIMARY VEGETATION: *Themeda triandra* Grassland maintained by fire, with some fairly extensive areas of tall forest on fire protected sites. This forest was dominated by *Podocarpus* spp.

PRESENT VEGETATION: Twenty to 30 per cent of the vegetation has been cleared for cultivation. The remaining vegetation is mainly secondary *Aristida junciformis* Grassland. In some areas *Themeda triandra* is still common. Indigenous forests have been exploited for timber and are depauperate, though quite extensive areas still occur.

PLANT INDICATORS: Patches of Mistbelt *Podocarpus* Forest are characteristic of this vegetation type, indicator species are *Xymalos monospora*, *Kiggelaria africana*, *Cryptocarya myrtifolia*, *Ptaeroxylon obliquum*, *Strophanthus speciosa*, *Podocarpus* spp., *Rapanea malenophloeos* and *Selaginella kraussiana*. The surrounding grassland is characterised by *Aristida junciformis* associated with *Microchloa caffra*, *Rendlia altera*, *Andropogon filifolius* or *Panicum ecklonii*.

8.1.7. Highland Grassland and Montane Podocarpus Forest

AREA: 720 sq. km (278 square miles)

ALTITUDE: 1 372m (4 500ft)

TOPOGRAPHY: Fairly flat tableland with some steep slopes.

GEOLOGY: Mainly Beaufort Series.

SOILS: Generally fairly deep; highly leached.

CLIMATE: Moderately warm and moist in summer, cold and fairly dry in winter. Temperatures: mean daily 14°C (57°F); extremes 30°C (95°F), and -10°C (14°F). Mean annual rainfall 850 to 1 000mm. Snow usually occurs in winter. Frosts are severe.

PRIMARY VEGETATION: Fire maintained Grassland, with very mixed composition, mainly *Themeda triandra* and some temperate species were common. Forest occurs on fire protected sites, which are also protected from winds.

PRESENT VEGETATION: Most of the Grassland has been only slightly disturbed by selective grazing and fire. Recently fairly extensive areas have been cleared for cultivation.

PLANT INDICATORS: The Grassland is distinguished from that of the Mistbelt

Themeda-Aristida Grassland by the almost total absence of *Aristida junciformis*. Additional indicators to those given for the Mistbelt *Themeda-Aristida* Grassland is *Festuca costata*. Montane *Podocarpus* Forest indicators are *Podocarpus latifolius* with *Olinia emarginata*, *Scolopia* spp. and *Euclea crispa*. Possibly the best indicator species is *Leucosidea sericea*.

8.2 A SUMMARY OF THE RELATIONSHIPS BETWEEN THE VEGETATION TYPES

In the Three Rivers Region seven vegetation types have been recognised. These are, however, all related one to another, with ecotonal regions existing between adjacent vegetation types. On the vegetation map boundary lines have been drawn through the ecotones. This continuous variation between plant communities is known as a 'vegetational continuum' (Curtis, 1959). It is only the Dry Valley Scrub and Bushland Mosaic that is fairly discrete. In Fig. 22 the general relationships between the various vegetation types are indicated.

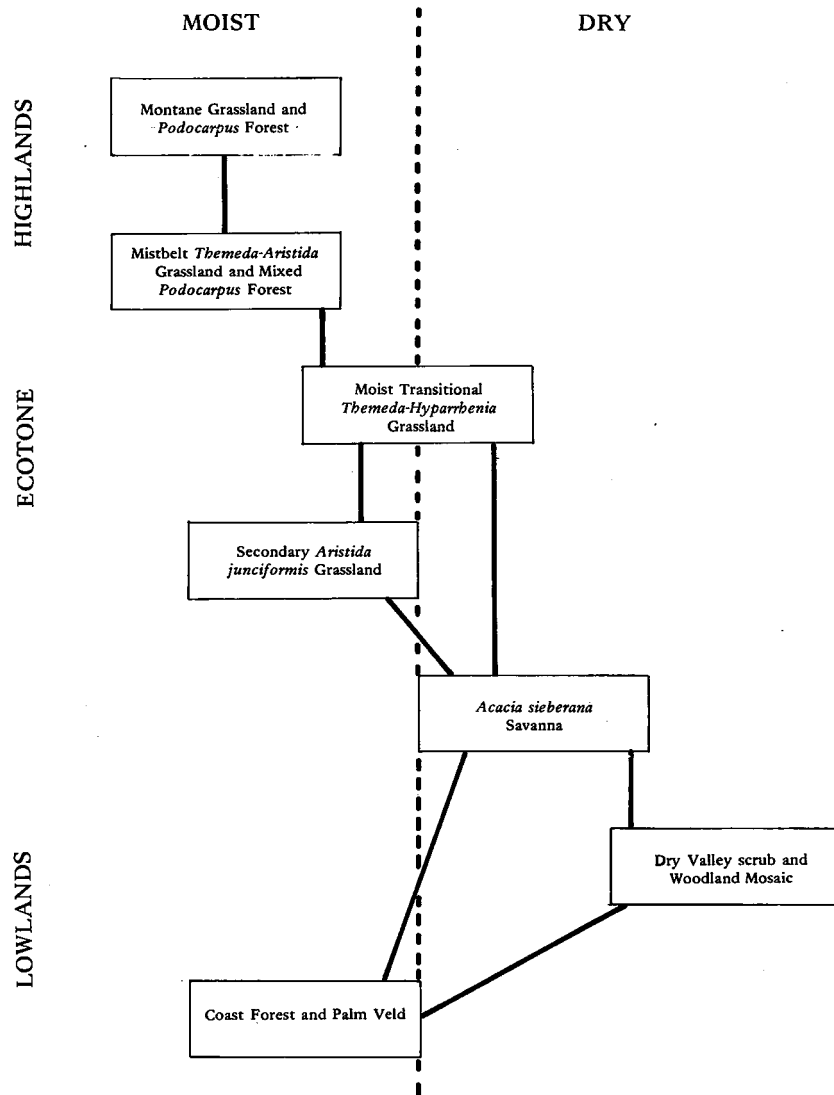


FIG. 22: A greatly simplified diagrammatic representation of the vegetational continuum in the Three Rivers Region.

8.3 A SUMMARY OF THE VARIOUS REGIONAL CLASSIFICATIONS

Table 5 gives a summary of the various recent regional classifications delimited by altitude.

ALT. IN FT	PENTZ 1945	ACOCKS 1953	EDWARDS 1967	MOLL 1967	ALT. IN M.
5000	Highland Sourveld and <i>Podocarpus</i> Forest	Highland Sourveld and <i>Podocarpus</i> Forest	Mountain <i>Themeda</i> - <i>Trachypogon</i> Grassland and Mountain <i>Podocarpus</i> Forest	Highland Grassland and Montane <i>Podocarpus</i> Forest	1524
4000	Tall Grassland of <i>Hyparrhenia</i> and <i>Acacia</i>	Ngongoni Veld of the Mistbelt	Secondary grassland and Mistbelt Mixed <i>Podocarpus</i> Forest	Mistbelt <i>Themeda</i> - <i>Aristida</i> Grassland and Mixed <i>Podocarpus</i> Forest	1219
3000	Temperate Forest				
2000	Dry Thornveld or Bushveld	Ngongoni Veld	Semi-coast Forest, Bush - clumps and Secondary <i>Aristida</i> Grassland		914
1000	Coastal Evergreen Bush	Coastal Forest and Thornveld	Coast Lowlands Forest and Thorn Scrub		610
					305

Additional labels within the table cells:

- Open Bush (between 3000 and 2000 ft)
- Southern Tall Grassland (between 4000 and 3000 ft)
- Valley Bushveld (between 3000 and 2000 ft)
- Valley Vegetation (between 2000 and 1000 ft)
- Dry Valley Scrub and Woodland Mosaic (between 2000 and 1000 ft)
- Coast Forest and Palm Veld (between 1000 ft and 305 m)
- Moist Transitional *Themeda* - *Hyparrhenia* Grassland (between 3000 and 2000 ft)
- Secondary *Aristida juncea* - *Aristida juncea* Grassland (between 2000 and 1000 ft)
- Acacia *robusta* Savanna (between 2000 and 1000 ft)

TABLE 5 A SUMMARY OF THE MORE RECENT DETAILED REGIONAL CLASSIFICATION OF THE PRINCIPLE VEGETATION TYPES, DELIMITED BY ALTITUDE.

PART III

Practical Implications and Recommendations

CHAPTER 9	Practical Implications and Recommendations	<i>page</i>	89
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Practical Implications and Recommendations

The present survey is the second plant ecological investigation which has been sponsored jointly by the Botanical Research Institute and the Natal Town and Regional Planning Commission. These surveys are of practical importance because they outline the interactions between the plants and their environment; basically topography, soil, climate and history of utilization. Since the vegetation indicates the biological production-potential of the land, much useful information for land-use criteria can be gained from these plant ecological studies. In this way plant ecological studies can play an important rôle in planning for future development. However, at the scale at which the present survey was conducted only broad guidelines can be given for the Region; the planning of specific local areas requires more detailed plant ecological studies.

It is the task of the planner to co-ordinate the data available in compiling the final plan, the purpose of this report and this chapter in particular is to provide the planners with some of the raw material which will help them to determine the optimum land capability ratings in the Region.

The best approach to the classification of land potential is by the recognition of ecological land-units where topography, soils and climate are related to the basic vegetation types (Pratt, Greenway and Gwynne, 1966). In the Three Rivers Region comprehensive soil and climate data are not available, thus the recommendations for future land-use must be based on the vegetation and topography alone. These parameters give an adequate basis for planning as the plants are the best indicators of the total environment.

The seven vegetation types recognized and mapped in this report are considered to be ecological entities, though it is recognised that within each type a wide range of variation occurs; the most important deviations have been covered in the text. Therefore, a careful study of the report, and the area to be planned, is necessary to obtain maximum use of the plant ecological considerations.

To assist the planners in using this report a generalized land capability map has been compiled (Fig. 23). This map, used in conjunction with the vegetation map, should give an adequate base-line from which the planner can work.

In compiling the vegetation map and the plant ecological report, I had

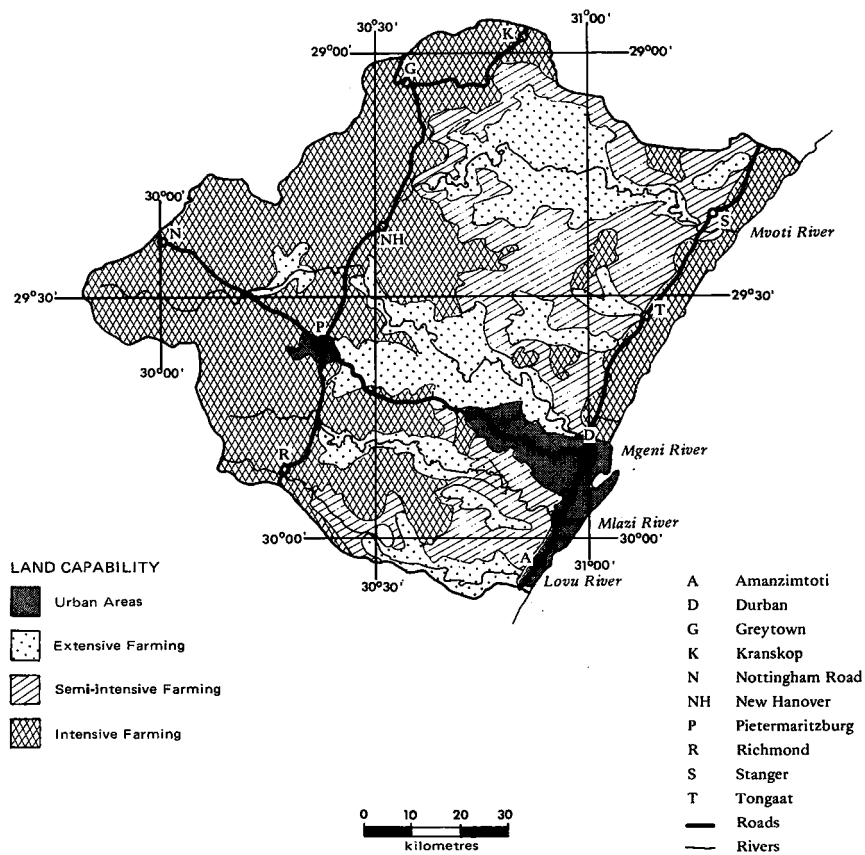


FIG. 23: General land capability map of the Three Rivers Region.

to cover large portions of the Region. While doing this I had ample opportunity to study the implications of various factors affecting the ecology of the Region. With this in mind I feel that my recommendations can be usefully divided into two categories:

9.1 GENERAL RECOMMENDATIONS

9.1.1. Soil and Water conservation

The existing conservation status of these basic resources is low and the situation is deteriorating. Existing legislation, if properly implemented, is adequate to improve the situation.

The areas most severely eroded are the Bantu areas and poorly managed White farm lands. The Vegetation Types particularly susceptible to erosion are the Secondary *Aristida junciformis* Grassland, the Dry Valley Scrub and Bushland Mosaic, the *Acacia sieberana* Wooded Grassland and the Moist Transitional *Themeda-Hyparrhenia* Grassland.

9.1.2. **Pollution**

Air and water pollution are part of modern life. Again existing legislation is adequate to cope with the menace if strictly implemented, but tardiness to prosecute offenders seems to indicate lack of realization of the seriousness of the situation.

All major rivers are polluted to some degree, particularly the Mgeni which flows through the most densely urbanized and industrialized part of the Region. Air pollution is particularly bad in Pietermaritzburg and Durban where cold air drainage intensifies the problem on clear, calm winter nights. As a general recommendation residential areas should be above the temperature inversion.

9.1.3 **Nature Conservation**

By this I mean the management of areas to conserve the indigenous fauna and flora. I include such items as Green Belts, Recreation Areas and Nature Reserves under this heading.

In the Region some provision has been made to provide "lungs" but this needs to be considered in the overall plan to ensure that adequate space is allocated for this use.

- (a) GREEN BELTS should be provided round all the major cities and towns. Pietermaritzburg has plans for a belt to the north, west and south, but not to the east. Durban has no such plan and as a consequence is badly off for open spaces. Provision for Green Belts should be part of all Town Plans; to provide the "lungs" and scenic relief from suburbia.
- (b) RECREATION AREAS have been provided for at all the major dams and along the coast. In this respect the Region is fairly well supplied with facilities. However, this is to be expected as Recreation Areas earn revenue, so can easily be justified in this modern world.
- (c) NATURE RESERVES are not adequate in the Region. Representative areas of each of the major Vegetation Types should be conserved for their educational, scientific and recreational value. At present none of the Vegetation Types are conserved in this manner; except by private land-owners.

9.1.4. **Agricultural Research**

Ideally there should be a Research Station in each Vegetation Type. Only the Coast Forest and Phoenix Bush Clump is adequately covered, by the Sugar Research Institute at Mt. Edgecombe.

9.1.5. **Non-indigenous Invasive Plants**

These only become a serious problem when the natural balances within the Vegetation Type have been upset. In most cases the plants can be easily controlled, but the obvious long term solution is one of "biological control".

9.2 SPECIFIC RECOMMENDATIONS

9.2.1. Coast Forest and Palm Veld

Ninety-five per cent of the indigenous vegetation has been cleared for cultivation, and most of the remaining indigenous vegetation is disturbed. It is essential that the few remaining areas of indigenous vegetation such as Hlogwene Forest (Moll and Cooper, 1966), Hwaan Forest (Moll, 1968a) and an area of Palm Veld near Groutville, be conserved.

With the rapid urbanisation in this area there is increased pressure on the known fragile environment of the coast dune system. Urban sprawl and uncontrolled trampling of the vegetation in this narrow fringe could have disastrous repercussions and already the problem of drift sand is known to be serious in the Zinkwazi, Durban and Amanzimtoti areas. The only long term solution to the problem is the re-establishment of the indigenous pioneers and the controlled access to the beach areas to minimize trampling.

Further inland the arable land has valuable food producing potential and land zoned for agricultural use must be maintained as such.

9.2.2. Dry Valley Scrub and Bushland Mosaic

Most of the vegetation of this area is secondary and badly downgraded. Soil erosion is most severe in this vegetation type as the soils are generally shallow, the terrain is steep and the land is heavily populated by the Bantu. Sheet and gully erosion is particularly severe below Nagle Dam on the Mgeni River above Mapumulo on the Mvoti River, and above Shongweni Dam on the Mlazi River. The problem of silt deposition in the reservoirs which supply Durban has been recognised and Nagle and Shongweni dams have been designed accordingly. Nevertheless, this precaution has not entirely eliminated massive silt deposition at Shongweni (cf. 1937 and 1965 aerial photographs, and Morris, 1967).

Pressing conservation problems are the re-establishment of good vegetation cover to halt soil erosion, the control of domestic stock populations, the improvement of farming methods, and the re-establishment and subsequent stabilization of the river banks.

Certain areas of natural vegetation should be protected by the state and managed in such a way as to maintain the primary vegetation cover. Such areas would be of scientific, educational and recreational value, and suitable sites are an area of *Combretum molle* Woodland and associated stands of *Encephalartos natalensis* near Thornville (Moll and Morris, 1968), an area of *Faurea saligna* Woodland near Baynes Drift, an area of Mixed Deciduous Communities at Shongweni Dam (Morris, 1967), an area of *Acacia* Savanna at Ashburton, and an area of Mixed Succulent Communities and *Spirostachys africana* Woodland in the lower Mgeni River valley.

The dry Valley Scrub and Woodland Mosaic is mainly suitable for extensive agriculture, except in restricted areas. The climate is the hottest and driest in the Region, but constitutes no bar to human habitation. It seems logical to channel future industrial development to this area, where land is agriculturally poor and water for industry is readily obtainable. Air pollution, if not strictly controlled, will be severe, owing to the phenomenon of cold air drainage.

Numerous dam sites exist in the valleys and water at the lower levels could be used industrially. Water at the upper levels could be used for human consumption and for agriculture. The Mgeni River valley is suited for such development owing to its proximity to both Durban and Pietermaritzburg, and main lines of communication. Housing estates for industrial areas could be situated on the crests of the ridges where it is cooler. At the moment the reverse is true, with factory development on the ridges at Cato Ridge and Hammarsdale.

Because of the generally poor agricultural potential, and the success of game farming in similar areas to the north, this form of land use should be encouraged.

9.2.3. *Acacia sieberana* Wooded Grassland

Thirty to forty per cent of the vegetation has been cleared and the remainder is almost entirely secondary. The area is not badly eroded, though gully and sheet erosion are relatively widespread in the lower faciation. No large rivers rise here but there are fairly numerous vleis and patches of Kloof Forest.

Where the land is arable it is suited for sugar and maize farming, pasture development, and where water is available for irrigation vegetables will grow. Where soils are fairly shallow or the terrain relatively steep, plantations of *Pinus* spp., *Saligna* spp. and *Acacia mearnsii* grow successfully. Water is a limiting factor for agriculture, and the valleys and depressions are subject to frost.

No areas of prime vegetation suitable for conservation remain but areas in both the upper and lower faciation should be preserved and reclaimed. Possibly the best site would be near Thornville in the upper faciation and in the lower faciation in the Tongati or Mdloti River valleys.

9.2.4. Secondary *Aristida junciformis* Grassland

Sixty to seventy per cent of the vegetation has been cleared for cultivation and most of the remainder is secondary. Much of the land is flat, and where the soils are deep crops such as sugar and maize may be grown, and where there is water available for irrigation vegetables will also grow. Where soils are shallow or the terrain too steep for cultivation, plantations of *Pinus* spp., *Saligna* spp. and *Acacia mearnsii* should be established. Already there are many plantations in the area, but recently there has been a tendency to clear these and plant sugarcane.

There are three areas suitable for conservation, Table Mountain (Killick, 1968), the Groenberg near Inanda and part of the ridge between Mapumulo and Kranskop. All three contain grassland and Kloof Forest.

9.2.5. Moist Transitional *Themeda-Hyparrhenia* Grassland

As the name implies this vegetation type is transitional, occupying the ecotone between the drier lowland vegetation and the moister highland vegetation. Most of the vegetation has been cleared for cultivation or it has been interfered with in some way by man. Thus, where the indigenous vegetation occurs it is usually mixed *Themeda-Hyparrhenia* Grassland.

Soil erosion in this vegetation type is not common, though local areas can

be eroded. Some of the area is arable, though the presence of dolerite dykes and sills limits the size of the fields. Where there is sufficient arable land it is suitable for maize and pasture production. Where the soils are rocky or fairly shallow the land is suitable for timber. Trees should not be grown in any of the vleis, and the natural riverine vegetation should be protected.

There are a fair number of large vleis in the Moist Transitional Themeda-Hyparrhenia Grassland, the Mvoti Vlei being the best example. The vleis should be carefully planned to ensure a perennial water supply to the rivers such as the Mvoti, Mlazi and Lovu.

There are no suitable witness areas, but two sites should be conserved, one in the north adjacent to the Mvoti Vlei which is already protected, and one in the south, possibly east of Richmond.

9.2.6. Mistbelt Themeda-Aristida Grassland and Mixed Podocarpus Forest

Twenty to thirty per cent of the vegetation has been cleared for cultivation and much of the remainder is secondary. Most of the land is unsuitable for cultivation, either because of dolerite dykes and sills, or because it is too steep. Rainfall is high and fog is frequent in summer. Consequently many streams and rivers rise in the area often flowing through, and even rising in Mistbelt Podocarpus Forest patches. Vleis are numerous, but small.

Some of the area is suitable for cultivation, and maize and potatoes do well. Trees grow well in the area, but the precautions mentioned previously (see Section 9.2.5.), must be observed.

A suitable witness area is the Karkloof Forest including adjacent grassland.

9.2.7. Highland Grassland and Montane Podocarpus Forest

Most of the area is still covered by indigenous vegetation. Only some 20 per cent of the area is arable. The growing season is short – approximately 5 months. In general the area is suited to intensive farming. Recently large vleis have been drained and planted to pasture. These pastures have proved highly productive. This method of land-use is not recommended, unless adequate measures are taken to conserve water below the vleis such as the installation of storage dams.

Suitable witness areas would not be difficult to find, the best area being the Mgeni Vlei with adjacent grassland and forest.

9.3 GENERAL SUMMARY

9.3.1. Soil Conservation

The danger of soil erosion in the region has been indicated and the situation requires immediate remedial attention. Responsible bodies have already recognised the threat of soil erosion, but an overall effort is required to remedy the position. The most serious soil losses occur in Bantu occupied areas (Photos 40 to 43) as comparative silt load figures, from the Mgeni River at Howick and the Msunduzi at Pietermaritzburg, indicate (Chapter 1).

9.3.2. Water Conservation

The region has a good reliable rainfall (Chapter 2) and the larger rivers all maintain a perennial flow of water. However, as a result of the denudation of the vegetation cover by selective-overgrazing, cultivation of steep slopes, the removal of riverine vegetation and the draining of vleis, soil erosion and rain run-off has increased and the rivers are rapidly becoming storm-water drains. One way of averting a water shortage is to build reservoirs, and it has been estimated that the Mgeni River can supply an assured, sustained yield of $1\ 100 \times 10^3 \text{ m}^3$ pd. and the Mvoti $750 \times 10^3 \text{ m}^3$ pd. The best long term approach to water conservation is to ensure that a good vegetation cover is maintained to prevent erosion and rapid run-off, that vleis are conserved, and that riverine communities are re-established and maintained (Photos 37 and 38).

9.3.3. Pollution

Soil, water and air pollution are dangers which are becoming increasingly important and can no longer be neglected (see Moore, 1966). The most conspicuous form of pollution is smog, dense clouds of which can be seen over Durban and Pietermaritzburg, particularly on days following clear, calm winter nights. Measures for control and prevention of all forms of pollution should be introduced and rigidly enforced.

9.3.4. Urbanization

Population increases mean greater demands on the land for food and for housing. Because there is a paucity of highly productive areas, such land should be reserved solely for food production, and new urban development should be confined to land of a low ecological rating.

9.3.5. Nature Reserves

Ideally one area within each vegetation type, which incorporates representatives of each of the major plant communities, should be conserved. These areas should be managed and maintained as biological controls by some responsible body. They would also be of educational, scientific and recreational value.

9.3.6. Agricultural Research Centres

Ideally some form of agricultural research centre should be established in each vegetation type to investigate agricultural potential, even if this takes the form of a co-operative experiment with progressive local farmers. Each centre should include representatives of the major plant communities and soil types, so that local variations within each type can be studied.

9.3.7. Man's influence on the vegetation

The historical background of the region indicates that the vegetation has deteriorated greatly in the last hundred years. The most significant changes have been the clearing of large areas, particularly below 1 372m (4 500ft), for cultivation and for exploitation of the indigenous forests. The natural fire régime has been altered and grasslands have been subjected to continuous selective over-grazing by domestic stock. This has resulted in accelerated soil

erosion, replacement of the best and most palatable grazing grasses by less palatable and nutritious species, a reduction in carrying capacity of grasslands, reduced grass cover and increased encroachment of *Acacia* species. In addition to the encroachment of thorny *Acacia* species, a number of undesirable non-indigenous plants, such as *Eupatorium odoratum*, *Psidium guajava* and *Lantana camara* (Photo 39) along the coast, and *Rubus cuneifolius* (Photo 40) and *Acacia dealbata* between 1 067 and 1 372m (3 500 and 4 500ft) have spread into, and are replacing indigenous species.

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PHOTO 1: The Mhlanga lagoon showing the row of low dunes across the mouth. Note the *Phragmites* reed bed extending into the water.

September 1965

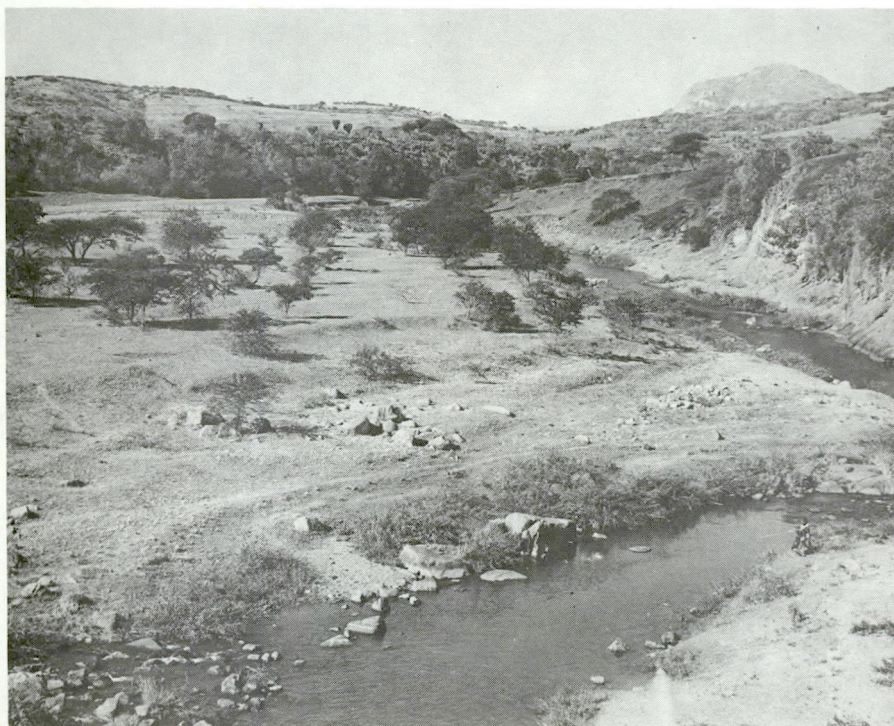


PHOTO 2: The Msunduzi River valley near its confluence with the Mgeni River, showing the alluvial soils of the valley floor.

May 1965



PHOTO 3: Slip scars on a south-facing slope, at approximately 1 524m (5 000ft), which are attributed to frost action.

August 1965



PHOTO 4: A section of Dune Forest illustrating the clipped-hedge effect. Note the very tight, smooth canopy which increases in height further away from the sea.

October 1965

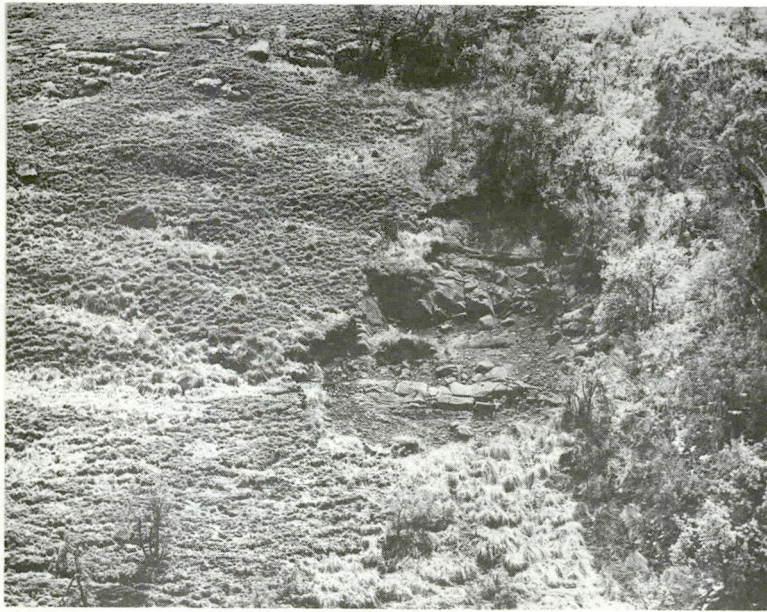


PHOTO 5: The weight of snow on the saturated grass mat caused the small landslide pictured.

October 1965



PHOTO 6: The concentration of cattle on the old termitarium where the grass cover is short, illustrates the phenomenon of selective grazing.

September 1965

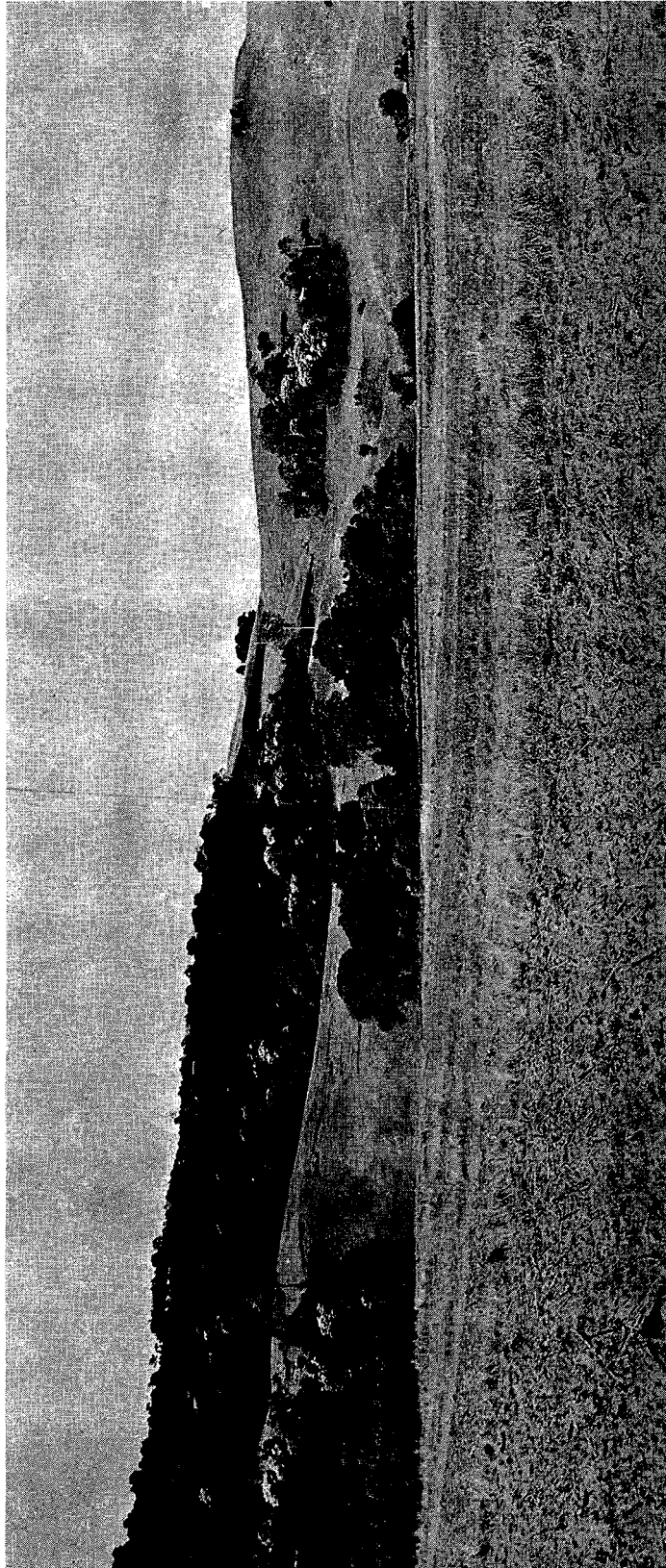


PHOTO 7: Mistbelt Mixed *Podocarpus* Forest near Dargle, showing the sharp margins of the relic patches that once comprised continuous forest.

December 1964



PHOTO 8: Showing the most common dune pioneer, *Scaevola*. This community is being invaded by *Eugenia* and *Mimusops*, centre right.

November 1965



PHOTO 9: A remnant of Coast Forest. The sugarcane in the foreground is growing on land that was once forested.

December 1966



PHOTO 10: The interior of Coast Forest is open. There is no field layer, the ground being littered with dead leaves. The large canopy tree on the left is *Ekebergia*. Most of the subcanopy trees are *Bequaertiodendron*.

September 1966



PHOTO 11: A clump of *Syzygium* growing in a sheltered river valley at the upper boundary of the Dry Valley Scrub and Woodland Mosaic.

July 1966



PHOTO 12: The surrounding Swamp Forest trees have been cleared, giving a clear view of the mass of *Stenochlaena* climbing on the hole of the *Syzygium* pictured.

October 1967



PHOTO 13: A view of the mangrove community at Beachwood. The short trees in the middle distance are *Bruguiera*, and the taller trees behind these are *Avicennia*.

Photo by K.H. Cooper



PHOTO 14: A partly cleared *Avicennia* community at Isipingo. Note the drain in the foreground.
November 1965

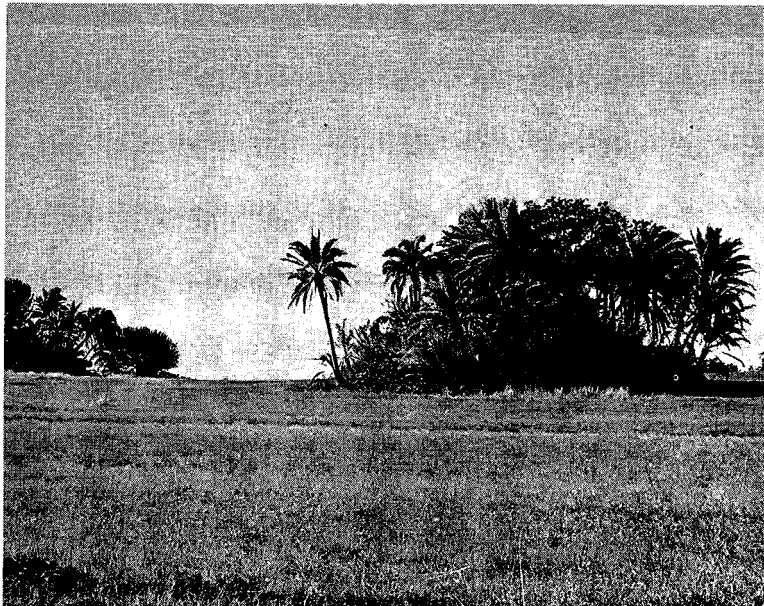


PHOTO 15: Two bush clumps with *Phoenix*, *Euphorbia ingens* and *Ficus capensis*, separated by *Aristida* grassland.
October 1967



PHOTO 16: Showing cleared patches of vegetation for cultivation. The dark tree in the foreground is *Boschia albitrunca*, most of the other trees are *Euphorbia ingens* and *Acacia* spp., with a large *Aloe bainesii* in the left foreground.

October 1966



PHOTO 17: Where the land is more suitable for cultivation large areas have been cleared. In the area pictured the remaining trees are *Cussonia spicata*.

October 1966

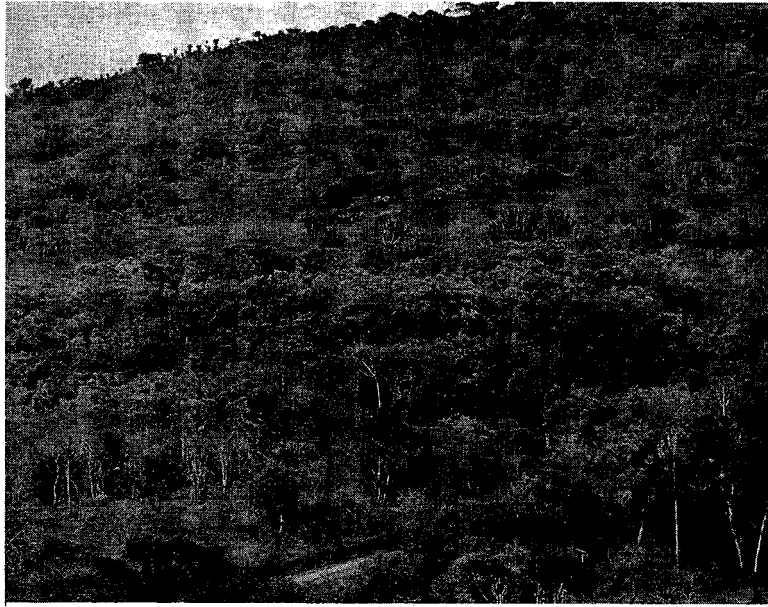


PHOTO 18: Semi-deciduous Scrub covers most of the hillside. In the foreground there is a large, dense patch of *Euphorbia tirucalli*, marking an abandoned cultivation site.

October 1966

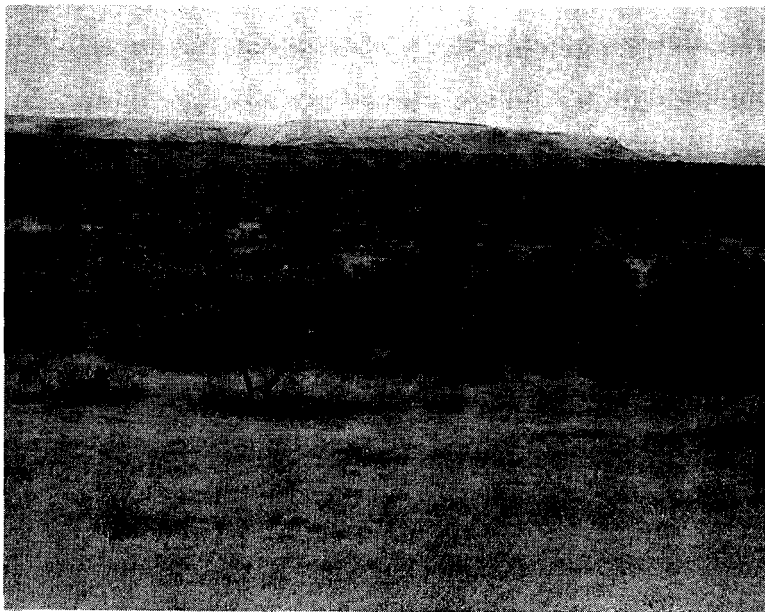


PHOTO 19: *Acacia* Savanna and Scrub in the shallow Mlazi River valley near Eston. Note the surrounding hills which are grass-covered, and that the herbaceous vegetation in the foreground is short and coarse.

December 1965



PHOTO 20: Secondary *Acacia* Savanna with mixed *Eragrostis-Sporobolus* grassland. Note the scrub encroachment.

September 1965



PHOTO 21: A dense stand of *Acacia nilotica* in a heavily grazed area. Note the extremely poor ground cover.

September 1965



PHOTO 22: A mixed *Combretum molle* and *Aloe candelabrum* Community. Note the surface boundaries and the *Aristida* grassland understorey.

January 1966

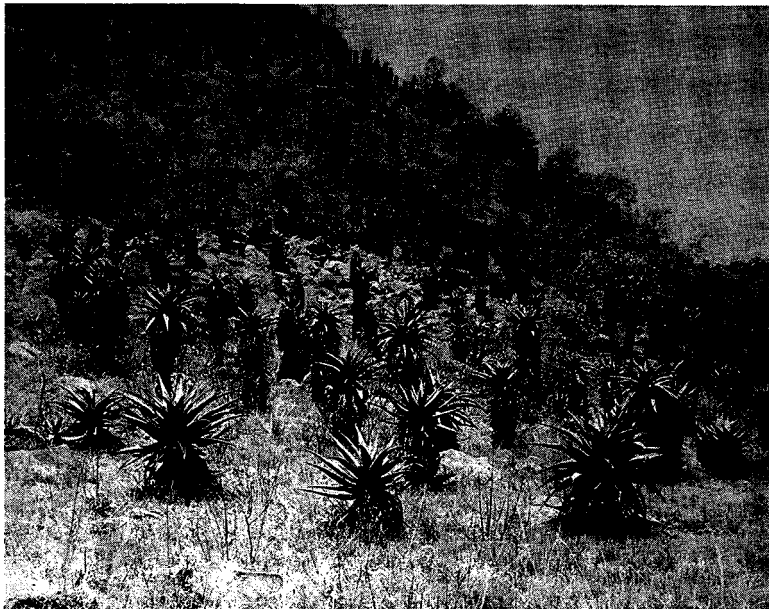


PHOTO 23: *Aloe candelabrum* Community. Note the associated woody plants, particularly the large-leaved *Erythrina latissima* right.

October 1965



PHOTO 24: A scrub forest community on a very steep south-east-facing slope.

August 1966

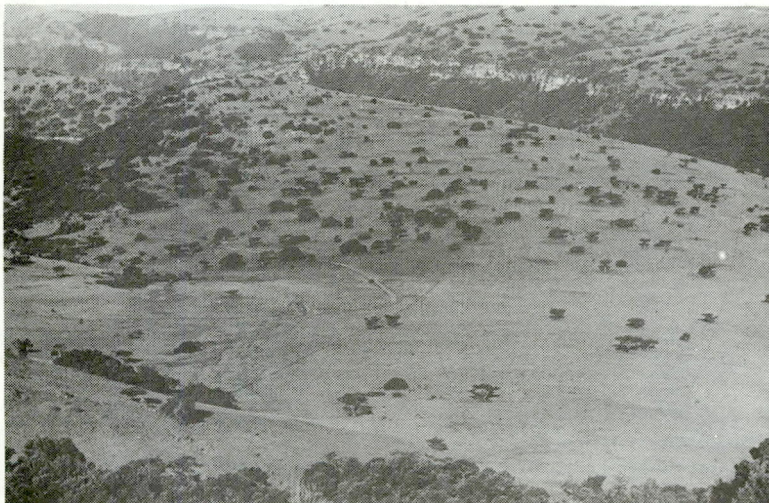


PHOTO 25: *Acacia sieberana* Savanna occurs on the flat terrain, sometimes showing a tendency to form bush clumps, left middle distance. Note the forested areas below the Table Mountain Sandstone cliffs, on the steep south-facing slopes.

February 1966

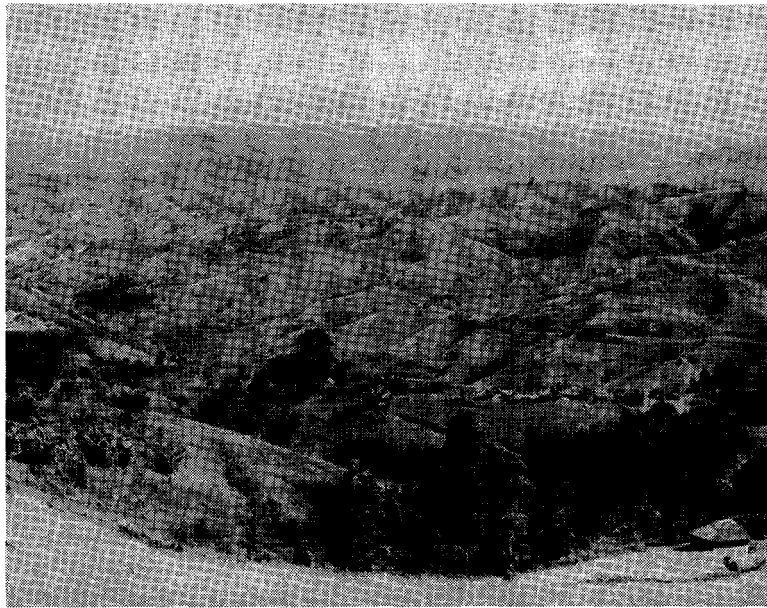


PHOTO 26: A view across the Mdhloti River valley giving an appreciation of the amount of disturbance. Note the numerous, small cultivated areas and the relic forest patches, right middle distance.

September 1965

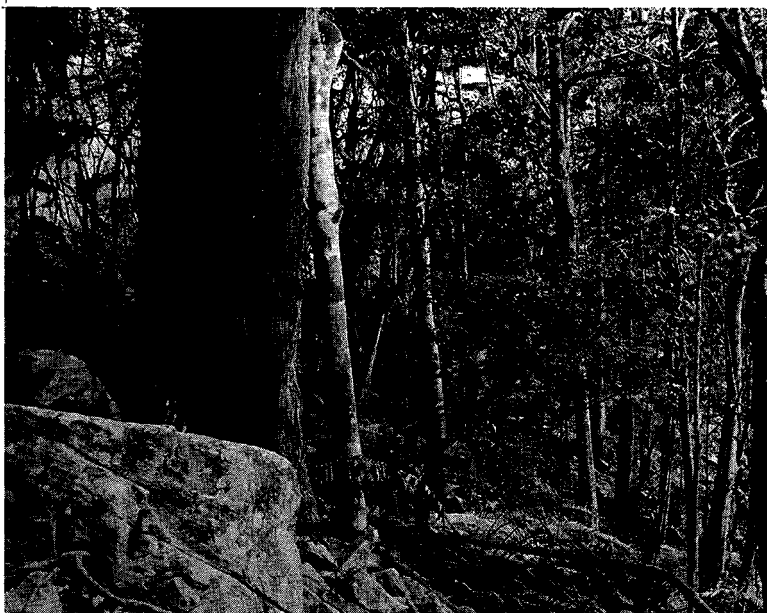


PHOTO 27: A view inside climax forest. The large canopy tree, left, is *Podocarpus latifolius*. Most of the remaining trees are *Drypetes gerrardii*. The shrub in the foreground is *Eucephalartos villosus*. Note the generally sparse field layer and the number of exposed boulders.

August 1966

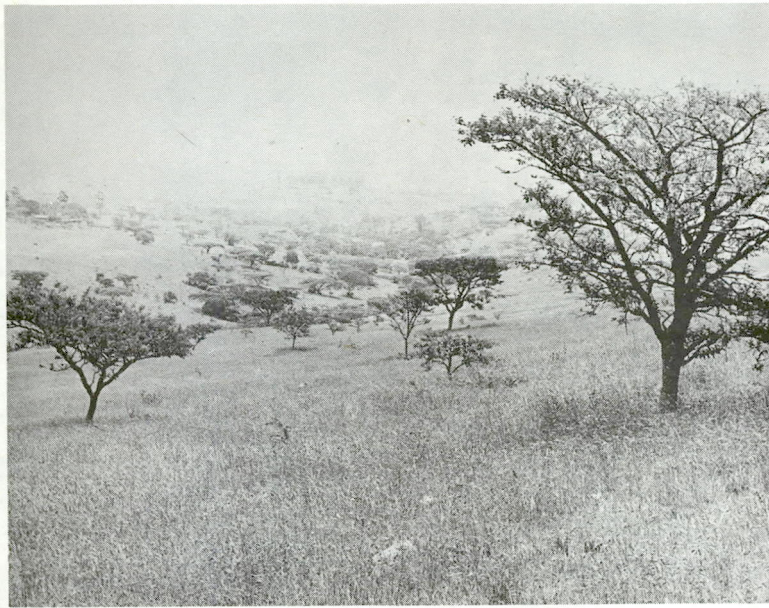


PHOTO 28: *Acacia sieberana* Wooded Grassland with *Themeda* grassland understorey.

December 1966



PHOTO 29: The spring aspect forb pictured in *Acacia sieberana* Wooded Grassland is *Gazania linearis*.

September 1965

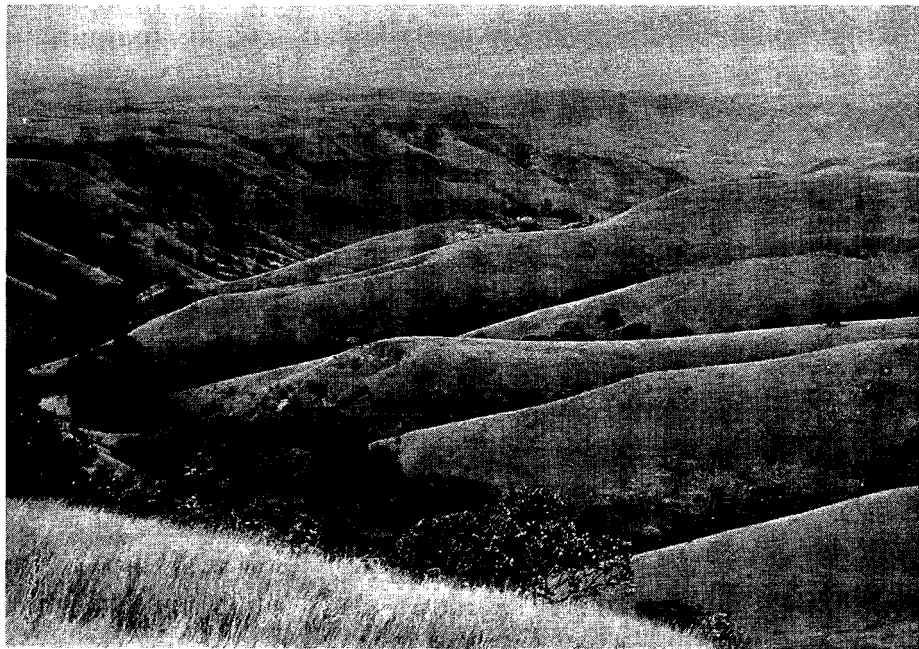


PHOTO 30: Secondary *Aristida* Grassland is the climax community on the relatively flat land above the steep river valleys, left middle distance and background. Note the patches of forest in the steep valleys along the drainage lines.

September 1965



PHOTO 31: The *Aristida* grassland in the foreground also occurs on the many buttes pictured in the middle distance and background. The forb in the foreground is *Watsonia densiflora*.

February 1966



PHOTO 32: A view inside climax forest where the dark boled *Protorbus* is the common canopy tree. The subcanopy comprises mainly *Tricalysia capensis*. Note the poor field layer and heavy leaf litter.

August 1966



PHOTO 33: An example of frequent burning of the forest margin which has resulted in considerable destruction to the forest.

July 1965



PHOTO 34: A view inside the forest showing some of the tall straight boles and the good field layer.
August 1964



PHOTO 35: General view inside Montane *Podocarpus* Forest. Dominant trees shown are *Podocarpus latifolius*. Note the grass understorey.
May 1964

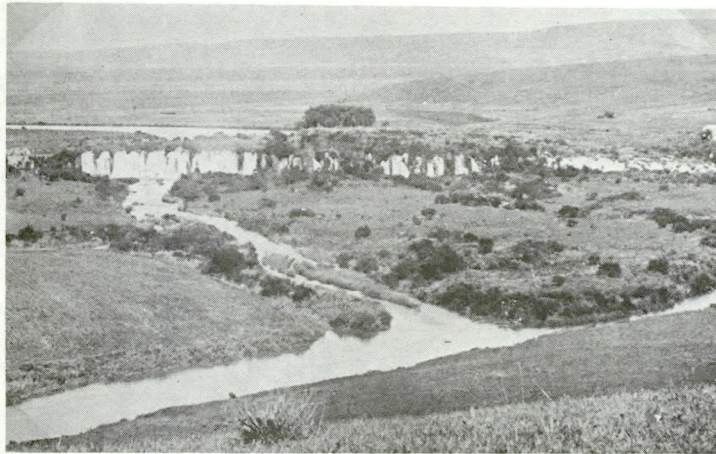


PHOTO 36: Albert falls: (a) by Bews in 1917; (b) by Comins in 1953; and (c) by Moll 1965. Note the increase of woody plant communities and the recent appearance of *Acacia sieberana*.

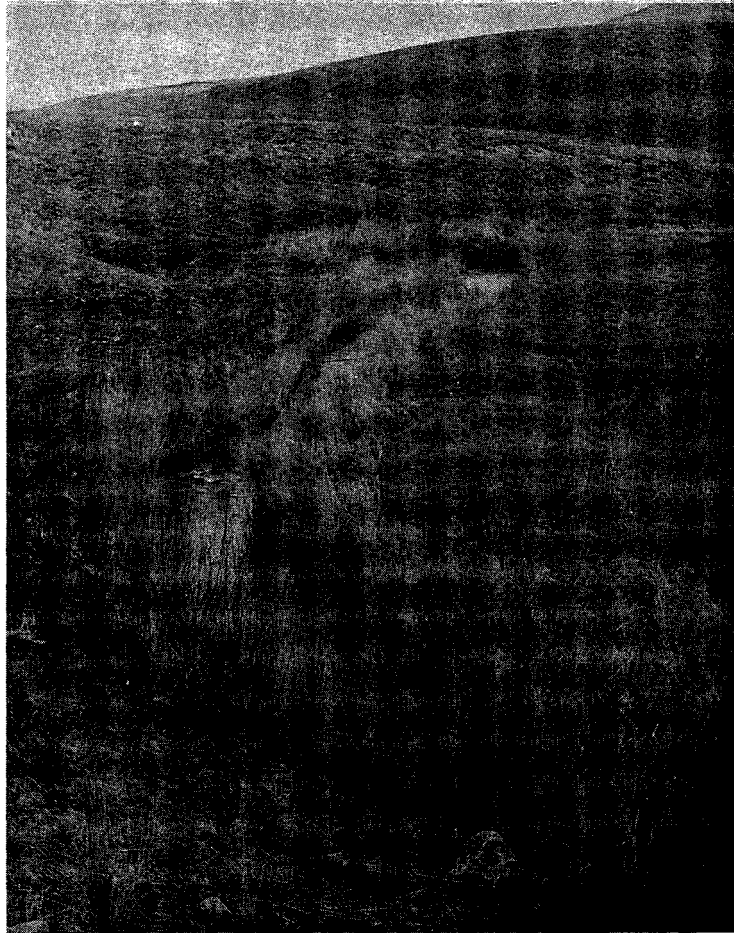


PHOTO 37: Indiscriminate burning will eventually destroy the remaining *Phragmites* fringe to this stream in the Lions River district, allowing rapid erosion of the now stable stream banks.

September 1964



PHOTO 38: A good example of a stable river bank is seen on the Mgeni River just above Howick Falls, where the *Combretum erythrophyllum* pictured forms a fringing woodland.

October 1964

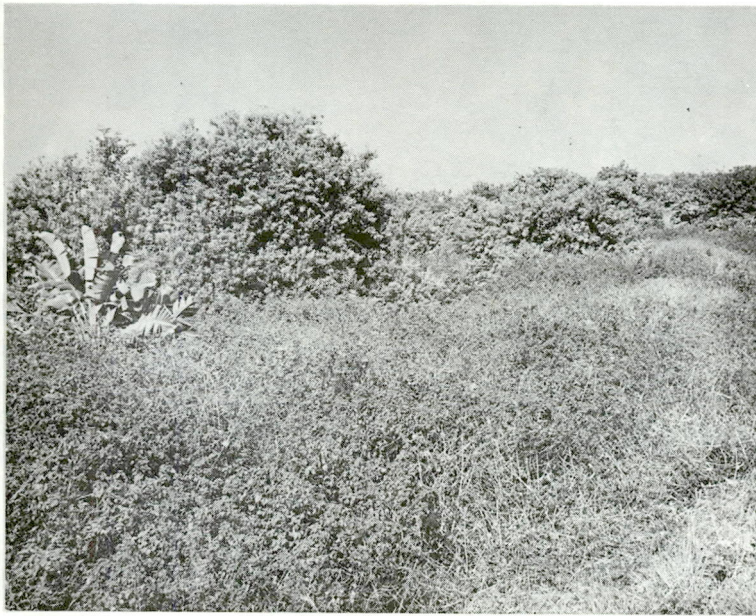


PHOTO 39: *Lantana camara* scrub being invaded by taller growing *Strelitzia nicolai* (left) and *Brachylaena discolor* (middle distance). A typical community resulting from severe disturbance, near Amanzimtoti.

July 1968



PHOTO 40: *Rubus cuneifolius* scrub near Hilton Road. Note the dense stand which was up to 2,5m (8 ft) tall.

November 1965

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