AN ECOLOGICAL/ENVIRONMENTAL APPROACH TO THE PLANNING OF THE KNYSNA LAKES REGION.

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A Thesis submitted in partial fulfilment of the requirements for the Degree of Master of Urban and Regional Planning.

University of Cape Town

May, 1972

A C K N O W L E D G E M E N T S

The author wishes to extend his sincere and grateful thanks to the following:

Mr. P. Betts, Mr. and Mrs. Jack Meaker, Mr. J.M. Jooris, Dr. Nellie Downs all of Swartvlei.
Messrs. Tom Heineken and Neil van Wyk, of the Dept. of Nature Conservation stationed at Groenvlei and Rondevlei respectively.
Mr. C.P. van der Merwe, Assegaaibos, Stellenbosch.
Mr. F. van Wyk, Director of Inland Fisheries, Jonkershoek, Stellenbosch.
Mr. Sayers, Curator of the George Museum.
Mr. Leppan, of the farm Mandalay, Hoekwil.
Mr. Victor Smith for the aerial survey of the Region.
Capt. and Mrs. Doug. Meaker of Pine Lake Marina for their kind hospitality in accommodating me during the course of my investigations.
Mr. G. von dem Bussche, Indigenous Forestry Department, Saasveld.
Mr. B. Metelerkamp, Forestry Department, Knysna.
Mr. Hjalmar Thesen, Naturalist.
Mr. A. Genade, Fisheries Development Corporation, Knysna.
Mr. Kobus Steyn, Dept. of Geography, University of Stellenbosch.
Prof. J.F.V. Phillips for his inspiring lectures and stimulating discussion in the field of ecology.
Prof. G. v.R. Marais, Dept. of Civil Engineering, University of Cape Town.
Mr. Mike Hart for advice on computer programming for landscape evaluation.
Mr. Ian MacDonald who conducted the Step-Wise Regression computer programming for landscape evaluation.
Mr. George Donnelly for photo-reduction of the base map.
Mrs. Nola Grendon for her splendid artistry.
Miss Pauline Houniet who unselfishly devoted many hours of her time in compiling the base map and gave help in the fields of mapping and field work.
Messrs. Jose Cotta and Dave Dewar for their stimulating help and guidance throughout the project.
Mrs. Di Dickinson and Mrs. E.J. Robson for typing.

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THE GEORGE - KNYSNA LAKES REGION

1:250,000

0 5 10 15 Miles

C H A P T E R I

INTRODUCTION

" - - - - - - - - - - -
But the comfort is
In the covenant
We may get control
If not of the whole
Of at least some part
Where not too immense,
So by craft or art
We can give the part
Wholeness in a sense
- - - - - - - - - - - "

Robert Frost

1.1 The Problem

The George-Knysna Lakes Region presents a complex and sensitive situation from which to assess the potentialities and restrictive conditions that nature offers.

Man in a totally uninformed way has imposed himself on the Region. As a result detrimental effects have crept in. He has furthermore not been sensitive to the natural processes which govern his life and well-being in every respect.

Despite nature's earlier warnings, the pollution and destruction of the natural environment has gone on intensively and extensively without awakening sufficient stimulus within him to consider the importance of establishing healthy working relationships therewith.

It is what a thing wants to be that is important - man must consider all the implications of his actions relative to these natural processes rather than to manifest his misconceived ideas to the landscape, which prove incompatible with the environment and become major problems which require much more time and effort to rectify if it is ever able to be achieved.

The consideration therefore of ecological and environmental constraints in the planning process are the keystones of land utilization, conservation and management of the natural resource base - a process of human cooperation and biological partnership.

1.2 THE REGION AND WHY IT WAS CHOSEN

The Region is situated within the divisions of George and Knysna along the Southern Cape Coast and occupies a section of the coast commonly known as the Garden Route. It lies some 480 km from Cape Town, 320 km from Port Elizabeth and 1200 km from Johannesburg.

It comprises a unique system of lakes, lagoons, rivers and shoreline found nowhere else in South Africa. This Region is a natural asset and is a Mecca of the tourist industry. These factors stress the importance of optimising future planning and management of all its natural resources for posterity.

The Region (Map 1) forms an isolated unit by virtue of the fact that it is almost entirely surrounded by forest reserves. It was determined in this respect to incorporate all private land within this study. It engrosses in the main complete river systems which is important when undertaking an holistic or ecological approach. The river systems which are not entirely located within the region are afforded optimum control by virtue of their location within forest reserves.

The western extremity of the Region adjoins private land and in this respect adequate land was incorporated within the Region to provide a comprehendable picture of the Kaaimans River system.

One of the major significances of the Region is that it forms a complex recreational unit.

The final criteria was the necessity to encompass the spatial extent of all natural resource base elements as these are considerably inter-related in this Region. Therefore basic provision has been made for an ecological/environmental approach to the planning of the Region.

1.3 PURPOSE OF THE STUDY

The purpose of this study is to analyse the Region in terms of ecological and environmental criteria, to investigate these inherent problems, and to derive some measure of control and optimum natural resource management of its existing and potential suitabilities in terms of conservation, forestry and agriculture,

and recreation.

These four criteria comprise the natural resource base of the Region and will be assessed individually and in an ecological or holistic manner thereby deriving an all-encompassing concept of the whole system.

Landscape aesthetics is an important aspect in such a study and presents a constraint on the suitability and the potentiality of all elements and activities within the natural resource base. Emphasis has furthermore been placed on controlling the region as a recreational unit.

1.4 METHODOLOGY

In the analysis the Region has been divided up on the basis of existing land use i.e. natural environment areas, forestry and agriculture, and recreation. These are discussed in terms of how they operate and the effect of man operating on them.

On the basis of this analysis the objective is to derive criteria for assessing the potential of each component land use within the Region and then to formulate a composite suitability plan. Such methods have been extensively applied by McCarg and others (1). A composite suitability map for all four major components is derived consisting of conservation, recreation, agriculture and forestry suitabilities.

The Region operates as a system through distinct interrelated ecosystems.* In the analysis of natural environment areas this was conducted at a fairly intimate scale related to water resources. This was considered to be the most practical breakdown owing to the nature of the problems encountered within them. This furthermore isolated the coastal fynbos areas, which display particular characteristics and which moreover suffer from a lack of water.

Indigenous forestry was related in part to factors which affect other forestry and as such for the purpose of convenience, was dealt with in that section.

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* An ecosystem is a natural unit in which vegetation animals and environment above and below the ground are inter-coordinated. It is an interplay of environment and life and may engross large or minute areas and many varied communities of organisms. (A more detailed definition is given in Section 1.5)

Although urbanization is apparent in the Region, recreation and residential components comprise the major forms of development and activities. Furthermore, criteria for determining urbanization suitability are different to those for purely residential and recreational suitability. As such urbanization has not been considered in this study.

Economic considerations relating to the need and desirability of various forms of recreational development (which includes residential or holiday township development) are discussed in Appendix I. This is related to the type of accommodation which should be provided in the Region and the degree to which residential subdivision should be permitted.

Finally an attempt has been made to quantify landscape evaluation by means of people's preferences to landscapes. The methods and results that were observed are discussed in Appendix 2. Since this method of landscape evaluation would be applied to all sections, it has been included as a separate section and has not been included in the matrix of composite suitabilities.

Where assumptions have been made these have been related in the text. These were necessary in order to arrive at an assessment of the potentiality and suitability of each major component within the Region. As such this plan should not be regarded as a rigid synthesis but one which presents an approximation of all factors necessarily incorporated to form a concept of the whole.

1.5 DEFINITIONS

It is necessary that various terms used in the text be defined in order to enlighten those readers who are not familiar with them.

Anaerobic	In the absence of air
Association	Plant: A climax community of plants with two or more dominant species
Bioclimate	Used here in the sense of a complex of climatic conditions controlling the vegetation within a natural region. It is constituted by a certain interplay of climatic factors and biotic phenomena, so integrated as to permit the development of natural vegetation to a stage where this is in dynamic equilibrium with the climate. Examples from the terrain are the forest bioclimate and the wooded savanna and scrub bioclimate.
Biotic Community	An association of plants and animals of no specific successional or other ecological status; used here as broadly synonymous with the term ecosystem

↳ BUT THESE TERMS ARE NOT SYNONYMOUS AT ALL!

Climax	The final kinds of biotic communities (in practice, today, mainly vegetation communities) which develop under the existing environmental conditions
Coaction	The interaction among organisms in a community through competition, co-operation and symbiosis (or the living together of organisms of different kinds); (Vide action, reaction.)
Community	A convenient term referring to any kind of gathering together, aggregation or association of plants and animals (or plants or animals) ecologically with no successional or other ecological status or constitution implied
Ecological Approach	Generally synonymous with the synoptic or the holistic approach, more specifically to examine all the possible factors, features and interrelations of phenomena in a unit area, a project, or a problem
Ecology	Study of the interrelations of organisms one to the other and to the environment; all forms of life from microbe to man in any kind of environment are involved
Edaphic	Referring to the soil - edaphic features or features of the soil
Environment	A general concept covering the sum total of all physical characteristics to which any form of life may be subjected and by which it might be influenced; synonymous with locality factors, habitat, site as understood by silviculturists
Exotic, Exotics	Introduced, not native; refers to plants and animals from other continents, states, or natural regions of a country: in contrast with indigenous
Fen	A low marshy or flooded tract of land with extensive continuous open areas of water
Fen Carr	A fen which is in a process of succession furnishing a foundation for growth of higher plants. (viz. Carr Woodland, The Fens, Scotland).
Fynbos	Dense, mainly evergreen, tall, small-leaved shrubby growth, characteristic of the Cape Peninsula and some high montane areas in East and North-east Africa; confined to higher elevations in Natal (c.f. vegetation known in Europe as Macchia or Maquis, and in California as Chaparral.)
Habitat	The sum of the environmental factors and conditions of a site occupied by an organism or a biotic community; synonymous with environment, but used in a less general sense
Holistic Approach	Synonymous with synoptic or ecological approach, to take the whole into consideration when studying a proposition; derived from Smuts' concept of holism
Indigenous	Used to define plants which are native to a country, region or locality, by contrast with those which are exotic or foreign or introduced
Primary Succession	"Natural" succession, that is not caused by the direct or indirect agency of man; a succession from primary rock, sand, water. (Vide secondary succession.)

Secondary Succession	Succession following the disturbance or destruction of a part or the whole of the vegetation in an area, usually caused by human agencies - such as felling trees or shrubs, burning, cultivation, browsing and grazing; much of the vegetation in Natal is secondary today
Succession	The process whereby successive kinds of plants or biotic community replace one the other; progressive changes in vegetation and associated animal life which may culminate in the climax
Symbiotic	Mutually beneficial partnership between organisms of different kinds especially such an association where one lives within the other

1.6 REFERENCES

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C H A P T E R 2

PHYSICAL BACKGROUND

2.1 Physiography

The complex physiography of the Region is presented on Map 2, with cross-sections on Maps 3 and 4, and Slope Analysis on Map 5.

The heavily dissected inland plateau is drained directly to the sea through the Noetzie, Kaaimans, Touws and Goukamma Rivers, and via two lake systems, and the Knysna River and Lagoon. The Eilandvlei-Rondevlei system drains via the meandering Serpentine and its floodplain to meet the Touws River approximately three miles upstream from its mouth. The Ruigtevlei-Karataravlei-Swartvlei system drains via Swartvlei Lagoon.

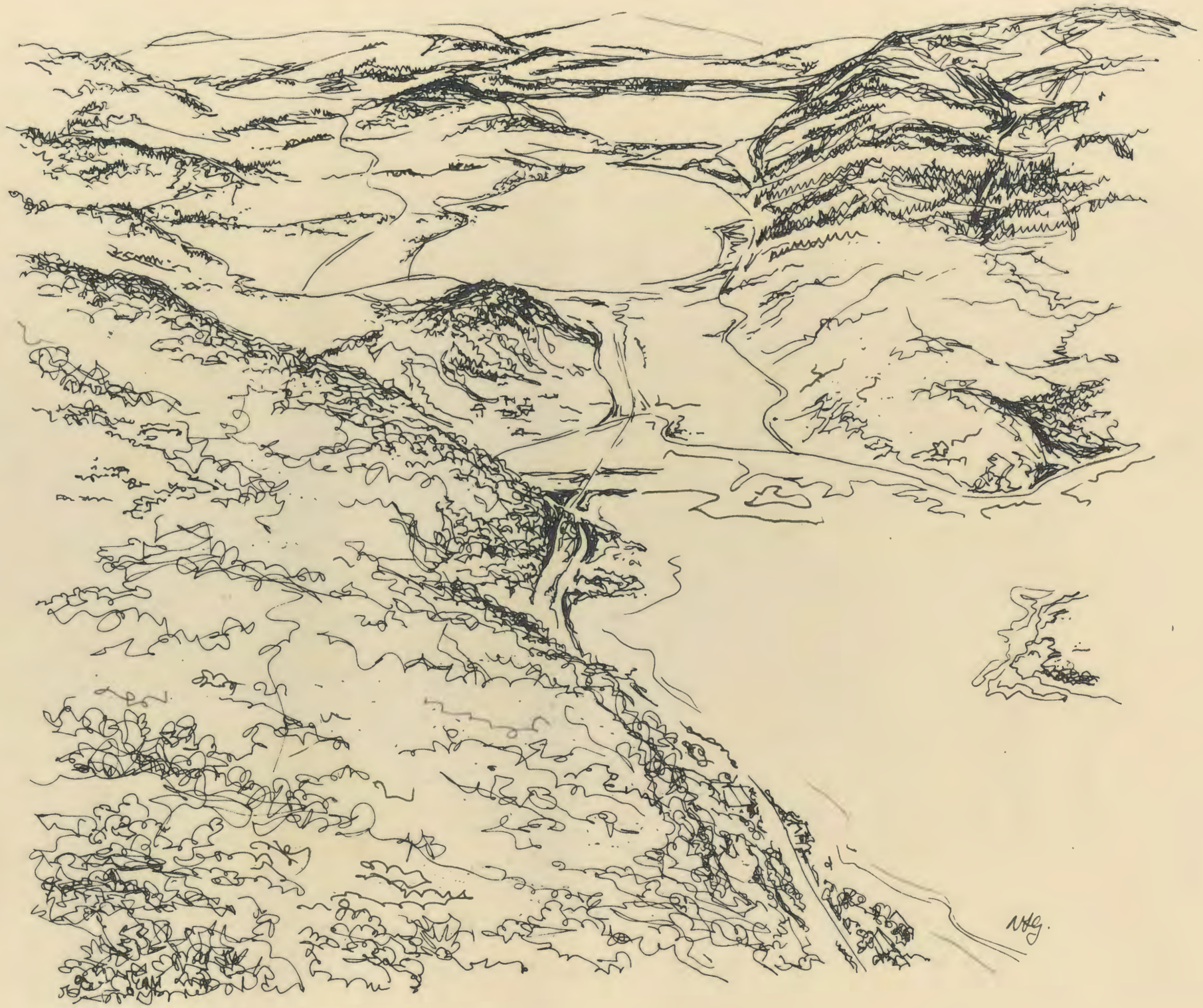
Groenvlei and Vankervelsvlei have no tributaries and no outlets. Groenvlei is believed to be fed by underground springs in its eastern section.

The lakes lie in a valley flanked by the inland plateau escarpment and the leeward escarpment of the coastal plateau. (See Sketches 1 and 2) The latter escarpment which is uniformly steep, appears to represent the old lateral lake bed, prior to the recession of the system. It extends from the Serpentine to the Goukamma River.

The Coastal Plateau attains maximum heights of 600 ft. whereas the inland plateau exceeds 800 ft. in places. Steep cliffs make the coastline inaccessible for the most part. Access is made even more difficult by the numerous east west trending sand dunes which are well consolidated.

The Heads provide a spectacular opening to the Knysna Lagoon (Sketch 3). Further upstream the lagoon narrows to a deep channel, fertile alluvial terraces and river valley. The Goukamma River has alluvial plain characteristics. Both these rivers form unique picturesque settings (see Sketches 4 & 5).

Pronounced headlands at Gericke Point and Buffelsbaai create embayments. Although precipitous cliffs extend along most of the coastline, beaches extend unbroken, except for river mouths, Gericke Point and Buffelsbaai, from immediately east of the Kaaimans River to Castle Rock.



EASTWARD PANORAMA FROM EILANDVLEI.

SKETCH 1

PANORAMA WESTWARDS FROM SWARTVLEI

SKETCH 2

PHYSIOGRAPHY

Contours at 50' intervals

— Head of Tidal Effect

Scale 1:100,000

0 1 2 3 4 Statute miles

0 1 2 3 4 5 6 Kilometres

Swartvlei

Karatara vlei

Ruigtevlei

Groenvlei

Gericke Point

INDIAN OCEAN

Knysna Lagoon

Thesens Island

Leisure Isle

Castle Rock

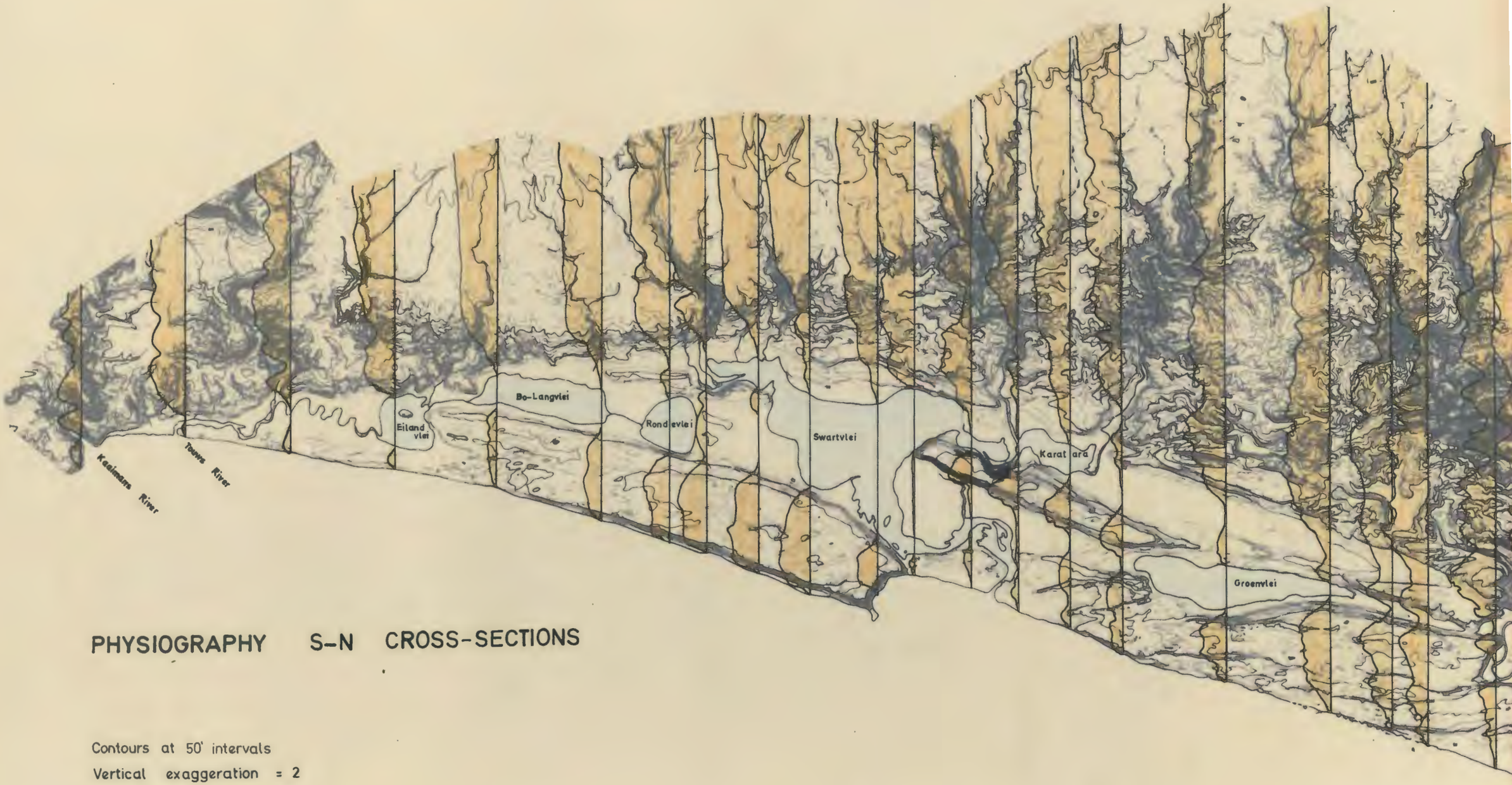
Buffels Bay

Walker Point

Goukamma R

Noetzie R

N



PHYSIOGRAPHY S–N CROSS-SECTIONS

Contours at 50' intervals
Vertical exaggeration = 2

Scale 1:100,000

0 1 2 3 4 Statute miles

0 1 2 3 4 5 6 Kilometres

Swartvlei

Karatara

Groenvlei

Knysna Lagoon

Goukamma River

Noetzie River

N

PHYSIOGRAPHY E-W CROSS-SECTIONS.

Contours at 50' intervals

Vertical exaggeration = 2

Scale 1:100,000

0 1 2 3 4 Statute miles

0 1 2 3 4 5 6 Kilometres

N

Swartvlei

Karatara v

Ruigtevlei

Groenvlei

Knysna Lagoon

Gericke Point

Goukamma R

SLOPE ANALYSIS

- Slopes ≤ 1 in 6
- Slopes > 1 in 6 and ≤ 1 in 3
- Slopes > 1 in 3


BASE LEGEND
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops
Contour at 50' intervals
1:100,000
INDIAN OCEAN
KNYSNA
Knysna Lagoon
Brenton-on-Sea
Buffalo Bay

The deep river valleys in the plateau have slopes greater than 1 in 3. Comparatively few areas have slopes between 1 in 6 and 1 in 3. Transport linkages have been confined to the Lakes as a result of the steep ravine, and inland linkages follow the catchment ridges on the plateau. Settlements are all oriented to the lakes and rivers, and are located on alluvial river terraces in the main, and on flood plains in places, and are subject to flooding every year.

2.2 GEOLOGY

There is some speculation as to the origin of the lake systems as described by Martin (1) and others. It is therefore not my intention to describe possible events fully, but to outline briefly the main geological formations covering the area. Map 6 (Geology) was compiled with the aid of geological maps and other evidence (2).

Originally the present area occupied by the lakes and Knysna Lagoon comprised two embayments. The section west of the Goukamma River appears to have had a different history to that on the east. This is exemplified by the extensive deposits of Enon Conglomerate to the east. From Section E - F it would appear that this conglomerate formed the lacustrine deposits of the Knysna Lagoon system. Off-shore deposits resulting in a series of east west trending dune formations appear to have created a series of lakes and lagoons (see Geological Map 6).

The symmetry of the contours around all the lakes and the Lagoon appears to indicate that the region has been subject to recent uplift much to the detriment of water levels in the lakes and Lagoon.

The main formation in this Region from oldest to youngest include:-

(1) Cango Formation - Malmesbury series comprising shales, phyllite, quartzites and conglomerates in the main.

(2) Cape Granite - Reheating of this system affected the base of the Malmesbury series.

(3) Table Mountain Sandstone (T.M.S.) - comprising compact sandstone, shale and tillite; and Bushveld Series comprising slate and sandstone.

(4) Enon Conglomerate - These contain large quartzite pebbles with sands and clay. These beds have been found to be as deep as 400 ft.

(5) The Sundays River Beds - cemented sand, shell fragments and pebbles, calcareous sandstone, limestone, located in the south east bank of the Knysna Lagoon. These have a maximum thickness of 20 ft. and are horizontal.

GEOLOGY

- Present day beaches, drift sand and consolidated dunes.
- Lagoonal and river terrace deposits.
- Detrital Breccia
- Raised beach
- Knysna beds
- Dune deposits, aeolianite associated sands
- Sundays river beds
- Enon Conglomerate
- Bokkeveld series
- Table Mountain sandstone
- Cape Granite
- Cango beds (Malmesbury formation)

f——f Fault

Vertical exaggeration of sections = 2

BASE LEGEND

- National Road
- Main Roads
- Secondary Roads
- Railway Line
- Marshes
- Water Grass
- Tidal Mud Flats
- Tidal Sand Flats
- Unconsolidated Sand & Beach
- Prominent Rock
- Contour at 50'

f f f f

D

E

F

H

G

Swartvlei

Groenvlei

INDIAN OCEAN

Plettenberg Bay

Brenton-on-Sea

KEYSNA

A Sea Eilandvlei B

C Sea Swartvlei D

E Ruigtevlei Goukamma River Knysna River Estuary F

G Sea Cliff H

(6) The Dune Deposits, Aeolianite and Associated Sands

These deposits are very largely dull white unconsolidated sands or brittle rock (aeolianite).

(7) The Knysna Beds

These rest on the levelled surface of the marine cut platform, and have an estimated thickness of 200 ft. They are made up of yellow, red and brown unconsolidated sands with occasional white patches.

(8) The Raised Beach

Only one raised beach is apparent - exposed behind the Total Garage on the left of the main road entering Knysna from the west. It is 4 ft. thick and about 15 to 20 feet above sea level, and comprises coarse grained sand, dull white in colour and containing numerous shells and shell fragments.

2.3 WATER RESOURCES

2.3.1 Surface Water

Although dams in the deep ravines may prove costly, the storage potential is high and the T.M.S. provides excellent base foundations for walls. The implementations of a regional water scheme does not, however, appear likely. Such a scheme might prove possible. However, costs owing to the broken terrain, and the distances between small townships spread over a wide area, would appear to exceed the net benefits considerably. Therefore each development or group of developments may have to obtain individual supplies of potable water from underground sources or rivers (3).

Fortunately numerous streams run from the plateau thereby reducing the supply distance. Moreover, except for the smaller ones, these streams are perennial. Pumping from these waters is therefore possible, and is carried out on the Touws and Goukamma Rivers at present to supply Wilderness Township and Buffelsbaai respectively.

A problem in this respect is the fact that tidal effect creates varying saline conditions for considerable distances upstream (see Map 2) and within all the lakes apart from Groenvlei. The head of tidal effects in each stream is located at the base of the inland plateau escarpment.

2.3.2 Underground Water

Generally the T.M.S. deposits are of little importance as regards borehole supplies as they are too

KNYSNA HEADS

SKETCH 3

compact to bear any appreciable amounts of underground water. The formation is, however, important as an aquifer. The springs that rise in the T.M.S. mountains form a source of supply for such coastal towns as Cape Town, Port Elizabeth, Knysna and Mossel Bay. Numerous inland towns like Bredasdorp, Oudtshoorn, Riversdale etc., which would otherwise be dependent on the highly saline borehole waters from the Malmesbury, Cretaceous and Bushveld formations, obtain their water supplies from mountain springs in the Table Mountain Series.

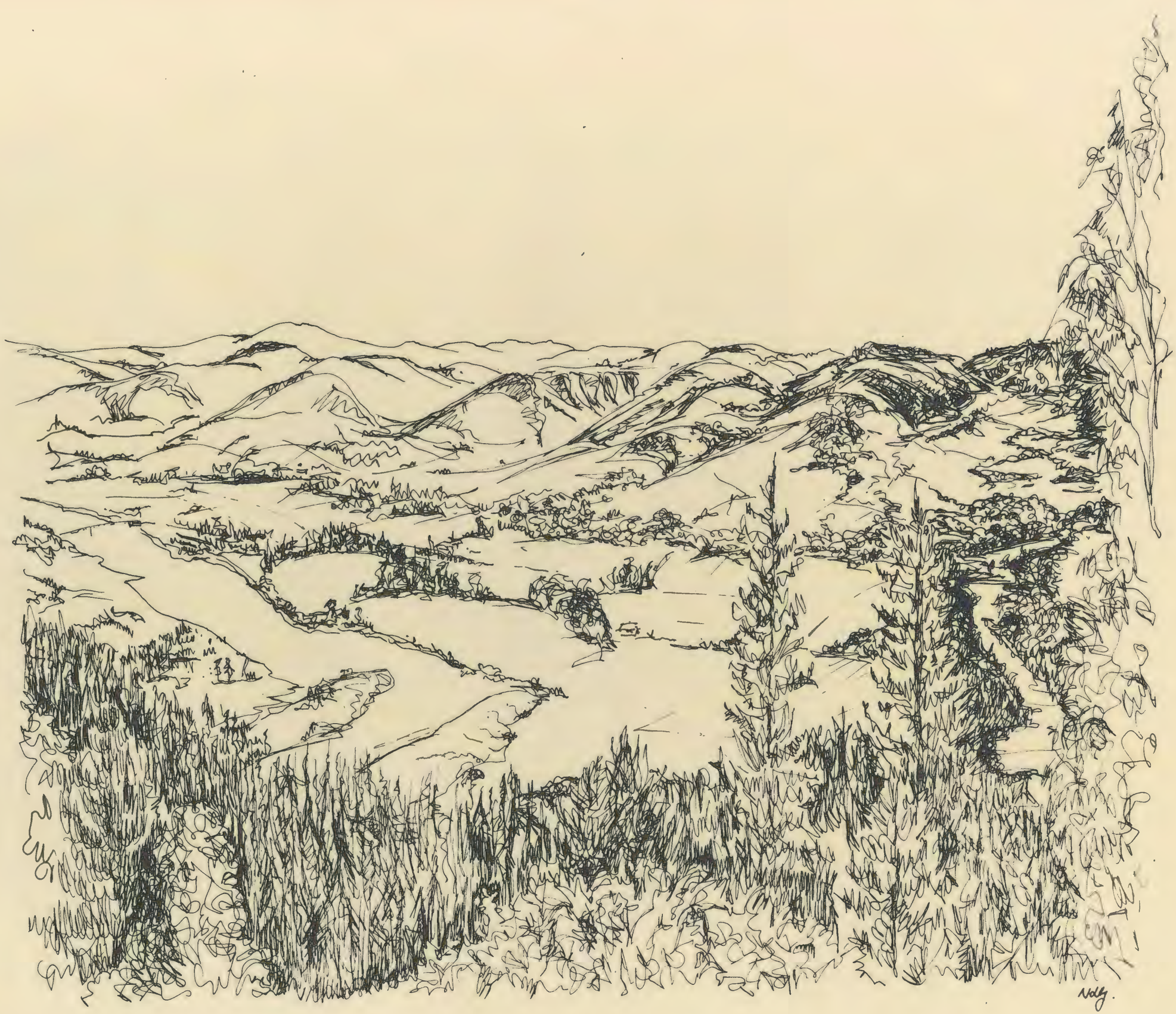
Although of low mineral content these spring waters are among the most acid natural waters encountered. PH figures as low as 4.5 are quite common.

Another prominent characteristic is the faint brown to dark coffee colour of all spring waters of the T.M.S. series, noticeable at the very eye of the spring but darkening as the water passes through dense beds of vegetation. On account of this brown colouration, and because the waters often deposit a little brown oxide on standing, it is assumed that the water contains a great deal of iron. The dark colouring would appear to bear this out, however, the iron content of these waters appears to be of a very low order. The colour seems to be entirely due to organic colouring matter, which also partly accounts for the low pH values. (4) This organic colouring matter of the waters is derived in part from the abundant heath-like vegetation (fynbos).

It is evident that the brown discolouration of the water has no detrimental effects when consumed, and the organic matter passes through the human digestive system without creating any problems. When attempts have been made to remove this component, corrosion of reticulation pipes sets in rapidly(5).

The Bokkeveld shales on the other hand are water retentive, but water from these shales tends to be brack and unpotable. Similarly, the Cretaceous and Tertiary systems, while being water retentive, tend to produce very brak, unpotable water. Potable water has been found in a few places, but the reliability of these supplies is doubtful, and they are also difficult to locate.

The best deposits of underground water are those located in the scree deposits at the base of the inland escarpment in association with rivers and streams. Well points can be inserted in these deposits at very shallow depths. With the relatively constant rainfall experienced here, a reliable supply of water could be anticipated(6).



Rich Alluvial Plain + Meandering River - Knysna River Valley.

SKETCH 5

2.4 CLIMATE

2.4.1 Temperature

Relatively mild temperatures are experienced in the Region owing to the influence of the warm Agullhas Current. However, hot dry "berg" winds and cold polar air masses are experienced occasionally.

Table 1. Mean Daily Maximum and Minimum Temperatures for Knysna.

	January	July
Mean Daily Maximum	25.0°C	78.8°C
" " Minimum	15.6°C	7.1°C
Maximum Figures Recorded	40.4°C	30.6°C
Minimum " "	6.7°C	1.0°C

Average monthly temperatures for Knysna are similar to those of Bloubergstrand (Cape Town) and are 4° cooler than corresponding figures for Durban.

2.4.2 Sunshine

Owing to the physiography of the Region and its coastal position cold and mist reduce the period of sunshine to 50% of the possible number of hours which is comparatively low for South Africa. The range of sunshine cover varies between 50% and 65% for January and July respectively. Durban's variation is 42%to 70% for October and May/June respectively.

However, it should be borne in mind that most rain falls at night in this Region. This factor coupled with the comparatively low percentage of sunshine results in relatively low evaporation.

2.4.3 Winds

Gale force winds are not as common as in Cape Town or Port Elizabeth. These are generally associated with winds varying from South West to Northerly and South East. Average hourly maximum windspeeds per month range from 54.7 k.p.h. to 74 k.p.h. Maximum wind speeds range from 96.5 k.p.h. to 127 k.p.h. and range from South Westerly to North North Westerly.

(Problems have occurred in reclaiming sand dunes because of the change in direction of winds from South Easterly to South Westerly thereby altering the alignment of attack on dune crests.)(7)

Diagram 1 indicates annual velocity, frequency and distribution of winds for George. Westerly to Northerly winds predominate in July and South Easterly in January.

2.4.4 Rainfall

(a) Distribution

Map 7 indicates the rainfall distribution over the Region. Owing to the relatively small scale of the map from which this was derived the isohyets are probably not very accurate. Furthermore, there are few weather stations in the area from which isohyets could be obtained. However, this Map does give an indication as to the distribution of rainfall, and shows that generally relief has a great bearing on both orographic and cyclonic rainfall.

The coastal plateau appears to receive maximal rainfall - between 700 and 800 mm. (approximately 28 to 32 inches). This appears to be correct and is substantiated by recent rainfall recordings at Swartvlei and Groenvlei which were both 28 inches (8) and were taken close to the 700 mm isohyet as shown on Map 7. Sedgefield and the Goukamma River Mouth areas which are low lying probably receive less rain than indicated.

(b) Variability

Diagram 3 and Table 2 indicate the distribution of rainfall for George and Knysna from 1900 to 1970. This reveals a distinct series of peaks and troughs which vary considerably from year to year. Knysna has a lower rainfall regime generally but experiences similar fluctuations.

Diagram 2 is a histogram for the rainfall figures of George. These are normally distributed with a mean of 34.55 inches and a standard deviation of 6.33 inches i.e. the average deviation from the mean are 28.22 and 40.88 inches.

A wide variation in annual rainfall figures can be anticipated however. Using the chi square test for observed and expected percentage figures within each class distribution, it was found to be significantly normally distributed at the 5% significance level.

Diagram 4 indicates the mean maximum and monthly rainfall figures recorded for George together with mean monthly rainfall and standard deviations. Of significance are

GEORGE AND KNYSNA ANNUAL RAINFALL DISTRIBUTION 1900 - 1970

YEAR	GEORGE	KNYSNA	YEAR	GEORGE	KNYSNA	YEAR	GEORGE	KNYSNA	YEAR	GEORGE	KNYSNA
1900	30.26	28.17	1921	36.08	32.79	1941	37.34		1961	33.04	27.83
01	38.66	29.06	22	40.87	33.95	42	34.57		62	40.34	31.54
02	44.50	40.79	23	26.89	27.19	43	40.00		63	38.43	26.98
03	32.03	30.82	24	30.14	25.20	44	26.21		64	38.71	30.28
04	38.13	29.56	1925	43.78	30.66	1945	26.06		1965	39.37	31.80
1905	49.42	35.98	26	25.76	25.97	46	20.59		66	27.37	24.55
06	33.60	33.55	27	21.93	20.37	47	32.80		67	46.09	28.17
07	29.56	25.33	28	37.91	30.28	48	31.29		68	30.27	30.18
08	44.08	36.70	29	31.84	20.73	49	28.04		69	22.03	25.10
09	37.43	25.88	1930	37.77	23.92	1950	29.81		1970	31.08	25.19
1910	33.55	27.71	31	46.82	32.67	51	29.37				
11	41.43		32	39.10	36.42	52	39.71				
12	34.26		33	26.62	22.06	53	40.39	34.95			
13	29.84	25.62	34	35.51		54	44.10	40.22			
14	34.21	31.03	1935	39.85		1955	39.54	33.52			
1915	26.05	20.47	36	37.18		56	35.47	32.70			
16	37.20	37.01	37	31.92		57	28.66	26.68			
17	38.72	38.40	38	29.81		58	32.98	25.99			
18	25.70	26.02	39	38.12		59	42.73	36.77			
19	30.54	24.64	1940	30.77		1960	40.04	27.82			
1920	28.85	26.47									

TABLE 2

WIND ROSES FOR GEORGE: DIRECTION FREQUENCY & VELOCITY.

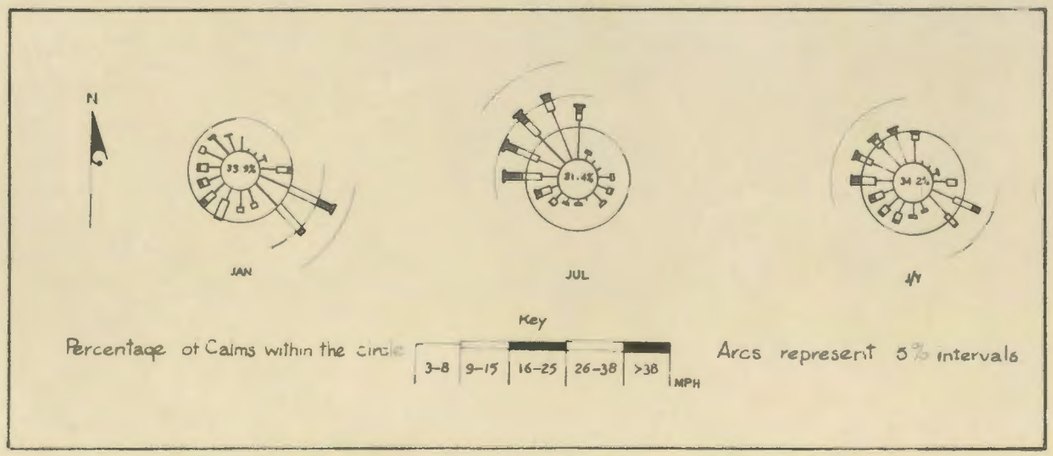


DIAGRAM 1

DISTRIBUTION OF ANNUAL RAINFALL FIGURES FOR GEORGE. 1900 - 1970

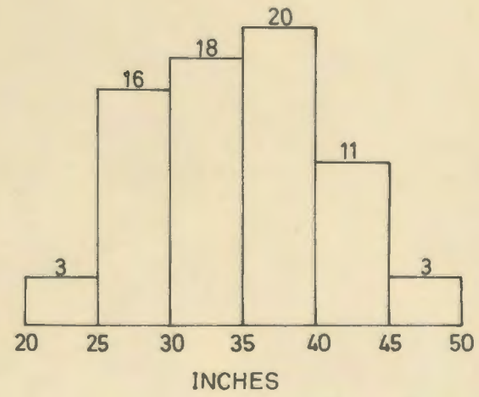
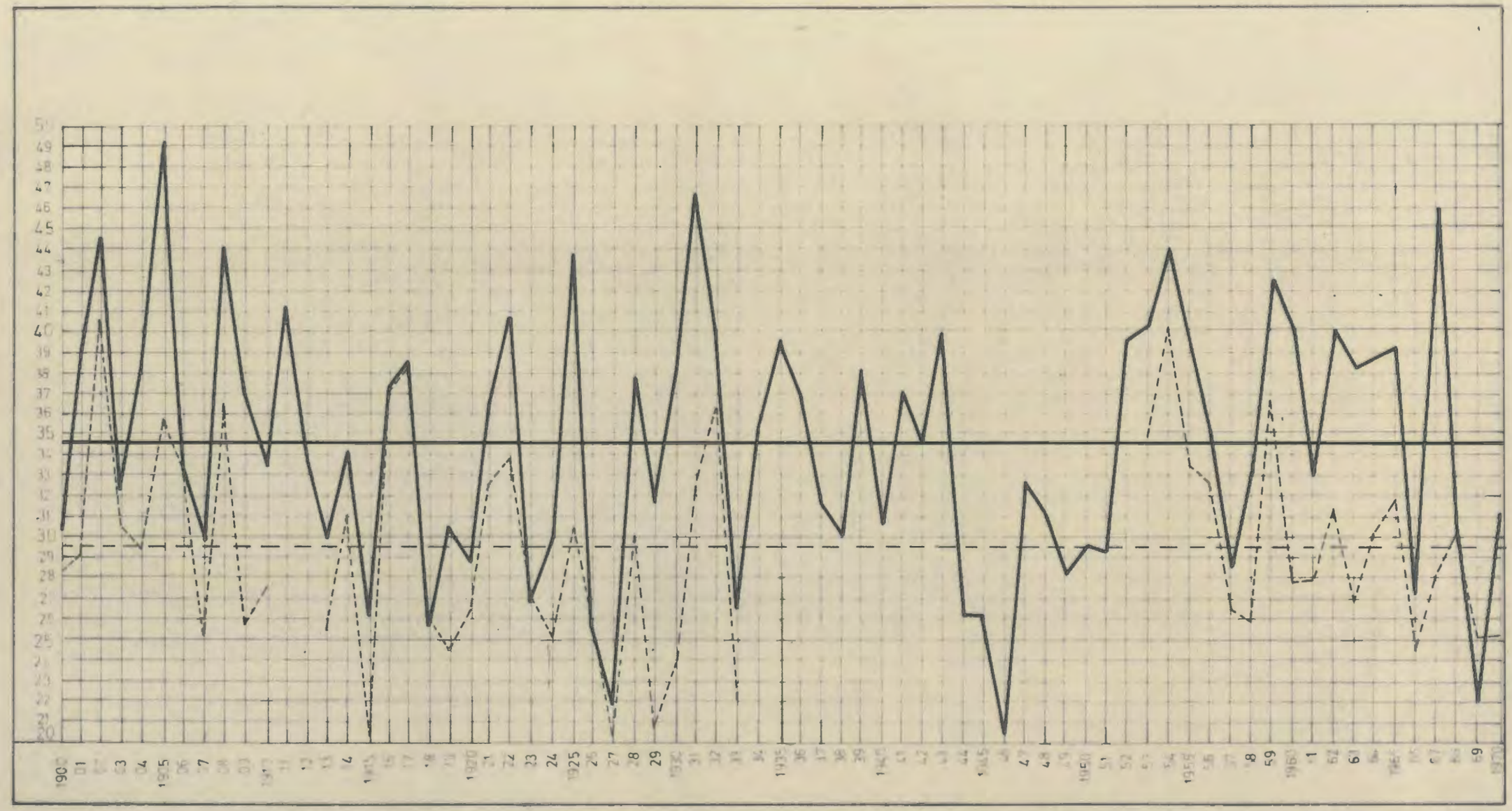


DIAGRAM 2



GEORGE AND KNYSNA ANNUAL RAINFALL DISTRIBUTION

1900 - 1970

(Compiled from graph and Weather Bureau, Dept. of Transport, figures obtained from Mr. Sayers, curator, George museum, distribution printed in The Herold, Tues 26th Jan, 1971)

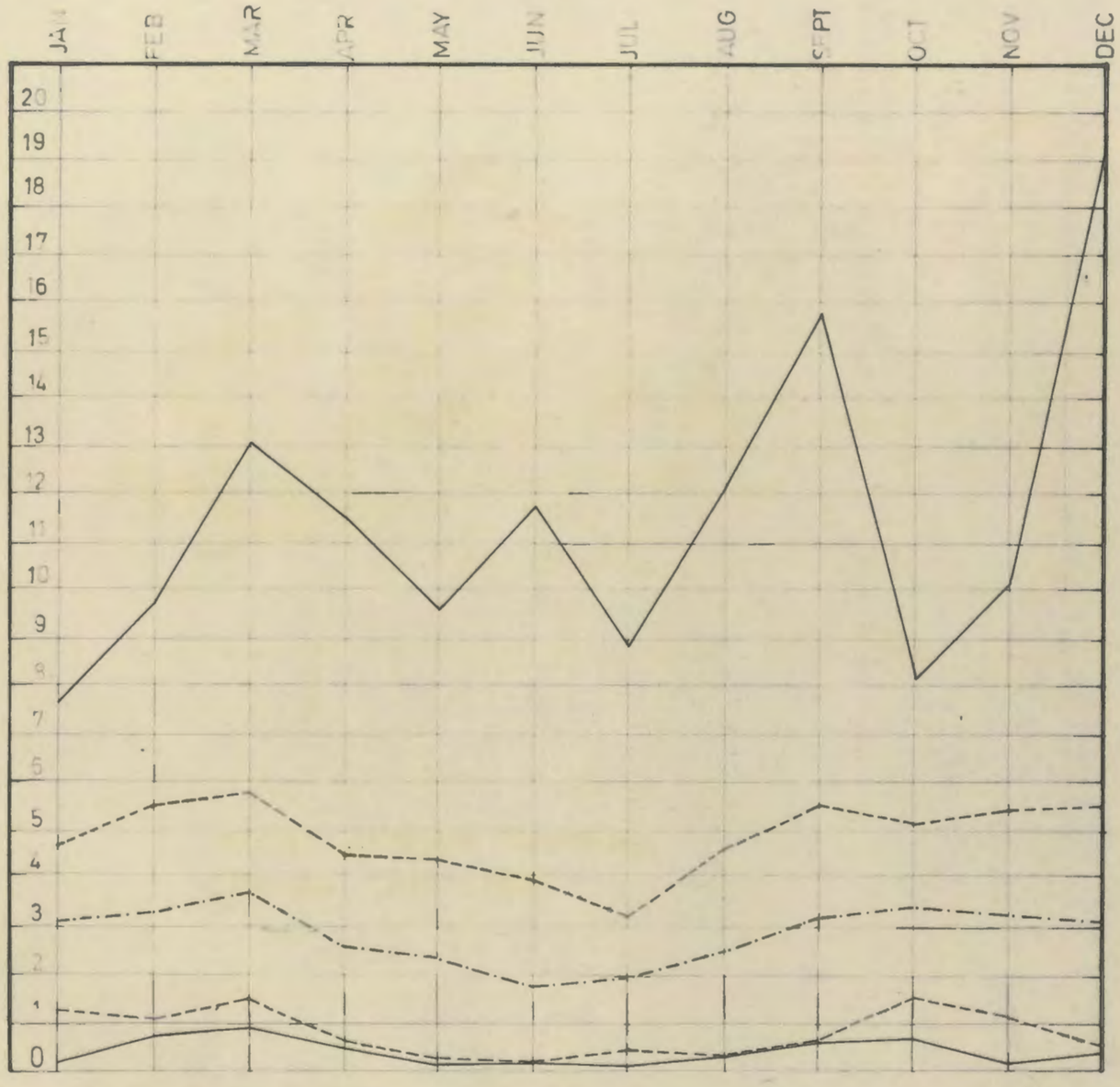
(Knysna rainfall figures from 1911 - 1912 & 1934 - 1952 not available)

Mean Annual Rainfall

—— GEORGE 34.55

--- KNYSNA 29.51

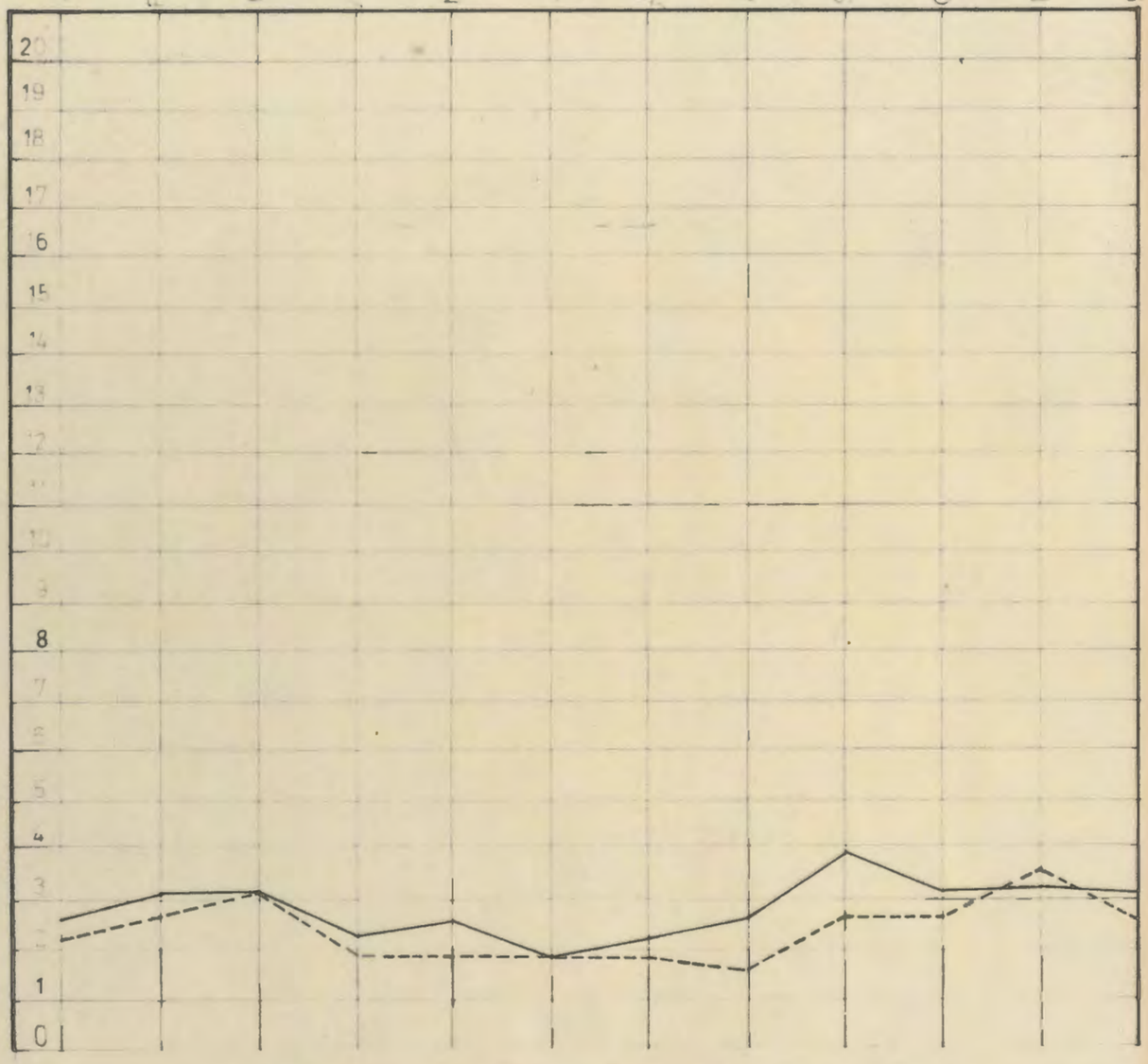
DIAGRAM 3



ANALYSIS OF MONTHLY RAINFALL FIGURES 1900-1970 FOR GEORGE

— Maximum and minimum rainfall
-·-· Mean rainfall
--- Standard deviations

DIAGRAM 4



MEAN MONTHLY RAINFALL FOR CONCORDIA & WOODVILLE

—— Concordia
- - - Woodville

DIAGRAM 5

MEAN ANNUAL RAINFALL
(Period 1921 - 1960)

Isohyets in hundreds of millimetres.

COMPILED FROM 1:250,000 RAINFALL MAP - SHEET 3322 OUDTSHOORN


BASE LEGEND
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops
Contour at 50' intervals
1:100,000
English Feet
Metres
8
7
INDIAN OCEAN
KNYSNA
Buffalo Bay

the similarity between minimum values and the lower standard deviations, and the large discrepancy between maximum figures recorded for each month and the standard deviations. This indicates that low rainfall figures below the mean can generally be anticipated whereas there are likely to be greater fluctuations in larger quantities of rainfall.

Concordia and Woodville forest reserves which abutt the Region north of Knysna have similar mean monthly rainfall distributions to those of George. (See Diag. 5). Local residents at Knysna generally anticipate rain falling at George to reach them the following day.

Annual rainfall figures which fall within the acceptance region lie between 46.96 and 22.14. At the 2% level of significance (2% probability values or 50 year flood values)the accepted normal range of rainfall figures lie between 49.30 and 19.80 inches. In this instance the highest figure recorded was 49.42 and the lowest was 20.59 wnich lie just without the acceptance region i.e. they approximate normality at the 2% level of significance. At the 1% level the range in acceptable rainfall lies between 50.82 and 18.28 inches i.e. all rainfall figures appear to be normally distributed at the 1% level of significance.

No correlation was found between the duration of rainfall (in days) and the quantity of rain falling within that period. It would therefore appear that although there is a certain amount of certainty that the total annual figures will tend to be confined to the 2% critical levels of 49.42 and 20.59 inches and even the 5% level with a high degree of certainty, the amount of rain falling over a specified period of days is not predictable. This implies that larger or smaller quantities of rain may possibly occur over longer or shorter periods of time than have previously been encountered. It is therefore possible that floods in excess of those already encountered may occur. (It should be noted that for greater accuracy in determination of rainfall distribution a much larger number of figures is necessary.)

2.5 NATURAL VEGETATION

Natural Vegetation has been classified into five major zones. (Beach vegetation forms a sixth, but is a negligible quantity on this scale of representation and comprises in the main, stunted varieties

found within other zones.) They are fynbos, littoral bush with metatasis sp. (blombos) predominating, dry northern slope vegetation (blombos), indigenous forest including milkwood forest, and exotic acacia. (Map 8)

Fynbos predominates in many areas. Once pines or indigenous forest have been cleared this species rapidly establishes itself, and in this respect becomes a useful soil cover. The scattered shacks and other dwellings on the periphery of Knysna are located in amongst the fynbos. There was difficulty in determining the exact boundary of the fynbos on the eastern side of Knysna Lagoon, particularly where suburban developments have taken place.

Littoral bush comprises a dense matrix of thickly wooded fynbos vegetation. These areas were originally burnt in order to provide better grazing etc. The boundary of the littoral bush zone which is located in the Goukamma Nature Reserve clearly marks the boundary of the old Buffalo Bay Forest Reserve. Very little of this vegetation remains, and large areas of fynbos are used for rough grazing.

The vegetation of dry northern sand dune slopes (blombos) will be discussed in detail in connection with the Coastal Fynbos Ecosystems. This phenomena relates to the steep leeward slopes of the sand dunes with vegetation growing in clusters, uniformly distributed.*

Indigenous forest comprising mainly milkwood in this region is located on steep slopes and in moist hollows among sand dunes. Their association with river catchments is advantageous in that their presence has considerably reduced the siltation of the rivers. These are discussed in more detail and with respect to commercial forestry and related ecological considerations in Section 4.4.

* The sand dunes, many of which are consolidated and approaching aeolianite compaction are not afforded much additional protection by this vegetation. As such shearing of these steep slopes is a common occurrence, particularly after heavy rains. This has recently occurred along the Swartylei shoreline in two places and along the old lake side at Groenvlei and Goukamma River. One has occurred on a north facing cliff face while the other on a typical dry northern slope which in this case is dominated by acacia sp. as opposed to metalasia (blombos).

The milkwood areas south of the National Road at Swartvlei have been thinned out considerably by the local Coloured inhabitants. This slope provides an interesting backdrop to the Lake and should be preserved as far as possible.

The spreading of acacia into the fynbos to the west and south west of this area is cause for concern. It was difficult to determine a specific boundary between fynbos and acacia as a result.

It should be noted that within the Cape Peninsula the milkwood is a totally protected plant, and may not be removed or damaged at all by any person. People who wish to clear, or tamper with, such plants require permission at ministerial level to do so. It is of the utmost importance that such control be applied in this region, and elsewhere along the coast where this plant abounds.

These natural vegetation areas, singly or in combination, form important wild life habitat regions and therefore potential flora and fauna conservation management regions can be determined. These relationships are amplified within section 3.5 (Wild Life Habitat).

NATURAL VEGETATION

- Fynbos and/or rough grazing (Passarena etc)
- Dry northern slopes (Metalasia scrub)
- Littoral bush (Metalasia, Passarena etc)
- Indigenous forest (Milkwood)
- Exotic acacia sp. (Rooikrans)


BASE LEGEND
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops
Contour at 50' intervals
100,000
INDIAN OCEAN
KNYSNA
Knysna Lagoon
Brenton on Sea
Buffs Bay

2.6 REFERENCES

(1) Martin A.R.H. : "Evidence Relating to the Quaternary History of the Wilderness Lakes". Transactions of the Geological Society of South Africa, Vol LXV, Part I, 1962.

(2) Miller R. McG. : Geology of the Knysna Area. University of Cape Town, Dept. of Geology, Honours Project, 1963.
Departement van Beplanning : Riviermonde, Strandmere en Vleie, Knysna - Wildernis Mere Kompleks. Vol. IV 1970. (Geology map compiled from various sources.)

Martin A.R.H. op. cit.

(3) Personal communication with Mr. Lee, Ninham Shand & Partners, Consulting Engineers, Cape Town.

(4) Menne R. : The Effect of Geology on Natural Waters. Course Project C5.18 - Water Treatment. June 1971. Dept. of Civil Engineering, University of Cape Town. pp. 12 & 13.

(5) Personal communication with Prof. G. Marais, Dept. of Civil Engineering, University of Cape Town.

(6) Mr. Lee op. cit.

(7) Personal communication with Mr. Tom Heineken, Dept. of Nature Conservation, Goukamma Nature Reserve, Groenvlei.

(8) Rainfall figures recorded by Mr. J.M. Jooris of Jooris Caravan Park, Swartvlei; and Mr. Tom Heineken, op. cit.

CHAPTER 3

NATURAL ENVIRONMENT AREAS

3.1 Introduction

The Region comprises a series of distinct inter-related ecosystems, of which the undeveloped areas form an integral part. As such this chapter firstly assesses the problems associated with specific ecosystems and in so doing provides an insight into planning and land use controls required for these. Secondly this chapter provides an assessment of the suitability of the Region for conservation management of flora, fauna and other conservation criteria.

This section furthermore emphasises the need for the holistic and ecological approach to be maintained throughout the future planning and improvements on the existing infrastructure within the Region.

The dominant factor throughout the region is water and for the purposes of reviewing the specific problems and phenomena related to the Region, a series of ecosystems have been outlined, all but one of which are related to water systems i.e. complete drainage systems.

This splits the Region into eight ecosystems (see Map 9). Three of these comprise lakes and lagoons and include their tributary and catchment areas, namely Touws River/Rondevlei, Swartvlei/Ruigtevlei, and Knysna Lagoon. The fourth comprises Groenvlei, which is a fen apparently fed by underground springs, and surrounding areas. The Goukamma River Valley and catchment area forms the fifth. The sixth consists of the three major areas of coastal fynbos associated with the plateaux of quaternary deposits, and recent sand dunes. These comprise the non-water based ecosystems. The seventh and eighth are the Kaaimans and Noetzie Rivers respectively, only part of which are included in the region. The hinterland farmlands have been incorporated into the respective river catchment areas of which they form part.

3.2 The Need for Conservation and Resource Management

In comparison with South Africa as a whole, and the surrounding areas, this region is relatively insignificant economically. Despite this, it has suffered from considerable mismanagement of its resources.

ECOSYSTEMS

1. Touws River/ Rondevlei
2. Swartvlei / Ruigtevlei
3. Knysna Lagoon
4. Groenvlei
5. Goukamma River
6. Coastal Fynbos
7. Kaaimans River
8. Noetzie River

Contours at 50' intervals

Scale 1 : 100,000

0 1 2 3 4 Statute miles

0 1 2 3 4 5 6 Kilometres

iles

There have been a number of factors causing this.

As this region has a vast recreational potential, its resources must be carefully administered. It may not be possible to completely eradicate these and other problems, but a supreme effort must be made to correct them where possible.

One major problem is that of the misplacement of transport linkages throughout the region. In many instances the scenic destruction has been extensive and irreparable. For example, gravel works have been located adjacent to the national road on the Knysna Lagoon. Major access roads, which have been misplaced, have excessively scarred the mountainside at Eilandvlei,and the southern backdrop of Knysna Lagoon.

In a scenic area the emphasis should not be on improving traffic flow and increasing speed to a maximum, but on creating an interesting series of changing views and minimising the impact of the road on the natural environment.

Small constrictions,due to bridging and the indiscriminate location of both minor and major roads, are creating siltation problems, and advancing the deterioration of the Lakes System as a whole. For example, at Swartvlei and Knysna the foundations of road and rail bridges have led to extensive siltation and flooding problems.

Another aspect is the poor location of urban and recreational developments in the vicinity of the lakes with respect to flooding. The danger of flooding has resulted in the premature opening of the silted outlets of Swartvlei and the Touws River. Furthermore, flooding presents a health hazard with regard to water supply and sewerage disposal.

A third aspect is that the natural vegetation has been destroyed by agricultural and urban development. General bush clearing for pastures and firewood has also taken place.

3.3 Background to the Lakes

Although the lakes and Knysna Lagoon comprise four distinct ecosystems, many of the problems and phenomena relate to all of these. For the purpose of clarity the overlapping phenomena and their implications are described here prior to their individual consideration within their respective ecosystems.

3.3.1 Size.

Table 3, Relation of Size of Lakes to Catchment Areas (1)

Lake	Surface Area Sq. Miles	Catchment Area Sq. Miles	Ratio S/C
Eilandvlei	0.58	4.36	0.132
Langvlei	0.835	8.12	0.103
Rondevlei	0.55	1.86	0.297
Swartvlei	4.19	155.30	0.027
Karatara	0.28	-	-
Ruigtevlei	0.46	5.90	0.076
Groenvlei	0.96	3.69	0.259

Most of the lakes are large in relation to their catchment areas as can be seen from the above Table. Swartvlei alone has a large water supply, receiving the water of three perennial streams the Diep, Hoëkraal and Karatara Rivers.

Occasionally floods may bring violent changes of level to the lakes. Although floods normally occur at widely spaced intervals, two recently occurred within three months (November 1950 and January 1951). Knysna Lagoon is open to the sea all year round at The Heads, and therefore floods do not significantly affect the level of this water body. Tidal fluctuations vary considerably (see Map 11).

3.3.2 Salinity.

Salinity has a major effect on the ecosystems, particularly with regard to fish life, vegetation and its ability to provide drinking water for wild life.

Table 4. Data for Lake Waters of Wilderness Area (2)

Lake		Total Dissolved Solids g/l	Total Halides g/l NaCl	pH	Transparency m
Groenvlei	Jan 1951	3.822	2.775	9.5	3.25
	Sept.1952	3.547	2.800		
Karatara	Dec 1951	5.980	5.339	7.0	0.70
	April 1952	5.596	4.546		
Swartvlei	April 1951	3.600	3.228	c.9.2	
	July 1952	16.160	13.740		5.0
Rondevlei	April 1951	17.506	16.370	9.0	
Langvlei	April 1951	5.735	5.296	9.0	
Eilandvlei (Bridge)	April 1951	3.846	3.528	8.5	
Eilandvlei (North Shore)	April 1951	4.071	3.774		

All the lakes are more or less saline, but this probably stems in part from the low Precipitation/Evaporation of the region, as is shown particularly in the Eilandvlei-Langvlei-Rondevlei group, which has a distinct salinity gradation. Rondevlei, although being the farthest from the sea, is the most saline, as it is least affected by the flow of fresh water from the Touws River. Swartvlei, however, derives much of its salt from the sea and the degree of salinity fluctuates considerably. (Table 5)

3.3.3 Lake Depths

Depths are an important constraint with regard to the nature, location and extent of the biotic community within these water bodies. They are of particular importance within Swartvlei where depths of over 40 ft. are recorded and where anaerobic conditions and salinity gradations are found.

Apart from Swartvlei, Knysna Lagoon (east of the rail bridge) and Groenvlei, no depths have been recorded for the major water bodies in the Region. (See Maps 10 and 11) A survey of Groenvlei is being conducted at present by the Department of Nature Conservation. The lake bottom has gradual sloping sides and uniform depths with the exception of the eastern section where a shallow ridge runs into the middle of the lake. (5) Swartvlei depths have been recorded by Mr. J.M. Jooris of Swartvlei (Map 9) and the Rhodes University Hydrological Research Institute. Knysna Lagoon depths have recently been conducted

by the C.S.I.R. Hydrological Research Institute, Stellenbosch, but these are not as yet available.

The depths of Eilandvlei, Bolangvlei and Rondevlei appear to average 15 ft. in depth, whereas those for Karataravlei would be in the region of 6 to 7 ft. at most. Eilandvlei, which is saucer-shaped, and the Serpentine have depths in the region of 14 ft. Langvlei, although shallow along its northern shore, attains depths in the region of 14 ft., and which continue in a ridge along the axis, south of its centre line (6).

3.3.4 Plant Types

There are five major species of plant found in the lakes and their effect on the lakes varies greatly. The five types are (in order of least occurrence):- (5)

(a) Underwater moss type.
This is possibly an algae and is found in isolated patches, usually around artifical structures, but sometimes in quiet waters in association with reeds. It is seldom extensive enough by itself to be of nuisance value and is said to be killed off by salt water.

(b) Salvinia hastata (=S. arriculata) is found only in the Karatara River upstream of Swartvlei. It is said to have been introduced from Lake Kariba into a farm dam which later broke, resulting in the infestation of the river. It is known, however, to have been present in Karatara Lake from as early as 1958. It is probable that it was originally carried over from the Port Elizabeth area where its presence was known many years ago. Its absence in Swartvlei is attributable to its inability to survive in saline water. The main disturbing features are the possible carrying over of the seed by birds to other fresh water systems, and its humus creating capacity owing to its prolific growth.

(c) Palmiet (biesiesriet) is found under marsh conditions, generally in not very extensive patches in the lakes except around Langvlei. It appears to be able to root in water not exceeding 12 inches in depth, although it can survive deeper submergence once rooted. Thus it commonly occurs on islands or shallowly submerged banks in Swartvlei. Except where it has encroached into the shallow channel between Langvlei and Rondevlei, its inability to spread into deep water renders it of little threat to the lake system provided siltation is not occurring.

(d) Reeds Less common types are bulrush and a flat-stemmed variety. The major concern

here is with the round-stemmed type known as fluitiesriet (common reed). It appears to be able to grow in depths of up to 5 ft. and forms a dense thicket which prevents normal access to the shoreline and renders bathing unsafe. It grows several feet in height above water level and thus obscures the view. From comparisons given it appears to have spread quite considerably. Attempts to check it have been made in isolated places. The roots can be pulled out quite easily, and it is said that perseverance in uprooting it two or three times enables it to be cleared completely. Experiments with a weed-killer were started recently, but its effectiveness will not be known for some time. From advice received, however, it appears that reeds can be controlled at a reasonably low cost by the use of a trade product 'Dalapon' which is non-toxic to fish, humans and animals. It is possible that reed growth is checked by high salinity. If unchecked, reed growth could undoubtedly be a serious threat to the beauty of the lakes, and would prevent swimming and fishing from the banks.

(e)Water Grass. Two main types have been identified through the Botanical Research Institute of the Department of Agricultural Technical Services. They are Ruppia (spiralis, Dom.) and Potamogeton (pectinatus). Of these Ruppia was found to be the most widespread, while Potamogeton was positively identified in several places usually in association with the former.

The tendrils grow at very close intervals and the resulting dense mass is such that the larger fish do not attempt to enter it even when chasing small fry. Its resistance to boating (skin friction) is very high and normal outboard propellers are soon entangled. Swimming is impossible. The grass grows in depths up to at least 10 ft. for Ruppia and about 4 ft. for Potamogeton, and is apparently able to remain submerged by flood rise for months at a time without damage.

Water grass appears extensively in all the lakes and in the upper half of the Serpentine, but it is also found in isolated patches in the Lagoon. Examination of the aerial photographs of 1936, however, showed little sign of the grass at that time, except for Eilandvlei and Langvlei where a fringe growth, similar to that revealed by the 1958 photographs, was apparent. In relation to the shoreline its extent is normal. It is therefore possible that it has reached equilibrium in many places, but under drought conditions it could encroach further. Some 10% increase in the width of the grass fringe in Swartvlei between 1950 - 1960 is attributable to this factor. The

primary concern is, however, with its spread and appearance in places where it was not found in more recent times. It must therefore be considered as a serious threat to the beauty and recreational value of the lakes.

It should also be mentioned that the grass tends to trap flotsam, such as the easily disturbed moss type described in (a) above. This could lead to a health problem due to the decaying vegetation. In 1958/59 fish deaths, mainly among the larger kabeljou, also created a problem. Since salinity conditions were found to be normal, this was attributable to marsh grass, probably associated with the water grass.

3.3.5 Incidence of Aquatic Plants in the Lakes System

The extent of the various aquatic plant types can be seen on the base map for the Region. The detailed extent of the occurrence within Swartvlei and Knysna Lagoon can be seen on Maps 9 and 10.

(a) Touws River Lagoon

Reeds are found on some 40% of the banks. They occur in sections, usually on the shallower side of a bend. Since the Lagoon is a channel with relatively steep banks, conditions for plant growth are not very favourable. The danger lies in the trapping of silt in established plant areas and progressive encroachment.

(b) Serpentine

Below the suspension bridge the Serpentine is relatively weed free. The low-lying banks and flood plains are, however, completely overgrown with reeds. They prevent access, and restrict the absorption of flood water from the Touws River considerably.

Some reed encroachment has occurred in the channel above the suspension bridge, and up to 50% of the waterway is covered by water grass (mainly Potamogeton). The difference in conditions could be accounted for by the more frequent boating in the lower section. The aerial photographs of 1936 show that there was considerable growth in the channel even at that date.

(c) Elandvlei

The width of reed growth around the shore is relatively small, possibly owing to a steep beach profile. Water grass forms a more or less continuous fringe, about 100 ft. wide, around the shore.

(d) Channel to Langvlei

This is so overgrown with reed that no definite channel outline can be seen. Where there are open patches in the reed, water grass appears. Palmiet is found extensively on the flood plain.

(e) Langvlei

This lake appears to have a gradual beach slope with the result that reeds grow into it to an average width of 100 ft. Water grass is observed mainly in the breaks between reed patches, and it grows to much the same width.

(f) Channel to Rondevlei

The approach is choked with water grass. Upstream of the causeway the channel is overgrown with palmiet, probably because it was originally much shallower.

(g) Rondevlei

There is little reed encroachment, probably on account of the high salinity. Palmiet along the shoreline extends up to 10 ft. into the lake. Water grass along the southern (protected) shore extends about 150 ft. into the lake, compared with 30 - 50 ft. along the eastern shore. This difference could be due to the effect of wind. Rondevlei appears to have been free of water grass in 1936.

(h) Swartvlei

Reed growth is relatively thin and scattered. The periodically higher salinity is probably an inhibiting factor. Palmiet is more extensive, especially in the estuary section. Water grass (mostly Ruppia) is to be found in a fringe up to 150 ft. wide in the lake, and covers the shallower side channels of the estuary.

(i) Knysna Lagoon

Two types of plant life are found in the Lagoon. Above the old road bridge a thin reed (Junius sp.) is abundant, while below the bridge Eel Grass (Imperata cylindrica) and Sea Grass (Zostera Sp.) covers the entire intertidal zone.

(j) Groenvlei

The bottom of this fen, which is of a soft chalky nature, is covered by aquatic vegetation consisting of Ceratophyllum in deep water and Nitella in the shallows.

Around the edge of the fen extensive beds of reeds are found, varying from a few feet to 200 yards in width. Plankton and bottom samples revealed abundant food for the young bass and bluegill, and it was suggested that the vegetarian fish species Tilapia mossambica be introduced in order to make better use of the available food. (6)

3.3.6 Water Wild Life

Fish and bird life are ubiquitous to the lakes' systems. They are important in terms of their symbiotic relationship with one another and with the remaining components of the biotic community within the lakes.

Birds play an important part in the ecology of the whole system. They help to maintain a balance by using fish and plants, and fertilizing the vlei with their droppings.

The most important fish species found in the lakes and Knysna Lagoon include:-

Species	Common Name	Size lbs. Maximum	Size lbs. Average	
Mugil cephalus	Springer	9	1-3	
Mugil tricuspidens	Streepharder	6¼	1-2	
Mugil richardsoni	Haarder	4	1	
Hypacanthus amia	Leervis	71	5	
Johnius hololepidotus	Kabeljou	162	6	
Lithognathus lithognathus	Steenbras	66	3-20	
Pomadasys commersoni	Grunter	30	3-6	
Rhabdosargus holubi	Stumpnose/Flatty	3	1	
Gilchristella aestuaries	Whitebait			)
Gambusia affinis	Top Minnows			) Groenvlei
Lepomis macrochirus	Bluegill Sunfish			) only
Huro salmoides	Largemouth Bass	24-30 c.m. average		)

Bird species found associated with the lakes include:-

Species	Common Name
Phalacrocorax capenis	Cape Cormorant
Phalacrocorax africanus	Reed Cormorant
Podiceps cristatus	Great Crested Grebe
Fulica cristata	Red-Knobbed Coot
Anas undulata	Yellowbill Duck
Anas capensis	Cape Teal
Podiceps ruficollis	Dabchick
Netta erythrophthalma	Pochard
Tadorna cana	Shelduck
Haliaëtus vocifer	Fish Eagle

Groenvlei, which forms part of the Goukamma Nature Reserve, is remarkable for its varied bird life, especially its fish-predatory species. The most common species include those listed above, as well as the following:- (For a comprehensive list refer to Department of Nature Conservation Investigational Report No.16, 1970.)

Species	Common Name
Ardea cinerea	Grey Heron
Egretta garzetta	Little Egret
Spatula capensis	Cape Shoveller
Circus ranivorus	African Marsh Harrier
Gallinula chloropus	Moorhen
Burhinus vermiculatus	Water Dikkop
Larus dominicanus	Black-backed Gull
L. cirrocephalus	Grey-headed Gull
Sterna hirundo	Common Tern
Centrous superciliosus	White-browed Coucal (Burchell's)
Ceryle rudis	Pied Kingfisher
Megaceryle maxima	Giant Kingfisher
Bampethera notata	Knysna Woodpecker

Species	Common Name
Musicapa adusta	Dusky Flycatcher
Motacilla capensis	Cape Wagtail
Cygnus olor	Mute Swan

These species are not exclusive to Groenvlei, but they are far less common on the other lakes. The Mute Swan, however, is found only at Groenvlei, although a pair is to be transferred to Rondevlei in the near future. (7)

"Groenvlei" - so called because of the greenish colour of the water, supports a large number and variety of waterfowl, and provides drinking water for most of the animals on the reserve." (8)
The Serpentine and Swartvlei support prolific quantities of bird life particularly. General bird-life counts have not been made apart from recent assessment at Swartvlei and detailed knowledge of the variety of species at Groenvlei.

3.4 THE ECOSYSTEMS

3.4.1 Touws River - Rondevlei Ecosystem

The main components of this system are the Touws River, three lakes - (Rondevlei, Bolangvlei and Eilandvlei), and the meandering Serpentine River together with its unique flood plain. The Serpentine connects the lakes to the Touws River and then to the sea at Wilderness. Rondevlei is not fed by any streams. A few minor rivers flow directly off the escarpment into Bolangvlei. Eilandvlei is fed by the Duiwe River. The Touws River has the largest catchment area. Tidal action on this river extends up-stream for three miles. Ideally it should extend through the Serpentine to the remainder of the system, but bridging constructions have impeded the flow to a large extent.

The fresh water replenishment of the lakes is derived for the most part by the flooding of the Touws and Duiwe Rivers. When wave action closes the mouth of the Touws River, water is pushed through the Serpentine and Eilandsvlei to Rondevlei. The water level builds up and the mouth is forced open. The whole system then drains, clearing silt and debris into the sea at Wilderness.

Constrictions have now occurred in both the in and outward flow of water at four points in the system. They have given rise to increased flooding problems, and an increase in plant growth and siltation.

From east to west these constrictions are:-

(a) the new road linkage to Hoekwil which cuts directly across the Serpentine flood plain. Prior to the construction of this road, water draining to the lakes flowed virtually unimpeded across the flood plain. Now, however, flood waters are cut off by embankments, and must flow through the relatively narrow arches of the new bridge. The central arch is 52 ft. wide; while the combined width of the north and south arches, after flood waters have risen approximatelv 4 ft. above normal river level, is 78 ft. The size of the flood waters' escape route has thus been considerably reduced.

The construction of this road has created a physical barrier which restricts flooding on the east side, and thus reduces the fish breeding grounds. This has detracted further from the conservation potential of the area. Moreover, in terms of bird and animal life, this physical barrier does, in effect, isolate the two areas of the flood plain from one another.

(b) the old road bridge across the Serpentine some 300 yards east of the new road. This restricts the normal flow of water across the flood plain. During floods, however, it is submerged and in this respect it is not a major problem.

(c) the gravel road across the Eilandvlei-Langvlei linkage which was built to connect the National Road to the inland road between Wilderness and Rondevlei. The Eilandvlei-Langvlei linkage is a wide, shallow stretch of water. At normal lake level water depth is 12 inches. Flow is now confined to a 10 ft. box culvert.

(d) the road across the Langvlei-Rondevlei linkage. This linkage has been similarly affected. Three 24" concrete pipes now form the only outlet, and have reduced the flow between these lakes to a mere trickle.

This lack of velocity in all the channels owing to the constrictions severely reduces any scouring action which might lead to the removal of reed growth.

Because of the constriction at the two causeways, levels within the lakes do not fluctuate as much as before. The result is that lands adjacent to the lakes suffer from a much higher water table. Furthermore "Rondevlei has a very high salinity at present (16gm/l compared to 36gm/l for seawater) and the indications are that its seepage outflow is lower than any of the other lakes. Thus if isolated its salinity could well rise to much higher levels and it is probable that the present excellent fish life in this lake would suffer. On the other hand the growth of reeds along its shore is likely to be reduced by higher salinity, and boating and swimming would be improved" (9).

Coupled with these factors is the fact that the Touws River mouth is opened prematurely owing to the danger of flooding. At one stage this was done because crops were threatened, and later because certain houses and caravan parks on the river were in danger.

Premature opening has resulted in the general level of the system being consistently kept at a low level. This has given rise to the outward growth of plant life within the lakes, particularly Rondevlei and Langvlei. It has therefore provided an added stimulus for siltation, particularly in the linkage channels. Furthermore the natural migration of fish to the sea for breeding purposes has been prevented, and fish are generally isolated within Langvlei and Rondevlei.

When the Touws River mouth has been opened by floods the level of the water is generally higher than sea level. Moreover with natural opening the mouth is broad and

once the westward flow of water has reduced the level of the lakes to that of the sea, sea water enters the river with the rising tide and the mixture flows out with the ebb. Only during Spring tides does sea water flow into Eilandvlei. Furthermore the salinity of the lakes is seldom the same for the mouth does not remain open for long. It is apparent however that the water within the lakes is never entirely fresh(10). During the dry summer months the salinity reaches maximum proportions, but it is never as high as that of sea water (see salinity recordings p.27). Rondevlei has by far the highest salinity and this is attributable to its lack of feeder streams and evaporation.

The siltation of the Serpentine is of particular concern. Old residents have reported that formerly one could not touch the river bottom, whereas in some parts the water is only chest high at present.

With premature opening the volume of silt accumulated at the mouth cannot be forced out into the sea with the result that boating and skiing become impossible in many sections of the river.

In 1971 one of the highest flood levels - approximately 10 ft. above the normal level of the water - was recorded. The river mouth was opened prior to the normal recognised danger level being reached. Had it not been opened the flood level could have been considerably higher. As mentioned before, the quantity of rainfall is unpredictable and such floods will always occur.

The logical solution to this problem would therefore seem to lie in the State or Provincial Administration acquiring all land subject to flooding within the system; and permitting the natural process to continue. (The only problem in the acquisition of land would be the fact that the present high water mark conflicts with the old owing to the road linkages across the system which have raised the flood level. Optimum improvements within the system should therefore be made prior to the acquisition of the land.)

If this happened control over the opening and closing of the river mouth would not be necessary. This natural process should be assisted by means of dredging the Serpentine and possibly the other linkages. At the same time additional gaps should be made in the road embankment across the Serpentine, particularly the northern section, and the bridging across the other two lake linkages should also be improved. Ideally all roads cutting across this system should be closed, and the area should be allowed to return to its natural state. However, the cost of reconstructing the Hoekwil linkage

would be as detrimental as the present location of this road. To my mind the problem is that developers may regard the introduction of this main road across this flood plain as a stimulus to develop various forms of recreational development, since it has changed the primitive character of the Serpentine region. The potential of this area for conservation of flora and fauna has therefore been reduced to a certain extent. Furthermore the cost of improving the existing road at the base of the escarpment, and completely removing the linkage across the Serpentine would be prohibitive.

It should be borne in mind that the Serpentine forms ideal fish feeding grounds and the system's only exit to the sea. Contamination or alteration of this section of the system could result in a complete decline of the entire ecological balance in terms of fish life, bird life and the whole biotic community.

3.4.2 Swartvlei-Ruigtevlei Ecosystem

The main components of this ecosystem are Vankervelsvlei, Ruigtevlei, Karataravlei, Swartvlei and Swartvlei Lagoon; and the Wolwe, Diep and Hoëkraal Rivers.

The virtually unknown fen of Vankervelsvlei, situated 550 feet above sea level east of Ruigtevlei, comprises marsh and reeds to-day. It appears to have followed a normal succession process of siltation and encroachment of aquatic vegetation, as with Ruigtevlei and partially with Karataravlei. On the available geological information it is not possible to determine whether this isolated vlei forms an underground catchment for the Groenvlei System, or for the Swartvlei System via Ruigtevlei. It is adjacent to Ruigtevlei, and it is possible that the underground drainage pattern follows the old exposed lake bed of Ruigtevlei through to the Swartvlei outlet. It has therefore been included in this Ecosystem.

Although recession of the whole lake system is a normal process, within this system it has been considerably accelerated by human interference. This is evident at Ruigtevlei and Karataravlei. The former is totally overgrown with reed, and the latter has considerable reed growth and is in danger of being overgrown. Other evidence is seen in the extensive growth of Ruppia in the areas around the edges of Swartvlei, and reed growth at the "Dragon's Head".

Miller (11) has indicated the presence of a fault underlying the quaternary deposits at Vankervelsvlei (see Geological Section E - F, Map 6). This may form an outlet for the water from this fen. The strike of this fault runs in the direction of Groenvlei, and may be a major feeder for the springs feeding

Groenvlei at its eastern section. However, it should be borne in mind that the surficial catchment area for this fen is small, and that possibly the quantity of water stored in this lake bears a strong relationship to the amount of rainfall experienced, the height of the water table, and the rate of drainage to lower lying areas. It is therefore very difficult to assess the significance of Vankervelsvlei and environs for use as a nature conservation and wild life management area, should consideration thereof be made. This vlei is completely covered with reeds.

Therefore its main conservation potential will be in its use as a bird sanctuary, although not with respect to birds which depend on symbiotic relationships in a water environment. Owing to the advantage of its isolated position it should be considered for this purpose, despite the disadvantage due to the fact that it is surrounded by pine forest which is in the main sterile to any form of flora and fauna. Very little is known about this fen. Its significance in relation to this ecosystem, and to a wider field, should be investigated in detail.

Table 5. Physical and Chemical Parameters in Swartvlei (13)

Depth m	Temperature °C	Oxygen mg/l	Salinity °/oo	Date
0	19.8	6.0	4.9	
3	19.1	5.8	5.2	
6	-	1.2	10.0	21 April, 1971
9	21.8	0.0	-	
12	21.0	0.0	15.3	
0	13.2	7.2	5.8	
4	12.4	-	-	
7	-	1.0	10.8	6 June, 1971
10	20.2	0.0	-	
12	20.0	0.0	15.3	

From the above table it can be seen that Swartvlei can be divided into two distinct water masses; a surface layer of between 4 - 5 metres deep and a deeper layer of 6 - 7 m deep. There seems to be little mixing between the dense, warmer layer at the bottom, and the fresh, colder water at the surface. The pH varies very slightly, being 7.2 near the surface and 6.8 near the bottom; after floods in August 1971

the surface pH dropped to 6.3, the bottom staying at 6.8 (14). (It is interesting to note, as indicated in Table 2, that the pH value recorded for April 1951 was in the region of 9.2).

The water has a salinity gradient and there is humic (peat) colouration of the surface waters, which is typical of most rivers and lakes in the area. The other lakes in the Wilderness system have little or no stratification.

From a depth of 5 m oxygen starts to decrease, and an anaerobic hetrotrophic community appears i.e. a community which requires no oxygen to survive, and which is self-supporting, obtaining its food supply from organic food.

As the distribution of oxygen in the lake is confined to the upper levels, it is apparent that the fish life will be concentrated almost entirely on the fringes. The acidity and salinity in this instance do not have a significant bearing on fish life although salinity would generally tend to check the outward growth of the water grass, which grows prolifically around the edge of the lake. This water grass (generally known as the "Swartvlei weed" owing to its nuisance value to persons wanting to gain access to the water) plays a vital part in the functioning of the ecosystem as:

(a) a feeding ground for fish,
(b) a protection ground for small fish,
(c) a rich cultural area for bacteria and diatoms, and
(d) a sponge and filter.

All life is orientated towards the weed, and the whole biosphere is dependent on it. (12)

Should the weed in the lake be removed it is probable that the entire bacterial community within it would be released into the lake, which would then become eutrophic, with pea green colouration and slimy. This algal growth would reduce fish life and the amount of light entering the water. The entire eutrophic mass might then be washed out to sea resulting in the lake becoming sterile owing to the acidic content of the inflowing water. (It is imperative therefore to retain a certain amount of weed within this lake(15).)

On the basis of the 1936 aerial photographs, Chunnet (16) indicates that there did not appear to be any water grass in Swartvlei at that time. Examination of the 1944 photographs showed that the weed growth was approaching its present limits. No weed was, however, evident along the north east shorelines (see Map 10). In 1964 a tidal wave which coincided with spring tides created a 3 ft. rise in lake level. The

resultant inflow of salt water killed a considerable amount of weed, despite the fact that both varieties of water grass require, or can withstand, highly saline conditions. (17) Beacons were placed in the water about this time, and the prolific growth of weed into the lake, has occurred since then. The new growth is clearly visible on the December 1968 aerial photographs. This indicates that a large increase and a rapid change in the salinity killed off certain amounts of this plant. When normal lake conditions were established again, prolific growth once again took place.

In 1928 the railway bridge was built across Swartvlei. Owing to the fact that soft sand was found down to 136 ft. a foundation for the bridge was constructed by dumping stone across this section. Bridge piers were then cast on this embankment. There are 22 spans, one of which is 30 ft. wide and has a water depth at normal lake level of about 5 ft. The other spans are 12 ft. wide, and each has a 36 inch pipe set into the crest of the rock fill which is just submerged at normal lake level. In 1958 some rock was removed to improve the waterway area.

As a result of this barrier the flow pattern within the lake has changed. The present movement of the water is directed by the flow from the two main sources; Karatara/Hoekwil on the east, and the Diep and Wolwe Rivers to the west. Two anti-clockwise eddies of water are created in the two deep sections in the north east. The resultant build up forces the water to move southwards. Flow is then retarded by the southern shore, and the water is forced to move into the middle of the lake where it joins the other main stream from Karatara/Hoekwil flowing directly through the openings in the railway bridge in the south east.

Deposition of silt is possible where the water velocity is retarded namely along the southern bank, the north eastward tongue partially separating the two major "holes", and the areas immediately above the blockaded section of the bridge. Siltation due to the small clearance of water near the railway bridge is also considered a major problem.

As weed growth is confined to a maximum depth of 3 metres it is therefore possible that by 1944 the general topography of the lake had already been affected by the changed water flow. Chunnet (18) has indicated that no significant amounts of sand, silt or clay are entering the lake from an external source. (This is also evident from Table 5). He mentions too that organic sediment is being created. Although it occupies only a very minor fraction of the volume of the lakes, this promotes plant growth, "which by suppression of the erosional mechanism traps other sediment in suspension."

Rondevlei Nature Reserve

Pine Lake Marina

Montmere

SWARTVLEI:- WEED ENCROACHMENT AND DEPTHS.

Compiled from Chart prepared by Mr. J.M. Jooris Box 22, Sedgefield. for SAFMARINE.

SCALE 1:18,000

N

WEED LINES

1944

1959

1964

1969

DEPTHS (in feet)

1964

1969

1969 Weed Line approximates 7-10' Depth.

In support of this, Map 10 indicates the change in submerged topography within Swartvlei between 1964 and 1969, and the outward growth of weed for the years 1944 (approximate), 1959, 1964 and 1971. This change in topography could be attributed to the swirling motion experienced during flood periods. There is evidence of discolouration of the water during the 1954 and 1965 floods (19).

Another possibility related to the growth of weed is the fact that plant communities have climax periods of growth - cyclical periods ranging from 30 - 40 years. This may attribute to the recent rapid growth of the weed as indicated on Map 10.

Other problems related to the above and/or which are problems in themselves are:-

(a) The possibility of the flooding of certain developments on the flood plain on the eastern side of Swartvlei which results in persons whose properties are affected opening the mouth prematurely. This results in a constant low level being attained in the lakes with the result that the weed has the opportunity of growing outward to reach depths of 10' once more. Furthermore, the railway bridge holds back a large volume of water during floods and threatens to flood more extensive areas than normal. The highest flood level recorded, reached the rails on the bridge which is approximately 9 feet above LWOST. Under average flood conditions there is often a 3 ft. difference in levels above and below the bridge.

(b) The eastern bank of Swartvlei below the road bridge has silted up, and although this has created an intertidal habitat, the area has lost its potential for water based recreation and development along the banks as a result.

(c) Fishermen are apparently opening the river mouth prematurely to attract fish life to facilitate netting. (20)

(d) Constriction of the volume of water, coupled with premature opening, has resulted in the general deterioration of the lagoon side of Swartvlei. Channels exist, but the volume of water is insufficient for adequate flushing of the mouth, with the result that the bar is becoming wider annually.

(e) Tidal rise in the lake is generally never higher than 1 ft. This has reduced the amount of shoreline suitable for boating.

(f) As already mentioned, premature opening of the river mouth has resulted in the weed being able to extend further into the lake.

The Department of Nature Conservation feels that there is generally no weed problem related to the ecology of the system. Evidence from Chunnet's report and within this report supports this.

The following suggestions take the fact into consideration that this system cannot be restored to its original state. It would seem that attempts to improve the recreational potential of the lakes, both upstream and downstream of the road and rail bridges, should make provision for:

(a) The acquisition of the entire shoreline and flood plain below maximum flood level by the State or Cape Provincial Administration. This would permit natural opening and closing of the river mouth and would facilitate clearance of silted areas within the lagoonal section.

(b) State legislation to restrict any opening or closing of the river mouth.

(c) Relocation (with compensation) or protection of all buildings subject to flooding.

(d) An increased number of channels in the road and rail barricades to permit a greater volume and more dispersed flow of water downstream, and to provide a direct outlet for flood waters from the two main sources.

(e) Deepening of the channels under the railway bridge, if possible, to remove the bank of silt which has built up making it difficult for boats to gain access to the sea.

(f) Annual weed cutting to clear boat channels, provided that this is controlled by the Department of Nature Conservation and carefully timed, as the risk of spreading the plant in the process is high.

3.4.3 Knysna Lagoon Ecosystem

The Knysna River has a typical dissected plateau and indigenous forest catchment area and opens at the head of its tidal effect into a broad valley with alluvial terraces on both sides. The stream broadens and forms the Lagoon with Thesens Island and Leisure Island in the eastern section.

Map 11 indicates the siltation which has arisen from the restriction or complete blockage of water flow within certain sections of the Lagoon. These include:

(a) Partial blockage by the infill of the old road bridge which no longer exists.

(b) Restriction of flow by the National Road infill.

(c) Restriction of flow by the railway line infill.

(d) Total blockage of flow between the mainland and Knysna by a road.

(e) Total blockage by the road linkage between Leisure Island and George Rex Drive on the mainland.

Channels in the Lagoon have definite flow lines related to openings in the various barriers. Large areas have, as a result, become totally unnavigable and others can only be utilised at certain tide levels. Maximum and minimum levels are recorded on Map 11.

The inter-tidal habitat is without doubt the most prolific in the Region, and this can be attributed to the fact that the Lagoon is open to the sea all the year round. This factor may conflict with the possibility of opening various linkages further (21).

A large proportion of the Lagoon shoreline has been developed. The southern shoreline, apart from the old township of Belvedere, the prospective township of Brenton-on-Lake and the Lake Brenton Holiday Resort, is undeveloped. Apart from the Eastern Heads, conservation management of the on-shore areas would have to be confined to this area.

3.4.4 Groenvlei Ecosystem

Groenvlei, although previously a part of the Swartvlei lakes system, and possibly of the entire lakes system west of the Goukamma, is completely isolated from any other surficial water bodies. For this reason, coupled with the fact that it is composed of fresh water, it is treated as a separate system.

Martin (22) summarises Groenvlei as "a shallow eutrophic coastal lake with a coastal sand dune catchment area stabilized by heath and dune woodland. The lake is fed by rainfall, run off, and ground water from the dunes, and is without outlet. The lake water is calcareous, it is slightly saline, rich in other salts, and well oxygenated.

Correspondingly base-rich conditions occur in the surrounding soils, and peat formation by sedge plants has formed a true eutrophic fen. Primary succession leading to fen carr, and secondary succession due to human utilization of the fen leading to fen meadow and salt marsh communities."

The lake level is 18 ft. above sea level and it remains fairly constant, with a rise and fall of approximately 6 inches to 1 foot throughout the year (23). It is possible that this lake forms the major underground water source for Sedgefield supplying water through the old Lacustrine deposits.

Care should therefore be taken in preventing excessive use of septic tanks by the hotel and caravan park and any further developments which may be located on the western extremity of Groenvlei. This is

grass & mud

Thesen's Island

grass & mud

grass & mud

Leisure Island

Belvedere

Brenton on Lake

The Heads

KNYSNA LAGOON DEPTHS.

Section East of Railway Line compiled from 1:10000 Hydrographic Chart of Knysna 1966 (South African Hydrographic Office, Simonstown)

Section West of Railway Line interpolated from 1:12,000 Aerial Photography 1958 & 1968 related to Hydrographic Chart.

SCALE 1:25,000

N

ANNUAL MAX & MIN DEPTHS.

At Mean Spr HWM	At Mean Neap HWM	At Mean Spr LWM	At Mean Neap LWM
	Marsh		
4·6'	2·8'	1'of land	1'
7·6'	5·8'	2'	3'

furthermore of concern in reducing the succession problem of Groenvlei as described above by Martin.

This lake has a unique combination of natural components namely a eutrophic water mass rich in fish life, extensive reed growth, dune woodland comprising indigenous milkwood forest providing habitat for small game and bird life, and fynbos. Although ideal shallow water conditions do not exist for wild duck, marsh conditions do exist and, as a result, although it has not been proved, ducklings fall prey to the largemouth bass (24).

Harmful effects on this ecosystem have been the developments of the National Road and railway line which are located directly adjacent to the northern shore of Groenvlei, and the extensive cutting of milkwood forest to the east of the lake extending to the Goukamma Valley. This could be attributed in part to the fact that "the milkwood was sought after for boat building as it is a very hard durable wood and the characteristic bends and curve of the milkwood tree makes it ideal for the manufacturing of ribs, lances and elbows" (25).

Restoration of this section of milkwood forest, and removal of the subsistence farming practised there, would be most beneficial in increasing and preserving the wildlife habitat of this ecosystem.

Relocation of the road and railway line is certainly not possible. However, there is some comfort in the fact that wildlife does become accustomed to the traffic. The two pockets of milkwood forest north of the road and railway line have become isolated from the lake.

The Department of Nature Conservation is in the process of completing a contour map of Groenvlei. Of concern is a narrow shallow ridge which extends from the eastern extremity of the lake for some 800 metres into the centre of the lake. As mentioned earlier, the bottom of the lake is covered in water grass, and coupled with this shallowness, the ridge could give rise to a rapid increase in the succession process in the eastern section of the lake.

3.4.5 Goukamma River Ecosystem

The catchment of the Goukamma comprises heavily dissected plateau, densely vegetated with indigenous forest in the valleys. This typifies all other river catchment areas in the Region. These valleys form natural barriers to man, and have preserved the remains of forest which may have covered the entire plateau region at one time.

The main stream opens out into a flood plain and meanders to the mouth. Milkwood forest covers the steep sides of the western valley wall. The alluvial plain is fertile and comprises rich grazing land for cattle in the main. Flooding is a regular feature.

1936 aerial photography reveals that the entire river mouth comprised drifting sand dunes which threatened to block the river mouth and cover the forest and fynbos veld in the vicinity. Furthermore, the river did not open directly to the sea but swung westwards approximately 1 km from its present location i.e. the annual variation in outlet probably covered the distance between the western extremity and the T.M.S. outcrop to the east. At one stage the river did open regularly at this outcrop (26). The dunes shifted owing to the wind directional onslaughts in Summer and Winter namely south-east and south-west respectively.

"During 1955 the floodwater of the Goukamma River entirely swept away a firmly fixed littoral dune at the river mouth. This resulted in a long and difficult programme of river training and sand reclamation which is now being undertaken by the Department of Nature Conservation". (27) The result has been the reclamation of the littoral dune on the western side of the river mouth.

Problems which now arise are:

(a) The eastern bank, which comprises picnic sites on reclaimed drift sands and the old river channel, is eroded and flooded extensively. This necessitates continuous reclamation work and strengthening of the river bank which is expensive.

(b) Erosion of once reclaimed drift sands is occurring toward the river mouth on the east bank. This threatens to undermine the main road to Buffalo Bay.

It would appear that the main road to Buffalo Bay may have been aligned approximately at the eastern extremity of the flood line of the Goukamma River.

A solution to both problems will be costly. They should, however, be carefully considered, particularly in view of the possibility of drift sands re-appearing.

Tampering with the mouth could lead to adverse effects on the river further upstream. An investigation into this problem should be carried out by the C.S.I.R. Hydrological Research Institute. As the river has forced openings to the sea in the past with no apparent effect upstream, I feel a possible solution to the

problem, although costly, would be to open the littoral dune at present being reclaimed, to allow a more perpendicular flow to the sea. (Sketch 6) Extensive reclamation and stabilization of the eastern bank, the river bed and beach front, would then be necessary to bear the onslaught of floodwaters. The reclaimed land would provide extensive land for recreation in a natural environment, and annual flood damage costs would be reduced to a minimum. The cost of such a project should be related to the public benefit of recreation in a natural environment for posterity. Moreover, the long run costs of such a scheme will definitely not exceed those of a series of short run costs which would be made necessary in constantly reclaiming land eroded away by annual floods.

Owing to the acidity of the river, fish life is not abundant. However, the bird life is plentiful (116 varieties have been recorded by a number of people (28).

The tidal effect of the river extends up to the National Road bridge and the river is fairly deep. (See Map 2) The mouth is closed for the most part and the water relatively fresh at times. Land on the flood plain is valued at R2000 per morgen at present. The cost is probably prohibitive in terms of acquisition by the Department of Nature Conservation for conservation purposes. This river valley appears ideal for primitive recreational and conservation management purposes, and if not the whole, then some portion at least should be acquired for this purpose.

3.4.6 Coastal Fynbos Ecosystems

These ecosystems comprise the extensive coastal plateau which rises east of the Touws River Mouth and continues along the entire coastal stretch of the Region, with three breaks permitting the outflow of the Swartvlei, Goukamma and Knysna Lagoon waters. Most of this section could be classified as Coastal Sand Dune Veld with the exception of the stretch east of Brenton-on-Sea to Noetzie which comprises a more stable rolling plateau landscape, and consists entirely of fynbos and indigenous milkwood forest in the hollows and along the cliff face.

Reclamation of drift sand has been achieved by the use of exotic acacia species and also to a lesser extent fynbos specie. Large tracts of drift sand occurred at Swartvlei Peninsula, Goukamma River Mouth and Buffalo Bay and the area east of Touws River extending along the plateau to Kleinkrantz.

An understanding of the ecological relationship of plant life to dune formations is vital, not only in the consideration of the stabilization of dunes, and wild life associations, but also in the use of these areas for recreation and other forms of development.

Redirecting the Goukamma River Mouth.

McCarg (29) describes the development of this environment in detail. Development begins with the pioneers(sedges in Europe and marram in the United States) which "are outstandingly tolerant to high salinity, extreme glare, soils lacking humus, an uncertain and oscillating supply of water. Indeed they thrive on these conditions, and as the sand piles around the neck of the plants, the roots extend below ground and the stems and leaves rise from the sand. The product is a dense mat of roots, which stabilize the dune below and the leaves that entrap sand and anchor it above ground level."

These dune grasses, however, cannot tolerate man as they are highly vulnerable to trampling. It is therefore important to prohibit access to the primary dune in particular, to avoid destruction of consolidated sand and encroachment inland by wind action. Disturbance of primary sand dunes has occurred at Stilbaai with the result that sand has engulfed a number of houses which were previously sheltered by the dune.

Diagrams 6 and 7 indicate the relationship between sand movement, salt spray, soil salinity and soil moisture, and the tolerance levels of the sand dunes to development respectively.

Soil moisture tends to remain fairly constant, and this is attributable to capillary action which causes water to rise within the sand dunes. A major problem in this respect is that where shallow wells are used in the vicinity of sand dunes, the groundwater is lowered below a critical level and the stabilizing plants die. Often water is extracted too quickly resulting in the sand being unable to filter the brak water. In certain places there is a high water table in the primary dune and in the hollow behind the secondary dune. In such places water is found at a depth of between one and two metres. The water is generally not very brak and is potable.

The second problem is that of breaking the primary dune or trampling of the dune grasses. This area must be prohibited to all, and access to beaches must be achieved by bridging such areas. If the primary trough area is over-developed, run-off water will be increased dramatically by water drained from roofs and paving that direct the run-off into drains and piped waste-water systems. A third prohibitive measure should be to prevent the interruption of littoral drift by means of groins or any other tangential structure. This will prevent the perpetuation of a natural sandbar and its native vegetation and expression.

The inland dune is the inland bar of defence and is as vulnerable as the primary dune. The backdune, however, is generally more tolerant and fresh water is more abundant in this environment.

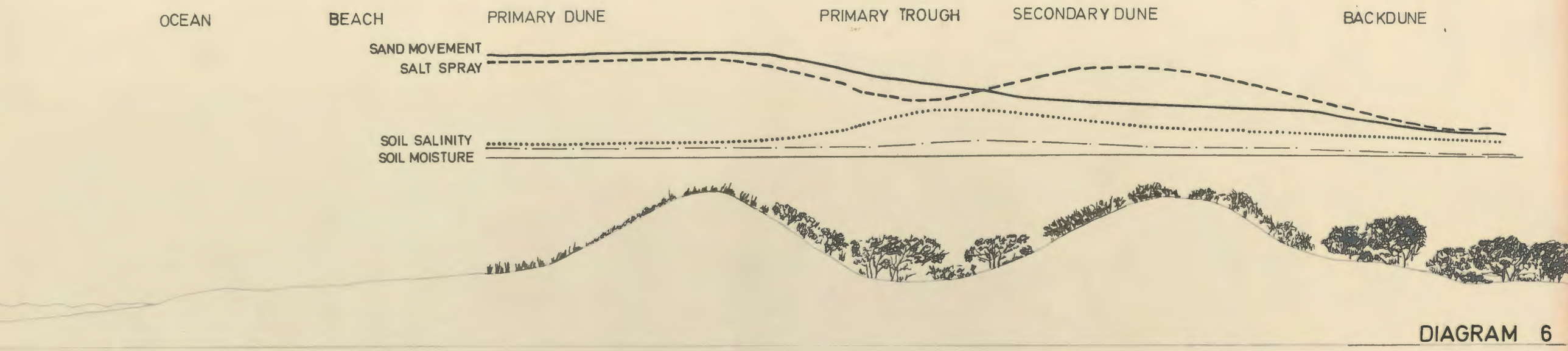


DIAGRAM 6

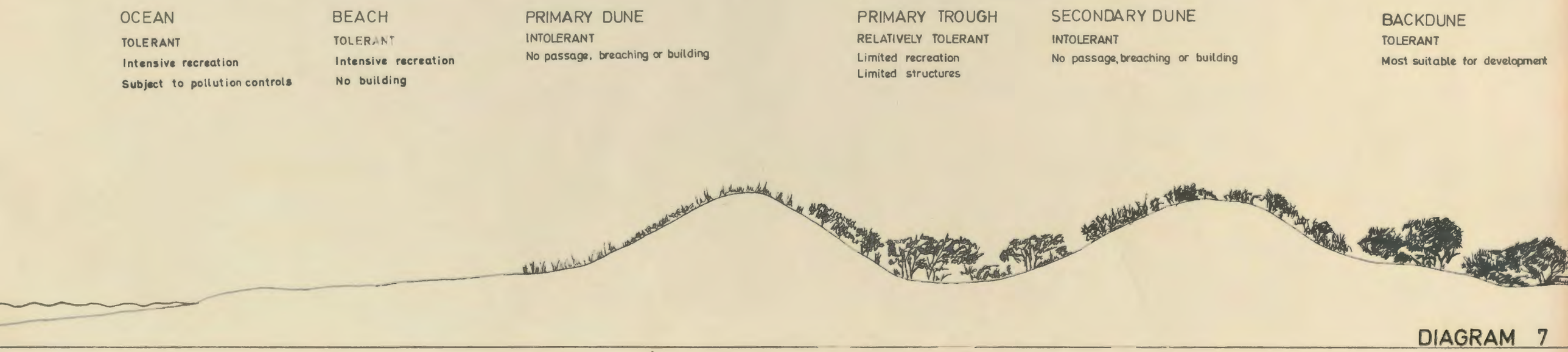


DIAGRAM 7

DIAGRAM 6: SAND DUNE PLANT ASSOCIATIONS: RELATIONSHIP TO PHYSICAL ELEMENTS

DIAGRAM 7: SAND DUNE PLANT ASSOCIATIONS: TOLERANCE LEVELS TO DEVELOPMENT & RECREATION

McCarg (30) indicates that the development of highways running concordantly with and on the backdune could result, if sufficiently elevated, in a third dune.

Septic tanks are liable to pollute the water supply in such environments owing to the high water table.

Plant associations in this coastal section appear to have similar processes to those described by McCarg. The development of dune heath (fynbos) is described in detail by Philips (31) from tide washed pioneer plants to the climax stage of dense littoral bush.

Briefly a primary and secondary dune are formed by wind action in sand and the seaward encroachment of plant life. Initial stages of the secondary or inland dune are first formed at the thicket line. The primary dune forms when the dune grass community is established on the secondary dune, and has advanced seaward to the high tide line. Wind action removes sand in front of the secondary dune and the established dune grass community initiates primary dune formation. Large plant species invade the rising backdune sand under the protection of the growing secondary dune and advance seawards and inland. Mesic or medium moist conditions in the primary trough resulting from a high water table and capillary action allow dune grass communities to spread seaward. As the primary dune is established, the secondary dune is stabilized. Salt spray is reduced by the primary dune and thickets replace dune grass.

In the case of Swartvlei Peninsula moist conditions on the backdune have possibly given rise to the well established milkwood forest. Where moist conditions do not occur in the system typical fynbos is dominant in the troughs, and dry northern slopes sparsely vegetated with the metalasia (blombos) species of fynbos. The steepness, height and orientation away from moist sea air create unstable conditions on these northern slopes, and creep and collapsing are common with heavy rainfall. Even above the milkwood forest on the Peninsula typical dry northern slope persists.

No development should be permitted on the crests of the stabilized sand dunes and only limited recreation and structures should be permitted in the primary troughs. Buffalo Grass (Stenotaphrum secundatum) has been planted within primary dune troughs with success, enabling more intensive forms of recreation and development to take place.(32)

With moist conditions prevailing, the backdune trough is tolerant of development. Opportunities for putting this principle into practice occur at the Swartvlei estuary, Goukamma River and at Touws River East.

OCEAN BEACH PRIMARY DUNE PRIMARY TROUGH SECONDARY DUNE BACKDUNE

Sea pumpkin

Sea pumpkin

Stunted coastal scrub
Fynbos Sp.
Milkwood
Acacia Sp.

Milkwood forest

Dry Northern slope

Metalasia veld (blombos)

Milkwood forest

Fynbos (Littoral bush)

SAND DUNE PLANT ASSOCIATIONS WITHOUT THE PRESENCE OF EXOTIC ACACIA SP.

DIAGRAM 8

The drier inland section of the secondary troughs constitutes dense impenetrable littoral bush (fynbos).

Passarena sp. of fynbos (gonnabos) which is resistant to sea spray grows both on inland and littoral sand areas, and may have been the original plant within the primary troughs prior to the succession of the highly resistant Milkwood Forest.

Marram grass (Ammophila arenaria link) is a perennial pioneer species and would have existed prior to the stunted coastal shrub. These plants are tenacious and hold sand very well and their roots penetrate the sane dune to a depth of several feet.

Diagram 9 indicates its presence relative to the succession of exotic acacia sp. Marram grass is rapidly suppressed and killed by the exotic acacia scrub. (37) In this example, nowever, the exotic acacia cyclops (Rooikrans) is present and is reluctant to grow in exposed areas. The specie Myrica quercifolia (maagpynbossie) and cordifolia (wax berry) dominate the secondary dune and backdune. The succession of marram grass by Passarena sp. (gonnabos) and other indigenous acacia or fynbos species has not yet been achieved.

Passarena sp. comprises low bush which grows to a maximum height of between 1 and 1½ m. and therefore thrives in association with the Rooikrans which achieves a height of between 3 and 4 m. Myrica sp. attains a height of approximately 1.6m. and is generally succeeded by Rooikrans in the hollows.

Ficinia sp. is found together with Passarena in the hollows and attain approximately the same height of ½m.

Diagram 10 represents a typical section across Swartvlei Peninsula. Prior to reclamation work, the area comprised a barely consolidated primary dune comprising marram grass, a secondary dune which checked the seaward movement of sand, and a tertiary dune which developed typical dry northern conditions while the secondary trough contained milkwood and patches of blombos.(38)

The area has since been totally reclaimed with Acacia sp., which has reached the crest of the secondary dune. Patches of blombos have progressed southwards into the acacia. The primary dune is covered in low acacia with newer patches of marram grass. Sea pumpkin is found in patches on the beach, though during storms and spring tides, the primary dune is undercut to a certain extent which does not make it a suitable

OCEAN BEACH PRIMARY DUNE PRIMARY TROUGH SECONDARY DUNE BACKDUNE

Sea Pumpkin

Marram grass

Ficinia Radiata (Star grass)

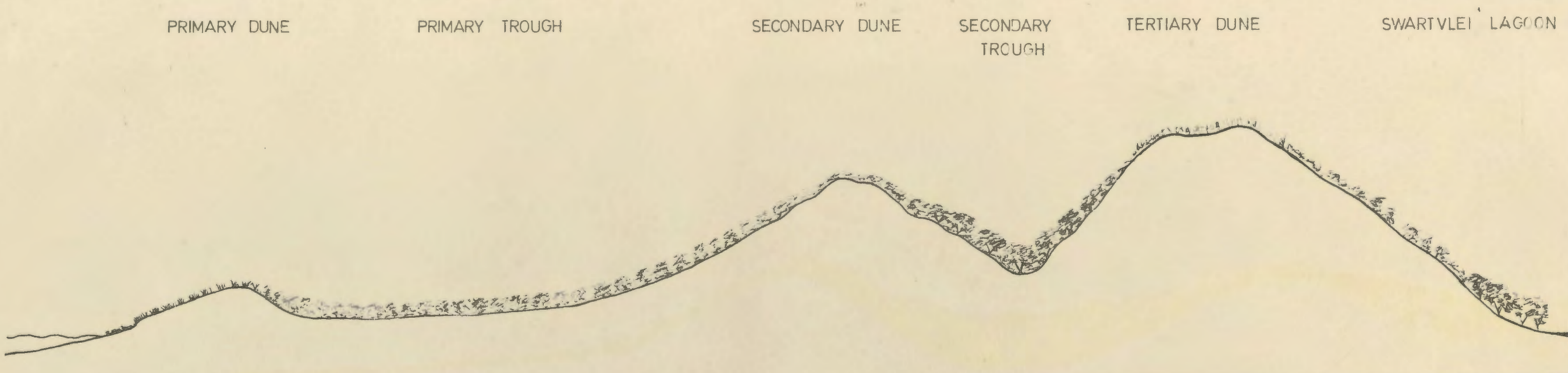
Myrica Quercifolia (Maagpynbossie) 1-1½ m
Myrica Cordifolia (wax berry)

Passarena Sp. (Gonnabos) 1-1½ m

Acacia cyclops (Rooikrans) (exotic) 3-4 m

ACACIA DOMINATED DUNES

DIAGRAM 9



Sea pumpkin

Marram grass

Acacia Sp. (Rooikrans)

Dry Northern Slopes

Metalasia (Blombos)

Milkwood (Sideroxolon)

Milkwood

Scale 1 : 9,600

No vertical exaggeration

TYPICAL SOUTH-NORTH SECTION AND PLANT ASSOCIATIONS ACROSS SAND DUNES ON SWARTVLEI PENINSULA

DIAGRAM 10

environment for this plant. However, this dune is well consolidated and withstands the impact of wave action.

The primary trough is well vegetated and virtually impenetrable. The texture of the soil has changed somewhat from the resulting debris. Development in the form of limited structures could be permitted. The secondary trough is too steep and isolated to be of significant recreational value. It forms a sheltered bird sanctuary in the milkwood and should be retained as such, particularly in view of the close proximity of the Swartvlei Lagoon - an ideal environment for accommodating many varieties of bird life.

As mentioned earlier should sections of this primary trough be cleared for development Buffalo Grass (Stenotaphrum secundatum) can be used with great success to retain the stability of the sand.

3.4 7 Kaaimans River Ecosystems

Apart from three houses on the western bank of the river, the National Road and the railway bridge, this river has not been significantly affected by man.

It has a typical catchment area and its brown acidic waters are not conducive to fish life.

Conservation management should be orientated towards protection of the indigenous forest, possibly with the provision of related primitive recreational facilities. This area is a potential scenic reserve. The river banks are precipitous and natural protection of wildlife is afforded. No further development should be permitted.

3.4.8 Noetzie River Ecosystem

This relatively small river has its entire catchment area in indigenous forest and plantations. Acidic waters produce sterile conditions for fish life, and tidal action is minimal owing to the large sand bar across the mouth.

The eastern bank forms the boundary of the Harkerville Forest.

3.5 WILD LIFE HABITAT

3.5.1 Introduction

Wild life habitat regions can be divided up into three major categories. These include:

(a) On-shore habitat
(b) Under-water, wetland, and water associated habitats
(c) Inter-tidal habitat (i) Sea-shore reserves
(ii) Estuarine or lagoonal conditions.

As mentioned previously, the Region comprises a complex series of interrelated ecosystems of which the on-shore habitats form part. These habitats overlap the ecosystem boundaries as described already and demarcated on Map 9. They provide meaningful constraints for determining conservation management areas specific species of flora and fauna and in conjunction with the defined ecosystems (together with their water-based habitats (a, b and c) above) provide the mechanism for total consideration of flora and fauna conservation management.

(a) On-shore habitat is related in the main to natural vegetation areas. Some species of animals or bird life are very specialised and are strictly confined to closed habitats (dense vegetation) and are reluctant to venture into open habitat regions. They are adapted to only "feel at home" in environments of this kind.

At the other extreme we have species which are specialised inhabitants of open habitats and do not willingly go into dense vegetation. These behaviour patterns are a function of the physical and psychological attributes of the species. (39)

(b) Under-water habitat here relates to the total biotic community living below the surface of the water and this, together with wetland and water associated habitats form yet another set of overlapping and interrelated ecosystems. Of major importance in this respect are the symbiotic relationships of plant, fish and animal life interrelated with each of these three habitats and in this respect are inseparable. For example, fish are provided with an under water environment and are associated with wetlands for food and breeding purposes. Wetlands are vital wildfowl habitats and provide natural bird sanctuaries. These feed on organisms, plant life or fish within these areas and re-fertilize the water bodies, thereby replenishing the system.

Wetlands are regarded here as being those areas which are related to continuous or sporadic association with water and plant life e.g. marsh and reed environments or areas which are from time to time subject to flooding.

Water-associated habitat refers here to animals and birds etc. which are related to water-bodies but not located permanently within a water body.

The values of inter-tidal habitat include the following:

(a) It provides a nursery for young fish which feed on the rich vegetation and invertebrate life of these flats.

(b) Mud prawns (Upogebia Africana), sand prawns (Callionassa kraussii), and others feed on vegetation and organisms found in these areas. Mud prawns are filter feeders, and they in turn are a valuable source of food for the bird and fish life. They are therefore a vital link in the food-chain process.

(c) Many species of bird and fish life are directly or indirectly reliant on inter-tidal rock zones in the sea. Per square metre this forms the richest area of animal life to be found anywhere

(d) Spring tides create flooding of vast areas of lagoons which provide excellent bird life habitat. Furthermore these areas form a rich food supply for fish. In turn smaller fish are protected at low tide from other fish, and bird life is given the opportunity of feeding on bountiful supplies of fish.

Estuaries are areas of brackish water, where the fresh water from the river meets the salt water of the sea and a gradient of salinity is established between the two. As the tides flow in and out the salinity at any point of the estuary increases and decreases and the fauna and flora is adapted to tolerate such changes. The river water carries with it much that has been derived from the drainage basin. In times of flood there will be mud, particularly if the lands are eroded, rotting plants debris from the river banks, and plant nutrients leached from the soil. When this river water reaches the calm saline water in the estuary, the suspended mud is deposited, the humus is precipitated by the salt, so that the banks of mud and sand along an estuary provide ideal conditions for the growth of all plants that can tolerate salt water.

Although they may be dreary to look at, these salt marshes provide the food on which the estuarine fauna depends. Indeed, experiments have proved that the quantity of food produced by an estuary is as

great as that from good agricultural land.

Not many animals feed directly on the living plants, but as the leaves die and rot on the mud the nitrifying bacteria actually increase the protein content, until a rich vegetable soup drifts around the estuarine water. This provides food for a host of animals - worms, shellfish, shrimps, crabs, certain fishes such as mullets and some birds such as shovellers and ducks. The small invertebrates in turn provide food for predators, particularly fish. Estuaries are ideal nursery grounds for young fish such as stumpnose, dassies, white steenbras and grunters. All of these breed in the sea when mature, but many large fish enter the estuaries to feed in the summer when the estuarine water is warmer than the sea. It is difficult to overemphasise the importance of estuaries in the economy of the sea and yet it is these estuaries which are most easily damaged by human activities.

3.5.2 On-Shore Wild LIfe Habitat

Map 12 indicates the wild life habitat of various animals and birds in the Region. Bird life, apart from wetland areas and water bodies, is in the main related to the indigenous forests. Furthermore the number of common species which occur in the Region exceeds 100, and individual mapping is thus impracticable. The acacia species do not form good wild life habitats and only two bird species are associated with them, namely the Starling and the Rameron Pigeon (Bush Dove). Of great concern is the encroachment of the acacia sp. inland which is reducing the wild life habitat. The only areas in which this species of plant do not encroach are those which provide a thick canopy namely exotic and indigenous forests.

Generally wild life habitat comprises "closed" or "open" habitats or a combination of both.

(a) The indigenous forests provide the closed habitat in the region and species which inhabit these areas include:-

(i) The Knysna Elephant - confined to Harkerville Forest bordering the study region.
(ii) The Blue Duiker - a browser of young bush and shoots in the main.
(iii) The Leopard - a fine species, white with dark rosettes.
(iv) Baboons.
(v) Bush Pig.

Mr. Hjalmer Thesen is of the opinion that the reduction in the number of wild life species present is related to the change in symbiotic relationships brought about by man.

ON-SHORE WILD LIFE HABITAT

- Closed
- Open
- Nature Reserves

BASE LEGEND

National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops

Contour at 50' intervals

1:100,000

KNYSNA

Knysna Lagoon

Brenton-on-Sea

INDIAN OCEAN

The lush indigenous forests provide a plentiful food supply for the elephant. Protection was therefore afforded the Blue Duiker which followed the elephant through the forests. With the reduction of elephant, the blue duiker was no longer protected and fell prey to the Serval Cat and to a lesser extent the lynx. The numbers of serval cat were related to the numbers of lynx.

He maintains also that the abundance of lynx in the region is related to the overspill of lynx in the Little Karroo across the Outeniqua range because their numbers increased as a result of the reduction of the chief predators of their young - namely the jackal and serval cat.

His main concern is the shooting of the leopard by farmers. The problem stems from the fact that farms and homesteads are located on the fringes of the indigenous forests with the result that the natural reaction is for leopard to stalk the easy prey of domestic stock. His suggestion is that the leopard should be proclaimed Royal Game, and that a state fund should be set aside for the subsidization of farmers who have sustained stock losses due to the leopard. It has been suggested that leopards should be trapped and removed to remote parts of the indigenous forests. (41)

The need to preserve indigenous forests is reflected in the fact that these areas attain the maximum wild life conservation suitability rating for apart from the importance of its preservation as natural vegetation, in itself, it represents the greatest aggregation of plants and animals to be found in the region.

The encroachment of exotic forests on the land once occupied by indigenous forests is not desirable in terms of conservation of flora and fauna. However where this has taken place, an important relationship rests on the association of the bush pig and baboon with the pine forests - namely their feeding on the larvae of the Emperor Moth and the Christmas Caterpillar. If these species proliferate unchecked, they can and do breed in sufficient quantities to devastate entire plantations. Plantations in mountainous areas do not suffer from these species due mainly to the constant presence of the baboon. (42)

Fortunately considerable areas particularly in steep ravines, are not accessible for forestry exploitation and therefore are provided natural protection.

(b) Open habitat areas in the Region comprise fynbos or associated rough grazing areas in the main.

Wild life associated with these includes:-

(i) The Grysbok - commonly associated with the strong sweet-smelling herb "Bughu". (43) It is found solely in the fynbos areas and coastal dunes.

(ii) Lynx - a main predator of the grysbok and the extensive population of the fynbos areas and coastal dunes.

(iii) Larger animals which once abounded in the fynbos regions, in particular the thicker and harder littoral bush zones, included: buffalo, eland, Hartebees and bontebok. It is anticipated that these may be re-introduced into the Goukamma Reserve. (44)

Although Dry Northern Slope (fynbos) areas will not support such wild life, their total physical and vegetable preservation is of utmost importance.

(c) Wild life which requires both closed and open habitats and which generally shelters on the fringes of the "closed" areas includes:-

(i) Pheasants, red necked franklyn, red winged partridge.

(ii) Guinea Fowl.

(iii) Bush Buck - in fynbos and milkwood forest.

3.5.3 Wetland, Water and Water Associated Habitats

(a)

Marshes should be protected together with their fresh and sea water sources of supply i.e. the whole water mass from the catchment to the outlet should remain completely natural, and the incoming waters should be left unpolluted - in other words such water bodies should be treated as ecosystems. Stagnant marshes such as Vankervelsvlei and Ruigtevlei provide environments for different communities.

These include in order of priority: Groenvlei; Serpentine; Rondevlei; Knysna Lagoon and the "dragon's head" of Swartvlei; Karataravlei, Ruigtevlei, Vankervelsvlei and Bolangvlei. Knysna Lagoon provides excellent sanctuaries for bird and fish life amidst its extensive tracts of salt water marsh. (See Map 11)

(b) Under-water habitat comprises in the main fish life which abounds in the lakes and Knysna Lagoon. All water bodies have large quantities of fish and are protected in terms of the General Ordinance which permits fishing under licence only, except for Bolangvlei, and more recently, Swartvlei where netting is permitted. As mentioned previously fish life in Swartvlei is related directly to the presence of oxygen and is confined to a depth at maximum of 7 metres. The central portions of Swartvlei

are only frequented by migrating fish at the surface of the water.

Netting, in terms of conservation of fish and the amount of fish available for the recreationist, is not desirable. Consideration should be given to the prevention of such activities in future.

For conservation management suitability purposes each water mass has been given the same weighting as far as fish life is concerned apart from those which are sterile owing to acidic waters (see Map 13). These include all the rivers and the central areas of Swartvlei.

(c) Water associated habitats refer mainly to bird species which rely on water bodies for their existence. These species are related primarily to the indigenous forests and other forms of vegetation associated with water bodies. (See Map 13)

3.5.4 Inter-Tidal Habitat

Reclamation works, e.g. marina development or extensions to land masses, in these areas could damage the whole lake or lagoonal system if an assessment of the location of major concentrations of all forms of wildlife and their symbiotic relationships is not made.

There are three inter-related zones in the region, namely Swartvlei Lagoon, Knysna Lagoon and the sea inter-tidal zone.

Swartvlei Lagoon, as with the other rivers in the region, has a blocked mouth for most of the year, and therefore does not form as rich an inter-tidal habitat as the other two areas, i.e. the water level remains fairly constant for most of the year. Here the Sand Prawn occurs mainly. Another area is the Kaaimans River mouth.

The following areas in particular contain major concentrations of particular species and should be conserved and managed (see Map 14). (45)

(a) Mud Prawn Callianassa kraussii, large concentrations of which occur on the Knysna Lagoon.

(b) Blood worm Arenicola lovenii, which occurs in the tidal sands at Leisure Island.

WETLANDS, WATER, WATER ASSOCIATED HABITATS

- Wetland
- Water
- Water associated habitat

INDIAN OCEAN

BASE LEGEND

- National Road
- Main Roads
- Secondary Roads
- Railway Line
- Marshes
- Water Grass
- Tidal Mud Flats
- Tidal Sand Flats
- Unconsolidated Sand & Beach
- Prominent Rock Outcrops

Contour at 50' intervals

1:100,000

(c) Oysters occur in the lagoonal area to the west of Leisure Island and immediately north of the Western Heads; both these areas are located on the main channels from The Heads. Larvae are brought into the lagoon from the sea. They are prolific on exposed rocks in the inter-tidal zone between Kaaimans River and The Heads, and are being heavily exploited for local consumption. This activity should be controlled to prevent over-exploitation.

Oyster cultivation is being conducted in the Knysna Lagoon. Shallow water cultivation has been conducted although emphasis is now placed on deep water culture, as the oysters grow three times as fast under these conditions. The relevant areas are indicated on Map 14.

(d) Exploitation of mud crab (Scylla serrata) is in the experimental stage in these areas. No large concentrations of this invertebrate are apparent.

3.6 EXISTING NATURE RESERVES AND PROTECTED AREAS

3.6.1 Nature Reserves

There are three nature reserves in the area namely the Ebb and Flow on the Touws River, The Lakes incorporating Rondevlei and extending to Swartvlei, and the Goukamma. (See Map 12)

The Ebb and Flow Nature Reserve, although owned by the Provincial Administration, is run by the Divisional Council of George for the purpose of conserving the natural fauna and flora in the area, and providing picnicking facilities and accommodation in the form of primitive rondavels for the general public. Picnic facilities are also available in the Goukamma Nature Reserve on the east bank of the river.

The Lakes was established in 1969 primarily to enable fish research to be carried out on Rondevlei and was more recently extended to Swartvlei for investigations within this lake.

The Goukamma Nature Reserve was only established in 1960, although the historical background of the area is complex and interesting. (46) The objective of its establishment is to restore the area as far as possible to its original condition in terms of flora and fauna, and to preserve and manage it as such. "The introduction of extensive artificial practices, even if practicable, is also contrary to the purpose of this reserve." It is doubtful whether the reserve will be capable of maintaining a high


BASE LEGEND
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops
Contour at 50' interval
100,000
INDIAN OCEAN
KNYSNA
Buffalo Bay

INTER TIDAL HABITAT

- Mud Prawn
- Sand Prawn
- Oysters
- Raft cultured oysters
- Shallow water cultured oysters
- Blood worm

gross population, even though veld-management techniques such as periodic burning, have succeeded in improving the carrying capacity for game to a certain degree. (47)

3.6.2 Other Protected Areas

(a) Private Nature Reserves

No proclaimed private nature reserves exist in the Region, although a number of people have established private sanctuaries on their properties.

This Region has attracted people who are very conservation conscious. Some comfort may be drawn from this should the establishment of private nature reserves, or the acquisition of land by any authorities for conservation purposes, prove impossible.

In terms of a 1968 amendment to the Nature Conservation Ordinance, landowners are enabled to apply for a particular form of protection to properties zoned as Private Nature Reserves. The problems attached to establishing these reserves stem from the fact that landowners cannot be financially assisted in such ventures. Expenses incurred in the provision of water holes and adequate fencing for example may therefore be prohibitive.

A solution to this problem might be for interested landowners to form private nature reserve syndicates. This would enable larger tracts of land to be acquired and would then considerably reduce the costs of establishment for individual landowners.

(b) Protected Areas

An unusual amendment to the Nature Conservation Ordinance No. 26 of 1965, provides the legal constraints for protecting bird and wildlife, that is, except for species specifically mentioned. All the lakes except Langvlei and Swartvlei, where netting is carried out, enjoy full protection. In terms of the Ordinance general fishing licences must be obtained by all anglers.

In terms of regulations promulgated in 1966 as part of the Sea Fisheries Act of 1940, no marine life may be collected along the shores or in the adjoining territorial waters of the Goukamma Nature Reserve, except for the sole use as bait within the reserve boundaries. Also no netting is permitted anywhere in the Knysna Lagoon seawards of the old road bridge.

3.7 OTHER CONSERVATION CRITERIA

There are many other factors which must be taken into consideration. These do not necessarily constitute conservation of flora and fauna as such. However, in the context of other land uses, there are features which should be conserved.

These include: (See Map 16)

Scenic values
Physiographic features value
Geological feature value
Features of historic value.

3.7.1 Scenic values - on land and water, i.e. visual intrusion values. Although Appendix I deals with scenic quality, in that context it deals with visual preferences rather than physical conservation criteria having scenic impact problems. Any area exposed to view in a negligent way could destroy the scenic value of the area. To a certain extent this is related to conserving physiographic components in as much as they dominate the landscape or are particularly sensitive owing to the proximity of roads, and accessibility to the public eye. Maps 3 and 4 illustrate sections across the Region and have assisted in determining which areas are most sensitive in this respect.

Areas which have been damaged scenically include:

(a) The southern slopes of Knysna Lagoon which are marred by the new road to Brenton-on-Lake.
(b) Knysna Lagoon at the northern side of the National Road bridge is defaced by gravel and crush workings.
(c) The scarp face at Eilandvlei is spoilt by the new Divisional Road which cuts across it.
(d) The southern slopes of Langvlei to the west which are marred by gravel workings.
(e) The steep scarp slopes of the plateau which have been damaged by farming.
(f) At Swartvlei South habitations on the fringes of the milkwood forest have resulted in the thinning out of this scenic backdrop.
(g) Alongside the National Road east of Eilandvlei and on the slopes of the Goukamma Valley plantations have been cut down.
(h) The eastern Heads have been damaged by the development of the Heads Township.

(i) The coastal bush area at Brenton-on-Sea has been marred by this development - roads and houses are extremely visible in the landscape.
(j) North west and east of Knysna haphazard shanty dwellings spoil the landscape.
(k) Thesens Island has been marred by the industrial complex on it.
(l) The mountain slopes alongside the Main Road on the east bank of the Karatara River have been washed away. This was caused by the location of a culvert at an underground stream in the Enon Conglomerate which is not a well consolidated formation.

Map 15 outlines areas subject to visual intrusion. However, this has been represented as a blanket intrusion coverage and is based on independent assessment criteria. This method was adopted in order not to distract from the final composite map, in terms of conservation priorities, as careful planning, management or design of developments in these areas may be all that is necessary to minimise the degree of visual intrusion.

3.7.2 Physiographic Features Value

The system of lakes, rivers, and lagoons is unique in itself, and it should be borne in mind that any development in this area will alter this quality and the natural attraction of this National Reserve. It is tragic in one respect that government action was not taken many years ago to proclaim the entire lakes area and the eastern part of the Lagoon a nature reserve, and to control public recreation in the area.

Whereas visual intrusion as described above covers all areas which are subject to direct visibility in the Region, this section refers to specific physiographic features which should be conserved for their uniqueness. These include:-

1. The Heads, Knysna
2. The stack at Gericke Point
3. The original side of the lake system (north facing slopes)
4. Castle Rock at Brenton-on-Sea
5. The entire cliff face extending along the coastline
6. The Serpentine, Goukamma and Knysna Rivers and flood plains
7. Vankervelsvlei
8. The plateau escarpment extending from Wilderness to Swartvlei
9. Uniquely peaked crests of Sand Dunes and north facing slopes located in the Coastal Dune Areas.


BASE LEGEND
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Unconsolidated Sand & Beach
INDIAN OCEAN
MYSNA
Brenton-on-Sea

VISUAL INTRUSION

- View points
- Sensitive areas

OTHER CONSERVATION CRITERIA

- Geological & Physiographic features value
- Physiographic features value
- Geological features value
- Historical features of value


BASE LEGEND
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops
Contour at 50' intervals
1 100,000
INDIAN OCEAN
Buffalo Bay
Knysna Lagoon

3.7.3 Geological Features Value

(a) Exposed cliff faces, exposing bedding, folding and faulting, along the coast, and providing chronological geological information.

(b) Fossils in the Raised Beach. Part of which is exposed behind the Total Garage on the left of the main road entering Knysna from the west (48).

3.7.4 Historical Features Value

These sites include:-

(a) George Rex's Grave, Knysna.
(b) Old St. George's Church, Knysna.
(c) Belvedere Church, Knysna Lagoon.
(d) George Rex's Slipway, Knysna River.

3.8 CONSERVATION SUITABILITY

The major natural vegetation, wild life habitat and other conservation criteria have been outlined. In attempting to develop a weighting system whereby potential conservation suitability areas can be graded the problem arises as to which criteria are the most important, either singly, or in combination with one another. The criteria in my opinion would be assessed firstly by the combination of components which could be conserved in any one particular area. This is the method adopted by McCarg (49) in his Staten Island study. Individual values were graded according to their importance and by means of transparent negatives were superimposed on top of one another. The final composite picture was then photographed producing a series of colour gradations with the darker tones indicating the greater intrinsic suitability for conservation.

The author has used the same approach as McCarg to evaluate conservation suitability for this region, although he was not able to use such sophisticated processes.

The value of one conservation component and its value relative to another is difficult to assess. However, each particular component was regarded as being as important as the other. These were therefore ranked equal per se. Areas which provide a habitat for a variety of species or prolific quantities of one received a higher rating. All the factors were treated on an equal basis.

Three grades of colour were used to indicate the degree of suitability of each particular area for conservation purposes - the darker the shade the greater the intrinsic value (Map 17).*

Problems were incurred in determining suitabilities in the vicinity of man made elements. These have isolated suitable areas from one another thereby reducing the value of both areas as in the case of roads and railway line, bridges and plantations. In the vicinity of Knysna, semi-rural areas located in fynbos have completely destroyed the possibility of the area serving as an open habitat or as a combination of open and closed habitats.

From the synthesis it is evident that areas displaying the greatest suitability for conservation include the inland plateau ravines and adjacent fynbos areas, the eastern and western heads areas, Groenvlei and the coastal fynbos plateau lying to the south and east, Rondevlei and the area extending to and including the dragon's head at Swartvlei, the Serpentine and the entire plateau escarpment extending from Wilderness to Swartvlei, and major inter-tidal habitat in Knysna Lagoon.**

Secondary graded areas included the left bank of the Knysna River, the Coastal Plateau west and north of Gericke Point, Karatara and Ruigtevlei.

**Stress is placed on the preservation of the various physical conservation elements in the region - sand dune crests, north facing slopes, escarpments vegetated or bare etc. as these are particularly sensitive to any physical onslaught.

Another consideration is that before future developments which are located in the vicinity of the demarcated areas are considered, their impact on those areas must be fully assessed. For example, the location of a marina in a significant inter-tidal habitat zone, marsh, or flood plain may affect the entire biotic community within the ecosystem to an extent where repairing the damage is not possible. This is particularly stressed in Knysna Lagoon and the Serpentine.

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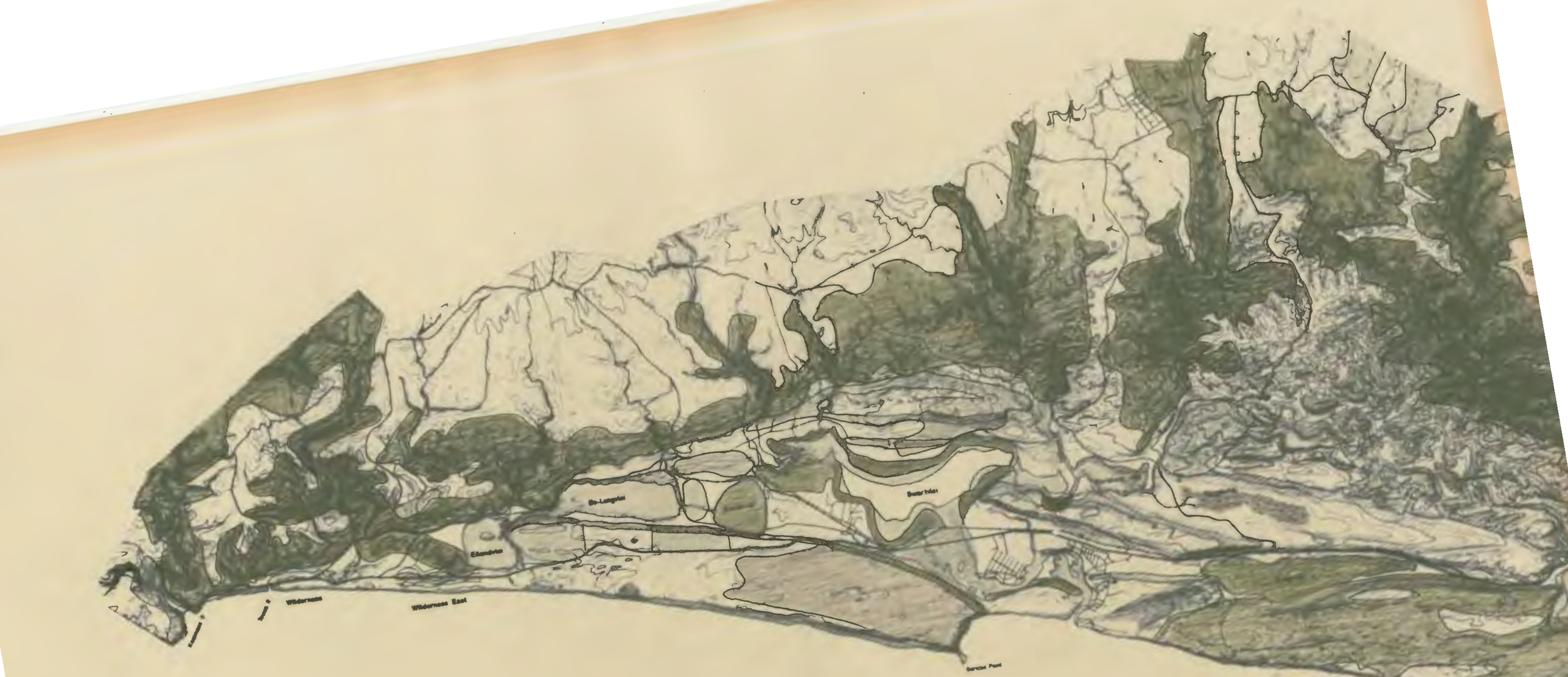
*It was considered impractical to use a larger gradation owing to the fact that the final composite map and related evaluation would become too refined and far less meaningful.

** Many farms within the inland plateau areas are not exploited extensively. As a result large areas of fynbos are evident. Should these be agriculturally developed in the future the extent of grade 1 areas will be reduced to possibly including the ravine sections only.



INDIAN OCEAN

CONSERVATION SUITABILITY

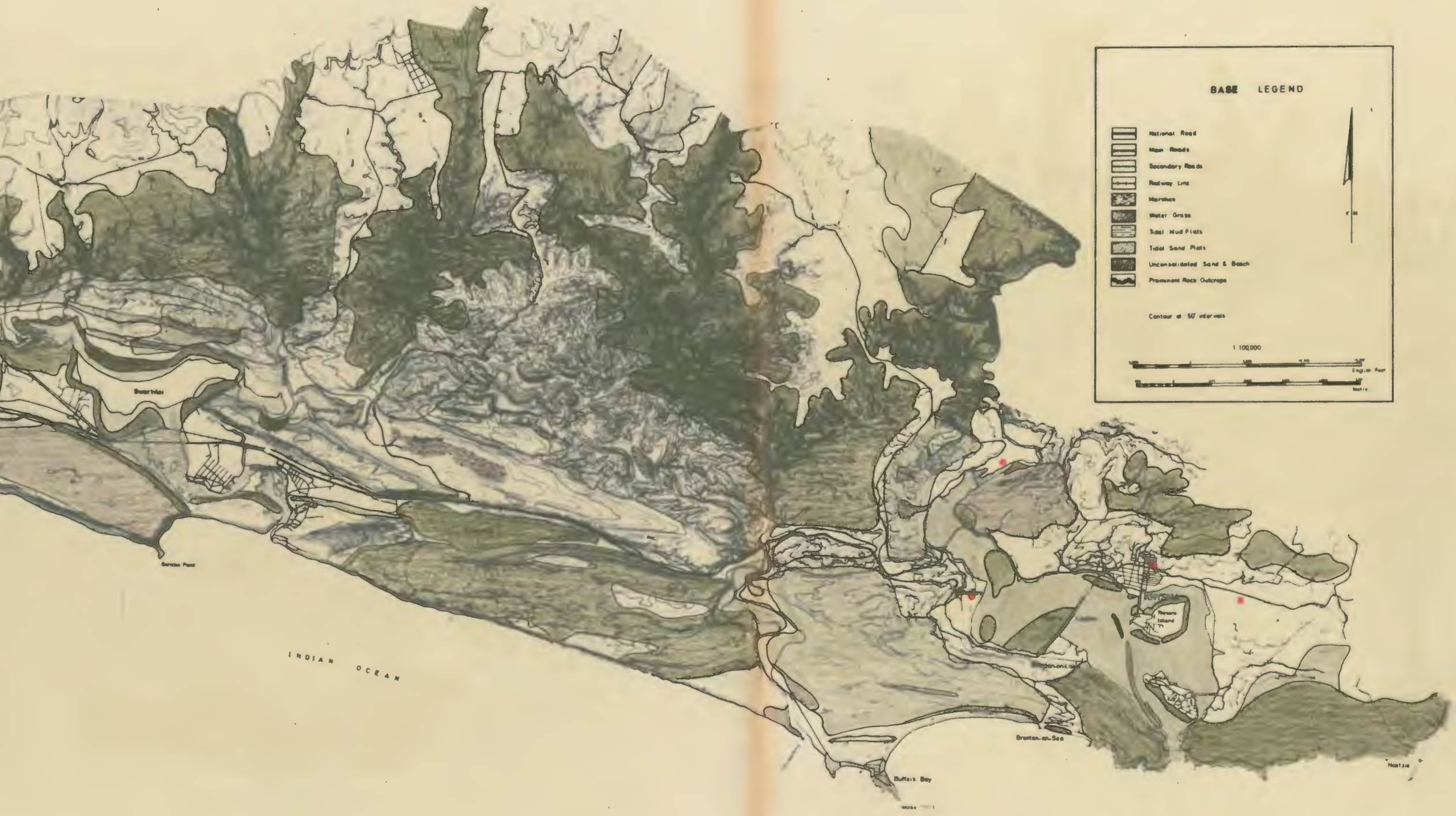
Suitability Grades

1

2

3

Historical Sites


BASE LEGEND
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops
Contour at 50' intervals
1:100,000
INDIAN OCEAN
Buffalo Bay
Brenton-on-Sea

Although the Goukamma and Knysna Rivers have great intrinsic value for conservation, their preservation is important as emphasised within Appendix 2.

The Region has extensive tracts of land suitable for development as nature reserves, private nature reserves or for proclamation as protected areas. These include:-

(a) the catchment and fynbos areas of the Goukamma and Knysna areas which could have been linked but for the Karatara Road along the catchment ridge,
(b) the Northern shoreline of Swartvlei,
(c) the Serpentine, Touws River and Duine River areas,
(d) Kaaimans River,
(e) the upper reaches of the Hoëkraal and Karatara Rivers,
(f) the northern escarpment,
(g) all physical conservation criteria mentioned - possibly proclaimed protected areas - particularly cliff faces, dune crests, dry northern slopes, geological and other physiographic features.

It is moreover evident from Map 15 that a large portion of the Region is subject to view. This stresses the importance of locating all gravel workings, roads etc. in positions which will have least effect on the natural scenic quality of the area (apart from developments which may in fact enhance the scenic quality of these areas). In an area of such importance in conserving the entire natural resource base, the opportunity cost foregone in locating these elements in alternative areas is outweighed by the maintenance and enhancement of the intrinsic values in the Region for posterity.

Finally, the control and acquisition of all areas subject to flooding, the opening and closing of river mouths by authority, and the improvement of existing channels between water bodies, is an important function in maintaining an ecological balance of the entire biotic communities within the two major lakes systems. The succession process has been enhanced considerably as a result of man made elements in the region and as such it is of vital importance that all major water bodies are optimally conserved and improved as they play a vital role as a major part of the natural resource base of the Region.

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C H A P T E R 4

AGRICULTURE AND FORESTRY.

4.1. Introduction

From a national viewpoint the region as part of the larger region of the Southern Cape, is relatively unimportant agriculturally and forestry wise. Locally, however, their importance is relatively high. Knysna's basic function is related to forestry. Agriculturally cash crop production and dairy farming supply processing and packing industries at George and a cheese factory at Karataravlei.

In terms of composite suitabilities these two components form a major function in creating the environment of activity and attractiveness which has made this region unique and renowned both nationally and internationally.

Indigenous forests in this region are not exploitable. It is, however, necessary to outline this component in relation to the exploitation of agricultural land and exotic forest, and in relation to the important environmental and ecological constraints oriented towards their preservation and management, and their function in the region as a whole.

4.2 Agricultural Practices in the Region

May 18 represents the total area under cultivation in the region (1). The major areas under agriculture are outlined further by the assessment of the potential value of existing land for agricultural use in the region. (Map 19)(2).This is related to good and relatively good soils, higher rainfall, gentle gradients, the aspect of the plateau regions and flood plains, and the availability of irrigation water on the inland plateau areas.

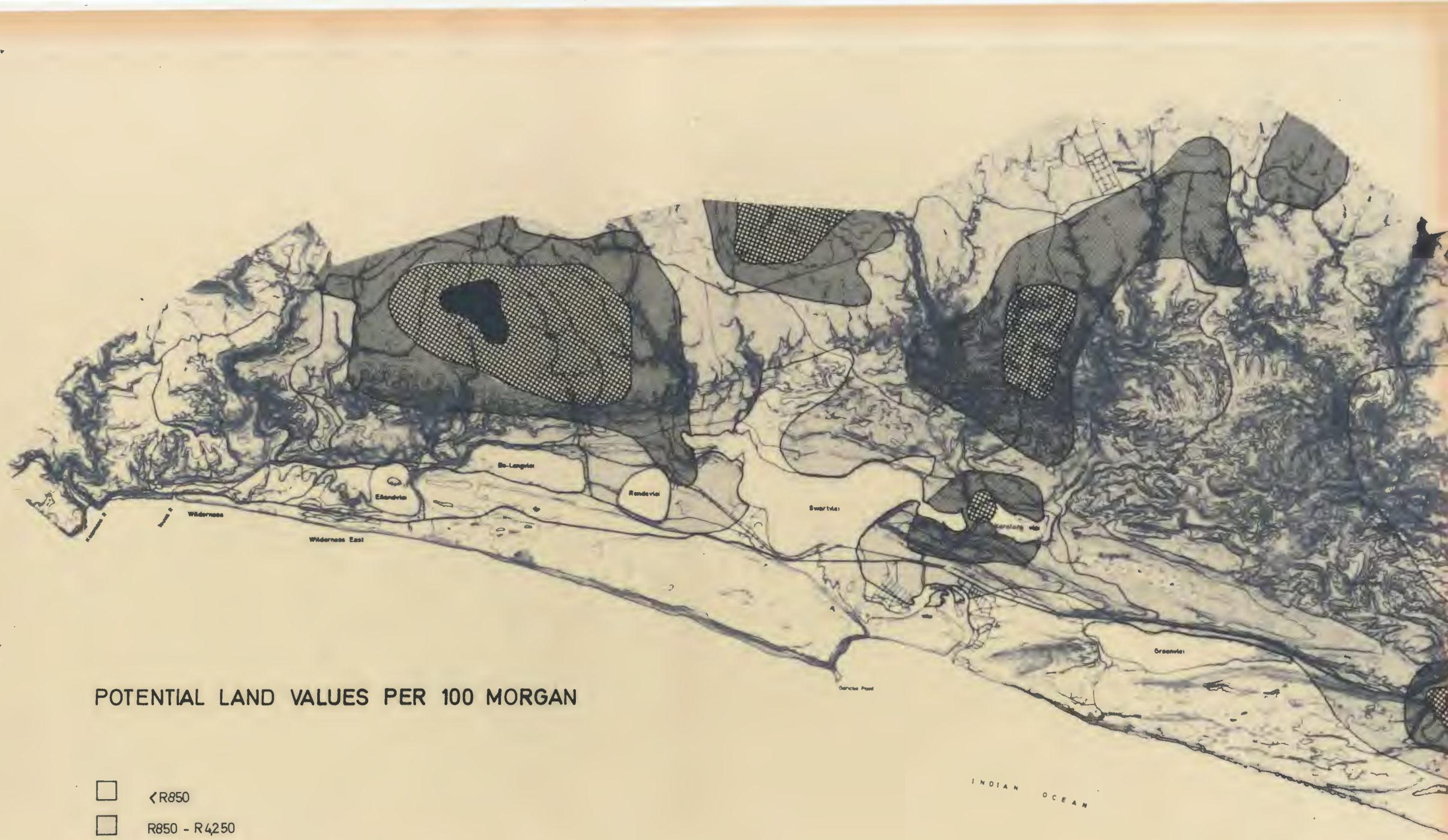
The most important and extensive area for agriculture is the Hoekwil area, followed by pockets along the inland plateau, and the flood plains of Swartvlei, Knysna Lagoon and the Goukamma River.

The coastal plateau area, although receiving less rain (approximately 28" per annum) than the inland plateau generally, owing to the relative lower relief, have the problem of poor sandy soils which enhance this dry condition.

AGRICULTURE & FORESTRY

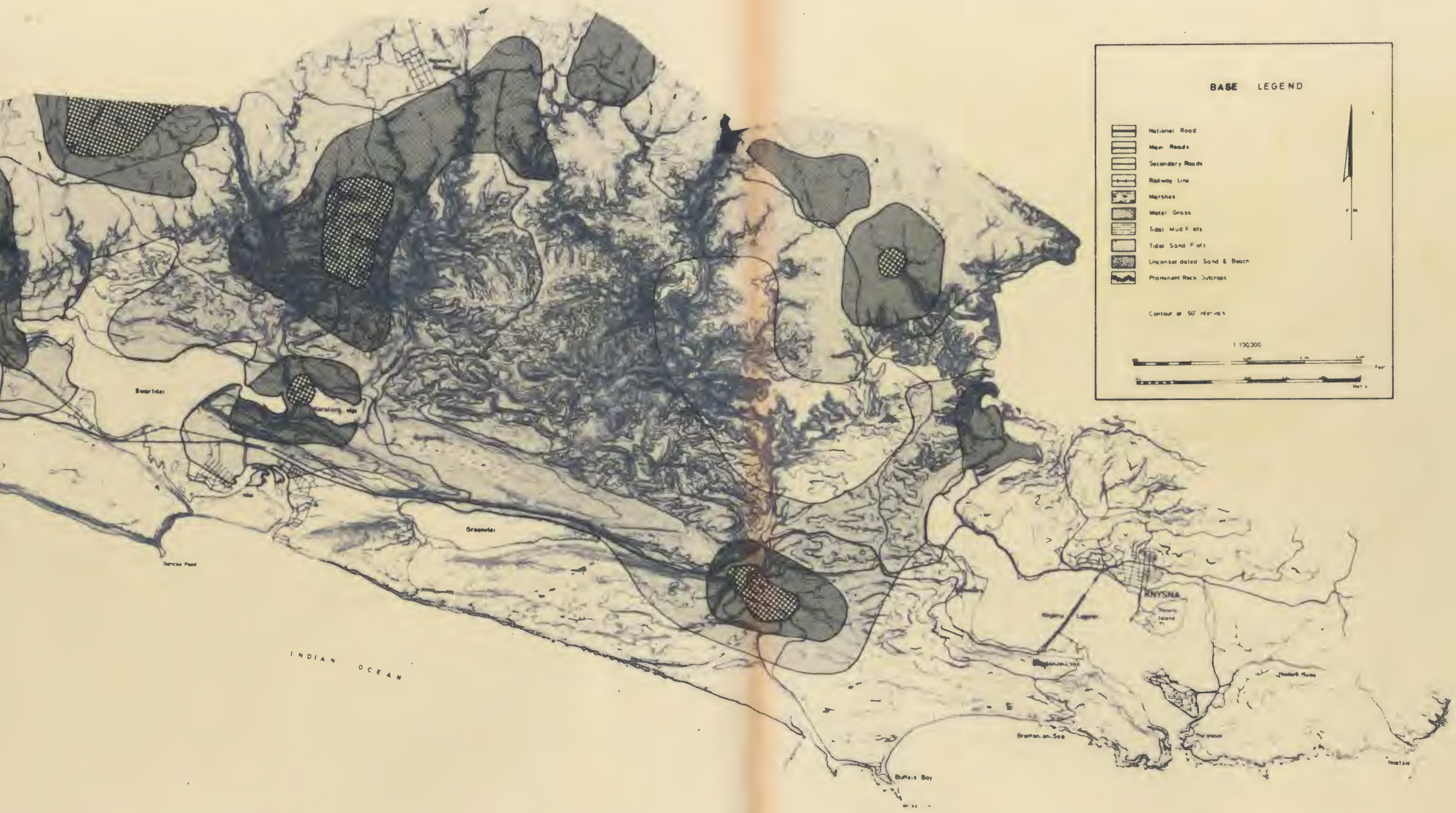
- Field crops
- Pastures
- Plantations


BASE LEGEND
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Areas
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops
Contour at 50' interval
INDIAN OCEAN
Buffalo Bay
Island



POTENTIAL LAND VALUES PER 100 MORGAN

- < R850
- R850 - R4,250
- R4,250 - R8,500
- R8,500 - R17,000
- R17,000 +


BASE LEGEND
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops
Contour at 50' intervals
1:100,000
Swartvlei
Groenvlei
Sedgefield
Buffalo Bay
Brenton-on-Sea
KNYSNA
Island
INDIAN OCEAN

Large tracts of land are not used or mis-used for agriculture as many retired or semi-retired persons occupy these areas. These persons comprise pensioners of the Department of Forestry, Railways, Divisional Council, Saw Mills, etc. They carry out a little market gardening and stock a few dairy cows. Furthermore urbanites come to this region and retire on relatively small sub-divisions which are left uncultivated.

The following figures present a breakdown of the Region: (3)

Land Use	Area	%
Afforested Areas	29 000 ha.	52%
Agriculture	16 000 ha.	29%
Private Land and Virgin Forest	8 000 ha.	14%
Protected Areas	2 600 ha.	5%
Total	55 600 ha.	100%

There are 590 properties under agriculture with the following size distribution:

Size	No.
0-20 ha.	322
21-50 ha.	103
50+ ha.	165

Owing to the nature of farming activities, the size of the properties and the value thereof, it is essential for farmers to maximise their returns from even the smallest portions of their land. They cannot afford to leave any part of their ground idle. This implies using catchment-irrigation methods. Farmers cannot afford to rely on the variable though frequent rainfall in the area for cash crops (4).

Farming is generally mixed and crop rotation is practised. The most common rotation is market gardening, wheat, pastureland.

The region's most important agricultural and livestock products are: potatoes, peas, wheat, silage, other legumes, sweet potatoes, vegetables; cattle, sheep and milk.

The time factor with regard to ready and swift access to urban centres does not generally occur as the

main markets for produce are further afield than George and Knysna.

Market gardening requires good management and programming of activities. Problems can arise when farmers take on too large an area at one time for quick cultivation, reaping and irrigation. Furthermore, many farmers have inadequate catchment-dams and have to rely on rainfall. The Department of Water Affairs has not as yet made any concrete proposals for an irrigation scheme. (5)

It should be noted that the Department of Agriculture is at present planning the plateau farms hydrologically, i.e. laying out contours and drainage canals, in order to optimise the utilization and protection of all agricultural land.

4.2.1 Suitability Criteria - Soils, Slopes, Siltation and Drainage

Although soil quality is an important aspect with regard to the production of cash crops, the availability of irrigable water appears to be the major constraint on the productive capacity of the land. (6) The rotation system leaves no fallow period as such, which adds to the necessity of having water on tap.

Borehole water on the quaternary deposits south of the island plateau scarp is generally brak. The water table is high in the flood plain areas and provides rich pasturelands in the main. On the plateau streams are too incised to permit draw off. Boreholes are deep and expensive to operate for irrigation. The geological formations here are not so compact and do not retain much water.

No detailed surveys of edaphic characteristics (i.e. the erodibility, stability, texture, depth, water retention, moisture infiltration and drainage of soils) in the Region are available. It was felt. therefore, that an intuitive assessment of the meagre available information was necessary in order to arrive at a composite agricultural suitability map for the Region. The rationale behind this is the fact that the measurement of the edaphic components available in the Region represents major weightings relative to all the other agricultural suitability components. Furthermore, at minimum, this process will indicate marginal agricultural areas. This will certainly narrow the margin of error when weighting of the final composite suitability map for the entire natural resource base.

This problem is particularly evident in the case of slopes. Soils related to the Cango Beds (Malmesbury Formation) are derived from shales and possess the most suitable edaphic characteristics in the Region. Thev are reddish soils and do not erode easily. Cultivation on slopes of up to 45% (roughly

1 in 2) is possible with contour ploughing without any damage. This would appear to be excessive, but it should be borne in mind that rainfall is generally light and runoff as such is slight for the most part. Generally contour ploughing in the Region is carried out on slopes of 25% (1 in 4) or greater. (7)

Soils derived from T.M.S. are greyish brown to black, darkening with higher concentrations of humus. As with granite soils they are erodible.

There appears to be very little siltation within the rivers and ultimately the lakes. Table 6 below gives silt readings which were taken in July and August 1971.

Table 6. Siltation Reading in Peak Floods - Rivers of the Lakes (8)

Lake	Name of River	Percentage Silt On 30/7/71	Percentage Silt On 22/8/71
Swartvlei	Karatara	0,023	Could not reach water
	Klein Wolwe	0,025	" " " "
	Wolwe	0,031	0,028
	Hoëkraal	clear	clear
Eilandvlei	Duiwe	0,030	0,016
Bolangvlei	Rondevlei Heights	0,036	0,120
Ebb & Flow Wilderness	Touws	clear	clear

The rainfall figures over the period of the floods were 125 and 175 mm respectively. These represent normal rainfall flood period values. (9)

Rondevlei Heights had the largest amount of silt concentration. This catchment has not been hydrologically planned as yet. Secondly water and silt runoff is direct from the agricultural lands to the lake, whereas in all other catchment areas silt may accumulate within the dense indigenous forests which

flank the steep river valley sides.

The total extent of land which is hydrologically protected at present is 2300 ha. (16%) of the total of 16000 ha. of agricultural land. No figure is, however, available for the extent of the area still requiring hydrological planning.

It is apparent that slopes should provide the major constraint for agricultural suitability. Table 7 below presents an analysis of optimum slopes which was made as part of a land capability study of Swaziland.

Table 7. Slope Suitability for Agriculture (10)

	Good	Fair	Fair-Poor	Poor	Unfit
Irrigated	- 3%	3-7%		7-14%	14% +
Dryland	- 7%		7-20%		20% +

Although the climate and edaphic characteristics of this area are suited to different crops and farming methods, it is interesting to note that unfit soils include slopes of 14% (1 in 7) and greater for irrigated land, and 20% (1 in 5) and greater for dry farming.

Generally, steep slopes are better suited to pastureland in this Region, although in the better Malmesbury soils crop production lies adjacent to indigenous forests, and relatively little pastureland exists.

Although to the farmer preservation of the indigenous forests may not present a total over-riding consideration against economical exploitation of the land, clearing of trees to provide cropland on excessive slopes should be outlawed. Where possible the Department of Forestry should acquire sections of forest in order to preserve the unique characteristics of the region, preserve the siltation inflow into the lakes, and possibly develop these as primitive recreation areas for the general public.

In areas of steep gradients, thin strips of land are cultivated, and it is necessary for these generally to be less than 100 metres wide to prevent excessive accumulation of runoff water and to prevent the use of storm water drainage. Accessibility to these areas is another important constraint, coupled with the ability to use mechanised equipment for cultivation. Length of slope and the degree of slope are therefore the major constraints here.

Farming on excessive slopes in the Region results in a final problem. As soils are generally thin the growing of crops on excessive slopes is common. In my opinion, taking this and the other constraints mentioned into consideration, 33% (1 in 3)slopes should represent the maximum slope permissible for cropland or pastureland.

Humidity and aspect are two important factors in agricultural production. However, in this region the major influence of these factors is in the marginal Coastal Dune plateaux where dry northern slopes are common. The inland plateau rainfall is high and the topography relatively flat, apart from marginal areas alongside the scarp or steeply incised river valleys.

Where cropland and pastureland are left unmanaged, kweek grass, weeds and fynbos rapidly occupy the area. As such good and continuous farm management are the keystones.

4.3 FORESTRY

4.3.1 Exotic Forestry

(a) Softwoods

In parts of the Region the landscape is dominated by large plantations of exotic pine most of which are owned and managed by two large timber concerns, namely, Thesens and Parks.

The most common of species of pine include those listed below.

Table 8. Species of Pine

	Specie	Common Name	Origin	Preferable Site Selection
Main Sp.	Pinus Pinasta	Cluster or Marrantine Pine	Portugal & Southern France	1st & good 2nd quality sites
Main Sp.	Pinus Radiata	Monterey Pine	California	Poor 2nd & 3rd " "
Subsidiary Sp.	" Taeda	Loblolly	Southern U.S.A.	Poor 2nd & 3rd " "
" "	" Heliotti	Slush Pine	" "	Moist swampy sites
" "	" Canariensis	Canary Island Pine	Canary Islands	Very poor soils

(b) Hardwoods

The Karri Gum (Diversicole sp.) comprises approximately 85% of the eucalypts grown. They are generally used as "spark arresters", but are slowly being eradicated as they have proved relatively inefficient.

The Australian Blackwood (Acacia Melanoxylon sp.) is being investigated in and on the outskirts of the indigenous forests. This specie produces excellent furniture wood.

In my opinion Hardwoods are insignificant in the analysis of suitabilities in the Region.

4.3.2 Suitabilities

(a) Agriculture versus Forestry

More productive soils situated on low gradients are generally placed under cultivation or used for livestock rearing in preference to forestry. This is an economic necessity for the private individual who requires a rapid return on his investment, and furthermore a very high return per unit area. Parks and Thesens companies, however, own certain tracts of land which are suitable for agricultural purposes. However, once this land has been under plantations, the fertility, and composition of the soil drops considerably, acidity increases and restoration is costly and time consuming. The existence of exotic forests therefore promotes their re-establishment.

Agriculturally suitable land owned by these timber companies is most likely to be developed as forest land. Despite this I have not given this factor a weighting in the compilation of the composite map as the test criteria is that of optimum land suitability, rather than its probable future use. In other words, this land, although likely to be exploited for timber, is capable of being used for agriculture. Decisions about the use of this land should be made in terms of whether the advantage of its use for timber exceeds the opportunity cost foregone of its use for agriculture. The final decision, irrespective of the suitability assessment made by the planner, rests with the land owner.

(b) Rainfall, Humidity and Aspect

Within the Western Conservancy (i.e. the Western Cape) the limiting factor to the good growth of trees is the 25 inch isohyet. With less rain soil is an important

non-operable - as a result of inaccessability, steep slope, distance from mill or stream (the latter is not applicable here), there is no present possibility of economic lumbering." (14)

The indigenous forests in the steep ravines have been protected as a result of the inaccessability factor, and steepness of the slopes. Steep slopes are exploited in the Region where access can be obtained from the base of the slope.

Where land values exceed R30-40 per hectare forestry becomes uneconomic. (15)

4.3.3 Indigenous Forestry

Apart from the three Nature Reserves in the region, no other areas afford protection of this unique vegetation. As mentioned previously, extensive areas are preserved by inaccessability in steep sided ravines. However, the fringes in particular are being destroyed by fire or cleared to provide additional agricultural land. Regeneration of these forests takes considerable time. It is, moreover, a difficult process involving detailed consideration of the plant associations within the indigenous forest ecosystem.

Indigenous forest in the Region is not exploitable owing to the environment which is not suitable for the growth of large trees. If they do occur, they are found only in small quantities which makes their use uneconomical, particularly in view of the considerable time lag before other trees in the area can be "culled". Table 9 below indicates the six principal types of indigenous forest.

Table 9. Indigenous Forest Bioclimatic Regions (16)

Forest Zone	Zone & Altitude	Temperature	Humidity	Forest Type
Very Dry	Littoral - 800 Ft.	High	Low	Scrub
Dry	" " " "	de-	in-	
Medium Moist	Lower & Upper Plateaux 8 - 1500 Ft.	creas-	crease-	Economically Exploitable
Moist	Lower & Upper Plateaux 8 - 1500 Ft.	ing	ing	Economically Exploitable
Wet	Foothills 1500 Ft. +	to	to	
Very Wet	" " "	Low	High	Scrub

This region contains mostly littoral, lower and upper plateaux zones with mainly Very Dry to Medium Moist conditions. Medium Moist conditions are most suitable for economic exploitation. In this respect the Region is marginal.

Exploitation is conducted by a system of culling the over-mature or undesirable species, and regenerating the sustained growth of natural habitat. The big trees in the forest attempt to kill everything else. Furthermore old trees fall over and damage or kill off a large number of other trees in the vicinity.

For the benefit of regeneration the crowns of these large trees are carefully cut. This can only be done on plateaux and moderate slopes, which rules out this process in the Region.

It is of the utmost importance that the fringes of forested areas in all zones be protected as they represent different ecological types to those deeper in the heart of the forest. A 100 ft. wide belt of land on the fringes and river banks should be acquired by the Indigenous Forestry Department so that alien vegetation may be prevented from creeping in, and the effects of erosion and fire controlled. These forests are fire resistant, but the fringes are damaged by the burning of fynbos. (17)

The major principle of exploitation is to retain a safety factor or "Normality Pattern" of growth, i.e. forests are never cut below their surplus. Hence cutting only takes place when the number of large trees exceeds the anticipated normal number for a particular area.

Undergrowth is cut selectively which creates an improved foundation for regeneration. Growth is prolific on moderate south facing slopes, but quite sparse on north facing slopes. These slopes in particular should therefore be preserved at all costs.

Regeneration of indigenous forests is difficult. However, extensive experiments have been conducted in this respect and have proved successful. Nurse stands comprise the Keurboom (Virgilia oroboides) and Assegaai (Curtisia dentata). This is, however, only possible without the existence of some indigenous forest in the vicinity, unless ideal conditions exist.

As mentioned previously the association of pine and indigenous forest as wildlife habitat is of value in preventing plagues of Emperor Moth from destroying the pine. However, the encroachment of Pinus Pinasta, in particular, into these forests is not desirable as these trees grow rapidly and will

eventually succeed in destroying this vegetation.

Although in the Sand Dune areas exotic Acacia species tend to succeed all other plant growth, except in areas where a dense canopy exists, the milkwood tends to regenerate under these bushes. The lifetime of the invading species of Acacia is much shorter than that of the milkwood and hence the milkwood will succeed these species. Birds tend to drop milkwood seeds into these areas.

This ecological process should be investigated further, particularly in view of the extensive tracts of exotic acacia species in the Coastal fynbos areas.

Even though the succession process would take years to materialise it would be worth the effort in attempting to maintain and recreate a suitable natural environment for these sterile areas.

The management and protection of indigenous forestry is devided into five activity zones by the Indigenous Forestry Department namely production, protection, recreation, reproduction and research. Within this Region the two activity fields lie mainly in protection and recreation, and it is hoped that the Department could initiate some measure of conservation and recreation, management and protection of the indigenous forest areas within the Region, which are unfortunately privately owned in the main.

4.4 SUITABILITY

Map 20 indicates areas suitable for agriculture and forestry. Apart from existing forestry in the Region no other areas conflict with those under agriculture owing to the slope 1 in 3 which has been the boundary determinant i.e. as mentioned previously agriculture has been considered to be more important per economical unit of land than forestry. Geological formations were major determinants for agricultural suitability owing to the fact that these soils were dependent on their parent rock for their characteristics.

The Region is suitable for mixed farming. Where water is not available livestock in many instances replace cash crops. Farmers adapt to the environmental constraints and therefore more extensive areas could be included under Agriculture rather than those farms which have catchment dams.

The value of agricultural land at Knysna and Goukamma river valley is much higher than those found

AGRICULTURE & FORESTRY SUITABILITY

Suitability Grades

1		Forestry
2		
3		
1		Agriculture
2		
3		


BASE LEGEND
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops
Contour at 50' intervals
1 100,000
English Feet
Metric
INDIAN OCEAN
KWYSNA
Buffels Bay
Brenton-on-Sea

within any other areas. As such these two pockets have been graded the highest in the Region. It should be borne in mind that environmental factors may have been partly responsible for these inflated prices. The second highest intrinsic value relates to the Malmesbury series and to the areas around the lake systems and flood plains.

Although the northern shores of the lakes west of and including Karatara comprise recent and quaternary deposits, their suitability is enhanced by their association with the Malmesbury deposits on the escarpment and plateau - salts are brought down in solution and are deposited on the lower slopes. This is particularly evident around the "Dragon's Head" at Swartvlei and farmlands bordering the Hoëkraal and Karataravlei. The T.M.S., Granite and Enon areas received third grades.

Little agriculture is practised on the coastal plateau and it has a low intrinsic value for agriculture. No weighting has been applied to these areas.

Forestry, on the other hand, is located mainly in the quaternary deposits north of the lakes. Large areas on the inland plateau have also been planted. The most productive forest lands are those located on the Enon Conglomerate Malmesbury series and Knysna Beds. These were given top gradings whereas those located on T.M.S., granite and pronounced south facing slopes on the quaternary deposits were the second most suitable sites. Gentle southerly slopes and north facing slopes on the quaternary deposits received third rating. These latter areas are located south of the Eilandvlei, Langvlei and Rondevlei, and north and north east of Groenvlei.

The section between the Eastern Heads and Noetzie has particularly thin soils with exposed T.M.S. in places and as such its suitability for agriculture has been reduced.

Therefore these areas have been graded for forestry suitability, parts of which are in the process of being planted.

Scattered settlements around Knysna have reduced the potential of this area for both Forestry and Agriculture production.

Although agriculture is confined to the inland plateau, the pockets around the lakes are most suitable sites and should be retained for this purpose.

The management of these areas is of vital importance in conserving the natural resource base and retaining the rural character.

4.5 REFERENCES

(1) Compiled from (a) map entitled "Grondgebruik in die Wilderness-Knysna Merekompleks" in Departement van Beplanning, Ondersoek na die Benutting van die Riviermonde, Strandmere en Vleie in die Republiek van Suid Afrika. Vol. IV Streek Knysna-Wildernis, Government Printer, Pretoria, 1970, p. 68;
(b) analysis of 1:36000 aerial photography of the area by the author.

(2) Departement van Beplanning, op. cit., p. 70.

(3) Personal communication with Mr. Steytler, Chief Agricultural Extension Officer, George.

(4) Personal communication with Mr. Lappan, Chairman of the Farmers Association, Hoekwil.

(5) Ibid.

(6) Ibid.

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(10) Murdoch, G., "Soil Survey - The Basis for Improved Farming." South African Geographical Journal, Vol. XLIII, Dec., 1961, p. 71.

(11) Smith, D.A.M., "Afforestation in the Western Conservancy of South Africa," 3rd year thesis, Department of Geography, University of Cape Town, 1955, p. 7.

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CHAPTER 5

RECREATION

5.1 Introduction

Economically this Region would be classed as stagnant and undeveloped having a lack of economic opportunity and no growth industries and no substantial economic base apart from timber industries at Knysna. However, its recreational potential is very high owing to the variety of recreation, both active and passive, it has to offer, its outstanding scenic splendour, and its environmental quality which has made it the retirement 'Mecca' of South Africa.

Relative to the major centres in South Africa this Region is the most distant of all recognised recreational areas. As a result the tremendous influx of holiday population into holiday homes, cottages, caravan parks, tent camps and hotels is very seasonal. Many homes are occupied for only a few weeks of the year.

Wilderness, Wilderness East, Sedgefield and Knysna are to a large extent retirement centres and represent the three concentrations of population in the Region. They represent in the main suburban environments rather than city or townscape environments, apart from the central area of Knysna.

Recreation and residential components have been combined into one section as residential developments play a large part in providing the opportunity for holiday accommodation. (This is the common trend along the entire South African coastline.)

Control of the growth, extent and nature of existing townships and the necessity in preventing the establishment of additional residential nodes is of prime importance and is outlined within Appendix I.

Urbanisation suitability which incorporates commercial, industrial and residential components in the main has not been investigated within this report as the suitability criteria are in many respects different from purely recreational and residential oriented developments, the suitability of which are governed in particular by environmental quality and optimum location relative to existing natural amenities. Furthermore, apart from Knysna and the possibility of relocation of and additions to the industrial component on Thesens' Island in the near future, very little urban and industrial development per se is anticipated. Suitable locations for these components can however be assessed with further

syntheses of these suitabilities on to the recreation and residential suitability map and in particular the final composite suitability map.

5.2 Recreational Activities and Developments in the Region

Recreational activities comprise both active and passive forms. These values, with recreation suitabilities have been combined to form a recreation suitability map (Map 24).

Many of these activities are most space consuming. For example the areas used for hiking, horse riding, speed boating etc. compared to the use of a particular area for bathing are extensive to say the least. Their importance relative to one another which is perhaps assessed by the number of people partaking in such activities on a national scale is impossible to determine here. Areas, therefore, within this Region, which can cater for the greatest differences in tastes and demands for outdoor recreation will have the greatest suitability. When accessible natural outdoor recreation facilities are located adjacent to areas suitable for recreational development, the desired combination is achieved for stimulating rapid development and which in turn stimulates the development of amenities not attached to the resource base.

These intensive recreation areas may not necessarily have the greatest desirability among recreationists who value isolation and tranquillity above other inherent factors within the recreational landscape, and as such tend to avoid these areas where emphasis has not been placed on attempting to create recreational developments within a natural environment setting, but rather to exploit these areas beyond the desirable capacity for maximum enjoyment.

In this respect it is essential that the values of all recreationists are satisfied as far as possible. It is necessary therefore to provide a range of environments which will satisfy these requirements, but at the same time facilitating the optimum use of the recreational resources, their protection, control and management.

Activity zoning and multi-purpose usage of areas is therefore an important constraint for both land and water-based activities. This has led to the instigation and implementation of a recreational land classification system by the Outdoor Recreation Resources Review Commission in the U.S.A. A six-fold land use classification system was adopted and ranged from high density mass recreational areas to unique

natural and primitive areas (1). Gasson (2) has delimited the coastal region from Wilderness to Keurboomstrand (east of Plettenberg Bay) using this concept. The department of Planning (3) has published similar proposals based on this method for an area approximating that of this Region. Furthermore the Cape Provincial Administration is in the process of adapting this concept to suit the South African recreational setting and implementing these proposals for optimum recreational land use control.

These concepts however have not taken ecological considerations entirely into account. It is my endeavour therefore to assess the recreation suitability in the area which by virtue of its synthesis together with the other natural resource base constraints, will provide an evaluation of the intensity and nature of use to which an area can be subjected either singly or in combination with the other three elements.

5.2.1 Passive Recreation

Activities in this field relate mainly to criteria which create visual, emotional and scientific appreciation of the natural environment which comprise the conservation landscape in the main rather than active pursuits on that space.*

These include	Unique physiographic features
	features of historic value
	high quality forests
	high quality marshes
	scenic land features
	unique geological features
	scarce ecological associations
	water associated wild life habitats
	field forest wild life habitats.

*The exceptions to this are high quality forests which may include sterile exotic plantations and which do not represent a part of the conservation landscape apart from their scenic attraction although, as indicated in Appendix 2, ubiquitous and monotonous landscapes which these generally comprise received a low visual rating. As such these areas, in themselves are not significant passive recreation areas particularly flat or slightly undulating parts, though in combination with other landscape components as a scenic backdrop they may form a significant part in enhancing the landscape. Therefore only indigenous forests have been included in this category.

Within the assessment of landscape preferences in Appendix 2, individual components, combination of components, or general patterns and activities within landscapes have a great bearing on the preferences people have to those landscapes and moreover these preferences are enhanced by the inherent passive and active recreational pursuits which can be derived from these areas or which are envisaged by the recreationist. This presents an additional component of passive recreation although all other criteria are governed by their particular regular attraction as an entity rather than as a part of a matrix of factors which stimulate visual appreciation and emotional delight.

As such, landscape evaluation has been treated separately though it has a bearing on the passive recreation experience as well as all other components of the natural resource base.

Unfortunately no information is available on the assessment of preferences for passive recreation criteria. However these are all important recreation values, all of which should be preserved for posterity. These criteria can therefore receive equal value ratings. As they are synonymous with conservation criteria it was felt that passive recreation should not form a part of the composite suitability map in order to reduce the complexity of combinations of criteria which will be generated.

The value of these features relative to active recreation pursuits is not known. However, natural amenities suitable for active recreation and associated developments appear to be the prime concern of most recreationists in areas where both forms of recreation are inherent. It would therefore appear that passive recreational pursuits enhance the potential of an area for recreation suitability but are not priority draw cards. (Game reserves however have the opposite effect.)

5.2.2 Active Recreation

Active natural recreational components are related in the main to water bodies. (See Map 21)

These include:
- Swimming - beaches, streams, lagoons and lake bodies
- expanse of water for pleasure craft
- angling waters
- diving, surfing and other sea-based activities
- picnicking sites.

ACTIVE RECREATION AREAS

- Bathing safe
- Unsafe bathing beaches
- Picnicking
- Surfing
- Angling
- Boating
- Skin Diving


BASE LEG
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops
Contour at 50' intervals
1:100,000
INDIAN OCEAN
KRYSNA
Buffels Bay

Concentrations of recreational developments will occur, where possible, in association with these activities apart from three which cater for passing trade on the National Road. (This is, however, an additional important constraint when found in combination with active recreation criteria).

Where combinations of amenities are available there is a greater probability that more intensive development will be found in associative catering for a larger population. A major factor in promoting healthy residential development along the Cape coastline has been the occurrence of a safe bathing beach. Developments and bathing activities in this Region are oriented towards lagoon waters in the main as beaches are generally unsafe for bathing, apart from Buffalo Bay, a small stretch (relatively inaccessible) at Gericke Point and at Noetzie. Lake waters in the main are inaccessible or dangerous for swimming owing to the water grass or wide belts of weeds fringing the waters.

All the lakes provide good angling waters. Rondevlei, however, is afforded complete protection. Bolangvlei and Swartvlei are heavily netted. Accessibility to Bolangvlei is difficult and is generally not used by sporting anglers or boaters.

5.2.3 Recreational Development

Factors which determine the suitability of areas for recreational developments include:

- proximity and accessibility of active recreational amenities
- scenic quality
- environmental quality - locations relative to the presence of or combinations of water beaches, high quality vegetation; topography (slope) and views
- slope (buildability)
- aspect (north and east facing slopes)
- potable water
- foundation suitability.

Adverse factors include: (See Map 23)

- areas subject to flooding
- 50 year flood plains (in this area existing maximum flood levels)
- aquifer recharge areas. (all land uses permitted within limits of percolation)
- aquifers " " " " " " "
- slopes greater than 1 in 3, dry northern slopes and sand dune crests
- unconsolidated sand.

In order of importance positive suitability criteria include:

Accessible safe bathing beaches and lagoon waters.

Proximity to and accessibility of all active recreational amenities (including unsafe bathing beaches)

Environmental quality

Slope

Aspects, water availability and foundations suitability do not present major problems in the Region. One reason for this is the lack of prime areas for recreational development.

With regard to slope, the value placed on land in this regard tends to promote sufficient financial interest in residential developments, in particular, with which to overcome this hurdle. This is particularly evident at The Heads township where houses are being built on very steep slopes, in one or two instances greater than 1 in 3.

The Townships Board has a general policy of permitting development on slopes of up to 1 in 3 (3) although slopes less than or equal to 1 in 6 are regarded as being the limiting factor to economical development.

Development in the past has been confined largely to South facing slopes. The microclimatic differences between lagoonal and lake shorelines and to sea frontages are considerable. Temperatures at Brenton on Sea are generally lower than those at Knysna owing to its exposed position, for example.

Foundations limitations are related to areas subject to flooding. These include impervious layers underground creating a high water table and instability of the soil.

5.2.4 Constraints on Recreational Development (including Summary of Appendix I)

(a) Recreational townships do not appear to be the most desirable forms of development. Within the Region the emphasis has been on provision of recreational development for the temporary vacationist apart from the three major nodes of development. The growth rates within these towns are high compared with other coastal records along the Cape Coast (5). Buffalo Bay, Leisure Isle and the Heads are fully

developed while apart from Wilderness and Knysna, all other towns have a low percentage of plots built on. Additional townships are not desirable in terms of the need for all other forms of accommodation types for recreationists in the area and the minimal areas which are suitable for recreational development.

Map 22 indicates all accommodation facilities within the Region. Apart from the three major development nodes namely Wilderness and Wilderness East, Sedgefield and Knysna, other townships include Sedgefield Extension 1, Buffalo Bay (leased cottages), Brenton-on-Sea, Belvedere and Noetzie. Knysna has four major sections - the main town, Hunters Home, Leisure Isle and The Heads.

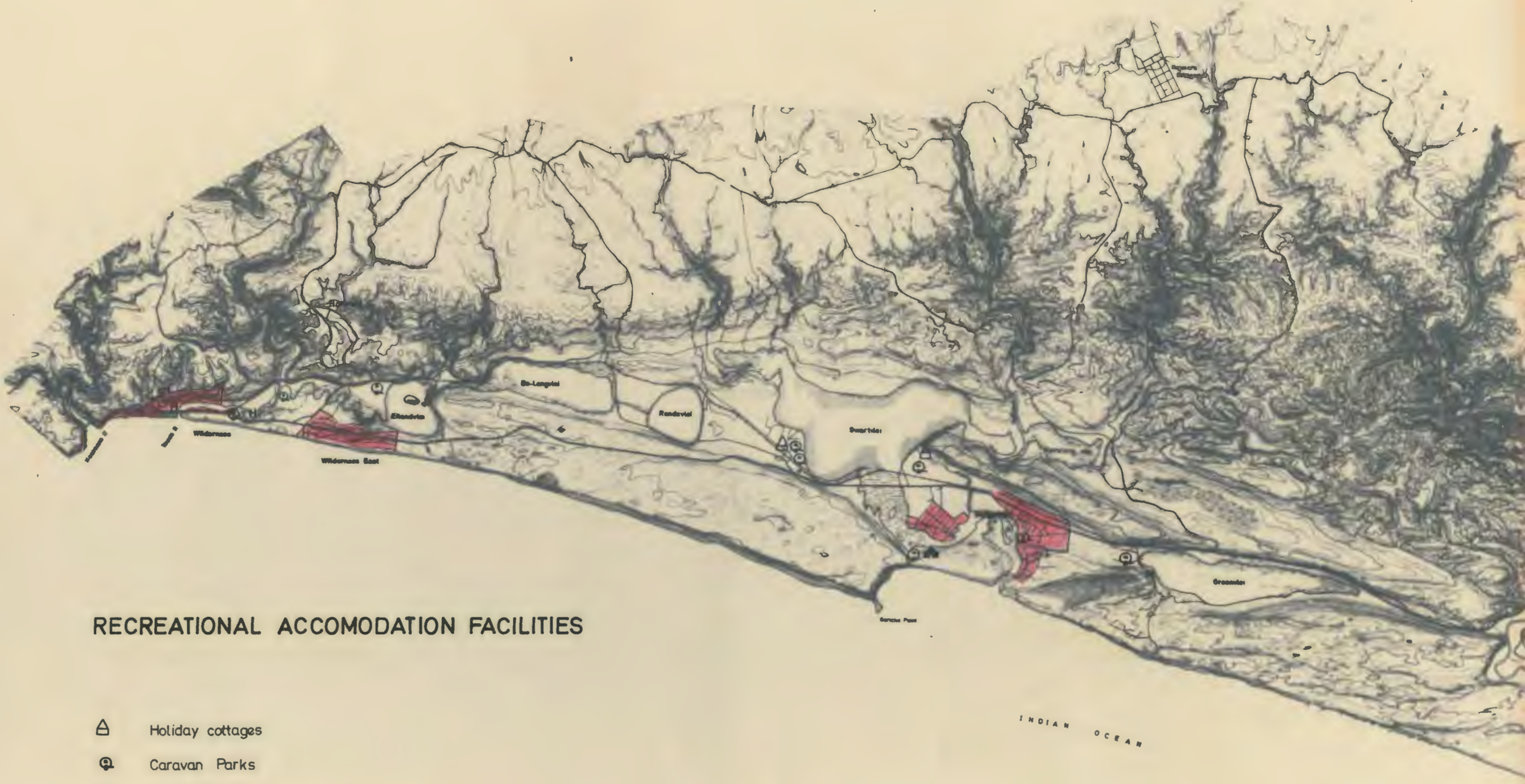
Brenton-on-Sea is poorly located on the plateau. The beach is unsafe and access can only be made at one point.

Brenton-on-Lake is not developed as yet and Belvedere, which comprises a small layout is increasing in size steadily.

(b) Retired persons form a large part of the permanent resident population within the various townships. However, the majority of homes, apart from Knysna, are only occupied for short periods during the year and as such the desirability of these forms of accommodation is questionable in an area which can cater for a high recreationist population and which requires accommodation facilities. Furthermore, the need for recreational accommodation in a natural environment is stressed.

(c) Swartvlei Peninsula is owned by the Divisional Council of George. The bathing along this section of coastline is unsafe apart from around Gericke Point. This area should therefore only be developed for short-period accommodation periods - with these facilities providing a base from which people can enjoy recreation potential of the entire area, and furthermore catering for persons with a particular desire to recreate in one particular way - fishing, diving, etc. Township development in the area would result in speculative buying and selling with little development taking place. Furthermore this land would be lost to public use in terms of accommodation facilities and recreational activities on land.

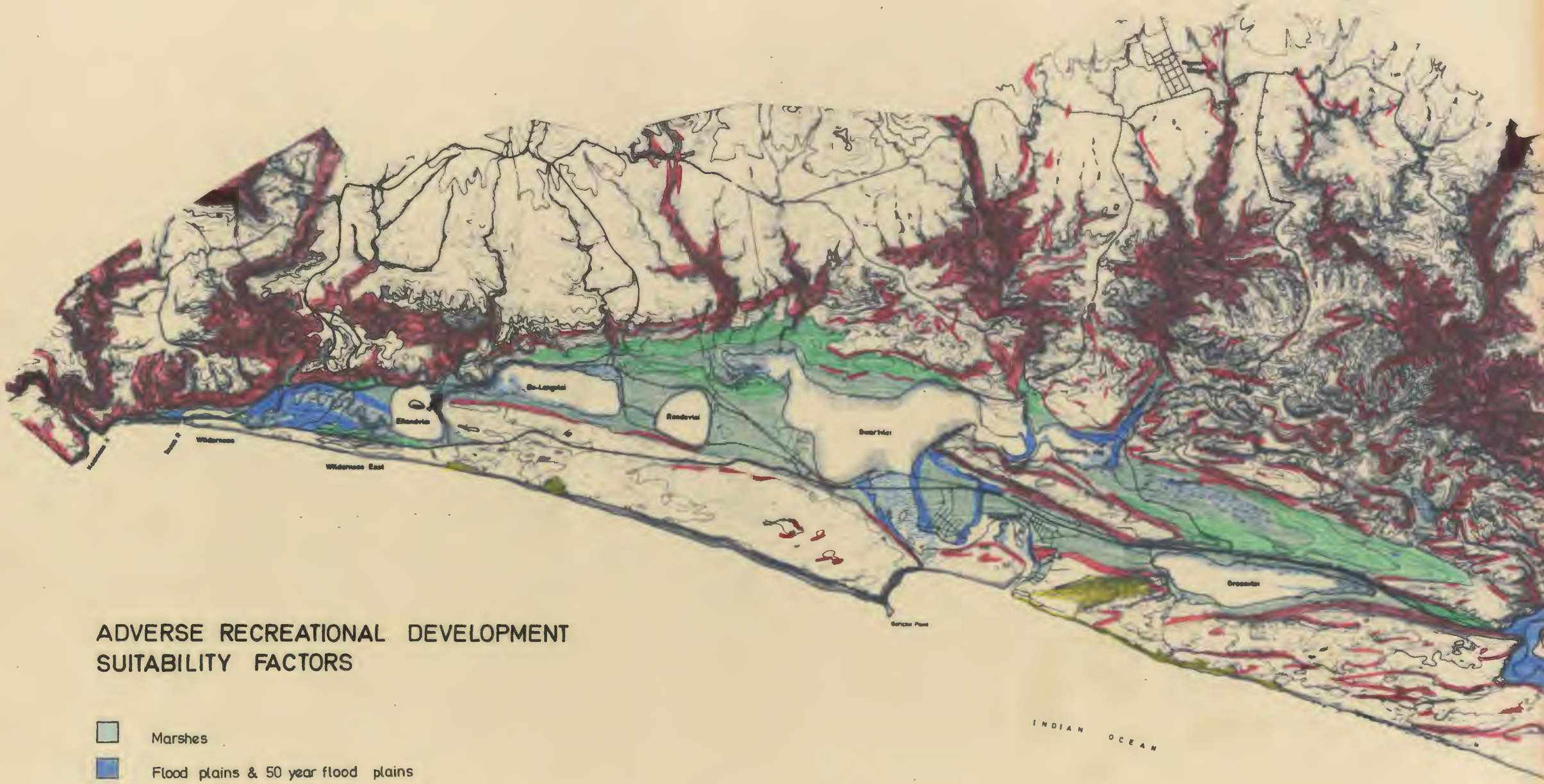
(d) Acquisition of and leasing of land should be integrated by the local authorities concerned to provide access to the Lake and lagoon waters, and to provide land which could be leased by private organisations for boating purposes. This venture would be most welcome along the southern shoreline of Swartvlei, Brenton-on-Lake, Eilandvlei (north eastern shore) and at Belvedere.



RECREATIONAL ACCOMODATION FACILITIES

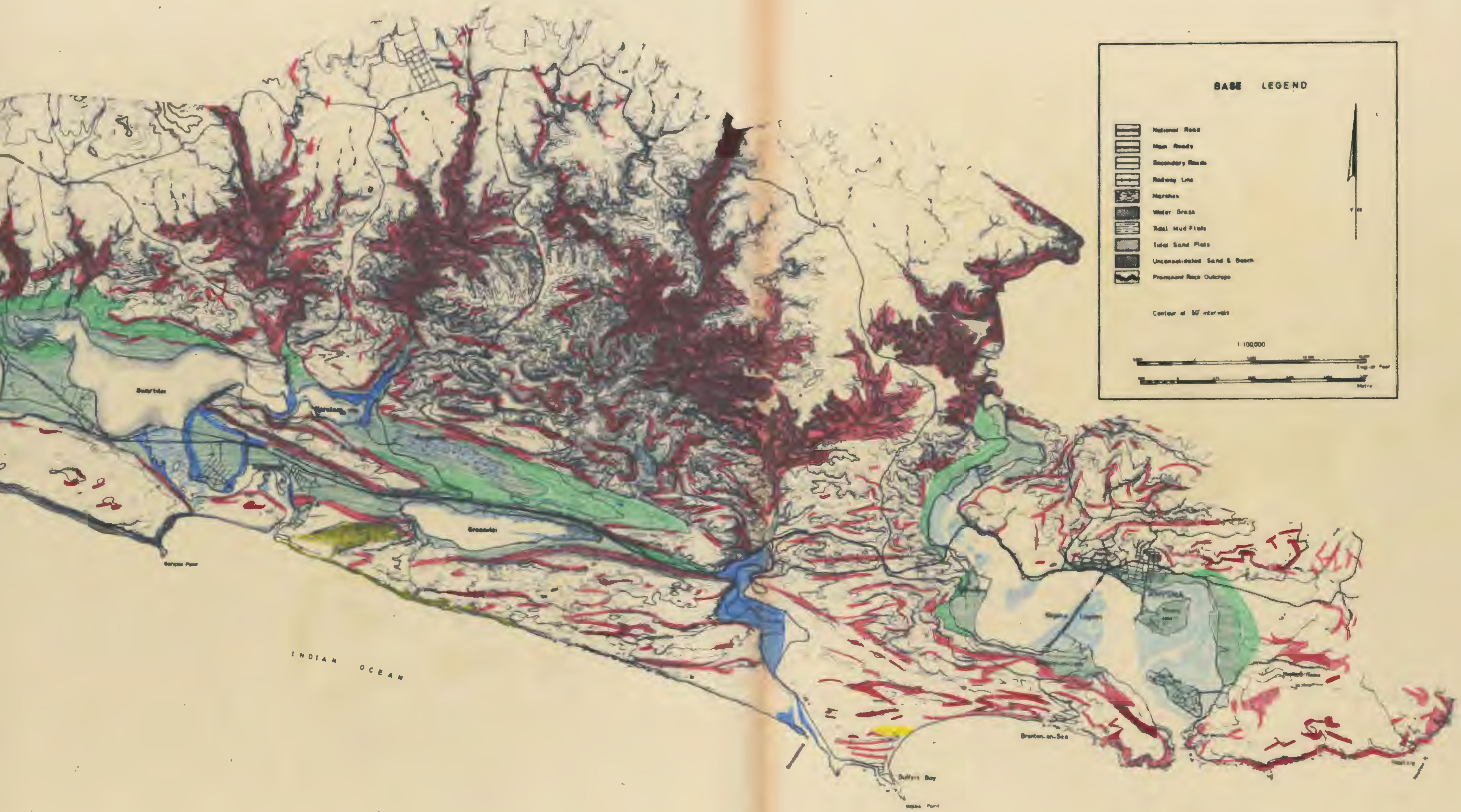
- Holiday cottages
- Caravan Parks
- Tent Camps
- H. M. B. F. — Hotels & Holiday Inns, Motels, Boatel & Flatotel
- Developed Towns & Resorts

BASE LEGEND
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops
Contour at 50' interval
1 100,000
Greenvlei
Buffels Bay
Brenton-on-Sea
KNYSNA
Noetsie
INDIAN OCEAN



ADVERSE RECREATIONAL DEVELOPMENT SUITABILITY FACTORS

- Marshes
- Flood plains & 50 year flood plains
- Aquifers (All recreational land uses permitted within limits of percolation
- Aquifer recharge areas
- Slopes 1 in 3 Dry Northern Slopes & Sand dune crests
- Unconsolidated sand


BASE LEGEND
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops
Contour at 50' intervals
1:100,000
English Feet
Metre
INDIAN OCEAN
Buffels Bay
Brenton-on-Sea

Furthermore accommodation facilities or picnic sites should be provided by the Local Authorities in areas which would be sensitive to maximum development. These areas include the Duiwe River ravine, the Hoëkraal River(three areas, along the eastern bank), at Noetzie and possibly within the Rondevlei Nature Reserve, Goukamma River and Knysna River.

(e) Balanced holiday resort accommodation within townships is stressed in order to promote development and prevent decay of services. This may particularly be suitable for Brenton-on-Sea which is perhaps the least desirable township area, although Wilderness East displays the similar symptons of lack of and accessibility to natural amenities - here steep cliffs prevent access to the dangerous beach. It should be noted that Wilderness is well developed (Approaching 70%) and as such this has resulted in the second best site being chosen for development at present.

Sedgefield Extension I should have a stimulus in the form of a caravan park, a tent camp and picnic sites. The environmental quality of the area should furthermore be enhanced by tree planting - the flat topography and low grass cover has reduced the desirability for development here and furthermore all developed plots are located within close proximity of the lagoon. This is typical of all similar developments along the Cape Coastline where riverside or lagoonside plots and one or two further back are developed.

(f) The area requires temporary forms of accommodation facilities and local authorities should play an important part in providing them in areas of outstanding scenic splendour. As mentioned in Appendix 2 the competition between private and public development can be outweighed by subsidies and the fact that the demand for recreational accommodation will certainly not be satisfied by private or public bodies.

(g) The extent of holiday township development should be related to the total extent of facilities which the developer provides and furthermore controlled growth of residential erven. This can be effected by assessing the total extent of development to which townships grow, thereby assessing the speculative and undesirable erven which remain. Therefore the total extent of erven allowed on the free market could be assessed relative to the extent of existing natural amenities in the area and the minimum number of erven which should be permitted to ensure healthy growth without the speculative element taking control of the situation.

The demand for residential plots is high in this region. However, the degree of development will possibly become marginal as the Region reaches optimum development in terms of

what population the natural amenities can cater for and the extent to which the landscape can absorb such developments. It is therefore essential that excessive development is curtailed in order to prevent the deterioration and overloading of these natural resources at a later stage.

5.3 RECREATION SUITABILITY

Both suitable and active recreation and recreational development areas have been incorporated into the recreational suitability map (Map 24). This map therefore depicts the total extent which the Region can be used for recreation and the quality and suitability of these areas for all forms of recreation.

Graded areas on land reflect (apart from beaches) areas suitable for recreational developments i.e. from picnicking through to intensive recreation areas and residential development.

As emphasised within Section 5.2.3 and Appendix 1 no further residential growth should be permitted. It is therefore stressed that these land based suitability grades relate to the suitability of other forms of development from primitive picnic sites, tent camps, holiday cottages and caravan parks.

No consideration of marina development has been made. Thesens Island is in the process of being developed in stages as a marina and the potential for such a scheme within the Lagoon is high. Other possible areas include the Serpentine, other areas within the Knysna Lagoons and Swartvlei Lagoons. It is stressed that such developments may have an injurious effect on their ecosystems with regard to reduction of fish and bird feeding grounds as marshes and flood plains, creating inbalances in the natural symbiotic processes, water pollution and destroying and reducing the preserves of many bird species etc.

Before consideration of these is made an ecologist should be employed to consider the effect of these developments on the entire ecosystem.

The suitability map also indicates both the value of water bodies for recreation and the related potential use of the adjacent land masses. Belvedere, for example, has a high potential for recreational development which is related to accessible and deep lagoon waters.

It is stressed however that high recreational development constraints not necessarily involved access-ibility of natural amenities as is the case of The Heads township, where the environmental quality is

RECREATION SUITABILITY

Suitability Grades

1
2
3


BASE LEGEND
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops
Contour at 50' intervals
1 100,000
INDIAN OCEAN
KNYSNA
Buffels Bay

extremely high.

Intensive use of inland water bodies is related to the Touws River, Eilandvlei, Swartvlei and Knysna Lagoon. Secondary waters include the Serpentine, Hoëkraal River and Groenvlei. Concentrations of activities along the sea front are confined to Noetzie, The Heads, Buffels Bay, Sedgefield, Gericke Point and Wilderness. A large proportion of the coastline is inaccessible and as such its suitability has been reduced. Furthermore no developments are possible in relation to this amenity.

The Swartvlei weed has reduced the potential of extensive on-shore accommodation facilities, particularly along the southern shoreline. Water grass and weed growth has reduced the recreational suitability considerably.

Extensive areas on the escarpment above Bolangvlei are developable but have poor access to natural amenities and a relatively low environmental quality.

Knysna has extensive tracts of land which could be developed. Environmental quality is the important constraint in this area, in particular, views and on-site vegetation quality, as the lagoon waters are generally inaccessible.

Finally it is stressed that the author had to make intuitive decisions with regard to the extent of an area which was suitable for recreational development. Very often, however, these were defined by physical limitations.

5.4 REFERENCES

1. Outdoor Recreation for America : A report to the President to the Congress by the Outdoor Recreation Resources Review Commission, Washington, U.S. Government Printing Office, 1962.

2. Gasson, Barrie : Toward a Development Plan for the Knysna Lakes Region. Thesis submitted in partial fulfilment of the degree, Master of Urban & Regional Planning, University of Cape Town. March, 1970.

3. Departement van Beplanning : Ondersoek na die Benutting van die Riviermonde, Strandmere en Vleie in Republiek van Suid Afrika, Vol IV Streek Knysna-Wilderness, 1970.

4. Personal communication with Mr. A. Altmann, Chairman of the Townships Board, Cape Provincial Administration.

5. Detailed analysis of development in the region has been conducted by Gasson op. cit. and by the Cape Provincial Administration, Town & Regional Planning Dept.

C H A P T E R 6

COMPOSITE SUITABILITIES

6.1 Within chapters 3, 4 and 5 intrinsic suitabilities for each major component within the natural resource base have been determined. In order to obtain an evaluation of suitabilities relative to one another, it is necessary to compare these by means of the pre-emptive method whereby all Grade I values not in competition with any other Grade I values were initially mapped. This was continued for second and third grades, thereby pre-empting the appropriate combinational areas. These were then ear-marked. The result (Map 25) is a summary of unitary, complementary and competing intrinsic land uses within the Region.

It must be borne in mind that this synthesis has not taken into account the all important cost benefit aspect in land use planning. As such this plan must be viewed as being indicative of locating these phenomena relative to one another and promoting a balanced consideration - the plan does show the relative concurrence of positive factors and their relative absence.

6.2 SYNTHESIS

The synthesis reveals the following:

6.2.1 <u>Unitary Land Uses</u>

Areas which neither conflict nor compete in land uses include:

(a) First, second and third grade conservation areas within the inland plateau ravines and coastal plateau, and certain wild life habitat sections within the lake bodies and Knysna Lagoon, and the inland plateau escarpment at Wilderness.

(b) First, second and third grade agricultural areas. Certain of these areas may however prove to be suitable for use as guest or holiday farms.

(c) First, second and third grade forestry areas - these apply to sites which are already under plantations in the main.

(d) First, second and third grade recreational areas. These include the Knysna area, Goukamma River and Buffalo Bay - the acacia dominated sections, Sedgefield, Wilderness East, Wilderness and Noetzie.

It should be noted that the coastal plateau area south of the National Road at Bolangvlei has no intrinsic suitability apart from third grade forestry sites. This area may therefore prove suitable for certain land uses which may conflict with the land uses this paper is concerned with should the need arise for locating them in the Region. This would furthermore apply to certain areas within the Grade 3 conservation areas. These could furthermore be camouflaged considerably by tree cover and by virtue of their location within troughs where slopes are gentle or in areas where no visual intrusion is apparent.

6.2.2 Competing and Complementary Land Uses

(a) There are many areas of competing land uses suitabilities. On the inland plateau and escarpment first and second land use grades conflict with first and third conservation grades. This is accounted for in the main by farmlands which are being totally exploited or are being neglected. In view of this, the most suitable solution would be to exhort farmers in the area to establish syndicate nature reserve areas incorporating their rough pasture lands and indigenous forest areas into large reserves as mentioned in Chapter 3.

(b) On the quaternary deposits, potential forest land competes with conservation suitability areas. These land uses conflict with one another and cannot co-exist which, in the case of wild-life habitat, applies particularly to the Goukamma Nature Reserve, the Eastern Heads extending to Noetzie and the Western Heads area. In many areas, however, forestry would enhance the scenic value of the bare landscape. This applies particularly to the area between Knysna Lagoon and the Goukamma River Valley.

(c) In certain areas recreation, agriculture and conservation values compete with one another. In this instance these activities could co-exist. However, recreational developments will have to be designed to minimise their impact on the landscape and on the conservation value. In other words, emphasis must be placed on conserving the natural environment.

This applies particularly to the Knysna River, Brenton-on-Lake, The Heads, Noetzie area, Goukamma River, Karatara River, Swartvlei shoreline.

(d) Recreation, conservation and forestry areas include the Eastern Heads extending to Noetzie. On the north facing slopes the suitability is reduced to recreation and conservation.

(e) Recreation and conservation suitabilities within water bodies may conflict with one another or co-exist. Rondevlei and Groenvlei, for example, comprise primary grades for conservation purposes and as such

motor boating should be prohibited to ensure that the water is not polluted with oil. The effect of one boat per day on a water body is approximately equal to the effluent from thirty people per day entering a water body (1).

In this respect and in view of the noise factor recreational use zoning is imperative. These have been instigated by the Department of Nature Conservation at Swartvlei (2) and are in the process of being revised for all the lake bodies. The water grass and reed areas for example will be protected from speed boating by the imposition of a speed limit, limitations on outboard motor capacities or the complete restriction thereof in these areas.

This will therefore provide areas which can be used solely for quiet boating (canoeing, row-boating, swimming and fishing). This could apply to sailing as well but in this respect these craft are generally used on large expanses of water such as at Elandvlei and Swartvlei.

Quiet waters should include (i) the Touws River, at the mouth of the river, and within the Ebb and Flow Nature Reserve, (ii) Swartvlei - the river mouth section and Dragon's Head, (iii) the Hoëkraal River and Karataravlei, (iv) the Goukamma River, (v) the Knysna River above the old road bridge, (vi) Groenvlei - in this instance a minimal quantity of engine-driven craft could possibly be permitted but their numbers would have to be strictly controlled. Furthermore, speed limits would have to be imposed (3).

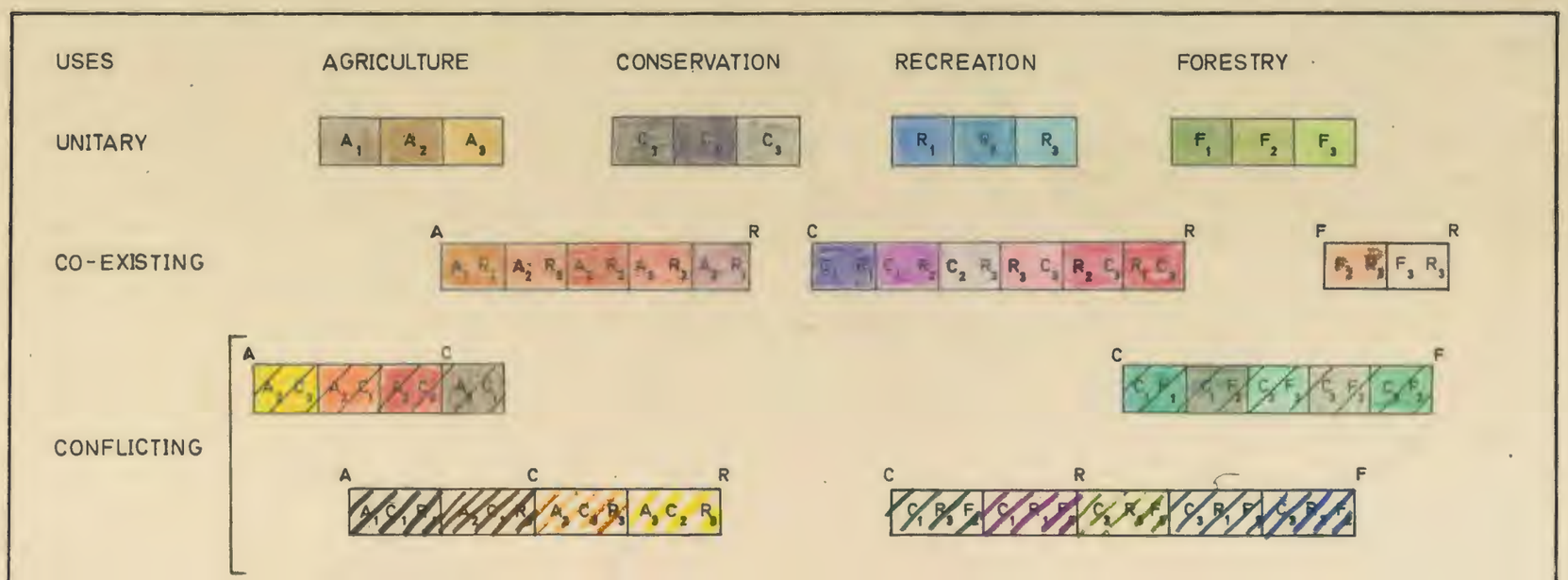
Recreational use of Rondevlei is completely restricted as the lake is used for fish research. This is tantamount to the necessity within nature reserves of having areas which should be entirely restricted to man - wilderness areas.

Such areas naturally occur within the steep ravine of the inland plateau. This reason in particular should motivate the instigation of certain tracts of land on the inland plateau for nature reserve purposes - particularly the agricultural areas which have lowest intrinsic values. Ideal nature reserve qualities would therefore be on hand - both open and closed habitat and wilderness areas for optimum conservation management and minimal public recreation in the form of sightseeing and nature walks on the fringes of the wilderness areas (4).

6.3 CONCLUSIONS AND CONTROL

This plan does not fix precise money values on various land uses and hence one intrinsic land use value may supervene another. However the concurrence of the majority of positive factors in any one

COMPOSITE SUITABILITIES



BASE LEGEND

- National Road
- Main Roads
- Secondary Roads
- Railway Line
- Marshes
- Water Grass
- Tidal Mud Flats
- Tidal Sand Flats
- Unconsolidated Sand & Beach
- Prominent Rock Outcrops

Contour at 50' intervals

1:100,000

English Feet

Metric

ECREATION FORESTRY

R

F R

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location does indicate its intrinsic suitability for the land use or land uses in question.

"Another value is that the information os compiled and interpreted constitutes the base data required to subject any planning proposal to the test of least cost - maximum benefit. Moreover, these same data simplify the quest for least social-cost locations" (5).

The task of any controlling body for the region is therefore to assess at each particular location the intrinsic value of each conflicting or competing land use criteria as it is outlined on the plan. Divisions must furthermore be related to the cost-benefits, both economic and social, and to the demand or necessity for such land uses within the Region as a whole.

It is imperative within this Region to regard minimum social cost and maximum social benefit as over-riding constraints owing to its natural resources which require both optimal management of, and design with, nature.

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C H A P T E R 7

SUMMARY & CONCLUSIONS.

The Region has been analysed in depth in the foregoing chapters. An attempt has been made to integrate all the phenomena which comprise the natural resource base of the Region into an harmonious unit.

This has necessitated the ecological consideration of water based ecosystems and the importance of maintaining and improving their function as an ecological entity. Man has considered least cost - maximum benefit lines in the Region rather than that of least social cost - maximum environmental benefit. The hope is that man in his wisdom today can minimise the effects of poor foresighting economic wisdom in the past which has imposed excessive costs on improving the environment today. Recreation in the Region can not be exploited extensively as a result.

Conservation Management of all water-based ecosystems, the coastal fynbos ecosystems and the indigenous forest environment are all highly sensitive to man-made elements. Guidlines have therefore been suggested for the rectification and control and management of these ecological entities.

The Region is well-endowed with conservation management regions and yet there are many areas which should be incorporated for total protection and or management of each intrinsic value. Criteria which should be considered include physical, historical, scientific cultural and scenic values which in the past have been ignored. These may be lost for all time, and in so doing only then are the prime values of these elements to society realised.

The rural atmosphere engenders characteristics which should be preserved and managed in the Region. These qualities particularly apply to the lakes and riverine areas. To the recreationist their economic value comes secondary to that of scenic quality and relaxed activity. The inland plateau areas are in the main not in the view of the recreationist and yet play an important part in the regional system. The constant encroachment into indigenous forest land whose co-existence with agriculture is stressed in terms of preservation of the water systems, is not condoned.

The recreationist forms a major integral part of the economic activity in the region. The Region offers a variety of activities which would satisfy the palate of even the most particular recreationist.

The recreationist requires two major elements - a feeling of relaxation and diversions. He should have a free choice of determining the environment in which he wants to recreate and not to have a different set of values imposed on him. As such a variety of recreation to suit the constraints which environment imposes should be provided for him.

The natural resource base provides the major economic incentives in the region and all its elements must be planned to co-exist.

Intrinsic suitabilities should be weighed relative to conserving the natural resource base rather than permitting incentives for undesirable and artifical demands. The negligent decision-maker can create the basis for a series of injurious decisions which in the short run will appear insignificant, but will mushroom into a malignant growth with each new onslaught.

The ecological view offers an invaluable insight into guiding man in both his creativity and his instinctive desires to retain a natural environment for which to live with, rather than to compete with, nature.

APPENDIX I

Some Economic Issues in Coastal Recreational Development.

1.1 Holiday Cottages vs. Holiday Homes.

1.1.1 Although the holiday home has to a large extent become an accepted form of recreational development, other forms of development, specifically catering for the holiday maker, offer a freedom of choice in the nature and location of holidays.

1.1.2 The lack of development within coastal townships makes one wonder whether holiday homes are the most desirable form of accommodation. Very few persons today have the capital and means to build a second home. However, in certain areas along the Cape coastline monthly premiums on a small erf or plot range from as little as R20 per month without a deposit. This enables a considerably higher proportion of the population to invest and speculate. The person genuinely interested in establishing a holiday home immediately, or in the near future after buying his plot, represents a minority. Furthermore the speculator has created artificial prices for erven and has assisted tremendously in raising the prices to a level either prohibitive to the man in the street or to a level where he can no longer afford to develop a plot in the foreseeable future.

1.1.3 In developing extensive holiday township areas many problems are apparent:

(a) Vast areas are at the mercy of the bulldozer which is geared systematically to cutting unsparingly into the natural wildlife habitat. It is interesting to note that in many instances wildlife adapts to this semi-suburban atmosphere as this forms a protection from predators, except man himself.

(b) With few plots having been developed and often interspersed within the layout, services decay through non-use. Maintenance costs therefore rise. The value of these affected plots will be reduced. Where building clauses are imposed on erven i.e. rates to the value of a plot with a certain minimum value house thereon, services still become increasingly difficult to maintain owing to this non-use factor. This would not seem equitable in terms of the home owner in the township

(c) Development of plots far from the sea or river front is slow or does not take place at all. This is particularly evident where vistas are either poor or non-existent.

(d) Township areas which were once sparsely populated and had a large reserve of undeveloped plots may lose a considerable amount of attractiveness when nearing capacity development. Overcrowding of the natural amenities may also occur.

A complete character change may result within the resort and this may be enhanced by the introduction of man-made amenities to cater for the additional population and compensate for the lack of natural amenities.

Although this form of holiday is desirable to a considerable section of the population, other persons may prefer the tranquillity and character of a less intense form of recreation area.

It is therefore essential that resorts of varying sizes and intensities of recreational use be carefully planned to meet the needs and values of all recreationists.

In this respect it would seem important to provide higher density accommodationin a natural environment. This could be achieved by means of cluster housing or holiday cottage accommodation preferably. The imposition of high rise development is certainly not desirable in many areas where vistas would be impaired considerably, or where the skyline would be broken.

A further point is that excessive township development may not be desirable in terms of the future needs and values of recreationists, i.e. the extent and impact of recreational development on the landscape should not completely prevent the implementation of improved concepts and their design, nature and spatial allocation. In many instances all developable land within close proximity to an amenity has been developed solely for township development and in certain instances very little land is available for any other usage.

R.A. Pistorius, in commenting on conditions along the Natal North Coast, stated that "..... unless there are radical changes in the economics of seaside development, proportionately fewer and fewer people will be able to afford to build or rent a substantially built seaside cottage on an expensive quarter or third acre plot. However, there are signs that the trend in mass recreation is away from the housework and responsibilities of a holiday in a seaside cottage and towards other kinds of accommodation which offer all the advantages of the traditional cottage without its disadvantages. If these views are accepted, it is obvious that the effort and money spent on laying out seaside townships has been wasted. Worse than that, we are now saddled with a pattern of sub-division which is likely to be useless or at best grossly inefficient for the new kinds of seaside development which will be wasted, and it will be as difficult to

change that pattern as if the plans and title deeds which define it represented something solid and real. In an organised society Man's financial institutions, even if they exist only on paper, acquire a permanence which makes them difficult or impossible to destroy short of a revolution".(1)

He furthermore stated that "Most of the best spots have already been committed to a pattern of ¼ to 1/3 acre plots whose title deeds restrict their use to one dwelling house or cottage. What remains must at all costs, be kept in reserve for other kinds of accommodation which will surely be demanded in the future".(2)

1.2 In order to encourage development of certain township areas and particularly those which have been dormant for many years, certain facilities should be introduced into these areas such as general outdoor recreation, caravan parks and tent camps. These components will form an economic base for these nodes and will furthermore assist in maintaining services in the area.

These components, it is anticipated, should spark off a multiplier effect in attracting development and further recreational and commercially orientated land uses. If these fail to revive development of erven, achievement may still be measured in that a wide range of facilities for the general public has been provided.

A further incentive in this respect stems from the fact that services have already been installed and therefore the expense of establishing such enterprises will be reduced to a certain extent.

The lack of development within such areas may have originated from the fact that the natural attractions are insufficient or not sufficiently diversified to attract a large number of people. The development of these facilities will stimulate interest in the area and give it the added impetus it requires.

1.3 With respect to enterprises which provide for accommodation on a temporary basis e.g. holiday cottages, caravan parks, tent camps. hotels, etc. the investment risk falls entirely on the developer. As such the provision of services and amenities will be optimised if a return is to be expected.

In certain instances where the holiday season is short, such development may not be profitable. It is felt that subsidies in the form of reduced rates or tax rebates should be permitted. In certain areas local authorities should acquire land and lease it for such purposes. The principle involved here is the fact that these facilities provide a service to the general public and every assistance should be given to this form of enterprise.

1.4 Within coastal townships developers are only required to provide a basic minimum of services. The onus has been on the Local Authorities, through rates from property owners, to maintain and develop services further, and to repair existing unused services.

In this respect, staged development would be preferable to prevent dispersed minimal development of vast areas and furthermore the developer should be made to install the full range of non-rateable services i.e. drainage, roads, water reticulation and sewerage, and an endowment for their maintenance should be made compulsory. The developer could then receive a return on this endowment from rates accrued from developed stands.

In certain townships building clauses have been imposed on properties, i.e. after every two years rates on erven are increased to a value proportionate to the expected standard minimum value of a house on that plot. This in itself would appear to be an adequate measure in order to maintain services, although rates paid are very low in these areas. The loss of this revenue, however, to the local authority, coupled with the fact that within these two years the property may change hands a number of times, makes this form of building clause an inequitable and impractical system. The Niemand Report (3) recommended that the responsibility for providing services should be divided in this way: the Local Authority provides the rateable services such as water and electricity, while the developer is responsible for sewerage, roads, stormwater, light standards, etc. In this way the burden of unrateable services is passed directly to the purchaser, while rateable services are charged according to use - the public debt incurred in their provision gradually being marked off. Payment for maintenance of these non-rateable services is, however, still necessary particularly in terms of their non-use.

1.5 A problem which arises from staged development is that the market mechanism is unable to function in simple terms of supply and demand for erven. The demand is however to a large extent artificial in terms of the large number of plots sold and the small proportion built on. The sale of plots is very similar to selling ice cream - the fact that there is a mouth-watering sign outside a shop displaying a magnificent ice cream stimulates the desire to buy one. If the ice cream was not advertised, one would possibly not consider buying one.

In this respect, although consumer sovereignty should remain, ownership of land at the sea should be considered a privilege and a luxury and should be treated as such, i.e. the need to conserve our natural environment in many areas should override the market mechanism to the extent that people should pay for the privilege of owning a plot in a select area along the coast.

Furthermore the artificial demand which has been induced would be curtailed considerably if large scale provision was made for other forms of holiday accommodation. This would be of particular benefit if they were provided in or within close proximity of holiday townships (bearing in mind that these different land uses are to a certain extent incompatible. The balanced holiday resort would therefore appear to solve the problem to a certain extent.

In areas where the natural landscape can be enhanced, or not particularly destroyed, by means of extensive township layouts, the market mechanism should be permitted to operate.

The preferable solution would therefore be to restrict the number of erven permitted in the first stage of development. However, the developer must still be allowed a sufficient profit margin to re-invest in a further stage of development. The proven desirability of the first stage development, in terms of degree of development, will justify reinvestment into a second stage development. In other words, the developer should be permitted to establish townships of a size large enough to create a cash flow which will enable him to make the development a profitable venture with further stages of development. In this respect the initial basic service provision has been installed, and hence the cost of providing additional services will be minimised within future extensions.

Furthermore, space should be allocated for other forms of accommodation. This should be in proportion to the number of people catered for within the residential layout and furthermore related to the regional demand for each accommodation type. This breakdown should be flexible as a particular site may not lend itself to particular uses. With increasing number of erven a reduction in hotels, caravan and tent sites, and cottages, could be expected, i.e. as the desirability for development within the township is evident additional residential erven may be permitted with less provision of other forms of accommodation. The regional balance of accommodation is however emphasised, although it is felt that the attractiveness of an area must not be spoilt by excessive caravan park, tent camp and holiday cottage allocation, which can do as much damage as township development. It is therefore necessary that each application be treated on its own merits.

Inducements should be given to private developers of holiday cottages in the form of subsidies, and possibly leasing of local authority land. This would facilitate the establishment of these much needed developments and would also help to minimise the costs to holiday makers, and help to maximise the variety and degree of sophistication of accommodation.

This space allocation should therefore form part of the developer's land endowment to the local Authority, i.e. the Local Authority will be endowed with land suitable for recreation as well as land for other services. This would maximise public use of recreation space, and reduce public expenditure on recreation.

Although Local Authority competition with private enterprise is not desirable, with subsidies given an equable situation could be reached. This healthy competition could optimise all facilities and minimise excessive profits which may accrue. "Services should be priced so that the facilities are used in an optimal way and such that the deficits or surpluses in the operation are held to a minimum ..... over the long run the resources devoted to recreation are themselves a variable and a decision is required as to whether investment in recreation should be increased, decreased, or held constant." (4)

This aspect would also play an important part in restricting the degree of development, and thereby prevent the entrepreneur from attempting to cater for too many people far in excess of the availability of natural amenities.

Furthermore Warren G. Robinson stated that "private development, even when it did not generate an aesthetically acceptable service of the type desired, might be carried on too intensively and at too swift a pace thus producing as a side effect, a "using up" of the resource. This is, of course, the classic conservationist argument of the role of government as society's trustee for future generations.....Having decided against a very intensive short run development does not preclude profitable operation of some resource even though profits may be somewhat lower" (5).

1.6 Cottages which could be leased to private individuals on the condition that they should be let to other individuals when the lessees were not occupying them, are welcomed. However, it is felt that this privilege does not give other members of the general public the opportunity of making use of them at a convenient time or during the best times of the year. In this respect these developments should be allowed in intensive recreation areas where the emphasis is on providing a full range of activities and accommodation for ownership, lease or hire rather than in areas where the emphasis is placed on conserving the natural environment.

1.7 Of great concern is the way in which local authorities are developing, or attempting to develop, holiday townships on land they own which is suitable for recreational development. Such land should remain in their hands and be developed for general public use, or in the event of adequate land being available, portions thereof could be leased to private organisations for outdoor recreation purposes only.

1.8 REFERENCES

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(4) Robinson Warren: "The Simple Economics of Public Outdoor Recreation". Land Economics Vol. XLIII, No. 1, February, 1967, p. 80.

(5) Ibid p. 75.

2. APPENDIX 2 LANDSCAPE EVALUATION

Introduction

This is an attempt at assessing peoples' preferences to landscapes and formulating criteria on which recreational planning decisions can be made in terms of optimal utilization, enhancement and protection of the natural environment.

Although the basis of this thesis is to formulate a regional model for conservation, agriculture and forestry, and recreation, I feel that this additional independent constraint should be placed on this synthesis i.e. although all other factors have been evaluated and have each played a considerable part in optimizing land usage, I feel that this evaluation will be of some use as a final check in both locating projects in detail as part of the future landscape.

Although the results obtained in the section will not necessarily be of use in assisting delineation of optimum land usage for the region, it is anticipated that they may be of some use when consideration of detailed location of projects within or without the study area is being made.

2.2 BACKGROUND RESEARCH

A considerable amount of research has been conducted in the evaluation of peoples' preferences and attitudes towards landscapes. A review of some of these is necessary in enlightening the reader as to the degree to which and the nature of which studies have been undertaken, and furthermore the degree to which I am able to utilize these findings in formulating methodology, and as supplementary criteria to my evaluation.

2.2.1 It is necessary to have confidence that the public will show a substantial level of agreement on the attractiveness of a given scene, and secondly that the public will identify some scenes as substantially more attractive than others.

In order to explore these fundamental questions Robert E. Coughlin and Karen A. Goldstein (1) conducted five pilot tests in which several related research questions were dealt with. For example, do people rate a site differently when asked about the value of the site for specific uses for which an aesthetic environment is important, than when queried directly about the aesthetics of the site? As another example. are judges' reaction to photographs similar to their reactions to experience in the field? i.e. Are photographs an adequate proxy for field observations?

The tests locally consisted of asking a number of judges to rate the attractiveness of a number of environments on a scale ranging from 1 to 7. In all but one test, which was conducted in the field. the environments were depicted by colour photographs.

The tests indicated that significant agreement on attractiveness of various scenes can be expected and that environmental attractiveness can be determined and analysed.

Major Findings.

(a) Agreement on Environmental Attractiveness

Two requirements were necessary:-

(i) tendency of agreement in the ratings given to slides i.e. measured by standard deviation of ratings by individual judges on a given slide - the smaller the standard deviation the greater the extent of agreement;

(ii) significant mean differences in mean ratings which are indicated by the distribution of mean ratings for each slide. The standard deviation of mean ratings provides one measure of this distribution - the larger the standard deviation, the more "spread out" or differentiated are the environments.

The following table indicates the probable range of various combinations of agreement and differentiation.

This diagram is equivalent to the concept of an analysis of variance which deals with "within-slide" variance (difference in ratings by different judges on a given slide) and "between-slide" variance (difference in mean ratings).

Analysis of variance of the ratings given in the five tests indicates that judges are able to discriminate among environments on the basis of their attractiveness and tend to have a relatively high level of agreement of a given environment.

The judges generally agreed on the environmental attractiveness of the scenes they were asked to rate. Differences in the scenes themselves were more important than differences in opinion among the judges. Therefore, although tests do differ significantly, it may be possible to assign values to particular scenes which would be recognised as valid by the judges as a group, or, by extension by the public at large.

(b) Agreement on Attractiveness of Various Landscapes for Various Purposes.

The lowest levels of agreement were found when the judges were asked to rate slides with regard to functional attractiveness for living in and for sightseeing rather than for environmental attractiveness in the abstract. This suggests that participating judges agree.

Tests 1 and 3 indicated that judges preferred natural rural environments to suburban and urban environment. However, the difference in preferences between urban and suburban environment was not significant.

Although results were not conclusive, there was also some indication that judges agreed more on level of attractiveness of natural environment than attractiveness of suburban and urban environment.

(c) Consistency of Ratings

If preference ratings have any meaning it is necessary that there be no significant difference between the ratings given to a particular landscape by an individual in repeated observations. Similarly mean ratings given by a group of judges should not vary significantly by either an intervening in-depth analysis or a time lapse of one month. However, after an in-depth analysis, the judges tended to disagree somewhat more than on their first observation. The time lapse of one month had less effect on agreement levels.

(d) Photographs vs. Field Observations

Although a small number of field judges (totalling 11) were used, thereby limiting the significance of this result, this test provided some evidence that responses to slides tend to be consistent with responses to the same environments in the field.

A related and consistent finding is that photographs taken at one place but in different directions tend to receive similar ratings. This finding lends support to the proposition that a single photograph can be used to represent a place.

2.2.2 Carla B. Rabinowitz and Robert E. Coughlin (2) were able to base further landscape preference studies on the work of the previous paper outlined above, namely "The Identification of specific objective characteristics of those landscapes which could be chosen to have significant relationship to preference ratings."

The data used in this stage of the analysis consisted of the 337 slides used in Test 3 of the earlier paper, brief written comments by observers on the 14 of those slides which were used in Test 5 and other data obtained in the field as part of a much more extensive project (Field Test - Stream Sites) which will appear in a later paper of the same series. The Field Test involved 15 stream sites in the Philadelphia area, ranging in character from rural to completely urbanised. Data on pollution, channel enlargement, and other characteristics of streams which are related to urbanization of the watershed area had already been collected for most of these sites, further information was gathered on 183 other variables, primarily measures of visual characteristics such as size and shape of the streambed, roughness of surrounding topography, area covered by trees, grass, or other ground cover, and elements of visual pollution such as junk or discolouration of water. Ten observers were then taken to these sites, and asked for brief written descriptions, as well as ratings of the sites on a 1 - 5 basis for 29 different preference scales. These observers were selected for their similarity in background and education, rather than for diversity or "representativeness", the rationale was that in this exploratory study the researchers wished to focus upon differences between sites rather than differences between observers.

Several different methods of analysis were employed. For the 337 slides of Test 3 (rating the attractiveness of the natural environment as seen in each slide), extreme high and extreme low-scoring groups were selected, dominant characteristics of slides in each group were identified by inspection, and the extreme groups were then compared with each other and with the "average" group. For the 14 photographs used in Test 5 (Consistency Test - rating attractiveness of (a) each slide (b) each slide after verbal analysis (c) each slide after a wait of one month), the method was basically the same, but the analysis was much more thorough. For each photograph, a 17 x 23 descriptive matrix was completed, dealing with such aesthetic characteristics as Variety, Colour, Brightness, Spaciousness, and Naturalness, applied to individual elements of the scene as well as to the whole. All of these characteristics were measured on a 1 - 5 scale. Three RSRI employees participated, each completing a matrix for each of the photographs; the results were then averaged for each photograph and analysed to determine similarities and differences between the five highest scoring, the five lowest scoring, and the "average" photographs.

For the Field Test data (rating the attractiveness of the environment in the field) a matrix of sample correlations (241 x 241) was produced, containing the 183 "objective" variables as well as means and standard deviations of the 29 preference scales for each stream.

The brief comments of the observers on the 14 photographs of Test 5 (Consistency Test), and the longer "objective descriptions" of 15 sites, which were provided by the observers in the Field Test, were analysed in terms of the frequency of occurrence of certain descriptive elements, and the evaluative connotations of these elements.

The results obtained suggest that there does exist a reasonably strong, consistent pattern of preference, with high agreement among judges as to the essentials of a "good" landscape. The field test and photographic findings agree substantially.

Major conclusions were as follows:-

(a) (i) There are some good landscapes which everyone agrees are good. People tend to agree more about what they like than about what they dislike.

(ii) Within the 337 slides the highest scoring 10% of photographs were found to be strikingly similar. This similarity was even more pronounced for the 14 photographs which were analysed extensively as part of Test 5 (Consistency Test). Furthermore, three of the highest scoring Field Test sites contained the same general type of landscape which predominated among the highest scoring photographs. For all three tests, the lowest-scoring landscapes were less similar and those scoring in the middle range least similar of all.

(b) These generally preferred landscapes bore a strong tendency to be "park-like" or obviously man-influenced. Mowed grass and scattered large shade trees seem to be the determining factors. The scenes are not in a wild or natural state but clearly landscaped.

(c) This preference for park-like landscapes is partially explained by the fact that, where the instructions on a test do not differentiate between preference for "use" and for "abstract attractiveness" of sites, judges, in rating these sites, seem to think primarily in terms of their usefulness for recreation. "Recreation", moreover, seems to be defined primarily as "picnics", and only secondarily as "hiking" or "active sports". Recreational

use of sites is mentioned with equal frequency in the comments for the Field Test and the Consistency Test, although the instructions for the latter did not include any mention of such use.

Statistical analysis of the Field Test results also suggests that the "use" aspect of a site is of primary importance to the participating judges. There was considerably less variation among stream sites in rating them as places to pass through and enjoy the scenery (Question 2) than considering these sites for living and recreation. Furthermore, the average number of comments per judge for any site is more highly correlated with the use question than question 2.

(d) There are significant "minority preferences" relating primarily to extreme spaciousness, extreme seclusion, and extreme naturalness.

(e) The characteristics common to those landscapes with high mean preference ratings and low standard deviations are largely synthetic, having to do with patterns and arrangements rather than individual elements. Dislike, on the other hand, seems to focus on individual elements, and primarily man-made ones.

"Misfit" elements such as polluted water, excessive amounts of trash or excessively loud automobile noise have a consistent strong relationship to low mean ratings.

(f) Objective analysis and comments by judges on elements within high and low scoring photographs were similar. The exception was the high proportion of the Field Test comments which were devoted to non-visual stimuli such as stream noise and grass smells: almost no significant correlations were found between preference ratings and pleasant non-visual characteristics.

(g) The more judges liked a slide in a site, the more they tended to talk about it.

(h) The more judges think about and attempt to verbalise their preferences, the more their personal reactions seem to come to the fore.

(i) Rural slides which were considered to have positive characteristics i.e. those characteristics which differentiated "High" slides form the majority of "High Average" and "Low Average" rural slides contained:-

(i) "Balance" - an appropriate balance and integration of open space and tall vegetation in both foreground and background.

(ii) "Pattern" - a striking complex pattern of light and shade, created by

vegetation and covering most of the photograph.

Negative rural characteristics which seemed to occur frequently in "Low Average" and "High Average" rural slides, but not in "High":-

(i) "Road" - A road which either dominates the foreground or goes straight off into the distance, creating a monotonous vista, unshaded, detracting.

(ii) "Flat-Bare" - Any large, flat or slightly rolling, unshaded expanse of ground in foreground or mid-ground of picture.

(iii) Either (i) or (ii) or both.

(iv) "Dense" - Thick growth with no open space. This variable found impossible to measure on any other basis than the researchers' subjective opinions as to the attractiveness of the vegetation, and so was discarded.

(v) "Scruffy" - Large weeds or vines, typical of an area which has been cleared by a man and then neglected.

(vi) "Misfits" - Prominent, ugly, man-made elements.

(j) (i) Urban Characteristics: "Quantity of Vegetation" displayed a consistent positive relationship to ratings for each category i.e. natural environment, urban and suburban.

(ii) "Neighbourhood Status" does not seem to be an important factor except insofar as high-status neighbourhoods tend to have more vegetation. Nevertheless it was agreed that "status" has a concealed effect on the high ratings of rural slides. Only one of the "High" rural slides contained a cultivated field as opposed to 20 of the average rural slides - an indication that "High" slides might be seen as part of large estates rather than as truly rural.

(k) High photographs had greater:-

(i) variety of brightness

(ii) variety of elements in total scene

(iii) brightness of ground cover

(iv) contract of total scene

(v) variety of colour

(vi) dominance (importance) of variety

(vii) dominance of naturalness

(viii) quantity of focal points

(ix) more "lush" vegetation on areas of flat land.

Low photographs had:-

(i) larger sky
(ii) greater dominance of location i.e. the focal distance, whether near or far, was an important component of the total visual effect.
(iii) greater dominance of sky
(iv) larger areas of flat land
(v) larger areas of slopes
(vi) more ground cover
(vii) more trees
(viii) higher naturalness.

The following is a list of characteristics for which one group of extreme photographs was much more similar within itself than was the other group:

High photographs were more similar in:-

(High) variety of total scene
(Low) spaciousness of total scene
(Low) variety of naturalness
(High) brightness of grass
(Medium) brightness of sky
(Low) quantity of ground cover
(High) visual field covered by topography
(High) spaciousness of grass
(Lush) condition of grass
(Low) dominance of ground cover

Low photographs were more similar in:-

(Low) dominance of variety
(Medium) colour intensity of grass
(Medium) naturalness of slopes

Average photographs contained:-

Highest and lowest spaciousness of total scene
Highest spaciousness of slopes
Smoothest texture of ground cover
Highest quantity of ground cover (as opposed to grass)
Most visual field covered by ground cover

Most visual field covered by grass
Highest spaciousness of ground cover
Highest naturalness of flat land
Highest naturalness of total scene.

A general conclusion that was reached is that extreme naturalness, extreme spaciousness or extreme seclusion in a landscape will tend to be disliked or ignored by a majority of observers, but will inspire extremely strong favourable reactions in a few (Minority Preference Hypothesis).

2.2.3 Edward L. Shafer Jr., John F. Hamilton Jr., and Elizabeth A. Schmidt (3) have conducted a recent experiment using black and white photographs of landscapes. The purpose of the study was to identify what quantitative variables in a natural landscape are significantly related to public preference for that landscape.

The experiment indicates that preference for a landscape depends on the area or perimeter measurements of six items within a photograph. These six items can be used to help evaluate and compare the aesthetic quality of different landscapes.

In the study, landscapes were depicted by one hundred 8 x 10 inch, black and white photographs taken throughout the United States when trees were in foliage. The photographs, all taken on the ground and all of professional quality included representative views of typical wildlands in the United States, excluding seashore scenes. Landscapes included forests, mountains, meadows, water and various combinations of each.

Landscapes were divided into zones of vegetation, non-vegetation, water and sky. However, every zone did not occur in each photograph.

The 10 zones were:-

A. Sky zone. Includes only sky and clouds.
B. Immediate vegetation zone. Where the characteristics of individual leaves, needles, bark, or stems of trees or shrubs are easily distinguishable.
C. Intermediate vegetation zone. Where the outlines of individual trees or shrubs are recognizable, but not in the fine detail found in the immediate vegetation zone.

D. Distant vegetation zone. Where trees or shrubs occupy the landscape, but the shape of individual crowns is not discernible.

E. Immediate non-vegetation zone. Where soil or snow texture, boulders or rock outcrops are distinguishable.

F. Intermediate non-vegetation zone. Where the outlines of individual rocks, prominent features of exposed soil, grass or snow-covered areas are recognisable but not in the fine detail found in the immediate non-vegetation zone.

G. Distant non-vegetation zone. Soil, rocks, grass or snow occur, but no details of these features are recognisable.

H. Stream zone. Includes only water and rocks in a stream.

I. Waterfall zone. Includes only water and rocks in a waterfall.

J. Lake zone. Includes water rocks in a lake.

By means of a plastic grid overlay each photograph was divided into ¼ inch squares. Landscape zones were then outlined with each zone being noted by a set Sn.

Four variables were used to describe any set Sn namely:

(a) Perimeter. The number of boundary edges all squares in Sn, in other words the length of the boundary separating Sn from external squares.

(b) Interior. The number of squares in set Sn without boundary edges.

(c) Area. The total squares in Sn.

(d) Horizontal end squares. The number of squares in Sn that have vertical boundary edges. This variable shows the difference between two or more zones that have the same shape and size, but occur in two different positions. However, the variable does not differentiate between similar inverted zones.

So with four variables per landscape zone multiplied by 10 zones, a total of 40 variables describe the configurations in a photograph.

Three additional variables used to describe a landscape were tonal variation of sky, land and water. A photometer was used to measure the tonal value in each circle of a 15 x 19 inch rectangular array of $^{1}/_{10}$ inch circles. Each circle was assigned numbers 1, 2 or 3 depending on whether it represented sky, land or water.

So with 40 variables to describe configurations, three variables to describe tonal variation, and three variables to describe the composite areas of sky, land or water a total of 46 variables could be used to see

if there was a significant relationship between quantitative items in the photographs of a landscape and the preference score of that landscape.

The preference score (Y) of a landscape was obtained from sample interviews with Adirondack campers. The 100 photographs were randomly distributed into 20 packets of 5 pictures each. Each respondent was asked to examine four packets and rank the landscapes in each packet from 1 to 5, with 1 indicating the first preference.

The picture rating and inteviewing procedure continued until 50 random sorts had been made and 250 respondents had been interviewed.

The resulting 50 rank-values for each photograph were added and the total value for each photograph was designated as its preference score (Y).

Theoretically, the preference score could have ranged from 50 to 250 - 50 being the most preferred, 250 being the least. The values actually ranged from 71 to 228 with a mean of 150 and a standard deviation of 37.75.

The final equation, or model, that used 10 significant terms and explained 66% of the variations in landscape preference scores was:-

$$Y = 184.8 - 0.5436X_1 - 0.09298X_2 + 0.002069(X_1X_3) + 0.0005538(X_1X_4) - 0.002596(X_3X_5) + 0.001634(X_2X_6) - 0.008441(X_4X_6) - 0.0004131(X_4X_5) + 0.0006666X_1^2 + 0.0001327X_5^2.$$

where:-

X_1 = perimeter of immediate vegetation

X_2 = perimeter of intermediate non-vegetation

X_3 = perimeter of distant vegetation

X_4 = area of intermediate vegetation

X_5 = area of any kind of water

X_6 = area of distant non-vegetation

By use of the model, the predicted scores for the 100 photographs ranged from 84 to 236, with a mean of 150.05 and a standard deviation of 30.58.

The negative items or combinations of items in the model have a positive effect on a landscape's aesthetic appeal:

(a) Perimeter of immediate vegetation
(b) Perimeter of intermediate non-vegetation
(c) Perimeter of distant vegetation multiplied by area of water
(d) Area of intermediate vegetation multiplied by area of distant non-vegetation.

The following items or combinations of items have a negative effect on a landscape's aesthetic appeal:

(a) perimeter of immediate vegetation squared
(b) area of water squared
(c) perimeter of immediate vegetation multiplied by perimeter of distant vegetation
(d) perimeter of immediate vegetation multiplied by area of intermediate vegetation
(e) perimeter of intermediate vegetation multiplied by area of distant non-vegetation.

2.3 APPLICATION TO SOUTH AFRICAN POPULATION

The information gathered above, although pertaining to populations within the United States, provides useful guide lines as to the responses which could be expected from a South African population.

In order to test that a population in this country would generally not react in too different a manner from that of another, a pilot survey was conducted on a similar basis to that described in 2 above using natural landscape shots from the Study Area. Furthermore, after each person was asked to rank the photographs they were asked to comment why they liked or disliked each photograph. Twenty persons randomly selected from an office block were asked to rank 20 black and white photographs i.e. 4 lots of 5, in order of preference.

The rank totals ranged from 31 to 83 with a possible range of between 20 and 100. A frequency distribution was plotted for the rank totals. A normal distribution was obtained though somewhat platykurtic i.e. there was a low agreement as far as attractiveness of photographs was concerned. This could be expected with the sample population interviewed where the spectrum of levels of education and salaries were not as high as one would normally obtain in a representative sample.

Comments on landscapes were categorised and the general attitudes recorded by the people are as follows:

(It should be noted that Rabinowitz and Coughlin have statistically tested this method and found it to be a valid approach, particularly with regard to photographs obtaining higher ranked values).

"High" photographs i.e. with totals ranging from 30 - 50 received comments with regard to:

(a) visual complexity
(b) trees in foreground and uniqueness thereof
(c) extensive vista and/or panorama
(d) quality or tranquillity of water in the foreground or middle distance
(e) unspoilt quality
(f) water reflections or water as the attractive element in the photographs
(g) farmscape
(h) tranquillity and restfulness of the scene
(i) bias towards sea-scapes
(j) relationship of vegetation to water
(k) existence of mountains
(l) depth of photograph
(m) secluded and rocky beach
(n) sea water refreshing
(o) waves breaking over rocks
(p) nice for a holiday
(q) cosy

Medium photographs (with sub-totals ranging from 50 - 70) received the following comments. Positive and negative reactions are indicated:

\- (a) too much beach
\+ (b) trees infrequent, mountains in background
\+ (c) varied nature of view and pleasing in depth
\+ (d) variety of trees
\+ (e) never ending landscape
\- (f) flat
\- (g) cloudy
\+ (h) nice picnic spot

Low photgraphs received the following comments:

- (a) flat
- (b) cloudy
- (c) uninteresting
- (d) dead, boring, dull
- (e) water not interesting
- (f) landscape too wild
- (g) monotonous landscape
- (h) no unique features
- (i) sea-scape too barren; any old desolate beach
- (j) too many bushes, trees
+ (k) variety of trees
+ (l) sun and shade, dull and bright colours
+ (m) trees in intermediate distance
- (n) no sea
+ (o) pleasing at a glimpse
- (p) too wild
- (q) too much forest
- (r) trees too dark in immediate distance
+ (s) water and vegetation contrast
+ (t) river and reeds
+ (u) sea gives "nice holiday feeling"
+ (v) clean sand and sea
+ (w) nice bathing in sea
- (x) too barren
+ (y) nice sea sand
+ (z) grandiose, gives one feeling of strength
+ (aa) lush pastureland, feel like rolling over it
- (ab) water uninviting
- (ac) too much water
+ (ad) water nice for canoeing
+ (ae) water good for sailing
+ (af) lovely picnic spot
- (ag) water looks stagnant

It would appear from this exercise that the attitudes of people within this sample do not appear to differ from those expressed statistically by the three studies mentioned above.

Generally photographs with a farming or park-like landscape received highest values and these were associated with water with a full variety and contrast of many components.

Persons interviewed generally reacted to a landscape in terms of its potential for recreation - either active or passive.

Wild landscapes and over-vegetated and mountainous landscapes were given low ratings. The person generally evaluates the photograph by "feeling" the environment and attractiveness. In this respect the natural sounds or smells within the environment would stimulate this "feeling". This aspect cannot however be measured.

Other factors which have an important influence on landscape evaluation and described by K.D. Fines(4) are:-

(a) Sentiment towards a particular landscape
(b) Fear - an atavistic dread of the wildernesss. "In the form of awe it may intensify the response to the point of quasi-religious ecstacy".
(c) Curiosity - Identification of Landmarks and the minutia of activity.
(d) Surprise engendered by an unexpected prospect mav temporarily enhance its impact.
(e) Veneration of age and history can endow man-made structures with greater beauty or permit the acceptance in the landscape of structures which would otherwise be regarded as intrusive.
(f) The kinetic or sequential landscape or the continual transformation of the view by atmospheric conditions, or a spectacular sunset, seasonal patterns, continually changing view while in motion, or a pattern of structural change.

Colour is a major determinant in landscape appreciation. Although my objective is to evaluate the importance of components within a landscape relative to preference, I felt it was necessary to conduct an experiment to see whether colour photographs could be used with the possibility of obtaining the same results.

Black and white and colour photographs of scenes in the Study Area were taken, each scene having an identical colour and black and white coverage. Development as well as natural landscapes were photographed.

Sixteen photographs of such natural landscapes and suburban scapes were ranked in the same manner as above i.e. 4 sets of 4 photographs and the resultant ranked totals were correlated. The correlation coefficient between ranked totals of the developed scapes was 0.30 whereas that for natural scapes was 0.65.

It therefore would appear that the added variables and combinations thereof brought about by development on the landscape reduce the correlation between black and white and colour photographs by approximately one half. This is to be expected since the imposition of development on a landscape increases the number of component variables within that landscape considerably, irrespective of the degree to which development covers the landscape.

Although a high correlation was obtained between colour and black and white photographs of natural landscapes, black and white photographs were used in the final analysis of landscapes for the following reasons:-

(a) There is an importance in correlating this work with that done by Shafer, Hamilton and Schmidt as described above.
(b) The above studies refer to components within the landscape and do not deal with colour as a variable i.e. although the first two studies described were conducted with colour slides, no reference was made to the effect of colour on peoples' preferences.

2.3.3 Method & Application

As there was limited time available to conduct this analysis it was necessary to considerably reduce the number of persons interviewed and the number of photographs used in the test. Forty photographs ranked in 8 lots of 5 by 20 persons was considered to be adequate for this purpose, and conducted in the same manner as before.*

The ranked totals were distributed normally and ranged from 29 to 81 with possible scores ranging from 20 - 100. A histogram for the distribution was plotted. It was found to be normally distributed and found to be significant at the 5% level of acceptance, by means of the Chi squared test for normality.

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* This survey and the penultimate survey were conducted on Fish Hoek beach, and each sample comprised both holiday makers from a variety of places in South Africa and Rhodesia, and Cape Town residents.

The dependent variable for each photograph is represented by the rank totals and had therefore been determined. The next stage was to apply these dependent variables to quantified independent variables within each photograph and attempt to find which had the greatest impact on preferences. These could then be spatially represented in plan form within the region. Secondly, the object was to obtain a linear model by which a quantifiable assessment of the value of a landscape i.e. the photograph of a landscape could be made in terms of its inherent value and in the consideration of conservation, management and utilization of the landscape.

This was considered to be best achieved by means of the Step-Wise Regression Method of computer analysis (University of California). This process furthermore gives the value of positive or negative variables in order of significance and linear equations comprising increasing numbers of these variables in order of significance, i.e. there is an automatic selection process of an increasing number of positive and negative variables in order of significance at each step within the programme.

In order to quantify variables, the author and two observers assessed the quantity and quality of each defined variable within the photographs by ranking them in order of significance from 1 to 3, with 3 representing the greatest degree of significance a variable displayed. In order to reduce the subjective quantification of component variables, although the quality of certain variables are necessarily subjective, the median value of each set of three values for each variable was recorded. There was a distinct consistency of ratings in most instances.*

The final matrix of the dependent variables and the median ranked independent variables and significant combinations of these were computed to 25 steps. (This was considered to be adequate as the final linear equation derived by Shafer, Hamilton and Schmidt by means of factor analysis included a constant and 10 independent variables). The process of Step-Wise Regression produced a series of equations ranging from 1 constant variable and 1 independent variable to 1 constant variable and 25 independent variables.

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* These methods have been used by Rabinowitz and Coughlin (Test 3) as described above, and by Linton (5).

(a) Variables Used in the Analysis

The independent variables used were for the most part adopted from the various references discussed above, and the pilot survey conducted by the author. They are listed below. Variables which were used as defined by Shafer, Hamilton and Schmidt include (i) (ii) and (iv) below and the distance criteria for all Immediate (Imm.) Intermediate (Inter.) and Distant (Dist.) zones, have been made the same for all variables.

(i) Vegetation Zone: Imm., Inter., Dist.
(ii) Non-Vegetation Zone: " " " (Here grass cover was treated separately.)
(iii) Grass Cover: " " "
(iv) Water: " " "
(v) Sea: " " "
(vi) Views: Closed/Secluded - view effectively terminated
Limited - view effectively terminated between ½ to 1½ kms.
Open - A view which extends for approximately 1½ to 6 kms.
Panorama - a sequence of adjacent or overlapping open views seen from a single viewpoint.
(vii) Unique features/Individual Objects: Imm., Inter., Dist.
(viii) Visual complicity :
(ix) Ubiquity of Components: (Monotony of landscapes i.e. ubiquitous cover of one or more components)
(x) Density of Vegetation : Imm., Inter., Dist.
(xi) Wild Landscapes:
(xii) Terrain: (i) Rolling - The more pronounced the higher the rating given.
(ii) Flat - Degree of flat topography.
(iii) Jagged - The more pronounced the higher the rating given.
(xiii) Parkland (Accidental Breaks) - Park like landscape, trees and grassland with intermittent breaks.
(xiv) Farmland: degree of intensity of farming.
(xv) Scruffiness: Landscapes with no apparent balance or pattern of vegetation i.e. no inherent pattern which is pleasing to the eye. A value of 3 denotes the greatest degree of scruffiness.
(xvi) Naturalness: - The degree to which the photograph reflects a natural environment untouched by man or man-made elements.
(xvii) Quality of Vegetation: Degree of lushness or richness. Imm., Inter., Dist.

With the aid of the linear model derived by Shafer, Hamilton and Schmidt and the author's findings within the pilot survey conducted , probable effective combinations of variables which were used in the process were:

(i) Immediate Vegetation X Distant Vegetation
(ii) Immediate Vegetation X Intermediate Vegetation
(iii) Distant Vegetation X Imm. Water
(iv) " " X Inter. Water
(v) " " X Dist. Water
(vi) " " X Imm. Sea
(vii) " " X Int. Sea
(viii) " " X Dist. Sea
(ix) Int. Non Vegetation X Dist. Non Vegetation
(x) Int. Vegetation X Dist. Non Vegetation
(xi) Imm. " X Imm. Water
(xii) " " X Inter. Water
(xiii) " " X Dist. Water
(xiv) " " X Imm. Sea
(xv) " " X Inter. Sea
(xvi) " " X Dist. Sea
(xvii) $(\text{Imm. Vegetation})^2$
(xviii) $(\text{Imm. Water})^2$
(xix) $(\text{Inter. Water})^2$
(xxiv) $(\text{Dist. Water})^2$
(xx) $(\text{Imm. Sea})^2$
(xxi) $(\text{Inter. Sea})^2$
(xxii) $(\text{Dist. Sea})^2$
(xxiii) Jagged Terrain X Dist. Vegetation
(xxix) Rolling terrain X Dist. Vegetation
(xxv) Int. Vegetation X Imm. Water
(xxvi) " " X Inter. Water
(xxvii) " " X Dist. Water

(b) Results of the Computer Process

The effect of these combinations together with all the variables were computed by means of step-wise regression. The process was taken to 25 steps resulting in the 24 most effective factors being automatically printed in order of significance.
Positive and negative variables included:

-	Ubiquity of Components	x_1
+	Panoramic Views	x_2
+	Dist. Vegetation X Dist. Water	x_3 x_4
+	Imm. Vegetation X Imm. Water	x_5 x_6
+	Wild landscapes	x_7
+	Dist. unique features	x_8
+	Parkland	x_9
+	Rolling Terrain X Dist. Vegetation	x_{10} x_3
+	Imm. Water X Dist. Vegetation	x_6 x_6
-	Open View	x_{11}
+	Dist.Vegetation Quality	x_{12}
+	Inter. Sea	x_{13}
+	Dist. Grass Cover	x_{14}
+	Imm. Vegetation	x_5
+	Inter. unique features	x_{15}
+	Imm. " " /individual objects	x_{16}
-	Degree of Naturalness	x_{17}
+	Jagged Terrain X Dist. Vegetation	$x_{18}x_3$
+	Dist. Vegetation Density	x_{19}
-	Imm. Sea X Dist. Vegetation	$x_{20}x_3$
+	Density of Inter. Vegetation	x_{21}
-	Inter. grass cover	x_{22}
+	Dist. Sea squared	x_{23}^2
-	Imm. Water	x_6

The linear equation resulting from this is

$$Y_1 = 47 + 3.05\ x_{22} - 3.38\ x_{14} + 2.60\ x_6 - 4.90\ x_{13}$$
$$+ 4.56\ x_{11} - 11.76\ x_2 - 8.01\ x_{16} + 5.84\ x_{15} - 4.71\ x_8$$
$$+ 6.84\ x_1 - 2.52\ x_{21} - 4.85\ x_{19} - 8.92\ x_7 - 1.87\ x_9$$
$$+ 14.0\ x_{17} - 6.39\ x_5 + 2.25\ x_{12} - 4.02\ x_6\ x_3$$
$$+ 8.24\ x_{20}\ x_3 - 2.44\ x_5\ x_6 - 0.90\ (x_{23})^2 - 7.53\ x_{18}\ x_3$$
$$+ 4.51\ x_{10}\ x_3$$

Positive factors are reflected as negative values and negative factors are positive values i.e. the value for photographs will be small if their total scenic quality is high and vice versa.

The value of this expression is found in evaluating various photographs of landscape; with the aid of at least three observers, components within each photograph should be valued in terms of all those which are represented above. The median value of each component variable is then placed in the above equation. The greater the scenic quality the smaller will be the final value of that photograph.

As mentioned above, even one photograph tends to significantly reflect the scenic quality of an area and therefore a minimal number of photographs could produce a valid assessment of a particular landscape. If a number of photos are used, the median value of the range of values could be taken.

This method has to a certain extent reduced the inconvenience of having to make quantitative measurements of photographs in order to arrive at values for each variable. It should however be borne in mind that the degree of subjectivity in quantitatively assessing the spatial extent of components within photographs was high although agreement between the observers was high - the margin of error within the linear expression would possibly be higher therefore. Positive and negative effects have however been significantly outlined.

Positive factors in order of importance include:

Panoramic Views
Wild Landscapes
Immediate unique features/individual objects
Distant Water
Immediate Vegetation
Intermediate Sea
Distant Vegetation density
Distant unique features
Immediate Water and Distant Vegetation
Distant Grass Cover
Density of intermediate Vegetation
Immediate Vegetation X immediate Water
Parkland

Negative factors in order of importance include:

Degree of Naturalness
Immediate Sea X Distant Vegetation
Ubiquity of Components
Intermediate unique features/individual objects
Open View
Rolling Terrain X Distant Vegetation
Intermediate Grass Cover
Immediate Water
Distant quality of Vegetation

(c) Some Notes on the Impact of Development on the Landscape

Although it was not possible to evaluate photographs of developed landscape in the time available and owing to the large number of combinations and irregular variables which occur, it was felt that a few comments should be made on significant factors found within black and white and coloured photographs used in the second survey, i.e. photographs of each scene in black and white and colour.

(i) As mentioned previously the correlation between black and white and colour rank totals was low. However, certain photographs were found to be in a similar rank order.

The common denominator in these instances were spectacular views, open or panoramic, which tended to reduce the effect of development in the landscape.

(ii) Colour was a major determinant in enhancing the intrinsic value.

(iii) The greater the degree of vegetation, the less the impact development had on the landscape.

(iv) Development tended to enhance landscapes which were otherwise stark.

(v) Development located in the distance reduced its impact on the landscape, and in this respect qualities found within natural landscapes were important.

(vi) The quality and uniqueness of development where determinable was an important factor in enhancing the landscape.

(d) Application of Results to the Region

The task of displaying all landscape variables in map form is difficult owing to the fact that at each particular site all variables will have changed in location or a new set of variables appears.

However, analysing the major positive variables it is evident that there are four major groups of factors which are inherent:

(i) The character of the landscape is an important criteria - grandiose or panoramic landscape, wild landscape or parkland.

(ii) Distant variables that are important are vegetation, vegetation density, grass cover, unique features and water.

(iii) Criteria within immediate zones include the combination of water and vegetation, unique features or objects, immediate water related to distant vegetation i.e. backdrops to lakes or rivers etc. and immediate vegetation.

(iv) Intermediate variables are vegetation density and sea.

These criteria are the major components which should be protected in the Region.
Significant negative variables include

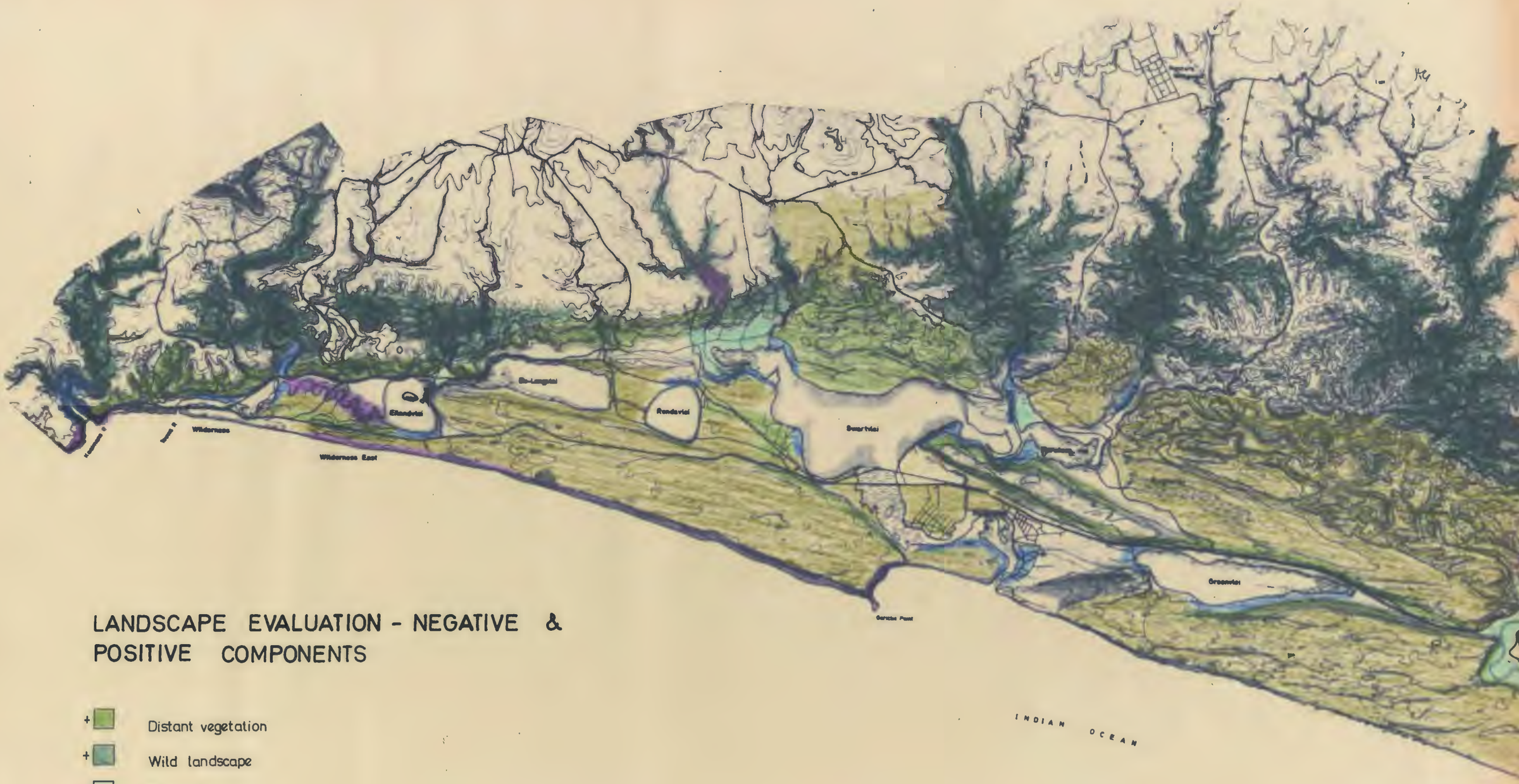
(i) Degree of naturalness, ubiquity of components, open views.

(ii) Intermediate unique features and grass cover.

(iii) Immediate water.

From the above it is apparent that the most important components in the landscape to preserve are the following and these have been indicated in Map 26.

(i) Vegetation which has an important bearing for distant landscapes - particularly on the



LANDSCAPE EVALUATION - NEGATIVE & POSITIVE COMPONENTS

+ Distant vegetation
+ Wild landscape
+ Parkland
+ Unique features
+ Water/Vegetation environments

- Ubiquitous landscapes


BASE LEGEND
National Road
Main Roads
Secondary Roads
Railway Line
Marshes
Water Grass
Tidal Mud Flats
Tidal Sand Flats
Unconsolidated Sand & Beach
Prominent Rock Outcrops
Contour at 50' intervals
1:100,000
INDIAN OCEAN
Swartkei
Breakwater
Gonubie Point
KNYSNA
Knysna Lagoon
Brenton-on-Sea
Buffalo Bay
Walker Point

plateau escarpment areas and mountain side.

(ii) Wild landscapes - these apply particularly to the indigenous forest cover and extensive tracts of inaccessible areas in the Region.

(iii) Parkland - this applies particularly to the Knysna and Goukamma River valleys, Dragon's Head area, Swartvlei and Karatara/Hoëkraal area. As the degree of naturalness increases, i.e. as the farmland characteristics and the influence of man is reduced so the value of that landscape is reduced. (However, wild landscapes received a high rating.)

(iv) Unique features - these include the Serpentine, The Heads, and other outstanding landmarks.

(v) Water/vegetation environments.

Negative features include:

Ubiquitous landscapes - extensive areas of flat or undulating grassland and extensive plantations, both of which are not located in association with natural features which enhance the landscape.

(d) Development and Constraints

(i) Stark landscapes appear to be enhanced by unique developments. Areas displaying these characteristics which are to be developed within the region should be carefully assessed in terms of the nature and design and extent of development.

(ii) Well vegetated landscapes should remain as far as possible within their natural environment state. No measurement with regard to the optimum density of development was made in this respect. Decisions in this respect should be made by an intuitive assessment of optimum density constraints in maximising the preservation of the natural environment.

(e) Careful consideration of all developments should be made with respect to minimising the destruction of natural vegetation. In this respect, on site investigations foe each development should be made.

Furthermore, the Indigenous Forestry Department and ecologists, should be involved in any development projects to ensure that minimal destruction is made to all forms of vegetation cover.

(f) Conclusions

This evaluation can be applied to the region as a guidline in the evaluation of landscapes relative

to any projects - the optimum location of highways, hiking trails, etc. and recreational developments, and to areas which have the greatest and least sensitivity to change.

It furthermore provides a basic awareness of all the components which are combined to provide spectacular views which should be preserved at all costs. This particularly relates to both rural and wild characteristics which prevail in the region, coupled with unique waters and land features.

This stresses the importance for conservation management of this important constraint.

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