A WATER RESOURCES AND SANITATION SYSTEMS SOURCE BOOK WITH SPECIAL REFERENCE TO KWAZULU-NATAL:

PART 2

by

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Part 2 contains the following:

Chapter 6: Catchments in Natal/KwaZulu **CATCHMENTS**

Chapter 7: Estuaries in Natal/KwaZulu **ESTUARIES**

Chapter 8: Wetlands and pans in Natal/KwaZulu **WETLANDS**

Chapter 9: Rainfall **RAINFALL**

Each chapter has its own contents page/s. The pagination in **Part 2** is consecutive. A comprehensive set of contents pages for the entire thesis can be found in Part 1.

This thesis consists of the following:

- Part 1. Chapters 1 - 5
- **Part 2. Chapters 6 - 9**
- Part 3. Chapters 10 - 12
- Part 4. Chapters 13 - 15
- Part 5. Chapters 16 - 17
- Part 6. Chapters 18 - 20

CHAPTER 6: CATCHMENTS IN NATAL/KWAZULU

Of nature, solitude and thoughts that lie deep...

Die stem van Suid-Afrika

Uit die blou van onse hemel, uit die diepte van ons see,
Oor ons éwige gebergtes waar die kranse antwoord gee,
Deur ons vér-verlate vlaktes met die kreun van ossewa -
Ruis die stem van ons geliefde, van ons land Suid-Afrika.

C.J. Langenhoven, quoted in Opperman, D.J., 1991. Junior Verseboek, Tafelberg-uitgewers Bpk, Cape Town, 239 p.

The land-call

I have seen the world's great cities,
Heard the thunder of their streets...
* * *
Yet I long for trackless spaces
Where the leaping springbok roam:
For the stillness and the vastness
And the distances of home.

F.E. Walrond, quoted in Dodd, A.D. and Faulding, C.I., [1964]. The Poet Sings: an Anthology of Poetry, Juta, Cape Town, 206 p.

Drakensberg

No fear dwells there, but lasting peace sublime,
Enriching life down all the lengths of time.

B. Godbold, 1984, quoted in Journal of the Mountain Club of South Africa, No. 87, p. 46.

CHAPTER 6: CATCHMENTS IN NATAL/KWAZULU

Contents | *Page*

6.1 Introduction 4

6.2 Physiographic regions of Natal/KwaZulu 4

6.3 Bioclimatic regions of Natal/KwaZulu 26

6.4 Geobioclimatic sub-regions in Natal/KwaZulu 50

6.5 Catchment management in Natal/KwaZulu 52

- 6.5.1 Mountain Catchment Areas 52
- 6.5.2 The Natal Drakensberg 55
- 6.5.3 Other catchments 61

6.6 Forestry in Natal/KwaZulu 63

- 6.6.1 Commercial afforestation potential in Natal/KwaZulu 63
- 6.6.2 Impacts of commercial afforestation 67
- 6.6.3 The afforestation permit system in South Africa 72
- 6.6.4 Some primary publications on grasslands and forests in southern Africa 79

6.7 Conservation areas and categories in Natal/KwaZulu 87

- 6.7.1 Other nature reserves in Natal 104
- 6.7.2 Biosphere reserves in Natal/KwaZulu 108
- 6.7.3 Wetlands of International Importance in Natal/KwaZulu 109
- 6.7.4 The South African Natural Heritage Programme 111
- 6.7.5 Sites of Conservation Significance in Natal 115
- 6.7.6 Conservancies in Natal 119
- 6.7.7 Metropolitan Open Space System (M.O.S.S.) areas in Natal 130
- 6.7.8 State forests in Natal and conservation areas within the forests . . 132
- 6.7.9 Protected areas and indigenous forests in KwaZulu 133

Tables | *Page*

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu 5

Table F2: Physiographic regions of Maputaland 25

Table F3: Bioclimatic regions of Natal/KwaZulu 28

Table F4: Monthly distribution of rainfall plus other climatic data and present vegetation in each bioclimatic group in Natal/KwaZulu 38

Tables (continued) **Page**

Table F5: Further data on bioclimatic groups in Natal/KwaZulu 46

Table F6: Correlation of physiographic regions, bioclimatic groups and mean annual runoff density in Natal/KwaZulu 47

Table F7: Some important geobioclimatic sub-regions in Natal/KwaZulu 50

Table F8: Summary of use and management guidelines for zones of the Natal Drakensberg 57

Table F9: Some catchment afforestation data for Natal/KwaZulu 64

Table F10: Veld types (Acocks, 1975) which would be affected by future afforestation and their present nature conservation status in Natal, 1990 69

Table F11: Conservation status of indigenous forests in Natal/KwaZulu (forests >50 ha) 70

Table F12: Afforestation permits allocated from June 1972 - October 1986 in relation to the area planted before June 1972 and to the biological potential after 1975 - with reference to Natal/KwaZulu 74

Table F13: Nature reserves in Natal controlled by the Natal Parks Board, 1994 .. 90

Table F14: Game reserves in Natal controlled by the Natal Parks Board, 1994 ... 99

Table F15: Game parks and (national) parks in Natal controlled by the Natal Parks Board, 1994 101

Table F16: Marine reserves in Natal controlled by the Natal Parks Board, 1994 .. 103

Table F17: Conservation areas on former South African Development Trust land in Natal and previously controlled by the (since defunct) Department of Development Aid, 1994 104

Table F18: Some nature reserves in Natal owned or administered by local authorities, the Wildlife Society of Southern Africa and the South African Nature Conservation Centre (now the Delta Environmental Centre), 1989 106

Table F19: Biosphere reserves in Natal/KwaZulu, 1994 109

Table F20: Wetlands of International Importance in Natal/KwaZulu, 1993 110

Table F21: South African Natural Heritage Sites in Natal, 1993 112

Table F22: Sites of Conservation Significance in Natal, 1993 115

Tables (continued) *Page*

Table F23: Conservancies in Natal, 1994 120

Table F24: State forests including wilderness areas in Natal, controlled by the Natal Parks Board, 1994 133

Table F25: Conservation areas in Natal State forests, controlled by the Department of Water Affairs and Forestry, 1993 136

Table F26: Game, nature, forest and freshwater reserves in KwaZulu, 1993 138

Table F27: Some proclaimed indigenous forests in KwaZulu 140

6.1 Introduction

The purpose of this chapter is to provide an overview of the physiographic regions/sub-regions and bioclimatic groups/sub-regions of Natal/KwaZulu - as a means of classifying the landscape - before some catchment management issues (including afforestation) are discussed. Selected information is then presented on various categories of protected land in Natal/KwaZulu. The current chapter also provides useful background data for Chapter 7 (Estuaries) and Chapter 8 (Wetlands and pans).

6.2 Physiographic regions of Natal/KwaZulu

Turner (1967, quoted in Phillips, 1973)* originally divided Natal into 43 physiographic sub-regions. Seven major physiographic features incorporating the 43 sub-regions were identified namely, mountain regions, plateau regions, upland regions, basin plainlands, intermediate regions, low-lying regions and coastal regions. With the incorporation of East Griqualand into Natal, a further six physiographic sub-regions were identified, making a total of 49 sub-regions in all (Schulze, 1982)**. The various sub-regions (excluding those in East Griqualand) are fully described in Phillips (1973). The physiographic regions and sub-regions are listed in Table F1 (including corresponding bioclimatic sub-regions, discussed later). The next table (Table F2) presents further physiographic data on Maputaland, given the importance of the area in terms of conservation proposals, and the general lack of physical data on the Maputaland region. Thereafter, data on bioclimatic groups in Natal/KwaZulu are provided (Tables F3, F4 and F5). Table F6 then outlines a correlation between physiographic regions, bioclimatic groups and mean annual runoff density information.

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* See Phillips, J., 1973. The agricultural and related development of the Tugela Basin and its influent surrounds: a study in subtropical Africa, Natal Town and Regional Planning Commission Report, VOL 19, Pietermaritzburg, 299 p. and maps. See also, Turner, J.L., 1967. The mapping and study of certain geomorphological features of Natal and its adjacent regions, M.Sc. Thesis, Department of Geography, University of Natal, Pietermaritzburg, 166 p.

** See Schulze, R.E., 1982. Agrohydrology and climatology of Natal, ACRU Report No. 14, Agricultural Catchments Research Unit, Department of Agricultural Engineering, University of Natal, Pietermaritzburg, 136 p.

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu.

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
Mountain regions					
1. Lesotho Plateau and the High Drakensberg Escarpment	2 500 - 3 300	The highest landmass in southern Africa. The plateau (a remnant of the ancient landsurface of Gondwanaland) is gently tilted to the south west, its surface slightly concave. The plateau surface is bevelled across thick basaltic lavas of the Stormberg Series. The basalt is exposed along the vertical face of the mountainous eastern escarpment (the High Drakensberg). Origin of many rivers draining Natal/KwaZulu ranging from the Tugela to the Mzimkulu	5a 5b	5a 5b(ext)	- -
2. Spurs and foothills of the High Drakensberg "the Little Berg"	1 800 - 2 100	Area along the foot of the great escarpment. Deeply dissected by many streams and rivers which rise in the High Drakensberg. The general level is the same as the Highveld. Except near the foot of the escarpment, the Stormberg lavas have been removed by erosion and the higher surface levels are cut across upper sediments of the Stormberg Series. A feature of the area is the overhanging cliffs and pinnacles of brightly coloured Cave Sandstone	4c 4d 4e 5b	4a 4d(ext) 4e(ext) 5a(ext)	-

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
3. Orange Free State Highveld and the Low Drakensberg Escarpment	2 000 - 2 100	Area between Mont-aux-Sources and Majuba. Its relatively smooth surface extends further to the north across the Highveld of the eastern Transvaal. The Highveld is bevelled across Ecca and Beaufort sediments (from north to south), with the Beaufort Series dipping gently beneath the landmass of Lesotho. Cave Sandstone is common. The Low Drakensberg (forming the border of Natal/KwaZulu and the Orange Free State), was carved out of the Highveld by the rapid westward advance of the Tugela and Buffalo rivers. Thick Beaufort beds occur near Van Reenen, with Ecca sediments found near Volksrust. Dolerite intrusion (dykes and sills) is common in both the latter formations	-	4d 4e(incl. 4a in 4d and 4e)	-
4. Spurs and foothills of the Low Drakensberg	1 350 - 1 800	A narrow zone of spurs and foothills extending along the entire length of the Low Drakensberg Escarpment. These erosional features are carved in the shales and sandstone of the Beaufort Series and the Ecca Series. Indigenous forest occurs in the sheltered kloofs and ravines	-	4a 4d 4e 6a	-
5. Ingeli Mountain	2 100	Forms the eastern flank of mountains encircling Kokstad and is part of the southern boundary of Natal/KwaZulu	3c	-	-

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
Plateau regions					
6. Belelasberg-Skurweberg Plateau	1 500 - 1 950	Is an extension of the Transvaal Highveld. Beaufort strata are spread across the more elevated parts while deep valleys cut into underlying Ecca beds. Sheets of dolerite are common	-	4g(ext)	4g(ext)
7. Biggarsberg Range	1 650	The narrow divide which separates the basin of the Buffalo from that of the Tugela River. This remnant of the Highveld is capped by strata of the Beaufort Series and in places by thick sills of intrusive dolerite. The range is deeply dissected by a network of small streams	-	4f(ext) 6a(ext) 8a(sl)	-
8. Helpmekaar Plateau	1 500	Takes the form of a low plateau. The region is underlain by Ecca beds with most of the plateau surface spread across a major dolerite sill	-	4f(sl) 6a(ext) 8a(sl)	-
9. Msinga-Qudeni Massif	1 500 - 1 700	The tablelands of Msinga and Qudeni are remnants of the Highveld. The Buffalo and Tugela rivers flow in deeply incised gorges having penetrated the entire thickness of the Karoo System and exposing the Basement Complex	- -	(South west): 2b(v.v.sl) 3a(v.sl) 4e 4f (North east): 6a(sl) 8a(ext)	- -

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
Upland regions					
10. Nqutu Divide	1 400 - 1 500	The divide separates the headwaters of the White Mfolozi from the Blood and Buffalo rivers. At lower levels an extensive horizon of dolerite is exposed with large boulders and donga erosion common	-	8a(ext)	8a(ext)
11. Babanango Block	1 200 - 1 350	Situated in the south west of Zululand. Lower Ecca shales are exposed at the summit and Dwyka Tillite crops out along the lower slopes	-	2b 3e 4e(v.sl) 6a(sl)	2b(sl) 3a(v.sl) 4f(ext) 8a
'12. Hlobane-Manyini-Ceza Block	1 350 - 1 500	Broken and mountainous country. Remnants of the Highveld. Ecca beds are exposed across the higher reaches, with Dwyka Tillite found in the deep river valleys	-	-	3b(v.sl) 3e 6a 8a
13. Impendle Block	1 750 - 1 850	Elevated block of country - isolated from the spurs of the High Drakensberg below Giant's Castle by the headwater valleys of the Mooi and Mkomaas rivers. The Mgeni River rises in the general area. The region is underlain by brightly coloured sandstones, shales and mudstones of the Beaufort Series, which are greatly intruded by dykes and sills of dolerite	4e(ext)	-	-

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
14. Natal Midlands	1 200 - 1 650	Comprises a large tract of country stretching from Richmond in the south through Elandskop to Mooi River in the north and along the Mooi-Mvoti Divide towards Greytown, terminating in the east at the Richmond-Pietermaritzburg-Greytown Escarpment and to the west against the Impendle Block and spurs of the High Drakensberg. Beds of the Ecca Series crop out at lower levels in the east and in the river valleys and are succeeded at higher elevations in the west by Beaufort sandstones, shales and mudstones. Considerable intrusion of dolerite	3a 3c(ext) 3d 4e(ext) 6a(sl)	3c(sl) 4e 6a(sl) 8a(sl)	-
15. Howick Benchland	1 300 - 1 400	Contained by a thick sheet of dolerite at the edge of the Pietermaritzburg-Greytown Escarpment. Above the Howick and Karkloof falls, lateral erosion has cut a broad flat benchland	3a(ext) 3c(sl) 3d(sl) 6a	-	-
16. Bulwer Block	1 700 - 2 000	Found between the Mkomaas and Ngwangwane rivers. In the south the country is deeply dissected by the Polela and Mzimkulu rivers. The Marwaqa Plateau is an outlier of the Highveld. Severe soil erosion is evident in the general area	3a 3c(sl) 4c 4e(ext) 6a(sl)	-	-
16a. Swartberg Block	1 800 - 2 100	-	-	-	-
16b. Kokstad Block	1 700 - 1 900	-	-	-	-

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
16c. Matatiele Block	1 650 - 1 950	-	-	-	-
16d. East Griqualand Uplands	1 350 - 1 650	-	-	-	-
Basin Plainlands					
17. Winterton-Estcourt-Muden Plain	1 000 - 1 100	Forms the southern half of the extensive Upper Tugela Plainland and is the transition between the Natal Uplands and the Tugela Thornveld. Traversed in the west by the Lindeque, the Sterkspruit, Little Tugela, Bloukrans and the Bushmans rivers. Contains the Tugela Fault and is underlain by Beaufort beds	-	4e(sl) 6a 8a(ext)	-
18. Bergville-Ladysmith-Elandslaagte Plain	1 150 - 1 200	Forms the northern part of the Upper Tugela Plainland - stretches from Bergville beyond Ladysmith to Elandslaagte. The underlying rocks are mainly Ecca, with a vast zone of dolerite between Colenso and Ladysmith. Drained by the Tugela, Klip and Sundays rivers	-	6a 8a(ext)	-
19. Wasbank Plain	1 000 - 1 100	A small and smoothly bevelled area of Sandy Sourveld between the Helpmekaar Plateau in the east and a low scarp of Middle Ecca sandstone in the west that leads up to the Elandslaagte Flats. Falls within the rain shadow of the Helpmekaar Plateau	-	6a(sl) 8a(ext)	-

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
20. Buffalo Plain	1 150 - 1 250	Consists of a vast tract of country with a subdued relief, enclosed between the Biggarsberg, the Low Drakensberg and the Belelasberg-Skurweberg Plateau. Underlain by Middle Ecca sandstones with sand common in the Buffalo River surrounds	-	8a(sl) 8b(ext)	-
21. Dundee Plain	1 300 - 1 400	Relatively small region enclosed within a circle of higher land - Mpati and Talana in the north, Tangeni and Indumeni - and the eastern extremity of the Biggarsberg in the south	-	4f(v,sl) 6a(ext) 8a(ext)	-
22. Ngagane Plain	1 300 - 1 400	Situated between the Biggarsberg and the low ridge of country separating the Horn and Incandu rivers and extending westwards from the Dundee Plain to the Low Drakensberg Escarpment. Underlying rocks belong to the Upper Ecca Series with widespread deposits of lateritic "ouklip"	-	6a(ext) 8a(ext)	-
23. Newcastle-Utrecht Plain	1 200 - 1 350	A smoothly bevelled region stretching from Newcastle to Utrecht, below the foothills of the Low Drakensberg Escarpment and the Belelasberg Plateau. Underlain by beds of the Ecca Series with widespread deposits of ouklip	-	6a(ext) 8a(ext)	-
24. Utrecht-Vryheid Plain	1 150 - 1 250	Consists of peripheral flat terrain. Underlying rocks belong to the Ecca Series	-	8a(ext) 8b(sl)	- 6a

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
25. Pongola-Pivaan Basin	1 200 - 1 350	A wide shallow basin with broken topography which lies between the eastern escarpment of the Belelasberg-Skurweberg Plateau and the rugged country formed by the deep Lowveld valley of the Pongola River. Granitic rocks of the Basement Complex are widely exposed in shallow river valleys near Paulpietersburg. Further east patches of Dwyka Tillite rest upon Dominion Reef rocks of the Insuzi Series. The tillite is absent thereafter and in the south western parts of the basin, the Ecca sediments rest directly on the Basement platform. Dolerite is common	-	-	4g(sl) 6a(ext) 8a(sl) 10a(sl)
26. Nondweni-White Mfolozi Basin	850 - 950	Well formed shallow basin situated between Babanango and Vryheid. Drained by the White Mfolozi River and its tributary the Nondweni. Dwyka Tillite is exposed over wide areas around the margins of the basin with the Basement platform immediately below the tillite, in the central and eastern parts of the region. Erosion of the Dwyka soils is apparent everywhere	-	-	8a(ext) 10a
27. Underberg-Himeville Plain	1 400 - 1 600	Low-lying region between the Bulwer Block and the foothills of the High Drakensberg. Beaufort beds are exposed over the entire area, and intrusive dolerite (sills and dykes) is widespread	4e	-	-

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
27a. East Griqualand Plains	1 500 - 1 600	-	-	-	-
Intermediate regions					
28. Greytown-Pietermaritzburg-Richmond Benchland	750 - 900	One of the most extensive and important natural regions in Natal/KwaZulu. It stretches from Greytown in the north to the brink of the deep Mkomaas Valley south of Richmond. In the west the region is bordered by the "Pietermaritzburg" Escarpment which leads up to the Natal Midlands. North of Cato Ridge the region ends abruptly at the crest of the Table Mountain sandstone escarpments overlooking the Valley of a Thousand Hills. In the south the benchland fades into the hills of the Coastal Hinterland. Several of the larger rivers in Natal/KwaZulu traverse the region from west to east such as the Mvoti, Mgeni, Msinduzi, Mlazi, and Illovo. Above the resistant barriers of the Table Mountain sandstone, lateral erosion has excavated wide and shallow basins in the more erodible Dwyka Tillite and Lower Ecca shales resulting in for example, the Mvoti wetland.	2a(sl) 2b(ext) 2d(ext) 2f(sl) 3a(ext) 3c(ext) 3d(ext) 6a 10a	-	-

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
28. Greytown-Pietermaritzburg-Richmond Benchland (continued)		Along the eastern section of the benchland, Karoo rocks have been stripped from the underlying Table Mountain sandstone. In the north, Dwyka Tillite crops out as a narrow band down the middle of the region spreading over wider areas in the south. Lower Ecca shales underlie the western part of the region			
29. Kranskop Divide	1 050 - 1 200	A narrow plateau between Kranskop and Mapumulo separating the deep valleys of the Tugela and Hlimbitwa rivers. The plateau is mainly underlain by Table Mountain sandstone	2a(ext) 3a(ext) 3c(sl)	2a(ext) 7a(ext)	-
30. Melmoth-Nkandla Block	600 - 1 200	An extensive plateau situated between the White Mfolozi Lowveld and the valley of the Mhlatuze River to the south. The region is underlain by Table Mountain sandstone. Towards Babanango the Table Mountain sandstone passes beneath Dwyka Tillite which is exposed over extensive areas. Ecca sediments occur in the Nsuze-Mhlatuze watershed. Basement Complex rocks are exposed in the Mhlatuze River Valley	-	2a(sl) 2b	2a(ext) 2b(ext) 4f(sl) 9c 10a

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
31. Middleveld of Zululand	500 - 900	Known as the watershed regions, which separate the Lowveld valleys north of the White Mfolozi River. The region could be divided into three subsections: 1) The Pongola-Mkuze Divide. Consists of hilly country between Magut and Dwarsrand. Includes the Intermediate Benchland below the Louwsburg Escarpment. Generally underlain by Ecca and Dwyka formations with the Mozaan Series and Pongola granite exposed at lower levels around the Pongola Valley 2) The Mkuze-Block Mfolozi Divide. Extends from the foot of the Ngome Escarpment, past Nongoma to relatively high country around Hlabisa and the Hluhluwe Game Reserve. Underlying rocks belong almost exclusively to the Ecca Series 3) The Black-White Mfolozi Divide. Stretches from Gluckstad through Mahlabatini to Tabankulu and is underlain by Dwyka and Ecca rocks. Broken terrain in parts with severe erosion on Dwyka soils	-	-	2c(sl) 2e(sl) 4f 6a(sl) 8a 9b(sl) 9c(sl) 10a(ext)

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
32. Ixopo-Highflats Benchland	900 - 1 100	Lies between the deeply incised valleys of the Mkomaas and Mzimkulu rivers and is the southerly extension of region 28. Lower Ecca shales are exposed near Ixopo and are succeeded by Dwyka Tillite further to the south east near Highflats. Extensive areas of tillite are found in lower lying areas to the north and south of Ixopo. Table Mountain sandstone is evident south east of Highflats. Considerable faulting is found nearer the coast	1b(sl) 1c 2a 2b(ext) 2d 3a 3c(ext) 3d	-	-
33. Harding Benchland	600 - 900	Situated between the Mzimkulu and the Mtamvuna rivers. Rock of the Ecca Series is exposed in the west with the eastern section underlain by Dwyka Tillite. The rolling topography and rounded contours found in the region is typically characteristic of tillite	2b 2d(ext)	-	-
33a. Umzimkulu Benchland	700 - 1 250	-	-	-	-

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
Low-lying regions					
34. Valley of the Tugela River	100 - 800	This rugged and deeply incised region lies between Colenso and Mandini and has been eroded by the Tugela River together with its six main tributaries: the Buffalo, Sundays, Klip, Bloukrans, Bushmans and Mooi rivers. In its upper reaches the valley has cut into Ecca rocks and intrusive dolerite. Nearer the coast, lateral erosion has carved a magnificent valley through granitic rocks of the narrow eastern stem of the Tugela Basin	-	2b(sl) 7a(ext) 8a(sl) 10a(ext) 10b	-
35. Pomeroy Benchland	1 050 - 1 200	Situated between the southern end of the Helpmekaar Plateau and the deep valleys of the Tugela and Buffalo rivers. The benchland is separated from the Wasbank Plain in the north west by a prominent ridge between Ilenga and the Helpmekaar Plateau. The region is underlain by rocks of the Ecca Series in which outcrops of intrusive dolerite are widespread	-	4f(sl) 8a(ext)	-

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
36. Valley of a Thousand Hills and the Mvoti River Valley	350 - 900	The Valley of a Thousand Hills has been cut deep into the granitic rocks of the Basement Complex by erosion. The region is bounded on all sides by escarpments of pink sandstones and quartzites. The Table Mountain sandstone thins out towards the west and the Msinduzi and Hlambiti rivers are rapidly advancing their valleys in the direction of Pietermaritzburg and Umlaas Road. The more erodible Basement rocks have given rise to a maze of hills and valleys, through which the Mgeni, Msinduzi, Mgegu and Mhloti rivers meander in great loops. The valley of the Mvoti River, further to the north is not denuded to the same extent, and large blocks of Table Mountain sandstone remain, such as Zwatini and Noodsberg. East of the Mvoti-Hlimbitwa confluence the sandstone cover has been removed and the hilly landscape is similar to the Valley of a Thousand Hills	2b 2d 2f(ext) 10a(ext)	-	-

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
37. Lowveld of Zululand	150 - 450	An extensive region stretching for 160 km from the Pongola River in the north to the valley of the Mhlatuze River in the south. In the east the region is bordered by the Lebombo Mountains and the Zululand Coastal Plain. In the west, the Lowveld valleys of the Pongola, Mkuze and Black as well as White Mfolozi rivers penetrate far into the interior. A broad belt of Stormberg basalt is exposed along the entire length of the eastern margin of the region, succeeded inland by a narrow zone of Stormberg and Beaufort sediments, followed in turn by extensive exposures of Ecca rocks and Dwyka Tillite	-	-	1d 9a(sl) 9c 10a 10b(ext) 11a(ext)
Coastal regions					
38. Natal Coastal Belt	0 - 250	A narrow belt of low-lying country stretching along the coast of Natal/KwaZulu from the Mlalazi River to the Mtamvuna River. The Coastal Plain is broader to the north of Durban than south of the city. The region is generally underlain by beds of the Ecca Series and the Dwyka Series. South of Durban exposures of Table Mountain sandstone and Basement rocks become increasingly widespread	1a(ext) 1b(ext) 10a(sl)	1a(sl) 1b(sl)	1a(ext) 10a(v.v.sl)

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
39. Natal Coastal Hinterland	200 - 600	Between the Tugela and Mgeni rivers tilted blocks of Table Mountain sandstone rise upward from the western margin of the Coastal Belt and present a steep escarpment inland. The escarpment is continuous from Glendale to Ndwedwe except where cut by the Mvoti, Tongaat and Mhloti rivers. To the west of Durban between the Mgeni and Illovu rivers, a series of major faults has interrupted the regularity of the terrain, isolating the sandstone blocks. Further to the south, erosion has removed all except for a few outliers of the sandstone	1b(ext) 2a(sl) 2b 10a	1b(sl) 2a	-
40. Eshowe Block	450 - 600	Consists of an uplifted region situated in the general vicinity of Eshowe and environs, extending westwards to include the Tugela-Amatikulu Divide. Basement granite is exposed along the Ngoye horst in the east (inland of Richards Bay), and is succeeded by the overlying Table Mountain sandstone in the neighbourhood of Eshowe. The low-lying Coastal Belt to the south and the Nkwaleni graben in the north are underlain by down faulted Karoo sediments	-	2b	2a(ext) 2b 10a(sl)

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
41. Lebombo Mountain Range	400 - 800	The Lebombo Mountain Range extends southwards along the entire length of the eastern Transvaal and Swaziland, forming a natural barrier between those territories and the low-lying coastal regions of Mocambique and the Zululand Coastal Plain. South of the Pongola River the range curves slightly to the south east and pitches beneath the Cretaceous sediments of the coastal plain near Hluhluwe. To the west the mountain range presents a steep escarpment 610 m high, to the Lowveld of Swaziland and Zululand. To the east the dip slopes pass beneath Cretaceous beds which fringe the western margin of the coastal region. The range is formed from rhyolite lavas overlying Stormberg volcanics	(Excluded from the analysis)	(Excluded from the analysis)	(Excluded from the analysis)

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
42. Zululand Coastal Plain	0 - 150	The region lies between the coastline of Zululand and the Lebombo Range. From the border of Mocambique where it is some 72 km wide, the region stretches 240 km to the south to a point near Richards Bay, at the mouth of the Mlalazi River. In the west a fringe of Lower and Upper Cretaceous sediments crop out along the foot of the Lebombo Mountains above the rhyolites building the range. A few kilometres to the east these beds dip gently beneath Tertiary sediments and sands of more recent formation. The coastline is smooth and almost devoid of rock outcrops. The Usuthu, Ngwavuma, Pongola and Mkuze rivers have transected (from west to east), the extremely hard rhyolites of the Lebombo Range - and are diverted north or south in the soft sandy sediments of the plain. These diversions result in the Mozi Swamps and short watercourses draining into the Mkuze River. The many lakes and pans which are found along the coast may be attributable to the successive development of coast dunes during the emergence of the region from beneath the sea	-	-	1a(v.ext) 1b(v.sl) 1c(v.v.sl)

Table F1: Physiographic regions and sub-regions of Natal/KwaZulu (continued).

Physiographic region/sub-region	Typical altitude (m)	Brief description	Occurrence of bioclimatic sub-regions		
			South western influent surrounds	Tugela Basin	North eastern influent surrounds
43. Incised river valleys of Natal	200 - 500	The large rivers of Natal flow in deep gorges from the north west to the south east. Where the protective cover of Table Mountain sandstone was removed, downward erosion in the more erodible rocks of the Basement Complex has been rapid. Lateral erosion has only been of minor significance. The rivers have extended their narrow and deep valleys far into the interior and are a characteristic feature of the landscape between the Tugela and Mtamvuna rivers. Major river valleys include those of the Mkomaas, the Mzimkulu, the Mvoti, Mgeni, Mlazi, Illovu, Mpambanyoni, Mtwalume, Mzumbe and the Mtamvuna rivers	10a(sl)	-	-

__Source:__ (i) After Phillips, J., 1973. The agricultural and related development of the Tugela Basin and its influent surrounds: a study in subtropical Africa, Natal Town and Regional Planning Commission Report, VOL 19, Pietermaritzburg, 299 p. and maps.

(ii) After Schulze, R.E., 1982. Agrohydrology and climatology of Natal, ACRU Report No. 14, Agricultural Catchments Research Unit, Department of Agricultural Engineering, University of Natal, Pietermaritzburg, 136 p.

<u>See also</u>: (i) Arthur, A.M., 1973. A landform study of Natal using trend surface techniques, <u>Petros</u>, VOL 5, p. 15 - 22.

(ii) Thorrington-Smith, Rosenberg and McCrystal, 1978. Towards a plan for KwaZulu: a preliminary development plan, VOL 1, The written report, 341 p., and VOL 2, Atlas of maps and illustrations, various pages, KwaZulu Government, Ulundi.

(iii) Van der Eyk, J.J., MacVicar, C.N. and De Villiers, J.M., 1969. Soils of the Tugela Basin: a study in subtropical Africa, Natal Town and Regional Planning Commission Report, VOL 15, Pietermaritzburg, 263 p. and maps.

<u>Note</u>: (i) The designations 16a, 16b, 16c, 16d, 27a and 33a refer to East Griqualand.

(ii) The occurrence of bioclimatic sub-regions (outlined in Table F1) is as follows:

ext : extensive
v.ext : very extensive
sl : slight
v.sl : very slight
v.v.sl : very, very slight
incl. : including

(iii) The geological terminology used in the above table, refers to the publication in question. The source of the latest terminology is discussed in the chapter on geology.

Table F2: Physiographic regions of Maputaland.

Physiographic region	Altitude (m)	Mean annual precipitation (mm)	Mean maximum and minimum daily temperature (^{o}C) January		July		Topography	Vegetation type and bioclimatic group	Geology
			max.	min.	max.	min.			
Lebombo Mountains and foothills	300 - 600 with foothills from 120 - 300	650 - 850	31	21	24	14	Rolling plateau with steep mountainous flanks	Zululand Thornveld Bioclimatic group 2	Volcanic rocks (rhyolite and dacite)
Pongola Floodplain and terraces	60 - 120	550 - 650	32	21	25	9	Very gently sloping stepped topography with three main levels/terraces	Riverine forest and Acacia woodland Bioclimatic group 10	Younger and older alluvium/ Cretaceous sediments
Tshongwe-Sihangwane Ridge	70 - 130	600 - 700	32	21	25	10	Gently undulating ridge	Sandveld forest and thicket Bioclimatic group 10	Windblown sand
Muzi Depression	40 - 80	700 - 750	31	21	24	11	Low-lying with very gentle slopes	Zululand Palm Veld Bioclimatic group 9	Brown clayey sand of the Muzi Formation
Coastal Interior	50 - 90	750 - 850	31	21	24	11	Undulating with smoothed dunes	Coast Grassveld Bioclimatic group 1c	Re-distributed sand
Coastal Zone	0 - 100	850 - 1 050	31	21	25	12	*Rolling sand* dune topography	*Dune forest and* Swamp forest Bioclimatic groups 1a and 1b	*Sand dunes of* the Berea Formation and re-distributed sand

Source: After Rural Development Services, 1989. Preliminary report on agriculture in Maputaland, In: Ubombo-Ingwavuma Structure Plan, VOL 1, Appendices 1 - 13, Vandeverre Apsey Robinson and Associates, Durban, 31 p.

See also: Mountain, A., 1990. Paradise Under Pressure: St Lucia, Kosi Bay, Sodwana, Lake Sibaya, Maputaland, Southern Book Publishers, Johannesburg, 149 p.

Note:

(i) For detailed data on plant communities, see: Bruton, M.N. and Cooper, K.H. (eds), 1980. Studies on the Ecology of Maputaland, Rhodes University and the Natal Branch of the Wildlife Society of Southern Africa, Grahamstown and Durban, 560 p. and map, as well as Tinley, K.L. and Van Riet, W.F., 1981. Tongaland: zonal ecology and rural land use proposals, Report to the Department of Co-operation and Development, Pretoria, 132 p. A further useful report *is the following: Bourn, H.C., 1980. Proposals towards an* environmental plan for KwaZulu, KwaZulu Department of Agriculture and Forestry, [Ulundi], 67 p.

(ii) Tinley and Van Riet (1981) divided Maputaland into six physiographic zones, namely: the Lebombo Range, the Pongolo Zone (pediment, terraces and floodplain), the Sand Forest Zone, the Mozi Swamp/Palm-belt Zone (Mozi north and south drainage and/or main Lala Palm-belt), the Coastal Lake Zone (dune barrier lakes, estuarine lagoons and swamps; treeless grasslands and Savanna-forest mosaic), and the Coastal Zone (generally 1 km seaward and landward of the shoreline).

(iii) The geological terminology used in the above table, refers to the publication in question. The source of the latest terminology is discussed in the chapter on geology.

6.3 Bioclimatic regions of Natal/KwaZulu

Phillips (1973 - see below) divided and mapped Natal/KwaZulu in terms of 11 bioclimatic groups with 35 sub-regions (Table F3). Phillips referred to bioclimate as a complex of climatic conditions controlling the vegetation within a natural region. A particular bioclimate is formed by the specific interaction of climatic factors and biotic phenomena, so integrated to allow the development of natural vegetation to reach a stage where the natural vegetation is in dynamic equilibrium with the climate*. A bioclimatic region is a bioclimatically natural unit of considerable area, usually made up of a number of ecologically related smaller units (sub-regions), either forming part of the same large area, or more often, widely separated by other bioclimatic units. A bioclimatic group is a mapping unit based on the ecological interrelationships of the various bioclimatic sub-regions, which can be grouped together. Bioclimatic potential is the inherent capacity of a specific bioclimatic unit (group, sub-region), in terms of the potential for agricultural (crop and livestock) and forestry production. Reasonable circumstances and management are assumed, and the bioclimatic potential is then the biologically attainable level of production. In practice, the potential of the soils must also be considered. In addition, *there is a need for the further refinement of bioclimatic sub-group boundaries* (*especially* in the extensive groups of 8 and 10) - for detailed planning at a local level - following the availability of improved climate statistics as well as soil and topographic data (Phillips, 1973). Bioclimates are not static for all time, given the various climatic cycles operating over thousands of years (not excluding "global warming"). A new method of classifying vegetation/climate involves *23* bioresource groups, which are briefly discussed in the chapter on soils and soil erosion, elsewhere in this publication. Bioresource groups will in due course replace bioclimatic groups for planning and scientific purposes.

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* Also known as the (climatic) climax vegetation, namely, the highest (primary) type of plant community which the particular environmental conditions can support. The climax vegetation is the final result of plant succession which begins with the first pioneer plants establishing themselves in a virgin area. It should be noted that secondary, disturbed or induced vegetation communities either at a stage (sub-climax) or a number of stages (pro-climax) below the climax, are generally more extensive today (as a result of man's activities) than the climax vegetation itself. The actual distribution and extent of present-day vegetation accordingly, differs greatly from the bioclimatic <u>potential</u> vegetation.

Table F3: Bioclimatic regions of Natal/KwaZulu.

Group	Group title based on bioclimatic potential and details	Altitude (m)	Sub-region	Potential climax	Range in mean annual precipitation (mm)	Humidity range	Mean annual temperature range (°C)	Seasonal temperature range	
								warm season	cool season
1	Coast Lowlands: Evergreen forest, medium/tall thicket and woodland. (Situated adjacent to the coast, stretching inland for 15-65 km. Topography mostly undulating but may be very steep (>30% slope) locally)	0-457	1a	Forest and thicket	850->1 400	Humid to humid-subhumid	20,0-22,5	Hot-warm	Warm-mild
			1b	Forest and thicket		Humid-subhumid		Hot-warm	Warm-mild
			1c	Shorter forest and thicket		Subhumid		Hot-warm	Warm-mild
			1d	Thicket		Sub-subhumid		Hot-warm	Warm-mild
2	Coast Hinterland: Evergreen forest, medium/tall thicket and woodland. (Situated in an often continuous belt inland from group 1. The landscape is broken due to river dissection)	457-915	2a	Forest and thicket	850-1 300	Humid to humid-subhumid	17,5-20,0	Warm-mild	Mild
			2b	Forest and thicket		Humid-subhumid		Warm-mild	Mild
			2c	Short forest and thicket (Hlabisa faciation)		Humid-subhumid		Warm-mild	Mild
			2d	Short forest and thicket		Subhumid		Warm-mild	Mild
			2e	Thicket (Hlabisa faciation)		Subhumid		Warm-mild	Mild
			2f	Thicket		Sub-subhumid		Warm-mild	Mild

Table F3: Bioclimatic regions of Natal/KwaZulu (continued).

Group	Group title based on bioclimatic potential and details	Altitude (m)	Sub-region	Potential climax	Range in mean annual precipitation (mm)	Humidity range	Mean annual temperature range (°C)	Seasonal temperature range	
								warm season	cool season
3	Mistbelt: Evergreen forest, medium/tall forest, thicket and woodland (also forest and thicket of the Ngome faciation). (Situated along the central spine of Natal/KwaZulu inland of group 2. Generally hilly with steep slopes)	915-1 372	3a	Mistbelt forest and thicket	800-1 600	Humid to humid-subhumid	16,0-18,0	Mild-cool	Cool-cold
			3b	Upland forest and thicket (Ngome faciation)		Humid		Mild-cool	Cool-cold
			3c	Mistbelt forest and thicket		Humid-subhumid		Mild-cool	Cool-cold
			3d	Mistbelt forest and thicket		Subhumid		Mild-cool	Cool-cold
			3e	Upland thicket (Ngome faciation)		Subhumid		Mild-cool	Cool-cold

Table F3: Bioclimatic regions of Natal/KwaZulu (continued).

Group	Group title based on bioclimatic potential and details	Altitude (m)	Sub-region	Potential climax	Range in mean annual precipitation (mm)	Humidity range	Mean annual temperature range (°C)	Seasonal temperature range	
								warm season	cool season
4	Highland/Montane Podocarpus-other species. Evergreen forest, mixed Evergreen short/ *medium thicket and* woodland. (Extends seawards from the foothills of the Drakensberg in a continuous sector situated between 1 372 - 1 981 m, especially wide in East Griqualand, with many steep slopes in parts)	1 372-1 981	4a	Podocarpus forest *scattered in 4e*	800-1 500	Humid to humid-*subhumid*	13,0-15,0	Mild-cool	Cool-cold-*occasionally* very cold locally
			4b	Podocarpus forest scattered in 4d		Humid to humid-subhumid		Mild-cool	Cool-cold-occasionally very cold locally
			4c	*Forest and* medium/tall thicket, Sub-montane and *Highland*		*Humid to humid-*subhumid		*Mild-cool*	*Cool-cold-*occasionally very cold locally
			4d	Medium/tall thicket and Protea shrubland		Humid to subhumid		Mild-cool	Cool-cold-occasionally very cold locally
			4e	Medium/tall thicket		Humid to subhumid		Mild-cool	Cool-cold-occasionally very cold locally
			4f	Medium thicket		Subhumid		Mild-cool	Cool-cold-occasionally very cold locally

Table F3: Bioclimatic regions of Natal/KwaZulu (continued).

Group	Group title based on bioclimatic potential and details	Altitude (m)	Sub-region	Potential climax	Range in mean annual precipitation (mm)	Humidity range	Mean annual temperature range (°C)	Seasonal temperature range	
								warm season	cool season
4	Continued from previous page		4g	Short/medium *thicket*		Subhumid		Mild-cool	Cool-cold-*occasionally* very cold locally
5	Montane fynbos and Evergreen short thicket. (Includes the High Drakensberg and summit plateau)	1 981-3 353	5a	Montane fynbos-upper	>1 500	Humid to humid-subhumid	≤13,0	Cool-cold	Cool-cold to very cold
			5b	Montane fynbos-lower		Humid to humid-subhumid		Cool-cold	Cool-cold to very cold

Table F3: Bioclimatic regions of Natal/KwaZulu (continued).

Group	Group title based on bioclimatic potential and details	Altitude (m)	Sub-region	Potential climax	Range in mean annual precipitation (mm)	Humidity range	Mean annual temperature range (°C)	Seasonal temperature range	
								warm season	cool season
6	Upland mixed short thicket and woodland: moister faciation. (Located mainly in the upper reaches of the major river valleys mostly in the north west of Natal/KwaZulu. The group forms the transition between group 4 (high altitude, cool, high rainfall) and groups 8 and 10 (low altitude, warm, low rainfall). The terrain is broken to rolling with occasional steep areas)	915-1 372	6a	Short thicket	800-1 000	Subhumid to mild subarid	16,0-18,0	Warm-mild	Cool-cold

Table F3: Bioclimatic regions of Natal/KwaZulu (continued).

Group	Group title based on bioclimatic potential and details	Altitude (m)	Sub-region	Potential climax	Range in mean annual precipitation (mm)	Humidity range	Mean annual temperature range (°C)	Seasonal temperature range	
								warm season	cool season
7	Riverine (Tugela) mixed short/medium thicket. (Confined to the lower Tugela River Valley stretching from Mandini inland, branching into two long arms south west and north east of the river. Steep rugged terrain)	305-610	7a	Short/medium thicket	700-800	Subhumid to mild subarid	17,0-18,0	Warm-mild -hot locally	Cool-cold
8	Upland mixed short thicket and woodland: drier faciation. (Situated mostly as a large tract of land stretching across northern Natal/ KwaZulu with a high proportion of nearly level or gently undulating terrain)	915-1 372	8a	Short thicket	600-800	Mild subarid	16,0-18,0	Warm-mild	Cool-cold
			8b	Short thicket (drier faciation)		Mild subarid to subarid		Warm-mild	Cool-cold
			8c	Grassland pro-climax		Mild subarid to subarid		Warm-mild	Cool-cold to very cold

Table F3: Bioclimatic regions of Natal/KwaZulu (continued).

Group	Group title based on bioclimatic potential *and details*	Altitude (m)	Sub-region	Potential climax	Range in mean annual precipitation (mm)	Humidity range	Mean annual temperature range (°C)	Seasonal temperature range	
								warm season	cool season
9	Lowland to Upland mixed short/medium thicket and woodland. (Confined to Zululand. The terrain varies from level to gently rolling with occasional steep areas)	152-457 (Lowland); 457-1 067 (Upland)	9a	Short/medium thicket	700-860	Subhumid to mild subarid	21,0-22,0	Hot-warm	Warm-mild to cool
			9b	Short/medium thicket		Mild subarid		Hot-warm	Warm-mild
			9c	Short/medium thicket		Mild subarid to subarid		Hot-warm	Warm-mild

Table F3: Bioclimatic regions of Natal/KwaZulu (continued).

Group	Group title based on bioclimatic potential and details	Altitude (m)	Sub-region	Potential climax	Range in mean annual precipitation (mm)	Humidity range	Mean annual temperature range (°C)	Seasonal temperature range	
								warm season	cool season
10	Riverine and Lowland *mixed short/medium* thicket and woodland. (Highly fragmented with the exception of two main areas, one in the north and the other in the central part of the province. Scattered areas of Riverine vegetation are found in all major river valleys in Natal/ KwaZulu. Valleys often very steep and rocky, especially in the Weenen area. Marked rain shadow effects found in this group)	152-457-915	10a	Short/medium thicket: riverine valley and other low-lying terrain	600-700	Mild subarid to subarid	18,0-23,0 (warmer in north east facing areas)	Warm to locally hot	Warm-mild to cool-cold
			10b	Short/medium thicket: riverine valley and other *low-lying terrain*		Subarid		Hot-warm	Warm-mild

Table F3: Bioclimatic regions of Natal/KwaZulu (continued).

Group	Group title based on bioclimatic potential and details	Altitude (m)	Sub-region	Potential climax	Range in mean annual precipitation (mm)	Humidity range	Mean annual temperature range (°C)	Seasonal temperature range	
								warm season	cool season
11	Arid Lowland mixed short/medium thicket and woodland. (Located in two main areas in the Pongola River Valley and in the Mkuze River Valley, west of the Lebombo Mountains. The terrain is generally level to undulating)	152-457	11a	Short/medium thicket	320-600	Arid	21,0-33,0	Hot-warm	Warm-mild

<u>Source</u>: After Phillips, J., 1973. The agricultural and related development of the Tugela Basin and its influent surrounds: a study in subtropical Africa, Natal Town and Regional Planning Commission Report, VOL 19, Pietermaritzburg, 299 p. and maps.

<u>See also</u>:

(i) Anonymous, 1974. Development programme for the Natal Region, Department of Agricultural Technical Services (Natal Region), Cedara, 273 p. + app.

(ii) Anonymous, 1981. Agricultural development program: Natal Region, 1981, Department of Agriculture and Fisheries (Natal Region), Cedara, 114 p.

(iii) Anonymous, 1986. Natal Region agricultural development programme, Department of Agriculture and Water Supply (Natal Region), Cedara, various pages.

Note:

(i) Mean daily temperature ranges are as follows:

Hot	>23°C
Warm	18 - 23°C
Mild	12 - 18°C
Cool	7 - 12°C
Cold	3 - 7°C
Very cold	-3 - 3°C

(ii) The term "faciation" denotes a specific type or form of climax plant community. The term "facies" refers to a specific type or form of successional stage (seral) plant community.

(iii) *For a non-technical explanation of bioclimatic regions in* Natal/KwaZulu, see Tainton, N.M., 1984. The grasses and grasslands of Natal, Neon, No. 46, December 1984, p. 12 - 19.

(iv) Short bioclimatic group titles are often used in the literature. Such titles are:

Bioclimatic group	Short title
1	Coastal Lowlands
2	Coastal Hinterland
3	Midlands Mistbelt
4	Highland Sourveld
5	Montane
6	Moist Tall Grassveld
7	Riverine (Valley Thornveld - Tugela)
8	Dry Tall Grassveld
9	Zululand Bush and Lowveld
10	Riverine and Interior Lowland (Valley and Interior Thornveld)
11	Arid Lowland (Zululand)

Table F4: **Monthly *distribution of rainfall* plus other climatic data and present vegetation in each bioclimatic group in Natal/KwaZulu.**

Bioclimatic group (short *title*)	Present vegetation	Humidity mixing ratio range (g kg^{-1})		Saturation deficit at 14h00 range (hPa)	Distribution of rainfall by months			Mean annual total evaporation range: Symons pan (mm)	Occurrence of frost and snow
		Nov/April	May/Oct		W	MW	ED		
1. Coastal Lowlands	Almost wholly secondary or replaced by extensive cultivation. Acocks: Coastal Forest and Thornveld (1) Pentz: Coastal Evergreen Bush (1)	10,0-17,5	7,5-15,0	Below 10 5-10	5-6	7-5	0-1-(2)	1 143-1 295	Nil to rare to very occasional; light to locally moderate (may "frost" sugar cane lightly)
2. Coastal Hinterland	Apart from small relict forest, much grassland (Aristida spp.) heavily grazed and extensively cultivated. Acocks: Ngongoni Veld (5) Pentz: Open Bush Sandy Country (7)	10,0-15,0	5,0-12,5	Below 10 *also* 10-15	5-6	7-4-3	0-1-(2-3)	1 270-1 295	Nil to rare to occasional; light to locally moderate (may frost sugar cane moderately)

Table F4: **Monthly distribution of rainfall plus other climatic data and present vegetation in each bioclimatic group in Natal/KwaZulu (continued).**

Bioclimatic group (short title)	Present vegetation	Humidity mixing ratio range ($g\ kg^{-1}$)		Saturation deficit at 14h00 range (hPa)	Distribution of rainfall by months			Mean annual total evaporation range: Symons pan (mm)	Occurrence of frost and snow
		Nov/April	May/Oct		W	MW	ED		
3. Midlands Mistbelt	Apart from several larger and many small relict forests, mainly secondary grassland (Aristida spp.). Forests greatly reduced and altered. Acocks: Ngongoni Veld (5) and Natal Mistbelt Ngongoni Veld (45) Pentz: Temperate Forest (5) (in part)	10,0-15,0	5,0-10,0	10-15	5-6	7-6	0-(1)	1 270-1 346	Nil to rare to occasional; light to moderate to locally moderately severe (may frost sugar cane moderately severely); snow rare on highest points

Table F4: Monthly distribution of rainfall plus other climatic data and present vegetation in each bioclimatic group in Natal/KwaZulu (continued).

Bioclimatic group (short title)	Present vegetation	Humidity mixing ratio range (g kg^{-1})		Saturation deficit at 14h00 range (hPa)	Distribution of rainfall by months			Mean annual total evaporation range: Symons pan (mm)	Occurrence of frost and snow
		Nov/April	May/Oct		W	MW	ED		
4. Highland Sourveld	Many petty relict forests. Extensive grassland (Highland Sourveld: Themeda/Trachypogon spp. except in the north where Themeda/ Tristachya/Digitaria spp.) is found. Some areas are already much deteriorated. Acocks: Highland Sourveld (44a), Highland Sourveld to Cymbopogon-Themeda Veld Transition (56), North-eastern Sandy Highveld (57) and Piet Retief Sourveld (63) in part Pentz: Highland Sourveld (4)	10,0-15,0	2,5-7,5	10-15	5-6	5-3	2-3	1 270-1 346	Over long period moderate to severe; snow locally for short periods

Table F4: Monthly distribution of rainfall plus other climatic data and present vegetation in each bioclimatic group in Natal/KwaZulu (continued).

Bioclimatic group (short title)	Present vegetation	Humidity mixing ratio range ($g\ kg^{-1}$)		Saturation deficit at 14h00 range (hPa)	Distribution of rainfall by months			Mean annual total evaporation range: Symons pan (mm)	Occurrence of frost and snow
		Nov/April	May/Oct		W	MW	ED		
5. Montane	Locally fired, browsed and grazed but locally conserved. <u>Acocks</u>: <u>Themeda-Festuca</u> Alpine Veld (58) <u>Pentz</u>: Bergveld (-)	10,0-15,0 to 7,5-12,5	2,5-7,5	10-5	6-7	4-1	2-4	1 143-1 270	Over very long period up to nine months; severe to very severe; snow may fall in any month, and may lie for long periods
6. Moist Tall Grassveld	Tall Grassveld (<u>Themeda</u>/<u>Hyparrhenia</u> spp.) and transitional veld of several facies, much grazed and deteriorated. <u>Acocks</u>: Northern and Southern Tall Grassveld (64 and 65), Piet Retief Sourveld (63) and Natal Sour Sandveld (66), all in part <u>Pentz</u>: Tall Grassveld (3) in part and Sandy Sourveld (8) in part	10,0-12,5	2,5-7,5	15-18	5	4	3-4-(5)	1 346-1 448	Over several months; moderate to severe

Table F4: **Monthly distribution of rainfall plus other climatic data and present vegetation in each bioclimatic group in Natal/KwaZulu (continued).**

Bioclimatic group (short title)	Present vegetation	Humidity mixing ratio range (g kg^{-1})		Saturation deficit at 14h00 range (hPa)	Distribution of rainfall by months			Mean annual total evaporation range: Symons pan (mm)	Occurrence of frost and snow
		Nov/April	May/Oct		W	MW	ED		
7. Valley Thornveld-Tugela	In the lower Tugela Valley and elsewhere locally: much disturbed. Acocks: Valley Bushveld (23) Pentz: Dry Thorn or Bushveld (2)	7,5-12,5	2,5-7,5	10-15	3-4	6-(5)	3	-	Nil to occasional; light
8. Dry Tall Grassveld	Tall Grassveld (Themeda/Hyparrhenia spp.) and Sandy Sourveld (Tristachya/ Digitaria spp.) - grazed and locally cultivated: portions much deteriorated with thorn encroachment. Acocks: Northern and Southern Tall Grassveld (64 and 65) and Natal Sour Sandveld (66), all in part Pentz: Tall Grassveld (3) in part and Sandy Sourveld (8) in part	7,5-10,0	2,5-5,0	15-18	5	3	4-(5)	1 398-1 473	Over several months; moderate to severe

Table F4: Monthly distribution of rainfall plus other climatic data and present vegetation in each bioclimatic group in Natal/KwaZulu (continued).

Bioclimatic group (short title)	Present vegetation	Humidity mixing ratio range (g kg^{-1})		Saturation deficit at 14h00 range (hPa)	Distribution of rainfall by months			Mean annual total evaporation range: Symons pan (mm)	Occurrence of frost and snow
		Nov/April	May/Oct		W	MW	ED		
9. Zululand Bush and Lowveld	In parts heavily grazed and browsed with thicket intensification. <u>Acocks</u>: Zululand Thornveld (6) <u>Pentz</u>: Dry Thorn or Bushveld (2)	10,0	2,5-5,0	15-0 15-20 (north east)	5	3	4	1 448-1 524	Nil to very rare, locally very light
10. Riverine and Interior Lowland	Extensively altered by grazing and browsing; much severe thicket intensification. <u>Acocks</u>: Valley Bushveld (23) and Lowveld (10) <u>Pentz</u>: Dry Thorn or Bushveld (2)	7,5	2,5	15 (Tugela Basin) 15-20 in the north east	2-4	6-4	(3)-4-5-6	1 448-1 524	In Riverine faciation only in the Tugela Basin and South western surrounds moderately severe; nil in the north west Lowveld faciation

Table F4: **Monthly distribution of rainfall plus other climatic data and present vegetation in each bioclimatic group in Natal/KwaZulu (continued).**

Bioclimatic group (short title)	Present vegetation	Humidity mixing ratio range (g kg^{-1})		Saturation deficit at 14h00 range (hPa)	Distribution of rainfall by months			Mean annual total evaporation range: Symons pan (mm)	Occurrence of frost and snow
		Nov/April	May/Oct		W	MW	ED		
11. Arid Lowland	Extensively altered by grazing and browsing: local thicket intensification. <u>Acocks</u>: Arid Lowveld (11) <u>Pentz</u>: Dry Thorn or *Bushveld (2)*	5,0	<2,5	15-20 to (20-25)	0	6	5-6+3	>1 524	Nil

<u>**Source**</u>: (i) After Phillips, J., 1973. The agricultural and related development of the Tugela Basin and its influent surrounds: a study in subtropical Africa, Natal Town and Regional Planning Commission Report, VOL 19, Pietermaritzburg, 299 p. and maps.

(ii) After Anonymous, 1981. Agricultural development program: Natal Region, 1981, Department of Agriculture and Fisheries (Natal Region), Cedara, 114 p.

<u>**See also**</u>: (i) Geldenhuys, C.J. and MacDevette, D.R., 1989. Chapter 14. Conservation status of Coastal and Montane Evergreen forest, In: Huntley, B.J. (ed), <u>Biotic Diversity in Southern Africa: Concepts and Conservation</u>, Oxford University Press, Cape Town, p. 224 - 238.

(ii) Macdonald, I.A.W., 1989. Chapter 3. Man's role in changing the face of southern Africa, In: Huntley, B.J. (ed), <u>Biotic Diversity in Southern Africa: Concepts and Conservation</u>, Oxford University Press, Cape Town, p. 51 - 77.

Note:

(i) The humidity mixing ratio is the ratio of the mass of water vapour (g) to the mass of dry air (kg) with which the water vapour is associated.

(ii) Rainfall distribution:

Wet months (W: $\geq$101,6 mm)
Ecologically dry months (ED: $\leq$25,4 mm)
Medium wet months (MW: Intermediate in relation to the above)

Brackets ( ), denote occasionally, not usually.

(iii) The vegetation type and number (classification system) is per Acocks, J.P.H., 1988. Veld types of South Africa, third edition, Memoir No. 57, Botanical Survey of South Africa, Botanical Research Institute, Department of Agriculture and Water Supply, Pretoria, 146 p. and maps, and Pentz, J.A., 1938. The value of botanical survey and the mapping of vegetation as applied to farming systems in South Africa, Memoir No. 19, Botanical Survey of South Africa, Department of Agriculture and Forestry, Pretoria, 15 p. + app. and map, as well as Pentz, J.A., 1945. An agro-ecological survey of Natal, Bulletin No. 250, Soil and Veld Conservation Series No. 7, Department of Agriculture and Forestry, Pretoria, 10 p.

(iv) The original saturation deficit data were presented in millibars (mb). The unit now used is hectopascals (hPa), where 1 mb = 1 hPa. Saturation deficit is the difference between the amount of water vapour in the air at a given time and the maximum which it could contain at the same temperature, expressed either as the difference between the relative humidity and the humidity at saturation, or in terms of vapour pressure (deficit).

Table F5: **Further data on bioclimatic groups in Natal/KwaZulu.**

Bioclimatic group	Total area of bioclimatic group in KwaZulu (km^2)	Percentage of bioclimatic group in KwaZulu	Percentage of KwaZulu in bioclimatic group*	Total area of bioclimatic group in Natal/KwaZulu (km^2)	Percentage of bioclimatic group in Natal/KwaZulu
1	4 922	51,7	14,8	9 522	11,2
2	5 870	57,6	17,7	10 190	12,0
3	749	15,0	2,3	4 993	5,9
4	1 979	17,7	6,0	11 160	13,1
5	0	0	0	1 851	2,2
6	1 719	17,7	5,2	9 694	11,4
7	489	84,0	1,5	582	0,7
8	4 180	26,9	12,6	15 555	18,3
9	3 568	80,9	10,8	4 410	5,2
10	9 586	58,4	28,9	16 422	19,3
11	98	17,0	0,3	578	0,7
Total	33 160	-	100	84 957	100

<u>Source</u>: After Thorrington-Smith, Rosenberg and McCrystal, 1978. Towards a plan for KwaZulu: a preliminary development plan, VOL 1, The written report, 341 p., and VOL 2, Atlas of maps and illustrations, various pages, KwaZulu Government, Ulundi.

<u>Note</u>:

(i) The asterisk indicates that the column does not total to 100 due to rounding errors.

(ii) The table excludes East Griqualand in Natal. The areas for KwaZulu are based on the 1975 consolidation proposals.

(iii) *Further bioclimatic distribution data (including* East *Griqualand and* northern Transkei) as well as information on land use patterns in each bioclimatic group, can be found in the following reports: Anonymous, 1974. Development programme for the Natal Region, Department of Agricultural Technical Services (Natal Region), Cedara, 273 p. + app. See also, Anonymous, 1981. Agricultural development program: Natal Region, 1981, Department of Agriculture and Fisheries (Natal Region), Cedara, 114 p., and Anonymous, 1986. Natal Region agricultural development programme, Department of Agriculture and Water Supply (Natal Region), Cedara, various pages. For data on land use patterns by bioclimatic group in KwaZulu, see Anonymous, 1988. KwaZulu development information, VOL 1 - 2, various pages, Government of KwaZulu and the Development Bank of Southern Africa, Halfway

House. (Examine Section 7: Agriculture and mining). The distribution of bioclimatic groups by tribal area in KwaZulu (including maps), is outlined in the following report: Anonymous, 1981. A proposed rural development strategy for KwaZulu, VOL 2, Appendices, Agriculture Division, KwaZulu Development Corporation, Durban, 38 p.

(iv) Useful overall statistics on Natal including bioclimatic groups, major categories of land use (urban areas, State forests, Natal Parks Board areas, (former) South African Development Trust land, agricultural land and areas of Transkei and KwaZulu within Natal), as well as various other important agricultural statistics can be found in: Anonymous, 1991. Description and statistics of the Natal Region of the Department of Agricultural Development, Cedara Report No. N/A/91/25, Department of Agricultural Development (Natal Region), Cedara, 65 p.

Table F6: Correlation of physiographic regions, bioclimatic groups and mean annual runoff density in Natal/KwaZulu.

Number and physiographic region		Number and bioclimatic group		Mean annual runoff density ($m^3\ km^{-2}$)
North eastern influent surrounds				
37	Zululand Lowveld	11	Arid Lowland	23 813 (Lower Pongola, Mkuzi and Umsinduzi)
37	Zululand Lowveld	10	Riverine and Interior Lowland	47 625 - 95 250 Hluhluwe Valley
			Black and White Umfolozi River valleys	47 625 in the middle reaches, 95 250 - 381 000 in the lower and coastal reaches
			Umhlatuze River Valley	From 95 250 in the interior (near Nkandla) to 476 250 at the coast
25 24	Pongola-Pivaan Basin to Vryheid Plain	6	Upland	238 125
12	Hlobane/Manyini/Ceza (Ngome) Block	3	Mistbelt (higher portion)	142 875 - 238 125
		8	Upland (lower portion)	47 625 - 142 875
31	Zululand Middleveld	8/9	Lowland to Upland	47 625 - 95 250

Table F6: Correlation of physiographic regions, bioclimatic groups and mean annual runoff density in Natal/KwaZulu (continued).

Number and physiographic region		Number and bioclimatic group		Mean annual runoff density ($m^3 km^{-2}$)
31	Zululand (Hlabisa Block)	2/9	Coast Hinterland/ Upland	142 875 - 238 125
11/30	Babanango/Melmoth Block	2/3/4	Coast Hinterland/ Mistbelt/Highland	95 250
40	Eshowe/Nkandla Divide	2	Coast Hinterland	238 125
42	Coast Plain	1	Coast Lowlands	238 125 - 476 250
Tugela Basin				
6	Belelasberg/Skurweberg	4	Highland to Submontane	190 500 - 238 125
3	Low Drakensberg	4	Highland to Submontane	238 125
1	High Drakensberg	5	Montane	476 250 - 952 500
2	Foothills of the High Drakensberg	4	Highland to Submontane	238 125 - 476 250
4	Western fringes of the great plainlands	6	Upland	95 250 - 238 125
17/18	Ladysmith/Estcourt Plains	8	Upland	47 625 - 95 250
20/24	Buffalo Plain and Benchlands	8	Upland	95 250
7/8	Biggarsberg/ Helpmekaar Range	4/6	Highland to Submontane	95 250 - 238 125
34	Tugela Valley	10	Riverine and Interior Lowland	Up to 47 625
14	Natal Midlands	4/3	Highland to Mistbelt	142 875 - 238 125
34	Tugela Valley (east of Jameson's Drift)	10	Riverine and Interior Lowland	47 625 - 95 250
10	Nqutu Divide	6	Upland	95 250
South western influent surrounds				
1	High Drakensberg	5	Montane	952 500
2	Foothills of the High Drakensberg	4	Submontane sector	476 250 - 952 500
13/27/ 16	Impendle/Underberg/ Bulwer	4	Highland sector	238 125

Table F6: Correlation of physiographic regions, bioclimatic groups and mean annual runoff density in Natal/KwaZulu (continued).

Number and physiographic region		Number and bioclimatic group		Mean annual runoff density ($m^3\ km^{-2}$)
32	Ixopo/Highflats	4/3	Highland to Mistbelt	95 250 - 238 125
14/15	Natal Midlands	4/3	Highland to Mistbelt	95 250 - 238 125
43	Deep river valleys (of the interior)	6	Upland	142 875 - 238 125
43	Deep river valleys (of the Coast Hinterland)	10	Riverine and Interior Lowland	95 250
43	Greytown/ Pietermaritzburg Benchland	3	Mistbelt	95 250 - 142 875
5/33	Ingeli/Harding Benchland	3	Mistbelt	95 250 - 238 125
38	Coast Belt	1	Coast Lowlands	238 125

Source: After Phillips, J., 1970. Ecology and ecological classification in relation to the conservation and use of land and water in Natal, Paper No. 4, 1st Technical Session, Symposium Water Natal 1970, 27 - 29 May 1970, Durban, 30 p.

Note:

(i) East Griqualand was excluded from the analysis.

(ii) It is desirable, with the hydrological data now available, that revision of the mean annual runoff density information be undertaken. See however the chapter on the surface water resources of Natal/ KwaZulu (Section 10.11), and in particular data provided by Schulze (1984).

(iii) According to Phillips (1970 - above) bioclimatic groups 3,4,5,6 and 8 have a high mean annual runoff density. Given mean annual runoff, relative elevation and local physiography, small or medium scale hydro-electricity generation would be feasible at selected sites in bioclimatic groups 5,6,8,10 and 11. Schistosomiasis is possible in waters below 1 220 m in altitude. Chemical (surface) water quality (as a broad overview), is good in bioclimatic groups 2 - 6 inclusive (in areas with a mean annual precipitation >800 mm); good to moderate (excluding coal-mining areas) in those parts of bioclimatic group 8 with a mean annual precipitation <800 mm, and moderate to poor in bioclimatic groups 7, 9, 10 and 11 (in areas with a mean annual precipitation <800 mm). Chemical quality is fair in bioclimatic group 1 (in areas with a mean annual precipitation >800 mm).

6.4 Geobioclimatic sub-regions in Natal/KwaZulu

Geobioclimatic sub-regions are of considerable importance for land use rating purposes. Phillips (1973 - see below), defined and mapped 66 geobioclimatic sub-regions in Natal/KwaZulu (excluding East Griqualand), based on the relationships between geology, physiography, climate, vegetation and soils. Phillips observed that over 100 geobioclimatic sub-regions could be derived from extant data, depending on the degree of detail required. Some of the more important geobioclimatic sub-regions, by way of example, are outlined in Table F7. It should be noted that geobioclimatic sub-regions (which were never accepted in the literature) have been superseded by Land Types - see the chapter on soils and soil erosion. The geological terminology used by Phillips, as indicated earlier, is out of date.

Table F7: Some important geobioclimatic sub-regions in Natal/KwaZulu.

Area	*Geological formation/bioclimatic group*	*Geobioclimatic sub-region*
North eastern influent surrounds	Recent to Tertiary/Coast Lowlands	1/1
	Basement Complex/Coast Lowlands	9/1
	Table Mountain sandstone/Coast Hinterland	8/2
	Basement Complex/Coast Hinterland	9/2
	Ecca/Mistbelt	6/3
	Ecca/Lowland to Upland mixed thicket and woodland	6/9
	Basalt/Riverine and Lowland mixed thicket and woodland	3/10
Tugela Basin	Beaufort/Highland/Montane Podocarpus-other species	5/4
	Ecca/Highland/Montane Podocarpus-other species	6/4
	Basalt/Montane fynbos and thicket	3/5
	Beaufort/Upland mixed thicket and woodland: moister faciation	5/6
	Ecca/Upland mixed thicket and woodland: moister faciation	6/6
	Ecca/Upland mixed thicket and woodland: drier faciation	6/8

Table F7: **Some important geobioclimatic sub-regions in Natal/KwaZulu (continued).**

Area	Geological formation/bioclimatic group	Geobioclimatic sub-region
	Beaufort/Riverine and Lowland mixed thicket and woodland	5/10
	Ecca/Riverine and Lowland mixed thicket and woodland	6/10
	Basement Complex/Riverine and Lowland mixed thicket and woodland	9/10
South western influent surrounds	Ecca/Coast Lowlands	6/1
	Dwyka/Coast Lowlands	7/1
	Table Mountain sandstone/Coast Lowlands	8/1
	Table Mountain sandstone/Coast Hinterland	8/2
	Basement Complex/Coast Hinterland	9/2
	Ecca/Mistbelt	6/3
	Beaufort/Highland/Montane Podocarpus-other species	5/4
	Basalt/Montane fynbos and thicket	3/5
	Basement Complex/Riverine and Lowland mixed thicket and woodland	9/10

Source: After Phillips, J., 1973. The *agricultural and related development of the* Tugela Basin and its influent surrounds: a study in subtropical Africa, Natal Town and Regional Planning Commission Report, VOL 19, Pietermaritzburg, 299 p. and maps.

Note: The geobioclimatic sub-region is recorded as geological formation/bioclimatic group for example, 6/1 where 6 refers to Ecca Series and 1 refers to bioclimatic group 1. Such a composite number indicates an area underlain by rocks of the Ecca Series in bioclimatic group 1 (Coast Lowlands). The designations of the geological formations used by Phillips are as follows:

Geological formation	Phillips number
Recent to Tertiary*	1
Rhyolite	2
Stormberg basalt	3
Stormberg sediments	4
Beaufort Series	5
Ecca Series	6
Dwyka Series	7
Table Mountain sandstone	8
Basement Complex	9
Undifferentiated formations	10

6.5 Catchment management in Natal/KwaZulu

6.5.1 Mountain Catchment Areas

In terms of the Mountain Catchment Areas Act No. 63 of 1970, the Minister of Environment Affairs may proclaim any privately owned land (of which the water yield is of great importance), to be a Mountain Catchment Area. The value of an area as a source of water for current and future use is the primary criterion for the establishment of a Mountain Catchment Area. High rainfall per se is not necessarily the major determinant, where for example, a catchment has a relatively low runoff - and where the runoff may be of crucial importance for downstream use in that particular locality. Mountainous areas with a low agricultural potential and a relatively high water yield may also be included in declared Mountain Catchment Areas. Moreover, mountainous areas where the water yield is not significant, but where the natural vegetation has deteriorated to the extent that further environmental degradation must be avoided, may likewise be declared as Mountain Catchment Areas. Other important objectives include general environmental conservation and recreation. State "forest" lands (often comprising grassland with patches of indigenous forest), situated adjacent to Mountain Catchment Areas, are not declared as

* The relevant map in Phillips (1973) refers to the first geological formation as "Recent to Cretaceous".

Mountain Catchment Areas but are managed (in terms of the Forest Act No. 122 of 1984), on the same basis as the adjoining declared area (Bands, 1989)*.

No clear definition of a Mountain Catchment Area has been universally agreed upon, with respect to water resources management. Van der Zel (1981)** suggested that mountain catchments in southern Africa consist of well-watered areas (with a minimum unit mean annual runoff of 100 mm - equal to 1 000 m^3 ha^{-1} y^{-1}), which are situated in the highest land areas; and which are managed for the supply of the optimum volume of usable water (bearing in mind reasonable water requirements within the given area). The highest land areas are defined as land with elevations equal to or greater than 600 m above sea level in the summer rainfall regions, and land equal to or higher than 300 m in "constant" and winter rainfall regions. Also included in the definition are dry Mountain Catchment Areas with a unit mean annual runoff of less than 100 mm, representing important local sources of water. Such an overall definition would include large parts of Natal/KwaZulu or 12% of the area of southern Africa.

Management of Mountain Catchment Areas is aimed at securing the maximum volume of water at the highest possible quality on the most dependable basis, while retaining optimal vegetation cover and species variety. A management plan is compiled for each catchment area (private and State owned land), where management is undertaken in terms of an advisory committee for the particular catchment. Management guidelines may be enforced if necessary on privately owned land, by virtue of the Mountain Catchment Areas Act.

In South Africa approximately 616 811 ha of privately owned land is presently controlled in terms of the Mountain Catchment Areas policy. The proclamation of additional Mountain Catchment Areas is an on-going process. Van der Zel (1981) stressed the importance of Mountain Catchment Areas with regard to water resources, given that the 12% of the land area of southern Africa consisting of mountain catchments, provides 53% of the mean annual runoff of the region. It should be borne in mind that only 6,4% of all major mountain catchments on private land in South Africa have been declared as

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* See Bands, D.P., 1989. The Forest Act and the Mountain Catchment Areas Act: their role in the conservation of water resources, Southern African Journal of Aquatic Sciences, VOL 15(2) (stated as VOL 16(2) in the paper), p. 226 - 235.

** See Van der Zel, D.W., 1981. Optimum mountain catchment management in southern Africa, South African Forestry Journal, No. 116, March 1981, p. 75 - 81.

Mountain Catchment Areas. Act No. 63 of 1970 accordingly, does not apply to approximately 9 100 000 ha of privately owned mountain catchment land. The area of mountain catchments on State land amounts to some 1 700 000 ha (Rabie, Blignaut and Fatti, 1992)*.

The control of catchments in mountain areas is also exercised through the Forest Act (as stated above); the National Parks Act No. 57 of 1976; the Water Act No. 54 of 1956; the Conservation of Agricultural Resources Act No. 43 of 1983, and the Defence Act No. 44 of 1957 (mountains in Defence Force areas). Various other Acts such as the Environment Conservation Act No. 73 of 1989 and the National Monuments Act No. 28 of 1969 may be indirectly applicable. Certain Provincial Ordinances likewise apply to mountain catchments. In Natal, this includes the (Natal) Nature Conservation Ordinance No. 15 of 1974, with reference to mountain catchments in nature reserves - both private and public. (See the chapter on the laws of South Africa, elsewhere in this publication). The situation regarding fire control is discussed in the chapter on fire.

<u>For further information contact</u>:

- Department of Agriculture, Private Bag X9059, Pietermaritzburg, 3200.
- Department of Environment Affairs, Private Bag X447, Pretoria, 0001.
- Department of Water Affairs and Forestry, Private Bag X313, Pretoria, 0001.
- Mountain Club of South Africa, 97 Hatfield Street, Cape Town, 8001.
- Natal Parks Board, P O Box 662, Pietermaritzburg, 3200.

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* See Rabie, M.A., Blignaut, P.E. and Fatti, L.P., 1992. Chapter 24. Mountains, In: Fuggle, R.F. and Rabie, M.A. (eds), <u>Environmental Management in South Africa</u>, Juta, Cape Town, p. 624 - 646.

6.5.2 The Natal Drakensberg

While no proclaimed Mountain Catchment Areas are found in Natal/KwaZulu, control is exercised for similar purposes through the Drakensberg Catchment Area policy. The Drakensberg Catchment Area of Natal/KwaZulu is approximately 3 033 km^2 in extent, consisting of some 2 428 km^2 controlled primarily by the Natal Parks Board (this area is now known as the Natal Drakensberg Park). The Upper Tugela Location - KwaZulu Area No. 8 (605 km^2) forming part of the catchment area - is controlled by KwaZulu. No part of the catchment is privately owned (Bainbridge, 1982; 1994)*. The High Drakensberg portion of the catchment area (at an altitude of 762 - 2 134 m), consists of seven State forests and associated wilderness areas plus grassland under the jurisdiction of the Natal Parks Board. Several indigenous forests are also managed by the Board in the Little Berg (the lower altitude portion of the main Drakensberg). A similar function is performed in the Little Berg and elsewhere by the Department of Water Affairs and Forestry, through the control of areas such as Ngele Mountain situated in the Weza State Forest near Harding. Just under 80% of the High Drakensberg and the Little Berg is now conserved, with the exception of the Upper Tugela Location. The primary legislation involved is the Forest Act No. 122 of 1984 and the (Natal) Nature Conservation Ordinance No. 15 of 1974.

The Drakensberg Catchment Area is of paramount national importance in terms of water yield (and water quality) and is the source of three important rivers, namely, the Tugela, the Mkhomazi and the Mzimkulu. The Drakensberg is also a vital component of the Tugela-Vaal hydro-electric and water transfer scheme. Bainbridge (1982) estimated that runoff from the Drakensberg Catchment Area was worth approximately R130 million per annum (1982 prices). Schulze (1979)** provided a comprehensive analysis of the hydrology of the Drakensberg.

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* See Bainbridge, W.R., 1982. The Drakensberg State forests - a case study of land use zoning and management, Proceedings of the Jubilee Symposia, 23 - 24 September 1982, VOL 2, Communication No. 98, Faculty of Forestry, University of Stellenbosch, Stellenbosch, p. 466 - 496., and Bainbridge, W.R., 1994. Personal communication, Natal Parks Board, Pietermaritzburg.

** See Schulze, R.E., 1979. Hydrology and water resources of the Drakensberg, Natal Town and Regional Planning Commission Report, VOL 42, Pietermaritzburg, 179 p. (The report also discusses soil erosion modelling in the Drakensberg). See in addition, Tyson, P.D., Preston-Whyte, R.A. and Schulze, R.E., 1976. The climate of the Drakensberg, Natal Town and Regional Planning Commission Report, VOL 31, Pietermaritzburg, 82 p.

Two of the seven major floristic regions of southern Africa are found in the Drakensberg. Killick (1963)* identified three critical zones of the Drakensberg, namely, the Alpine Belt (2 865 - 3 353 m), the Sub-alpine Belt (1 830 - 2 865 m), and the Montane Belt (1 280 - 1 830 m). The three vegetation regions however, are not necessarily always arranged in a broadly parallel altitudinal sequence.

According to Killick, the only alpine vegetation to be found in southern Africa occurs in the Drakensberg and the adjacent Maluti Mountains in Lesotho. Vegetation in the Alpine Belt, subject to harsh environmental conditions, consists mainly of evergreen, dwarf shrubs especially the Erica and Helichrysum species. The vegetation in the Sub-alpine Belt consists of Themeda triandra grassland with other grass-dominated communities. Woody communities also exist, principally Cliffortia linearifolia and Protea species (the climax vegetation of the Sub-alpine Belt). Characteristic tree species of the forests in the Montane Belt (confined to small patches in upland valleys), are the yellowwoods (Podocarpus species), Black ironwood, Cape beech, Stinkwood and Sneezewood. The largest part of the Montane region is grassland, particularly Themeda triandra grassland.

The Natal Town and Regional Planning Commission produced a number of reports outlining management proposals for different zones of the Drakensberg. Important issues include recreation, the protection of the terrain from indiscriminate development, and the conservation of vital water resources (see Table F8). Considerable difficulties with the management of the Drakensberg catchment as a unit are being experienced in the Upper Tugela Location, where the uncontrolled felling of trees for fuel, building requirements and agricultural land has considerably reduced the remaining patches of forest. A fairly recent development is the extensive cultivation of dagga (Cannabis sativa) on sensitive, steep

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* See Killick, D.J.B., 1963. An account of the plant ecology of the Cathedral Peak area of the Natal Drakensberg, Memoir No. 34, Botanical Survey of South Africa, Botanical Research Institute, Department of Agricultural Technical Services, Pretoria, 178 p. and map. See also, Killick, D., 1990. A Field Guide to the Flora of the Natal Drakensberg, Jonathan Ball and AD. Donker, Johannesburg, 196 p., as well as Werger, M.J.A. and Van Bruggen, A.C. (eds), 1978. Biogeography and Ecology of Southern Africa, Monographiae Biologicae VOL 31, W. Junk, The Hague, 1439 p., plus Anonymous, 1988. Vegetation and grazing evaluation: Upper Tugela Location, prepared for the Department of Development Aid, various pages, and Map album, various pages, HKS Agriland, Durban. The following is also of relevance: Hilliard, O.M. and Burtt, B.L., 1987. The Botany of the Southern Natal Drakensberg, National Botanic Gardens, [Cape Town], 253 p.

Table F8: Summary of use and management guidelines for zones of the Natal Drakensberg.

Zone
Drakensberg Catchment Area (the Inner Berg) (i) <u>Wilderness Heart Zone</u> In the State forests, dedicated or proposed for dedication as wilderness areas; composed of highly sensitive land systems containing the landscapes least modified by human interference <u>Uses</u> The primary management objectives include water production and conservation of the natural resources; traditional use as wilderness, without roads for public access and accommodation for the public; restrictions on agricultural use
(ii) <u>Landslide Zone</u> The major natural barrier in the Drakensberg Catchment Area - which acts as a visual and physical buffer between the Wilderness Heart Zone and the peripheries - in the State forests protected as nature reserves; highly fragile landscapes subject to soil erosion <u>Uses</u> Management substantially the same as for the Wilderness Heart Zone; roads restricted to those essential for management and research purposes; public accommodation only in rock shelters; access restricted with regard to numbers; footpaths for public access kept to a minimum (to prevent soil erosion)
Drakensberg Catchment Buffer Zone (the Drakensberg Approaches) (i) <u>Trail Zone</u> Where present in the State forests, protected as nature reserves; more resilient land systems with greater carrying capacity for outdoor recreation (includes the areas most preferred by tourists from the accommodation centres) <u>Uses</u> Topography is well suited for walks, fishing and activities related to rivers in the broad valleys; new accommodation should be of a rustic nature catering for walkers or riders; no new roads to be constructed for public access; present roads must not be upgraded to urban standards
(ii) <u>Drakensberg Threshold Zone</u> Mostly in private ownership except for a few major valleys in the State forests; where present in State land, to be protected as nature reserves (the only valleys so protected); most resilient landscapes with high capacity for intensive use <u>Uses</u> In privately owned areas hotels and all other forms of accommodation integrated with agriculture, sufficiently close to the mountains to enjoy magnificent Berg views, with easy access to the State forests; the type of recreation facilities must be in keeping with the environment

Source: After Phelan (1976, quoted in) Bainbridge, W.R., 1982. The Drakensberg State forests - a case study of land use zoning and management, Proceedings of the Jubilee Symposia, 23 - 24 September 1982, VOL 2, Communication No. 98, Faculty of Forestry, University of Stellenbosch, Stellenbosch, p. 466 - 496*.

See also:

(i) Martin, B.F., 1990. Drakensberg Approaches policy, Natal Town and Regional Planning Commission Report, VOL 74, Pietermaritzburg, 70 p.

(ii) Blignaut, P.E., 1988. Mountain land use zoning: proposals to create an effective mechanism for the conservation, use and management of the mountains of South Africa, Town and Regional Planning, No. 25, September 1988, p. 39 - 42. See also, Blignaut, P.E., 1989. The Mountain Club of South Africa (Central Committee) submission to the Council for the Environment on land use zoning proposals to create an effective mechanism for the conservation, use and management of the mountains of South Africa, In: Mountain Areas Workshop on a National Policy and Strategy for the Conservation and Utilization of Mountain Areas in South Africa, Committee for Terrestrial and Fresh Water Systems, Council for the Environment, 6 - 8 March 1989, Franschhoek, p. 1 - 19. (The paper is an expanded version of Blignaut (1988 - above) and contains a more detailed background discussion. Both papers refer mainly to the Cape Province). See in addition: Blignaut, P.E., 1992. Towards a zoning policy for the conservation and sustainable utilization of the mountain environments of South Africa, Ph.D. Thesis, Department of Environmental and Geographical Science, University of Cape Town, Rondebosch, 586 p. + app. and maps. The following should also be examined: Rabie, M.A., Blignaut, P.E. and Fatti, L.P., 1992. Chapter 24. Mountains, In: Fuggle, R.F. and Rabie, M.A. (eds), Environmental Management in South Africa, Juta, Cape Town, p. 624 - 646.

(iii) King, L.C., 1944. Geomorphology of the Natal Drakensberg, Transactions of the Geological Society of South Africa, VOL 47, p. 255 - 282.

Note:

(i) In terms of the guidelines, the Drakensberg is divided into four zones based on physiographic features. The zones run approximately parallel with the main escarpment.

(ii) The Drakensberg Catchment Area (the largest single composite conservation area in Natal/KwaZulu) is separated from the Drakensberg Catchment Buffer Zone, by the Natural Physiographic Catchment Boundary (the base of the Landslide Zone - separating the steep mountainous areas from the flatter more undulating valleys), which in turn, defines the eastern (lower altitude) boundary of the

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* See Phelan, A.J., 1976. Drakensberg policy statement, Natal Town and Regional Planning Commission Report, VOL 34, Pietermaritzburg, 21 p.

Drakensberg Catchment Area. All land in the Drakensberg Catchment Area is managed primarily for water production.

(iii) The Wilderness Heart Zone in the Inner (High) Berg should not be confused with declared wilderness areas (discussed later in the chapter), forming part of State forests. Such wilderness areas may extend from the Wilderness Heart Zone down into the Trail Zone and even into the (lower-lying) Drakensberg Threshold Zone.

(iv) The Drakensberg zoning guidelines as outlined above, were extended to include the East Griqualand part of the Natal Drakensberg, where dolerite intrusions (in the virtual absence of basalt), have appreciably altered the topography to form separate hills and mountains in certain areas. Accordingly, the Natural Physiographic Catchment Boundary is not always as clearly defined as in the northern part of the Drakensberg. In addition, there are no high basaltic cliffs and it is not as difficult to reach parts of the High Berg, as is the case in the northern Drakensberg. Given that the southern Drakensberg differs considerably from the rest of the Drakensberg, the proposals by Phelan (1976 - above), were applied with slight modifications. The respective zones in the southern Drakensberg are the Wild Area and the Landslide Zone in the Drakensberg Catchment Area, plus the Trail Zone, and the Drakensberg Threshold Zone. A Wild Area is designated (in place of a Wilderness Heart Zone), since the remoteness, solitude and absence of any form of development is not so evident in the southern Drakensberg. See Little, A.M. and Taylor, W.M., 1981. Southern Drakensberg policy statement, Natal Town and Regional Planning Commission Report, VOL46, Pietermaritzburg, 16 p.

slopes at high altitudes, which combined with soil disturbance due to overstocking, results in erosion and the deposition of sediment in the Woodstock Dam*.

Granger (1993)** compared the condition of vegetal cover in State forests (including grasslands), with the adjoining areas in the Upper Tugela Location. Granger found a marked deterioration in canopy cover due to uncontrolled livestock grazing in the Sub-alpine and Montane grasslands, as well as a significant change in species composition, both in the KwaZulu area. Moderately palatable species in the KwaZulu area such as Themeda triandra, are being replaced by highly competitive and unpalatable species, due to excessive and selective defoliation by livestock. A further issue, as shown by work at the CSIR Cathedral Peak Forestry Research Station, involves water consumption by exotic plantations which use considerably more water than the natural grasslands of the Drakensberg. The specific use of fire as a management tool (while widely accepted), is also subject to a degree of controversy in terms of season of burning and the frequency (from one vegetation type to another), with additional research required***. In essence, management of the Drakensberg involves concern for the area as a primary watershed, as a protected natural zone and as a recreation area, as well as an important forestry region - where the aim is to produce a sustained yield of forest products at some near-optimum level (Bainbridge, 1982 - above). It must be acknowledged that the present state of conservation of the Natal Drakensberg is the result of years of research in many disciplines, as well as active veld and soil conservation measures undertaken inter alia by

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* See Mas[s]on, J.P., 1991. The Amangewane Tribal Ward: Okhahlamba Magisterial District - an environmental assessment, KwaZulu Bureau of Natural Resources, Pietermaritzburg, 61 p., as well as Masson, J.P., 1992. An assessment of RSA reserved indigenous forests within KwaZulu for proclamation purposes (in terms of the 1936 Native Trust and Land Act), Okhahlamba District, Amazizi Ward (Bergville District as given in Government Gazette, 30th June 1950, No. 1489), KwaZulu Bureau of Natural Resources, Pietermaritzburg, 9 p. + app. For an alternative (and rather interesting) perspective on the environmental problems of the Drakensberg Catchment Area, see: McIntosh, A., 1994. Reforming local administration in South Africa's rural areas: lessons from the Upper Tugela catchment experience, Development Southern Africa, VOL 11(3), p. 395 - 408.

** Granger, J.E., 1993. Personal communication, Department of Botany, University of Natal, Pietermaritzburg.

*** See Everson, C.S., 1985. Ecological effects of fire in the Montane grasslands of Natal, Ph.D. Thesis, Department of Grassland Science, University of Natal, Pietermaritzburg, 236 p., and Granger, J.E., 1976. The vegetation changes, some related factors and changes in the water balance following 20 years of fire exclusion in catchment IX; Cathedral Peak Forestry Research Station, Ph.D. Thesis, Department of Botany, University of Natal, Pietermaritzburg, 612 p., as well as Garland, G.G., 1987. Erosion risk from footpaths and vegetation burning in the central Drakensberg, Natal Town and Regional Planning Commission Supplementary Report, VOL 20, Pietermaritzburg, 74 p. and map.

the Department of Agriculture. (See the section on soil erosion and veld management in the bibliographic database).

As defined by Van der Zel (1981 - above), the term "mountain catchment" also refers to other high lying land, not necessarily viewed as a "mountain". This would include parts of the Natal Midlands, where Van der Zel (1982)* identified some 7 997 km^2 of land with a mean annual runoff of 1 362 x $10^6 m^3$, as mountain catchment systems. It should be noted that the catchment areas per se for example, of both the Mgeni and the Mvoti rivers (which rise in the Natal Midlands), have no overall controlling legislation for their protection as a catchment unit. A worthwhile research project would involve the examination of the catchment areas of the 71 main rivers in Natal/KwaZulu to determine present conditions - and the effectiveness of conservation legislation and practices (if applied at all).

Additional categories of land in Natal, such as biospheres and to a certain extent conservancies (some situated in the Little Berg), also have elements of "mountain" catchment conservation as part of their overall management objectives. To assist the reader, the various categories of conserved land in Natal and KwaZulu are outlined later in the chapter.

6.5.3 Other catchments

Much of the bibliographic database and the present publication concerns Integrated Catchment Management**. Accordingly, the various aspects of management such as

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* See Van der Zel, D.W., 1982. Mountain catchment management decision making: a forestry planner's view, Proceedings of the Jubilee Symposia, 23 - 24 September 1982, VOL 2, Communication No. 98, Faculty of Forestry, University of Stellenbosch, Stellenbosch, p. 413 - 426.

** See Stewart, T.J., Scott, L. and Iloni, K., 1993. Scenario based multicriteria policy planning for water management in South Africa, WRC Report No. 296/1/93, Water Research Commission, Pretoria, 59 p. + app. See also, Braune, E., 1986. Catchment management: overseas practices and South African perspectives, In: Schulze, R.E. (ed), Proceedings of the Second South African National Hydrology Symposium, South African National Committee for the International Association of Hydrological Sciences and the Department of Agricultural Engineering, University of Natal, Pietermaritzburg, 16 - 18 September 1985, ACRU Report No. 22, Agricultural Catchments Research Unit, Department of Agricultural Engineering, University of Natal, Pietermaritzburg, p. 8 - 38., as well as Braune, E., Gerber, F.A., Schulz, C.B., Forster, S.F., Looser, U., Maaren, H., Craddock, S.A., Howman, A.H., Stickler, G.J. and Carter, J., 1985. Integrated catchment management: guidelines and recommendations based on a pilot study in the Upper Mooi and Mgeni catchments, Hydrological Research Institute, Department of Water Affairs, Pretoria, 189 p.

the extent and distribution of water resources; fire control; afforestation; water quality; soils and soil erosion; demographic pressures and the administrative and legal framework, form integral components of catchment control. The different sections of the source book therefore, should be viewed inter alia from a catchment management perspective. Lake St Lucia represents an important catchment focus which is dealt with via several reports listed in the bibliographic database*. Other catchment management issues in Natal/KwaZulu (see the database) involve flood damage and the reasons for such damage - including catchment degradation - on the Mfolozi Flats; the impact of the Pongolapoort (Jozini) Dam on the Pongola Floodplain and the Thonga people; the deterioration of wetlands plus "estuaries", and coastal zone management in general. An important catchment management modelling study of the Mgeni River was undertaken by Tarboton and Schulze (1992)** as part of an on-going research programme. The Mgeni catchment comprises the economic core of Natal/KwaZulu, and numerous management as well as planning data are required for the optimum control of water resources in the future. (See the chapter on water quality). The next part of this chapter examines commercial afforestation in the province and various control measures aimed at catchment management.

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* A very brief and general overview of some of the catchment management problems relating to St Lucia can be found in Wright, I., 1993. St Lucia: an embattled estuary, African Wildlife, VOL 47(6), p. 259 - 262.

** See Tarboton, K.C. and Schulze, R.E., 1992. Distributed hydrological modelling system for the Mgeni catchment, WRC Report No. 234/1/92, Water Research Commission, Pretoria, 111 p., as well as Tarboton, K.C., 1992. Interfacing GIS and hydrological modelling: Mgeni case study, Water SA, VOL 18(4), p. 273 - 278.

6.6 Forestry in Natal/KwaZulu

6.6.1 Commercial afforestation potential in Natal/KwaZulu*

The future potential for commercial afforestation namely, hardwoods (Eucalypts, gums and wattles) and softwoods (pines) in Natal (estimated in 1978), was 146 300 ha in northern Natal; of which 81 800 ha was readily available good land, with 64 500 ha of readily available marginal land (Van der Zel, 1989). A total of 239 700 ha was available for afforestation in the rest of Natal, of which 155 000 ha was readily available good land. In East Griqualand, a total of 70 000 ha was available, of which 50 000 ha was considered readily available good land. A total area of 450 200 ha was tentatively identified as potentially available in KwaZulu, of which 178 000 ha was considered to be good land for afforestation (both high estimates).

Potentially good forestry land was defined as areas with a mean annual rainfall of more than 750 mm, and with other climatic and pedological conditions similar to sites presently afforested (bioclimatic groups 1, 2, 3 and 4). Potentially marginal forestry land was defined as areas which either because of a mean annual rainfall of less than 750 mm, or because of poor soil conditions, were expected to yield sub-economic returns (bioclimatic group 6). (A mean annual rainfall of 850 mm is widely cited in the literature as the minimum necessary for commercial afforestation).

Thirteen priority catchments in South Africa were identified for future commercial forestry expansion. In Natal/KwaZulu these catchments were the Pongola/Umfolozi/Umhlatuze catchments; the Tugela Basin; the Natal Midlands plus coastal Natal catchments, and the Umkomaas/Umzimkulu catchments. The relevant data are presented in Table F9.

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* Discussion based on Van der Zel, D.W., 1989. Strategic forestry development plan for South Africa: an evaluation of past influences, an analysis of the present forestry sector and a plan for projected development of the forest industry, Directorate of National Forestry Planning and Extension, Department of Environment Affairs, Pretoria, 215 p. + app. (The publication contains a 1 : 2 500 000 scale map entitled, Priority areas for new afforestation and a 1 : 2 000 000 scale map entitled, Forest areas of southern Africa (commercial and indigenous), as well as maps showing each of the 13 priority catchments identified as future areas for the expansion of forestry in South Africa). See also, Schönau, A.P.G. and Schulze, R.E., 1984. Climatic and altitudinal criteria for commercial afforestation with special reference to Natal, South African Forestry Journal, No. 130, September 1984, p. 10 - 18., as well as Richardson, D.M. and McMahon, J.P., 1992. A bioclimatic analysis of *Eucalyptus nitens* to identify potential planting regions in southern Africa, South African Journal of Science, VOL 88(7), p. 380 - 387. See in addition, Smith, J.M.B., 1994. Crop, pasture and timber yield estimate index, Cedara Report No. N/A/94/4, Cedara Agricultural Development Institute, KwaZulu-Natal Department of Agriculture, Cedara, 82 p.

Table F9: **Some catchment afforestation data for Natal/KwaZulu.**

Catchment	Area (ha)
Pongola/Umfolozi/Umhlatuze catchments (Mean annual rainfall of 800 - 1 600 mm)	
Global catchment area	3 138 500
Present afforested area	167 000
Allowable afforestation permit area	418 075
Afforestation permit area issued to-date	91 084
Potentially good forestry land area	136 800
Potentially marginal forestry land area	96 200
Estimated biological forestry potential	179 000
Tugela Basin (Mean annual rainfall of 600 - 800 mm)	
Global catchment area	2 910 000
Present afforested area	10 600
Allowable afforestation permit area	354 531
Afforestation permit area issued to-date	10 000
Potentially good forestry land area	178 000
Potentially marginal forestry land area	251 500
Estimated biological forestry potential	115 000
Natal Midlands and coastal Natal catchments (Mean annual rainfall of 900 mm)	
Global catchment area	1 157 400
Present afforested area	154 100
Allowable afforestation permit area	141 427
Afforestation permit area issued to-date	47 600
Potentially good forestry land area	105 000
Potentially marginal forestry land area	45 000
Estimated biological forestry potential	160 000
Umkomaas/Umzimkulu catchments (Mean annual rainfall of 950 mm)	
Global catchment area	1 177 300
Present afforested area	94 000
Allowable afforestation permit area	86 000

Table F9: Some catchment afforestation data for Natal/KwaZulu (continued).

Catchment	Area (ha)
Afforestation permit area issued to-date	48 500
Potentially good forestry land area	65 000
Potentially marginal forestry land area	35 000
Estimated biological forestry potential	55 000
Umzimvubu/Bashee (Transkei) catchments (Mean annual rainfall of 900 mm) Global catchment area	3 100 000
Present afforested area	48 000
Allowable afforestation permit area	-
Afforestation permit area issued to-date	-
Potentially good forestry land area	240 000
Potentially marginal forestry land area	350 500
Estimated biological forestry potential	85 000

Source: After Van der Zel, D.W., 1989. Strategic forestry development plan for South Africa: an evaluation of past influences, an analysis of the present forestry sector and a plan for projected development of the forest industry, Directorate of National Forestry Planning and Extension, Department of Environment Affairs, Pretoria, 215 p. + app.

See also:

(i) Anonymous, 1986. Management of the Water Resources of the Republic of South Africa, Department of Water Affairs, Pretoria, various pages.

(ii) Phillips, J., 1973. The agricultural and related development of the Tugela Basin and its influent surrounds: a study in subtropical Africa, Natal Town and Regional Planning Commission Report, VOL 19, Pietermaritzburg, 299 p. and maps.

(iii) Schönau, A.P.G. and Fitzpatrick, R.W., 1981. A tentative evaluation of soil types for commercial afforestation in the Transvaal and Natal, South African Forestry Journal, No. 116, March 1981, p. 28 - 39. (See relevant map).

(iv) Schulze, R.E., 1982. Agrohydrology and climatology of Natal, ACRU Report No. 14, Agricultural Catchments Research Unit, Department of Agricultural Engineering, University of Natal, Pietermaritzburg, 136 p. (See relevant maps).

Note: (i) The northern Transkei data include some afforestation areas in Natal/KwaZulu and such data are therefore presented in the table. It is important to bear in mind that the areas listed above are **estimates of land which could be planted.** Numerous factors including market conditions will determine the actual areas planted. Estimates of the potential area which could be planted are varied. Le Roux (1990)* for instance, referred to a potential area of 1 056 000 ha for Natal/KwaZulu (constituting 44% of the total area available in South Africa). Approximately 800 000 ha are in Natal *per se* with some 256 000 ha in KwaZulu *per se*.

(ii) The classes VH (very high) and H (high) suitabilities of Schönau and Fitzpatrick (1981 - above) can be compared with Van der Zel's (1989 - above) potentially good land category, while the Schönau and Fitzpatrick M (moderate) and L (low) zones can be compared with the Van der Zel category of potentially marginal land. The optimum commercial plantation areas put forward by Schulze (1982 - above), can be compared with the potentially good land category of Van der Zel, while Schulze's other classes can be compared with the potentially marginal land category of Van der Zel.

(iii) The total (presently planted) commercial forestry area in Natal/KwaZulu, was estimated by the Forestry Council (1993), to be of the order of 525 463 ha. According to the KwaZulu Department of Agriculture and Forestry, there are nine major commercial plantations in KwaZulu. These plantations are mainly pine with some gum species, and cover an area of 23 000 ha. The Department regards a further 4 000 ha in KwaZulu as highly suitable for commercial afforestation.

(iv) The following (envisaged) time scales for afforestation were provided by Van der Zel (1989 - above):

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* See Le Roux, S.D., 1990. Impact of afforestation on the agricultural resources of Natal, Cedara Report No. N/A/90/16, Department of Agricultural Development (Natal Region), Cedara, 8 p.

Catchment	Time period and area (ha)		
	1990 - 1999	2000 - 2009	2010 - 2019
Pongola/Umfolozi/Umhlatuze catchments			
Scenario 1: historical trend	40 000	45 000	55 000
Scenario 2: optimum development	50 000	45 000	40 000
Tugela Basin			
Scenario 1: historical trend	10 000	20 000	35 000
Scenario 2: optimum development	30 000	25 000	25 000
Natal Midlands and coastal Natal catchments			
Scenario 1: historical trend	30 000	40 000	50 000
Scenario 2: optimum development	65 000	60 000	65 000
Umkomaas/Umzimkulu catchments			
Scenario 1: historical trend	20 000	25 000	30 000
Scenario 2: optimum development	40 000	30 000	30 000

6.6.2 Impacts of commercial afforestation

The impacts on former agricultural areas planted to commercial timber species are varied. Impacts may include altered water balances; the removal of indigenous patches of forest and grassland; the dangers of forest fires; soil acidification, and the destruction of existing ecosystems including springs and wetlands - resulting in the loss of animal and plant species and possibly even extinction of some species. Other effects could include soil erosion from firebreaks and poorly planned forest roads plus rural depopulation*. Aesthetic considerations are likewise of importance (the "green desert" syndrome). A somewhat alternative argument could also apply, namely, the environmental consequences of <u>not</u> planting small subsistence or commercial woodlots in developing rural (and peri-

* A useful case study is the following: Mander, J.J., 1991. Environmental evaluation of the proposed commercial afforestation in the Mbazwana area, VOL 1 - Main report, INR Investigational Report No. 53, Institute of Natural Resources, University of Natal, Pietermaritzburg, 86 p. + app. See also, Mander, J.J., A'Bear, D., Schulze, R.E., Kienzle, S.W., Butler-Adam, J., Quinlan, T. and Zingel, J., 1991. Environmental evaluation of the proposed commercial afforestation in the Mbazwana area, VOL 2 - Supplementary report, INR Investigational Report No. 53, Institute of Natural Resources, University of Natal, Pietermaritzburg, various pages.

urban) areas. Woodlots may well be necessary to avoid problems such as veld degradation and soil erosion in view of the high demand for firewood, as the main source of fuel in rural South Africa*.

An increasing environmental awareness is now being shown by commercial forestry companies. Several firms have produced environmental guidelines (see later in the chapter). With reference to the Van der Zel (1989) afforestation proposals, Porter (1990 - see below) observed that at least seven of the 18 veld types in Natal would be negatively affected (to a greater or lesser extent) (Table F10). The conservation status of various types of indigenous forests in Natal/KwaZulu is outlined in Table F11.

While the commercial forestry industry has been attacked for the negative impacts of afforestation on the landscape, including "excessive" water consumption, it is also true that similar arguments could be advanced for the sugar or maize/wheat industry as well. (See the chapter on soils and soil erosion). It is possible (although not proven) that the sugar industry has given greater attention to environmental degradation, and has been more successful - or is perceived to have been more effective - in addressing these issues.

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* Policy as well as practical issues concerning rural woodlots (social forestry/agroforestry), have been investigated inter alia by the Land and Agriculture Policy Centre, P O Box 243, Wits, 2050; the Chief Directorate: Transport, Energy and Energy for Development, Department of Mineral and Energy Affairs, Private Bag X03, Lynnwood Ridge, 0040; the Department of Water Affairs and Forestry, Private Bag X313, Pretoria, 0001, and by Progreen (Trees for Africa), P O Box 2035, Gallo Manor, 2052. The latter programme is known as Plant for Life or the Biomass Initiative - see Footnote (i) of Table F25, later in the chapter.

Table F10: Veld types (Acocks, 1975) which would be affected by future afforestation and their present nature conservation status in Natal, 1990.

Threatened veld type	Percentage in Natal	Total area in South Africa (km^2)	Total area conserved		
			Natal (km^2)	Natal Parks Board protected areas (km^2 and percentage)	
Natal Mistbelt Ngongoni Veld	100	3 694	3 694	16,7	0,45
Ngongoni Veld	76	11 130	8 481	7,0	0,08
Coastal Forest and Thornveld	75	20 088	14 984	1 085,0	7,24
Highveld Sourveld	33	39 535	12 986	895,6	6,89
Piet Retief Sourveld	19	7 594	1 457	8,6	0,59
North-eastern Sandy Highveld	8	14 678	1 145	4,0	0,35
North-eastern Mountain Sourveld	6	9 541	624	11,4	1,82

<u>Source</u>: After Porter, R.N., 1990. Future afforestation and the potential impacts on nature conservation in Natal, In: Erskine, J.M. (ed), The Physical, Social and Economic Impacts of Large-scale Afforestation in Natal/KwaZulu: Proceedings of the Forestry Impacts Workshop held at the Sinodale Centre, Pietermaritzburg, 8 May 1990, INR Occasional Publication No. 40, Institute of Natural Resources, University of Natal, Pietermaritzburg, p. 29 - 46.

<u>See also</u>:

(i) Brett, M.R., 1984. A revision of the adequacy of conserved areas in relation to veld types, Department of Geography, University of Natal, Pietermaritzburg, 51 p.

(ii) De Villiers, L., 1989. Afforestation in the Elands River catchment: a preliminary environmental assessment, INR Working Paper No. 43, Institute of Natural Resources, University of Natal, Pietermaritzburg, 36 p.

(iii) Le Roux, S.D., 1990. Impact of afforestation on the agricultural resources of Natal, Cedara Report No. N/A/90/16, Department of Agricultural Development (Natal Region), Cedara, 8 p.

(iv) Little, T. and Hornby, D., 1994. Socio economic effects of changes in land use resulting from afforestation initiatives: to identify and explore the major issues in the light of the Reconstruction and Development Programme - report on proceedings of a workshop held in Durban, 16 August 1994, INR Occasional Paper No. 146, Institute of Natural Resources, University of Natal, Pietermaritzburg, 33 p.

Note: (i) Several other papers dealing with the impacts of afforestation can be found in Erskine (1990 - above).

(ii) Various important (source) texts (including Acocks, 1975, re-issued in 1988) are listed later in this chapter.

Table F11: Conservation status of indigenous forests in Natal/KwaZulu (forests >50 ha).

Forest type	Total area (ha)	Area conserved (ha)	Percentage conserved
Montane Podocarpus forest	9 273	3 817	41,2
Mistbelt mixed Podocarpus forest	30 868	16 295	52,8
Dune forest	14 491	13 611	93,9
Swamp forest	4 843	4 683	96,7
Riverine forest	1 887	1 707	90,5
Sand forest	5 986	5 946	99,3
Coast Scarp forest	15 076	13 304	88,2
Coast Lowlands forest	8 777	6 096	69,5
Total (1,05% of Natal/KwaZulu)	91 201	65 459	71,8

Source: (i) After Bartholomew, R.L.C., 1989. The conservation status of Natal forests, In: Gordon, I.G. (ed), Natal Indigenous Forests: a Preliminary Collection of Reports on Indigenous Forests in Natal, Natal Parks Board, Pietermaritzburg, p. 153 - 159.

(ii) After Cooper, K.H., 1985. The conservation status of indigenous forests in Transvaal, Natal and O.F.S., South Africa, Conservation Division, Wildlife Society of South Africa, Durban, 108 p. and map. (The publication contains a map entitled, Indigenous Evergreen forests of South Africa: Sheet 1, compiled by K.H. Cooper and the Forest Biome Working Group, National Programme for Environmental Sciences).

See also: (i) Edwards, D., 1974. Survey to determine the adequacy of existing conserved areas in relation to vegetation types: a preliminary report, Koedoe, No. 17, p. 3 - 38.

(ii) Geldenhuys, C.J., 1991. Inventory of indigenous forest and woodland in southern Africa, South African Forestry Journal, No. 158, September 1991, p. 83 - 94.

(iii) Geldenhuys, C.J. and MacDevette, D.R., 1989. Chapter 14. Conservation status of Coastal and Montane Evergreen forest, In: Huntley, B.J. (ed), Biotic Diversity in Southern Africa: Concepts and Conservation, Oxford University Press, Cape Town, p. 224 - 238.

(iv) Moll, E.J., 1972. The current status of Mistbelt mixed Podocarpus forest in Natal, Bothalia, VOL 10(4), p. 595 - 598.

(v) Scheepers, J.C., 1983. The present status of vegetation conservation in South Africa, Bothalia, VOL 14(3/4), p. 991 - 995.

(vi) Wager, V.A., 1976. Dwindling forests of the Natal Coast, Wildlife Society of Southern Africa (Natal Branch), Durban, 36 p.

Note:

(i) The area for Sand forest is an underestimate (Cooper, K.H., 1993. Personal communication, Natal Branch of the Wildlife Society of Southern Africa, Durban).

(ii) The area for Riverine forest does not reflect the loss of forest caused by the September 1987 floods in Natal/KwaZulu (Cooper, 1993).

(iii) Some 500 ha of the Coast Lowlands forest has been lost due to damage caused by squatters in the Dukuduku State Forest (Cooper, 1993). The Dukuduku Forest is the largest Coast Lowlands forest in South Africa.

(iv) There is a difference of opinion in terms of areas of specific forests with reference to Bartholomew (1989 - above), and Geldenhuys and MacDevette (1989 - above).

(v) Bartholomew (1989) believed that a figure of 71,8% of forests under conservation was a high estimate and that a figure of 61% could also be regarded as optimistic.

(vi) Riverine forest, followed by Swamp forest and Sand forest are the rarest types of forest in Natal/KwaZulu. For an overview of Swamp forests in Natal/KwaZulu see, Wessels, N., 1991. The Swamp forests of Lake St Lucia, African Wildlife, VOL 45(5), p. 256 - 263. The figure for Swamp forest in KwaZulu (82,3% see below) - and accordingly the overall percentage of Swamp forest conserved - is an overestimate given considerable disturbance of such forest in the Kosi Bay area of KwaZulu*. Swamp forests which typically occur in hyposaline (freshwater) drainage lines and in marshy areas around

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* Problems are also being experienced in the environs of Sodwana Bay. For a brief discussion, see: Marneweck, G. and Van der Walt, R., 1996. Rare hardwood Swamp forests destroyed, South African Wetlands, No. 7, November 1996, p. 8 - 9. Swamp forests however, have expanded in a few areas, for example, on the Mfolozi Floodplain. The Swamp forest component in this area increased from some 16 ha in 1937, to 516 ha in 1996. Reasons include the accumulation of sediment as a result of catchment degradation and the prolonged absence of fire (Van der Walt, R., 1996. Personal communication, Department of Environmental Affairs and Tourism, Pretoria).

freshwater lakes must not be confused with mangrove swamps, which are associated with salt water.

(vii) The approximate distribution of the 31 698 ha of indigenous forest types in KwaZulu (according to Cooper, 1985 - above) is as follows - in the same order as the main table.

Forest type	Area (ha)	Percentage
Montane Podocarpus forest	302	3,3
Mistbelt mixed Podocarpus forest	7 422	24,0
Dune forest	5 746	39,7
Swamp forest	3 985	82,3
Riverine forest	140	7,4
Sand forest	4 583	76,6
Coast Scarp forest	8 931	59,2
Coast Lowlands forest	589	6,7

6.6.3 The afforestation permit system in South Africa*

All proposals for the planting of new commercial forests or for the considerable expansion of existing forests must be examined by the Central Committee for the Allocation of Afforestation Permits - of the Department of Water Affairs and Forestry - in terms of a permit system**. The permit system operates by virtue of the (previous) Forest Amendment Act No. 46 of 1972, and subsequently the Forest Act No. 122 of 1984. South Africa has been divided on a catchment basis into three forestry permit areas namely, Category I, II and III catchments. Catchments are classified according to the national and regional importance of the river concerned in terms of water. The purpose of the permit system is to regulate the consumption of water by forests through depletion of runoff, which may adversely affect users downstream. For example, in grassland areas with a mean annual precipitation of 1 000 mm and a mean annual runoff of approximately 200 mm, commercial afforestation could reduce the runoff by some 100 mm or

* Discussion based on Anonymous, 1986. Management of the Water Resources of the Republic of South Africa, Department of Water Affairs, Pretoria, various pages.

** The Committee usually decides on applications in consultation with the Department of Agriculture.

1 000 m^3 ha^{-1} y^{-1}. The establishment of six hectares under timber therefore, would reduce the runoff to an equivalent amount of water required for one hectare of wheat under irrigation (Le Roux, 1990 - see Table F10)*.

In Category I catchments, no new commercial afforestation has been permitted since 1972 and is unlikely to be allowed in the future. Water in these areas was already scarce in 1972 and is needed for higher priorities such as domestic and industrial use, extant irrigation, and for power generation. No Category I catchments are found in Natal/KwaZulu. Category II catchments are those in which competing water demands limit new afforestation to an area which will not reduce the catchment's mean annual runoff (as determined in June 1972), by more than 5%. Only two Category II catchments are found in Natal/KwaZulu (Table F12). Category III catchments include the rest of South Africa, where an afforestation area consuming only up to an additional 10% of the mean annual runoff of the catchment as measured in June 1972, is permitted. In order to meet the 10% limit, the area planted to timber in any catchment should not exceed approximately 16% of the catchment (depending on vegetation in the catchment) (Le Roux, 1990). At present only water conservation, mean annual runoff and large catchments are the parameters involved for the issuing of afforestation permits.

The quota system is aimed at reducing the effect that afforestation will have on the total volume of water flowing from a catchment. The system however, does not address the real problem, namely, the reduction in base flow during winter or dry periods. Furthermore, the present system allows for a procedure where the total of all the permissible afforestation area could be concentrated in one portion of a catchment - resulting in the entire afforestation of one (or more) sub-catchments. Such a concentration would seriously affect the water resources of users immediately downstream (Le Roux, 1990). After several years, the system was updated by introducing a new field manual and a revised assessment method. The system is again being reviewed, and the subdivision of catchments on the basis of quaternary sub-catchments has been accepted,

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* Earlier estimates of the water consumed by commercial plantations were based on the so-called "Nänni curves", derived from work undertaken in the Cathedral Peak catchments of the Natal Drakensberg. Models more recently developed such as the Agricultural Catchments Research Unit (ACRU) procedure, take account of numerous factors such as the effects of various tree species (including the different rooting systems), the age of the trees, site preparation methods and land use changes. An important research focus - with regard to the afforestation permit system - is the influence of age class distribution on water use. A significant reduction in peak consumption is likely if trees are planted at different times in a particular area.

Table F12: Afforestation permits allocated from June 1972 - October 1986 in relation to the area planted before June 1972 and to the biological potential after 1975 - with reference to Natal/KwaZulu.

Catchment (secondary drainage region)	Description and area allocated (ha)	Planted area in March 1975 (ha)	Total area allocated after 1972 (ha)	Catchment category	Permit maximum (in addition to area planted) (ha)	Biological potential (ha)
W10 - W70 (W50 part)	Matigulu (1 076); Mhlatuze (17 932); Mkukuze (68); White Mfolozi (14 734); Black Mfolozi (5 557); Mfolozi (2 258); Mkuzi (St Lucia) (6 140); Bivane up to Pongola (2 695); Pongola up to and including Spekboom (11 984); Assegaai above Heyshope Dam (3 127); Assegaai below dam (14 121); Hlelo above proposed Ishlelo Dam (8 505); Hlelo below dam (200); Usuthu below Westoe Dam (2 208); Bonnie Brook up to Usuthu (1 093); Umpuluzi below proposed Busby Dam (12 200); Lake Chrissie and pans (532), Metula (310) and Little Usuthu (2 848)	307 609	107 520	III	447 167	280 000
V10 (part) V70	Tugela below Colenso (348); Mooi River tributary above Craigieburn Dam (1 968); rest of Mooi (2 301); Buffalo up to Tugela (55); Tugela (411); Tugela and Mpisi (438); Sundays and Nadi (624) and Tugela (Estcourt) (3)	18 308	6 148	III	312 670	90 000
V10 (part)	Tugela above Colenso	423	182	II	41 951	25 000

Table F12: Afforestation permits allocated from June 1972 - October 1986 in relation to the area planted before June 1972 and to the biological potential after 1975 - with reference to Natal/KwaZulu (continued).

Catchment (secondary drainage region)	Description and area allocated (ha)	Planted area in March 1975 (ha)	Total area allocated after 1972 (ha)	Catchment category	Permit maximum (in addition to area planted) (ha)	Biological potential (ha)
U10, U30 U50, U70 U80	Mkomanzi above proposed Mpendle Dam (1 751); Mkomanzi below proposed dam (18 396); coastal rivers between Mgeni and Mvoti (220); coastal rivers between Mvoti and Tugela (40); Illovo above Richmond (854); Illovo below Richmond (5 523); coastal rivers between Umzimkulu and Mkomanzi (4 703)	74 764	31 487	III	166 852	100 000
U20, U40 U60	Mgeni between Midmar and Albert Falls dams (6 031); Mgeni above Midmar (7 439); Mgeni below Albert Falls (2 852); Mvoti above Umvoti Poort (7 952); Mvoti below Umvoti Poort (3 994); Mlazi above Umlaas Poort (5 587) and Mlazi below Umlaas Poort (248)	118 432	34 103	II	81 147	80 000
T10 - T90	Umzimvubu (1 054); Umtamvuna (1 589) and Umzimkulu (11 840)	47 428	14 483	III	231 238	105 000

Source: After Anonymous, 1986. Management of the Water Resources of the Republic of South Africa, Department of Water Affairs, Pretoria, various pages.

See also: Bosch, J.M. and Von Gadow, K., 1990. Regulating afforestation for water conservation in South Africa, South African Forestry Journal, No. 153, June 1990, p. 41 - 54.

Note: (i) Secondary drainage regions W50 and W60 are not in Natal/KwaZulu. Likewise, only drainage regions T30, T40 and T50 are in Natal/KwaZulu.

(ii) Where the biological potential exceeds the permit maximum area, forestry expansion will be restricted by the afforestation permit system.

(iii) Where the area allowed by the permit system (the permit maximum) is greater than the biological potential, the latter becomes the limiting factor. The lower of these two figures accordingly, indicates the maximum expansion possible in excess of the area under afforestation in 1975.

(iv) Where the maximum afforestation area is reached in Category II catchments, such catchments become Category I catchments.

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with additional parameters under investigation. The Wildlife Society of Southern Africa suggested that there is a need to change the permit system, in order to include the environmental impacts of afforestation in any permit application. Some environmental issues are currently being addressed by virtue of the Environment Conservation Act No. 73 of 1989. In terms of the Act, those wishing to apply for an afforestation permit must first advertize their intentions in two local newspapers, so that any objections may be directed to the Department of Water Affairs and Forestry for further consideration. All adjoining land owners/controllers must be informed by letter of the planned afforestation. The aim of these requirements is to promote public awareness of the proposed changes and to prevent local abuse. An Environmental Impact Assessment (EIA) is now mandatory for all extensive afforestation applications, and is also required where objections are lodged, and are subsequently upheld by the Department. The EIA must be paid for by the applicant.

Where extension of the afforested area is still possible, permits valid for implementation up to five years after allocation are allowed per farm, in order of application. The permit usually limits afforestation to 75% of the area of any property, and prohibits the planting of trees within a specified distance (10 - 100 m) from any perennial stream, spring or wetland (with certain exceptions). The original permit system was not applicable in KwaZulu and similar areas. The revised system however, is enforced throughout South Africa*. The forestry industry is deeply aggrieved at being singled out as "the" main culprit involved in major agricultural land use changes (with subsequent environmental and

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* For a recent overview of the permit system, see: Van der Zel, D.W., 1995. Accomplishments and dynamics of the South African afforestation permit system, South African Forestry Journal, No. 172, March 1995, p. 49 - 58.

water balance implications). The view has been expressed that the apportionment of water between forestry and other bulk water users has been somewhat arbitrary, and that no real effort has been made to base the apportionment of water on sound economic factors (Gardiner, 1994)*. The forestry industry is also the only agricultural sector subject to (water) permit conditions.

<u>For further information consult the following:</u>

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- Anonymous, 1995. Guidelines for environmental conservation management in commercial forests in South Africa, Forestry Industry Environmental Committee, [Forest Owners' Association], Johannesburg, 38 p.

- Bigalke, R.C. (ed), 1990. Guidelines for the application of conservation practices in production forestry, Forestry Council, [Johannesburg], 14 p.

- Poynton, R.J., 1979. Report to the Southern African Regional Commission for the Conservation and Utilization of the Soil (SARCCUS), on tree planting in southern Africa, VOL 1, The pines, 576 p. and map, and VOL 2, The eucalypts, 882 p. and map, Department of Forestry, Pretoria. (The publication provides a useful description of various tree species, with some data on their commercial distribution in southern Africa).

- Ross, J.C., 1961. Report of the Interdepartmental Committee on the Conservation of Mountain Catchments in South Africa, Department of Agricultural Technical Services, Pretoria, 79 p.

- Van der Zel, D.W., 1975. Umgeni River catchment analysis, <u>Water SA</u>, VOL 1(2), p. 70 - 75.

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* Gardiner, P., 1994. Personal communication, Mondi Forests (South), Pietermaritzburg.

- Van der Zel, D.W., 1989. Strategic forestry development plan for South Africa: an evaluation of past influences, an analysis of the present forestry sector and a plan for projected development of the forest industry, Directorate of National Forestry Planning and Extension, Department of Environment Affairs, Pretoria, 215 p. + app.

- Von Gadow, K., Van der Zel, D.W., Van Laar, A., Schönau, A.P.G., Kassier, H.W., Warkotsch, P.W., Vermaas, H.F., Owen, D.L. and Jordaan, J.V. (eds), 1987. South African Forestry Handbook, Southern African Institute of Forestry, Pretoria, 602 p. (The publication is a most valuable source document on scientific and planning aspects of forests and forestry in South Africa).

For further information contact:

- Association of Pulp, Paper and Board Manufacturers of South Africa, P O Box 10606, Marine Parade, 4056.

- Cathedral Peak Forestry Research Station, Private Bag X1, Winterton, 3340.

- Department of Water Affairs and Forestry, Private Bag X313, Pretoria, 0001.

- Faculty of Forestry, University of Stellenbosch, Private Bag X1, Matieland, 7602.

- Forest Owners' Association, P O Box 1553, Rivonia, 2128.

- Forestry Council, c/o Coopers and Lybrand, P O Box 2536, Johannesburg, 2000.

- Institute for Commercial Forestry Research, P O Box 100281, Scottsville, 3209. (The Foresters Association of South Africa is c/o the same address).

- Institute for Plant Conservation, Department of Botany, University of Cape Town, Private Bag, Rondebosch, 7701.

- Jonkershoek Forestry Research Centre, Private Bag X5011, Stellenbosch, 7599.

- KwaZulu Department of Agriculture and Forestry, Private Bag X05, Ulundi, 3838.
- Natal Agricultural Union, P O Box 186, Pietermaritzburg, 3200.
- Saasveld School of Forestry, Private Bag X6531, George, 6530.
- South African Lumber Millers' Association, Private Bag X686, Isando, 1600.
- South African Timber Growers Association, P O Box 803, Pietermaritzburg, 3200.
- South African Wattle Growers Union, P O Box 633, Pietermaritzburg, 3200.
- Southern African Institute of Forestry/South African Forestry Association, P O Box 1022, Pretoria, 0001.
- Timber Trade Federation of Southern Africa, P O Box 2294, Johannesburg, 2000.
- Transkei Department of Agriculture and Forestry, Private Bag X5002, Umtata, 5100.
- Wattle Bark Industry Board, c/o Deloitte and Touche, P O Box 365, Pietermaritzburg, 3200.

6.6.4 Some primary publications on grasslands and forests in southern Africa

- Acocks, J.P.H., 1988. Veld types of South Africa, third edition, Memoir No. 57, Botanical Survey of South Africa, Botanical Research Institute, Department of Agriculture and Water Supply, Pretoria, 146 p. and maps. (A new vegetation map and accompanying description, based on available information, is being prepared by the National Botanical Institute. A revised vegetation map of South Africa however, based on vegetation structure and species composition, was published in 1996. The map with a scale of 1 : 2 000 000 is entitled, Vegetation of South Africa, Lesotho and Swaziland. A report is also available: Low, A.B. and Rebelo, A.G. (eds), 1996. Vegetation of South Africa, Lesotho and Swaziland: a

companion to the vegetation map of South Africa, Lesotho and Swaziland, Department of Environmental Affairs and Tourism, Pretoria, 85 p.).

- Arnold, T.H. and De Wet, B.C. (eds), 1993. Plants of southern Africa: names and distribution, Memoir No. 62, Botanical Survey of South Africa, National Botanical Institute, Pretoria, 825 p.

- Bromilow, C., 1995. Problem Plants of South Africa, Briza Publications, Pretoria, 315 p.

- Camp, K.G.T. and Smith, J.M.B., 1994. Veld management planning in KwaZulu-Natal, Cedara Report No. N/A/94/44, Cedara Agricultural Development Institute, KwaZulu-Natal Department of Agriculture, Cedara, 143 p. (The publication covers a number of topics including farm planning for veld management, the estimation of grazing capacity, veld management principles and veld burning).

- Carr, J.D., 1976. The South African Acacias, Conservation Press, Johannesburg, 323 p.

- Carr, J.D., 1988. Combretaceae in Southern Africa, Tree Society of Southern Africa, Johannesburg, 236 p.

- Chippindall, L.K.A. and Crook, A.O., 1976. 240 Grasses of Southern Africa, VOL 1 - 3, various pages, M.O. Collins, Salisbury.

- Coates Palgrave, K., 1981. Trees of Southern Africa, C. Struik, Cape Town, 959 p.

- Coates Palgrave, K., Coates Palgrave, P. and Coates Palgrave, M., 1985. Everyone's Guide to Trees of South Africa, Central News Agency, Johannesburg, 110 p.

- Cooper, K.H., 1985. The conservation status of indigenous forests in Transvaal, Natal and O.F.S., South Africa, Conservation Division, Wildlife Society of South Africa, Durban, 108 p. and map.

- Davidson, L., 1981. Acacias: a Field Guide to the Identification of the Species of Southern Africa, Centaur, Johannesburg, 121 p.

- De Winter, B., Vahrmeijer, J. and Von Breitenbach, F., 1985. The National List of Trees, second edition revised, J.L. Van Schaik, Pretoria, 266 p.

- Du Toit, P.C.V., 1986. The grassveld types of South Africa: their distribution, characteristics and management, with particular reference to Natal, Cedara Report No. N/A/86/7, Department of Agriculture and Water Supply (Natal Region), Cedara, 21 p. + app.

- Edwards, D., 1967. A plant ecological survey of the Tugela River Basin, Memoir No. 36, Botanical Survey of South Africa, Botanical Research Institute, Department of Agricultural Technical Services, Pretoria/Natal Town and Regional Planning Commission Report, VOL 10, Pietermaritzburg, 285 p.

- Geldenhuys, C.J., 1985. Annotated bibliography of South African indigenous Evergreen forest ecology, South African National Scientific Programmes Report No. 107, Foundation for Research Development, CSIR, Pretoria, 125 p.

- Gibbs Russell, G.E., Reid, C., Van Rooy, J. and Smook, L., 1985. List of species of southern African plants, edition 2: recent literature and synonyms, Part 1: Cryptogams, Gymnosperms, Monocotyledons, Memoir No. 51, Botanical Survey of South Africa, Botanical Research Institute, Department of Agriculture and Water Supply, Pretoria, 152 p.

- Gibbs Russell, G.E. and Staff of the National Herbarium, 1984. List of species of southern African plants, Memoir No. 48, Botanical Survey of South Africa, Botanical Research Institute, Department of Agriculture, Pretoria, 144 p.

- Gibbs Russell, G.E., Watson, L., Koekemoer, M., Smook, L., Barker, N.P., Anderson, H.M. and Dallwitz, M.J., 1990. Grasses of southern Africa: an identification manual with keys, descriptions, distributions, classification and automated identification and information retrieval from computerized data, Memoir

No. 58, Botanical Survey of South Africa, Botanical Research Institute, Department of Agricultural Development, Pretoria, 437 p.

- Gibbs Russell, G.E., Welman, W.G., Retief, E., Immelman, K.L., Germishuizen, G., Pienaar, B.J., Van Wyk, M. and Nicholas, A., 1987. List of species of southern African plants, edition 2: recent literature and synonyms, Part 2: Dicotyledons, Memoir No. 56, Botanical Survey of South Africa, Botanical Research Institute, Department of Agriculture and Water Supply, Pretoria, 270 p.

- Grabandt, K., 1985. Weeds of Crops and Gardens in Southern Africa, Seal Publishing, Johannesburg, 135 p. + app.

- Greyling, T. and Huntley, B.J. (eds), 1984. Directory of southern African conservation areas, South African National Scientific Programmes Report No. 98, Foundation for Research Development, CSIR, Pretoria, 311 p.

- Hall, A.V. (ed), 1984. Conservation of threatened natural habitats, South African National Scientific Programmes Report No. 92, Foundation for Research Development, CSIR, Pretoria, 185 p.

- Henderson, L., 1995. Plant invaders of southern Africa: a field guide to the identification of 161 of the most important and potentially important alien species, Plant Protection Research Institute Handbook No. 5, Plant Protection Research Institute, Agricultural Research Council, Pretoria, 177 p.

- Henderson, M. and Anderson, J.G., 1966. Common weeds in South Africa, Memoir No. 37, Botanical Survey of South Africa, Botanical Research Institute, Department of Agricultural Technical Services, Pretoria, 440 p.

- Henderson, M., Fourie, D.M.C., Wells, M.J. and Henderson, L., 1987. Declared weeds and alien invader plants in South Africa, Bulletin No. 413, Department of Agriculture and Water Supply, Pretoria, 167 p.

- Hilliard, O.M., 1987. Grasses, sedges, restiads and rushes of the Natal Drakensberg, Ukhahlamba Series No. 2, University of Natal Press, Pietermaritzburg, 69 p.

- Hilton-Taylor, C., 1996. Red Data List of Southern African Plants, Strelitzia No. 4, National Botanical Institute, Pretoria, 117 p. (The publication covers South Africa, Botswana, Lesotho and Swaziland. Over 4 100 species are assessed, of which nearly 3 500 are threatened with extinction, or are extinct (58 species)).

- Immelman, W.F.E., Wicht, C.L. and Ackerman, D.P. (eds), 1973. Our Green Heritage: the South African Book of Trees, Tafelberg, Cape Town, 332 p.

- Macdonald, I.A.W. and Jarman, M.L. (eds), 1985. Invasive alien plants in the terrestrial ecosystems of Natal, South Africa, South African National Scientific Programmes Report No. 118, Foundation for Research Development, CSIR, Pretoria, 88 p.

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- Moll, E.J., 1967. Forest Trees of Natal - a Field Guide to 200 Species, Wildlife Protection and Conservation Society of South Africa (Natal Branch), Durban, 180 p.

- Moll, E.J., 1976. The vegetation of the Three Rivers Region, Natal, Natal Town and Regional Planning Commission Report, VOL 33, Pietermaritzburg, 134 p.

- Moll, E.J., 1992. Trees of Natal: a Comprehensive Field Guide to Over Eight Hundred Indigenous and Naturalized Species, Eco-Lab Trust Fund, University of Cape Town, Rondebosch, 542 p.

- O'Connor, T.G., 1985. A synthesis of field experiments concerning the grass layer in the Savanna regions of southern Africa, South African National Scientific

Programmes Report No. 114, Foundation for Research Development, CSIR, Pretoria, 126 p.

- Palmer, E., 1981. A Field Guide to the Trees of Southern Africa, revised edition, Collins, Johannesburg, 393 p.

- Palmer, E. and Pitman, N., 1972 - 1973. Trees of Southern Africa: Covering All Known Indigenous Species in the Republic of South Africa, South-West Africa, Botswana, Lesotho and Swaziland, VOL 1 - 3, 2235 p., A.A. Balkema, Cape Town.

- Pooley, E., 1993. The Complete Field Guide to Trees of Natal, Zululand and Transkei, Natal Flora Publications Trust, Durban, 512 p.

- Ross, J.H., 1972. The acacia species of Natal: an introduction to the indigenous species, revised second edition, Wildlife Protection and Conservation Society of South Africa (Natal Branch), Durban, 64 p.

- Ross, J.H., 1979. A conspectus of the African acacia species, Memoir No. 44, Botanical Survey of South Africa, Botanical Research Institute, Department of Agricultural Technical Services, Pretoria, 155 p.

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- Rutherford, M.C. and Westfall, R.H., 1986. Biomes of southern Africa: an objective categorization, Memoir No. 54, Botanical Survey of South Africa, Botanical Research Institute, Department of Agriculture and Water Supply, Pretoria, 98 p. (A second edition was published in 1994. Maps showing the primary divisions of the various biomes, based on mean annual precipitation, can be obtained from the Range and Forage Institute, Private Bag X05, Lynn East, 0039).

- Schirge, G.U. and Penderis, A.H., 1978. Fire in South African ecosystems: an annotated bibliography, South African National Scientific Programmes Report No. 33, Cooperative Scientific Programmes, CSIR, Pretoria, 114 p.

- Smith, C.A., 1966. Common names of South African plants, Memoir No. 35, Botanical Survey of South Africa, Botanical Research Institute, Department of Agricultural Technical Services, Pretoria, 642 p.

- Steyn, M., 1994. S.A. acacias: identification guide - 40 species, sub-species and varieties, [published by the author], Pietersburg, 31 p.

- Tainton, N.M. (ed), 1981. Veld and Pasture Management in South Africa, Shuter and Shooter and the University of Natal Press, Pietermaritzburg, 481 p.

- Tainton, N.M., 1984. A guide to the literature on research in the grassland biome of South Africa, South African National Scientific Programmes Report No. 96, Foundation for Research Development, CSIR, Pretoria, 77 p. (The publication contains a very useful bibliography).

- Tainton, N.M., Bransby, D.I. and Booysen, P. de V., 1979. Common Veld and Pasture Grasses of Natal, Shuter and Shooter, Pietermaritzburg, 198 p.

- Van Oudtshoorn, F.P., 1992. Guide to Grasses of South Africa, Briza Publikasies, Pretoria, 301 p. (The book is also available in Afrikaans).

- Van Wyk, P., 1993. Southern African Trees: a Photographic Guide, C. Struik, Cape Town, 144 p.

- Venter, F. and Venter, J-A., 1996. Making the Most of Indigenous Trees, Briza Publications, Pretoria, 305 p. (The book describes 137 tree species found in South Africa, Swaziland and Lesotho. The various uses of the trees are also discussed).

- Von Breitenbach, F., 1984. National List of Introduced Trees, Dendrological Foundation, Pretoria, 146 p.

- Von Breitenbach, F. and Von Breitenbach, J., 1986. National List of Indigenous Trees, Dendrological Foundation, Pretoria, 372 p.

- Von Breitenbach, F. and Von Breitenbach, J., 1992. Tree Atlas of Southern Africa: Section 1, Dendrological Foundation, Pretoria, 226 p. (The book is the first volume in a proposed series of 24 volumes, and covers tree ferns, cycads, yellowwoods, Cape cedars and the Wellwitschiaceae).

- Wagner, S. (ed), 1996. Kristo Pienaar Introduces the Ultimate Book of Trees and Shrubs for Southern African Gardeners, Southern Book Publishers, Halfway House, 512 p. (More than 1 500 trees and shrubs - both exotic and indigenous - are described in the book).

- Wells, M.J., Balsinhas, A.A., Joffe, H., Engelbrecht, V.M., Harding, G. and Stirton, C.H., 1986. A catalogue of problem plants in southern Africa incorporating the national weed list of southern Africa, Memoir No. 53, Botanical Survey of South Africa, Botanical Research Institute, Department of Agriculture and Water Supply, Pretoria, 658 p.

- Werger, M.J.A. and Van Bruggen, A.C. (eds), 1978. Biogeography and Ecology of Southern Africa, Monographiae Biologicae VOL 31, W. Junk, The Hague, 1439 p.

Note: (i) Memoirs of the Botanical Survey of South Africa, published by the Botanical Research Institute (now known as the National Botanical Institute), Private Bag X7, Claremont, 7735, should be consulted for information of relevance to grasslands and forests. All Memoirs contain a list of previous reports in the Memoirs series. Sixty-two Memoirs are currently available (1993). Plant surveys of special interest for Natal/KwaZulu include Memoirs 2 (Natal and Zululand), 5 and 8 (Natal vegetation), Memoirs 23 (Weenen) and 32 (Table Mountain, Pietermaritzburg area), Memoirs 34 (Natal Drakensberg) and 36 (Tugela River Basin), plus Memoirs 39 (flora of Natal) and 45 (Isipingo Beach). Specialist Memoirs such as No. 57 (veld types of South Africa) and No. 58 (grasses of southern Africa) are likewise available. The full list of publications should therefore be examined for source documents of interest. The National Botanical Institute is also involved in a long term project concerning the publication of numerous volumes on the flowering plants of southern Africa (originally defined as South Africa, Lesotho, Swaziland and Namibia). The first volume was published in 1963, with a total of 33 volumes planned for the Flora of Southern Africa series. Introductory volumes, dealing inter alia with the genera of southern African flowering plants, as well as Cryptogam volumes which mainly concentrate on mosses, form part of the Flora of Southern Africa series.

(ii) Specimens of plants and plant material specific to given geographic regions in South Africa, can be examined inter alia at the eight national botanical gardens and the four national herbaria of the National Botanical Institute. The respective gardens are as follows (with date of establishment in brackets): Natal (Pietermaritzburg, 1872); Pretoria (1946); Lowveld (Nelspruit, 1969); Witwatersrand (Krugersdorp/Roodepoort, 1982); Orange Free State (Bloemfontein, 1969); Harold Porter (Betty's Bay, 1957); Karoo (Worcester, 1921), and Kirstenbosch (1913). The four herbaria are: Natal (Durban, 1882); National (Pretoria, 1903); Compton - incorporating the South African Museum Herbarium founded in 1825 (Kirstenbosch, 1939), and Stellenbosch (1902). The controlling legislation for the national botanical gardens/herbaria is the Forest Act No. 122 of 1984.

6.7 Conservation areas and categories in Natal/KwaZulu

The various categories of conserved (protected) land are examined in this section*. One objective is to list areas where examples of vegetation typical of bioclimatic sub-regions might be found. Conserved areas moreover, represent an important category of land use, viewed from a **catchment planning/management** and general environmental perspective.

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* A proposed classification system for South African terrestrial and marine protected areas is presented in, Council for the Environment, 1993. The South African classification of terrestrial and marine protected areas, Council for the Environment, Pretoria, 17 p. See also, Wahl, M. and Naudé, K., 1996. National register of protected areas in South Africa, 1996, Department of Environmental Affairs and Tourism, Pretoria, 38 p. According to the International Union for the Conservation of Nature and Natural Resources (IUCN), now the World Conservation Union, 10% of the land area of each country should be legally protected for conservation purposes. See Siegfried, W.R., 1989. Chapter 12. Preservation of species in southern African nature reserves, In: Huntley, B.J. (ed), Biotic Diversity in Southern Africa: Concepts and Conservation, Oxford University Press, Cape Town, p. 186 - 201. A useful reference on legal aspects of protected areas is the following: Hanks, J. and Glavovic, P.D., 1992. Chapter 27. Protected areas, In: Fuggle, R.F. and Rabie, M.A. (eds), Environmental Management in South Africa, Juta, Cape Town, p. 690 - 714. (See also Chapter 3. Resource economics, p. 26 - 52., as well as Chapter 11. Plants, p. 212 - 249., and Chapter 12. Wild animals, p. 250 - 276). Refer in addition to the chapter on the laws of South Africa.

It is unfortunate but true, that many of the benefits associated with protected areas in South Africa, cannot easily be valued in terms of the market mechanism. Benefits of protected (and other natural) areas include catchment preservation, soil erosion control, runoff and flood regulation, the fixing and cycling of essential nutrients as well as water purification, and the maintenance of life support systems with reference inter alia to species diversity and ecological processes. Other benefits include aesthetic, spiritual, cultural and historical factors. Virtually no work has yet been undertaken in South Africa in an attempt to provide a market value for protected areas, if only in terms of the hydrological properties of these areas. Since protected/natural areas have not been given a formal market value, it follows that degradation and destruction is seldom vigorously acted upon (other than hand-wringing appeals to emotion), and where action is taken, the fines do not even begin to approach true market values. The situation is complicated by those who are utterly dependent on natural resources for their very survival (for example, for firewood), where degradation is unavoidable. No simple solutions are apparent.

Some 11% of the land area of the Province of Natal, consists of formally conserved land directly under the jurisdiction of the Natal Parks Board and the KwaZulu Department of Nature Conservation (previously known as the KwaZulu Bureau of Natural Resources). Approximately 27% of the coastline is also protected (in one form or another)*. Data on nature reserves in Natal controlled by the Natal Parks Board are presented in Table F13, followed by game reserves (Table F14), game parks and national parks (Table F15), and marine reserves (Table F16). Thereafter, data are provided on conservation areas formerly controlled by the (now defunct) Department of Development Aid (Table F17), as well as nature reserves owned or administered by local authorities, the Wildlife Society of Southern Africa, and the South African Nature Conservation Centre (now the Delta Environmental Centre) (Table F18)**. Biospheres (Table F19) are then described. Data on wetlands of international significance in terms of the Ramsar Convention are outlined in Table F20.

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* It is interesting to note that Natal/KwaZulu which comprises 8,1% of South Africa's land area, is home to approximately 55% of all terrestrial mammals, 89% of all marine mammals, 86% of all birds, 50% of all amphibians, 31% of all reptiles, 35% of all freshwater fish, 75% of all marine fish, 63% of all butterflies and 76% of all the dragonflies found in South Africa - in terms of the proportion of known species (Bourquin, O., 1994. Personal communication, Natal Parks Board, Pietermaritzburg).

** A useful publication on the protected areas in the province is the following: Pooley, T. and Player, I., 1995. KwaZulu/Natal Wildlife Destinations: a Guide to the Game Reserves, Resorts, Private Nature Reserves, Ranches and Wildlife Areas of KwaZulu/Natal, Southern Book Publishers, Halfway House, 375 p.

The next three tables concentrate on South African Natural Heritage Programme areas (Table F21)*, Sites of Conservation Significance (Table F22), and conservancies in Natal (Table F23). M.O.S.S. (Metropolitan Open Space System) areas are briefly discussed. The following tables examine State forests (including wilderness areas) controlled by the Natal Parks Board (Table F24), and State forests controlled by the Department of Water Affairs and Forestry (Table F25). The next data-set (Table F26) concerns game, nature, forest and freshwater reserves in KwaZulu. The final table (Table F27) deals with proclaimed indigenous forests in KwaZulu. Readers should note that certain conservation categories such as municipal nature reserves, may in part or in full, be regarded for instance, as Sites of Conservation Significance. It is therefore possible for a numerical duplication to occur. Discrepancies in the data are also evident. Management plans and maps are available for the various conservation areas controlled by the Natal Parks Board. The plans contain valuable information specific to the area in question.

The South African Defence Force controls a significant proportion of rural land in South Africa (excluding Natal/KwaZulu). All such Defence Force properties are managed as multiple-use conservation areas. In Natal/KwaZulu, these areas include the Hell's Gate Military Area in the St Lucia complex; the Boschhoek Military Area; the Bluff Military Area (Durban); the Dukuduku Military Area (Mtubatuba), and the Merrivale Military Area (Howick). The total land area (as at 1993), controlled by the Defence Force in Natal/KwaZulu was approximately 7 181 ha**.

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* Two possible World Heritage Sites have been recommended for Natal/KwaZulu, namely, the Natal Drakensberg Park and the (proposed) Greater St Lucia Wetland Park - see the footnotes of Tables F13 and F14. The World Heritage Site concept was initiated by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1972. Approximately 440 natural/cultural sites are listed in 100 countries, involving places of such natural and/or cultural importance, that they should be protected for all time.

** For a brief discussion of the role of the Defence Force in environmental conservation see Godschalk, S., 1991. In defence of the environment, Conserva, VOL 6(4), p. 10 - 13.

Table F13: Nature reserves in Natal controlled by the Natal Parks Board, 1994.

Nature reserve	Area (ha)	Proclaimed and amended in terms of Government Notice (GN) and (Natal) Administrator's Proclamation (AP) (the latter in terms of the (Natal) Nature Conservation Ordinance No. 15 of 1974) or as stated	Locality
Albert Falls Public Resort Nature Reserve	3 012	AP 102/75	Cramond
Beachwood Mangroves Nature Reserve (mangroves also declared as a national monument in terms of the National Monuments Act No. 28 of 1969 (GN 1461/80))	76	AP 76/77	Durban
Blinkwater Nature Reserve	791	See footnotes	Greytown
Bluff Nature Reserve	45	AP 55/75 and AP 30/82	Durban
Chelmsford Public Resort Nature Reserve	6 845	AP 158/77 and AP 73/80	Newcastle
Coleford Nature Reserve	1 272	AP 72/59 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947)	Underberg
Craigieburn Public Resort Nature Reserve	330	AP 103/78	Greytown
Dlinza (Hlinza) Forest Nature Reserve	208	AP 67/52 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947) and AP 197/76	Eshowe
Doreen Clark Nature Reserve	5	AP 23/69 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947) and AP 47/78	Pietermaritzburg
Enseleni Nature Reserve	293	AP 4/48 and AP 72/58 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947)	Empangeni

Table F13: Nature reserves in Natal controlled by the Natal Parks Board, 1994 (continued).

Nature reserve	Area (ha)	Proclaimed and amended in terms of Government Notice (GN) and (Natal) Administrator's Proclamation (AP) (the latter in terms of the (Natal) Nature Conservation Ordinance No. 15 of 1974) or as stated	Locality
Entumeni Nature Reserve	393	AP 109/73 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947)	Eshowe
Harold Johnson Nature Reserve	104	AP 46/67 and AP 163/71 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947) and AP 35/87	Stanger
Hazelmere Public Resort Nature Reserve	304	6 June 1977 by (Natal) Administrator-in-Executive Committee Resolution No. 1243	Verulam
Himeville Nature Reserve	105	AP 71/73 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947)	Himeville
Hlathikulu Nature Reserve (forms part of the Cathedral Peak and Monk's Cowl State forests)	2 700	GN 955/89 (in terms of the Forest Act No. 122 of 1984)	Winterton
Impofana Nature Reserve (forms part of the Highmoor State Forest)	7 626	GN 956/89 (in terms of the Forest Act No. 122 of 1984)	Nottingham Road
Itala Nature Reserve	29 653	AP 36/73, AP 157/74 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947), AP 31/75, AP 61/77, AP 158/79 and AP 157/82	Louwsburg

Table F13: Nature reserves in Natal controlled by the Natal Parks Board, 1994 (continued).

Nature reserve	Area (ha)	Proclaimed and amended in terms of Government Notice (GN) and (Natal) Administrator's Proclamation (AP) (the latter in terms of the (Natal) Nature Conservation Ordinance No. 15 of 1974) or as stated	Locality
Kamberg Nature Reserve	2 980	AP 38/51 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947)	Rosetta
Karkloof Nature Reserve	1 726	AP 76/80	Howick
Kenneth Stainbank Nature Reserve	211	AP 11/63, AP 88/64, AP 193/69, AP 194/72 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947) and AP 107/81	Durban
Klipfontein Dam Public Resort Nature Reserve	1 400	8 January 1986 by (Natal) Administrator-in-Executive Committee Resolution No. 82	Vryheid
Krantzkloof Nature Reserve	584	AP 73/59 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947), AP 18/78 and AP 10/86	Kloof
KwaMehlenyati Nature Reserve (forms part of the Mkhomazi State Forest)	7 400	GN 957/89 (in terms of the Forest Act No. 122 of 1984)	Rosetta
Lake Eteza Nature Reserve	350	AP 69/76	Mtubatuba
Loteni Nature Reserve	3 984	AP 21/53, AP 52/58, AP 134/66 and AP 62/73 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947)	Himeville

Table F13: Nature reserves in Natal controlled by the Natal Parks Board, 1994 (continued).

Nature reserve	Area (ha)	Proclaimed and amended in terms of Government Notice (GN) and (Natal) Administrator's Proclamation (AP) (the latter in terms of the (Natal) Nature Conservation Ordinance No. 15 of 1974) or as stated	Locality
Maphelane Nature Reserve	1 103	GN 2611/84 (in terms of the since repealed Forest Act No. 72 of 1968) - portion of the former State forest	KwaMbonambi
Mfifiyela Nature Reserve (forms part of the Cathedral Peak State Forest)	2 200	GN 959/89 (in terms of the Forest Act No. 122 of 1984)	Winterton
Midmar Public Resort Nature Reserve	2 857	AP 24/68, AP 97/72 and AP 17/74 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947), AP 127/76, AP 62/84, AP 21/85 and AP 31/90	Howick
Mihobi Nature Reserve (forms part of the Dukuduku State Forest)	162	Proclaimed by Ministerial letter, on 6 July 1933	Mtubatuba
Moor Park Nature Reserve	264	AP 114/67 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947)	Estcourt
Mount Currie Nature Reserve	1 777	AP 141/81	Kokstad
Mpenjati Public Resort Nature Reserve	51	27 August 1985 by (Natal) Administrator-in-Executive Committee Resolution No. 1425	Palm Beach
Mzimkulwana Nature Reserve (forms part of the Cobham and Garden Castle State forests)	28 140	GN 1563/79 (in terms of the since repealed Forest Act No. 72 of 1968) and GN 960/89 (in terms of the Forest Act No. 122 of 1984)	Himeville

Table F13: Nature reserves in Natal controlled by the Natal Parks Board, 1994 (continued).

Nature reserve	Area (ha)	Proclaimed and amended in terms of Government Notice (GN) and (Natal) Administrator's Proclamation (AP) (the latter in terms of the (Natal) Nature Conservation Ordinance No. 15 of 1974) or as stated	Locality
Ncandu Nature Reserve	1 875	GN 958/89 (in terms of the Forest Act No. 122 of 1984)	Newcastle
North Park Nature Reserve	53	AP 9/68, AP 74/72 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947) and AP 74/84	Queensburgh
Oribi Gorge Nature Reserve	1 917	AP 19/50, AP 35/57 and AP 167/72 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947)	Port Shepstone
Pongola Bush Nature Reserve	585	AP 172/72 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947)	Paulpietersburg
Pongolapoort Public Resort Nature Reserve	11 917	27 February 1979 by (Natal) Administrator-in-Executive Committee Resolution No. 423	Mkuze
Queen Elizabeth Park Nature Reserve	93	AP 31/60 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947)	Pietermaritzburg
Reunion Nature Reserve	5	See footnotes	Durban
Rugged Glen Nature Reserve	762	AP 32/50	Bergville

Table F13: Nature reserves in Natal controlled by the Natal Parks Board, 1994 (continued).

Nature reserve	Area (ha)	Proclaimed and amended in terms of Government Notice (GN) and (Natal) Administrator's Proclamation (AP) (the latter in terms of the (Natal) Nature Conservation Ordinance No. 15 of 1974) or as stated	Locality
Skyline Nature Reserve	15	Expropriated from Uvongo Municipality by the Administrator of Natal on 1 November 1986. Managed by the Natal Parks Board	Uvongo
Soada Forest Nature Reserve	498	GN 1379/60 (in terms of the since repealed Forest Act No. 13 of 1941) and AP 63/67 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947)	Donnybrook
Spioenkop Public Resort Nature Reserve	5 065	AP 101/75	Winterton
The Swamp Nature Reserve	220	AP 77/84	Himeville
Tugela Drift Nature Reserve	41	AP 98/73 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947) and AP 42/85	Colenso
Umgeni Vlei Nature Reserve	950	See footnotes	Nottingham Road
Umhlanga Lagoon Nature Reserve	32	AP 74/80 and AP 58/86	Umhlanga Rocks
Umlalazi Nature Reserve	1 028	AP 50/50 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947), AP 183/74, AP 101/77 and AP 16/86	Mtunzini

Table F13: Nature reserves in Natal controlled by the Natal Parks Board, 1994 (continued).

Nature reserve	Area (ha)	Proclaimed and amended in terms of Government Notice (GN) and (Natal) Administrator's Proclamation (AP) (the latter in terms of the (Natal) Nature Conservation Ordinance No. 15 of 1974) or as stated	Locality
Umtamvuna Nature Reserve	3 257	AP 97/71 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947) and AP 39/83	Port Edward
Umvoti Vlei Nature Reserve	267	AP 88/75	Greytown
Vergelegen Nature Reserve	1 159	AP 110/67, AP 135/70 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947) and AP 133/76	Himeville
Vernon Crookes Nature Reserve	2 189	AP 157/76	Umzinto
Vryheid Nature Reserve	1 150	Owned by the Vryheid Municipality and leased by the Natal Parks Board in terms of (Natal) Administrator-in-Executive Committee Resolution No. 795 of 8 May 1984	Vryheid
Wagendrift Public Resort Nature Reserve	764	AP 22/78	Estcourt
Weenen Nature Reserve	4 183	AP 116/75, AP 85/81, AP 51/82, AP 31/85 and AP 56/86	Weenen

Source: (i) After The Official Gazette of the Province of Natal and Republic of South Africa Government Gazette data, plus unpublished data supplied by the Natal Parks Board, Pietermaritzburg, 1994.

(ii) Fieldwork.

See also: (i) Anonymous, 1990. Natal Parks Board conservation areas, Natal Parks Board, Pietermaritzburg, 45 p.

(ii) Greyling, T. and Huntley, B.J. (eds), 1984. Directory of southern African conservation areas, South African National Scientific Programmes Report No. 98, Foundation for Research Development, CSIR, Pretoria, 311 p.

(iii) Shepherd, O., 1989. Wild places of Natal: nature reserves, resorts and parks, Wildlife Society of Southern Africa (Natal Branch), Durban, 151 p.

Note: (i) Repealed legislation is not included in the above table (see (xiii) below).

(ii) The Kosi Bay Nature Reserve proclaimed by AP 4/50 of the 11th of January 1950, was deproclaimed by AP 113/84 of the 18th of October 1984 and was subsequently transferred to the KwaZulu Government (see Table F26).

(iii) The first proclamation of Pongola Bush as a protected area was in terms of GN 31/12, which referred to the Pongolabosch Crown Forest. Likewise, the first proclamation of the Incandu State Forest (as part of the then Normandien Forest Reserve - proclaimed in 1914), was per GN 1485/25. The Incandu State Forest subsequently became the Ncandu Nature Reserve.

(iv) The Natal Drakensberg Park (a term applied by the Natal Parks Board), consists of the Cathedral Peak, Cobham, Garden Castle, Highmoor, Mkhomazi and Monk's Cowl State forests; the Giant's Castle Game Reserve, the Royal Natal National Park and the Kamberg, Loteni, Rugged Glen and Vergelegen nature reserves.

(v) The Blinkwater Nature Reserve (previously privately owned land) was donated to the Natal Parks Board in 1988 and is managed by the Board.

(vi) The Reunion Nature Reserve was leased from the Durban Municipality in 1987 and is managed by the Natal Parks Board.

(vii) The Natal Parks Board has managed the Umgeni Vlei Nature Reserve since 1972. Ownership of the land is (apparently) vested with the central Government.

(viii) The Makasa area (1 700 ha) situated near Mkuze on black settled land, is in the initial stages (since 1992) of being proclaimed as a nature reserve. The area is jointly administered by the Natal Parks Board and the tribal authorities. The reserve (when proclaimed) will be similar to the Community Conservation Areas established by the KwaZulu Department of Nature Conservation (see Table F26).

(ix) The Natal Lion Park (a privately leased area 283 ha in extent) near Cato Ridge is owned by the Natal Provincial Administration. The area was originally proclaimed as a nature reserve (by virtue of AP 112/67 in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947), and was managed by the Natal Parks Board.

(x) The Itala Nature Reserve, although proclaimed as a nature reserve, is commonly referred to as the Itala Game Reserve.

(xi) The Ngele Nature Reserve proclaimed by virtue of GN 1385/94 in terms of the Forest Act No. 122 of 1984 - comprising 4 358 ha - is located in the Weza State Forest near Harding, and is controlled by the Department of Water Affairs and Forestry. The nature reserve is the only such reserve managed in Natal by the Department. (See Table F25).

(xii) The Natal Parks Board administers all land between the shoreline and the boundary fence of the various public resorts surrounding major dams in Natal. The Board accordingly, is partly responsible for the control of important water resources assets. Recently however, control of the conservation and recreational areas of the Albert Falls and Hazelmere public resorts was taken over by Umgeni Water (via Msinsi Holdings). The latter company also manages the conservation and recreational areas of the Inanda, Nagle and Shongweni dams, as well as the Darvill Ponds and Bird Sanctuary (see Table F18).

(xiii) The original (subsequently repealed) proclamation data for certain nature reserves (not reflected in the above table), are provided below. All other original proclamation data are as per Table F13.

Nature reserve	Proclamation data
Bluff Nature Reserve	AP 181/74
Chelmsford Public Resort Nature Reserve	AP 111/75
Coleford Nature Reserve	AP 15/48
Entumeni Nature Reserve	AP 114/70
Himeville Nature Reserve (apparently proclaimed in one locality, which was subsequently deproclaimed - with a further proclamation in an adjacent area - the latter reflected in the above table)	AP 13/56
Krantzkloof Nature Reserve	AP 55/50
Umlalazi Nature Reserve	AP 13/48
Vernon Crookes Nature Reserve	AP 254/72
Wagendrift Public Resort Nature Reserve	AP 166/73

Table F14: Game reserves in Natal controlled by the Natal Parks Board, 1994.

Game reserve	Area (ha)	Proclaimed and amended in terms of the relevant Zululand Government Notice (GN), Natal Government Notice (GN), Natal Provincial Notice (PN) and (Natal) Administrator's Proclamation (AP) (the latter in terms of the (Natal) Nature Conservation Ordinance No. 15 of 1974) or as stated	Locality
Corridor Game Reserve (links the Umfolozi and Hluhluwe game reserves)	25 633	AP 35/89	Hluhluwe
Giant's Castle Game Reserve	34 638	Natal Government Notice GN 735/03 and GN 356/07, PN 74/16, PN 57/17, PN 140/39, PN 131/41, AP 20/43 (in terms of the since repealed Natal National Parks Ordinance No. 14 of 1942), AP 119/77 and AP 69/80	Mooi River
Hluhluwe Game Reserve	23 067	Zululand Government Notice GN 12/1895 and GN 16/1897, PN 86/12, PN 74/16, PN 57/17, PN 140/39 and AP 35/39 (in terms of the since repealed Zululand Game Reserves and Parks Ordinance No. 6 of 1939)	Hluhluwe
Mkuzi Game Reserve	37 985	PN 23/12, PN 28/12, PN 74/16, PN 57/17, PN 266/18, PN 140/39, PN 131/41, AP 62/84 and AP 31/90	Mkuze
Richards Bay Game Reserve	1 200	PN 353/35, PN 140/39, PN 131/41, AP 28/74 and AP 29/74 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947)	Richards Bay
St Lucia Game Reserve	36 826	Zululand Government Notice GN 12/1895 and GN 16/1897, PN 74/16, PN 57/17, PN 108/35, PN 140/39, AP 35/39 (in terms of the since repealed Zululand Game Reserves and Parks Ordinance No. 6 of 1939) and PN 331/55	St Lucia

Table F14: **Game reserves in Natal controlled by the Natal Parks Board, 1994 (continued).**

Game reserve	Area (ha)	Proclaimed and amended in terms of the relevant Zululand Government Notice (GN), Natal Government Notice (GN), Natal Provincial Notice (PN) and (Natal) Administrator's Proclamation (AP) (the latter in terms of the (Natal) Nature Conservation Ordinance No. 15 of 1974) or as stated	Locality
Umfolozi Game Reserve	47 743	Zululand Government Notice GN 12/1895, GN 11/1897 and GN 16/1897, Natal Government Notice GN 322/07, PN 74/16, PN 57/17, PN 147/20, PN 140/39, PN 131/41 and AP 53/62 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947)	Hluhluwe

Source: After Natal Government Gazette and The Official Gazette of the Province of Natal data, plus unpublished data supplied by the Natal Parks Board, Pietermaritzburg, 1994.

See also:

(i) Anonymous, 1990. Natal Parks Board conservation areas, Natal Parks Board, Pietermaritzburg, 45 p.

(ii) Greyling, T. and Huntley, B.J. (eds), 1984. Directory of southern African conservation areas, South African National Scientific Programmes Report No. 98, Foundation for Research Development, CSIR, Pretoria, 311 p. (Possible errors in the report, in terms of the legal details, have been noted for the Hluhluwe Game Reserve).

(iii) Shepherd, O., 1989. Wild places of Natal: nature reserves, resorts and parks, Wildlife Society of Southern Africa (Natal Branch), Durban, 151 p.

Note:

(i) Repealed legislation is not included in the above table.

(ii) The proposed Greater St Lucia Wetland Park will link the Cape Vidal, the Dukuduku, the Eastern Shores, the Mhlatuze, the Nyalazi and the Sodwana State forests, as well as the Mkuzi and St Lucia game reserves, the False Bay and St Lucia parks, the Sodwana Bay National Park, the Maphelane Nature Reserve, and the Maputaland and St Lucia marine reserves, with private reserves such as the Phinda Izilwane Reserve, within an overall conservation management strategy.

(iii) The Hluhluwe-Umfolozi Park (a term applied by the Natal Parks Board) consists of the Corridor, Hluhluwe and Umfolozi game reserves.

(iv) Certain land for urban purposes was excised from the St Lucia Game Reserve.

(v) The Itala Nature Reserve, although proclaimed as a nature reserve, is commonly referred to as the Itala Game Reserve - see Table F13.

(vi) The Ndumu Game Reserve was proclaimed by PN 96/24 of the 16th of April 1924, as amended by PN 140/39, PN 131/41 and AP 13/47. The Reserve was declared as Released Area 88 by Proc 9/87 and was deproclaimed by AP 19/88 of the 24th of March 1988, before transfer to the KwaZulu Government (see Table F26).

Table F15: Game parks and (national) parks in Natal controlled by the Natal Parks Board, 1994.

Park	Area (ha)	Proclaimed and amended in terms of the relevant Proclamation (Proc), Government Notice (GN), Natal Provincial Notice (PN) and (Natal) Administrator's Proclamation (AP) (the latter in terms of the (Natal) Nature Conservation Ordinance No. 15 of 1974) or as stated	Locality
Game park			
False Bay Park	2 247	AP 35/39 and AP 9/44 (in terms of the since repealed Zululand Game Reserves and Parks Ordinance No. 6 of 1939), AP 111/52 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947) and PN 331/55	St Lucia
St Lucia Park	12 545	AP 35/39 and AP 11/44 (in terms of the since repealed Zululand Game Reserves and Parks Ordinance No. 6 of 1939) and AP 36/57 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947)	St Lucia

Table F15: Game parks and (national) parks in Natal controlled by the Natal Parks Board, 1994 (continued).

Park	Area (ha)	Proclaimed and amended in terms of the relevant Proclamation (Proc), Government Notice (GN), Natal Provincial Notice (PN) and (Natal) Administrator's Proclamation (AP) (the latter in terms of the (Natal) Nature Conservation Ordinance No. 15 of 1974) or as stated	Locality
National park			
Royal Natal National Park	8 094	31 August 1916 by Executive Council of South Africa Minute No. 2288 (in terms of Proc 204/13), GN 1065/33 and AP 20/43 (in terms of the since repealed Natal National Parks Ordinance No. 14 of 1942)	Bergville
Sodwana Bay National Park	413	AP 72/50 (in terms of the since repealed Natal Parks, Game and Fish Preservation Ordinance No. 35 of 1947), Proc 105/81 and AP 67/89	Sodwana Bay

Source: After Natal Government Gazette, The Official Gazette of the Province of Natal and Union of South Africa Government Gazette data, plus unpublished data supplied by the Natal Parks Board, Pietermaritzburg, 1994.

See also:
(i) Anonymous, 1990. Natal Parks Board conservation areas, Natal Parks Board, Pietermaritzburg, 45 p.

(ii) Shepherd, O., 1989. Wild places of Natal: nature reserves, resorts and parks, Wildlife Society of Southern Africa (Natal Branch), Durban, 151 p.

Note:
(i) The term "national" park does not refer to parks proclaimed by virtue of the National Parks Act No. 57 of 1976, but parks which may be declared by the Administrator in terms of the (Natal) Nature Conservation Ordinance No. 15 of 1974 (and previous such Ordinances).

(ii) Repealed legislation is not included in the above table.

(iii) Certain land for urban purposes was excised from the St Lucia Park.

Table F16: Marine reserves in Natal controlled by the Natal Parks Board, 1994.

Marine reserve	Area (ha)	Locality
Maputaland Marine Reserves No. 1 and No. 2	39 740	Sodwana Bay
St Lucia Marine Reserves No. 1 and No. 2	44 280	St Lucia
Trafalgar Marine Reserve	1 500	Southbroom

Source: After The Official Gazette of the Province of Natal and Republic of South Africa Government Gazette data, plus unpublished data, supplied by the Natal Parks Board, Pietermaritzburg, 1994.

See also:

(i) Anonymous, 1990. Natal Parks Board conservation areas, Natal Parks Board, Pietermaritzburg, 45 p.

(ii) Robinson, G.A. and De Graaff, G., 1994. Marine protected areas of the Republic of South Africa, Council for the Environment, Pretoria, 202 p. and map.

(iii) Shepherd, O., 1989. Wild places of Natal: nature reserves, resorts and parks, Wildlife Society of Southern Africa (Natal Branch), Durban, 151 p.

Note:

(i) Marine reserves extend from the low-water mark on the beach, for a distance of up to three nautical miles out to sea. The St Lucia and Trafalgar marine reserves were proclaimed in terms of the (Natal) Nature Conservation Ordinance No. 15 of 1974 (Administrator's Proclamation) AP 35/79 and AP 48/86. The Maputaland Marine Reserves were proclaimed by virtue of Government Regulation Notice GN R404/86, issued in terms of the (since repealed) Sea Fisheries Act No. 58 of 1973, which was subsequently replaced by the Sea Fishery Act No. 12 of 1988 (certain regulations are still in force, including GN R404/86). There appears to be some confusion regarding the western boundary of the various marine reserves. Both AP 35/79 and AP 48/86 define the St Lucia and Trafalgar marine reserves as extending seawards from the low-water mark. However, GN R404/86 refers to the high-water mark for all the marine reserves in Natal/KwaZulu.

(ii) In terms of GN 1340/70, public access to a 16 km wide strip of both land and sea (including parts of the St Lucia Marine Reserves No. 1 and No. 2), is prohibited for military reasons. It is probable however, that this restriction has subsequently been lifted, or is no longer observed.

(iii) The sea-shore (also known as the intertidal zone), is the land and water between the high-water and low-water marks. The Admiralty Reserve (an historical concept not related to conservation), and which applies to parts of the coast mainly in Natal/KwaZulu, is defined as the area to the west of the high-water mark, extending landwards for a distance of approximately 200 feet (61 m). The Admiralty Reserve is State land owned by the Department of Regional and Land Affairs.

6.7.1 Other nature reserves in Natal

The relevant data are provided in Tables F17 and F18.

Table F17: Conservation areas on former South African Development Trust land in Natal and previously controlled by the (since defunct) Department of Development Aid, 1994.

Site	Area (ha)	Locality
Nature reserve		
Fundimvelo Nature Reserve	700	Empangeni
Impendle Nature Reserve	8 000	Bulwer
Mbumbazi Nature Reserve	2 100	Paddock
Molweni Nature Reserve	150	Hillcrest
Oliphantskop Nature Reserve	2 500	Ladysmith
Open area		
Phongolo Floodplain and Sand Forest Zone	±50 000	Jozini
Resource area		
Ezansi Resource Area	400	Port Edward
Medicinal Plant Resource Area	100	Adjacent to the Phongolo Floodplain
New Hanover/Hamburg Resource Area	400	New Hanover

Source: After the Division of Nature Conservation, Community Services Branch, Natal Provincial Administration, Pietermaritzburg, 1994.

Note:

(i) As a temporary measure, control of the areas listed above, has been vested with the (especially created) Division of Nature Conservation which falls under the jurisdiction of the Chief Directorate: Administration, Community Services Branch, Natal Provincial Administration, Private Bag X9037, Pietermaritzburg, 3200. The Natal Provincial Administration controls these areas, on an agency basis, on behalf of the Department of Regional and Land Affairs (with effect from April 1992).

(ii) Only a portion of the Mbumbazi (previously known as the Ntubeni) Nature Reserve (628,6 ha) has been officially proclaimed, in terms of Government Notice GN 765/86 issued by virtue of Section 3(1) of Regulation Proclamation Proc R R6/78 (Nature Conservation in Black Areas). The latter in turn, was issued via the (now repealed) (Native) subsequently, Black Administration Act No. 38 of 1927, read together with the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936. All other areas listed in the table have not been formally proclaimed, but are administered for the specified purpose (see below). Management of the various areas is undertaken in terms of R6/78.

(iii) The Oliphantskop Nature Reserve is likely to be reduced in size in the future. Part of the Reserve will be allocated for agricultural needs.

(iv) Open areas (as the name implies), are areas consisting of valuable conservation land, where direct management is required in order to preserve the flora and fauna. The only such area in Natal/KwaZulu is the Phongolo Floodplain, which is settled by approximately 80 000 people. Conservation activities are therefore managed in association with the residents.

(v) Resource areas are parcels of land where local communities can participate in the development and utilization of natural resources in the given area. Accordingly, the propagation of medicinal plants, the harvesting of thatching grass and controlled livestock grazing is permitted. The main aim of resource areas concerns environmental education and the wise use of natural resources.

Table F18: Some nature reserves in Natal owned or administered by local authorities, the Wildlife Society of Southern Africa and the South African Nature Conservation Centre (now the Delta Environmental Centre), 1989.

Nature reserve (owner/administrator)	Area (ha)	Locality
Assagay Nature Reserve (Assagay Health Committee)	-	Botha's Hill
Bisley Valley Nature Reserve (Pietermaritzburg Municipality)	250	Pietermaritzburg
Burman Bush Nature Reserve (Durban Municipality)	50	Durban
Clive Cheesman Nature Reserve (Wildlife Society of Southern Africa)	5	Kloof
Crestholme Nature Reserve (Wildlife Society of Southern Africa)	5,9	Hillcrest
Darvill Ponds and Bird Sanctuary (Pietermaritzburg Municipality, subsequently Umgeni Water)	220	Pietermaritzburg
Dr Alden Lloyd Nature Reserve (Dundee Municipality)	±500	Dundee
Estcourt Nature Reserve (Estcourt Municipality)	100	Estcourt
Ferncliffe Forest (Pietermaritzburg Municipality)	250	Pietermaritzburg
Frederika Nature Reserve (South African Nature Conservation Centre/Southbroom Health Committee)	7	Southbroom
Glenholme Nature Reserve (Wildlife Society of Southern Africa)	42	Kloof
Hawaan Forest Nature Reserve (Tongaat Group/Wildlife Society of Southern Africa)	55	Umhlanga Rocks
Ilanda Wilds Nature Reserve (Amanzimtoti Municipality/Wildlife Society of Southern Africa)	20	Amanzimtoti
Illovo Lagoon Nature Reserve (Kingsburgh Municipality/Wildlife Society of Southern Africa)	-	Kingsburgh
Ingwenya Nature Reserve (Wildlife Society of Southern Africa)	74	Mandini
Lake Merthley (Greytown Municipality)	-	Greytown

Table F18: **Some nature reserves in Natal owned or administered by local authorities, the Wildlife Society of Southern Africa and the South African Nature Conservation Centre (now the Delta Environmental Centre), 1989 (continued).**

Nature reserve (owner/administrator)	Area (ha)	Locality
Malendeni Nature Reserve (Wildlife Society of Southern Africa)	-	Ladysmith
Mariannwood Nature Reserve (Pinetown Municipality)	12,5	Pinetown
Mountain Lake Nature Reserve (Matatiele Municipality)	-	Matatiele
New Germany Nature Reserve (New Germany Municipality)	110	New Germany
Palmiet Nature Reserve (Westville Municipality/Wildlife Society of Southern Africa)	60	Westville
Paradise Valley Nature Reserve (Pinetown Municipality)	38	Pinetown
Roosfontein Nature Reserve (Westville Municipality)	70	Westville
Silverglen Nature Reserve (Durban Municipality)	220	Durban
Springside Nature Reserve (Hillcrest Municipality/Wildlife Society of Southern Africa)	21	Hillcrest
T.C. Robertson Memorial Sanctuary (Scottburgh Municipality/Wildlife Society of Southern Africa)	20	Scottburgh
Treasure Beach Environmental Education Centre (Wildlife Society of Southern Africa)	16	Durban
Umgeni Valley Nature Reserve (Wildlife Society of Southern Africa)	759	Howick
Umhlanga Ponds Nature Reserve (Umhlanga Rocks Municipality)	-	Umhlanga Rocks
Uvongo River Nature Reserve (Uvongo Municipality/Wildlife Society of Southern Africa)	28	Uvongo
Virginia Bush Nature Reserve (Durban Municipality)	38	Durban
Wilfried Bauer Nature Reserve (Matatiele Municipality)	218	Matatiele

Source: After Shepherd, O., 1989. Wild places of Natal: nature reserves, resorts and parks, Wildlife Society of Southern Africa (Natal Branch), Durban, 151 p.

Note: (i) An important sanctuary for cranes is the 186 ha Hlatikulu Crane and Wetland Sanctuary, which is near the Giant's Castle Game Reserve. The Sanctuary is managed by the Southern African Crane Foundation, P O Box 905, Mooi River, 3300.

(ii) Other private game and nature reserves as well as municipal or privately owned parks, game parks, bird sanctuaries, resorts and ranches are not given in the table. Details of these sites can be found in Shepherd (1989 - above).

6.7.2 Biosphere reserves in Natal/KwaZulu

The biosphere concept was initiated by the United Nations Educational, Scientific and Cultural Organization (UNESCO). Biosphere reserves ideally consist of a core area (a formally protected area of the highest conservation status, for example, a wilderness area), surrounded in turn by a buffer zone consisting of a game or nature reserve. Surrounding both areas, is a larger zone comprising other land use categories such as agriculture, silviculture and commercial tourism. Biosphere reserves accordingly, constitute an integrated unit ranging from areas of strict conservation to areas of intensive land use, and are administered in terms of a common management policy. The goal of a biosphere reserve is to promote a balanced relationship between people and their environment, and to ensure that resources are used on a sustainable basis. The influence of specialized conservation management policies in the wilderness/nature/game reserve area is therefore extended to other land use categories. Such a procedure ensures that land use practices immediately external to the conserved area do not prejudice the status of the conserved area. An example is the detrimental effects of severe soil erosion (upstream of the conservation area), on wetlands in the conservation area. The Natal Parks Board provides advice on various aspects of biosphere reserve management. Relevant data are available for the core conservation areas of each biosphere. There are currently six biosphere reserves in Natal/KwaZulu (March 1994), with a total area of approximately 150 000 ha (Table F19).

Table F19: Biosphere reserves in Natal/KwaZulu, 1994.

Biosphere reserve	Area (ha)	Locality
Bulwer Biosphere Reserve	18 000	Bulwer
Kamberg Biosphere Reserve	15 000	Rosetta
Ngwangwane Biosphere Reserve	7 000	Underberg
Polela Biosphere Reserve	35 000	Himeville
Pongolapoort Biosphere Reserve	25 000	Pongola
Thukela Biosphere Reserve	50 000	Weenen

Source: After the Natal Parks Board, Pietermaritzburg, 1994.

6.7.3 Wetlands of International Importance in Natal/KwaZulu

Wetlands of International Importance are declared in terms of the Ramsar Convention which was signed on the 2nd of February 1971, at Ramsar in Iran. (The accord is more properly known as the Convention on Wetlands of International Importance Especially as Waterfowl Habitat). Individual countries in terms of the Convention, undertake to conserve their own national wetlands as part of a larger international effort, in order to ensure the preservation of all, but particularly key wetlands and associated fauna and flora. Contracting parties are required to advise the Ramsar Secretariat of any threats to listed sites. There are 12 sites in South Africa, of which four are in Natal/KwaZulu (with a total area of 210 250 ha) (Table F20). The Department of Environment Affairs is responsible for the administration of the Ramsar Convention in South Africa.

In terms of the Convention*, wetlands are defined as areas of marsh, fen, peatland or water (whether natural or artificial, permanent or temporary), with water that is static or flowing, fresh, brackish or salt - including areas of marine water, the depth of which at low tide does not exceed six metres. Wetlands may also incorporate riparian and coastal zones adjacent to the wetlands, plus islands or bodies of marine water deeper than six metres at low tide, situated within the wetlands. Accordingly, the provisions of the Convention

* See Matthews, G.V.T., 1993. The Ramsar Convention on Wetlands: Its History and Development, Ramsar Convention Bureau, Gland, Switzerland, 122 p. (The publication is available in the Life Sciences Library, University of Natal, Pietermaritzburg).

extend to a wide variety of habitat types including rivers, coastal areas, and even coral reefs. More specifically, the definition refers to shallow marine waters; marine beds; coral reefs; rocky shores; sand/shingle shores (including dune systems); estuarine waters; tidal mud flats (including intertidal flats and salt flats); salt marshes; mangrove/tidal forests; coastal brackish/saline lagoons; coastal freshwater lagoons; deltas; rivers/streams/creeks: permanent as well as seasonal/intermittent; freshwater lakes: permanent as well as seasonal/intermittent; saline/brackish lakes/marshes: permanent as well as seasonal/intermittent*; freshwater marshes/pools: permanent as well as seasonal/intermittent*; peatlands (including peat bogs, swamps and fens); tundra/alpine wetlands; shrub-dominated wetlands; tree-dominated wetlands (including swamp forests)*; freshwater springs (including oases) and finally, geothermal wetlands. Man-made wetlands are fish/shrimp ponds; farm ponds/small tanks; irrigated land (including rice fields); seasonally flooded agricultural land; salt pans/salines; reservoirs/barrages/dams; gravel/brick/clay pits as well as wastewater treatment (sewage) farms and canals.

Table F20: Wetlands of International Importance in Natal/KwaZulu, 1993.

Site	Area (ha)	Locality
Kosi (Bay) system	8 000	Jozini
Lake Sibaya	7 750	Hluhluwe
St Lucia system	155 000	St Lucia
Turtle beaches and coral reefs of Tongaland (Maputaland)	39 500	Jozini

<u>Source</u>: After the Department of Environment Affairs, Pretoria, 1993.

<u>See also</u>: Cowan, G.I. and Müller, M., 1993. Convention on Wetlands of International Importance Especially as Waterfowl Habitat, South Africa: national report: June 1993, <u>South African Wetlands</u>, No. 5, February 1993, p. 6 - 10. (The newsletter <u>South African Wetlands</u>, is published periodically by the Department of Environment Affairs, Private Bag X447, Pretoria, 0001. The purpose of the newsletter is <u>inter</u> <u>alia</u> to advise interested parties on how South Africa is meeting its obligations in terms of the Ramsar Convention).

<u>Note</u>: (i) Lake Sibaya is the largest natural freshwater lake in South Africa.

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* The asterisk denotes the inclusion of floodplain wetlands (such as seasonally inundated grassland to forest) in the given category.

(ii) The St Lucia system extends from the Mfolozi Swamps in the south, to Sodwana Bay and the Mkuze Swamps in the north, and forms an integral part of the proposed Greater St Lucia Wetland Park.

(iii) The Turtle beaches and coral reefs of Tongaland extend along the coast of Natal/KwaZulu, from just south of Cape Vidal to the Mozambique border, and include the Maputaland and St Lucia marine reserves.

(iv) The Ndumo Game Reserve (Table F26) and the Natal Drakensberg Park (Table F13), will be declared as Wetlands of International Importance in due course. Seekoeivlei in the Orange Free State (briefly discussed in the chapter on wetlands and pans) will likewise, be declared as a Wetland of International Importance.

6.7.4 The South African Natural Heritage Programme

The programme - initiated on the 7th of November 1984 - aims to preserve sites of national environmental significance (usually situated on private land), throughout South Africa. Also included is land owned by the South African Defence Force (in Natal/KwaZulu, only the Boschhoek Training Area). The programme is administered by the Department of Environment Affairs with the support of Telemecanique South Africa Ltd, P O Box 482, Bergvlei, 2012 (part of Schneider Electric South Africa Ltd); the Natal Parks Board, and the Southern African Nature Foundation (now the World Wide Fund for Nature South Africa). The voluntary protection of parcels of indigenous vegetation and wildlife is the main factor in the declaration of a Natural Heritage Site*. There are currently 50 sites in Natal (August 1993), with a total area of approximately 22 382 ha (Table F21).

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* Criteria for the declaration of a Natural Heritage Site include: stands of special plant communities, good examples of aquatic habitats, sensitive catchment areas, habitats for threatened species and outstanding natural features.

Table F21: South African Natural Heritage Sites in Natal, 1993.

Site number	Site (owner)	Area (ha)	Locality
7	Howick Falls (Howick Municipality)	10	Howick
8	Ihlanze Ranch (K. Leo-Smith)	550	Pietermaritzburg
9	Kronsberg Nature Reserve (E. Taeuber)	200	Greytown
10	Tanglewood Farm Trust (Baldura Ltd)	54	Pinetown
17	Amasundu Phezulu (B. Hodson and C.L.J. Kennedy)	8	Port Shepstone
18	Bellevue Lodge (R. Powell)	11	Port Shepstone
19	Estoril (J. Leach)	8	Port Shepstone
20	Hlatini Farm (J.C. Hart)	8	Port Shepstone
21	Outlook Farm (E.M. Peckham)	26	Port Shepstone
22	Strelitsia (H.W. Steyn)	9	Port Shepstone
23	Ukuthula (I.T. Ross)	14	Port Shepstone
29	Ehlatini (R.I. Forrester)	120,5	Pietermaritzburg
30	Goudhoek Farm (R.C. Turner)	1 809	Babanango
31	Holkrans (D.C.P. Van Niekerk)	600	Newcastle
32	Jachtpad and Waterhoek (T.C. Balmer and L.P. Moll)	177	Vryheid
33	Karkloof Falls Nature Reserve (J.P.H. Meyer)	960	Lions River
36	Mooi River Falls (F.C. Uys and H.J.W. Stockdale)	15	Weenen
39	The Fextal (J. Morphew)	64	Pietermaritzburg
40	The Valley's Wildlife Sanctuary A and B (J.W. Porter)	57	Port Shepstone

Table F21: South African Natural Heritage Sites in Natal, 1993 (continued).

Site number	Site (owner)	Area (ha)	Locality
44	Game Valley Estates (B. Porter)	1 504	Ixopo
46	Lebombo Cliffs (P. Rutherford and H.F. Stegen)	1 000	Ngotshe
47	Luiperdkloof (K.W. Klingenberg)	600	Utrecht
55	Umgeni Valley Nature Reserve (Wildlife Society of Southern Africa)	1 920	Howick
66	Rendsburg Cycad Colony (H.A. Volker)	50	Vryheid
67	Umziki Rietbokpan (W.H. Smith)	50	Hluhluwe
68	Twinfalls (L. Grové)	450	Lions River
100	Ian Garland Conservation Area (Mondi Forests)	50	Amatikulu
105	Little Kilgobbin (H.P. Booysens)	6	Dargle
109	Bruce's Valley (B.A. Scott)	200	Kokstad
110	Roselands (M.H. Nicholson)	350	Richmond
112	Boschhoek Training Area (South African Defence Force)	3 060	Glencoe
123	L'Abri Wilderness Training School (Youth for Christ, South Africa)	25	New Hanover
124	Milestone Forest (P. Francis)	20	Howick
125	Frederika Nature Reserve (South African Nature Conservation Centre, now the Delta Environmental Centre/Southbroom Health Committee)	8,2	Southbroom
126	Wahroonga (C. Kunhardt)	36	Merrivale
127	Leeukop (K.P. Landman)	4 230	Ngotshe

Table F21: South African Natural Heritage Sites in Natal, 1993 (continued).

Site number	Site (owner)	Area (ha)	Locality
128	Misty Ridge Forest (HL and H Timber Processors Ltd)	65	Eshowe
129	Rensburg Koppie (Paper Bark Properties Ltd)	50	Weenen
130	Fugitives Drift Nature Reserve (G.M. Rattray)	776	Rorke's Drift
131	Amangwe Forest (Loring Rattray Ltd)	141	Lower Umfolozi
149	Pigeon Valley Park (Durban Municipality)	10	Durban
150	Silverglen Nature Reserve (Durban Municipality)	200	Durban
153	Moorfield (L. Cronje)	25	Newcastle
154	Rocky Ridge (Rocky Ridge Estates Ltd)	250	Eshowe
155	Normandien (Normandien Timber Estates)	500	Newcastle
156	Shongweni Dam (Umgeni Water)	1 500	Pinetown
157	Boston House Indigenous Forest (R.W. Phipson)	390	Boston
164	Hlomohlomo Cycad Colony (K. Odendaal)	30	Louwsburg
165	Gwala-Gwala Vryheidensis Colony (N.T. Van Rensburg)	5	Vryheid
166	Umvoti Estuary (Jex Estates, Mabenga Estates and C.G. Smith Sugar Ltd)	180	Stanger

Source: (i) After Anonymous, 1993. South African Natural Heritage Programme annual report 1992/1993, [Telemecanique South Africa Ltd and the Southern African Nature Foundation, Johannesburg], 41 p. (Brief details of each site are provided in the publication).

(ii) After the Natal Parks Board, Pietermaritzburg, 1993.

See also: (i) Cohen, M., 1989. Special tool for protection, Conserva, VOL 4(5), p. 4 - 5, 22.

(ii) Cohen, M., 1990. The South African Natural Heritage Programme, Environmental Planning and Management, VOL 1(3), p. 14 - 21.

6.7.5 Sites of Conservation Significance in Natal

The programme was designed to cater for sites of regional habitat as well as vegetation and wildlife significance, and which fall outside the parameters required for the South African Natural Heritage Programme. Both programmes are complementary, and the parcels of land serve as corridors or "stepping stones" between the larger protected areas such as game or nature reserves. Sites of Conservation Significance mainly involve private land. In Natal, the programme with 72 sites covering approximately 9 651 ha (Table F22), is administered by the Natal Parks Board with the support of the Department of Environment Affairs and FBC Holdings Ltd.

Table F22: Sites of Conservation Significance in Natal, 1993.

SCS site number	Site (owner/administrator)	Area (ha)	Locality
1	NTE Recovery Forest (P. Gardiner)	140	Pietermaritzburg
2	Mbabala Lodge (D. Deacon)	8,8	Port Edward
3	Fern Valley Botanic Garden (L. Riggall)	14	Kloof
4	T.C. Robertson Memorial Sanctuary (Scottburgh Municipality/Wildlife Society of Southern Africa)	20	Scottburgh
5	Roosfontein Nature Reserve (Queensburgh Municipality)	11	Queensburgh
6	Ramsgate Coastal Nature Reserve (Ramsgate Town Board)	55	Ramsgate
7	Lot 799 Southbroom (G.D. Philpott)	0,5	Southbroom
8	Paradise Valley Nature Reserve (Pinetown Municipality)	50	Pinetown
9	Krantzkloof Nature Reserve (portions of) (Kloof Municipality)	37	Kloof

Table F22: **Sites of Conservation Significance in Natal, 1993 (continued).**

SCS site number	Site (owner/administrator)	Area (ha)	Locality
10	Glenholm Gorge (Kloof Municipality)	11,6	Kloof
11	Circle Park Reserve (Kloof Municipality)	1,7	Kloof
12	Burman Bush Nature Reserve (Durban Municipality)	50	Durban
13	Danville Park Reserve (Durban Municipality)	8	Durban
14	Umgeni River and Estuary (Durban Municipality)	100	Durban
15	Seaton Park (Durban Municipality)	6	Durban
16	Umbilo River Valley Reserve (Durban Municipality)	100	Durban
17	Umhlatuzana River Valley (Durban Municipality)	150	Durban
18	Southern Coastal Park (Bluff) (Durban Municipality)	200	Durban
19	Virginia Bush Nature Reserve (Durban Municipality)	45	Durban
20	Banabo-Southbroom (J.M. Thorp)	0,6	Southbroom
21	Rennies - Remainder Lot 1016 Port Edward (A.A.B. Williams)	75	Port Edward
22	Braeside (C. Burden)	41	Hilton
23	Malandeni Bird Sanctuary (Ladysmith Municipality)	40	Ladysmith
24	Tourgar (M. Manson-Smith)	4,5	Pietermaritzburg
25	Bisley Valley Nature Reserve (Pietermaritzburg Municipality)	250	Pietermaritzburg
26	Ferncliffe Nature Reserve (Pietermaritzburg Municipality)	250	Pietermaritzburg
27	Worlds View (Pietermaritzburg Municipality)	350	Pietermaritzburg

Table F22: Sites of Conservation Significance in Natal, 1993 (continued).

SCS site number	Site (owner/administrator)	Area (ha)	Locality
28	Darvill Ponds and Bird Sanctuary (Pietermaritzburg Municipality, subsequently Umgeni Water)	220	Pietermaritzburg
29	Malden (J. Keny)	630	Otto's Bluff
30	Mondi-Klipfontein (Mondi Forests)	402	Lions River
31	Boschhoek Farm (P.A. Gallo)	1 000	Balgowan
32	Jesmond Dene (Jesmond Dene Nursery)	3	Pietermaritzburg
33	Umbogavango Nature Reserve (AECI Ltd)	38	Umbogintwini
34	Mamba Valley (AECI Ltd)	13	Umbogintwini
35	The Arboretum (AECI Ltd)	3,8	Umbogintwini
36	Cascades (P. Dickinson)	2	Lions River
37	Ravine Forest (H. Swanepoel)	60	Volksrust
38	Marsabit Forest (J. Pretorius)	10	Empangeni
39	Clouds (R. Wilson)	180	Underberg
40	Sangwana Mountain (D. Duke)	891	Underberg
41	Lammermoor (P. and T. Bester)	800	Underberg
42	Mzimkulwana Gorge (W. Bainbridge)	1	Underberg
43	Waterberry Wood (Ballitoville Municipality)	1	Ballitoville
44	Pigeon Wood (Ballitoville Municipality)	0,97	Ballitoville
45	Utopia Valley (Avo-Park Properties)	8	Pinetown

Table F22: **Sites of Conservation Significance in Natal, 1993 (continued).**

SCS site number	Site (owner/administrator)	Area (ha)	Locality
46	Roosfontein Nature Reserve (Westville Municipality)	150	Westville
47	Palmiet Nature Reserve (Westville Municipality)	80	Westville
48	Hebron Wetland (A.F.W. and J.L. Scott)	100	Kokstad
49	Giant's Cup Wilderness Reserve (Masubasuba Ltd)	110	Underberg
50	Fernwood Lodge (Fernwood Shareblock Ltd)	184	Winterton
51	Mansfield Vlei (W. Buhr)	15	Paddock
52	Lynmouth (D. Servant)	50	Baynesfield
53	Ilanda Wilds (Amanzimtoti Municipality)	30	Amanzimtoti
54	Westville Nature Trail (Westville Municipality)	30	Westville
55	Horseshoe Farm (W. Buhr)	9	Paddock
56	Old Lands (R.E. Turner)	16	Estcourt
57	Tala Conservation Site (M. Martens)	150	Pietermaritzburg
58	Hillside (Sappi Forests)	978	Melmoth
59	Kenbirch Bird Sanctuary (Hans Merensky Holdings)	50	Howick
60	Michaelhouse School (Michaelhouse Trustees)	245	Balgowan
61	Disa Site (W. Buhr)	0,003	Paddock
62	Swamp Forest (G.A. and C.H. Buhr)	3	Paddock
63	Mavuya (Sappi Forests)	300	KwaMbonambi

Table F22: **Sites of Conservation Significance in Natal, 1993 (continued).**

SCS site number	Site (owner/administrator)	Area (ha)	Locality
64	Fordoun (J. Bates)	500	Nottingham Road
65	Leucospermum Site (L.A. Rossler)	0,01	Paddock
66	Rutledge Park Grassland (Eshowe Municipality)	5	Eshowe
67	Epsom Wetland 1 (Sappi Forests)	15	Bulwer
68	Epsom Wetland 2 (Sappi Forests)	3	Bulwer
69	Epsom Indigenous Forest (Sappi Forests)	120	Bulwer
70	Comrie Wetland (Sappi Forests)	104,5	Bulwer
71	Mossbank Wetland (Sappi Forests)	50	Bulwer
72	Dublin Wetland (P. Roth)	70	Himeville

Source: (i) After the Natal Parks Board, Pietermaritzburg, 1993.

(ii) After Cohen, M., 1989. Sites of Conservation Significance Programme, Department of Environment Affairs and FBC Holdings Ltd, [Pretoria], 8 p.

6.7.6 Conservancies in Natal

A conservancy consists of a group of land owners (mainly on private land), who have pooled resources primarily for the purposes of conserving indigenous vegetation and wildlife on their properties. Most conservancies are situated in rural areas, although a few conservancies include both urban and non-urban land, or are purely urban. Several marine conservancies have been established in Natal, aimed at conservation of the beach and the adjacent sea area to a particular depth. The conservancy programme began in Natal and is now found throughout southern Africa. There are currently 154 conservancies in Natal (March 1994), covering an area of approximately 1 200 000 ha (Table F23). The Natal

Parks Board advises conservancies on management issues. A series of management plans is available in the Natal Parks Board Library, Pietermaritzburg.

Table F23: Conservancies in Natal, 1994.

Conservancy (owner/administrator)	Area (ha)	Locality
Aalwynkop (H. Kloppers)	8 000	Dundee
Addington (L.S. Raath)	2 500	Durban
Alverston (I. Buchan)	700	Botha's Hill
Beaumont-Eston Farmers' Association (M. Stainbank)	24 685	Eston
Balgowan (T. Lenton)	1 990	Balgowan
Ballito Marine (S.C. Bundy)	269	Ballitoville
Baynesfield (D. Youd)	10 000	Baynesfield
Bergville (C. Shepherd)	4 000	Bergville
Besters (L.R.S. Miller)	15 000	Besters
Bhop Bhop (V. Turner)	9 147	Underberg
Biggarsberg (R. Smit)	12 500	Wasbank
Blythedale (M. Marais)	4 998	Stanger
Boesmansklip (C. Zunckel)	1 500	Bergville
Bona Manzi (N. Fairhead)	4 000	Hluhluwe
Boschberg (O. Glutz)	8 500	Elandslaagte
Boschfontein (P. Durham)	8 000	Dundee
Boston (C. Speirs)	11 900	Boston

Table F23: **Conservancies in Natal, 1994 (continued).**

Conservancy (owner/administrator)	Area (ha)	Locality
Byrne Valley (P. Acutt)	120	Richmond
Clan	10 344	New Hanover
Colenso (H. Bosse)	7 000	Colenso
Crossroads Game (M. Meyer)	16 131	Cedarville
Davelshoek (A. Poustie)	2 800	Ladysmith
Dingaans Stad	7 911	Melmoth
Donnybrook (2) (P. Bosse)	2 700	Donnybrook
Doornberg (K. Joubert)	12 000	Dundee
Dumbe (R. Niebuhr)	25 300	Paulpietersburg
Dundee Agricultural Research Station (Department of Agriculture)	1 200	Dundee
Efaye	1 400	Greytown
Ennersdale (R. Emmanuel)	3 040	Estcourt
Eshowe (Coopers and Lybrand)	6 300	Eshowe
Everton	341	Gillitts
Gingindlovu (C. Olivier)	900	Gingindlovu
Glen-Shaka (P. Eb)	3 887	Shakaskraal
Goedehoop (J. Channing)	3 409	Muden
Golden Valley (D. Jansen)	3 000	Vryheid
Golden Reef	4 316	Melmoth
Gongolo (G.T. Fricke)	1 650	Mooi River
Greater Chatsworth (C. Pillay)	3 928	Durban

Table F23: **Conservancies in Natal, 1994 (continued).**

Conservancy (owner/administrator)	Area (ha)	Locality
Greytown (B. Hayes)	7 172	Greytown
Hansford (M. Talanda)	7 000	Dannhauser
Harding	10 000	Harding
Hattingspruit (L. Wichmann)	5 000	Hattingspruit
Heatonville (P. Rowland)	3 100	Heatonville
Helpmekaar (1) (C. Vermaak)	8 000	Helpmekaar
Hermanskraal (G.L. Ardendorff)	[?1 000]	Hermanskraal
Highflats	No data	Highflats
Hlambanyathi	2 600	Hluhluwe
Hlatikhulu (L. Robinson)	13 931	Estcourt
Hlomohlomo (J.J. Odendaal)	6 000	Dundee
Hluhluwe (P. Hassard)	20 352	Hluhluwe
Hydewood (A. Charnaud)	384	Ladysmith
Impenjati South (H. Martens)	2 814	Ramsgate
Indumeni	No data	Glencoe
Isibindi (R. Muller)	4 500	Dundee
Ivanhoe	4 000	Dargle
Izotsha (D.F. Wichmann)	1 422	Uvongo
Kamberg	16 891	Rosetta
Karkloof (2) (P. Shaw)	5 000	Karkloof
Kranskop (H.R. Konigkramer)	16 226	Kranskop

Table F23: Conservancies in Natal, 1994 (continued).

Conservancy (owner/administrator)	Area (ha)	Locality
Kwa Nzimela	4 220	Melmoth
Laloudefra (R. Bouwer)	2 127	Pongola
Leeukop (K. Landman)	8 000	Golela
Lenjane (C. MacCrimmon)	13 464	Vryheid
Lion's Bush (L. Butcher)	13 000	Nottingham Road
Little Tugela (G. Hatty)	8 000	Winterton
Llanwarne Estates (L. Nel)	12 000	Pongola
Lowlands (S. Renton)	33 250	Estcourt
Lowlands East (L. Mackay)	6 825	Estcourt
Macaranga (Denham King)	875	Paddock
Mahlatini (I. Crafford)	1 478	Mkuze
Maringo	1 000	Paddock
Mashudu Ranch (K.H.W. Engelbrecht)	2 500	Weltevreden
Masonite Draycott (G. Wiggill)	No data	Draycott
Masonite Greytown (I. Henderson)	7 000	Greytown
Masonite Ixopo (M.S. Dale)	11 124	Ixopo
Matatiele	8 000	Matatiele
Maydon Wharf (L. Lourens)	101	Durban
Mbona Mountain Estate (L.J. Peel)	No data	Howick
Melmoth (Coopers and Lybrand)	37 993	Melmoth

Table F23: **Conservancies in Natal, 1994 (continued).**

Conservancy (owner/administrator)	Area (ha)	Locality
Merrivale (A. Hanbury)	7 982	Merrivale
Mfuli	5 345	Melmoth
Mgobhozi (J. Van Wyk)	3 500	Vryheid
Mid Illovo (J. Oftebro)	10 491	Mid Illovo
Mkuzi Falls (J.J. Marais)	3 000	Pongola
Montrose (E. Muller)	800	Pomeroy
Monzi (K. Morrison)	5 939	Mtubatuba
Mooi River Valley (A. Malherbe/J. Alcock)	70 000	Mooi River
Mooi River West (G. Smith)	12 879	Mooi River
Mount Gilboa (G. Kelman)	7 000	Howick
Mount Royal (A.J. Green)	20 000	Bergville
Mpenjati	700	Margate
Mpushini (P.N. Long)	4 000	Mpushini
Ndawana (G. Devereaux)	6 250	Underberg
Ndumeni (P. Gunther)	20 000	Dundee
New Biggin (G. Taylor)	4 500	Underberg
New Germany Nature Areas (New Germany Municipality)	110	New Germany
Newlands	580	Paddock
Njomelwana	4 688	Melmoth
Nkanyezi (W. Robinson)	[? 600]	Estcourt

Table F23: **Conservancies in Natal, 1994 (continued).**

Conservancy (owner/administrator)	Area (ha)	Locality
Nkonkoni (N. Fairhead)	5 000	Hluhluwe
Nkwalini (Coopers and Lybrand)	8 000	Eshowe
Nooitgedacht (S.P. Van Heerden)	1 500	Vryheid
Nqabeni	1 500	Paddock
Nqumile (D. Marais)	2 100	Pongola
Nseleni (B. Pike)	5 750	Empangeni
Nsubeni (G.C. Viljoen)	4 476	Babanango
Ntabazwa (A. Mitchell)	7 384	Impendle
Ntonjaneni	7 354	Melmoth
Nyalazi (N.R. Dobeyn)	35 000	Mtubatuba
Nyamakazi (C.A. Seele)	3 468	Baynesfield
Nyoni	5 675	Mandini
Oribi (P. Tolmay)	160	Port Shepstone
Paapkuilsfontein (J. Van der Merwe)	1 313	Estcourt
Paddock Plains	8 000	Paddock
Pinetown Nature Areas (A. Baker)	100	Pinetown
Renishaw (N. Hughes)	9 500	Renishaw
Richmond (Mgwempise) (M. Sykes)	10 300	Richmond
Roldan (M.J. Kimber)	2 500	Dargle
Rondebosch (A. Nel)	2 500	Pongola

Table F23: **Conservancies in Natal, 1994 (continued).**

Conservancy (owner/administrator)	Area (ha)	Locality
Rooderaay (P. Quested)	5 002	Estcourt
San Lameer (C. Andrews)	78	Southbroom
Sappi (Saligna)	86 793	Richmond
Seaview (A. Smyth)	2 700	Port Edward
Seaview Marine (J. Storm)	1 000	Port Edward
Seven Oaks (J. Maartens)	2 128	Seven Oaks
Sezela Wildlife (K.D. Humphrey)	16 500	Sezela
Shukuza Game Ranch (V. Meyer)	840	Mkuze
Smeertrouw (J. Labuschagne)	1 000	Hattingspruit
Sunset Rest (P. Johnson)	4 500	Glencoe
Sutherland (J. Van Zyl)	900	Pomeroy
Tendeni (P.D. Ivins)	1 500	Highflats
The Valley (E. Antel)	14 700	Baynesfield
Trans Athalia (J. Steenkamp)	No data	Pongola
Tsonga Vlei (T. Theron)	2 000	Rosetta
Two Rivers (I. Bryden)	23 000	Kokstad
Tygerskloof (L. Bartlett)	12 000	Vryheid
Umdloti Marine (J. Maeyer)	74	Umdloti
Umfolozi (N. Harris)	5 600	Melmoth
Umfuli	700	Umfuli

Table F23: Conservancies in Natal, 1994 (continued).

Conservancy (owner/administrator)	Area (ha)	Locality
Umgenyane (D. Armitage)	7 100	Umgenyane
Umhlali (D.K. Duane)	5 000	Umhlali
Umhlanga (Umhlanga Rocks Municipality)	1 340	Umhlanga Rocks
Umkopozi (I.C. Vorster)	800	Vryheid
Umvoti Vlei	7 000	Seven Oaks
Umvozana	11 000	Greytown
Umzumbe (D. Campbell)	4 563	Umzumbe
Valhalla (Helpmekaar 2) (D. Pedrelli)	2 000	Dundee
Vants Drift (L. Joubert)	10 000	Dundee
Wagendrift (E. Portsmouth)	983	Estcourt
Westville Nature Areas (Westville Municipality)	246	Westville
Zietover	4 159	Melmoth
Zinkwazi (B. Hagemann)	315	Zinkwazi
Zonyama (I. Goss)	12 500	Pongola

Source: After the Natal Parks Board, Pietermaritzburg, 1994.

See also:

(i) Kotzé, S., 1993. Conservancies in Natal, 1978 - 1993: the origins and application of a component in informal wildlife conservation, B.A. (Hons) Thesis, Department of Historical Studies, University of Natal, Pietermaritzburg, 91 p.

(ii) Penzhorn, B.L. (ed), 1994. The future role of conservancies in Africa?, Wildlife Monograph No. 1, Du Toit Game Services (Pty) Ltd, Pretoria, 54 p. (The publication provides a useful southern African perspective, where "conservancies" also include formally protected areas - such as game and nature reserves).

Note:

(i) The number and size of individual conservancies may vary from year to year.

(ii) A few conservancies extend into KwaZulu. Such conservancies are beginning to assume the role of general development agencies, by addressing socio-economic issues of local importance (including water supplies).

(iii) The Natal Conservancies Newsletter contains further information on conservancies. The first issue appeared in 1983. The publication may be ordered from the Natal Conservancies Association, 29 Oakleigh Drive, Howick, 3290. (Urban conservancies do not pay an affiliation fee to the Association. The emphasis in urban conservancies is mainly directed at overall environmental control, for example, the removal of rubbish found in open spaces and rivers).

(iv) The greatest concentration of conservancies is in the Melmoth area (near Eshowe), where the numerous individual conservancies are managed as one unit.

For further information consult the following:

Note: The list of management plans below is not exhaustive. The Natal Parks Board subsequently suspended the compilation of formal management plans. Management and other data however, are available from individual conservancies.

- Markham, R.W., undated. Boston Conservancy, VOL 1, Natal Parks Board, Pietermaritzburg, 62 p.
- Markham, R.W., 1983. Lowlands East Conservancy, Natal Parks Board, Pietermaritzburg, 53 p.
- Markham, R.W., 1983. The Mooi River West Conservancy, Natal Parks Board, Pietermaritzburg, 34 p. + app.
- Markham, R.W., 1984. Caversham Conservancy, Natal Parks Board, Pietermaritzburg, 52 p.
- Markham, R.W., 1984. Mid Illovo Conservancy, Natal Parks Board, Pietermaritzburg, 46 p.

- Markham, R.W., 1984. Upper Mvoti Conservancy, Conservancy Management Guidelines, Natal Parks Board, Pietermaritzburg, 49 p. and map.

- Markham, R.W., 1985. Baynesfield Wildlife Conservancy management guidelines, VOL 1, Natal Parks Board, Pietermaritzburg, 62 p.

- Markham, R.W., 1985. Besters Conservancy, Natal Parks Board, Pietermaritzburg, 62 p.

- Markham, R.W., 1985. Dargle Conservancy, Natal Parks Board, Pietermaritzburg, 63 p.

- Markham, R.W., 1985. Mooi River Valley Conservancy: game mammal management guidelines, Natal Parks Board, Pietermaritzburg, 25 p.

- Markham, R.W., 1985. Paddock/Plains Conservancy, VOL 1, Natal Parks Board, Pietermaritzburg, 62 p.

- Markham, R.W., 1985. Ripplemead Conservancy, VOL 1, Natal Parks Board, Pietermaritzburg, 62 p.

- Markham, R.W., 1985. Seaview Conservancy, Natal Parks Board, Pietermaritzburg, 70 p.

- Markham, R.W., 1985. Umgenyane Conservancy, VOL 1, Natal Parks Board, Pietermaritzburg, 62 p.

- Markham, R.W., 1986. Establishing a wildlife conservancy, Wildlife Management Technical Guides for Farmers No. 18, Natal Parks Board, Pietermaritzburg, 2 p.

- Markham, R.W., 1986. Merrivale Conservancy management guidelines, VOL 1, Natal Parks Board, Pietermaritzburg, 62 p.

- Markham, R.W., 1987. The Boston Conservancy management guidelines, VOL 2: the Elands River Floodplain and associated wetlands, Natal Parks Board, Pietermaritzburg, 20 p.

- Markham, R.W., 1988. Beaumont-Eston Farmers' Association Conservancy, Natal Parks Board, Pietermaritzburg, 62 p.

- Markham, R.W., 1988. Umzumbe Conservancy, VOL 1, Natal Parks Board, Pietermaritzburg, 62 p.

- Price, M.A., 1982. The Eston-Beaumont Conservancy, Natal Parks Board, Pietermaritzburg, 39 p. + app.

- Price, M.A. and Collinson, R.H.F., 1982. The Balgowan Conservancy, Natal Parks Board, Pietermaritzburg, 35 p.

6.7.7 Metropolitan Open Space System (M.O.S.S.) areas in Natal

M.O.S.S. *areas have been established in Pietermaritzburg and the Durban Functional* Region, as well as in Empangeni and Richards Bay. M.O.S.S. areas are urban conservation zones - which together with Open Space Systems linking such conservation areas - form a cohesive network of continuous green belts. Examples of M.O.S.S. areas include municipal parks and parcels of land with remnants of indigenous vegetation, as well as proclaimed municipal and Natal Parks Board nature reserves, and small unproclaimed nature conservation areas. The purpose of M.O.S.S. areas is inter alia to protect and sustain species; to maximize biological diversity by linking open spaces; to provide scenic variety and "green relief" in the built-up environment, and to prevent the deterioration of water quality via, for instance, a reduction in soil erosion. Certain M.O.S.S. areas will be given formal conservation status in the future. M.O.S.S. areas are not discussed further in this publication.

For further information contact:

- Department of Parks, Beaches and Recreation, Durban Corporation, P O Box 3740, Durban, 4000 (the D'M.O.S.S. - Durban M.O.S.S. concept).

- Natal Town and Regional Planning Commission, Private Bag X9038, Pietermaritzburg, 3200 (various unpublished reports are available).

- Wildlife Society of Southern Africa (Natal Branch), P O Box 2985, Durban, 4000 (some unpublished reports are available).

<u>See also</u>:

- Anonymous, 1977. Natural areas in towns: a symposium held in the Lecture Theatre at the Aquarium, Lower Marine Parade, Durban on Friday and Saturday 24th and 25th June 1977, Natal Branch of the Wildlife Society of Southern Africa and the Natal Town and Regional Planning Commission, Durban, 157 p.

- Anonymous, 1984. Durban Metropolitan Open Space System: the proceedings of a seminar organized by the Natal Town and Regional Planning Commission and the Wildlife Society of Southern Africa (Natal Branch), Natal Town and Regional Planning Commission Supplementary Report, VOL 10, Pietermaritzburg, 63 p. and map.

- Anonymous, 1987. Durban Metropolitan Open Space System: the proceedings of a seminar, February 1987, Natal Town and Regional Planning Commission Supplementary Report, VOL 24, Pietermaritzburg, 87 p. and map.

- Anonymous, 1989. D'MOSS: Durban Metropolitan Open Space System, Department of Parks, Beaches and Recreation, Durban Corporation, Durban, 96 p.

- Anonymous, 1989. Pietermaritzburg Metropolitan Open Space System: the proceedings of a seminar, June 1988, Natal Town and Regional Planning Commission Supplementary Report, VOL 34, Pietermaritzburg, 34 p.

- Cawood, B.G., 1980. Open space areas of Greater Durban: a preliminary survey, Natal Town and Regional Planning Commission Report, VOL 45, Pietermaritzburg, 46 p. and map.

- Cooper, K., 1991. The importance of urban conservation areas, African Wildlife, VOL 45(2), p. 91 - 95.

- Cooper, K. [Chairman], 1994. MOSS: Metropolitan Open Space Systems International Conference, "Putting Plans Into Action" - report of proceedings, IUCN (World Conservation Union), the Wildlife Society of Southern Africa and the Durban City Council, 9 - 11 February 1994, Durban, 146 p. (The "Agenda 21" concept is discussed in the proceedings. Briefly, Agenda 21 refers to a United Nations inspired programme for the formulation of practical (sustainable) management strategies inter alia for the urban and near-urban environment. All stake-holders such as local authorities and various interest groups are encouraged to negotiate local environmental and development issues including open space planning. Besides the Local Agenda 21 concept, the programme also operates on a national and international level. Three South African cities, namely, Johannesburg, Cape Town and Durban are currently engaged in formulating Local Agenda 21 policies)*.

- M.O.S.S. Newsletter (No. 1, January 1984 - No. 11, March 1988), published by the Wildlife Society of Southern Africa (Natal Branch), Durban.

- Nicolson, G., 1987. Towards a plan for the Durban Metropolitan Open Space System, Natal Town and Regional Planning Commission Report, VOL 70, Pietermaritzburg, 24 p. and map.

6.7.8 State forests in Natal and conservation areas within the forests

The relevant information is presented in Tables F24 and F25.

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* For a further perspective see, Walmsley, R.D. and Botten, M.L. (eds), 1994. Cities and sustainable development: a South African report on the Global Forum '94 Conference: Cities and Sustainable Development (Manchester, 24 - 28 June 1994), Foundation for Research Development and the Department of Environmental Affairs and Tourism, Pretoria, 27 p. See also, Anonymous, 1995. Urban open space: guidelines for effective management - discussion document based on Agenda 21 and the RDP, 1, Department of Environmental Affairs and Tourism and Technikon Pretoria, Pretoria, 24 p.

6.7.9 Protected areas and indigenous forests in KwaZulu

Refer to Tables F26 and F27.

Table F24: State forests including wilderness areas in Natal, controlled by the Natal Parks Board, 1994.

Forest/wilderness area	Area (ha)	Date of proclamation	Locality
Natal Drakensberg Park			
Cathedral Peak State Forest (Mdedelelo Wilderness Area; Mlambonja Wilderness Area)	32 246	1927	Winterton
Cobham State Forest (Mkhomazi Wilderness Area; Mzimkhulu Wilderness Area)	30 498	1927	Himeville
Garden Castle State Forest (Mzimkhulu Wilderness Area)	30 766	1951	Underberg
Highmoor State Forest (Mkhomazi Wilderness Area)	28 151	1951	Rosetta
Mkhomazi State Forest (Mkhomazi Wilderness Area)	49 156	1951	Rosetta
Monk's Cowl State Forest (Mdedelelo Wilderness Area)	20 379	1927	Winterton
Little Berg area			
Fort Nottingham State Forest	140	1909	Nottingham Road
iGxalingenwa State Forest	1 500	1906	Creighton
Indhloveni State Forest	30	1909	Bulwer
iNgelabantwana State Forest	338	1904	Bulwer
Kwa Yili State Forest	677	1906	Creighton
Marutswa State Forest	268	1904	Bulwer
Marwaqa State Forest	365	1904	Bulwer
Xotsheyake State Forest	98	1904	Bulwer
Coastal area			
Cape Vidal State Forest	11 313	1956	St Lucia
Dukuduku State Forest (which includes the Umfolozi Swamps State Forest) (see Footnote (iii) of Table F25)	13 332	1923	Mtubatuba

Table F24: ***State forests including wilderness areas in Natal, controlled by the Natal Parks Board, 1994 (continued).***

Forest/wilderness area	Area (ha)	Date of proclamation	Locality
Eastern Shores State Forest	12 873	Consolidated in 1976	St Lucia
Mehlomnyana State Forest	157	1908	Port Shepstone
Mhlatuze State Forest	1 103	1953	St Lucia
Nyalazi State Forest	1 367	1956	Hluhluwe
Sodwana State Forest	47 127	1956	Sodwana

Source: (i) After the Natal Parks Board, Pietermaritzburg, 1994.

(ii) Fieldwork.

See also: (i) Anonymous, 1974. Register of permanent conservation areas in South and South West Africa (August 1973), Koedoe, No. 17, p. 85 - 119.

(ii) Greyling, T. and Huntley, B.J. (eds), 1984. Directory of southern African conservation areas, South African National Scientific Programmes Report No. 98, Foundation for Research Development, CSIR, Pretoria, 311 p.

(iii) Walker, R.S., Bainbridge, W.R. and Scott, D.F., 1986. Policy statement for the Drakensberg State forests, Forestry Branch, Department of Environment Affairs, Pietermaritzburg, 112 p.

Note: (i) Several State forests controlled under the Forest Act No. 122 of 1984 and previously managed by the Department of Environment Affairs/Department of Water Affairs and Forestry (up to 1988/89 in some cases and 1992/93 in others), are now managed by the Natal Parks Board and are listed above. In reality, control of the State forests was devolved to the Administrator of Natal, who in turn delegated management powers to the Natal Parks Board.

(ii) State forests also include grasslands. Only the total area of the entire "State forest" is given in the table.

(iii) So-called Recreation Areas were established in the Cape Vídal and Eastern Shores State forests (with effect from the 14th of April 1977), and are also managed by the Natal Parks Board. Such areas were previously managed by the then Department of Forestry.

(iv) The Cathedral Peak Research Area situated in the Cathedral Peak State Forest does not have nature reserve or wilderness area status.

(v) Wilderness areas have the highest conservation rating of all protected areas, and are virtually uninhabited and undeveloped - hence the term "wild". No roads, dwellings or other visible signs of human economic activity are permitted. The respective sizes and proclamation data of the Natal Parks Board mountain wilderness areas are as follows. See also Table F25 (the Ntendeka Wilderness Area).

Wilderness area	Area (ha)	Proclaimed and amended in terms of Government Notice (GN)
Mdedelelo	27 000	GN 791/73 (in terms of the since repealed Forest Act No. 72 of 1968)
Mkhomazi	56 155	GN 791/73 and GN 962/89 (in terms of the since repealed Forest Act No. 72 of 1968 and the (current) Forest Act No. 122 of 1984)
Mlambonja	6 270	GN 961/89 (in terms of the Forest Act No. 122 of 1984)
Mzimkhulu	28 340	GN 1563/79 (in terms of the since repealed Forest Act No. 72 of 1968)

Note: Some of the wilderness areas encompass portions of more than one State forest.

Table F25: Conservation areas in Natal State forests, controlled by the Department of Water Affairs and Forestry, 1993.

Site	Area (ha)	Year of proclamation	Locality
Ngome State Forest (Ntendeka Wilderness Area)	5 230 (of which 2 594 ha is grassland)	1905	Louwsburg
Nkonzo State Forest		-	Creighton
Primary conservation area			
Hlabeni Forest	410	1904	
Ngoningoni Forest	100	?1904	
Ngwangwane (Mkanzeni) Forest	160	1904	
Sarnia State Forest		1904	Donnybrook
Primary conservation area			
Nxumeni Forest	360	1904/1922	
Weza State Forest		1904	Harding
Primary conservation area			
Ngele Forest	800 (of which 80 ha is grassland)	1904	
Ngele Mountain	3 335 (of which 2 200 ha is grassland)	1904	

Source: After the Department of Water Affairs and Forestry, Pietermaritzburg, 1993.

Note: (i) Many State forests are commercial plantations and are not regarded as conservation areas. Areas listed above refer to conserved land only, containing indigenous vegetation (10 395 ha). The Department of Water Affairs and Forestry has shifted the focus in extension from promoting commercial forestry to promoting rural forestry, including agroforestry, and the establishment of woodlots for firewood and building materials. A greater emphasis will accordingly be placed on the prevention of environmental degradation. The Forestry Branch of the Department in association with Progreen (Trees for Africa), P O Box 2035, Gallo Manor, 2052, aims to implement some 3 000 rural forestry projects during the next decade. A programme to plant a minimum of 1 000 trees in every "treeless" black township in South Africa is also envisaged*.

(ii) The former Dargle State Forest near Howick with an indigenous conservation area of 42 ha, is now managed by the South African Forestry Company (SAFCOL) Ltd, P O Box 428, Pretoria, 0001. The company was established on the 1st of April 1993, to manage (former) State commercial pine plantations on a profit basis. The company currently controls commercial plantations with an area of approximately 260 000 ha spread throughout South Africa, constituting some 20% of all commercial forests (estimated at 1 200 000 ha in total). The Gala Forest (with an indigenous conservation area of 50 ha) forming part of the Sarnia State Forest, is also managed by SAFCOL Ltd. Part of the Ngele Mountain (excluding the primary conservation area), is likewise managed by SAFCOL. For further details on SAFCOL see, Anonymous, 1993. Wins en bewaring is SAFCOL se doelwitte, Conserva, VOL 8(4), p. 22 - 23.

(iii) The Mihobi Nature Reserve with an area of 162 ha situated in the Dukuduku State Forest near Mtubatuba (and formerly managed by the Department of Water Affairs and Forestry) was, together with the entire forest, subsequently assigned to the Administrator, Natal Provincial Administration. The most recent legislation (Proc 96/92, Proc 97/92, Proc 9/93 and (Natal) Administrator-in-Executive Committee Resolution No. 1008 of the 15th of December 1993), provides for the control of the area (excluding the Futululu Forestry Research Station) by the Natal Parks Board. Difficulties have arisen due to widespread squatting in the Dukuduku Forest. See Anonymous, 1991. Settlement of the Dukuduku State Forest, Monitor, No. 12, First Quarter 1991, p. 10 - 11.

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* For a discussion of these issues, see Gandar, M.V., 1984. Wood as a source of fuel in South Africa, South African Forestry Journal, No. 129, June 1984, p. 1 - 9., and Gandar, M., 1994. Afforestation and woodland management in South Africa, South African Energy Policy Research and Training Project, EPRET Paper No. 9, Energy for Development Research Centre, University of Cape Town, Rondebosch, 104 p., as well as Eberhard, A.A., 1992. Shifting paradigms in understanding the fuelwood crisis: policy implications for South Africa, Journal of Energy R and D in Southern Africa, VOL 3(2), p. 19 - 25. See in addition: Van Horen, C., Afrane-Okese, Y., Eberhard, A., Trollip, H. and Williams, A., 1993. Energy poverty in South Africa: widening access to basic energy services, Project for Statistics on Living Standards and Development, Southern Africa Labour and Development Research Unit, University of Cape Town, Rondebosch, 188 p. See also, Anonymous, 1994. Trees for the people - Plant for Life, Wood Southern Africa and Timber Times, VOL 19(10), p. 19 - 21., and Dyer, S.T., 1996. Fuelwoods used in rural South Africa, Development Southern Africa, VOL 13(3), p. 485 - 494.

Table F26: Game, nature, forest and freshwater reserves in KwaZulu, 1993.

Game, nature, forest and freshwater reserve (KwaZulu district)	Area (ha)	Proclaimed in terms of the KwaZulu Nature Conservation Act No. 8 of 1975 under the following KwaZulu Government Notices (GN)
Game reserve		
Ndumo Game Reserve (Ingwavuma)	10 000	GN 132/88
Ophathe Game Reserve (Mtonjaneni)	8 826	GN 289/91
Nature reserve		
Amatikulu Nature Reserve (Ongoye)	1 477	GN 219/87
Dhlabe Nature Reserve (Nkandla)	121	GN 18/92
Edodweni Nature Reserve (Nkandla)	101	GN 45/92
Hlatikhulu Nature Reserve (North) (Ingwavuma)	1 213	GN 95/87
Hlatikhulu Nature Reserve (near Qudeni Forest Reserve) (Nkandla)	405	GN 50/92
Matshitsholo Nature Reserve (Mahlabathini)	493	GN 38/93
Mndunduzeli Nature Reserve (Nkandla)	142	GN 46/92
Mome Nature Reserve (Nkandla)	606	GN 16/92
Red Hill Nature Reserve (Mtunzini)	236	GN 63/92
Sibudeni Nature Reserve (Nkandla)	202	GN 17/92
Sileza Nature Reserve (Ingwavuma)	2 124	GN 9/92
Talmage Pan Nature Reserve (Mtunzini)	388	GN 18/93
Tembe Elephant Park (Ingwavuma)	30 013	GN 17/93
Ubombo Mountain Nature Reserve (Ubombo)	1 714	GN 64/92
Vungwini Nature Reserve (Nkandla)	404	GN 19/92
Forest reserve		
Coastal Forest Reserve including Kosi Bay Nature Reserve (Ubombo)	21 772	GN 97/92
Dengwini Forest Reserve (Mtunzini)	322	GN 35/92
Ezigwayini Forest Reserve (Mtunzini)	16	GN 33/92
Impeleshu Forest Reserve (Mtunzini)	44	GN 34/92

Table F26: ***Game, nature, forest and freshwater reserves in KwaZulu, 1993 (continued).***

Game, nature, forest and freshwater reserve (KwaZulu district)	Area (ha)	Proclaimed in terms of the KwaZulu Nature Conservation Act No. 8 of 1975 under the following KwaZulu Government Notices (GN)
Manguzi Forest Reserve (Ubombo)	237	GN 50/93
Ngoya Forest Reserve (Mtunzini)	3 903	GN 36/92
Nkandla Forest Reserve (Nkandla)	2 217	GN 37/92
Qudeni Forest Reserve (Nkandla)	2 357	GN 55/92
Freshwater reserve		
Lake Sibaya Freshwater Reserve (lake surface area only) (Ubombo)	7 218	Pending

Source: (i) After Nicholson, C.R. and Jenkin, F., 1992 (on-going). The Laws of KwaZulu: a Compilation of All the Acts, Regulations, Proclamations and Government Notices Relating to the Self-governing Territory of KwaZulu, VOL 3, Metis Publications Law Service, Durban, various pages.

(ii) After the KwaZulu Bureau of Natural Resources (now the KwaZulu Department of Nature Conservation), Ulundi, 1993.

See also: Evans, A., Johnson, P.A. and Lawson, D., 1986. The identification and investigation of land for conservation and recreation potential in southern KwaZulu, INR Investigational Report No. 24, Institute of Natural Resources, University of Natal, Pietermaritzburg, 769 p.

Note: (i) The boundaries (and other details) of each reserve are given in the relevant Official Gazette: KwaZulu Government Service. Legally protected land constitutes some 2,5% of KwaZulu, assuming a total land area for KwaZulu of 36 074 km^2.

(ii) The Drakensberg Mountain Catchment Area in the Upper Tugela Location (50 000 ha), above the ACB (Administrative Catchment Boundary) line, is in the process of being proclaimed. The line was established by the then Department of Forestry, the Natal Provincial Administration and the KwaZulu Government. The line represents the boundary of the critical zone for catchment management purposes.

(iii) A further programme, that of Community Conservation Areas (CCAs), was initiated in 1985. Community Conservation Areas are areas of special resource significance, which are voluntarily withdrawn from other forms of land use, and are managed by the community with the assistance of the KwaZulu Department of Nature Conservation. Areas to be proclaimed as CCAs include the Matshenezimpisi CCA (800 ha) near the town of Nkandla; Mangidini CCA (1 200 ha) near Eshowe; Dwebu Hill CCA (± 400 ha) near Highflats, and Makhanya CCA (± 500 ha) near Amanzimtoti. The Matshitsholo Nature Reserve will be re-proclaimed as a tribal game reserve in due course. The Mabaso Tribal Game Reserve (1 200 ha) situated on the shores of Lake Sibaya in the Ubombo District is in the process of being proclaimed. Tribal game/nature reserves are CCAs which contain the larger wild animals.

Table F27: Some proclaimed indigenous forests in KwaZulu.

Forest	*Area (ha)*	*Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936*
Bergville District		
Bobe Forest	35	GN 1489/50
Chobeni Forest	21	GN 1489/50
Ebuhohobeni Forest	36	GN 1489/50
Ehlatini Elikulu Forest	23	GN 1489/50
Elengwe Forest	34	GN 1489/50
Emagebeni Forest	73	GN 1489/50
Emahlabasifuba Forest	55	GN 1489/50
Emakhuzeni Forest	41	GN 1489/50
Endhlangu Forest	56	GN 1489/50
Engunjini Forest	98	GN 1489/50
Enkwazini Forest	70	GN 1489/50
Enkwazini "b" Forest	24	GN 1489/50
Eshiyana Forest	35	GN 1489/50

Table F27: Some proclaimed indigenous forests in KwaZulu (continued).

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Esifini Forest	28	GN 1489/50
Etsheni Chilaenhla Forest	22	GN 1489/50
Eweni Elibomvu Forest	98	GN 1489/50
Eweni Emajuba Forest	27	GN 1489/50
Exholini Forest	27	GN 1489/50
Fuzindhlu Forest	147	GN 1489/50
Hlatikulu Forest	41	GN 1489/50
Hlokwana Forest	52	GN 1489/50
Indabulo Forest	45	GN 1489/50
Indanyana Forest	35	GN 1489/50
Indhlukayivalwa Forest	101	GN 1489/50
Kamhlophe Forest	75	GN 1489/50
Kanokudelela Forest	28	GN 1489/50
Kanomdumo Forest	28	GN 1489/50
Konomshemulwana Forest	18	GN 1489/50
KwaGalela Forest	20	GN 1489/50
KwaMade Forest	37	GN 1489/50
Kwelengwe Forest	9	GN 1489/50
Lasitakwe Forest	26	GN 1489/50
Mabamba Forest	28	GN 1489/50
Mtimkulu Forest	141	GN 1489/50
Nozidwaba Forest	84	GN 1489/50
Oqalweni Forest	37	GN 1489/50
Qhowaha Forest	23	GN 1489/50
	Total 1 778	

Table F27: Some proclaimed indigenous forests in KwaZulu (continued).

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Camperdown District		
Madwabane Forest	63	GN 805/50
Mangethenge Forest	151	GN 805/50
Maqadini Forest	138	GN 805/50
Nyuswa Forest	30	GN 805/50
	Total 382	
Empangeni District		
Bonambi and Sokulu forests	9 401	GN 1301/49
Eshowe District		
Amatikulu Forest Reserve	704	GN 163/18
Budubudu No. 1 Forest	8	GN 373/53
Budubudu No. 2 Forest	7	GN 373/53
Bunge Forest	10	GN 373/53
Dingi Forest (Reserve No. 20)	11	GN 779/54
Dokodweni Forest (Reserve No. 20)	4	GN 779/54
Emadwaleni Forest	5	GN 373/53
Emalini Forest	13	GN 373/53
Emwomdeni Forest	48	GN 373/53
Ensimagweni Forest	6	GN 373/53
Entumeni Trust Forest Reserve (Bongosi, Manjithole and Udukweni forests)	207	GN 408/43; GN 133/46

Table F27: Some proclaimed indigenous forests in KwaZulu (continued).

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Forest A (Mome area)	607	GN 902/48
Forest B (Vungwini area)	405	GN 902/48
Forest C (Sibudeni area)	202	GN 902/48
Forest D (Dhlabe area)	121	GN 902/48
Forest E (Edhlodhlweni area)	101	GN 902/48
Forest F (Mndunduzeli area)	142	GN 902/48
Forest G (Hlatikulu area)	405	GN 902/48
Hlathukulu No. 1 Forest (Reserve No. 20)	12	GN 779/54
Hlathukulu No. 2 Forest (Reserve No. 20)	5	GN 779/54
Hlatikulu Forest	91	GN 267/48
Ivuta Forest	101	GN 267/48
Kabonhoso Forest	7	GN 373/53
Khayinae Forest	4	GN 373/53
KwaMachungco Forest	3	GN 373/53
Lot No. 65 Amatikulu Forest (Oliver's Mount Settlement)	11	GN 267/48
Makwakazi Forest	2	GN 1449/51
Mapata Forest	34	GN 267/48
M. Bendeni No. 1 Forest	12	GN 373/53
M. Bendeni No. 2 Forest	10	GN 373/53

Table F27: Some proclaimed indigenous forests in KwaZulu (continued).

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Ncunjeni Forest (Indulindi area)	142	GN 877/48
Nonkolombelana Forest	4	GN 373/53
Senkontje Forest	51	GN 267/48
Umfulo Forest	2	GN 373/53
Umgobozo Forest (Reserve No. 20)	5	GN 779/54
Wevuma Forest	6	GN 373/53
	Total 3 508	
Estcourt District		
Bosch Forest (Drakensberg Location No. 1)	245	GN 1875/52
Kwa Jack Forest (Drakensberg Location No. 2)	93	GN 1875/52
Ntabamhlope Forest (Drakensberg Location No. 1)	22	GN 1022/48
	Total 360	
Greytown District		
Ekwakwa Forest	48	GN 1166/54
Sigubudu Forest	34	GN 1166/54
Uphatha Forest	32	GN 1166/54
	Total 114	
Harding District		
Bazini Forest (Location No. 1)	217	GN 2081/48
Ehlongosi Forest (Location No. 1)	138	GN 2081/48

Table F27: Some proclaimed indigenous forests in KwaZulu (continued).

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Impetyne Forest (Division of Alfred)	33	GN 966/11
Manoba Forest *(Location No. 1)*	40	GN 2081/48
Mhlangwini Forest (Location No. 1)	117	GN 2081/48
	Total 545	
Hlabisa District		
Dukumbane Forest	13	GN 58/53
Emakhowe Forest	11	GN 58/53
Esihaqayini Forest	6	GN 58/53
Imbube Forest	3	GN 58/53
Impembeni Forest	155	GN 58/53
Inholohotoho Forest	8	GN 58/53
Inzimane Forest	4	GN 58/53
Isiwohlo Forest	21	GN 58/53
KwaBamba Forest	10	GN 58/53
Kwelomantombazane Forest	79	GN 58/53
Mankayana Forest	29	GN 58/53
Mquthungu Forest	54	GN 58/53
Ntombazi Forest	17	GN 58/53
Ogojwana Forest	45	GN 58/53
Qansa Forest	10	GN 58/53
Sikulukulu Forest	27	GN 58/53
Umudekaza Forest	8	GN 58/53
Wenzimane Forest	4	GN 58/53
	Total 504	

Table F27: Some proclaimed indigenous forests in KwaZulu (continued).

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Ingwavuma and Ubombo districts		
Hlatikulu Forest	1 139	GN 1381/49
Macambeya Forest	40	GN 17/53
Malangeni Forest	5 802	GN 487/50
Manhlali Forest (Reserve No. 16)	243	GN 1160/52
Mbazwana Forest (Trust Plantation Reserve No. 14)	17 892	GN 1158/59
Ntshangase Forest (Reserve No. 16)	222	GN 1160/52
Sikulukulu Forest (Reserve No. 16)	159	GN 1160/52
Sileze Forest	436	GN 487/50
Swanku Forest (Reserve No. 16)	431	GN 1160/52
Umbaswana Forest (Reserve No. 14)	1 168	GN 1159/52
	Total 27 532	
Ixopo District		
Deepvale Reserved Trust Forest	-	GN 549/46
Ntakamu Forest	181	GN 18/53
	Total 181	
Kranskop District		
Ekhwapheni Forest	56	GN 1776/51
KwaMbemiso Forest	44	GN 1776/51
Mbobombili Forest	12	GN 1776/51

Table F27: Some proclaimed indigenous forests in KwaZulu (continued).

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Qhola Forest	121	GN 1776/51
	Total 233	
Lower Umfolozi District		
KwaMbonambi Forest Reserve (Reserve No. 2)	4 832	GN 89/22
Maphumulo District		
Elomzila Forest	30	GN 1984/51
Emcakweni Forest	158	GN 1984/51
Engobe Forest (Isidumbeni Mission Reserve)	30	GN 1158/52
Enxiweni Forest	68	GN 1984/51
Esilevine Forest	65	GN 1984/51
Esithundu Forest	71	GN 1984/51
Etsheni Lengwenya Forest (Isidumbeni Mission Reserve)	22	GN 1158/52
Hlathi Forest	54	GN 1984/51
Ingobencane Forest (Isidumbeni Mission Reserve)	17	GN 1158/52
Iqubu Forest	52	GN 1984/51
Khanula Forest	71	GN 1984/51
Khanyile Forest	109	GN 1984/51
KwaNhlebi Forest (Isidumbeni Mission Reserve)	9	GN 1158/52
Kazwa Ngesisu Forest (Isidumbeni Mission Reserve)	11	GN 1158/52
Malibekeni Forest	169	GN 1984/51
Masoba Forest	208	GN 1984/51

Table F27: Some proclaimed indigenous forests in KwaZulu (continued).

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Mathole Ampunga Forest	9	GN 1984/51
Mbudwini Forest	66	GN 1984/51
Ngiyemuka and Nkandla Forest (Isidumbeni Mission Reserve)	182	GN 1158/52
Nombokojwana Forest	191	GN 1984/51
Onhlali Forest (Isidumbeni Mission Reserve)	22	GN 1158/52
Ozwathini Forest	38	GN 1984/51
Shaka Forest	92	GN 1984/51
Sisu Sikhulu Forest (Isidumbeni Mission Reserve)	6	GN 1158/52
Umhlali Forest (Isidumbeni Mission Reserve)	18	GN 1158/52
Umntwana Oziphayo Forest	20	GN 1984/51
Usompungana Forest No. 1	15	GN 1984/51
Usompungana Forest No. 2	17	GN 1984/51
Usompungana Forest No. 3	10	GN 1984/51
Zondelweni Forest (Isidumbeni Mission Reserve)	35	GN 1158/52
	Total 1 865	
Msinga District		
Izonyama Forest	304	GN 561/50
Izonyama Forest (b)	26	GN 561/50
Nocoboshe Forest	96	GN 1589/50
	Total 426	
Mtunzini District		
Forest Reservation Area (Drift sand reclamation)	4 047	GN 1315/49

Table F27: Some proclaimed indigenous forests in KwaZulu (continued).

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Port Durnford-Umhlatuzi Forest	2 948	GN 402/16
Umsingwenya Forest (Reserve No. 3)	840 Total 7 835	GN 951/22
Ndwedwe District		
Butelezi Forest	123	GN 500/51
Enkondweni Forest	61	GN 1775/51
Esilaheni Forest	59	GN 500/51
Hlatikulu Forest (Schedule K)	20	GN 500/51
Hlatikulu Forest (Schedule N)	43	GN 500/51
Ibabananho Forest	49	GN 500/51
Ishowe Forest	74	GN 500/51
Mathetheni Forest	199	GN 500/51
Mkhwabane Forest	146	GN 500/51
Mona River Forest	159	GN 500/51
Ngcingwani Forest	86	GN 500/51
Nozandla Forest	193	GN 500/51
Nyoni Twelenye Forest	74	GN 500/51
Shemula Forest	41	GN 500/51
Ulufofosi Forest	13	GN 500/51
Wewe Forest	105 Total 1 445	GN 1775/51
New Hanover District		
Enqoba Forest	32	GN 2477/48
Gobizembe Forest	118	GN 2477/48

Table F27: Some proclaimed indigenous forests in KwaZulu (continued).

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Mnyameni Forest	156	GN 2477/48
Mpetu Forest	299	GN 2477/48
Mposana Forest	41	GN 2477/48
Mqeku Forest	64	GN 2477/48
Msilili Forest	216	GN 2477/48
Ndhleshana Forest	5	GN 2477/48
Ngoje Forest	204	GN 2477/48
Nhlambamasoka Forest	249	GN 2477/48
Nkunshini Forest	127	GN 2477/48
Sihubuzi Forest	107	GN 2477/48
Tilongo Forest	101	GN 2477/48
Ubuqunu Forest	33	GN 2477/48
Umkabela (Upper Left Bank) Forest	122	GN 2477/48
Umkabela (Lower Left Bank) Forest	246	GN 2477/48
Umkabela (Right Bank) Forest	212	GN 2477/48
	Total 2 332	
Pietermaritzburg (Vulindlela) District		
Mzunge Forest	30	GN 488/50
Nxamalala Forest	1 339	GN 488/50
	Total 1 369	
Polela District		
Egala Forest	73	GN 1774/51
Emvuleni Forest	209	GN 1774/51
Emvunga Forest	20	GN 1774/51

Table F27: Some proclaimed indigenous forests in KwaZulu (continued).

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now *repealed*) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Endlovini Forest	34	GN 1774/51
Esikhabeni Forest	30	GN 1774/51
Forest No. 1 (Farm Half-My-Right)	81	GN 1025/47
Forest No. 2	18	GN 1025/47
Forest No. 3	2	GN 1025/47
Forest No. 4	11	GN 1025/47
Forest No. 5 (Farm Long Stratton)	2	GN 1025/47
Forest No. 6	14	GN 1025/47
Forest No. 7	11	GN 1025/47
Forest No. 8 *(Farm Long Elmsel)*	105	GN 1025/47
Magubudela Forest	148	GN 1774/51
Mkhanzi Forest	21	GN 1774/51
Ntanjana Forest	140	GN 1774/51
Qulash Forest	56	GN 1774/51
Sidandane Forest	117	GN 1774/51
Umgumbeni Forest	89	GN 1774/51
Xhegwana Forest	167	GN 1774/51
	Total 1 348	
Port Shepstone District		
Ebizeni Forest	1 153	GN 1023/48

Table F27: **Some proclaimed indigenous forests in KwaZulu (continued).**

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Forest (Farm Mankuzuka) Forest (Farm Og) Forest (Farm South Gate)	121 51 45	GN 9/48 GN 9/48 GN 9/48
Imbezana Forest Reserve (Reserve No. 4)	411	GN 701/21
Ntimbankulu Trust Forest	599	GN 762/47
Nyauwza Forest (Location No. 5)	244	GN 1383/50
Sunduza Forest (Location No. 6)	336	GN 1383/50
Usungulo Forest (Trust Farm Frankland No. 2)	164	GN 1383/50
	Total 3 124	
Richmond District		
Amanzimtoti Forest (Groothoek)	30	GN 1316/49
Bucini and Gwazabenza forests (Groothoek)	125	GN 1316/49
Dwengu Forest	45	GN 2324/49
Esgangeni Forest (Groothoek)	3	GN 1316/49
Imenzeni Forest	5	GN 1316/49
Indala Forest (Indaleni Mission Reserve)	102	GN 2324/49
KwaDladla Forest (Groothoek)	1	GN 1316/49
KwaSingingcana Forest (Groothoek)	8	GN 1316/49
Mfulamyama Forest (Groothoek)	38	GN 1316/49

Table F27: Some proclaimed indigenous forests in KwaZulu (continued).

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Mpofana Forest (Groothoek)	18	GN 1316/49
Njangweni Forest	287	GN 2324/49
Njebe Forest (Indaleni Mission Reserve)	6	GN 2324/49
Nojaja Forest	119	GN 2324/49
Nomandla Forest (Groothoek)	204	GN 1316/49
Ntubeni Forest	25	GN 1316/49
Songazuka Forest	460	GN 562/50
Upper Mpofana Forest (Groothoek)	9	GN 1316/49
Vinks River Trust Forest	182	GN 475/47
Welabafazi Forest (Groothoek)	15	GN 1316/49
	Total 1 682	
Umbumbulu District		
Etshe Likabakajane Forest (A)	292	GN 1663/49
Etshe Likabakajane Forest (B)	250	GN 1663/49
Golokodo River Forest	343	GN 1663/49
Mdelwa Forest	125	GN 1662/49
Ndaya Forest (A)	25	GN 1662/49
Ndaya Forest (B)	40	GN 1662/49
Ngoqozi River Forest	529	GN 1663/49
Ntinyane Forest	202	GN 1663/49
Nungwana Trust Forest Reserve	809	GN 2379/47
Nwabe Forest	217	GN 1663/49
Rwayi Forest	120	GN 1663/49

Table F27: Some proclaimed indigenous forests in KwaZulu (continued).

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Umbogintwini River Forest No. 1	28	GN 1663/49
Umbogintwini River Forest No. 2	273	GN 1663/49
Uqetho Forest	160	GN 1663/49
	Total 3 413	
Umzinto District		
Alexandra Forest Reserve (comprising the Hlogozi or "Shaka", Sea View and Waterfall forests)	364 283 42	GN 375/14
Ebutongo Forest (Mysie Land)	34	GN 2478/51
Forest No. 1 (Friedenau)	37	GN 2478/51
Forest No. 2 (Friedenau)	11	GN 2478/51
Forest No. 3 (Friedenau)	3	GN 2478/51
Forest No. 4 (Friedenau)	3	GN 2478/51
Forest No. 5 (Friedenau)	16	GN 2478/51
Forest No. 6 (Friedenau)	93	GN 2478/51
Forest No. 1 (Ifafa Crown Lands)	30	GN 2478/51
Forest No. 2 (Ifafa Crown Lands)	149	GN 2478/51
Forest on Trust Farm "The Goat" and portion of Oriel Crown Lands	35	GN 2478/51
Oriel Forest (Oriel Crown Lands)	12	GN 2478/51
Upper Hlatikulu Forest (Oriel Crown Lands)	7	GN 2478/51

Table F27: Some proclaimed indigenous forests in KwaZulu (continued).

Forest	Area (ha)	Proclaimed in terms of the relevant South African Government Notice (GN), mainly by virtue of the (now repealed) (Native) subsequently, Development Trust and Land Act No. 18 of 1936
Engwempisi Forest (Ifafa Mission Reserve)	10	GN 2478/51
Esperanza Forest (Ifafa Mission Reserve)	7	GN 2478/51
Forest No. 1 (Ifafa Mission Reserve)	53	GN 2478/51
Forest No. 2 (Ifafa Mission Reserve - north side of Umzinto (Port Shepstone road))	16	GN 2478/51
Forest (Schedule 22) (Ifafa Mission Reserve)	6	GN 2478/51
Forest (Schedule 25) (Ifafa Mission Reserve)	2	GN 2478/51
Gulumbane Forest (Ifafa Mission Reserve)	3	GN 2478/51
Indumazi Forest (Ifafa Mission Reserve)	6	GN 1032/54
Inkomo Forest (Ifafa Mission Reserve)	4	GN 2478/51
Qhusukani Forest (Ifafa Mission Reserve)	16	GN 2478/51
Gampokwe Forest (Trust Farm "Sheep Walk")	3	GN 2478/51
Nkobeni Forest (Oxlands)	13	GN 2478/51
Odadeni Forest	140	GN 2478/51
Umfumbi Forest (Trust Farm Umfumbi)	190	GN 2478/51
	Total 1 588	

Source: After Union of South Africa Government Gazette data supplied by the KwaZulu Bureau of Natural Resources (now the KwaZulu Department of Nature Conservation), Ulundi, 1993.

Note:

(i) The various forests are listed in terms of their original names, as per the Government Notice in question. Some forests may be difficult to identify, partly because the names of the divisions (counties) or districts may have changed over the years. An example is the Alexandra Forest Reserve which was described as being located in the (former) Division (County) of Alexandra (in the environs of the present day Umzinto) or more specifically, KwaZulu Area No. 4. The term "district" accordingly (used in the table) often refers to "vicinity of". Old maps of Natal (available in the Natal Society Library, Pietermaritzburg) may be of use in this regard. The Department of Regional and Land Affairs office and/or the Natal Archives Depot in Pietermaritzburg are more likely possibilities. It should be borne in mind that no exact survey of all indigenous forests (however defined) in Natal and KwaZulu has been undertaken to-date. Some confusion exists in terms of forests located in Natal per se, those located in KwaZulu per se and those located on (former) South African Development Trust land, parts of which have or are currently being transferred to KwaZulu. It is likewise possible that a few forests are located in the northern part of Transkei. Readers are therefore warned to interpret the above data with a degree of caution, since in the absence of detailed surveys, duplication (double counting) of forests may occur according to a given political/administrative region. Repealed Government Notices are not included in the table. Readers encountering any difficulty in finding the relevant Government Notice/s should examine the index to the Gazette in question.

(ii) Certain forest reserves in KwaZulu, re-proclaimed in terms of the KwaZulu Nature Conservation Act No. 8 of 1975, are listed in Table F26. See (v) below.

(iii) Data on the areas of forests refer to the proclamation date. It is entirely possible that many of the smaller forests no longer exist, while others (such as the Manguzi Forest Reserve) may be severely depleted. No accurate overall statistics on indigenous forest destruction in KwaZulu are however, available. In the case of the Manguzi Forest proclaimed on the 10th of March 1950 (GN 487/50), the area stated was 5 598 ha. When re-proclaimed by KwaZulu in 1993 (GN 50/93), the forest had been reduced to approximately 237 ha (an annual reduction of some 125 ha over a 43 year period). A visual impression of indigenous forest destruction concerns the small Dada Forest which was virtually felled in the period 1976 - 1984. See aerial photographs in Anonymous, 1984. Annual report: 1984, Institute of Natural Resources, University of Natal, Pietermaritzburg, 42 p. Timber from forests is used for building and fencing materials as well as for fuel, while cleared forests provide agricultural land and living-space. The Dukuduku State Forest managed by the Natal Parks Board is also a case-in-point.

(iv) Some of the proclaimed forests listed above (for example, the Sileze Forest) have been incorporated into nature reserves and are therefore protected. No comprehensive inventory is available of small indigenous forests or remnants of forests (outside of protected areas), which were never proclaimed.

(v) The following original South African Government Notices proclaimed the eight forest reserves subsequently re-proclaimed by KwaZulu (see Table F26):

- Coastal Forest Reserve GN 1160/52
- Dengwini Forest Reserve GN 1544/54
- Ezigwayini Forest Reserve GN 1544/54
- Impeleshu Forest Reserve GN 1544/54
- Manguzi Forest Reserve GN 487/50
- Ngoya Forest Reserve GN 1751/14
- Nkandla Forest Reserve GN 318/18
- Qudeni Forest Reserve GN 317/18

(vi) The commercial forest districts of KwaZulu (established in terms of the KwaZulu Forestry Act No. 15 of 1980), are outlined below:

Forest district	Magisterial district
Northern Forest District	Those areas of the KwaZulu Legislative Assembly as defined by South African Government Regulation Proclamation Proc R R70/72, as amended, and situated in the magisterial districts of Ingwavuma and Ubombo
Central Forest District	Those areas of the KwaZulu Legislative Assembly as defined by (Proc R) R70/72, as amended, and situated in the magisterial districts of Babanango; Dundee; Eshowe; Helpmekaar; Hlabisa; Klip River; Kranskop; Lower Tugela; Lower Umfolozi; Mahlabathini; Mapumulo; Msinga; Mtonjaneni; Mtunzini; Newcastle; Ngotshe; Nkandla; Nongoma; Nqutu; Piet Retief; Umvoti; Vryheid and Weenen
Southern Forest District	Those areas of the KwaZulu Legislative Assembly as defined by (Proc R) R70/72, as amended, and situated in the magisterial districts of Alfred; Bergville; Camperdown; Estcourt; Impendle; Inanda; Ixopo; Lions River; Ndwedwe; New Hanover; Pietermaritzburg; Pinetown; Polela; Port Shepstone; Richmond; Umbumbulu; Umlazi; Umzinto and Underberg

<u>Source</u>: After Nicholson, C.R. and Jenkin, F., 1992 (on-going). <u>The Laws of KwaZulu: a Compilation of All the Acts, Regulations, Proclamations and Government Notices Relating to the Self-governing Territory of KwaZulu</u>, VOL 2, Metis Publications Law Service, Durban, various pages.

NOTES:

CHAPTER 7: ESTUARIES IN NATAL/KWAZULU

Of floods, sediment and disaster...

The scorpion

Limpopo and Tugela churned
In flood for brown and angry miles
Melons, maize, domestic thatch,
The trunks of trees and crocodiles;

The swollen estuaries were thick
With flotsam, in the sun one saw
The corpse of a young negress bruised
By rocks, and rolling on the shore...

W. Plomer, quoted in Chapman, M. (ed), 1982. A Century of South African Poetry, AD. Donker, Johannesburg, 397 p.

CHAPTER 7: ESTUARIES IN NATAL/KWAZULU

Contents *Page*

7.1 Estuaries, lagoons, bays and river mouths in Natal/KwaZulu 161

7.1.1 Overview 161

7.2 Water quality in the estuaries of Natal/KwaZulu 196

7.3 A community degradation index for South African estuaries 200

7.4 CSIR data sources on estuaries and coastal zone management in Natal/KwaZulu 205

7.5 CSIR publications series on estuaries and coastal zone management in Natal/KwaZulu 207

7.6 The SANCOR estuaries programme 210

7.7 Some primary publications on estuaries and coastal zone management in Natal/KwaZulu 211

7.8 Coastal and estuarine lakes in Natal/KwaZulu 220

7.9 Mangroves in Natal/KwaZulu 227

Tables *Page*

Table G1: A revised basis for the classification of estuaries in Natal/KwaZulu, according to Begg (1984) 163

Table G2: The classification of South African estuaries, according to Noble and Hemens (1978) 165

Table G3: A simplified categorization of estuaries in Natal/KwaZulu (north to south) 166

Table G4: Characteristics of the main rivers and estuaries in Natal/KwaZulu, 1984 (north to south) 170

Table G5: Total freshwater requirements of estuaries in Natal/KwaZulu (north to south) 175

Table G6: The environmental condition of estuaries in Natal/KwaZulu, 1978 (north to south) 179

Tables (continued) | Page

Table G7: The state of knowledge of estuaries in Natal/KwaZulu, 1978 (north to south) 183

Table G8: Major impacts on estuaries in Natal/KwaZulu, 1978 (north to south) . 186

Table G9: Specific estuarine problems in Natal/KwaZulu, 1983 (north to south) . 189

Table G10: Summary of the various types and likely consequences of man-induced modifications to the estuarine environment in Natal/KwaZulu 194

Table G11: The sediment yield of Natal estuaries (north to south) (after Rooseboom, 1975) 197

Table G12: Estuary and group, *species richness and CDIs calculated for 62 estuaries* in Natal/KwaZulu 202

Table G13: A classification of coastal and estuarine lakes in South Africa 221

Table G14: Named coastal and estuarine lakes in Natal/KwaZulu (north to south) (freshwater to brackish or highly saline) 222

Table G15: Mangroves in Natal/KwaZulu (north to south) 227

7.1 Estuaries, lagoons, bays and river mouths in Natal/KwaZulu*

7.1.1 Overview

The aim of this chapter is to provide core information on "estuaries" in Natal/KwaZulu. The discussion includes coastal and "estuarine" lakes as well as mangroves. Readers *requiring comprehensive data on estuaries in Natal/KwaZulu are referred to reports by* Begg (1978; 1984; 1984; 1985)**. Given the very detailed nature of the reports, only a brief summary of estuarine characteristics is provided in this chapter.

Seventy-three of the most important estuaries covering some 408 km^2 and constituting approximately 68% of all estuaries in South Africa, are found in the 570 km stretch of coastline from just south of Ponta do Ouro, to the Mtamvuna Estuary adjacent to the Transkei. St Lucia is the major estuary in Natal/KwaZulu and covers at least 80% of the total estuarine area in the province. The latest classification (Begg, 1984) (Table G1) for the various systems in Natal/KwaZulu is based on four environmental variables, namely: mouth condition, tidal prism, mixing mechanism and salinity as well as the biotic factors (genera of fish, prawns and crabs) typical of each system. All environmental and biotic variables used in the classification system operate on a vertical and horizontal continuum, and may change over time. Estuaries are dynamic and the categorization of these systems is not fixed. A different classification system for South African estuaries (Noble and Hemens, 1978) is explained in Table G2.

A categorization as well as a review of some features of 73 estuaries in Natal/KwaZulu is presented in Tables G3 and G4. It should be noted that systems smaller than 0,25 ha have been excluded from the analysis. The data in Tables G3 and G4 are accordingly selective, since there are 239 independent outlets to various drainage networks along the Natal/KwaZulu coastline. The following table contains data on the freshwater

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* For the purposes of this discussion, collectively termed "estuaries" (where relevant).

** See Begg, G., 1978. The estuaries of Natal, Natal Town and Regional Planning Commission Report, VOL 41, Pietermaritzburg, 657 p., and Begg, G.W., 1984. The estuaries of Natal Part 2: supplement to NTRP Report VOL 41, Natal Town and Regional Planning Commission Report, VOL 55, Pietermaritzburg, 631 p., plus Begg, G.W., 1984. The comparative ecology of Natal's smaller estuaries, Natal Town and Regional Planning Commission Report, VOL 62, Pietermaritzburg, 182 p. + app. See also Begg, G., 1985. Policy proposals for the estuaries of Natal, Natal Town and Regional Planning Commission Report, VOL 43, Pietermaritzburg, 37 p.

requirements of estuaries (Table G5). Thereafter, the environmental condition of estuaries is outlined in Table G6, followed by Table G7, which illustrates the state of knowledge of estuaries in Natal/KwaZulu. Summaries of the major impacts and effects of man-induced changes to estuaries in Natal/KwaZulu are provided in Tables G8, G9 and G10. Data on the sediment yield and a community degradation index for estuaries are presented in Tables G11 and G12 respectively. A classification system for coastal and estuarine lakes *(Noble and Hemens, 1978) follows in Table G13. Table G14 lists some of the more* important coastal and estuarine lakes in Natal/KwaZulu. Finally, information on mangroves in the province is outlined in Table G15.

Several years have passed since the important work on estuaries was undertaken by Begg and others (the latter mainly employed by the CSIR). It is evident that consolidation of relevant data is required, especially in view of the demise of long term research inter alia on estuaries. It is deeply regrettable that budgets have been slashed and that research programmes have been terminated, with consequent loss of expertise and information. It is therefore strongly recommended that a comprehensive review document on estuaries in South Africa in general, should be compiled as soon as possible*. Pressure on estuarine environments will continue to increase, and detailed scientific as well as planning techniques and methods are urgently required to address estuarine problems. (See the chapter on water quality, elsewhere in this publication).

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* A useful document in this regard is the following: Whitfield, A.K., 1995. Available scientific information on individual South African estuarine systems, WRC Report No. 577/1/95, Water Research Commission, Pretoria, 204 p. (The publication contains an extensive bibliography. The bibliography is also available on a floppy or a stiffy diskette. Contact the author at the J L B Smith Institute of Ichthyology, Rhodes University, Private Bag 1015, Grahamstown, 6140).

Table G1: A revised basis for the classification of estuaries in Natal/KwaZulu, according to Begg (1984).

Coastal feature	Environmental variable				Community structure (typical genera)	Community
	mouth condition	*tidal* prism	*mixing* mechanism	*salinity** (g ℓ^{-1})		
Bay	Permanently open	Large	Tide	Euhaline (≈30)	Amblyrhynchotes; Leiognathus (fish) Harpilius; Penaeus semisulcatus (prawns) Portunus; Dehaanius (crabs)	Marine
Estuary	Open	Moderate	Tide	Polyhaline (≈30 - ≈18)	Rhabdosargus; Pomadasys (fish) Penaeus monodon; P. japonicus, Upogebia (prawns) Scylla; Hymenosoma (crabs)	Estuarine
Lagoon	*Closed*	Small	Wind	(≈18 - ≈5) Mesohaline ------------------ Oligohaline (≈5 - ≈0,5)	Oreochromis; Glossogobius (fish) Macrobrachium equidens (prawns) Rhyncoplax; Varuna (crabs)	Lagoonal
River mouth	Open	Absent	River flow	Potamonic or fresh (≈0,5)	Clarias; Barbus (fish) Macrobrachium petersii (prawns) Potamonautes (crabs)	Riverine

* After the "Venice system" (Spada, 1959, quoted in Begg, 1984).

<u>Source</u>: After Begg, G.W., 1984. The comparative ecology of Natal's smaller estuaries, Natal Town and Regional Planning Commission Report, VOL 62, Pietermaritzburg, 182 p. + app.

<u>Note</u>:

(i) An earlier classification procedure is discussed in Begg, G., 1978. The estuaries of Natal, Natal Town and Regional Planning Commission Report, VOL 41, Pietermaritzburg, 657 p.

(ii) An alternative classification method for estuaries can be found in Day, J.H., 1981. Chapter 1. The nature, origin and classification of estuaries, In: Day, J.H. (ed), <u>Estuarine Ecology With Particular Reference to Southern Africa</u>, A.A. Balkema, Cape Town, p. 1 - 6.

(iii) According to Begg (1984 - above), the two most important environmental variables determining the classification of systems are mouth condition and salinity. Essentially, Begg defined true estuaries as systems with a frequent and significant exchange with the sea, with lagoons exhibiting an infrequent and insignificant exchange with the sea. River mouths, by contrast, are open to the sea, although no significant mixing of freshwater and sea water occurs due to a perched (raised) river bed level. A bay (fully open to the sea), is self evident and contains only sea water. However, Whitfield, A.K., 1992. A characterization of southern African estuarine systems, <u>Southern African Journal of Aquatic Sciences</u>, VOL 18(1/2), p. 89 - 103., suggested that five types of systems are found in South Africa, namely: permanently open estuaries, temporarily open/closed estuaries, river mouths, estuarine lakes, and estuarine bays. The paper by Whitfield is a useful review document. See also, Whitfield, A.K., 1994. An estuary-association classification for the fishes of southern Africa, <u>South African Journal of Science</u>, VOL 90(7), p. 411 - 417.

(iv) Tidal prism refers to the difference between the volume of water at high tide and low tide.

Table G2: The classification of South African estuaries, according to Noble and Hemens (1978).

Type	Example
Estuaries forming temporary lagoons	
Sometimes termed blind estuaries. A closed standing water body formed periodically (mainly seasonally) by closure of the mouth by a low sand bar. Freshwater dominated and non-tidal while closed, usually with only occasional vertical salinity stratification. Plant communities requiring tidal movement are absent (mangroves and salt marshes). The system will behave like a typical estuary (tidal exchange and salinity stratification) when open, and like a river mouth (no tidal exchange, freshwater into the sea) briefly during floods	Mhlanga (Natal/KwaZulu) and Kleinriviersvlei (south western Cape) are good examples. Lagoons are formed at the mouths of most smaller rivers along the Natal/KwaZulu, Transkei and southern Cape coasts
Embayment estuaries	
Tidal water body and wetlands on the landward side of a coastal barrier. Always or almost always tidal, with typical estuarine characteristics (salinity stratification, rich sediments and estuarine biota). Salinity dominated by sea water. Almost never behave like river mouths	Knysna (southern Cape) is the best example and has all the features of a Cape estuary well developed. Mhlatuze/Richards Bay and Durban Bay were typical Natal/KwaZulu examples with mangroves, but are now disturbed. Langebaan (western Cape) is shallow with little freshwater inflow and has a wide mouth
Estuaries connected to coastal/estuarine lakes	
Otherwise like typical estuaries (see below) or (in one case) lagoons	Kosi, St Lucia (Natal/KwaZulu) and Swartvlei (southern Cape) are typical estuaries. Touw (southern Cape) is a lagoon
Typical estuaries	
Estuaries with a mouth which is usually open, often with a relatively large tidal and wetland area (with salt marshes or mangroves showing that the mouth closes for short periods only), illustrating typical estuarine characteristics (salinity stratification, rich sediments and estuarine biota). This category could be divided into several sub-types (for instance, mangrove estuaries, estuaries with salt marshes, estuaries with extensive mud flats and estuaries lacking extensive wetlands). Those estuaries fed by larger rivers will behave like river mouths during floods	Mlalazi (Natal/KwaZulu mangrove estuary); Kowie and Heuningnes (eastern and southern Cape estuaries, but the first physically disturbed and the second intermittently linked to Soetendalsvlei); Matigulu (Natal/KwaZulu, without extensive wetland); Swartkops and Breë (eastern and southern Cape, with salt marshes), Sundays (eastern Cape, with mud flats)

Table G2: The classification of South African estuaries, according to Noble and Hemens (1978) (continued).

Type	Example
River mouths River valley extends to the coastline and the volume of discharge is large; area of tidal exchange limited (freshwater and sea water mixing largely in the sea); wetland area negligible and typical estuarine characteristics (salinity stratification, rich sediments and estuarine biota), absent or poorly developed	Tugela (Natal/KwaZulu) and the Orange (western Cape)

Source: After Noble, R.G. and Hemens, J., 1978. Inland water ecosystems in South Africa - a review of research needs, South African National Scientific Programmes Report No. 34, Cooperative Scientific Programmes, CSIR, Pretoria, 150 p.

Table G3: A simplified categorization of estuaries in Natal/KwaZulu (north to south).

System	Estuary	Lagoon	Bay	Estuary linked lake system	River mouth
Kosi				•	
Mgobezeleni				•	
St Lucia				•	
Mfolozi	•				
Nhlabane				•	
Richards Bay			•		
Mlalazi	•				
Siyaya		•			
Matigulu	•				
Nyoni	•				
Tugela					•
Zinkwasi		•			
Nonoti		•			
Mdlotane		•			
Mvoti					•
Seteni		•			

Table G3: A simplified categorization of estuaries in Natal/KwaZulu (north to south) (continued).

System	Estuary	Lagoon	Bay	Estuary linked lake system	River mouth
Mhlali	•				
Tongati	•				
Mdloti		•			
Mhlanga		•			
Mgeni	•				
Durban Bay			•		
Sipingo		•			
Mbokodweni		•			
Manzimtoti		•			
Little Manzimtoti		•			
Lovu	•				
Msimbazi		•			
uMgababa		•			
Ngane		•			
Mkomazi	•				
Mahlongwana		•			
Mahlongwa		•			
Mpambanyoni	•				
Mzimayi		•			
Mzinto		•			
Mkumbane		•			
Sezela		•			
Mdesingane		•			
Fafa		•			
Mvuzi		•			
Mtwalume	•				
Mnamfu		•			
Kwa Makosi		•			
Mfazazana		•			
Mhlungwa		•			

Table G3: A simplified categorization of estuaries in Natal/KwaZulu (north to south) (continued).

System	Estuary	Lagoon	Bay	Estuary linked lake system	River mouth
Mhlabatshane		•			
Mzumbe					•
iNtshambili		•			
Koshwana		•			
Damba		•			
Mhlangamkulu		•			
Mtentweni		•			
Mzimkulu	•				
Mbango		•			
Boboyi		•			
Zotsha		•			
Mhlangeni		•			
Vungu	•				
Kongweni		•			
Uvuzana		•			
Bilanhlolo		•			
Mvutshini		•			
Mbizana		•			
Kaba		•			
Umhlangankulu		•			
Mpenjati		•			
Kandandhlovu		•			
Tongazi	•				
Ku-Boboyi		•			
Sandlundlu	•				
Zolwane		•			
Mtamvuna	•				
Total out of 73	16	48	2	4	3

Source:

(i) After Begg, G., 1978. The estuaries of Natal, Natal Town and Regional Planning Commission Report, VOL 41, Pietermaritzburg, 657 p.

(ii) After Begg, G.W., 1984. The estuaries of Natal Part 2: supplement to NTRP Report VOL 41, Natal Town and Regional Planning Commission Report, VOL 55, Pietermaritzburg, 631 p.

(iii) After Begg, G.W., 1984. The comparative ecology of Natal's smaller estuaries, Natal Town and Regional Planning Commission Report, VOL 62, Pietermaritzburg, 182 p. + app.

Note:

(i) Semi-functional estuaries: Tongati, Tongazi, Sandlundlu.
Estuaries verging on river mouth transformation: Mpambanyoni, Mtwalume.
Estuaries tentatively classified: Vungu.
Lagoons verging on river mouth transformation: Mzimayi, Mkumbane.
Non-functional lagoons: Sezela (subsequently "cleaned-up" and functional).
Lagoons tentatively classified: Zolwane.

(ii) Richards Bay is regarded as a bay, despite being divided into two separate systems.

(iii) The Mfolozi, Mgeni, Mkomazi and Mzimkulu systems have occasional river mouth tendencies,while the uMgababa has occasional estuarine tendencies. The Lovu system has occasional lagoonal tendencies.

(iv) The Fafa is the largest lagoon in Natal/KwaZulu, while the Vungu Estuary is probably the deepest system.

(v) The 62 estuaries south of (and including) the Zinkwasi system, have a mean frequency of occurrence of one estuary per 3,9 km of coastline.

(vi) The Nyoni and Matigulu estuaries have had a common mouth since 1971, while the Sipingo and Mlazi systems had a common mouth until 1952. Begg (1978 - above), did not regard the Mlazi as a functional system, since it is now partly a concrete-lined drainage canal. The Sipingo River was diverted along a grass-lined canal into the Mbokodweni River in 1969.

Table G4: Characteristics of the main rivers and estuaries in Natal/KwaZulu, 1984 (north to south).

Estuary	CSIR estuary number	Catchment characterisics			Estuarine morphometry	
		catchment area (km^2)	river length (km)	MAR (10^6m^3)	area (ha)	shoreline length (km)
Kosi	NN21	±500	30	-	3 500*	53,5
Mgobezeleni	NN20	33*	6	-	1,3	1,5
St Lucia	NN19	8 982*	306	295	32 500	347
Mfolozi	NN18	10 645*	395	729	-	-
Nhlabane	NN17	104*	12	29	17	6
Richards Bay/Mhlatuze	NN16	4 373*	209	616	2 820	60
Mlalazi	NN15	454*	54*	135*	129*	23,7
Siyaya	NN14	18	8	-	±8	5,2
Matigulu	NN13	876*	96*	159*	122	16,5
Nyoni	NN12	114	±25	21,6	±70	15
Tugela	NN11	28 702*	405*	5 071	55	±2
Zinkwasi	NN10	73*	22*	14,3	25,2	20,5
Nonoti	NN9	251*	37,5*	47,8*	18	4,2
Mdlotane	NN8	43*	13*	9,9	9,4	5
Mvoti	NN7	2 651*	197*	297*	18,4	3,8
Seteni	NN6	16	5	-	1,1	0,75 - 1

Table G4: Characteristics of the main rivers and estuaries in Natal/KwaZulu, 1984 (north to south) (continued).

Estuary	CSIR estuary number	Catchment characterisics			Estuarine morphometry	
		catchment area (km^2)	river length (km)	MAR ($10^6 m^3$)	area (ha)	shoreline length (km)
Mhlali	NN5	294*	46,5*	54,8*	21	6,4
Tongati	NN4	412*	50*	88,7*	7,6	4,7
Mdloti	NN3	558*	81*	112*	13,6	6,5
Mhlanga	NN2	135*	28	24,6*	11,4	5,3
Mgeni	NN1	4 871*	232*	707	48	14,2
Durban Bay	NS53	210	50	-	1 060	27
Mlazi (concrete lined drainage canal)	NS52	953*	300	68	-	-
Sipingo	NS51	39*	27	3,34	6,8	4,2
Mbokodweni	NS50	243*	59*	9,5	7,2	2,6
Manzimtoti	NS49	30*	11,6*	1,5*	6,7	2,6
Little Manzimtoti	NS48	12,5*	15	-	1,5	1,7
Lovu	NS47	938*	135	115	10,5	3,8
Msimbazi	NS46	36,4*	16*	-	13,2	8,4
uMgababa	NS45	37*	14,5*	13,5	17,6	8,2
Ngane	NS44	16,5*	8	-	1,4	0,75

Table G4: Characteristics of the main rivers and estuaries in Natal/KwaZulu, 1984 (north to south) (continued).

Estuary	CSIR estuary number	Catchment characterisics			Estuarine morphometry	
		catchment area (km^2)	river length (km)	MAR ($10^6 m^3$)	area (ha)	shoreline length (km)
Mkomazi	NS43	4 315	298	1 072	37,8	6,2
Mahlongwana	NS42	17	6	-	6,8	3,1
Mahlongwa	NS41	100	23	14,7	6,2	4,3
Mpambanyoni	NS40	548*	100	38,8*	2,3	0,8
Mzimayi	NS39	31	20	-	0,5	0,3
Mzinto	NS38	164*	37	25,2*	7	3,8
Mkumbane	NS37	28*	14*	-	0,31	0,42
Sezela	NS36	20*	12*	-	7,9	5,6
Mdesingane	NS35	6	5,2	-	0,4	1,0
Fafa	NS34	252*	66*	30*	30,1*	6,5
Mvuzi	NS33	8	6,5	-	0,8	1,5
Mtwalume	NS32	551*	85	68*	24,8	6,0
Mnamfu	NS31	15	9	-	1,48	1,5
Kwa Makosi	NS30	10	7	1,5	2,5	1,2
Mfazazana	NS29	15	10,5	-	2,1	1,3
Mhlungwa	NS28	31	18	-	3,87	2,7

Table G4: Characteristics of the main rivers and estuaries in Natal/KwaZulu, 1984 (north to south) (continued).

Estuary	CSIR estuary number	Catchment characterisics			Estuarine morphometry	
		catchment area (km^2)	river length (km)	MAR ($10^6 m^3$)	area (ha)	shoreline length (km)
Mhlabatshane	NS27	41,5*	16	-	3,14	2,1
Mzumbe	NS26	617*	84	74,8*	15,8	3,9
iNtshambili	NS25	34	12,5	-	1,7	1,5
Koshwana	NS24	12	6,3	-	1,2	1,3
Damba	NS23	26	11	-	1,7	1,2
Mhlangamkulu	NS22	12	7	-	3,9	2,0
Mtentweni	NS21	53*	20*	3,9	8,0	4,8
Mzimkulu	NS20	6 694*	329*	1 455	74	11,2
Mbango	NS19	12	8	-	0,9	1,3
Boboyi	NS18	31	14	-	1,3	1,2
Zotsha	NS17	71*	20*	12*	7,3	4,7
Mhlangeni	NS16	44	12,5	-	3,6 - 3,95	1,7 - 2,5
Vungu	NS15	102*	24*	17,5*	1,1	0,6
Kongweni	NS14	18	6	-	1,4	1,5
Uvuzana	NS13	7	2,5	-	0,6	0,7
Bilanhlolo	NS12	19	12	-	2,6	1,2

Table G4: Characteristics of the main rivers and estuaries in Natal/KwaZulu, 1984 (north to south) (continued).

Estuary	CSIR estuary number	Catchment characterisics			Estuarine morphometry	
		catchment area (km^2)	river length (km)	MAR ($10^6 m^3$)	area (ha)	shoreline length (km)
Mvutshini	NS11	6	6,5	-	0,9	0,7
Mbizana	NS10	150*	26	20,2*	12,4	3,9
Kaba	NS9	12	9	-	2,4	1,5
Umhlangankulu	NS8	10	6,5	-	5,8	2,6
Mpenjati	NS7	87*	18	16*	11,6	3,8
Kandandhlovu	NS6	11	8	-	1,8	1,2
Tongazi	NS5	20	8,5	-	0,8	0,7
Ku-Boboyi	NS4	4	4	-	1,1	1,2
Sandlundlu	NS3	19	7,5	-	4	1,2
Zolwane	NS2	7	6,5	-	0,5	0,5
Mtamvuna	NS1	1 589*	162*	281*	52,7	10,3
Total		82 440	4 459		40 878	776

__Source__: (i) After Begg, G., 1978. The estuaries of Natal, Natal Town and Regional Planning Commission Report, VOL 41, Pietermaritzburg, 657 p.

(ii) After Begg, G.W., 1984. The estuaries of Natal Part 2: supplement to NTRP Report VOL 41, Natal Town and Regional Planning Commission Report, VOL 55, Pietermaritzburg, 631 p.

See also: Anonymous, 1990. Hydro factors affecting siltation in the lower reaches of Natal/KwaZulu rivers, CSIR Report No. EMA-D 9006, Division of Earth, Marine and Atmospheric Science and Technology, CSIR, Stellenbosch, 22 p. + app. (Further information on physical features, not necessarily in agreement with the above, as well as sediment yield, simulated runoff and land use data are presented in the report). Physical and hydrological data (not necessarily in agreement with the above), can also be found in Jezewski and Roberts (1986) - see Table G5.

Note:

(i) The mean of the various figures quoted in Begg (1978 - above) is denoted by an asterisk. Totals are therefore approximate.

(ii) Some of the morphometry data refer to a closed or open mouth respectively. The data for the Mhlangeni Lagoon refer to both conditions.

(iii) The Nyoni and Matigulu estuaries have had a common mouth since 1971. The Mlazi system is not functional, since it is now partly a concrete-lined drainage canal. The Sipingo River was diverted along a grass-lined canal into the Mbokodweni River in 1969.

(iv) The term "MAR" refers to mean annual runoff.

Table G5: Total freshwater requirements of estuaries in Natal/KwaZulu (north to south).

Estuary	CSIR estuary number	Quaternary drainage region	Annual evaporative requirement of the estuary ($10^6 m^3$)	Annual flooding requirement of the estuary ($10^6 m^3$)	Total freshwater requirement of the estuary	
					quantity ($10^6 m^3$)	percentage of virgin mean annual runoff
Kosi	NN21	W700	23,860	2,957	26,817	-
Mgobezeleni	NN20	W700	0,008	0,192	0,200	-
St Lucia	NN19	W305	222,950	27,650	250,600	63,4
Mfolozi	NN18	W230	0,772	61,950	62,722	7,1
Nhlabane	NN17	W122	0,061	0,531	0,592	2,0
Richards Bay/ Mhlatuze	NN16	W122	3,567	45,150	48,717	7,6
Mlalazi	NN15	W130	0,505	3,767	4,272	3,5
Siyaya	NN14	W130	0,023	0,109	0,132	-
Matigulu	NN13	W110	0,540	6,308	6,848	3,8
Nyoni	NN12	W110	0,310	1,150	1,460	7,3

Table G5: Total freshwater requirements of estuaries in Natal/KwaZulu (north to south) (continued).

Estuary	CSIR estuary number	Quaternary drainage region	Annual evaporative requirement of the estuary ($10^6 m^3$)	Annual flooding requirement of the estuary ($10^6 m^3$)	Total freshwater requirement of the estuary	
					quantity ($10^6 m^3$)	percentage of virgin *mean* annual runoff
Tugela	NN11	V500	5,200	300,000	305,200	6,6
Zinkwasi	NN10	U500	0,141	0,387	0,528	3,7
Nonoti	NN9	U500	0,073	1,598	1,671	3,0
Mdlotane	NN8	U500	0,038	0,201	0,239	2,4
Mvoti	NN7	U403	0,073	24,895	24,968	5,2
Seteni	NN6	U302	0,004	0,033	0,037	-
Mhlali	NN5	U302	0,081	1,678	1,759	2,8
Tongati	NN4	U302	0,042	2,111	2,153	2,6
Mdloti	NN3	U301	0,080	5,130	5,210	5,1
Mhlanga	NN2	U301	0,049	0,752	0,801	3,5
Mgeni	NN1	U202	0,300	19,900	20,200	3,0
Subtotal (North Coast)			258,677	506,449	765,126	9,1
Durban Bay	NS53	U602	-	-	-	-
Mlazi (concrete lined drainage canal)	NS52	U602	-	-	-	-
Sipingo	NS51	U603	0,029	0,241	0,270	4,7
Mbokodweni	NS50	U603	0,031	1,703	1,734	4,9
Manzimtoti	NS49	U700	0,029	0,222	0,251	4,0
Little Manzimtoti	NS48	U700	0,006	0,079	0,085	4,7
Lovu	NS47	U700	0,086	7,722	7,808	6,5
Msimbazi	NS46	U700	0,056	0,168	0,224	4,6
uMgababa	NS45	U700	0,075	0,185	0,260	5,3
Ngane	NS44	U700	0,006	0,086	0,092	4,2
Mkomazi	NS43	U100	0,239	46,332	46,571	4,5
Mahlongwana	NS42	U804	0,029	0,068	0,097	-

Table G5: Total freshwater requirements of estuaries in Natal/KwaZulu (north to south) (continued).

Estuary	CSIR estuary number	Quaternary drainage region	Annual evaporative requirement of the estuary ($10^6 m^3$)	Annual flooding requirement of the estuary ($10^6 m^3$)	Total freshwater requirement of the estuary	
					quantity ($10^6 m^3$)	percentage of virgin *mean* annual runoff
Mahlongwa	NS41	U804	0,028	0,649	0,677	4,8
Mpambanyoni	NS40	U804	0,010	5,077	5,087	7,2
Mzimayi	NS39	U803	0,004	0,227	0,231	6,2
Mzinto	NS38	U803	0,030	0,702	0,732	3,7
Mkumbane	NS37	U803	0,001	0,162	0,163	4,8
Sezela	NS36	U803	0,039	0,120	0,159	6,6
Mdesingane	NS35	U803	0,002	0,037	0,039	5,6
Fafa	NS34	U803	0,129	1,707	1,836	6,1
Mvuzi	NS33	U803	0,003	0,043	0,046	-
Mtwalume	NS32	U802	0,106	4,863	4,969	7,0
Mnamfu	NS31	U802	0,006	0,072	0,078	3,7
Kwa Makosi	NS30	U802	0,011	0,051	0,062	4,1
Mfazazana	NS29	U802	0,009	0,072	0,081	3,9
Mhlungwa	NS28	U802	0,013	0,181	0,194	4,4
Mhlabatshane	NS27	U802	0,010	0,206	0,216	3,7
Mzumbe	NS26	U801	0,092	5,447	5,539	8,1
iNtshambili	NS25	U801	0,007	0,164	0,171	4,3
Koshwana	NS24	U801	0,005	0,049	0,054	3,9
Damba	NS23	U801	0,007	0,143	0,150	5,0
Mhlangamkulu	NS22	U801	0,017	0,053	0,070	5,0
Mtentweni	NS21	U801	0,034	0,225	0,259	4,2
Mzimkulu	NS20	T801	0,317	64,004	64,321	4,4
Mbango	NS19	T502	0,004	0,073	0,077	2,3
Boboyi	NS18	T402	0,006	0,156	0,162	1,9
Zotsha	NS17	T402	0,031	0,300	0,331	2,2
Mhlangeni	NS16	T402	0,015	0,157	0,172	1,9
Vungu	NS15	T402	0,005	0,475	0,480	1,7

Table G5: **Total freshwater requirements of estuaries in Natal/KwaZulu (north to south) (continued).**

Estuary	CSIR estuary number	Quaternary drainage region	Annual evaporative requirement of the estuary (10^6m^3)	Annual flooding requirement of the estuary (10^6m^3)	Total freshwater requirement of the estuary	
					quantity (10^6m^3)	percentage of virgin mean annual runoff
Kongweni	NS14	T402	0,006	0,049	0,055	1,1
Uvuzana	NS13	T402	0,003	0,018	0,021	1,1
Bilanhlolo	NS12	T402	0,011	0,091	0,102	2,0
Mvutshini	NS11	T402	0,004	0,031	0,035	2,2
Mbizana	NS10	T402	0,044	0,673	0,717	2,1
Kaba	NS9	T402	0,009	0,057	0,066	2,3
Umhlangankulu	NS8	T402	0,021	0,044	0,065	2,7
Mpenjati	NS7	T402	0,042	0,300	0,342	1,7
Kandandhlovu	NS6	T402	0,006	0,043	0,049	1,3
Tongazi	NS5	T402	0,002	0,073	0,075	1,1
Ku-Boboyi	NS4	T402	0,003	0,018	0,021	1,6
Sandlundlu	NS3	T402	0,012	0,056	0,068	1,1
Zolwane	NS2	T401	0,001	0,031	0,032	2,5
Mtamvuna	NS1	T401	0,145	18,105	18,250	6,0
Subtotal (South Coast)			1,836	161,810	163,646	4,5
Total			260,513	668,259	928,772	7,7

Source: After Jezewski, W.A. and Roberts, C.P.R., 1986. Estuarine and lake freshwater requirements, Technical Report No. TR 129, Department of Water Affairs, Pretoria, 22 p. + app.

Note:

(i) The data for Richards Bay refer to the freshwater requirements of the sanctuary area only.

(ii) The evaporation data include evaporation from the surface area of the 32 km reach of river between the Tugela mouth and the proposed Sunbury Dam. The evaporation data likewise include evaporation from the surface area of the 30 km stretch of river between the Mgeni Estuary and the (then proposed) Inanda Dam - which was completed after the data were published.

(iii) No data are presented for Durban Bay which is a harbour. The Nyoni and Matigulu estuaries have had a common mouth since 1971. The Mlazi system is not functional, since it is now partly a concrete-lined drainage canal. The Sipingo River was diverted along a grass-lined canal into the Mbokodweni River in 1969.

(iv) Other useful data for each estuary - which include mean annual gross evaporation; the length of the longest (watercourse) collector; the mean catchment slope, and the two year flood peak discharge (necessary for flushing out the system) - are presented in Jezewski and Roberts (1986 - above).

(v) The flooding requirement is not equivalent to the storage capacity of estuaries. A flooding requirement is necessary in order to counteract the development of hypersaline conditions; to introduce organic detritus which is a food source for estuarine organisms; to flush out accumulated sediment; for the occasional flooding by freshwater flows of swamps and marshes on the fringes of the estuary; to open the sand bar at the mouth (where applicable), and to allow migration of aquatic organisms to and from the sea*. The evaporation requirement refers to the volume of freshwater needed to counter the loss of water due to evaporation and accordingly, to prevent the occurrence of undesirable hypersaline conditions.

(vi) According to Jezewski and Roberts, the total annual estuarine and coastal lake freshwater requirement in South Africa (defined as a single annual flood with the flow characteristics of a two year flood), is of the order of 2 160 x $10^6 m^3$ or approximately 8% of the estimated total exploitable water resources of the country.

Table G6: The environmental condition of estuaries in Natal/KwaZulu, 1978 (north to south).

Estuary	Good	Fair	Poor
Kosi	•		
Mgobezeleni	•		
St Lucia	•		
Mfolozi*		•	
Nhlabane	•		
Richards Bay*		•	

* For a discussion of the freshwater needs of estuarine vegetation see: Adams, J.B. and Bate, G.C., 1994. The freshwater requirements of estuarine plants incorporating the development of an estuarine decision support system, VOL 1, WRC Report No. 292/1/94, 151 p. + app., and VOL 2 - Literature review, WRC Report No. 292/2/94, 73 p., Water Research Commission, Pretoria.

Table G6: The environmental condition of estuaries in Natal/KwaZulu, 1978 (north to south) (continued).

Estuary	Good	Fair	Poor
Mlalazi	●		
Siyaya		●	
Matigulu	●		
Nyoni	●		
Tugela			●
Zinkwasi		●	
Nonoti		●	
Mdlotane	●		
Mvoti*		●	
Seteni			●
Mhlali		●	
Tongati			●
Mdloti		●	
Mhlanga	●		
Mgeni*		●	
Durban Bay		●	
Sipingo		●	
Mbokodweni			●
Manzimtoti			●
Little Manzimtoti			●
Lovu		●	
Msimbazi	●		
uMgababa	●		
Ngane			●
Mkomazi		●	
Mahlongwana	●		
Mahlongwa	●		
Mpambanyoni			●
Mzimayi			●
Mzinto		●	

Table G6: **The environmental condition of estuaries in Natal/KwaZulu, 1978 (north to south) (continued).**

Estuary	Good	Fair	Poor
Mkumbane			•
Sezela			•
Mdesingane		•	
Fafa	•		
Mvuzi			•
Mtwalume			•
Mnamfu		•	
Kwa Makosi		•	
Mfazazana		•	
Mhlungwa			•
Mhlabatshane		•	
Mzumbe			•
iNtshambili	•		
Koshwana			•
Damba	•		
Mhlangamkulu		•	
Mtentweni		•	
Mzimkulu		•	
Mbango		•	
Boboyi		•	
Zotsha	•		
Mhlangeni			•
Vungu	•		
Kongweni			•
Uvuzana		•	
Bilanhlolo		•	
Mvutshini		•	
Mbizana*			•
Kaba		•	
Umhlangankulu		•	

Table G6: ***The environmental condition of estuaries in Natal/KwaZulu, 1978 (north to south) (continued).***

Estuary	Good	Fair	Poor
Mpenjati		•	
Kandandhlovu		•	
Tongazi		•	
Ku-Boboyi			•
Sandlundlu		•	
Zolwane	•		
Mtamvuna	•		
Total out of 73	20	33	20

Source: After Begg, G., 1978. The estuaries of Natal, Natal Town and Regional Planning Commission Report, VOL 41, Pietermaritzburg, 657 p.

See also:

(i) Begg, G.W., 1984. The estuaries of Natal Part 2: supplement to NTRP Report VOL 41, Natal Town and Regional Planning Commission Report, VOL 55, Pietermaritzburg, 631 p.

(ii) Begg, G.W., 1984. The comparative ecology of Natal's smaller estuaries, Natal Town and Regional Planning Commission Report, VOL 62, Pietermaritzburg, 182 p. + app.

(iii) Heydorn, A.E.F. (ed), 1986. An assessment of the state of the estuaries of the Cape and Natal in 1985/86, South African National Scientific Programmes Report No. 130, Foundation for Research Development, CSIR, Pretoria, 39 p.

Note:

(i) Systems marked with an asterisk indicate that an alternative rating may also apply. See Begg (1978 - above).

(ii) Certain changes have taken place since 1978. For example, the condition of the Sezela Lagoon has markedly improved, following clean-up operations. See: Ramm, A.E.L., Cerff, E.C. and Harrison, T.D., 1987. Documenting the recovery of a severely degraded coastal lagoon, Journal of Shoreline Management, VOL 3(3), p. 159 - 167. The Siyaya and Sipingo lagoons have also been rehabilitated inter alia through the re-establishment of indigenous vegetation and the restoration of wetland systems - see the bibliographic database. A useful general (brief) overview of work undertaken in the Siyaya Lagoon is, Anonymous, 1994. God's lone gardener, Natal Wildlife, VOL 35(7), p. 12 - 13. (Examine also, Anonymous, 1994. Twinstreams: the "green jewel" of the Natal North Coast, Wood Southern Africa and Timber Times, VOL 19(7), p. 30 - 31). *The effects of the September 1987 floods were* significant. The following is a useful source document: Badenhorst,

P., *Cooper*, J.A.G., *Crowther*, J., *Gonsalves*, J., *Grobler*, N.A., Illenberger, W.K., Laubscher, W.I., Mason, T.R., Moller, J.P., Perry, J.E., Reddering, J.S.V. and Van der Merwe, L., 1989. Survey of September 1987 Natal floods, South African National Scientific Programmes Report No. 164, Foundation for Research Development, CSIR, Pretoria, 137 p.

Table G7: The state of knowledge of estuaries in Natal/KwaZulu, 1978 (north to south).

Estuary	Very good	Good	Fair	Fairly poor	Poor	Very poor
Kosi		●				
Mgobezeleni			●			
St Lucia	●					
Mfolozi					●	
Nhlabane						●
Richards Bay		●				
Mlalazi			●			
Siyaya						●
Matigulu			●			
Nyoni						●
Tugela					●	
Zinkwasi					●	
Nonoti						●
Mdlotane						●
Mvoti					●	
Seteni						●
Mhlali					●	
Tongati					●	
Mdloti					●	
Mhlanga				●		
Mgeni		●				
Durban Bay				●		
Sipingo			●			
Mbokodweni				●		
Manzimtoti		●				

Table G7: The state of knowledge of estuaries in Natal/KwaZulu, 1978 (north to south) (continued).

Estuary	Very good	Good	Fair	Fairly poor	Poor	Very poor
Little Manzimtoti						•
Lovu					•	
Msimbazi			•			
uMgababa		•				
Ngane					•	
Mkomazi					•	
Mahlongwana						•
Mahlongwa					•	
Mpambanyoni					•	
Mzimayi						•
Mzinto					•	
Mkumbane						•
Sezela					•	
Mdesingane						•
Fafa		•				
Mvuzi						•
Mtwalume					•	
Mnamfu						•
Kwa Makosi						•
Mfazazana						•
Mhlungwa					•	
Mhlabatshane					•	
Mzumbe					•	
iNtshambili					•	
Koshwana						•
Damba					•	
Mhlangamkulu						•
Mtentweni				•		
Mzimkulu			•			
Mbango						•

Table G7: The state of knowledge of estuaries in Natal/KwaZulu, 1978 (north to south) (continued).

Estuary	Very good	Good	Fair	Fairly poor	Poor	Very poor
Boboyi					•	
Zotsha				•		
Mhlangeni				•		
Vungu				•		
Kongweni						•
Uvuzana						•
Bilanhlolo					•	
Mvutshini					•	
Mbizana					•	
Kaba						•
Umhlangankulu		•				
Mpenjati					•	
Kandandhlovu						•
Tongazi						•
Ku-Boboyi						•
Sandlundlu						•
Zolwane						•
Mtamvuna		•				
Total out of 73	1	8	6	7	25	26

Source: After Begg, G., 1978. The estuaries of Natal, Natal Town and Regional Planning Commission Report, VOL 41, Pietermaritzburg, 657 p.

Note: With reference to the above table, there was practically no information available on 51 estuaries in Natal/KwaZulu - which has important management implications. Begg (1984; 1984) - see Table G6 - remedied this state of affairs within time and financial constraints.

Table G8: Major impacts on estuaries in Natal/KwaZulu, 1978 (north to south).

Estuary	Urban	Agriculture	Industry	Transport
Kosi				
Mgobezeleni				●
St Lucia		●		
Mfolozi		●		
Nhlabane			●	
Richards Bay		●	●	●
Mlalazi		●		
Siyaya		●		
Matigulu		●		
Nyoni		■		
Tugela		●	●	
Zinkwasi		●		
Nonoti		●	●	
Mdlotane		■		
Mvoti		●	●	
Seteni		●		
Mhlali		●		
Tongati		●	●	
Mdloti		●	●	●
Mhlanga		●		●
Mgeni	●	●	●	●
Durban Bay	●		●	●
Sipingo		●	●	●
Mbokodweni		●	●	
Manzimtoti	●	●		●
Little Manzimtoti	●	■		●
Lovu		●	●	●
Msimbazi		●		●
uMgababa		●		●
Ngane		●		
Mkomazi		●	●	●

Table G8: ***Major impacts on estuaries in Natal/KwaZulu, 1978 (north to south) (continued).***

Estuary	Urban	Agriculture	Industry	Transport
Mahlongwana				■
Mahlongwa		●		
Mpambanyoni	●	●	●	●
Mzimayi		●		
Mzinto		●		●
Mkumbane		●		
Sezela		●	●	
Mdesingane		■		
Fafa	■	●		
Mvuzi		■		●
Mtwalume		●		●
Mnamfu		■		●
Kwa Makosi		■		●
Mfazazana		■		
Mhlungwa		●		●
Mhlabatshane		●		
Mzumbe		●		●
iNtshambili		■		
Koshwana	●	■		
Damba		■		
Mhlangamkulu		■		
Mtentweni		●		
Mzimkulu		●	●	●
Mbango			■	
Boboyi		■		
Zotsha		■		●
Mhlangeni	●	●		
Vungu				
Kongweni	●			
Uvuzana		●		

Table G8: **Major impacts on estuaries in Natal/KwaZulu, 1978 (north to south) (continued).**

Estuary	Urban	Agriculture	Industry	Transport
Bilanhlolo	●	■		
Mvutshini				
Mbizana		●		
Kaba	■	●		
Umhlangankulu	●	●		
Mpenjati		●		
Kandandhlovu		■		
Tongazi				
Ku-Boboyi		●		
Sandlundlu		●		
Zolwane				
Mtamvuna				
Total severe impacts	10	45	16	23

Source: After Begg, G., 1978. The estuaries of Natal, Natal Town and Regional Planning Commission Report, VOL 41, Pietermaritzburg, 657 p.

Note:
(i) The notation ● indicates severe impacts, while ■ indicates less severe impacts.

(ii) Transport refers to the impacts of harbours, airports, roads and railways.

(iii) No impacts were recorded for the Kosi, Vungu, Mvutshini, Tongazi, Zolwane and Mtamvuna systems.

Table G9: Specific estuarine problems in Natal/KwaZulu, 1983 (north to south).

X Past • Present ? Probable Estuary	Incoming silt or sand	Dredging activity	Drainage diversions	Embank-ments	Breach-ing	Impound-ments	Water area losses	Cropland pollution	Industrial pollution	Pesticide pollution	Nutrient enrich-ment	Faecal pollution	Disrup-tion of wetlands	Disruption of riverine vegetation
Kosi	•		?							•			?	
Mgobezeleni					•	•							•	
St Lucia	•	•	•										•	•
Mfolozi	•	•	•	•	•			•	•				•	
Nhlabane						•	•							
Richards Bay	•	•	•	•			•	•	•				•	•
Mlalazi	•	X		•									•	
Siyaya	•		•				•	•			?		•	•
Matigulu	•													
Nyoni	•													
Tugela	•						•		•					
Zinkwasi	•				•		•	•				•	•	•
Nonoti	•				•			•	X		•		•	
Mdlotane					•			•					•	
Mvoti	•						•	•	•				•	•
Seteni	•		•		•			?					•	
Mhlali	•				•	•							•	•
Tongati	•		?	•			•	?	•		•	•		•

Table G9: Specific estuarine problems in Natal/KwaZulu, 1983 (north to south) (continued).

X Past ● Present ? Probable Estuary	Incoming silt or sand	Dredging activity	Drainage diversions	Embank-ments	Breach-ing	Impound-ments	Water area losses	Cropland pollution	Industrial pollution	Pesticide pollution	Nutrient enrich-ment	Faecal pollution	Disrup-tion of wetlands	Disruption of riverine vegetation
Mdloti	●	?		●	●		●		X	?			●	●
Mhlanga	●		●	●	●		●				●		●	●
Mgeni	●	?	●			X	●	●	●	?	●	●	●	
Durban Bay		●					●		●			●	●	
Sipingo	●	X	●				●		●		●	●	●	
Mbokodweni	●		●		●				●			●	●	●
Manzimtoti	●	●			●	●			●		●	●	●	●
Little Manzimtoti	●	X	●			●					●	●		
Lovu	●		●	●	●		●	●	●			?	●	●
Msimbazi	●		●	●	●		●							●
uMgababa	●		●	●	●								●	
Ngane	●				●			●				?		
Mkomazi	●			●			●		●				●	
Mahlongwana	?												●	
Mahlongwa	●				●		●	?					●	●
Mpambanyoni	●			●			●		●				●	●
Mzimayi	●					●		●				?	●	

Table G9: Specific estuarine problems in Natal/KwaZulu, 1983 (north to south) (continued).

X Past ● Present ? Probable Estuary	Incoming silt or sand	Dredging activity	Drainage diversions	Embank-ments	Breach-ing	Impound-ments	Water area losses	Cropland pollution	Industrial pollution	Pesticide pollution	Nutrient enrich-ment	Faecal pollution	Disrup-tion of wetlands	Disruption of riverine vegetation
Mzinto	●			●	●		●	●	X	X			●	●
Mkumbane	●							?			●	●		
Sezela		?			●			●	●		●			
Mdesingane	●					●		?						●
Fafa	●				●	●	●					●		
Mvuzi			●	●										
Mtwalume	●			●	●		●	?					●	
Mnamfu	●			●									●	
Kwa Makosi	●			●										
Mfazazana	●													
Mhlungwa	?			●										
Mhlabatshane	●											?		
Mzumbe	●			●			●						●	●
iNtshambili	●						●	?						
Koshwana	?				●						?	●		
Damba	●			●	●		●	?			?	●	●	
Mhlangamkulu	●													

Table G9: Specific estuarine problems in Natal/KwaZulu, 1983 (north to south) (continued).

X Past ● Present ? Probable Estuary	Incoming silt or sand	Dredging activity	Drainage diversions	Embankments	Breaching	Impoundments	Water area losses	Cropland pollution	Industrial pollution	Pesticide pollution	Nutrient enrichment	Faecal pollution	Disruption of wetlands	Disruption of riverine vegetation
Mtentweni	●				●									
Mzimkulu	●			●			●		●			?	●	
Mbango									?			?		
Boboyi	●								?					
Zotsha	●			●										
Mhlangeni	●				●							●	●	
Vungu												?		
Kongweni	?				●							●	●	●
Uvuzana	●				●									
Bilanhlolo	?				●							?		
Mvutshini	?													
Mbizana	●				●		●							●
Kaba	●					●								
Umhlangankulu	●	X												
Mpenjati	●	●			●	●	●							●
Kandandhlovu	●													
Tongazi												●		

Table G9: Specific estuarine problems in Natal/KwaZulu, 1983 (north to south) (continued).

X Past ● Present ? Probable Estuary	Incoming silt or sand	Dredging activity	Drainage diversions	Embank-ments	Breach-ing	Impound-ments	Water area losses	Cropland pollution	Industrial pollution	Pesticide pollution	Nutrient enrich-ment	Faecal pollution	Disrup-tion of wetlands	Disruption of riverine vegetation
Ku-Boboyi	●							?				?		●
Sandlundlu	●						●				?			
Zolwane														
Mtamvuna	●													
Total Present	57	6	14	21	29	10	27	13	15	1	9	15	34	22
Past	0	4	0	0	0	1	0	0	3	1	0	0	0	0
Probable	6	3	2	0	0	0	0	9	2	2	4	9	1	0

Source: (i) After Begg, G., 1978. The estuaries of Natal, Natal Town and Regional Planning Commission Report, VOL 41, Pietermaritzburg, 657 p.

(ii) After Anonymous, 1983. The SANCOR estuaries programme 1982 - 1986, South African National Scientific Programmes Report No. 67, Cooperative Scientific Programmes, CSIR, Pretoria, 42 p. and map.

Note: (i) Only three small lagoons (along the Natal South Coast) were problem free (Begg, 1978 - above).

(ii) Siltation has had a greater detrimental effect on estuaries than any other single factor, with at least 45 of the 73 systems showing evidence of degradation due to silt and sand (Begg, 1984; 1984 - see previous tables). See also: Anonymous, 1990. Hydro factors affecting siltation in the lower reaches of Natal/KwaZulu rivers, CSIR Report No. EMA-D 9006, Division of Earth, Marine and Atmospheric Science and Technology, CSIR, Stellenbosch, 22 p. + app.

Table G10: Summary of the various types and likely consequences of man-induced modifications to the estuarine environment in Natal/KwaZulu.

Feature	Example	Expected environmental effect	Probable results in terms of estuarine productivity	
			adverse	beneficial
Incoming silt	Mpambanyoni	Losses in storage capacity; losses of water area; increased turbidity	Decreased production due to reduced light penetration; exclusion of visual feeders; suffocation of benthic fauna; decreased carrying capacity	Reed encroachment; mud flat formation
Dredging	Richards Bay	Substrate disruption; turbidity; wetland disruption; increased tidal exchange		Deepened areas offer refuge; increased passive transport of juveniles into estuary
Disruption of riverine vegetation	Mhlanga	Silt transport	As above	Reed encroachment; mud flat formation
Disruption of wetlands	Mtwalume	Silt transport, reduced winter flow; destruction of sources of detritus	As above, with particularly severe decrease in productivity due to the elimination of detritus sources	As above
Drainage diversion	Sipingo	Reduced flow in estuary giving rise to mouth closure; or else increased water velocities resulting in siltation	Impeded immigration; decreased production at all levels	None
Dam construction	Matigulu	Modification of flow, causing mouth closure	As above, including diminished beach nourishment; barriers to movement	Silt interception

Table G10: Summary of the various types and likely consequences of man-induced modifications to the estuarine environment in Natal/KwaZulu (continued).

Feature	Example	Expected environmental effect	Probable results in terms of estuarine productivity	
			adverse	beneficial
Road and rail construction		Reduced tidal exchange; reduced scour; water area losses; decrease in depth	Decreased production at all levels	None
Weirs and causeways	Mgobezeleni	Altered water levels; altered salinity; altered circulation	Lowered carrying capacity; decreased utilization; barriers to movement	None
Breaching	Mdloti	Altered water levels; altered salinity; altered circulation	Lowered carrying capacity; decreased utilization; barriers to movement	None
Cropland pollution	Zinkwasi	Deterioration in water quality; increased biological demand for oxygen; presence of toxic compounds	Modification of species composition and abundance; development of sludge communities; poor survival	*None*
Industrial pollution	Sezela	Deterioration in water quality; increased biological demand for oxygen; presence of toxic compounds	Modification of species composition and abundance; development of sludge communities; poor survival	Increased birdlife (Mvoti)
Pesticide pollution	Kosi	Deterioration in water quality; increased biological demand for oxygen; presence of toxic compounds	Modification of species composition and abundance; development of sludge communities; poor survival	None
Nutrient pollution	Fafa	Deterioration in water quality; increased biological demand for oxygen; presence of toxic compounds	Modification of species composition and abundance; development of sludge communities; poor survival	Limited enhancement of fertility
Faecal pollution	Mbokodweni	Deterioration in water quality; increased biological demand for oxygen; presence of toxic compounds	Modification of species composition and abundance; development of sludge communities; poor survival	Limited enhancement of fertility

Source: After Begg, G., 1978. The estuaries of Natal, Natal Town and Regional Planning Commission Report, VOL 41, Pietermaritzburg, 657 p.

7.2 Water quality in the estuaries of Natal/KwaZulu

Detailed water quality data including biological data are presented in Begg (1978; 1984; 1984 - see earlier in the chapter), as well as in various CSIR reports - discussed later. It should be noted that a few of the CSIR steering committee reports were combined into one volume*. Cloete (1979)** provided some data on trace element concentrations for the Kosi, St Lucia, Richards Bay, Durban Bay, uMgababa, Mzimkulu and Mzimvubu systems. Information on the volume of industrial and domestic effluents discharged into estuaries in Natal/KwaZulu can be found in the chapter on solid waste management, elsewhere in this publication. Data on the suspended solids and chemical oxygen demand loads in effluents discharged to estuaries, are likewise outlined in the same chapter.

While the chemical and bacteriological water quality of estuaries is of concern, it is the volume of sediment entering such systems which has a major impact on estuarine organisms and estuarine morphometry. Sediment data derived from work by Rooseboom (1975) are presented in Table G11. Sediment yields of the estuaries of Natal/KwaZulu vary from some 1 800 t y^{-1} for the Siyaya and Ku-Boboyi systems to 8 798 000 t y^{-1} for the Tugela (Anonymous, 1990)***. The latter research showed that sediment yield rates are generally very high, and that many of the lower reaches of rivers draining into estuaries in Natal/KwaZulu are aggrading. Specifically, 27 rivers have experienced a decrease in estuarine length this century - of which eight showed a further decrease in the period 1976 - 1983. Siltation of estuaries is primarily due to natural factors such as topography, geology, soils, runoff and river mouth configuration, although siltation has been aggravated by human influences during this century, and especially since the 1940s. *(See the chapter on water quality as well as the chapter on soils and soil erosion).*

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* See Hemens, J., Simpson, D.E. and Warwick, R.J., 1986. The chemistry and biology of some Natal estuaries, 1970 - 1972, National Institute for Water Research, CSIR, Durban, various pages.

** See Cloete, C.E. (ed), 1979. The transfer of pollutants in two southern hemispheric oceanic systems: proceedings of a workshop held at Plettenberg Bay, South Africa, 23 - 26 April 1979, South African National Scientific Programmes Report No. 39, Cooperative Scientific Programmes, CSIR, Pretoria, 188 p.

*** See Anonymous, 1990. Hydro factors affecting siltation in the lower reaches of Natal/KwaZulu rivers, CSIR Report No. EMA-D 9006, Division of Earth, Marine and Atmospheric Science and Technology, CSIR, Stellenbosch, 22 p. + app.

Table G11: The sediment yield of Natal estuaries (north to south) (after Rooseboom, 1975).

Estuary	CSIR estuary number	Mean maximum yield	
		t y^{-1}	t km^{-2} y^{-1}
Kosi	NN21	500 000	100
Mgobezeleni	NN20	3 300	100
St Lucia	NN19	-	-
Mfolozi	NN18	2 364 240	235
Nhlabane	NN17	10 400	100
Richards Bay/ Mhlatuze	NN16	- 1 055 470	- 288
Mlalazi	NN15	49 200	100
Siyaya	NN14	1 800	100
Matigulu	NN13	224 440	255
Nyoni	NN12	41 280	359
Tugela	NN11	8 798 000	302
Zinkwasi	NN10	29 200	400
Nonoti	NN9	84 000	400
Mdlotane	NN8	17 200	400
Mvoti*	NN7	813 850	288
Seteni	NN6	6 400	400
Mhlali	NN5	121 600	400
Tongati	NN4	174 400	400
Mdloti	NN3	210 800	400
Mhlanga	NN2	47 200	400
Mgeni*	NN1	1 657 670	374
Durban Bay	NS53	-	-
Mlazi (concrete lined drainage canal)	NS52	426 800	439
Sipingo*	NS51	20 400	400
Mbokodweni	NS50	113 200	400
Manzimtoti	NS49	15 600	400
Little Manzimtoti	NS48	7 200	400
Lovu*	NS47	398 900	447

Table G11: The sediment yield of Natal estuaries (north to south) (after Rooseboom, 1975) (continued).

Estuary	CSIR estuary number	Mean maximum yield	
		$t\ y^{-1}$	$t\ km^{-2}\ y^{-1}$
Msimbazi	NS46	14 000	400
uMgababa	NS45	14 800	400
Ngane	NS44	6 400	400
Mkomazi*	NS43	1 616 360	375
Mahlongwana	NS42	6 000	400
Mahlongwa	NS41	36 800	400
Mpambanyoni	NS40	184 550	328
Mzimayi	NS39	12 400	400
Mzinto	NS38	59 600	400
Mkumbane	NS37	11 200	400
Sezela	NS36	8 000	400
Mdesingane	NS35	2 400	400
Fafa	NS34	88 150	382
Mvuzi	NS33	3 200	400
Mtwalume*	NS32	226 000	400
Mnamfu	NS31	6 400	400
Kwa Makosi	NS30	6 400	400
Mfazazana	NS29	6 400	400
Mhlungwa	NS28	12 800	400
Mhlabatshane	NS27	18 800	400
Mzumbe*	NS26	214 400	400
iNtshambili	NS25	13 200	400
Koshwana	NS24	4 400	400
Damba*	NS23	10 000	400
Mhlangamkulu	NS22	4 400	400
Mtentweni	NS21	20 000	400
Mzimkulu*	NS20	2 170 020	322
Mbango	NS19	5 200	400
Boboyi	NS18	12 800	400

Table G11: The sediment yield of Natal estuaries (north to south) (after Rooseboom, 1975) (continued).

Estuary	CSIR estuary number	Mean maximum yield	
		$t\ y^{-1}$	$t\ km^{-2}\ y^{-1}$
Zotsha	NS17	22 800	400
Mhlangeni	NS16	15 200	400
Vungu	NS15	85 200	400
Kongweni	NS14	8 000	400
Uvuzana	NS13	3 200	400
Bilanhlolo	NS12	8 400	400
Mvutshini	NS11	2 800	400
Mbizana*	NS10	72 500	500
Kaba	NS9	4 400	400
Umhlangankulu	NS8	3 600	400
Mpenjati	NS7	60 000	600
Kandandhlovu	NS6	5 400	600
Tongazi	NS5	10 200	600
Ku-Boboyi	NS4	1 800	600
Sandlundlu	NS3	9 600	600
Zolwane	NS2	4 200	600
Mtamvuna	NS1	434 290	280

<u>Source</u>: After Anonymous, 1990. Hydro factors affecting siltation in the lower reaches of Natal/KwaZulu rivers, CSIR Report No. EMA-D 9006, Division of Earth, Marine and Atmospheric Science and Technology, CSIR, Stellenbosch, 22 p. + app.

<u>See also</u>:

(i) McCormick, S., Cooper, J.A.G. and Mason, T.R., 1992. Fluvial sediment yield to the Natal Coast: a review, <u>Southern African Journal of Aquatic Sciences</u>, VOL 18(1/2), p. 74 - 88. (The authors suggested that the sediment data provided by Rooseboom were overestimates, and that sediment yield for the Natal/KwaZulu coastline should be re-examined).

(ii) Rooseboom, A., 1975. Sedimentproduksiekaart vir Suid-Afrika (gebaseer op streeksindeling deur Harmse), Technical Report No. TR 61, Department of Water Affairs, Pretoria, 5 p. + app.

(iii) Rooseboom, A., 1978. Sedimentafvoer in suider-Afrikaanse riviere, <u>Water SA</u>, VOL 4(1), p. 14 - 17.

Note: (i) Cloete (1979) - see footnote at the beginning of Section 7.2 - estimated that some 45 - 68 x 10^6 t y^{-1} of sediment is carried into the sea by South African rivers.

(ii) Mean annual sediment yield values should be viewed with caution. High silt loads are seasonal and are linked to wet and dry climatic phases and floods. River mouth conditions also play an important role, for example, where long periods of mouth closure promote siltation behind the sandbar.

(iii) Systems marked with an asterisk indicate significant decreases in estuarine length.

7.3 A community degradation index for South African estuaries

Ramm (1988; 1990)* developed a community degradation index (CDI) which was applied to 62 estuaries south of the Tugela River (with the exception of the Matigulu), in Natal/KwaZulu. The CDI condenses complex biological community data into a more compact form which can easily be understood and used by water resources planners. The primary objective of the CDI is to provide a "picture" of the relative degree of degradation of estuaries within each grouping, and also to provide relative comparisons amongst groups. Accordingly, the absolute values of degradation are not as significant (for planning purposes) as the relative comparisons amongst systems.

The development of a CDI first involved the classification of the 62 estuaries into six major groupings, based on eight physical-hydrological parameters. The parameters included mean and median annual runoff; the catchment and estuarine area; elevation of the source; percentage of the year that the mouth is closed; the average bottom salinity, and estuarine shoreline development. Following the use of statistical procedures, reference faunal lists were then developed for each of the physical groupings using historical data, and by obtaining the consensus of local experts. A CDI value was calculated for each system by comparing the reference faunal list, with species lists obtained during surveys conducted firstly by Begg in the period 1978 - 1982; and secondly by the Natal Estuarine and Coastal Research Unit of the CSIR in the years 1984 - 1986.

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* See Ramm, A.E., 1988. The community degradation index: a new method for assessing the deterioration of aquatic habitats, Water Research, VOL 22(3), p. 293 - 301., and Ramm, A.E.L., 1990. Application of the community degradation index to South African estuaries, Water Research, VOL 24(3), p. 383 - 389.

The systems in Group I (Table G12) are large true estuaries (with the exception of the Mvoti) namely, systems with frequent and significant exchange with the sea. Group II systems constitute medium sized estuaries, while Group III systems are the smaller southern-most estuaries, generally with rocky mouths. Group V systems represent the large number of relatively smaller lagoons which are closed to the sea for more than 60% of the year. *Group VI systems consist of the smaller northern-most lagoons.* Group IV also consists of lagoons.

CDI values ranged from the Zinkwasi Lagoon: 0,2 (not degraded) to the Mvoti River mouth and the Damba Lagoon: 8,2 (severely degraded). The CDI value of 8,2 for the Mvoti River mouth, for example, reflects the state of the former estuary where siltation of the lower reaches of the Mvoti has reached such a stage that the river bed level is at an elevation above mean sea level. This prevents mixing of freshwater and sea water, with a limited faunal species richness evident. Within Group II systems, the Tongati Estuary has a CDI of 5,9 which indicates periodic industrial and municipal pollutant discharges a few kilometres upstream of the estuary. By contrast, the Mhlali Estuary is not influenced by such pollution events, and is relatively undegraded with a CDI of 2,4. It should be noted that the CDI of 5,4 for the Sezela Lagoon reflects the recovery of the system, following clean up operations.

Sources of information on estuaries and the coastal zone are outlined in the next part of the chapter. Coastal and estuarine lakes in Natal/KwaZulu are then discussed. Brief data on mangroves in the province are provided in the last part of the chapter.

Table G12: Estuary and group, species richness and CDIs calculated for 62 estuaries in Natal/KwaZulu.

Estuary and group	Richness (number of species)	CDI
Group I		
Matigulu	73	2,1
Mvoti	17	8,2
Mgeni	79	1,4
Mkomazi	66	2,8
Mzimkulu	31	6,6
Mtamvuna	36	6,1
$P(\mathrm{I}) = P_{max}$	92	0,0
Group II		
Nonoti	12	8,0
Mhlali	55	2,4
Tongati	28	5,9
Mdloti	41	4,2
Mhlanga	24	6,4
Lovu	39	4,5
Mpambanyoni	13	7,8
Mtwalume	28	5,9
Mzumbe	14	7,7
$P(\mathrm{II})$	74	0,0
Group III		
Boboyi	12	4,4
Vungu	4	6,4
Tongazi	5	6,2
Sandlundlu	25	1,0
Zolwane	3	6,7
$P(\mathrm{III})$	29	0,0
Group IV		
Msimbazi	32	3,2
uMgababa	38	2,2
Sezela	19	5,4

Table G12: Estuary and group, species richness and CDIs calculated for 62 estuaries in Natal/KwaZulu (continued).

Estuary and group	Richness (number of species)	CDI
Mdesingane	19	5,5
Mbango	11	6,8
Ku-Boboyi	13	6,5
P(IV)	51	0,0
Group V		
Sipingo	24	5,3
Mbokodweni	10	7,4
Manzimtoti	25	5,1
Little Manzimtoti	21	5,7
Ngane	13	7,0
Mahlongwana	8	7,7
Mahlongwa	37	3,3
Mzimayi	10	7,4
Mzinto	10	7,4
Mkumbane	8	7,7
Fafa	10	7,4
Mvuzi	9	7,6
Mnamfu	8	7,7
Kwa Makosi	12	7,1
Mfazazana	10	7,4
Mhlungwa	9	7,6
Mhlabatshane	10	7,4
iNtshambili	12	7,1
Koshwana	8	7,7
Damba	5	8,2
Mhlangamkulu	8	7,7
Mtentweni	16	6,5
Zotsha	20	5,9
Mhlangeni	16	6,5
Kongweni	9	7,6

Table G12: Estuary and group, species richness and CDIs calculated for 62 estuaries in Natal/KwaZulu (continued).

Estuary and group	Richness (number of species)	CDI
Uvuzana	11	7,3
Bilanhlolo	20	5,9
Mvutshini	16	6,5
Mbizana	16	6,5
Kaba	7	7,9
Umhlangankulu	9	7,6
Mpenjati	23	5,4
Kandandhlovu	17	6,3
P(V)	58	0,0
Group VI		
Zinkwasi	64	0,2
Mdlotane	12	7,5
Seteni	11	7,7
P(VI)	65	0,0

Source: After Ramm, A.E.L., 1990. Application of the community degradation index to South African estuaries, Water Research, VOL 24(3), p. 383 - 389.

See also: Ramm, A.E.L., Cooper, J.A.G., Harrison, T.D. and Singh, R.A., 1994. Chapter 19. The estuarine health index: a new approach to scientific information transfer, In: Uys, M.C. (ed), Classification of Rivers, and Environmental Health Indicators: Proceedings of a Joint South African/Australian Workshop, 7 - 11 February 1994, Cape Town, WRC Report No. TT 63/94, Water Research Commission, Pretoria, p. 271 - 280.

Note:

(i) The reference faunal species richness (P) associated with each physical group is shown in the above table. The richest group is representative of the large estuarine systems (Group I).

(ii) The CDI is calculated as follows (using the uMgababa system (Group IV) *as an example*):

$$\text{CDI} = 10\,(1 - J)\,[\log(P)/\log(P_{max})]$$
$$\text{where } J = O/P = 38/51 \text{ and } P_{max} = 92$$
$$\text{CDI} = 10\,(1 - 0{,}745)\,(\log 51/\log 92) = 2{,}2.$$

(iii) A CDI of 0,1 for the Zinkwasi Lagoon (Group VI) appears in the original table. The text and abstract however, refer to a CDI of 0,2. The value in the above table has accordingly been changed to 0,2.

(iv) The following general interpretations of the CDI apply:

CDI	Degree of faunistic degradation
<2	Relatively undegraded
2 - 5	Slightly degraded
5 - 7	Moderately degraded
7 - 8	Strongly degraded
>8	Severely degraded

For further information consult the following:

- Anonymous, 1987. *Rehabilitation of the Isipingo Estuary and Lagoon: proceedings of a seminar April 1986*, Natal Town and Regional Planning Commission Supplementary Report, VOL 25, Pietermaritzburg, 53 p.

- Brownlie, S.F., 1988. Restoration of degraded estuaries, EEU Report No. 8/88/32, Environmental Evaluation Unit, Department of Environmental and Geographical Science, University of Cape Town, Rondebosch, 144 p.

- Largier, J.L. and Slinger, J.H., 1991. Circulation in highly stratified southern African estuaries, Southern African Journal of Aquatic Sciences, VOL 17(1/2), p. 103 - 115.

- Wiseman, K.A. and Sowman, M.R., 1992. An evaluation of the potential for restoring degraded estuaries in South Africa, Water SA, VOL 18(1), p. 13 - 19.

7.4 CSIR data sources on estuaries and coastal zone management in Natal/KwaZulu

The Natal Estuarine and Coastal Research Unit (NECRU) was established in 1984 under the auspices of the Division of Water Technology, CSIR, Durban. The Unit continued the work of Begg (see above) on estuaries in Natal/KwaZulu, with special reference to water quality and biological surveys. The latter data are available on computer at the Durban and Pretoria offices of the Division of Water Technology. The CSIR database also includes all the information generated by Begg in the period 1978 - 1982. The database accordingly, is the most extensive computerized source of information on estuaries in Natal/KwaZulu. A voucher collection of representative specimens of all fauna (fish) obtained during the estuarine surveys can be examined at the Durban office.

A collection of over 1 000 reference articles and books on estuaries has likewise been established. This material has been included in the CSIR estuaries database. Maps and aerial photographs of the Natal/KwaZulu Coast and portions of the Transkei Coast, plus a set of colour stereo aerial photographs with a 1 : 5 000 scale (flown in July 1985), are also available at the Durban office. A second research phase undertaken by NECRU, which began in 1985, involved the development of an index for measuring the relative extent of degradation of estuaries in Natal/KwaZulu (discussed above). A comprehensive physical classification of estuaries was first required, based on the work of Begg as well as Perry (1986)*.

The Coastal Processes and Management Advice Programme of the Division of Earth, Marine and Atmospheric Science and Technology of the CSIR in Stellenbosch, investigated the hydrological and hydraulic characteristics of numerous estuaries in Natal/KwaZulu, as well as factors influencing the siltation of these estuaries (including St Lucia). The effects of the September 1987 floods on estuaries in Natal/KwaZulu were also assessed by the Stellenbosch office. Other organizations which have undertaken estuarine research in the province include the three universities in Natal/KwaZulu; the University of Cape Town; the University of Port Elizabeth; the Natal Parks Board; the KwaZulu Department of Nature Conservation; the Natal Provincial Administration; the Department of Environment Affairs; the South African Sugar Association Experiment Station; the Department of Water Affairs and Forestry, and a few consulting engineering firms.

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* See Perry, J.E., 1986. Basic physical geography/hydro data for Natal "estuaries", NRIO Data Report No. D 8607, Sediment Dynamics Division, Coastal Engineering and Hydraulics, National Research Institute for Oceanology, CSIR, Stellenbosch, 6 p. + app.

7.5 CSIR publications series on estuaries and coastal zone management in Natal/ KwaZulu

Note: Certain reports are presented in a slightly different format in the bibliographic database. The original names for research institutes have been used as per the CSIR document in question, in order to avoid confusion. (The National Institute for Water Research is now known as the Division of Water Technology, while the National Research Institute for Oceanology is now known as the Division of Earth, Marine and Atmospheric Science and Technology).

(a) A series of reports No. 1 - 65 providing general status information including physico-chemical and biological data, for estuaries south of the Tugela River.

Example

Ramm, A.E.L., Cerff, E.C. and Harrison, T.D., 1986. The Mkomazi Estuary, Natal Estuary Status Report No. 65, Estuaries and Coastal Processes Division, National Institute for Water Research, CSIR, Durban, no pagination.

(b) Physico-chemical data on estuaries and some lakes are found in the following CSIR annual reports.

Example

Ramm, A.E.L., Cooper, J.A.G., Harrison, T.D. and Singh, A., 1991. Natal Estuarine and Coastal Research Unit annual report 1990 - 1991, Division of Water Technology, CSIR, Durban, various pages.

(c) A series of annual reports No. 1 - 7 dealing with water quality and biological studies of selected Natal/KwaZulu estuaries.

Example

(1982). National Marine Pollution Surveys, East Coast Section, seventh annual report, National Institute for Water Research, CSIR, Durban, various pages.

(d) Some water quality data for estuaries and bays are found in certain reports of a CSIR steering committee series. The final report in the series is given in the example.

Example

Marine Disposal of Effluents, Forty-ninth Steering Committee Meeting 25 October 1984, Progress Report No. 48, Research Group for Natal, National Institute for Water Research, CSIR, Durban, various pages.

(e) A series of progress reports dealing with hydrological and hydraulic studies of selected Natal/KwaZulu estuaries. The final report in the series is given in the example.

Example

(1982). Hydrological/hydraulic Study of Natal Estuaries, Forty Fifth Steering Committee Meeting: Marine Disposal of Effluents and Estuarine Investigation Committee, Progress Report No. 8, NRIO Memorandum [No.] 8237, Sediment Dynamics Division, Coastal Engineering and Hydraulics, National Research Institute for Oceanology, CSIR, Stellenbosch, 5 p. + app.

(f) A series of reports No. 1 - 29 dealing with hydrological and hydraulic studies of some Natal/KwaZulu estuaries. The CSIR, Stellenbosch, should be contacted for a complete listing of these reports. See also the bibliographic database.

Example

Anonymous, 1990. Hydrological/hydraulic study of Natal estuaries, Data Report No. 29 uMhlanga NS 16, CSIR Report No. EMA-D 9004, Division of Earth, Marine and Atmospheric Science and Technology, CSIR, Stellenbosch, 10 p. + app.

See also:

- Anonymous, 1990. Hydro factors affecting siltation in the lower reaches of Natal/KwaZulu rivers, CSIR Report No. EMA-D 9006, Division of Earth, Marine and Atmospheric Science and Technology, CSIR, Stellenbosch, 22 p. + app.

- Perry, J.E., 1986. *Basic physical geography/hydro data for Natal "estuaries"*, NRIO Data Report No. D 8607, Sediment Dynamics Division, Coastal Engineering and Hydraulics, National Research Institute for Oceanology, CSIR, Stellenbosch, 6 p. + app.

(g) Some individual reports on hydraulic aspects of a few Natal/KwaZulu estuaries are also available.

Example

Anonymous, 1972. New estuary for the Richards Bay Lagoon: a preliminary investigation, VOL 1, Main report, submitted to the South African Railways Administration, CSIR Report No. ME 1143/1, Hydraulics Research Unit, National Mechanical Engineering Research Institute, CSIR, Stellenbosch, 24 p. + app. (With accompanying VOL 2, Appendices, CSIR Report No. ME 1143/2, 23 p. + app.).

(h) A series of reports is available from the Marine Geoscience and Sediment Dynamics Divisions of the National Research Institute for Oceanology, in terms of recent and present sedimentary processes in the St Lucia and Mfolozi estuaries, as well as the geological evolution of Lake St Lucia.

Example

Van Heerden, I. Ll. and Swart, D.H., 1986. St Lucia research - VOL 1: an assessment of past and present geomorphological and sedimentary processes operative in the St Lucia Estuary and environs, CSIR Research Report No. 569, Marine Geoscience and Sediment Dynamics Divisions, National Research Institute for Oceanology, CSIR, Stellenbosch, 60 p. + app.

(i) A series of steering committee reports dealing with the Siyaya (Siaya) Catchment Project near Mtunzini.

Example

Steering Committee for the Siyaya Catchment Project, 11th Meeting on 29th March 1985, National Institute for Water Research, CSIR, Durban, various pages.

Note: For a useful overview of previous research on estuaries in Natal/KwaZulu, undertaken inter alia by the CSIR and university departments, see: Bowmaker, A.P., Van der Zee, D. and Ridder, J.H. (eds), 1987. Marine research in Natal, *Proceedings of a symposium and workshop held at Durban, South Africa, 10 and* 11 February 1986, South African National Scientific Programmes Report No. 139, Foundation for Research Development, CSIR, Pretoria, 184 p.

7.6 The SANCOR estuaries programme

The (since defunct) South African National Committee for Oceanographic Research (SANCOR) programme (which subsequently operated under the auspices of the Foundation for Research Development, then of the CSIR), initiated an Estuaries Programme in 1981*. Various scientific publications were issued in terms of the South African National Scientific Programmes Report series. These reports included summaries of research activities undertaken on estuaries, as well as coastal research (the Coastal Processes Programme) - *see the bibliographic database. Two examples of summary reports are given below.*

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* For a broad overview of the research activities of SANCOR; as well as SCOR (Scientific Committee on Oceanic Research) and ECOR (Engineering Committee on Oceanic Resources) - both of the International Council of Scientific Unions - with South African components, see Simpson, E.S.W., 1983. South African oceanography: the way ahead, South African Journal of Science, VOL 79(4), p. 122 - 124. (Other papers in the journal issue may also be of interest). It should be noted that the Department of Environment Affairs and the Foundation for Research Development are the main sponsors of the recently established (as of the 3rd of December 1993), South African Network for Coastal and Oceanic Research (SANCOR). The aims of the revived SANCOR are to co-ordinate, stimulate and review marine science, engineering and technology in South Africa, in order to promote wise and informed management of the marine and coastal environment. Various co-ordinating groups, including the Coastal Processes Co-ordinating Group, the Coastal Zone Projects Steering Committee and the Marine Pollution Co-ordinating Group have been established. For brief details see, Anonymous, 1994. SANCOR, SASAQS News, Autumn 1994, p. 13 - 14.

- Anonymous, 1989. SANCOR summary report on marine research 1988, South African National Scientific Programmes Report No. 165, Foundation for Research Development, CSIR, Pretoria, 43 p.

- Swart, D.H. (ed), 1983. The SANCOR Programme on Coastal Processes April 1982 - March 1988, *South African National Scientific Programmes Report* No. 68, Cooperative Scientific Programmes, CSIR, Pretoria, 30 p. (Reports issued for the SANCOR Marine Pollution Programme may also be of interest).

7.7 Some primary publications on estuaries and coastal zone management in Natal/ KwaZulu

- Anonymous, 1990. Hydro factors affecting siltation in the lower reaches of Natal/KwaZulu rivers, CSIR Report No. EMA-D 9006, Division of Earth, Marine and Atmospheric Science and Technology, CSIR, Stellenbosch, 22 p. + app.

- Begg, G., 1978. The estuaries of Natal, Natal Town and Regional Planning Commission Report, VOL 41, Pietermaritzburg, 657 p.

- Begg, G.W., 1984. The estuaries of Natal Part 2: supplement to NTRP Report VOL 41, Natal Town and Regional Planning Commission Report, VOL 55, Pietermaritzburg, 631 p. (This volume contains amendments to the data presented in Begg (1978 - above), as well as additional data. Both reports should be carefully examined).

- Begg, G.W., 1984. The comparative ecology of Natal's smaller estuaries, Natal Town and Regional Planning Commission Report, VOL 62, Pietermaritzburg, 182 p. + app. (Further data are presented on 62 estuaries south of the Tugela River).

- Begg, G., 1985. Policy proposals for the estuaries of Natal, Natal Town and Regional Planning Commission Report, VOL 43, Pietermaritzburg, 37 p. (The publication also contains an overview of the responsibilities of the various authorities involved in coastal zone management in Natal/KwaZulu. The names of Government departments however, have changed).

- Bowmaker, A.P., Van der Zee, D. and Ridder, J.H. (eds), 1987. *Marine research* in Natal, Proceedings of a symposium and workshop held at Durban, South Africa, 10 and 11 February 1986, South African National Scientific Programmes Report No. 139, Foundation for Research Development, CSIR, Pretoria, 184 p.

- *Broekhuysen, G.J. and Taylor, H., 1959.* The ecology of South African estuaries, Part 8. Kosi Bay Estuary system, Annals of the South African Museum, VOL 44(7), p. 279 - 296.

- Cyrus, D.P., 1989. The Lake St Lucia system - a research assessment, Southern African Journal of Aquatic Sciences, VOL 15(1), p. 3 - 25. (The paper has numerous references).

- Day, J.H., 1951. The ecology of South African estuaries, Part 1. A review of estuarine conditions in general, Transactions of the Royal Society of South Africa, VOL 33(1), p. 53 - 91.

- Day, J.H. (ed), 1981. Estuarine Ecology With Particular Reference to Southern Africa, A.A. Balkema, Cape Town, 411 p.

- Day, J.H., Millard, N.A.H. and Broekhuysen, G.J., 1955. The ecology of South African estuaries, Part 4. The St Lucia system, Transactions of the Royal Society of South Africa, VOL 34(3), p. 129 - 156.

- Day, J.H. and Morgans, J.F.C., 1956. The ecology of South African estuaries, Part 7. The biology of Durban Bay, Annals of the Natal Museum, VOL 13(3), p. 259 - 312.

- Heydorn, A.E.F. (ed), 1986. An assessment of the state of the estuaries of the *Cape and Natal in 1985/86, South African National Scientific Programmes Report* No. 130, Foundation for Research Development, CSIR, Pretoria, 39 p.

- Heydorn, A.E.F., Glazewski, J.I. and Glavovic, B.C., 1992. Chapter 26. The coastal zone, In: Fuggle, R.F. and Rabie, M.A. (eds), Environmental Management in South Africa, Juta, Cape Town, p. 669 - 689.

- Jezewski, W.A. and Roberts, C.P.R., 1986. Estuarine and lake freshwater requirements, Technical Report No. TR 129, Department of Water Affairs, Pretoria, 22 p. + app.

- Millard, N.A.H. and Broekhuysen, G.J., 1970. The ecology of South African *estuaries, Part 10. St Lucia: a second report,* Zoologica Africana, VOL 5(2), p. 277 - 307.

- Millard, N.A.H. and Harrison, A.D., 1955. The ecology of South African estuaries, Part 5. Richard's Bay, Transactions of the Royal Society of South Africa, VOL 34(3), p. 157 - 179.

- Noble, R.G. and Hemens, J., 1978. Inland water ecosystems in South Africa - a review of research needs, South African National Scientific Programmes Report No. 34, Cooperative Scientific Programmes, CSIR, Pretoria, 150 p.

- Perry, J.E., 1986. Basic physical geography/hydro data for Natal "estuaries", NRIO Data Report No. D 8607, Sediment Dynamics Division, Coastal Engineering and Hydraulics, National Research Institute for Oceanology, CSIR, Stellenbosch, 6 p. + app.

- Ramm, A.E., 1988. The community degradation index: a new method for assessing the deterioration of aquatic habitats, Water Research, VOL 22(3), p. 293 - 301.

- Ramm, A.E.L., 1990. Application of the community degradation index to South African estuaries, Water Research, VOL 24(3), p. 383 - 389.

- Ramm, A.E.L., Cooper, J.A.G., Harrison, T.D. and Singh, R.A., 1994. Chapter 19. *The estuarine health index: a new approach to scientific information transfer,* In: Uys, M.C. (ed), Classification of Rivers, and Environmental Health Indicators: Proceedings of a Joint South African/Australian Workshop, 7 - 11 February 1994, Cape Town, WRC Report No. TT 63/94, Water Research Commission, Pretoria, p. 271 - 280.

- Taylor, R.H. (ed), 1993. Proceedings of the Workshop on Water Requirements for Lake St Lucia, organized by the St Lucia Ecological and Technical Committee (SCADCO) and held at Fanies Island, St Lucia, 12 - 13 May 1992, Department of Environment Affairs, Pretoria, 83 p.

- *Whitfield, A.K., 1992. A characterization of southern African estuarine systems,* Southern African Journal of Aquatic Sciences, VOL 18(1/2), p. 89 - 103.

- Whitfield, A.K., 1995. Available scientific information on individual South African estuarine systems, WRC Report No. 577/1/95, Water Research Commission, Pretoria, 204 p.

- Wiseman, K.A. and Sowman, M.R., 1992. An evaluation of the potential for restoring degraded estuaries in South Africa, Water SA, VOL 18(1), p. 13 - 19.

See also:

- Anonymous, 1984. Coastal zone management: proceedings of a seminar organized by the Natal Town and Regional Planning Commission, Pietermaritzburg, 1984, Natal Town and Regional Planning Commission Supplementary Report, VOL 14, Pietermaritzburg, 88 p.

- Anonymous, 1991. South African tide tables 1991, Maritime Headquarters, South African Navy, Cape Town, 260 p. (The tables are updated annually).

- Adams, J.B. and Bate, G.C., 1994. The freshwater requirements of estuarine plants incorporating the development of an estuarine decision support system, VOL 1, WRC Report No. 292/1/94, 151 p. + app., and VOL 2 - Literature review, WRC Report No. 292/2/94, 73 p., Water Research Commission, Pretoria.

- Branch, G. and Branch, M., 1981. The Living Shores of Southern Africa, C. Struik, Cape Town, 272 p.

- Branch, G.M., Griffiths, C.L., Branch, M.L. and Beckley, L.E., 1994. Two Oceans: a Guide to the Marine Life of Southern Africa, David Philip Publisher, Cape Town, 368 p.

- Council for the Environment, 1989. A policy for coastal zone management in the Republic of South Africa, Part 1: principles and objectives, Joan Lötter Publications, Pretoria, 11 p.

- Council for the Environment, 1991. A policy for coastal zone management in the Republic of South Africa, Part 2: guidelines for coastal land-use, Academica Publishers, Pretoria, 95 p. (The publication contains a useful synopsis of environmental legislation and the relevant controlling authorities with respect to the coastal zone. Note that the Integrated Environmental Management (IEM) procedure (likewise the subject of a report produced by the Council - see the bibliographic database) has relevance to coastal zone management, and was revised by the Department of Environment Affairs in 1992*. Refer also to Fuggle and Rabie

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* See Fuggle, R.F., Preston, G.R., Sowman, M.R., Robins, N., Short, R., Grindley, S.A., Hill, R.C., Stauth, R.B., Raimondo, J.P., Fowkes, S.M., Lane, S.B., Barker, J.A. and Glazewski, J., 1992. Guideline Document 1: The integrated environmental management procedure, Integrated Environmental Management Guideline Series, Department of Environment Affairs, Pretoria, 19 p., as well as Fuggle, R.F., Preston, G.R., Sowman, M.R., Robins, N., Short, R., Grindley, S.A., Hill, R.C., Stauth, R.B., Raimondo, J.P., Fowkes, S.M., Lane, S.B., Barker, J.A. and Glazewski, J., 1992. Guideline Document 2: Guidelines for scoping, Integrated Environmental Management Guideline Series, Department of Environment Affairs, Pretoria, 21 p., plus, Fuggle, R.F., Preston, G.R., Sowman, M.R., Robins, N., Short, R., Grindley, S.A., Hill, R.C., Stauth, R.B., Raimondo, J.P., Fowkes, S.M., Lane, S.B., Barker, J.A. and Glazewski, J., 1992. Guideline Document 3: Guidelines for report requirements, Integrated Environmental Management Guideline Series, Department of Environment Affairs, Pretoria, 21 p. See also Fuggle, R.F., Preston, G.R., Sowman, M.R., Robins, N., Short, R., Grindley, S.A., Hill, R.C., Stauth, R.B., Raimondo, J.P., Fowkes, S.M., Lane, S.B., Barker, J.A. and Glazewski, J., 1992. Guideline Document 4: Guidelines for review, Integrated Environmental Management Guideline Series, Department of Environment Affairs, Pretoria, 15 p., and Fuggle, R.F., Preston, G.R., Sowman, M.R., Robins, N., Short, R., Grindley, S.A., Hill, R.C., Stauth, R.B., Raimondo, J.P., Fowkes, S.M., Lane, S.B., Barker, J.A. and Glazewski, J., 1992. Guideline Document 5: Checklist of environmental characteristics, Integrated Environmental Management Guideline Series, Department of Environment Affairs, Pretoria, 13 p., to be read in conjunction with Fuggle, R.F., Preston, G.R., Sowman, M.R., Robins, N., Short, R., Grindley, S.A., Hill, R.C., Stauth, R.B., Raimondo, J.P., Fowkes, S.M., Lane, S.B., Barker, J.A. and Glazewski, J., 1992. Guideline Document 6: Glossary of terms used in integrated environmental management, Integrated Environmental Management Guideline Series, Department of Environment Affairs, Pretoria, 5 p. (It should be borne in mind that Environmental Impact Assessments (EIAs), undertaken according to IEM principles, will become compulsory in the future. Draft regulations for EIAs were published in General Notice 171/94, in terms of Section 26 of the Environment Conservation Act No. 73 of 1989. Activities for which EIAs will be required, with regard to Section 21 of the Act, were provisionally listed in General Notice 172/94. These activities include the construction of harbours/marinas as well as pipelines for the discharge of any matter into the sea; the formal disposal of other waste in the sea; mining of the sea bed, and the reclamation of land from the sea. Refer also to Government Notices 1749 - 1752 inclusive - all published in 1996 - for additional information).

(1992)*. See in addition: Council for the Environment, 1994. SEIA: *streamlined* environmental impact assessment, [Department of Environmental Affairs and Tourism], Pretoria, 10 p. + app.).

- Council for the Environment, 1994. Management of South Africa's coastal *resources: a status report with recommendations for its future conservation and* management, [Department of Environmental Affairs and Tourism], Pretoria, 18 p.

- Jackson, L.F. and Lipschitz, S., 1984. Coastal sensitivity atlas of southern Africa, 1984, Department of Transport, Pretoria, 34 p. (The publication classifies the vulnerability of the shoreline to oil pollution).

- Lusher, J.A. (ed), 1984. Water quality criteria for the South African coastal zone, South African National Scientific Programmes Report No. 94, Foundation for Research Development, CSIR, Pretoria, 25 p. + app. (The publication discusses the quality of sea water in estuarine and marine environments, with special reference to pipeline discharges of effluents into the sea).

- McCarthy, J.J., 1987. Natal's coastal margins: towards a planning policy for the management of urbanization, Natal Town and Regional Planning Commission Supplementary Report, VOL 22, Pietermaritzburg, 85 p. and map.

- McGlashan, J.E. (ed), 1992. Guide for the marine disposal of effluents through pipelines, WRC Report No. TT 58/92, Water Research Commission, Pretoria, 145 p. (Various other South African publications on pipeline effluent disposal procedures are listed in the report).

- Oosthuizen, A.J., 1987. The application of the Sea-shore Act and related legislation on the Natal Coast, Natal Town and Regional Planning Commission Supplementary Report, VOL 6, Pietermaritzburg, 113 p.

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* See Fuggle, R.F. and Rabie, M.A. (eds), 1992. <u>Environmental Management in South Africa</u>, Juta, Cape Town, 823 p. (Examine in particular, Chapter 30. Integrated environmental management, p. 748 - 761., as well as Chapter 31. Environmental evaluation, p. 762 - 780).

- Rosenthal, G. and Grant, S., 1989. Simplified tidal prediction for the South African coastline, South African Journal of Science, VOL 85(2), p. 104 - 107.

- Shackleton, L., 1993. A management perspective of marine and coastal research carried out in South Africa, 1975 - 1991, Department of Environment Affairs, [Pretoria], 44 p. (*The publication provides a useful overview of research and should* be examined from a synthesis viewpoint).

- Tinley, K.L., 1985. Coastal dunes of South Africa, South African National Scientific Programmes Report No. 109, Foundation for Research Development, CSIR, Pretoria, 300 p. and map. (The publication contains a useful description of the coastal climates of South Africa. The map illustrates the erosional status of the South African coastline, as well as suggested coastal dune ecosystem reserves).

For further information contact:

- Consortium for Estuarine Research and Management, c/o Institute of Natural Resources, University of Natal, Private Bag X01, Scottsville, 3209. (The Consortium is an informal association of estuarine researchers in South Africa).

- Council for the Environment, Private Bag X447, Pretoria, 0001.

- Departments of Biology/Geology and Applied Geology (Marine Geoscience Unit)/Geographical and Environmental Sciences, University of Natal, Private Bag X10, Dalbridge, 4014.

- Departments of Botany/Zoology and Entomology, University of Natal, Private Bag X01, Scottsville, 3209.

- *Departments of Botany/Hydrology/Zoology* (Coastal Research Unit of Zululand), University of Zululand, Private Bag X1001, KwaDlangezwa, 3886. (Note that the Department of Hydrology has processed meteorological and other information for the St Lucia Eastern Shores State Forest and environs including radiation, air temperature, wind, rainfall, evaporation, groundwater temperature and piezometric level data. Similar meteorological and hydrological data for St Lucia Estuary per se are available from the Natal Parks Board - see Section 2.2.4 (d) in Chapter 2).

- Department of Environment Affairs, Private Bag X2, Rogge Bay, 8012. (The Department together with the Natal and Cape provincial administrations, is involved in the Coastal Management Advisory Programme - CMAP, which aims to advise local authorities, planners, conservationists and developers on coastal zone planning).

- Department of Environmental and Geographical Science, University of Cape Town, Private Bag, Rondebosch, 7701. (The Department - in Natal/KwaZulu - is mainly concerned with St Lucia).

- Department of Geology/Institute for Coastal Research, University of Port Elizabeth, P O Box 1600, Port Elizabeth, 6000.

- Department of Water Affairs and Forestry, P O Box 1018, Durban, 4000.

- Division of Earth, Marine and Atmospheric Science and Technology, CSIR, P O Box 320, Stellenbosch, 7599.

- Division of Water Technology, CSIR, P O Box 17001, Congella, 4013.

- EPPIC (Environmental Planning Professions Interdisciplinary Committee), P O Box 90142, Bertsham, 2013.

- Institute of Environmental Law, University of Natal, Private Bag X10, Dalbridge, 4014.

- Institute of Marine Law, University of Cape Town, Private Bag, Rondebosch, 7701. (The Institute publishes a journal Sea Changes, which contains valuable summary information on amendments to South African marine legislation and coastal zone regulations, as well as pollution and conservation legislation).

- Institute of Maritime Law, University of Natal, Private Bag X10, Dalbridge, 4014.

- J L B Smith Institute of Ichthyology, Rhodes University, Private Bag 1015, Grahamstown, 6140.

- KwaZulu Department of Nature Conservation, Private Bag X98, Ulundi, 3838.

- Maritime Law Association/Environmental Law Association, c/o Shepstone and Wylie, P O Box 205, Durban, 4000.

- Natal Parks Board, P O Box 662, Pietermaritzburg, 3200.

- Natal Town and Regional Planning Commission/Chief Directorate: Physical Planning and Development, Natal Provincial Administration, Private Bag X9037, Pietermaritzburg, 3200. (The Commission was responsible for the overall co-ordination of much of the "official" research on estuaries in Natal/KwaZulu).

- Oceanographic Research Institute, P O Box 10712, Marine Parade, 4056.

- South African Sugar Association Experiment Station, Private Bag X02, Mount Edgecombe, 4300.

- C. Ward, P O Box 30501, Mayville, 4058. (The research worker concerned, previously a member of staff of the University of Durban-Westville, has an extensive collection of aerial and ground photographs for most of the estuaries of Natal/KwaZulu. The photographs were taken in the period 1937 - 1990, although much of the collection dates from 1960 onwards. The photographs illustrate various coastal processes including beach erosion and dune slumping).

- Wildlife Society of Southern Africa (Natal Branch), P O Box 2985, Durban, 4000.

- World Wide Fund for Nature South Africa/The Green Trust, P O Box 456, Stellenbosch, 7599.

Two other organizations of relevance:

- Department of Landscape Architecture, University of Pretoria, Pretoria, 0002. (The Department undertakes site surveys involving ecological planning and is a source of relevant expertise).

- Research Institute for Reclamation Ecology, Potchefstroom University for Christian Higher Education, Private Bag X6001, Potchefstroom, 2520. (The Institute is involved inter alia with the rehabilitation of areas disturbed by construction or mining activities).

As indicated above, numerous organizations are or have been involved with research on estuaries in Natal/KwaZulu. One of the major problems in terms of coastal zone management - with particular reference to wetlands, floodplains and estuaries - is the multiplicity of legislative and administrative controls (and conversely, sometimes the lack thereof); quite apart from population pressures and complex interactions between the diverse and varied land and sea ecosystems. With respect to controlling authorities, readers are referred to the section on local authorities and services in Natal and KwaZulu, as well as the section on structure plans, elsewhere in this publication. Acts and Provincial Ordinances dealing with coastal zone management are outlined in the chapter on the laws of South Africa*. See also the chapter on solid waste management.

7.8 Coastal and estuarine lakes in Natal/KwaZulu

Much of the total coastal and estuarine lake surface area in South Africa is in northern Natal/KwaZulu. The remaining lakes are restricted to the southern and south western Cape coasts as well as the Cape West Coast, north of the Berg River mouth. These lakes can be divided into two broad categories namely: coastal lakes which may contain fresh or brackish water and organisms of estuarine origin (not normally influenced by the sea); and estuarine lakes which are temporarily or permanently connected to the sea, and which exhibit varying degrees of marine salinity. Each group can be subdivided into three categories depending on the extent of marine influence (Noble and Hemens, 1978) (Table G13). Some important coastal and estuarine lakes in Natal/KwaZulu are listed in Table G14.

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* Readers are reminded that the Environment Conservation Act No. 73 of 1989, can be used to control or to prevent environmentally undesirable or destructive activities in the sensitive coastal zone (Section 31A of the Act).

Table G13: A classification of coastal and estuarine lakes in South Africa.

Type	Sub-type	Example
Coastal lakes Freshwater or brackish; marine influence minimal; may contain relict estuarine biota	Brackish with seepage outflow only	Sibaya (Natal/KwaZulu); Groenvlei (southern Cape), De Hoopvlei (south west Cape)
	Freshwater or brackish with outflow to sea but no tidal exchange	Mzingazi, Nsezi, Cubhu (Natal/KwaZulu); Soetendalsvlei (south western Cape), Zeekoevlei (western Cape)
	Freshwater or brackish with outflow to sea. Occasional sea water input	Verlorevlei, Wadrifsoutpan and other Cape West Coast vleis
Estuarine lakes Freshwater to highly saline; estuarine biota; permanent or semi-permanent tidal connection to the sea	Freshwater to saline. The lake shallow, normally with no vertical salinity stratification	Wilderness lakes (southern Cape) and Sandvlei (Cape Flats)
	Freshwater to saline. The lake less shallow, often with vertical salinity stratification	Swartvlei (southern Cape) and the Kosi lake system (northern Natal/KwaZulu)
	Freshwater to hypersaline	St Lucia system (Natal/KwaZulu)

<u>**Source**</u>: After Noble, R.G. and Hemens, J., 1978. Inland water ecosystems in South Africa - a review of research needs, South African National Scientific Programmes Report No. 34, Cooperative Scientific Programmes, CSIR, Pretoria, 150 p.

<u>**Note**</u>: Lake Sibaya is more commonly referred to in the literature, as a freshwater body.

Table G14: Named coastal and estuarine lakes in Natal/KwaZulu (north to south) (freshwater to brackish or highly saline).

Name	River/s	Nearest town	Latitude (S)	Longitude (E)	Surface area (km^2)	Volume at F.S.L. ($10^6 m^3$)	Mean depth (m)
Kosi system							
Zilonde	Nswamanzi, Sihadla	KwaNgwanase	26°50'-27°11'	32°38'-32°53'	2,0 ?		2,0 ? ; 4,0 (max. depth)[17]
uKhalwe inlet					0,16[1]		3,0 (max. depth)[1]
Enkovukeni					3,1[1]		1,0-1,5 (max. depth)[1]
Makhawulani					0,8-1,0[1]		6,0 (max. depth)[24]
Mpungwini					2,8[1]	± 23[1]	8,1[1]; >21 (max. depth)[24]
Nhlange					30,7-37,0[1]	± 220[1]	7,2[1]; >30 (max. depth)[24]
Amanzimnyama and adjacent Lake Shengeza	Groundwater	KwaNgwanase	27°02'	32°50'	1,5[1] 3,0 ?		2,0 (max. depth)[1] 2,0 ? ; 6,0 (max. depth)[17]
Lake Sibaya	Welandhlovu and seven other perennial streams	Mseleni	27°21'	32°41'	54,0-78,0[2,3]	620-981[2,3]	10,9-13,0[2,3]; 38,0 (max. depth)[23]
Lake Mgobezeleni and adjacent Lake Shazibe	Supplied by groundwater	Mbazwane	27°32'	32°40'	1,8[4]		±3,0; 5,0 (max. depth)[18]
Lake Bangazi North	Supplied by groundwater	Mkuze	27°39'	32°38'	16,4[19]		10,0 (max. depth)[19]

Table G14: Named coastal and estuarine lakes in Natal/KwaZulu (north to south) (freshwater to brackish or highly saline) (continued).

Name	River/s	Nearest town	Latitude (S)	Longitude (E)	Surface area (km^2)	Volume at F.S.L. ($10^6 m^3$)	Mean depth (m)
Lake St Lucia and adjacent Selley's Lakes as well as Lake Bangazi South	Mkuze Mzinene Hluhluwe Nyalazi Mpate	Hluhluwe, St Lucia	27°52'-28°24' 28°07'	32°21'-32°34' 32°32'	300-350[5,14] 2,82[20]	295-322[5,6] (mean F.S.L.) 7,09[20]	<1,0[2]; 2,0 (max. depth)[5] 3,05-3,66 (general depth); 4,11 (max. depth)[20]
Lake Mfuthululu	Mfolozi	Mtubatuba	28°25'	32°16'	1,55[7]		
Lake Teza	Msunduzi	Mtubatuba	28°29'	32°10'	1,88[7]		2,1 (max. depth)[21]
Lake Nhlabane (both lakes)	Nhlabane, groundwater	KwaMbonambi	28°36'	32°16'	4,4[22]	7,39-10,0[22,8]	2,44-2,74 (max. depth)[22]
Lake Nsezi	Nseleni	Empangeni	28°45'	31°58'	3,25[9]	8,33[10]	2,40 (max. depth)[25]
Lake Cubhu	Mzingwenya	Felixton	28°51'	31°57'	4,64[11]	±8,70[12]	±2,25[12]; 4,0 (max. depth)[26]
Lake Mzingazi	Mdibi Nkoninga Khondweni Phayeni	Richards Bay	28°46'	32°05'	12,16[13]	47,5[15]	±6,0[16]; 14,0 (max. depth)[17]
Lake Mpangeni	Mhlatuze	Empangeni	28°48'	31°50'			
Lake Sigwenyana	Not named	Felixton	28°49'	31°51'			
Lake Mdlangu	Not named	Mtunzini	28°56'	31°50'			

<u>Source</u>:

1. Begg, G.W., 1980. The Kosi system: aspects of its biology, management and research, In: Bruton, M.N. and Cooper, K.H. (eds), <u>Studies on the Ecology of Maputaland</u>, Rhodes University and the Natal Branch of the Wildlife Society of Southern Africa, Grahamstown and Durban, p. 358 - 373.

2. Pitman, W.V., 1980. Hydrology of the coastal lakes of Maputaland with special reference to St Lucia and Sibaya, In: Bruton, M.N. and Cooper, K.H. (eds), <u>Studies on the Ecology of Maputaland</u>, Rhodes University and the Natal Branch of the Wildlife Society of Southern Africa, Grahamstown and Durban, p. 12 - 17.

3. Hill, B.J., 1979. Bathymetry, morphometry and hydrology of Lake Sibaya, In: Allanson, B.R. (ed), <u>Lake Sibaya</u>, Monographiae Biologicae VOL 36, W. Junk, The Hague, p. 34 - 41.

4. Bruton, M.N. and Appleton, C.C., 1975. Survey of Mgobezeleni Lake-system in Zululand, with a note on the effect of a bridge on the mangrove swamp, <u>Transactions of the Royal Society of South Africa</u>, VOL 41(3), p. 283 - 294.

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8. Joubert, F., 1972. Memorandum to the Principal Scientific Officer, Natal Parks Board, on Lake Nhlabane, Natal Parks Board, Pietermaritzburg, 3 p.

9. Begg, G., 1989. The wetlands of Natal (Part 3): the location, status and function of the priority wetlands of Natal, Natal Town and Regional Planning Commission Report, VOL 73, Pietermaritzburg, 256 p. and map.

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See also: (i) Hill, B.J., 1969. The bathymetry and possible origin of lakes Sibayi, Nhlange and Sifungwe in Zululand (Natal), Transactions of the Royal Society of South Africa, VOL 38(3), p. 205 - 216.

(ii) Hill, B.J., 1975. The origin of southern African coastal lakes, Transactions of the Royal Society of South Africa, VOL 41(3), p. 225 - 240.

Note: (i) Some definitional problems may arise - for example, Lake Mdlangu near Mtunzini could also be regarded as a pan. Richards Bay as a harbour, has been excluded.

(ii) The physical data sources are often **very** conflicting and confusing, probably indicative inter alia of measurements taken in different seasons as well as in different years, under varying conditions.

(iii) The term "F.S.L." refers to full supply level.

(iv) The surface area of Lake Zilonde (partly in Mozambique) is given as 2 km^2 with a mean depth of 2 m. Likewise, the surface area of Lake Shengeza is given as 3 km^2 with a mean depth of 2 m. The data are attributed to reference 17 (Howard-Williams, 1980) by Reavell, P.E. and Cyrus, D.P., 1989. Preliminary observations on the macrocrustacea of coastal lakes in the vicinity of Richards Bay, Zululand, South Africa, Southern African Journal of Aquatic Sciences, VOL 15(1), p. 103 - 128. The data referred to are not found in Howard-Williams (1980). The data must accordingly have been obtained from elsewhere.

(v) Further data on Lake Mzingazi (including water supply information) can be found in: Archibald, C.G.M., Warwick, R.J., Fowles, B.K. and Muller, M.S., 1980. Lake Mzingazi - limnological characteristics, Steering Committee for Limnological Research and Water Treatment at Lake Mzingazi (Richards Bay), Third Meeting on 27 November 1980, Steering Committee Report No. 3, Reservoir Research Group (Natal), National Institute for Water Research, CSIR, Durban, 40 p. + app.

Additional data are presented in Cornelius (1981) - see reference 15 - as well as in Anonymous, 1971. Richards Bay Town Board Water Report No. 3, Part 1: assured yield of Lake Mzingazi, Part 2: estimated daily water demand, Report No. 256/110, Geustyn Forsyth and Joubert Inc., Pretoria, 14 p. + app., and in Anonymous, 1981. Dorpsraad Richardsbaai Water Verslag Nr. 18, Mzingazimeer as waterbron, Geustyn Boonstra Inc., Richards Bay, 11 p., to be read together with Anonymous, 1981.

Dorpsraad Richardsbaai Water Verslag Nr. 18 - addendum, Mzingazimeer as waterbron, Geustyn Boonstra Inc., Richards Bay, 4 p.

A re-examination of the Cornelius (1981) calculations can be found in Anonymous, 1981. Lake Mzingazi, 1. A revision of the hydrological regime, 2. A report on monitoring of the lake water at the intake to the water treatment works, 3. Atmospheric nutrient deposition, Steering Committee for Limnological Research and Water Treatment at Lake Mzingazi (Richards Bay), Fifth Meeting on 12 August 1981, Steering Committee Report No. 5, Reservoir Research Group (Natal), National Institute for Water Research, CSIR, Durban, 10 p.

7.9 Mangroves in Natal/KwaZulu

A total of some 1 058 ha of mangroves is found in South Africa, with approximately 785 ha in Natal/KwaZulu. Mangroves occur from Kosi Bay (26°54'S) southwards, with the last cluster evident along the Nahoon River (32°59'S) in the eastern Cape. The largest mangrove concentration is at Richards Bay (Table G15).

Table G15: Mangroves in Natal/KwaZulu (north to south).

Location of mangroves	Approximate area (ha)
Kosi Bay	59,0
Lake Mgobezeleni	2,5
Lake St Lucia	160,0
Mfolozi River	26,0
Richards Bay	427,5
Mlalazi River	30,0
Mhlanga River	<0,5
Mgeni River	44,0
Durban Bay	15,0
Sipingo River	12,5
Little Manzimtoti River	<0,5
Lovu River	2,0
Msimbazi River	0,5
Mgababa River	0,5

Table G15: Mangroves in Natal/KwaZulu (north to south) (continued).

Location of mangroves	Approximate area (ha)
Ngane River	0,5
Mkomazi River	2,0
Mahlongwa River	1,0
Kongweni River	<0,5
Bilanhlolo River	0,5
Mhlangankulu River	<0,5
Khandandlovu River	<0,5
Mtamvuna River	1,0

Source: After Ward, C.J. and Steinke, T.D., 1982. A note on the distribution and approximate areas of mangroves in South Africa, South African Journal of Botany, VOL 1(3), p. 51 - 53.

See also:

(i) Berjak, P., Campbell, G.K., Huckett, B.I. and Pammenter, N.W., 1986. In the mangroves of southern Africa, Natal Branch of the Wildlife Society of Southern Africa, Durban, 73 p.

(ii) Cockcroft, V.G. and Forbes, A.T., 1981. Temperature and humidity in a southern African mangrove swamp, South African Journal of Science, VOL 77(1), p. 41 - 42.

(iii) Keats, D., 1993. Mangroves: forests in the sea, African Wildlife, VOL 47(4), p. 154 - 160.

(iv) MacNae, W., 1963. Mangrove swamps in South Africa, Journal of Ecology, VOL 51(1), p. 1 - 25.

(v) Mepham, R.H., 1983. Some trends in the analysis of mangrove communities, South African Journal of Science, VOL 79(4), p. 155 - 156.

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(viii) Steinke, T.D., 1972. Further observations on the distribution of mangroves in the eastern Cape Province, Journal of South African Botany, VOL 38(3), p. 165 - 178.

(ix) Steinke, T.D. and Charles, L.M., 1983. Litter production by mangroves in Mgeni Estuary, South African Journal of Science, VOL 79(4), p. 157 - 158.

(x) West, O., 1945. Distribution of mangroves in the eastern Cape Province, South African Journal of Science, VOL 41, p. 238 - 242.

NOTES:

)TES:

CHAPTER 8: WETLANDS AND PANS IN NATAL/KWAZULU

The serenity of wetlands...

Vroegsomer

Die dag is windeloos en diep deurstraal
van son, die omgedolwe aarde blink, en oor
die water skud die stoere eik sy weelde los;
die vleie is 'n sketterende kleurevlam
waar ranke wit voëls deur die blomme gaan
en reeds die somerloomheid in hul fyne wieglyf
met die somerritme in hul stap verbind...

E. Van Heerden, quoted in Malherbe, D.F., 1959. Afrikaanse Verse: 'n Bloemlesing vir die Middelbare Skool, Nasionale Boekhandel Bpk, Cape Town, 214 p.

CHAPTER 8: WETLANDS AND PANS IN NATAL/KWAZULU

Contents — *Page*

8.1 Wetlands in Natal/KwaZulu 233

8.1.1 Introduction 233
8.1.2 Overview 234

8.2 The distribution of wetlands by bioclimatic group in Natal/KwaZulu 246

8.3 Priority wetlands of Natal/KwaZulu 247

8.4 The sustainable use of wetlands 247

8.5 Wetland degradation 265

8.6 Wetlands awareness programmes 266

8.7 Pans in Natal/KwaZulu 268

8.7.1 Pans of the Pongolo-Usuthu River system 268
8.7.2 Pans of the Mkuze River Floodplain 282
8.7.3 Other pans in Natal/KwaZulu 284

8.8 Some primary publications on wetlands in Natal/KwaZulu 288

Tables — *Page*

Table H1: A simplified classification of wetlands in Natal/KwaZulu 236

Table H2: A classification of vleis (wetlands) based on physiography in the Natal Highland Sourveld (bioclimatic group 4) 237

Table H3: Types of vleis (wetlands) in Natal/KwaZulu 238

Table H4: A provisional basis for differentiation between the main types of wetlands, other than floodplains in Natal/KwaZulu 240

Table H5: A brief overview classification of wetlands in South Africa 241

Table H6: A detailed wetland classification system for South Africa 242

Table H7: The estimated extent and distribution of wetlands in Natal and East Griqualand, 1981 246

Tables (continued) **Page**

Table H8: An overview of selected characteristics of the priority wetlands of Natal/KwaZulu 248

Table H9: A qualitative assessment of the functions and values of the priority wetlands of Natal/KwaZulu, according to the benefits that accrue from existing land uses 252

Table H10: A general interpretive guide to the sustainable use of wetlands in bottomland situations 255

Table H11: A simplified overview of some negative consequences of man-induced modifications to wetland ecosystems 257

Table H12: The effects of specific land use practices on some wetland characteristics and functions 259

Table H13: Wetland assessment and remedial checklist 261

Table H14: The status of soil and water conservation in each bioclimatic group of Natal in 1972, as determined by the then Department of Agriculture and Water Supply 264

Table H15: Named semi-permanent and permanent pans of the Pongolo River Floodplain (south to north) 269

Table H16: Named pans of the Usuthu River Floodplain (south to north) 278

Table H17: Inundation of Pongolo Floodplain pans in relation to river flow, due to releases from the Pongolapoort Dam 279

Table H18: The volume of water contained in various Pongolo Floodplain pans during and immediately after floods 281

Table H19: Percentage loss of volume with varying decreases in water levels of some Pongolo Floodplain pans (calculated from the maximum retention levels) 281

Table H20: Named semi-permanent and permanent pans of the Mkuze River Floodplain (north to south) 282

Table H21: Named semi-permanent and permanent pans of the Mfolozi River catchment (north to south) 284

Table H22: Some named semi-permanent and permanent pans elsewhere in Natal/KwaZulu (north to south) 285

8.1 Wetlands in Natal/KwaZulu*

8.1.1 Introduction

The format of this chapter is the same as Chapter 7 (Estuaries). Accordingly, only a brief summary of certain relevant information is presented here. Readers requiring a detailed discussion should examine primary reports by Begg (1986; 1988; 1989; 1990)**. There was a hiatus in research on wetlands in Natal/KwaZulu following the Begg reports. The next major set of scientific documentation, with special reference to management techniques, was provided by the Water Research Commission***. Time and financial constraints precluded incorporation of the latter material in this chapter. Readers should therefore examine the Commission reports - where relevant to their particular interests - at some length. It follows that any second edition of the source book will include data drawn from the Water Research Commission publications.

Some emphasis, especially in terms of pans, has been placed on inventories in this chapter. Information on pans in Natal/KwaZulu, with the exception of the Pongolo-Usuthu Floodplain system, is difficult to find (particularly locational data). It is recommended that

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* Discussion partly based on Begg, G., 1986. The wetlands of Natal (Part 1): an overview of their extent, role and present status, Natal Town and Regional Planning Commission Report, VOL 68, Pietermaritzburg, 114 p., as well as Hill, P.R., Scotney, D.M. and Wilby, A.F., 1981. Wetland development: ridge and furrow system (revised), Report No. N11/1981, Department of Agriculture and Fisheries (Natal Region), Cedara, 45 p.

** See Begg (1986 - above), and Begg, G., 1988. The wetlands of Natal (Part 2): the distribution, extent and status of wetlands in the Mfolozi catchment, Natal Town and Regional Planning Commission Report, VOL 71, Pietermaritzburg, 278 p. and map., plus Begg, G., 1989. The wetlands of Natal (Part 3): the location, status and function of the priority wetlands of Natal, Natal Town and Regional Planning Commission Report, VOL 73, Pietermaritzburg, 256 p. and map., as well as Begg, G., 1990. The wetlands of Natal (Part 4): policy proposals for the wetlands of Natal and KwaZulu, Natal Town and Regional Planning Commission Report, VOL 75, Pietermaritzburg, 86 p.

*** See Kotze, D.C. and Breen, C.M., 1994. Agricultural land-use impacts on wetland functional values, WRC Report No. 501/3/94, Water Research Commission, Pretoria, 70 p., and Kotze, D.C., Breen, C.M. and Klug, J.R., 1994. WETLAND-USE: a wetland management decision support system for the KwaZulu/Natal Midlands, WRC Report No. 501/2/94, Water Research Commission, Pretoria, 76 p. + app., as well as Kotze, D.C., Hughes, J.C., Breen, C.M. and Klug, J.R., 1994. The development of a wetland soils classification system for KwaZulu/Natal, WRC Report No. 501/4/94, Water Research Commission, Pretoria, 32 p. See in addition: Oellermann, R.G., Darroch, M.A.G., Klug, J.R. and Kotze, D.C., 1994. Wetland preservation valuation and management practices applied to wetlands: South African case studies, WRC Report No. 501/5/94, Water Research Commission, Pretoria, various pages. A brief summary of the research programme can be found in the following: Kotze, D.C., Breen, C.M. and Klug, J.R., 1994. A project to improve the management of wetlands in the KwaZulu/Natal Midlands: an overview, WRC Report No. 501/1/94, Water Research Commission, Pretoria, 8 p.

an overall inventory of wetlands and pans in the province should be compiled as soon as possible. Such a procedure is an essential prerequisite for the formulation of an holistic management strategy for the wetlands of Natal/KwaZulu. It is frankly surprising that a comprehensive inventory of wetlands in Natal/KwaZulu has yet to be undertaken*. Any inventory must include urban wetlands, many of which, are badly degraded.

8.1.2 Overview

Wetlands may be defined as areas where the soil is periodically or permanently saturated with water, where there is impeded drainage, occupying a characteristic position within the landscape, and with distinctive animal and plant communities (arid pans excepted) (Begg, 1986). Begg (1990) referred to the United States Corps of Engineers/ Environmental Protection Agency definition of wetlands, namely: those areas which are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support (and which under normal circumstances do support), a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands vary considerably in areal extent and play an important role in water storage; runoff regulation (including velocity reduction); flood attenuation and storage; water purification; groundwater discharge; nutrient assimilation; the trapping of sediment, and the control of erosion. Wetlands accordingly, have a vital ecological role and a considerable recreational and aesthetic value (including habitat and species preservation). Wetlands also function as sources of renewable raw materials used mainly by rural black households (Begg, 1986).

Wetlands occupy a position between aquatic and terrestrial environments and there is no single acceptable definition of a wetland. The term "wetland" refers to areas known for instance as swamps, reedswamps, bogs, marshes, fens, sponges, a morass, vleis, pans and floodplains (Begg, 1986). Wetlands are likely to be found in the catchment of every river system in southern Africa, but may be differentiated according to topography, geology, climate, soil, land use, vegetation and hydrological factors. Many natural features give rise to wetlands. These include geological formations inter alia dolerite dykes and sills which arrest valley incision, back-tilting of the landscape, reversal of the master drainage

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* An important workshop on the use of remote sensing for the discovery and monitoring of wetlands in South Africa, was organized by the Division of Forest Science and Technology (FORESTEK), CSIR, P O Box 395, Pretoria, 0001, in March 1994. A publication, based on the workshop and provisionally entitled, "Guidelines for the use of remote sensing in the mapping and monitoring of wetlands in South Africa" is being prepared, although is not yet available.

system, and natural levees along rivers and streams. Also important are springs and impervious soil or rock layers close to the surface. Induced (man-made) wetlands result from poor farm management practices (such as over-irrigation), or the faulty construction of conservation and irrigation works or impoundments (Hill, Scotney and Wilby, 1981).

Wetlands in South Africa are probably best represented on footslopes in proximity to mountainous areas, where humid conditions and geology often result in headwater wetlands near or at the source of rivers. Secondly, wetlands may be well represented in coastal environments where high rainfall and runoff as well as a low river gradient, are conducive to the formation of wetlands. There is a clear distinction between wetlands in an upland or bottomland position. Upland areas include gently sloping land stretching away from, and rising well above the local drainage ways, as well as undulating, rolling or hilly terrain. Wetlands may be found on relatively steep slopes, but are most common in lower slope positions or on crests with a slight slope. Waterlogging is generally of shorter duration than in bottomlands. A spring line can also cause permanent wetness in upland areas. In gently undulating terrain, up to 40% of the upland area can consist of poorly drained wetland soils, although these wetlands may occur in isolated patches, surrounded by well-drained soils. Bottomlands comprise level or near-level areas along, and on a level with, the local drainage ways receiving runoff and seepage water from the adjacent uplands. Wetlands in bottomlands include vleis, alluvial deposits subject to periodic flooding, floodplains, and pans (without a natural outlet). Wetlands in bottomland positions are easily identified and usually remain wet for long periods (Hill et al, 1981). Bottomlands generally, are geologically young landscape elements, confined to terrain unit 5 or toe slopes (valley bottoms - see Land Types in the chapter on soils and soil erosion, elsewhere in this publication). Much of the discussion in the literature concerns bottomland wetlands (Scotney and Wilby, 1983)*.

Begg (1986 - see below) with reference to Natal/KwaZulu, defined four types of wetlands according to altitude (Table H1). More specifically, Downing (1968 - see below), provided a physiographic classification for wetlands in the Natal Highland Sourveld (Table H2), while Scotney (1970 - see below) stressed the importance of soils in a definition of wetlands (especially bottomland wetlands (Table H3)). Begg (1990 - see below) outlined a further

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* See Scotney, D.M. and Wilby, A.F., 1983. Wetlands and agriculture, Journal of the Limnological Society of Southern Africa, VOL 9(2), p. 134 - 140.

wetland classification system for Natal/KwaZulu (Table H4). Additional classifications for wetlands include those of the Ramsar Convention (see the chapter on catchments)*, as well as Morant (1981)**, who inter alia reviewed the United States Fish and Wildlife Service wetland classification system to determine applicability in South Africa. A more detailed classification system for wetlands in South Africa is provided in Tables H5 and H6, with two major categories namely, vleis and floodplains as opposed to endorheic pans (pans with no outlet and hence a closed drainage pattern). Pans are a feature of the Kalahari, the western and north-central Orange Free State and the western and south eastern Transvaal, as well as Maputaland in Natal/KwaZulu***.

The next section provides specific data on wetlands in Natal/KwaZulu including distribution by bioclimatic group (Table H7), as well as information on the priority wetlands of Natal/KwaZulu (Table H8). Certain other aspects of wetlands, namely soils, are discussed in the chapter on soils and soil erosion, while the use of artificial wetlands for wastewater treatment is examined in the chapter on sanitation. Some health aspects of wetlands are outlined in the chapter on health. Hygrophilous (moisture-loving) vegetation is briefly described in the chapter on groundwater.

Table H1: A simplified classification of wetlands in Natal/KwaZulu.

Altitude (m)	Region	Wetland type
>1 500	Mountain and plateau region	Bogs
1 000 - 1 499	Upland region	Vleis
±600 - 999	Midland region	Marshes
0 - ±599	Coastal region	Swamps

* The Ramsar Convention is more correctly known as the Convention on Wetlands of International Importance Especially as Waterfowl Habitat.

** See Morant, P.D., 1981. Wetland classification: a review of existing wetland classification systems and their applicability in southern Africa, M.Sc. Thesis, Department of Environmental and Geographical Science, University of Cape Town, Rondebosch, 180 p. See also, Morant, P.D., 1983. Wetland classification: towards an approach for southern Africa, Journal of the Limnological Society of Southern Africa, VOL 9(2), p. 76 - 84. (The particular issue of the journal contains several other papers dealing with wetlands, and is an important source document).

*** See Anonymous, 1987. Types of pans in South Africa, African Wildlife, VOL 41(5), p. 230 - 231. (The paper consists of photographs illustrating different kinds of pans).

Source: After Begg, G., 1986. The wetlands of Natal (Part 1): an overview of their extent, role and present status, Natal Town and Regional Planning Commission Report, VOL 68, Pietermaritzburg, 114 p.

Note:

(i) The classification excludes other types of wetlands such as pans and floodplains.

(ii) According to Begg (1986), wetlands once occupied some 10 - 15% of every catchment in Natal/KwaZulu. Widespread destruction of wetlands has taken place this century.

(iii) Wyatt, J., 1993. Wetlands: assessment, management and rehabilitation of South African wetlands - an illustrated field guide for practical use by land agency extension services (draft), Renfreight Wetlands Campaign, [Natal Parks Board], Durban, 27 p., classified wetlands in terms of seven types namely: seepage slope wetlands; basin wetlands; plains wetlands (unchannelled); plains wetlands (channelled); stream bank wetlands; river mouth wetlands, and marine wetlands.

Table H2: A classification of vleis (wetlands) based on physiography in the Natal Highland Sourveld (bioclimatic group 4).

Vlei type	Description
Headwater (feeder) vleis	Small concave depressions (often less than 0,4 ha in extent) situated on steep hillslopes (approximately 15% gradient) at the beginning of drainage lines. Supplied by surface (excluding streams) and sub-surface flow. Some discharge from the vlei during the wet season with limited discharge during the dry season
Valley vleis	Found in narrow stream valleys. Confined to narrow belts, seldom more than 90 m wide alongside stream banks. The vlei may be up to 1,6 km in length with a gradient of approximately 10%. The vleis are supplied by the same streams through which the vleis are drained. These vleis are subject to fast flowing floods after heavy rainfall. There is a variable discharge from valley vleis throughout the year
Plain vleis	Found only on mature river floodplains. Plain vleis are broad, up to 80 ha or more in extent with a gradient of 1 - 2%. Levees and oxbow lakes are often present. Subject to flooding of up to 1 - 1,5 m in depth (in parts) after heavy rainfall. Variable discharge from plain vleis throughout the year. Deposition of sediment by the river and sub-surface erosion often results in relatively dry, high lying areas of alluvial soil

Source: After Downing, B.H., 1968. Notes on the ecology of Natal Highland Sourveld vleis, Proceedings of the Grassland Society of Southern Africa, VOL 3, p. 131 - 134.

<u>See also</u>: Walmsley, R.D. and Boomker, E.A. (eds), 1988. Inventory and classification of wetlands in South Africa: Proceedings of a Workshop held at the Hydrological Research Institute, Roodeplaat on 26 and 27 July 1988, Ecosystem Programmes Occasional Report Series No. 34, Foundation for Research Development, CSIR, Pretoria, 92 p.

<u>Note</u>: Downing (1968) regarded vleis as swamps, reedswamps, marshes and fens, but excluded pans and bogs. Downing defined a vlei in the Natal Highland Sourveld as a lower lying area with a hydromorphic (saturated) soil, capable of supporting a more hygrophilous vegetation than the surrounding area, and which is drained through an outlet.

Table H3: Types of vleis (wetlands) in Natal/KwaZulu.

Type	Description
Type 1 vleis (Vleis with acid hydromorphic soils - such as the Ivanhoe Series and the Katspruit Series)	Occur mainly in landscapes with highly leached upland soils (for example, Midland Mistbelt and Highland Sourveld - bioclimatic groups 3 and 4 areas). Such vleis are submerged for most of the year or throughout the year. Type 1 vleis are often the result of dolerite dykes and sills, which provide a natural barrier, resisting lateral or downward erosion. The vleis may also extend laterally from alluvial strips. In the Department of Agriculture Howick extension area, the mean slope of the vleis is of the order of 0,5 - 1,5%
Type 2 vleis (Vleis with neutral to alkaline hydromorphic soils - such as the Killarney Series)	Occur mainly in landscapes with considerably to moderately leached upland soils (for example, Moist Tall Grassveld and Dry Tall Grassveld - bioclimatic groups 6 and 8 areas). A well defined drainage channel usually runs through the vlei. Type 2 vleis are drier than Type 1 vleis. Type 2 vleis are periodically submerged unless artificially drained or gully eroded. Margalitic soils (soils with strongly developed structure in the A horizon and with a high base status) sometimes occur
Type 3 vleis (Vleis with margalitic and claypan soils - such as the Phoenix Series and the Rensburg Series)	Occur in landscapes with moderately to slightly leached upland soils (for example, Dry Tall Grassveld - bioclimatic group 8 areas). Such bottomlands are not typically vleis, since they are usually dry (although they may have been wet in the past). Type 3 vleis are not as sharply demarcated as Types 1 and 2, and generally merge gradually into the bordering uplands. A deep drainage channel is usually present. In most cases, erosion of the vleis has reached serious proportions. Extensive fan-like gully systems are common. The mean slope of many of the Type 3 vleis is 3 - 5%, which contributes to the erosion hazard

Source: After Scotney, D.M., 1970. Vleis of Natal - definition and distribution, In: Shone, F.K. (ed), Vleis of Natal: Proceedings of the Symposium held at Pietermaritzburg, South African Institute for Agricultural Extension (Natal Branch), 12 May 1970, Pietermaritzburg, p. 1 - 5. (Numerous other papers of interest are found in the proceedings, including a paper on wetland soils).

See also: Kotze, D.C., Hughes, J.C., Breen, C.M. and Klug, J.R., 1994. The development of a wetland soils classification system for KwaZulu/Natal, WRC Report No. 501/4/94, Water Research Commission, Pretoria, 32 p. (The report discusses the latest research on wetland soils and should be carefully examined).

Note:

(i) Scotney (1970 - above), broadly defined a vlei as a bottomland characterized by poorly drained hydromorphic soils, and which is associated with aquatic and hygrophilous vegetation.

(ii) Scotney (1970 - above), suggested that Type 1 vleis in Natal/KwaZulu (excluding the coastal belt), occupy some 8% of the land area; Type 2 vleis approximately 11% (with evidence of erosion of such vleis), and Type 3 vleis, some 15%. Approximately 90% of the Type 3 vleis are severely gully or sheet eroded. On an overall basis, the total area for Type 1 vleis in Natal/KwaZulu is 1 010 km^2, 1 064 km^2 for Type 2 vleis and 2 331 km^2 for Type 3 vleis. The extent of Type 1 vleis in the Midlands Mistbelt and Highland Sourveld areas is 130 km^2 and 881 km^2 respectively. MacVicar (1970, quoted in Scotney, 1970 - above) estimated that vleis in the Natal coastal belt occupy some 4 - 5% of the land area, with limited evidence of erosion.

(iii) Scotney, D.M., 1970. Soils and land-use planning in the Howick extension area, 361 p., Appendix and soil map, p. 362 - 380 and maps, Ph.D. Thesis, Department of Pasture Science, University of Natal, Pietermaritzburg, observed that Type 1 vleis occupy some 5,1% of the Howick extension area, Type 2 vleis approximately 7% and Type 3 vleis, some 18,1%.

(iv) The soil classification used in the above table has subsequently been updated (see the chapter on soils and soil erosion). Bioclimatic groups are discussed in the chapter on catchments.

Table H4: **A provisional basis for differentiation between the main types of wetlands, other than floodplains in Natal/KwaZulu.**

Parameter	Type 1 wetland	Type 2 wetland	Type 3 wetland
Hydrological indicators			
Duration of inundation	Short	Long	Very long
Depth to water table (for the major part of an average rainfall season)	>500 mm	150 - 500 mm	<150 mm
Pedological indicators			
Colour/texture	Light grey	Dark grey, clayey	Black heavy clay
Mottling of A horizon	None	Slight	Present, plus rust-like stains in root channels
Subsoil/gley	Slight mottling	Distinct mottling	Heavy mottling
Botanical indicators			
Dominant plants	Hygrophilous grasses	Sedges	Reeds, bulrushes and/or woody plants

<u>Source</u>: After Begg, G., 1990. The wetlands of Natal (Part 4): policy proposals for the wetlands of Natal and KwaZulu, Natal Town and Regional Planning Commission Report, VOL 75, Pietermaritzburg, 86 p.

<u>Note</u>:

(i) Short duration inundation refers to saturation for 7 days - 1 month; long duration inundation refers to saturation for 1 - 6 months, while very long duration inundation refers to saturation and frequent inundation for more than six months.

(ii) With reference to botanical indicators, frequently, vegetation alone, which is a reflection of hydrologic and soil conditions, will suffice in determining the presence and boundaries of a wetland.

(iii) The wetland types in the above table are partly based on those proposed by Scotney (1970 - see symposium reference in Table H3).

Table H5: A brief overview classification of wetlands in South Africa.

Main group	Sub-group	Individual type
Vleis and floodplains	River-source sponges (generally high altitude)	Bogs/sponges (sedges and mosses) Acid sponges (Restionaceae and Bruniaceae)
	Marshes and swamps (generally flat terrain)	Sedge marshes Restio marshes Reedbed marshes (vleis) Reedswamps Papyrus swamps Cape seasonal wetlands Swamp forests Salt marshes Mangrove swamps
	Floodplains (flat middle and lower reaches of rivers)	Karoo salt flats Floodplain vleis Storage floodplains
Endorheic pans (pans with no outlet and a closed drainage pattern)	-	Salt pans Temporary pans Grass pans Sedge pans Reed pans Semi-permanent pans

Source: After Breen, C.M. and Begg, G.W., 1989. Chapter 16. Conservation status of southern African wetlands, In: Huntley, B.J. (ed), Biotic Diversity in Southern Africa: Concepts and Conservation, Oxford University Press, Cape Town, p. 254 - 263.

Note: The above table is based on Noble and Hemens (1978). More specific information on a wetland classification system for South Africa (compiled by Noble and Hemens) is presented in the following table (Table H6).

Table H6: A detailed wetland classification system for South Africa.

Individual type	Characteristic
Bogs/sponges	Consist of seepage areas on steep slopes which are seasonally or perennially waterlogged. The vegetation is dominated by low (0,1 - 1,0 m in height) sedges and other hygrophilous angiosperms and mosses. Many sponges are mires (waterlogged areas on soil with an organic content >50 %) and some contain peat. Sponges are found for example, on mountain slopes in the Lesotho, Transkei and Natal Drakensberg between 1 800 - 3 500 m, and include perennially wet sponges on the slopes and mires with accumulated peat (bogs) in the mountain valleys. The low vegetation in the valleys form walls, damming up the perennial seepage water in a series of open pools in which hydrophytes and algae are evident. Small mounds of angiosperms and a few mosses are also found in the valleys. At altitudes less that 2 000 m, reeds and taller sedges appear and sponges on seepage areas intergrade with marshes developed around streams. Similar but smaller sponges with neutral water (pH = 7) are found at almost any altitude on slopes in summer rainfall areas, for example, in the eastern Transvaal Drakensberg, Natal/KwaZulu, Transkei and the eastern Cape. The vegetation is composed of sedges, grasses and other angiosperms
Acid sponges	Sponges with acid (pH 3,5 - 6) and often with very brown humic-stained water are found on slopes in the perennial rainfall area of the southern Cape and in the winter rainfall area of the south western Cape, at almost any altitude. The vegetation is mainly Restionaceae and Bruniaceae (both macchia/fynbos vegetation groups) and other angiosperms
Sedge marshes	The marshes are dominated by sedges, hygrophilous grasses and similar plants up to 1 m in height, which are perennially waterlogged. Such marshes intergrade with river source sponges on mountain slopes and with reedbed marshes at lower altitudes
Restio marshes	Restio marshes are the equivalent of sedge marshes in the southern and south western Cape. The marshes are acid, and are dominated by Restionaceae (characteristic of macchia/fynbos vegetation) and sedges
Reedbed marshes (vleis)	The marshes are dominated by <u>Phragmites</u> where the water level is somewhat below the soil surface in the dry season (for instance, on the fringes of non-perennial streams). These marshes can have a more diverse vegetation with stands of <u>Typha</u>, <u>Scirpus</u>, <u>Cyperus</u> and other taller sedges (1 - 2 m in height) in situations where the water level remains close to the soil surface in the dry season. The marshes intergrade with sedge marshes at higher altitude and with reedswamps in wetter areas

Table H6: A detailed wetland classification system for South Africa (continued).

Individual type	Characteristic
Reedswamps	Reedswamps are found in perennial standing water on floodplains and fringe many coastal and estuarine lakes, for example, at Groenvlei and Ruigtevlei in the Cape. Phragmites australis is the reed most characteristic of reedswamps and can tolerate salinities close to sea water, particularly if the seepage water is less saline. Typha, Scirpus, Cyperus and other taller sedges (2 - 3 m in height) also occur but are less tolerant of saline water. Reedswamps intergrade with reedbed marshes (where there is no perennial standing water) and with salt marsh plant communities at the upper ends of "estuaries"
Papyrus swamps	The swamps are dominated by Cyperus papyrus (2 - 3 m high) and are found in perennial and somewhat deeper freshwater areas in northern Natal/KwaZulu (Mfolozi, Mkuze and Richards Bay)
Cape seasonal wetlands	These are areas on the Cape Flats and elsewhere along the south western Cape coast which become waterlogged in winter forming seasonal pools
Swamp forests	The swamps are found on freshwater streams along the Natal/ KwaZulu coast and are dominated by Ficus trichopoda and other trees. A characteristic climbing fern is Stenochlaena tenuifolia. Very few swamp forests are left. The best example is the area south of the Kosi lakes
Salt marshes	Salt marshes are found on tidal sand and mud flats in most South African "estuaries". The vegetation consists of low salt-tolerant grasses, sedges and creeping succulent angiosperms
Mangrove swamps	The swamps are dominated by mangrove trees 3 - 4 m in height and were previously found in nearly all "estuaries" with a tidal exchange along the east coast. Very few mangrove swamps are left. A good example is the Beachwood Mangrove Swamp (Durban)
Karoo salt flats	Karoo salt flats are connected to drainage systems into which water is occasionally discharged. At other times, salt flats cannot be differentiated from salt pans. The largest examples of salt flats are Van Wyksvlei, Grootvloer and Verneukpan in the Cape
Floodplain vleis	The vleis consist of a riverine area (either a reedbed marsh or a reedswamp) and a grassy floodplain of varying width on either side. The riverine area is normally seasonally inundated and the grassy floodplain is inundated only by occasional floods. Good examples of these vleis include Nylvlei, Blesbokspruitvlei (Transvaal), Seekoeivlei (Orange Free State) and Tabamhlope Vlei (Natal/KwaZulu)

Table H6: A detailed wetland classification system for South Africa (continued).

Individual type	Characteristic
Storage floodplains	Storage floodplains consist of a riverine area and an adjacent floodplain inundated by flooding. Standing water is retained on the floodplain in pans and small lakes for long periods between floods. In some storage floodplains, the river meanders on the alluvial floodplain and small oxbow floodplain lakes (filled only during floods) are evident. In other storage floodplains, the river is confined by a levee on either side and is flanked by floodplain pans. The pans are formed either by the levee damming tributaries or by changes in the watercourse. Good examples of storage floodplains are the Pongolo, Mfolozi and Buffalo floodplains (Natal/KwaZulu)
Salt pans	Salt pans are dry for most of the year but may contain perennial pools filled by springs. Highly saline soils devoid of any higher vegetation are evident. The pans intergrade with temporary pans. Salt pans are found especially in the Karoo, the Kalahari, the western Orange Free State and in the Transvaal. Examples of salt pans include Soutpan (Transvaal), and Witpan (Orange Free State)
Temporary pans	These pans are shallow and dry for long periods (possibly with perennial pools). Soils are alkaline and moderately saline. The higher vegetation is restricted to a few salt-tolerant grasses. Temporary pans intergrade with salt pans, grass pans and semi-permanent pans. Temporary pans are the most common type of pan and are evident throughout the northern Cape, the western Orange Free State and the Transvaal. Examples are found on Eleazar farm as well as Neethlingpan on Grasdal farm (Transvaal)
Grass pans	Grass pans are seasonal, drying up in winter (except for perennial pools). The pans are covered by a thick growth of hygrophilous grasses and other low terrestrial vegetation (some salt-tolerant). In summer, submerged hydrophytes and filamentous and macrophytic algae may develop. The water is rich in nutrients, usually fresh in summer, and slightly brackish in winter. The pans intergrade with temporary pans and with sedge pans. Grass pans are found in the southern and eastern Transvaal. Examples are found on Grasdal farm and on Rietfontein farm (Transvaal)
Sedge pans	These pans are seasonal but do not dry out sufficiently in the centre for terrestrial vegetation to establish itself. The pans have a thick growth of marsh vegetation approximately 1 m high, mainly Cyperaceae around the edges of the pan, but no emergent vegetation in the middle. The water is rich in nutrients, fresh in summer, and slightly brackish in winter. Examples are found on Coalbank farm and West Tweelingpan on Weltevreden farm (Transvaal)
Reed pans	Reed pans are temporary or semi-permanent pans with a dense stand of Phragmites reedswamp in the middle and open water never more than a narrow peripheral ring. A rich hydrophyte and filamentous and macrophytic algal population can develop in summer in the peripheral ring of water. The water is clear and can be fresh to brackish. The sediments are rich in organic matter. Examples are found on the Goederverwachting, Mooi-plaats and Gemsbokheuvel farms as well as on Florence farm (Transvaal)

Table H6: A detailed wetland classification system for South Africa (continued).

Individual type	Characteristic
Semi-permanent pans	These are generally deeper than most other types of pans. Certain pans may develop fairly permanent Potamogeton and other hydrophyte and algal growths, while some pans do not. Most pans have a few sparse grasses around the margins. Some pans are fresh on occasion, but most pans are brackish. Semi-permanent pans intergrade with temporary pans. Examples include Barberspan and Lake Chrissie (Transvaal)

Source: After Noble, R.G. and Hemens, J., 1978. Inland water ecosystems in South Africa - a review of research needs, South African National Scientific Programmes Report No. 34, Cooperative Scientific Programmes, CSIR, Pretoria, 150 p.

See also:

(i) Allan, D., 1987. Transvaal Highveld pans, African Wildlife, VOL 41(5), p. 233 - 235.

(ii) Seaman, M., 1987. Pans of the Orange Free State, African Wildlife, VOL 41(5), p. 237 - 238. (Other papers in this issue of the journal may also be of interest).

Note:

(i) According to Noble and Hemens (1978), marshes can be described as areas where the water level is not much above soil level in the wet season, with emergent plants mostly less than 2 m in height. Swamps can be defined as areas where the water level is well above the soil level in the wet season. Swamps are usually more perennial than marshes and have a generally less diverse vegetation. Sedges, reeds or trees (many of which are 3 m or more in height) are evident.

(ii) Some pans are large enough and permanent enough to be termed lakes, for example, Lake Chrissie in the Transvaal.

8.2 The distribution of wetlands by bioclimatic group in Natal/KwaZulu

The relevant data are presented in Table H7. Bioclimatic groups are examined in more detail in the chapter on catchments.

Table H7: The estimated extent and distribution of wetlands in Natal and East Griqualand, 1981.

Bioclimatic group	Wetlands				Total area of wetlands	
	uplands		bottomlands			
	%	km^2	%	km^2	%	km^2
1	25	2 213	5	443	30	2 656
2	20	1 708	3	256	23	1 964
3	12	760	3	190	15	950
4	18	3 294	8	1 463	26	4 757
5	-	-	1	20	1	20
6	15	1 543	10	1 029	25	2 572
8	30	4 850	12	1 940	42	6 790
7) 9) 10) 11)	5	920	15	2 760	20	3 680
Total		15 288		8 101		23 389

Source: After Hill, P.R., Scotney, D.M. and Wilby, A.F., 1981. Wetland development: ridge and furrow system (revised), Report No. N11/1981, Department of Agriculture and Fisheries (Natal Region), Cedara, 45 p.

See also:

(i) Begg, G., 1986. The wetlands of Natal (Part 1): an overview of their extent, role and present status, Natal Town and Regional Planning Commission Report, VOL 68, Pietermaritzburg, 114 p.

(ii) Scotney, D.M. and Wilby, A.F., 1983. Wetlands and agriculture, Journal of the Limnological Society of Southern Africa, VOL 9(2), p. 134 - 140.

Note:

(i) The above estimates were made using available soil survey reports, supported by individual farm data. The extent of the wetlands therefore, reflects the general physiographic conditions of the landscape. Accordingly, local situations may differ from the percentage values in the table.

(ii) The data provided for bioclimatic groups 7, 9, 10 and 11 may be misleading, but are based on the occurrence of specified soils.

(iii) The data include wetlands degraded by extensive gully erosion.

(iv) A more accurate local assessment of the extent and distribution of wetlands is possible through examination of the Land Type maps produced by the Institute for Soil, Climate and Water, Private Bag X79, Pretoria, 0001. (See the chapter on soils and soil erosion, as well as the chapter on maps).

8.3 Priority wetlands of Natal/KwaZulu

Data on 24 priority wetlands in Natal/KwaZulu and adjacent areas, of which one wetland is mainly in the Transvaal and one fully in the Transkei, are provided in Table H8. Priority wetlands are defined as those which have a high priority for attention, with regard to management and policy formulation. Priority wetlands range in size from approximately 42 000 ha (the Mkuze Swamp system) to 104 ha (Melmoth Vlei). In total, the priority wetlands cover 111 427 ha or some 1,2% of the area of Natal/KwaZulu. An assessment of the functions and values of the priority wetlands is provided in Table H9.

8.4 The sustainable use of wetlands*

The sustainable use of wetlands is based on the premise that wetland conservation "must be made to work" by placing an economic value on the resource. In other words, if an economic motive can be established for the preservation of wetlands (viewed from the perspective of the land owner), then general benefits inter alia in the form of good quality water will accrue to society as a whole**. To determine the best form of utilization, each type of wetland must be treated on its own merits. Certain types of wetlands may need total protection, while other types of wetlands can be used for water storage, permanent pastures, specialized cropping, trees, fishing, or for the harvesting of reeds.

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* Discussion based on Begg, G., 1990. The wetlands of Natal (Part 4): policy proposals for the wetlands of Natal and KwaZulu, Natal Town and Regional Planning Commission Report, VOL 75, Pietermaritzburg, 86 p.

** Some financial data are presented in Oellermann, R.G., Darroch, M.A.G., Klug, J.R. and Kotze, D.C., 1994. Wetland preservation valuation and management practices applied to wetlands: South African case studies, WRC Report No. 501/5/94, Water Research Commission, Pretoria, various pages.

Table H8: An overview of selected characteristics of the priority wetlands of Natal/KwaZulu.

Wetland	Co-ordinates	Area (ha)	River system	Catchment name and upstream size (km^2)	Mean annual runoff ($10^6 m^3$)	Altitude at outlet (m above sea level)	Approx. perimeter (km)	Mean width (m)	Approx. length (km)	Landownership			Most characteristic genera or family of vegetation
										private	state	communal	
Pongolo Floodplain	27 13 S 32 14 E	13 000	Pongolo	Pongolo (7 831)	1 082	20	216	1 344	54		*	*(K)	Cyperus, Echinochloa
Muzi Swamp	27 05 S 32 35 E	15 000	Muzi	Maputo (N/R)	N/R	30	586	1 123	45			*(K)	Cyperus, Digitaria
Mkuze Swamp system	27 41 S 32 30 E	42 000	Mkuze	Mkuze (4 800)	236	5	364	3 542	47	(+)	*	*(K)	Papyrus, Phragmites
Mfolozi Swamp	28 29 S 32 18 E	9 059 #	Mfolozi	Mfolozi (10 075)	887	1	312	6 800	28	*	*		Papyrus, Ficus
Aloeboom Vlei	27 50 S 31 06 E	142	Black Mfolozi	Mfolozi (48)	6	1 135	19	183	6	*			Juncaceae, Gramineae
Mvamanzi Pan	28 25 S 32 01 E	390	Mvamanzi	Mfolozi (134)	4	31	32	312	7			*(K)	Potamogeton, Cynodon
Stilwater Vlei	27 47 S 30 44 E	1 828	White Mfolozi	Mfolozi (117)	13	1 150	84	866	11	*			Gramineae
Mhlatuze Swamp system	28 48 S 31 49 E	5 557 #	Mhlatuze	Mhlatuze (4 170)	620	2	471	N/R	21	*	(+)	*(K)	Papyrus, Barringtonia
Blood River Vlei	27 49 S 30 34 E	6 540	Buffalo	Tugela (557)	54	1 183	334	1 330	18	*			Phragmites, Gramineae
Paddavlei	28 09 S 30 02 E	912	Wasbank	Tugela (57)	5	1 330	48	430	9	*			Gramineae
Boschoffsvlei	27 40 S 30 14 E	1 850	Dorpspruit	Tugela (526)	78	1 167	80	875	12	*			Gramineae

Table H8: An overview of selected characteristics of the priority wetlands of Natal/KwaZulu (continued).

Wetland	Co-ordinates	Area (ha)	River system	Catchment name and upstream size (km^2)	Mean annual runoff ($10^6 m^3$)	Altitude at outlet (m above sea level)	Approx. perimeter (km)	Mean width (m)	Approx. length (km)	Landownership			Most characteristic genera or family of vegetation
										private	state	communal	
Groenvlei	27 27 S 30 11 E	762	Slang	Tugela (269)	38	1 740	50	430	6	*			Cyperaceae
Wakkerstroom Vlei	27 21 S 30 08 E	1 000	Thaka	Tugela (207)	30	1 737	56	726	8	(+)		*(WM)	Phragmites, Typha
Melmoth Vlei (1)	29 18 S 30 16 E	104	Mnyamvubu	Tugela (4)	N/R	1 595	8	280	2	*			Gramineae
Hlatikulu Vlei	29 15 S 29 41 E	733	Nsonga	Tugela (150)	44	1 561	56	275	7	*			Cyperaceae/ Gramineae
Boschberg Vlei	28 15 S 29 49 E	1 400	Sundays	Tugela (196)	18	1 250	88	797	8	*			Gramineae
Ntabamhlope Vlei	29 03 S 29 39 E	295	Little Bushmans	Tugela (34)	3	1 440	42	260	7	*	*		Phragmites, Typha
Stillerust Vlei	29 23 S 29 44 E	225	Mooi	Tugela (116)	33	1 631	10	724	2		*		Gramineae
Mvoti Vlei	29 09 S 30 35 E	2 800	Mvoti	Mvoti (316)	40	954	192	720	19	*	*		Phragmites
Mgeni Vlei	29 29 S 29 49 E	270	Mgeni	Mgeni (11)	N/R	1 828	13	755	4	(+)	*		Carex
Franklin Vlei	30 17 S 29 27 E	5 244	Mzintlava	Mzimvubu (377)	38	1 498	340	652	32	*			Phragmites/ Gramineae
Kromrivier Vlei	30 15 S 29 13 E	1 087	Tswilika	Mzimvubu (288)	41	1 627	88	394	11	*			Gramineae

Table H8: An overview of selected characteristics of the priority wetlands of Natal/KwaZulu (continued).

Wetland	Co-ordinates	Area (ha)	River system	Catchment name and upstream size (km^2)	Mean annual runoff ($10^6 m^3$)	Altitude at outlet (m above sea level)	Approx. perimeter (km)	Mean width (m)	Approx. length (km)	Landownership			Most characteristic genera or family of vegetation
										private	state	communal	
Ntsikeni Vlei	30 08 S 29 28 E	1 114	Lubhukwini	Mzimkulu (75)	22	1 752	81	690	11		*(T)		<u>Carex</u>, Gramineae
"The Swamp"	29 47 S 29 36 E	115 #	Pholela	Mzimkulu (230)	74	1 460	5	495	2	*	*		Gramineae
	Total	111 427											

<u>Source</u>: After Begg, G., 1989. The wetlands of Natal (Part 3): the location, status and function of the priority wetlands of Natal, Natal Town and Regional Planning Commission Report, VOL 73, Pietermaritzburg, 256 p. and map.

<u>See also</u>: Oellermann, R.G., Darroch, M.A.G., Klug, J.R. and Kotze, D.C., 1994. Wetland preservation valuation and management practices applied to wetlands: South African case studies, WRC Report No. 501/5/94, Water Research Commission, Pretoria, various pages. (The report contains useful management plans for the Blood River Vlei, Boschoffsvlei, Mgeni Vlei, Ntabamhlope Vlei and the Wakkerstroom Vlei).

<u>Note</u>: (i) The data in the table are selective and exclude wetlands in minor river catchments smaller than 1 000 km^2; coastal wetlands described in Begg (1978) and Begg (1984)*; wetlands smaller than 100 ha, and certain other wetlands.

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* See Begg, G., 1978. The estuaries of Natal, Natal Town and Regional Planning Commission Report, VOL 41, Pietermaritzburg, 657 p., and Begg, G.W., 1984. The estuaries of Natal Part 2: supplement to NTRP Report VOL 41, Natal Town and Regional Planning Commission Report, VOL 55, Pietermaritzburg, 631 p.

(ii) The following notation applies:

(1)	=	Selected as the most important of the Mnyamvubu Vlei systems
#	=	Extant portion only
N/R	=	No record
(+)	=	Only a small portion of the system is under this form of ownership
(K)	=	Tribal authority (KwaZulu)
(T)	=	Transkei Government
(WM)	=	Wakkerstroom Municipality (Transvaal)

(iii) The upstream size of the catchment refers to the catchment of the particular wetland.

(iv) According to Begg (1989 - above), some 65% of the priority wetlands of Natal/KwaZulu are privately owned and are potentially at risk.

Table H9: A qualitative assessment of the functions and values of the priority wetlands of Natal/KwaZulu, according to the benefits that accrue from existing land uses.

Wetland	Water storage	Streamflow regulation	Flood attenuation	Sediment trapping	Waste assimilation	Wildlife protection	Recreation	Agriculture	Silviculture	Most rational management options	
										total protection	multi-use objectives
Pongolo Floodplain	3	2	3	3	2	3	2	3	0	(*)	*
Muzi Swamp	3	2	3	3	2	2	1	2	0		*
Mkuze Swamp system	3	2	3	3	2	3	1	1	0	(*)	*
Mfolozi Swamp	2	1	3	3	1	3	1	3	0	(*)	*
Aloeboom Vlei	2	2	2	2	3	2	0	2	0		*
Mvamanzi Pan	2	1	2	2	1	3	0	2	0		*
Stilwater Vlei	3	2	3	2	1	2	0	2	0		*
Mhlatuze Swamp system	3	3	3	2	3	2	2	1	0	(*)	*
Blood River Vlei	3	3	2	2	1	3	2	2	0		*
Paddavlei	2	2	2	1	1	1	0	2	0		*
Boschoffsvlei	1	1	2	2	1	1	0	2	0		*
Groenvlei	1	1	2	2	2	1	0	2	0		*
Wakkerstroom Vlei	3	2	2	1	1	2	0	2	0		*

Table H9: A qualitative assessment of the functions and values of the priority wetlands of Natal/KwaZulu, according to the benefits that accrue from existing land uses (continued).

Wetland	Water storage	Streamflow regulation	Flood attenuation	Sediment trapping	Waste assimilation	Wildlife protection	Recreation	Agriculture	Silviculture	Most rational management options	
										total protection	multi-use objectives
Mnyamvubu Vlei systems	2	2	1	1	1	3	1	1	0	(*)	*
Hlatikulu Vlei	2	2	2	1	1	2	0	2	0		*
Boschberg Vlei	2	2	2	2	2	2	0	2	0		*
Ntabamhlope Vlei	3	3	2	2	1	2	0	1	0	*	
Stillerust Vlei	1	1	1	0	0	2	1	0	0	*	
Mvoti Vlei	3	3	2	2	1	2	1	2	2	(*)	*
Mgeni Vlei	2	3	1	2	2	3	1	0	0	*	
Franklin Vlei	2	2	2	2	2	3	1	3	0		*
Kromrivier Vlei	2	2	3	2	2	1	1	2	0		*
Ntsikeni Vlei	3	3	2	2	2	3	1	1	0	*	
"The Swamp"	0	0	1	0	0	2	1	0	0	*	

Source: After Begg, G., 1989. The wetlands of Natal (Part 3): the location, status and function of the priority wetlands of Natal, Natal Town and Regional Planning Commission Report, VOL 73, Pietermaritzburg, 256 p. and map.

Note: The following provisional rating applies:

0 = Unimportant
1 = Low value
2 = Moderate value
3 = High value
(*) = Certain parts only
* = Preferred option

For the sustainable use of wetlands, nine above-ground variables and seven below-ground variables need to be considered. The above-ground variables include the position of the wetland in the landscape; the slope; the erosion hazard; the vegetation; the top soil texture; the mean annual runoff; the climate; wildlife, and the adjacent land use. The below-ground variables are geology; soil form and depth, soil wetness, permeability, alkalinity and acidity. Accordingly, the wetland utilization which is planned, must suit the functions and values of the particular wetland (Begg, 1990). Various wetland management needs vis-a-vis wetland type are outlined in Table H10.

Considerable care must be exercised in terms of wetland utilization. Table H11 lists several negative consequences of man-induced modifications to wetland systems. A more detailed examination of probable damage is presented in Table H12. Table H13 then outlines some checklist parameters concerning wetland characteristics/impacts and remedial actions. Table H14 provides an overview of the soil and water conservation status in each bioclimatic group in Natal (with direct relevance to wetlands, as important components of the ecosystem). Recognition of the environmental value of wetlands is a fairly recent phenomenon*. In the not-too-distant past, wetlands were regarded as ideal sites inter alia for waste disposal, dams, afforestation, and sugar cultivation. In Natal/KwaZulu, for example, the Poplar tree industry (covering 3 000 ha) is almost entirely dependent on selected bottomland sites (Scotney and Wilby, 1983). Numerous small farm dams in Natal/KwaZulu likewise, have been constructed on wetland sites, although dams may act as a partial substitute for certain wetland functions such as flood control. Many wetland areas in the coastal belt have been planted to sugar cane.

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* See for example, Downing, B.H., 1968. Notes on the ecology of Natal Highland Sourveld vleis, Proceedings of the Grassland Society of Southern Africa, VOL 3, p. 131 - 134., as well as Hill, P.R., Scotney, D.M. and Wilby, A.F., 1981. Wetland development: ridge and furrow system (revised), Report No. N11/1981, Department of Agriculture and Fisheries (Natal Region), Cedara, 45 p., and Scotney, D.M. and Wilby, A.F., 1983. Wetlands and agriculture, Journal of the Limnological Society of Southern Africa, VOL 9(2), p. 134 - 140.

Table H10: A general interpretive guide to the sustainable use of wetlands in bottomland situations.

Type	Major characteristics		Management needs
Type 1 wetland	Hydrology	- water table below 500 mm - subject to periodic inundation	High erosion hazard implies that these sites must remain under permanent pasture
	Soil form	- Rensburg - Willowbrook	• Avoid compaction • Graze in winter • Block burn
	Vegetation	- Gramineae (grasses)	High conservation practice required
Type 2 wetland	Hydrology	- water table above 500 mm - saturated in summer - subject to occasional overflow (drainage channel frequently incised)	Suitable for specialized cropping, but use as permanent pastures preferred. Mow for silage, avoid grazing under wet conditions, graze on a rotational basis
	Soil form	- Katspruit	If cropped, timeous tillage, surface drainage and controlled irrigation is needed
	Vegetation	- Cyperaceae (sedges)	High conservation practice required
Type 3 wetland	Hydrology	- water table above 150 mm - saturated for most of the year, subject to overflow	Unsuitable for arable use. Site to remain in a natural state to safeguard societal functions and values
	Soil form	- Champagne	Total protection required
	Vegetation	- aquatic, bulrushes, reeds	

Table H10: **A general interpretive guide to the sustainable use of wetlands in bottomland situations (continued).**

Type	Major characteristics			Management needs
Neither of the above types	Hydrology	- subject to periodic flooding - water table unimpeded or controlled by the river regime		Suitable for: • poplar production • intensive cropping • intensive irrigation
	Soil form	- Oakleaf - Dundee	well drained	Stream bank protection required is 10 m horizontally beyond 1 : 10 year flood line
	Vegetation	- various herbaceous and woody forms		

Source: After Begg, G., 1990. The wetlands of Natal (Part 4): policy proposals for the wetlands of Natal and KwaZulu, Natal Town and Regional Planning Commission Report, VOL 75, Pietermaritzburg, 86 p.

See also:

(i) Kotze, D.C., Hughes, J.C., Breen, C.M. and Klug, J.R., 1994. The development of a wetland soils classification system for KwaZulu/Natal, WRC Report No. 501/4/94, Water Research Commission, Pretoria, 32 p.

(ii) Scotney, D.M. and Wilby, A.F., 1983. Wetlands and agriculture, Journal of the Limnological Society of Southern Africa, VOL 9(2), p. 134 - 140.

(iii) Taylor, R.H. and Cunningham, A.B., 1983. The conservation of wetlands, Journal of the Limnological Society of Southern Africa, VOL 9(2), p. 141 - 145.

Note:

(i) See Table H3 for a basic description of Type 1, 2 and 3 wetlands.

(ii) The soil classification used in the above table has subsequently been updated (see the chapter on soils and soil erosion).

Table H11: A simplified overview of some negative consequences of man-induced modifications to wetland ecosystems.

Form of wetland disruption	Expected environmental effect A = Reduced interception; B = Less infiltration; C = Reduced winter flow; D = Increased runoff; E = Increased stream velocity/flood damage; F = Reduced runoff; G = Reduced water storage; H = Lowered water table; I = Elevated water table; J = Deterioration in water quality; K = Desertification/dessication; L = Substrate disruption; M = Silt transport/ soil loss; N = Bank erosion; O = Gully erosion; P = Lowered productivity; Q = Wildlife disruption/habitat losses																
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Channelization/ excavation	•	•	•	•	•		•	•		•		•	•	•			•
Over-drainage	•	•	•	•	•		•	•		•	•	•	•				•
Crop production	•	•	•	•	•		•	•		•	•	•	•			•	•
Pasture production							•	•		•							•
Overgrazing	•	•	•	•	•		•	•		•	•	•	•		•	•	•
Burning	•	•	•	•			•	•			•					•	•
Afforestation	•		•		•	•	•	•					•				•
Road construction									•			•					•
Dam construction			•			•			•								•
Water abstraction			•			•	•	•		•	•						
Waste disposal										•						•	•

Source: After Begg, G., 1986. The wetlands of Natal (Part 1): an overview of their extent, role and present status, Natal Town and Regional Planning Commission Report, VOL 68, Pietermaritzburg, 114 p.

Note: An example of an important wetland damaged by poor agricultural practices is the Seekoeivlei (part of the Klip River system) near Memel, in the eastern Orange Free State (De Fontaine, 1996)*. The wetland has been reduced to a single river channel not more than 5 m wide. The water is turbid, reflecting upstream soil erosion. The long term rehabilitation of the wetland is being undertaken inter alia by the (post-1994 election) Department of Environmental Affairs and Tourism and Rand Water. Funds for the project have been obtained from the Reconstruction and Development Programme. Some 400 people will be employed to construct anti-erosion walls and gabions, in order to raise the water level in the channel (thereby flooding the previously-drained wetland). The benefits of wetland rehabilitation, as discussed in this chapter, will accrue to the Klip River system and the downstream Vaal River. The re-introduction of critically endangered Wattled Cranes as well as hippos in the Seekoeivlei, is a future possibility.

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* De Fontaine, M., 1996. Personal communication, Rand Water, Johannesburg.

Table H12: The effects of specific land use practices on some wetland characteristics and functions.

Wetland function	Land use practice				
	grazing	overgrazing	pastures	crops	impoundments
Velocity reduction					
Surface area of active floodplain	No effect	Very negative effect	Very small or negative effect	Very small or negative effect	No effect
Surface roughness (vegetation and ground surface)	Very small or negative effect	Negative effect	Negative effect	Negative effect	Negative effect
Slope	No effect	Negative effect	No effect	No effect	No effect
Detention storage capacity	No effect	Very negative effect	Negative effect	Very negative effect	Minor positive or no effect
Sinuosity of channels	No effect	Very small or negative effect	Negative effect	Negative effect	Not applicable
Overall impact	No effect	Negative effect	Very small or negative effect	Negative effect	No effect
Flood attenuation					
All characteristics influencing velocity reduction	See velocity reduction				
Soil saturation	No effect	No effect	Positive effect	Positive effect	Positive effect
Overall impact	No effect	Negative effect	Very small or negative effect	Negative effect	No effect

Table H12: The effects of specific land use practices on some wetland characteristics and functions (continued).

Wetland function	Land use practice				
	grazing	overgrazing	pastures	crops	impoundments
Erosion control and water purification All characteristics influencing velocity reduction	See velocity reduction				
Vegetation cover	Very small or negative effect	Very negative effect	Negative effect	Very negative effect	Negative effect
Disturbance level	Very small or negative effect	Very negative effect	Very small or negative effect	A range of effects (very negative to negative)	Positive effect
Overall impact	Very small or negative effect	Negative effect	Negative effect	Very negative or negative effect	No effect
Habitat value All characteristics influencing velocity reduction	See velocity reduction				
Native species replacement	No effect	Negative effect	Very negative effect	Very negative effect	Negative effect
Disturbance level	Positive effect	Negative effect	Very negative effect	Very negative effect	Minor positive or negative effect
Overall impact	Minor positive or negative effect	Negative effect	Very negative or negative effect	Very negative or negative effect	Negative effect

Source: (i) After Kotze, D.C. and Breen, C.M., 1994. Agricultural land-use impacts on wetland functional values, WRC Report No. 501/3/94, Water Research Commission, Pretoria, 70 p.

(ii) After Kotze, D.C., 1995. Personal communication, Department of Grassland Science, University of Natal, Pietermaritzburg.

Note: (i) Grazing refers to the grazing of natural wetlands by livestock, without gully erosion occurring. Overgrazing refers to incorrect grazing management with resultant severe gully erosion.

(ii) Pastures imply perennial pasture production. Annual pastures should be considered as a form of cropping which is less desirable than perennial pastures, in terms of negative impacts on wetlands. Poor management practices associated with pastures and crop production can also lead to severe gully erosion. The assessment in the above table, is based on the assumption that pasture and crop production practices have not resulted in severe gully erosion.

(iii) The assessment for impoundments is based on the assumption that the dams are intact (not breached).

Table H13: Wetland assessment and remedial checklist.

Landscape features and uses	Wetland remedial requirements
Development	
Use of natural veld	Apply correct veld and soil conservation measures
Planted pastures	Remove or minimize alteration to wetland and/or functions
Planted crops	Ensure an adequate and manageable wetland margin
Planted timber	Rehabilitate by allowing natural plant succession to take its course
Game - grazing	Apply correct stocking rates - consult the Department of Agriculture
Sheep - trampling	Remove stock from wetland, or fence off sensitive areas
Cattle - grazing Goats - trampling	Control timing, frequency, or pressure of grazing, trampling and water point access
Drains and channels	Fence off sensitive areas from damage caused by disturbance
Cambered beds	Discontinue excavating and allow channel/s to consolidate
Ridge and furrow terrain	Rehabilitate by allowing natural plant succession to take its course
Incised dongas	Plant banks with stabilizing vegetation

Table H13: Wetland assessment and remedial checklist (continued).

Landscape features and uses	Wetland remedial requirements
Stream confluence	In extreme cases support banks with masonry works
Stream banks on curve	Block and/or support channel/s or key point with earth and/or vegetative plug/s
Gradient change or key point	Block and/or support channel/s or key point with masonry plug/s
Stream debris	Remove debris from channel and flood area
Dams and weirs	Minimize damming of wetlands. Many small dams are inappropriate and destroy valuable wetland habitats and functions
Water abstraction - domestic/irrigation/ industrial	Measure and control water abstraction
Pipelines and pylons	Avoid wetlands and margins where possible
Road and rail construction Bridges and culverts	Design and construct to minimize alteration to wetland and functions
Buildings - residential/urban	Implement regulations which prevent structural development below the 1 : 50 year flood line
Buildings - industrial	Zone and manage wetland areas as open space
Buildings - other	Keep coastal development behind the frontal dunes
Tourist development	Avoid "ribbon" development along the coastline
Informal settlements	Control waste disposal and water pollution
Mining and dredging	Control mining activities and undertake the rehabilitation of wetlands and surrounds
Effluent disposal	Avoid using wetlands for the disposal of wastewater or thermal and harmful effluents in any form
Infilling - waste/rubble/soil	Avoid infilling (reclaiming) of wetlands
Solid waste disposal site	Monitor solid waste and leachates in wetlands and implement remedial measures where necessary
Nutrient enrichment	Identify industrial, agricultural or domestic sources and minimize any enrichment

Table H13: Wetland assessment and remedial checklist (continued).

Landscape features and uses	Wetland remedial requirements
Recreational and extractive activities	
Angling Bait collecting Hunting Food harvesting Material harvesting Boating - power/skiing Boating - sail/paddle Diving Swimming/surfing	Recreational and extractive activities provide an incentive to conserve wetlands - however, these activities should not have significant negative effects on other functions or values which are of local or regional benefit to society. Map and zone wetland into usage areas for wetland functional, recreational and public safety protection. Control and manage exploitation, trampling, boat and vehicle traffic in the various zones
Problem vegetation	
Invasive alien plants Problem indigenous plants	List and remove in planned phases (starting upstream, light infestations first) and maintain control via follow-ups
Burns	
Controlled block burn	Select and control timing, frequency and intensity of burns
Firebreak burn Uncontrolled burn	Implement wetland protective measures appropriate to the extent of run-away or arson fires from the surrounding area

<u>Source</u>: After Wyatt, J., 1993. Wetlands: assessment, management and rehabilitation of South African wetlands - an illustrated field guide for practical use by land agency extension services (draft), Renfreight Wetlands Campaign, [Natal Parks Board], Durban, 27 p.

<u>See also</u>: Kotze, D.C., Breen, C.M. and Klug, J.R., 1994. WETLAND-USE: a wetland management decision support system for the KwaZulu/Natal Midlands, WRC Report No. 501/2/94, Water Research Commission, Pretoria, 76 p. + app.

<u>Note</u>:

(i) Wetland characteristics/impacts may be graded as: nil, slight, moderate or serious, in terms of the functioning of a given wetland.

(ii) Wyatt (1993) suggested that where remedial action is required, the wetland functions most suitable (or preferred) in that part of the catchment should be selected, in order to accommodate the surrounding catchment uses and human population densities. (An example is the water purification function of wetlands in an area subject to high water pollutant loads).

(iii) The term "key point", refers to a natural obstruction which restricts downward erosion of the river channel. Frequently, the key point (also known as a nick-point), is a hard stratum of rock (such as a dolerite dyke or sill), but can also occur laterally in the form of alluvial ridges.

Table H14: **The status of soil and water conservation in each bioclimatic group of Natal in 1972, as determined by the then Department of Agriculture and Water Supply.**

Bioclimatic group	Soil and water conservation status
1	Cultivation of fertile bottomlands (river alluvium and wetlands) without planning has resulted in erosion; changes in drainage channel features, and crop damage
2	Water resources are inadequately planned
3	Development of water resources requires detailed planning
4	Wetlands extensively developed for the establishment of pastures. Little has been done about wetland conservation due to uncertain economic returns
5	Systematic protection, conservation and control of water resources must be given a high priority
6	Wetlands require proper management and protection
7	General management and conservation status is poor
8	Wetlands should be completely protected. The reclamation of eroded wetlands is necessary
9	Development of water resources requires careful planning
10	Over 90% of wetlands have been severely gully eroded. Wetlands should be totally protected. The reclamation of denuded areas must be accorded a high priority
11	Erosion is widespread in many parts, especially wetlands

Source: After Begg, G., 1986. The wetlands of Natal (Part 1): an overview of their extent, role and present status, Natal Town and Regional Planning Commission Report, VOL 68, Pietermaritzburg, 114 p.

Note: No accurate assessment of the extent of wetland development in Natal/KwaZulu has yet been made. Scotney, D.M. and Wilby, A.F., 1983. Wetlands and agriculture, Journal of the Limnological Society of Southern Africa, VOL 9(2), p. 134 - 140., suggested that 40 - 50% of wetlands in high rainfall areas (locally up to 75% or more, especially along the coastal belt), have been "developed". The extent of irrigation applied to "improved" wetlands could be of the order of 60 - 70% of such wetlands.

8.5 Wetland degradation

No (definitive) holistic wetland degradation data are presently available for Natal/KwaZulu. Begg (1988)* estimated that 58% of the original wetland area of 502 km^2 in the Mfolozi catchment has been altered or destroyed, and that only 2,1% of the catchment (10 075 km^2) is covered by functional wetlands. Likewise, in parts of the Tugela Basin (Scotney, 1978)** and in the Siyaya catchment (Begg, 1986)***, up to 90% of the original wetlands have been destroyed. Begg (1990)**** listed some consequences of wetland destruction in the Mfolozi catchment. Impacts include an increased incidence of, and severity of downstream flooding and river flow cessation, reduced winter flows, lowering of the water table, and higher sediment loads and therefore turbidity. Other effects are increased bank erosion and general habitat deterioration plus threatened wildlife resources - all of which result in declining agricultural productivity and a lower quality of life for rural inhabitants. It is regretable that no legislation in South Africa deals in toto with the protection of wetlands (Begg, 1990).

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* See Begg, G., 1988. The wetlands of Natal (Part 2): the distribution, extent and status of wetlands in the Mfolozi catchment, Natal Town and Regional Planning Commission Report, VOL 71, Pietermaritzburg, 278 p. and map.

** See Scotney, D.M., 1978. Session 1. Soil erosion in Natal and KwaZulu - the present situation in Natal, In: The Relationship Between Agriculture and Environmental Conservation in Natal and KwaZulu: a Symposium, Wildlife Society of Southern Africa (Natal Branch) and the Royal Society of South Africa (Natal Branch), 19 - 20 October 1978, Durban, p. 16 - 34.

*** See Begg, G., 1986. The wetlands of Natal (Part 1): an overview of their extent, role and present status, Natal Town and Regional Planning Commission Report, VOL 68, Pietermaritzburg, 114 p.

**** See Begg, G., 1990. The wetlands of Natal (Part 4): policy proposals for the wetlands of Natal and KwaZulu, Natal Town and Regional Planning Commission Report, VOL 75, Pietermaritzburg, 86 p.

The major Act of Parliament which provides for a measure of protection for wetlands is the Conservation of Agricultural Resources Act No. 43 of 1983*. The responsible department is the Department of Agriculture. Other relevant legislation includes the Forest Act No. 122 of 1984; the Mountain Catchment Areas Act No. 63 of 1970 (not applied in Natal/KwaZulu); the National Parks Act No. 57 of 1976 (not enforced in Natal/KwaZulu), and the Lake Areas Development Act No. 39 of 1975 (not applied in Natal/KwaZulu). Also important is the Environment Conservation Act No. 73 of 1989; the (Natal) Town Planning Ordinance No. 27 of 1949 (wetlands in urban areas), and the (Natal) Nature Conservation Ordinance No. 15 of 1974. (Refer to the chapter on the laws of South Africa, elsewhere in this publication)**. The Department of Agriculture retains overall responsibility for the protection of wetlands in the agricultural areas of Natal, in terms of the management, research and planning of wetland utilization (for example, the proposed cultivation or drainage of a wetland). In the latter case, permission must be obtained from the Wetlands Advisory Committee of the Department of Agriculture, Private Bag X9059, Pietermaritzburg, 3200. In KwaZulu, the Swamp Forest Committee of the KwaZulu Department of Nature Conservation, Private Bag X98, Ulundi, 3838, by virtue of the KwaZulu Nature Conservation Act No. 8 of 1975, is the wetlands regulatory authority in formally protected areas. The only South African Act of Parliament in any way dealing with wetlands, which is presently applicable in KwaZulu, is the Water Act No. 54 of 1956.

8.6 Wetlands awareness programmes

Two important wetlands awareness programmes are those of the Department of Environment Affairs and the Renfreight Wetlands Campaign. The Department of

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* The Act provides for the utilization and protection of vleis, marshes, water sponges and watercourses. No land user (except those holding a permit) may drain or cultivate any vlei, marsh or water sponge (or part thereof) on his farm unit. In addition, no land user may cultivate any land on his farm unit within the flood area of a watercourse (namely, the 1 : 10 year flood line), or within 10 m horizontally outside the flood area of a watercourse (without a permit). Such restrictions do not apply (unless there is clear evidence of excessive soil erosion), where wetlands or flood areas of a watercourse have previously been drained, or were already under cultivation on or before the 26th of May 1984. It should be noted that wetlands - not within a defined channel (in terms of the Water Act No. 54 of 1956) are regarded as private water - see the chapter on the surface water resources of Natal/KwaZulu. Scotney and Wilby (1983 - above) observed that in the period 1969 - 1983, no legal directions were served in Natal, with regard to wetland degradation (in terms of the since repealed Soil Conservation Act No. 76 of 1969 - see the chapter on soils and soil erosion).

** See O'Keeffe, J.H., Uys, M. and Bruton, M.N., 1992. Chapter 13. Freshwater systems, In: Fuggle R.F. and Rabie, M.A. (eds), Environmental Management in South Africa, Juta, Cape Town, p. 277 - 315.

Environment Affairs, Private Bag X447, Pretoria, 0001, is involved in the formulation of a national policy on wetland conservation, which includes the fields of research required to improve the understanding of wetland functions and values in South Africa. The Department is also compiling a source document on priority wetlands (given the few detailed inventories of South African wetlands - a serious omission). Some 784 wetlands are currently listed (November 1995) and the project is on-going. A map showing the locality of the various wetlands has been produced by means of a Geographic Information System (GIS). Data available for each wetland include wetland type (according to the Ramsar definition), the threat level (in five classes) and the degree of protection (also in five classes. Locality information is likewise available, specifically, 1 : 50 000 and 1 : 250 000 scale topographic map references; plus district, farm name and number, and/or the name of the protected area in which the wetland is found.

Management plans are being drawn up in association with land owners, for those wetlands on private land which have been rated as priority areas (within the framework of the Southern African Plan for Nature Conservation)*. A system of protected wetlands is to be established as part of the protected areas network, involving an integrated systems approach to environmental conservation and sustainable development, with wetlands as an important component. Such a system (in conjunction with other wetland controlling agencies and private land owners), will provide a comprehensive network of protected wetlands of national significance, which together represent the full range of wetland functions.

A bibliography on wetlands was recently completed (see the end of the chapter), while a document collection to be maintained by library staff of the Department of Environment Affairs has been established. A database of wetland expertise is likewise available**. Attention is being given to the consolidation and/or amendment of the various Acts dealing

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* The Southern African Plan for Nature Conservation administered by the Department of Environment Affairs, was initiated in 1975 to identify and place rare or endangered species and threatened areas under conservation management. The Plan aims to co-ordinate all nature conservation objectives, to maintain a register of conserved areas (classified according to conservation purposes), and to collate and map all data required for planning needs. Information on the various protected areas is centrally stored to co-ordinate national planning; and also to provide conservation data to Government departments and other organizations, thereby ensuring that important natural areas are included in development plans drawn up at national and regional level.

** See Erasmus, A. and Van der Walt, R., 1996. List of wetland-related expertise in South Africa, Working Document No. 3.2/1996, South African Wetlands Conservation Programme, Department of Environmental Affairs and Tourism, Pretoria, no pagination.

with the environment (primarily the Water Act No. 54 of 1956 - in terms inter alia of the specific allocation of water for environmental needs - including wetlands). A wetlands education and awareness programme is also being developed. Much of the current thrust of the wetlands programme is based on the requirements of the Ramsar Convention. The Department of Environment Affairs is responsible for the administration of the Ramsar Convention in South Africa.

The Renfreight Wetlands Campaign, c/o the Natal Parks Board, P O Box 17090, Congella, 4013, which was established by the Southern African Nature Foundation (now known as the World Wide Fund for Nature South Africa), the Natal Parks Board and the Wildlife Society of Southern Africa, aims to improve the broad understanding of wetland systems in this country, with regard to wetland protection. Emphasis has been placed on the compilation of a simplified wetland field guide (in a picture key form), with special reference to farmers (Wyatt, 1993)*. The wetland owner or manager is accordingly able to identify the type and condition of the wetland. Management and rehabilitation concepts are also outlined in the publication. Courses are planned on the use of the field guide in various parts of South Africa. A second phase of the programme will involve the assessment of important wetlands in all the provinces, with a view to the rehabilitation of those wetlands found to be significantly degraded.

A sub-committee of the Southern African Regional Commission for the Conservation and Utilization of the Soil (SARCCUS), Private Bag X250, Pretoria, 0001, is presently involved with the collation of an inventory of wetlands in the southern African region. The wetlands are being rated in terms of international, national and regional importance.

8.7 Pans in Natal/KwaZulu

8.7.1 Pans of the Pongolo-Usuthu River system

Most of the pans in Natal/KwaZulu are situated in Maputaland and environs, and more specifically on the Pongolo River Floodplain between the Pongolapoort Dam and the Mozambique border. There is a pattern of seasonally and permanently inundated pans on

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* See Wyatt, J., 1993. Wetlands: assessment, management and rehabilitation of South African wetlands - an illustrated field guide for practical use by land agency extension services (draft), Renfreight Wetlands Campaign, [Natal Parks Board], Durban, 27 p.

the floodplain, which vary considerably in areal extent (some of the pans are very small). One hundred and twenty-two named and located pans are found on the Pongolo Floodplain. Ten named and located pans form part of the Usuthu River Floodplain (although closely linked to and influenced by the Pongolo River). Certain pans in the Pongolo-Usuthu River system are listed (south to north) in Tables H15 and H16.

At maximum retention level (following the recession of floods sufficient to inundate the entire floodplain), the Pongolo and Usuthu pans have an estimated collective area of approximately 2 600 ha (Heeg and Breen, 1982)*. The areal extent of some of the more important pans is shown in Table H17, which also indicates the estimated discharge released from the Pongolapoort Dam, at which individual pans are in contact with the river. Table H18 shows the volume of water contained in given pans during and immediately after flooding of the Pongolo River. Table H19 illustrates the percentage loss of volume with varying decreases in water levels of some Pongolo Floodplain pans (calculated from maximum retention levels). Pans of the Mkuze River Floodplain are listed in Table H20. Some other pans in Natal/KwaZulu are outlined in Tables H21 and H22. The order of the pans in Tables H20 - H22 inclusive, is from north to south.

Table H15: Named semi-permanent and permanent pans of the Pongolo River Floodplain (south to north).

Name	Alternative name	Co-ordinates
Pans east of the Pongolo River		
1. Balamhlanga	Balemhlanga Bhalamhlanga	27 24 00 S 32 12 00 E
2. kuNhlanjana	Nhlanjana Pelican Pan Nhlanjane Hlanjana	27 20 00 S 32 15 00 E
3. eBhukubhukuwini	Ebugubugwini Ebugubugweni Ubukwe	27 17 20 S 32 14 50 E
4. eMakhongola	Makhongolo Makongola Makongolo	27 15 30 S 32 15 30 E

* See Heeg, J. and Breen, C.M., 1982. Man and the Pongolo Floodplain, South African National Scientific Programmes Report No. 56, Cooperative Scientific Programmes, CSIR, Pretoria, 117 p.

Table H15: Named semi-permanent and permanent pans of the Pongolo River Floodplain (south to north) (continued).

Name	Alternative name	Co-ordinates
5. eMbuyayeni	Mbuyayeni	27 12 15 S 32 15 30 E
6. kuPhongolwana	Pongolwani Pongolwana Pongolwane Mhlangana	27 11 40 S 32 14 45 E
7. eSithutshaneni	Ntujanini Stutshanene	27 11 15 S 32 14 50 E
8. kuNsimbi	iNsimbi Unsimbu Ntsimbi Nsimbu Nsimbe Nsimbi	27 10 40 S 32 14 40 E
9. eMthikeni	Mtigi Mthekeni Mtikeni Mtigene Mshlenga Mthikeni	27 10 00 S 32 14 30 E
10. ePhokolo	Pokolo	27 10 10 S 32 14 00 E
11. eSubane (three associated pans around an "island")	Nsubana Nsubane	27 09 30 S 32 14 00 E
12. eGodini	eMgodini eMgodeni	27 09 15 S 32 14 30 E
13. kuManandi	kuManandu Manandu	27 09 10 S 32 14 50 E
14. kuMathikalala	eMathikalala eMathigalala	27 09 10 S 32 15 40 E
15. kuMshayikhandomkhulu	kuShayikhanda uShayikhandomkhulu	27 08 35 S 32 15 50 E
16. kuMshayikhandomcane	uShayikhandomncane	27 08 20 S 32 15 50 E
17. kuTete	iTete Tete	27 08 30 S 32 16 20 E
18. eTetenyane	kuTetenyane kuTetomncane Tetomncane Tetemcani Tetomcane	27 07 30 S 32 15 40 E

Table H15: Named semi-permanent and permanent pans of the Pongolo River Floodplain (south to north) (continued).

Name	Alternative name	Co-ordinates
19. uMphini	-	27 08 10 S 32 15 10 E
20. eMakapulane	uMakapulane	27 07 30 S 32 15 00 E
21. eMsengeni	uMasengeni uMasenga eBusengeni	27 06 15 S 32 15 30 E
22. oLuphondo (three associated pans)	-	27 05 15 S 32 15 50 E
23. eMengu	Omengu Mengu	27 05 00 S 32 16 00 E
24. eShubane (northern arm of eMengu)	-	27 04 40 S 32 16 10 E
25. eNgwadeni	Ngwadene eNgwadini	27 04 30 S 32 16 00 E
26. eMkhuhlwaneni	eMkhuhlwanini Mkhuhlanene Nkuhlwanene	27 04 10 S 32 15 50 E
27. eBululu	Ubululu Bululu	27 03 15 S 32 15 25 E
28. kuShalalomncane	Ntshalalamncane Ntshalala-mcani Shalalomncane	27 02 30 S 32 15 00 E
29. kuShalala	Ntshalala Shalala	27 02 35 S 32 15 30 E
30. kuHlonzenkulu	Hlonzekhulu Hlonzenkulu	27 02 40 S 32 15 55 E
31. kuSokhunti	Sokunti Sokuntu Sukunti Sokonte Konti Sokunte	27 01 30 S 32 17 00 E
32. kuMathemzila	Matemzila Mathemzila	27 01 20 S 32 18 10 E
33. kuMagebhuka (three pools in the channel to uMhlolo)	uMagebhuka eMagebhukeni Igebuka Gepkan Mpolobela	27 01 05 S 32 18 20 E

Table H15: Named semi-permanent and permanent pans of the Pongolo River Floodplain (south to north) (continued).

Name	Alternative name	Co-ordinates
34. uMhlolo	uMhlolwe eMhlolweni Nhlolo Nhlole Mhlolo Emhlolweni Enhlolweni	27 01 15 S 32 19 00 E
35. eMthikini (head of uMhlolo)	Emtikini	27 02 00 S 32 20 15 E
36. kuSinyulungwana	eSinulugwana Singulungwane	27 00 10 S 32 18 35 E
37. kuBafazi	Bafazini	26 59 45 S 32 18 35 E
38. uBhukubhuku	-	26 59 30 S 32 18 20 E
39. kwaMantengane	eManthengane Mantengane Mantengana	26 59 20 S 32 18 10 E
40. kuMandlankunzi	eMandlankunti Mantengane Mahlanguze Mahlanguzi Manzakude Mandlankunzi	26 58 00 S 32 18 00 E
41. kuMantimba	-	26 57 25 S 32 18 45 E
42. uNisani	eNisani eNyisani	26 57 00 S 32 18 55 E
43. Munywanini	eBumbe uMunywanini KwaBumbe Bumte	26 56 40 S 32 19 30 E
44. kuNhlanjwana	Nhlanjane Nhlanjwana Hlanjana	26 56 20 S 32 20 15 E
45. ePholwe	Polwe Upolo	26 54 30 S 32 20 05 E
46. kuNdwaneni	Kundwanini Kindwaneni	26 53 25 S 32 20 17 E
47. eFahleni	-	26 52 50 S 32 20 20 E

Table H15: **Named semi-permanent and permanent pans of the Pongolo River Floodplain (south to north) (continued).**

Name	Alternative name	Co-ordinates
Pans west of the Pongolo River		
1. eMayazela	Mayezela Mlambo River Mayazela	27 22 50 S 32 08 15 E
2. eMfongosi	Mfongozi Mfongoze	27 21 25 S 32 10 45 E
3. eMahashele	-	27 14 30 S 32 14 15 E
4. kuMashukela	uMashukela	27 14 40 S 32 14 00 E
5. eKhetshwana	-	27 14 15 S 32 14 10 E
6. eNzila	-	27 14 10 S 32 13 55 E
7. eNgwenyeni	-	27 15 00 S 32 12 25 E
8. Ntambalala	-	27 14 30 S 32 12 10 E
9. eBangeni	-	27 14 00 S 32 12 50 E
10. eMzinyeni	Msenyeni Mzinyene Mzinyeni	27 13 00 S 32 12 30 E
11. Zinalote (in area of eMzinyeni inflow - but no longer visible on air photos)	-	27 12 55 S 32 13 10 E
12. ?eMzinyeniyane (immediately south of eMzinyeniyane)	-	27 12 25 S 32 12 40 E
13. eMzinyeniyane	-	27 12 12 S 32 12 50 E
14. eNqongozaneni	-	27 12 00 S 32 13 17 E
15. kuJerimiya	-	27 11 35 S 32 14 00 E
16. kuMathuthwane	Matutwana	27 11 00 S 32 14 05 E
17. uMthombothi	Thombothi Somtshatsha	27 10 35 S 32 13 42 E

Table H15: Named semi-permanent and permanent pans of the Pongolo River Floodplain (south to north) (continued).

Name	Alternative name	Co-ordinates
18. eButhanyanyeni	uButanyanyeni Somtshatsha	27 10 55 S 32 13 05 E
19. kuNyathi	eMlambongwenya iNyathi Mlambongwenya Mniati	27 11 30 S 32 12 00 E
20. kuMlawayana	kuNyathi Mlawanyana Mayiwanyana	27 11 00 S 32 12 25 E
21. kuNtunte	eNtunti eNtunte Mtoti Ntunte Ntonti Ntonte Mkwambose	27 11 00 S 32 12 05 E
22. kuMahulube	Mahulube	27 10 00 S 32 12 55 E
23. oLukhatheni	uLukhathi uLukhatheni	27 09 15 S 32 13 32 E
24. uButhi	Buti	27 09 00 S 32 13 40 E
25. iNdukazabo	uNdugazabo eNdugazabo Ndugozabo Ndukazabo	27 08 50 S 32 14 00 E
26. oLusundu	Ulusundu Lusundu	27 08 30 S 32 14 40 E
27. eMvamvana	eMvanvana Mvanvane	27 07 30 S 32 14 05 E
28. kuMaleni	Khumaleni Malene Maleni	27 07 00 S 32 14 30 E
29. eKhangazini	Kangazini Kangazi Khangazeni Khangazini	27 05 45 S 32 15 15 E
30. Hlalaleni	-	27 05 05 S 32 15 20 E

Table H15: Named semi-permanent and permanent pans of the Pongolo River Floodplain (south to north) (continued).

Name	Alternative name	Co-ordinates
31. kuSivunguvungu	iSivunguvungu Isivunguvungu Sifungafunga Sivunguvungu	27 04 20 S 32 15 30 E
32. kuSivunguvungwana	iSivunguvungwana Sivunguvungwana	27 03 45 S 32 15 20 E
33. uMphahlana	Mpahlane	27 03 20 S 32 14 58 E
34. kuBhayi	Sombaye	27 03 10 S 32 14 58 E
35. kuMfelo	Mfelo	27 02 15 S 32 15 50 E
36. eMadlukuyana	Mpanyana-mcani	27 02 10 S 32 15 57 E
37. kuMphanyanomncane	uPhanyanomcane ePhanyanomcane Mpanyanomncane	27 01 17 S 32 16 43 E
38. kuMphanyana	uPhanyanomkhulu ePhanyanomkhulu uMpanyanomkhulu Mpanyana Mpanyana enkulu	27 01 13 S 32 17 00 E
39. eBumbe	kuBumbe Bumbi Ubumbe Bubi Umbumbe Bumbe	26 59 40 S 32 18 00 E
40. eMasinga	iNgodo Ngodo	26 59 25 S 32 17 30 E
41. iNgodo	eMasinga Ukaqa Ngodo	26 59 12 S 32 17 12 E
42. uMkwakwa	-	26 59 35 S 32 16 08 E
43. eNamanini	Nomanini Namaneni Nomaneni Namanini	26 59 00 S 32 16 30 E
44. eSparetha	-	26 58 17 S 32 16 35 E

Table H15: Named semi-permanent and permanent pans of the Pongolo River Floodplain (south to north) (continued).

Name	Alternative name	Co-ordinates
45. Hlibanini	Eshlibanene Hlibanene	26 57 55 S 32 16 25 E
46. Limangezandla	-	26 57 30 S 32 17 20 E
47. eMatsegula	-	26 57 15 S 32 16 33 E
48. eMangalana (indicated as north eastern end of Hlibanini)	uMangalane	26 57 45 S 32 16 45 E
49. eMhlangeni	eMhlanganeni Mtigene	26 56 50 S 32 16 00 E
50. kuQotho	Msunduzi iQotho Msunduzi Qothu Umsunduze	26 56 10 S 32 13 00 E
51. uMsunduzi	Msunduze	26 56 05 S 32 14 00 E
52. uNgudla	-	26 57 17 S 32 17 05 E
53. iNgazini	-	26 57 30 S 32 17 40 E
54. kuMabuye	KwaMabuye eMabuyayeni	26 57 25 S 32 18 02 E
55. iSikhathimahewu	-	26 57 20 S 32 18 30 E
56. eSishangeni	eShangeni ?eNtshangeni ?eBalaseni	26 57 05 S 32 18 25 E
57. uLujwe	uLuju kuLujwe ?eSishangeni Ulujwe	26 56 55 S 32 18 25 E
58. kuMandala	-	26 56 20 S 32 18 45 E
59. eMbaganyani	eMbaganzane ?eNtshakeni ?uNtshakeni Mbulaleni	26 56 25 S 32 19 15 E

Table H15: **Named semi-permanent and permanent pans of the Pongolo River Floodplain (south to north) (continued).**

Name	Alternative name	Co-ordinates
60. eMhlongoshana	eNhlongoshana eMhlongoshwane	26 56 25 S 32 19 37 E
61. kuMalu (a 2 km long channel from uLujwe Pan passing north east along the edge of Ndumu hill)	-	26 56 10 S 32 19 17 E
62. eBazala	-	26 55 50 S 32 19 00 E
63. iNgwamathemncane	-	26 55 45 S 32 19 45 E
64. iNgwamathemkulu	-	26 55 37 S 32 19 35 E
65. eSilibindini	-	26 55 00 S 32 19 17 E
66. iNyezane	Umpanene	26 54 32 S 32 19 32 E
67. uMphumphununomncane	-	26 54 10 S 32 19 26 E
68. uMphumphununu	-	26 53 55 S 32 19 23 E
69. iNyamithi	Inyamithi Nyamiti Inyameti Nyamithi	26 53 20 S 32 18 10 E
70. Paradise	iNyamithemncane	26 52 50 S 32 18 40 E
71. eHothwe (more than one open water area)	Hotwe Hothwe	26 52 35 S 32 18 35 E
72. iSibhakabhaka	KuBhakabhaka Bakabaka	26 52 35 S 32 19 25 E
73. iSabathana (more than one open water area)	Sabatana	26 52 00 S 32 18 40 E
74. eMbulakazini (more than one open water area)	Mbulakazane Inyubulana	26 51 55 S 32 20 40 E
75. eNhlangano	eMahongwana	26 51 30 S 32 20 32 E

<u>Source</u>: (i) After La Hausse de Lalouvière, P., 1987. A toponymic survey of the waterbodies of the uPhongolo (Pongolo) Floodplain area, northern Zululand, INR Working Paper No. 24, Institute of Natural Resources,

University of Natal, Pietermaritzburg, 34 p. (The publication contains sketch maps of the various pans).

(ii) After Coke, M., 1990. Personal communication, Natal Parks Board, Pietermaritzburg. (The pans are marked on 1 : 50 000 scale topographic maps which are maintained by Coke. The maps are a most useful reference document series).

Note: The distribution of pans, especially smaller pans, is complex. In order to assist the reader, the south to north distribution of pans follows La Hausse de Lalouvière (1987), although certain locational differences are apparent in terms of data provided by Coke (1990). Some ephemeral rainpools (not named in the above table), are listed in the primary source document.

Table H16: Named pans of the Usuthu River Floodplain (south to north).

Name	Alternative name	Co-ordinates
1. Dombeni	-	26 51 33 S 32 12 25 E
2. kuZamsolo	Zamsolo	26 51 30 S 32 14 45 E or 26 51 40 S 32 15 30 E
3. Diphini	Zamsolo	26 51 30 S 32 14 45 E
4. eMvutshini	Mvuthsini Mvutsheni	26 52 00 S 32 16 15 E
5. eBanzi	Bandi Banzi	26 52 00 S 32 17 30 E
6. kuShokwe	Skokwe Shoku KuShokwe	26 52 00 S 32 13 05 E
7. iFonthana	Funtani Fontana kuFuntani	26 51 45 S 32 09 40 E
8. iBathana	Batana Batane Bantana	26 51 50 S 32 16 40 E
9. eMbumbaneni	Mbumbanene	26 52 25 S 32 12 35 E
10. eMagongolwaleni	Magongolwanini	26 52 20 S 32 12 00 E

Source: (i) After La Hausse de Lalouvière, P., 1987. A toponymic survey of the waterbodies of the uPhongolo (Pongolo) Floodplain area, northern Zululand, INR Working Paper No. 24, Institute of Natural Resources, University of Natal, Pietermaritzburg, 34 p. (The publication contains sketch maps of the various pans).

(ii) After Coke, M., 1990. Personal communication, Natal Parks Board, Pietermaritzburg. (The pans are marked on 1 : 50 000 scale topographic maps which are maintained by Coke. The maps are a most useful reference document series).

Note: The distribution of pans, especially smaller pans, is complex. In order to assist the reader, the south to north distribution of pans follows La Hausse de Lalouvière (1987), although certain locational differences are apparent in terms of data provided by Coke (1990). Some ephemeral rainpools (not named in the above table), are listed in the primary source document.

Table H17: Inundation of Pongolo Floodplain pans in relation to river flow, due to releases from the Pongolapoort Dam.

Pan	Area (ha)	Discharge rate ($m^3 s^{-1}$)						
		7,0	28,3	56,6	84,9	141,5	198,2	>300
Mayezela	25,8							•
Mfongozi	20,5							•
Nhlanjane	37,9							•
Nzila	14,2				•	•	•	•
Mzinyeni	74,2	•	•	•	•	•	•	•
Ebugubugwini	8,8						•	•
Pongolwane	9,9						•	•
Matutwana	27,1					•	•	•
Stutshanene	9,6					•	•	•
Nsimbi	15,7					•	•	•
Mthikeni	45,4				•	•	•	•
Pokolo	14,2				•	•	•	•
Somtshatsha	11,0					•	•	•
Mlawanyana	17,7					•	•	•
Ntunte	23,5					•	•	•
Subane	59,7				•	•	•	•

Table H17: Inundation of Pongolo Floodplain pans in relation to river flow, due to releases from the Pongolapoort Dam (continued).

Pan	Area (ha)	Discharge rate ($m^3 s^{-1}$)						
		7,0	28,3	56,6	84,9	141,5	198,2	>300
Tete	115,9			•	•	•	•	•
Tetomncane	23,9			•	•	•	•	•
Ndugozabo	14,5				•	•	•	•
Ulusundu	50,4				•	•	•	•
Maleni	46,5				•	•	•	•
Kangazini	74,0				•	•	•	•
Mengu	32,2				•	•	•	•
Sivunguvungu	40,4				•	•	•	•
Shalala	49,2						•	•
Sokunti	101,0			•	•	•	•	•
Mhlolo	56,0					•	•	•
Singulungwane	14,1					•	•	•
Bumbe	58,4		•	•	•	•	•	•
Ngodo	22,1		•	•	•	•	•	•
Namanini	63,4		•	•	•	•	•	•
Mandlankunzi	255,0				•	•	•	•
Ulujwe	37,5				•	•	•	•
Nhlanjane	16,8					•	•	•
Polwe	22,9				•	•	•	•
Nyamithi	183,4				•	•	•	•
Bakabaka	23,2				•	•	•	•

Source: After Heeg, J. and Breen, C.M., 1982. Man and the Pongolo Floodplain, South African National Scientific Programmes Report No. 56, Cooperative Scientific Programmes, CSIR, Pretoria, 117 p.

Table H18: The volume of water contained in various Pongolo Floodplain pans during and immediately after floods.

Pan	Maximum retention level ($10^6 m^3$)	High flood level ($10^6 m^3$)
Kangazini	0,091	1,142
Namanini	0,201	1,206
Mthikeni*	0,103	2,500
Tetomncane*	0,165	3,625
Maleni	0,0676	0,319
Tete*	1,105	3,625
Nsimbi*	0,340	2,500
Sivunguvungu	0,445	1,064
Shalala	0,598	1,253
Mandlankunzi	4,258	8,545
Mhlolo	0,483	1,626
Mengu	0,356	0,771
Sokunti	3,008	4,783

Source: After Heeg, J. and Breen, C.M., 1982. Man and the Pongolo Floodplain, South African National Scientific Programmes Report No. 56, Cooperative Scientific Programmes, CSIR, Pretoria, 117 p.

Note: Pans marked with an asterisk coalesce during floods.

Table H19: Percentage loss of volume with varying decreases in water levels of some Pongolo Floodplain pans (calculated from the maximum retention levels).

Pan	Decrease in water level (m)							
	0,5	1,0	1,5	2,0	2,5	3,0	3,5	4,0
Kangazini	100	-	-	-	-	-	-	-
Namanini	67,1	100	-	-	-	-	-	-
Mzinyeni	43,3	74,9	100	-	-	-	-	-
Mthikeni	46,6	96,1	100	-	-	-	-	-
Tetomncane	51,5	90,9	100	-	-	-	-	-
Maleni	73,9	89,7	100	-	-	-	-	-

Table H19: Percentage loss of volume with varying decreases in water levels of some Pongolo Floodplain pans (calculated from the maximum retention levels) (continued).

Pan	Decrease in water level (m)							
	0,5	1,0	1,5	2,0	2,5	3,0	3,5	4,0
Tete	63,8	86,4	100	-	-	-	-	-
Nsimbi	70,6	90,9	97,1	100	-	-	-	-
Sivunguvungu	42,7	70,8	78,6	98,4	100	-	-	-
Shalala	38,1	60,5	94,1	95,3	100	-	-	-
Mandlankunzi	29,5	53,6	71,8	93,8	100	-	-	-
Mhlolo	39,9	71,4	80,3	89,8	100	-	-	-
Mengu	45,2	71,6	87,3	94,4	99,7	100	-	-
Sokunti	16,2	29,9	41,8	54,7	63,4	73,5	80,0	86,7

Source: After Breen, C.M., Furness, H.D., Heeg, J. and Kok, J., 1978. Bathymetric studies on the Pongolo River Floodplain, Journal of the Limnological Society of Southern Africa, VOL 4(2), p. 95 - 100.

8.7.2 Pans of the Mkuze River Floodplain

The second major floodplain in Natal/KwaZulu where a number of pans are found, is that of the Mkuze River which links up to the northern part of Lake St Lucia (Table H20). Sixteen pans have been identified in the area between the confluence of the Msunduzi and Mkuze rivers, and Lake St Lucia.

Table H20: Named semi-permanent and permanent pans of the Mkuze River Floodplain (north to south).

Name	Co-ordinates
Hlabinyathi	27 32 S 32 37 E
Cezwana	27 34 S 32 18 E
Muzi (Mozi)	27 37 S 32 24 E

Table H20: Named semi-permanent and permanent pans of the Mkuze River Floodplain (north to south) (continued).

Name	Co-ordinates
Yengweni	27 39 S 32 26 E
Jarusalema	27 39 S 32 28 E
Mdlanzi	27 39 S 32 29 E
Ovengweni	27 40 S 32 25 E
Tshanetshe	27 40 S 32 26 E
Manyoni	27 40 S 32 29 E
Ntshangwe (Umbumbu)	27 41 S 32 29 E
Butterfly	27 41 S 32 31 E
Mpempe	27 42 S 32 28 E
Ngwenya	27 43 S 32 29 E
Mbazwane	27 43 S 32 32 E
Ndlanka	27 45 S 32 30 E
Demezane	27 45 S 32 31 E

<u>Source</u>:

(i) After Goodman, P.S., 1987. Mkuze Floodplain and swamps, In: Walmsley, R.D. and Botten, M.L. (compilers), Symposium on the Ecology and Conservation of Wetlands in South Africa, Ecosystem Programmes Occasional Report Series No. 28, Foundation for Research Development, CSIR, Pretoria, p. 174 - 187.

(ii) After Stormanns, C., 1986. The plant communities of the Mkuze Swamp system, In: Stormanns, C.H. and Breen, C.M. (eds), Proceedings of the Greater Mkuze Swamp System Symposium and Workshop, INR Investigational Report No. 22, Institute of Natural Resources, University of Natal, Pietermaritzburg, [5 p.].

Note: The list of semi-permanent and permanent pans is not claimed to be exhaustive, while some of the co-ordinates provided, are **subject to confirmation.** A further difficulty concerns the definition of pans per se as opposed to small, shallow coastal lakes. A concise inventory of all pans in Natal/KwaZulu is therefore required.

8.7.3 Other pans in Natal/KwaZulu

Named pans of the Mfolozi River catchment are presented in Table H21, while a general listing of other pans in Natal/KwaZulu is provided in Table H22.

Table H21: Named semi-permanent and permanent pans of the Mfolozi River catchment (north to south).

Name	Co-ordinates	Approximate open water surface area (ha)
Nkata	28 22 S 32 07 E	15
Mbukwini/Ngologoto	28 23 S 32 02 E	45
?Fuyeni reedbed	28 24 S 31 54 E	15 (no open water surface area)
Ntweni	28 24 S 32 04 E	32
Mgqizweni	28 24 S 32 56 E	7
Mvamanzi	28 25 S 32 01 E	42 - 55
Majamisa	28 26 S 32 07 E	31
Mvanyamvanya	28 26 S 32 09 E	10
Makata/Nyawothi	28 27 S 32 07 E	20

Source: After Begg, G., 1988. The wetlands of Natal (Part 2): the distribution, extent and status of wetlands in the Mfolozi catchment, Natal Town and Regional Planning Commission Report, VOL 71, Pietermaritzburg, 278 p. and map.

Note: The list of semi-permanent and permanent pans is not claimed to be exhaustive, while some of the co-ordinates provided, are **subject to confirmation.** A further difficulty concerns the definition of pans per se as opposed to small, shallow coastal lakes. A concise inventory of all pans in Natal/KwaZulu is therefore required.

Table H22: Some named semi-permanent and permanent pans elsewhere in Natal/KwaZulu (north to south).

Name	Co-ordinates
Pans of the Ingwavuma area	
Ingwavuma	27 08 S 32 02 E
Pans of the Kosi Bay area	
Judea	26 53 S 32 47 E
Lulube	26 54 S 32 49 E
Mahlungulu (Joe's Pan)	26 54 S 32 51 E
Enkovukeni	26 55 S 32 52 E
Nteza	26 57 S 32 48 E
Thengane	26 59 S 32 44 E
KwaGeorge	26 59 S 32 47 E
Mzingwane	27 03 S 32 47 E
Uhlalankwazi	27 05 S 32 48 E
Black Rock Pans	27 05 S 32 49 E
De Wet's	27 10 S 32 48 E
No name 1	27 32 S 32 37 E
Pans of the Mosi Swamps area and the Tembe Elephant Park	
nThibe	26 53 S 32 35 E

Table H22: Some named semi-permanent and permanent pans elsewhere in Natal/KwaZulu (north to south) (continued).

Name	Co-ordinates
Magwenya	26 54 S 32 31 E
Nyoni	26 54 S 32 34 E
Nungwe	26 55 S 32 34 E
Sifomothini	26 56 S 32 32 E
Umjamgazi	27 00 S 32 31 E
Uzingongo	27 01 S 32 30 E
Mahlasela	27 03 S 32 27 E
No name 1	27 07 S 32 37 E
Gondetembe	27 10 S 32 35 E
Manzimhlope	27 10 S 32 35 E
No name 2	27 12 S 32 32 E
Ngutshana	27 15 S 32 35 E
Ezinaleni	27 56 S 32 25 E
Pans in the Mkuzi Game Reserve Nhlonhlela	27 36 S 32 12 E
Nsumu	27 40 S 32 18 E
Pans in or near the Manzengwenya Forestry Plantation Mtombeni	27 06 S 32 39 E
Vasa	27 12 S 32 42 E

Table H22: **Some named semi-permanent and permanent pans elsewhere in Natal/KwaZulu (north to south) (continued).**

Name	Co-ordinates
Mabibi	27 19 S 32 44 E
Pans of the Greater Mhlatuze River wetland system Mtindala	 28 45 S 32 09 E
Thulazihleka (an artificially created pan)	28 46 S 32 04 E
Magongolo	28 46 S 32 07 E
Menywa	28 47 S 32 06 E
Sontwayo	28 47 S 32 06 E
Pans of the Port Durnford Lighthouse environs Ncombo	 28 53 S 31 57 E
Babane	28 55 S 31 53 E

<u>Source</u>:

(i) After Begg, G., 1989. The wetlands of Natal (Part 3): the location, status and function of the priority wetlands of Natal, Natal Town and Regional Planning Commission Report, VOL 73, Pietermaritzburg, 256 p. and map.

(ii) After Weisser, P.J., 1978. A vegetation study of the Zululand dune areas: conservation priorities in the dune area between Richards Bay and Mfolozi mouth based on a vegetation survey, Natal Town and Regional Planning Commission Report, VOL 38, Pietermaritzburg, 64 p.

(iii) After Weisser, P.J., 1987. Dune vegetation between Richards Bay and Mlalazi Lagoon and its conservation priorities in relation to dune mining, Natal Town and Regional Planning Commission Supplementary Report, VOL 19, Pietermaritzburg, 71 p.

(iv) After Coke, M., 1990. Personal communication, Natal Parks Board, Pietermaritzburg.

(v) After Kyle, R., 1990. Personal communication, KwaZulu Bureau of Natural Resources (now the KwaZulu Department of Nature Conservation), KwaNgwanase.

<u>Note</u>: (i) The list of semi-permanent and permanent pans is not claimed to be exhaustive, while some of the co-ordinates provided, are **subject to confirmation**. A further difficulty concerns the definition of pans <u>per se</u> as opposed to small, shallow coastal lakes. A concise inventory of all pans in Natal/KwaZulu is therefore required.

(ii) Rain-fed pans (seasonal pans) have been excluded from the above table.

(iii) The localities (on 1 : 50 000 scale topographic maps) of all the listed pans (Tables H20, H21 and H22) may be inspected by arrangement with M. Coke, Natal Parks Board, P O Box 662, Pietermaritzburg, 3200. R. Kyle, KwaZulu Department of Nature Conservation, P O Box 43, KwaNgwanase, 3973, should be approached for further data on selected pans in eastern Maputaland.

8.8 <u>Some primary publications on wetlands in Natal/KwaZulu</u>

- Begg, G., 1986. The wetlands of Natal (Part 1): an overview of their extent, role and present status, Natal Town and Regional Planning Commission Report, VOL 68, Pietermaritzburg, 114 p.

- Begg, G., 1988. The wetlands of Natal (Part 2): the distribution, extent and status of wetlands in the Mfolozi catchment, Natal Town and Regional Planning Commission Report, VOL 71, Pietermaritzburg, 278 p. and map.

- Begg, G., 1989. The wetlands of Natal (Part 3): the location, status and function of the priority wetlands of Natal, Natal Town and Regional Planning Commission Report, VOL 73, Pietermaritzburg, 256 p. and map.

- Begg, G., 1990. The wetlands of Natal (Part 4): policy proposals for the wetlands of Natal and KwaZulu, Natal Town and Regional Planning Commission Report, VOL 75, Pietermaritzburg, 86 p. (The publication contains a useful, although dated, overview of the functions of Government departments in terms of wetlands).

- Bruton, M.N. and Cooper, K.H. (eds), 1980. Studies on the Ecology of Maputaland, Rhodes University and the Natal Branch of the Wildlife Society of Southern Africa, Grahamstown and Durban, 560 p. and map.

- Cowan, G.I. (ed), 1995. Wetlands of South Africa, South African Wetlands Conservation Programme Series, Department of Environmental Affairs and Tourism, Pretoria, 292 p.

- Harmse, J.T., Olivier, P.G. and Goudie, A.S., 1990. A bibliography on pans and related deposits, University Press, Rand Afrikaans University, Johannesburg, 60 p. (The publication refers inter alia to pans in southern Africa).

- Heeg, J. and Breen, C.M., 1982. Man and the Pongolo Floodplain, South African National Scientific Programmes Report No. 56, Cooperative Scientific Programmes, CSIR, Pretoria, 117 p.

- Kotze, D.C. and Breen, C.M., 1994. Agricultural land-use impacts on wetland functional values, WRC Report No. 501/3/94, Water Research Commission, Pretoria, 70 p.

- Kotze, D.C., Breen, C.M. and Klug, J.R., 1994. A project to improve the management of wetlands in the KwaZulu/Natal Midlands: an overview, WRC Report No. 501/1/94, Water Research Commission, Pretoria, 8 p.

- Kotze, D.C., Breen, C.M. and Klug, J.R., 1994. WETLAND-USE: a wetland management decision support system for the KwaZulu/Natal Midlands, WRC Report No. 501/2/94, Water Research Commission, Pretoria, 76 p. + app.

- Kotze, D.C., Hughes, J.C., Breen, C.M. and Klug, J.R., 1994. The development of a wetland soils classification system for KwaZulu/Natal, WRC Report No. 501/4/94, Water Research Commission, Pretoria, 32 p. (See also, Kotze, D.C., Klug, J.R., Hughes, J.C. and Breen, C.M., 1996. Improved criteria for classifying hydric soils in South Africa, South African Journal of Plant and Soil, VOL 13(3), p. 67 - 73).

- Milton, J.R.L., 1978. Session 2. Management of rivers, flood plains and estuaries in Natal and KwaZulu - legal aspects of the management of flowing and standing waters, In: The Relationship Between Agriculture and Environmental Conservation in Natal and KwaZulu: a Symposium, Wildlife Society of Southern Africa (Natal Branch) and the Royal Society of South Africa (Natal Branch), 19 - 20 October 1978, Durban, p. 56 - 64.

- Noble, R.G. and Hemens, J., 1978. Inland water ecosystems in South Africa - a review of research needs, South African National Scientific Programmes Report No. 34, Cooperative Scientific Programmes, CSIR, Pretoria, 150 p.

- Oellermann, R.G., Darroch, M.A.G., Klug, J.R. and Kotze, D.C., 1994. Wetland preservation valuation and management practices applied to wetlands: South African case studies, WRC Report No. 501/5/94, Water Research Commission, Pretoria, various pages.

- Ramsden, H.T., 1987. Legal principles and wetland legislation, In: Walmsley, R.D. and Botten, M.L. (compilers), Symposium on the Ecology and Conservation of Wetlands in South Africa, Ecosystem Programmes Occasional Report Series No. 28, Foundation for Research Development, CSIR, Pretoria, p. 136 - 159.

- Stormanns, C.H. and Breen, C.M. (eds), 1986. Proceedings of the Greater Mkuze Swamp system symposium and workshop, INR Investigational Report No. 22, Institute of Natural Resources, University of Natal, Pietermaritzburg, no pagination.

- Van der Walt, M.M., Cowan, G.I., Erasmus, A. and Marneweck, G.C., 1996. Wetland bibliography for South Africa, South African Wetlands Conservation Programme Series, Department of Environmental Affairs and Tourism, Pretoria, 136 p. (The bibliography contains over 3 300 entries).

- Walmsley, R.D. and Boomker, E.A. (eds), 1988. Inventory and classification of wetlands in South Africa: Proceedings of a Workshop held at the Hydrological Research Institute, Roodeplaat on 26 and 27 July 1988, Ecosystem Programmes Occasional Report Series No. 34, Foundation for Research Development, CSIR, Pretoria, 92 p.

- Walmsley, R.D. and Botten, M.L. (compilers), 1987. Symposium on the ecology and conservation of wetlands in South Africa, Ecosystem Programmes Occasional Report Series No. 28, Foundation for Research Development, CSIR, Pretoria, 313 p.

- Wyatt, J., 1993. Wetlands: assessment, management and rehabilitation of South African wetlands - an illustrated field guide for practical use by land agency extension services (draft), Renfreight Wetlands Campaign, [Natal Parks Board], Durban, 27 p. (The publication is a most useful non-technical guide which aims to provide relevant information to interested lay-people, rather than experts. The publication has been updated. See immediately below).

- Wyatt, J., 1995. Wetland fix: assessment, management, and restoration of South African wetlands - an illustrated field guide for practical use by land agency extension services, Part 1. Introduction and wetland assessment, 15 p., Part 2. Wetland burning and grazing guide, 11 p., Part 3. Streambank stabilization and channel plug development, 23 p., Part 4. Indigenous plants suitable for streambank stabilization and channel plug development, 11 p., Part 5. Stream source wetlands - spring protection guide, 7 p., and Part 6. Alien plant control guide, 7 p., Renfreight/Rennies Wetlands Campaign, [Natal Parks Board], Durban.

Note: A Wetland Research Programme was initiated in 1988 under the auspices of the (former) National Programme for Ecosystem Research, Foundation for Research Development, then of the CSIR. (The Programme was subsequently discontinued). See Walmsley, R.D., 1988. A description of the wetlands research programme, South African National Scientific Programmes Report No. 145, Foundation for Research Development, CSIR, Pretoria, 26 p. The National Programme for Ecosystem Research (and other similar programmes) was established to co-ordinate research into environmental problems in South Africa. The various programmes included research activities on inland waters (see for instance, Noble and Hemens, 1978 - above), plus terrestrial ecosystems and aspects of nature conservation, as well as "estuaries" and coastal processes. Numerous publications relating to water systems were issued in terms of the South African National Scientific Programmes Report Series and the Ecosystem Programmes Occasional Report Series. All such activities (in their then mode of operation) have ceased. For an overview discussion of the respective research programmes, see Huntley, B.J., 1987. Ten

years of cooperative ecological research in South Africa, South African Journal of Science, VOL 83(2), p. 72 - 79.

For further information contact:

- Computing Centre for Water Research/Department of Agricultural Engineering, University of Natal, Private Bag X01, Scottsville, 3209.
- Department of Agriculture, Private Bag X9059, Pietermaritzburg, 3200.
- Department of Environment Affairs, Private Bag X447, Pretoria, 0001. (The Department periodically publishes the newsletter South African Wetlands, which is a useful source of information on current wetland events in South Africa).
- Department of Grassland Science, University of Natal, Private Bag X01, Scottsville, 3209.
- Department of Water Affairs and Forestry, P O Box 1018, Durban, 4000.
- Department of Zoology (Coastal Research Unit of Zululand), University of Zululand, Private Bag X1001, KwaDlangezwa, 3886.
- Division of Forest Science and Technology, CSIR, P O Box 395, Pretoria, 0001.
- EPPIC (Environmental Planning Professions Interdisciplinary Committee), P O Box 90142, Bertsham, 2013.
- Freshwater Research Unit, Department of Zoology, University of Cape Town, Private Bag, Rondebosch, 7701.
- Geological Survey (now the Council for Geoscience), Private Bag X112, Pretoria, 0001. (A database on the peat resources of South Africa is being compiled by the Council).

- Institute of Natural Resources, University of Natal, Private Bag X01, Scottsville, 3209.

- KwaZulu Department of Agriculture and Forestry, Private Bag X05, Ulundi, 3838. (It should be noted that the Department - theoretically - controls the use of wetlands in non-protected, agricultural areas in KwaZulu. In practice however, little effective management is possible, given population pressures and the demands on natural resources including wetlands).

- KwaZulu Department of Nature Conservation, Private Bag X98, Ulundi, 3838.

- Natal Parks Board, P O Box 662, Pietermaritzburg, 3200.

- Natal Town and Regional Planning Commission/Chief Directorate: Physical Planning and Development, Natal Provincial Administration, Private Bag X9037, Pietermaritzburg, 3200. (The Commission was responsible for the overall co-ordination of much of the "official" research on wetlands in Natal/KwaZulu).

- Rand Water, P O Box 1127, Johannesburg, 2000.

- Renfreight Wetlands Campaign, c/o the Natal Parks Board, P O Box 17090, Congella, 4013. (The Renfreight Wetlands Campaign is now known as the Rennies Wetlands Campaign/Project. The previous name has been retained in this publication for the sake of conformity).

- South African Sugar Association Experiment Station, Private Bag X02, Mount Edgecombe, 4300. (Extension staff of the Experiment Station are responsible for encouraging compliance with the provisions of the Conservation of Agricultural Resources Act No. 43 of 1983, in terms of wetlands, in the sugar growing areas of Natal/KwaZulu and the eastern Transvaal).

- Southern African Regional Commission for the Conservation and Utilization of the Soil (SARCCUS), Private Bag X250, Pretoria, 0001.

- Wetlands International, c/o the Department of Environment Affairs, Private Bag X447, Pretoria, 0001. (The agency promotes international cooperation for wetland research and conservation).

- Wildlife Society of Southern Africa (Natal Branch), P O Box 2985, Durban, 4000.

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CHAPTER 9: RAINFALL

The horror of drought...

Drought

Dead are the lilies in the veld-pans;
The veld-flowers have vanished.

*   *   *

Silent are the streams, sad and silent...

*   *   *

Dead are the blossoms and the berries,
The bright birds have departed...

*   *   *

Dead are the friendly sheep and cattle:
Bleached bones whiten in the sun;
No soft lowing comes from the valleys,
No faint bleat from the hills.

Lonely is the veld, stark and lonely,
On its scarred breast no living thing is seen...

*   *   *

The last of the water-wells
Is almost dry: the people will perish...

*   *   *

Thus [we have] sung of Drought,
Which is the hate of the sun...

F.C. Slater, quoted in Chapman, M. (ed), 1982. A Century of South African Poetry, AD. Donker, Johannesburg, 397 p. (Note: The poem was written in 1928 during an extended period of drought - briefly discussed towards the end of the chapter. A similar, tragic theme is described in "Die onteiening", by C.J. Langenhoven, quoted in Opperman, D.J., 1991. Junior Verseboek, Tafelberg-uitgewers Bpk, Cape Town, 239 p.).

The welcome grandeur of a large thunderstorm...

Storm in Tugela Valley, Natal

Seated on high upon the steep,
Amid the moonlight glow,
I looked upon a valley deep,
And on a river's flow.

Sudden, across the chasm wide
The heavy thunder growled,
While far below in sullen glide
The noble river rolled.

And now a thousand feet below,
Betwixt me and the stream,
The thunder-cloud, with lightning's glow,
Obscures the river's gleam.

*   *   *

Full in the midst the cloud now parts,
And wars on different sides,
And through the gap the light moon darts,
Where bright the river glides.

D.C.F. Moodie, quoted in Chapman, M. (ed), 1982. A Century of South African Poetry, AD. Donker, Johannesburg, 397 p.

RAINFALL

Expectation and joy...

<u>Die dans van die reën</u>
Lied van die vioolspeler, Jan Konterdans, uit die Groot Woestyn

O die dans van ons Suster!
Eers oor die bergtop loer sy skelm,
en haar oge is skaam;
en sy lag saggies.
En van ver af wink sy met die een hand;
haar armbande blink en haar krale skitter;
saggies roep sy.
Sy vertel die winde van die dans
en sy nooi hulle uit, want die werf is wyd en die bruilof groot.

Die grootwild jaag uit die vlakte,
hulle dam op die bulttop,
wyd rek hulle die neusgate
en hulle sluk die wind;
en hulle buk, om haar fyn spore op die sand te sien.

Die kleinvolk diep onder die grond hoor die sleep van haar voete,
en hulle kruip nader en sing saggies:
"Ons Suster! Ons Suster! Jy het gekom! Jy het gekom!"

En haar krale skud,
en haar koperringe blink in die wegraak van die son.
Op haar voorkop is die vuurpluim van die berggier;
sy trap af van die hoogte;
sy sprei die vaal karos met altwee arms uit;
die asem van die wind raak weg.
O, die dans van ons Suster!

E. Marais, quoted in Opperman, D.J., 1979. <u>Senior Verseboek</u>, Tafelberg-uitgewers Bpk, Cape Town, 278 p. (See the bibliographic database for papers describing various traditional rain ceremonies).

CHAPTER 9: RAINFALL

Contents *Page*

9.1 Weather 299

9.2 Types of weather stations in South Africa (excluding automatic stations) . . 302

9.2.1 Weather station identification numbers 304

9.3 Primary climatological data sources 306

9.3.1 Some Weather Bureau data publications of relevance 307
9.3.2 Some (regularly) published climatological data available from the Weather Bureau 310

(a) Less formal publications 310
(b) More formal publications 311

9.3.3 Department of Water Affairs and Forestry data publications of relevance 311
9.3.4 Other sources of climatological data 313
9.3.5 Climatological data available from the Department of Agriculture, Cedara 315

9.4 Rainfall maps 316

9.5 Record lengths for rainfall and evaporation in South Africa 319

9.5.1 Rainfall 319
9.5.2 Evaporation 320

9.6 Cloud types and precipitation 320

9.7 Mean annual precipitation over Natal/KwaZulu 324

9.8 Temperatures in Natal/KwaZulu 326

9.9 Floods 327

9.10 Droughts 330

9.11 Extreme wet and dry periods in South Africa 334

9.12 Wind 336

9.13 The length of daylight in South Africa 338

Tables *Page*

Table I1: Some weather terms used by the South African Weather Bureau 299

Table I2: Weather stations manned by Weather Bureau staff in South Africa, 1993 302

Table I3: Some climatological data available from the Weather Bureau 306

Table I4: Climatological and other data available from the Computing Centre for Water Research, University of Natal, Pietermaritzburg 314

Table I5: Number of stations with various lengths (years) of rainfall records in South Africa, 1984 319

Table I6: Cloud genera and associated prospects for precipitation in South Africa 321

Table I7: Characteristics of synoptic rain-producing types for Natal/KwaZulu .. 325

Table I8: Frequency of occurrence (percentage) of synoptic categories and their contributions to integrated annual rainfall over Natal/KwaZulu, 1965 - 1985 326

Table I9: Some consequences of extended wet and dry periods in southern Africa 335

Table I10: Beaufort scale of wind for a standard height of 10 m above flat ground 336

Table I11: Times of sunrise and sunset at selected South African cities 338

9.1 Weather

The term "weather" in observational practice is regarded as covering the qualitative or "eye" observations of the state of the atmosphere, and of associated phenomena. These events include the occurrence of any particular form of precipitation, the presence of obscuring matter giving rise to fog and haze, the appearance of optical phenomena; and the occurrence of tornadoes, funnel clouds, thunderstorms and squalls. Terms used in the description of weather are defined in Table I1.

Table I1: Some weather terms used by the South African Weather Bureau.

Feature	Characteristics
Virga	Fallstreaks observed below a cloud, comprising water or ice particles which fall from the cloud and evaporate before reaching the ground
Drizzle	Precipitation in which drops are very small (less than 0,5 mm in diameter). Due to the small size of the drops they appear to float; and will follow even slight movement of the air. Drizzle drops are too small to cause noticeable ripples on a still water surface. If the drops are of appreciable size (although the rain is limited in amount), the proper description is "slight rain". Drizzle usually falls from a low continuous Stratus-layer. The precipitation from drizzle does not exceed 1 mm h^{-1}
Rain	Precipitation in the form of water drops of appreciable size
Intermittent rain	Used to describe precipitation which has not continued without a break during the preceding hour
Slight or light rain	Describes a rate of fall not exceeding about 2,5 mm h^{-1}. Individual drops are easily identified and no spray forms above hard surfaces; puddles form very slowly; the sound on iron roofs ranges from slow "pattering" to "gentle swishing"
Moderate rain	Describes a rate of fall between 2,5 - 12,5 mm h^{-1}. Individual drops are not clearly identifiable; spray is formed immediately above hard surfaces; puddles form rapidly and the sound on iron roofs ranges from a "swishing" to a "roar"
Heavy rain	Describes a rate of fall in excess of 12,5 mm h^{-1}. Heavy rain seemingly falls in sheets; heavy spray to a height of 25 mm or more is formed over hard surfaces; puddles form very rapidly; the sound on iron roofs resembles a "distant roar"
Showers	Characterized by the suddenness of the onset or termination of precipitation. In general, showers are of short duration and the fair periods between showers are usually associated with a clearance of the sky. If the shower clouds are concealed by a lower layer, only a slight lightening of the sky may be seen. Although precipitation may not cease completely between showers, there is a definite decrease in intensity. Showers fall only from convective clouds

Table I1: Some weather terms used by the South African Weather Bureau (continued).

Feature	Characteristics
Freezing precipitation	Rain or drizzle which falls in liquid form but freezes on the exposed surface of the ground in the form of ice (clear or rime)
Dew (point)	The temperature at which the air would become saturated if cooled at constant pressure, without any addition or removal of water vapour. If the air temperature and dew-point are close together, the air is near saturation, and a small amount of cooling would then be sufficient to cause saturation with possible fog or dew formation
Fog	Consists of a cloud formed on the surface of the earth by the condensation of atmospheric water vapour into a multitude of minute water droplets (or tiny ice crystals), causing obscurity in the surface layers of the atmosphere. Mist is recorded where the visibility is greater than 1 km, whereas visibility is less than 1 km in a fog
Snow	Consists of crystals of white ice, apparently opaque, generally in flakes with a light feathery structure. Sometimes light snowfalls are associated with detached single rods about 2 mm long; when these occur alone they are recorded as "ice needles". Snow grains consist of opaque snow-like grains similar to soft hail but more or less flattened or oblong, and generally less than 1 mm in diameter. The grains do not readily rebound or burst when falling on hard ground
Blowing snow	Snow blown off the ground into the air after it has already fallen. The description, "drifting snow", is generally used when the snow is not raised more than 2 m above the ground
Sleet	Rain and snow falling together or snow melting as it falls
Ice pellets	Either hail or snow. The pellets consist of frozen raindrops or melted snowflakes subsequently refrozen, and are usually of small size
Hail	Ice balls or stones ranging in diameter from a medium-sized raindrop to 25 mm and more. Surface temperatures are usually above freezing when hail occurs
Rime	Caused by the solidification into ice, of supercooled water droplets in a fog, on coming in contact with solid objects at a temperature below freezing point. The deposit is white and feathery and is usually so delicate that it can be dislodged from twigs, etc. by a slight movement
Glaze	Composed of homogeneous, transparent ice layers which are built up on exposed surfaces either by supercooled rain or drizzle, or by rain or drizzle which freezes upon contact with surfaces whose temperature is below freezing point
Hoar-frost	A crystalline icy deposit formed in the same manner as dew, when the temperature is below freezing point
Dust devils	Whirling columns of dust raised a short distance above the earth. Dust devils may rotate in a clockwise or counter-clockwise direction

Table I1: Some weather terms used by the South African Weather Bureau (continued).

Feature	Characteristics
Dust storms	Occur when a very turbulent wind passes over dry sandy or dusty soil. Their arrival is usually marked by the advance of a "wall of dust", sometimes towering upwards for several thousand metres. In a sandstorm, relatively coarse particles of sand are carried aloft by the wind, although rarely to a height exceeding 20 - 30 m
Haze	A state of atmospheric obscurity due to non-aqueous particles in suspension (smoke, volcanic ash, fine dust or sand). Haze is easily distinguished from obscurity - due to water droplets - by the fact that the air is relatively dry. Visibility is reduced but not necessarily by any specific distance
Thunderstorm	A combination of thunder and lightning with or without precipitation. When thunder is heard, the occasion is counted as a thunderstorm even if lightning is not seen
Squall	A strong wind which rises suddenly, lasts for a short while and then dies away abruptly. There is frequently, but not necessarily, a change in wind direction. The essential difference between a squall and a gust is the duration, with the latter lasting a few seconds only
Tornado	A very violent whirl over a small area averaging a few hundred metres in diameter, with very high wind velocities estimated to exceed 300 km h^{-1} in some cases. Associated with this wind is a typical cloud in the form of a funnel. The funnel reaches to, or near, the earth's surface. The marine equivalent of a tornado is a waterspout

<u>Source</u>:

(i) After Anonymous, 1982. Weather codes for land stations (surface observations), Weather Bureau, Department of Transport, Pretoria, 36 p.

(ii) After Hattle, J., 1972. <u>Wayward Winds</u>, Longman Rhodesia, Salisbury, 138 p.

<u>Note</u>: The Division of Building Technology, CSIR, P O Box 395, Pretoria, 0001, in conjunction with ESKOM, has established a data bank on 175 tornadoes in South Africa, which occurred during the period 1905 - 1991. The data bank identifies the frequency of tornadoes and is being used to develop a tornado hazard risk model. A map showing the distribution of tornadic events in South Africa can be found in the following: Goliger, A.M., 1992. Tornado data-bank, <u>Weather Bureau Newsletter</u>, No. 517, April 1992, p. 12. See also, D'Abreton, P., 1991. A synoptic characterization of some South African tornadoes, <u>South African Journal of Science</u>, VOL 87(1/2), p. 56 - 61., as well as Landman, W.A., 1992. Sinoptiese kriteriums vir tornadovoorkoms, <u>Weather Bureau Newsletter</u>, No. 524, November 1992, p. 4 - 9.

9.2 Types of weather stations in South Africa (excluding automatic stations)*

There are four types of weather stations, namely:

(a) First order weather stations, manned by full time personnel of the Weather Bureau (weather offices), or by part time meteorological staff. Climatological observations are made at least three times a day, at 08h00; 14h00 and 20h00 SAST (South African Standard Time). Equipment includes a mercury barometer, a Stevenson screen (containing dry bulb, wet bulb, and maximum and minimum thermometers), and a standard rain gauge. Nearly all first order weather stations are equipped with autographic instruments for recording pressure, temperature, relative humidity, sunshine duration and rainfall, as well as wind direction and speed (at 18 weather offices). Upper air ascents at 02h00 and 14h00 SAST are made at some first order weather stations using radiosondes, with solar radiation equipment found at a few stations. Most stations also measure grass minimum temperatures and evaporation (which ceased in January 1994). First order weather stations include Marion and Gough islands. Some first order weather stations are listed in Table I2.

Table I2: Weather stations manned by Weather Bureau staff in South Africa, 1993.

Province and city/town	Address
Natal/KwaZulu	
Durban	P O Louis Botha Airport, 4029
Transvaal	
Irene	P O Box 169, Irene, 1675
Jan Smuts	Private Bag X1, Jan Smuts Airport, 1627
Pietersburg	P O Box 121, Pietersburg, 0700
Pretoria (head office)	Private Bag X097, Pretoria, 0001
Waterkloof	P O Waterkloof Airforce Base, Lyttelton, 0140

* Discussion based on Anonymous, 1992. Yearly weather report for the year 1991, Weather Bureau, Department of Environment Affairs, Pretoria, 75 p. and map. It should be noted that the Weather Bureau is replacing certain first, second and third order weather stations with automatic weather stations. Automatic stations measure rainfall, temperature, humidity, air pressure, wind speed and direction and in certain cases, radiation. There are currently (June 1993), some 100 automatic weather stations in South Africa.

Table 12: **Weather stations manned by Weather Bureau staff in South Africa, 1993 (continued).**

Province and city/town	Address
Cape	
Cape Town	P O D.F. Malan Airport, 7525
De Aar	P O Box 270, De Aar, 7000
East London	Ben Schoeman Airport, Private Bag X130, East London, 5200
George	P O Box 1207, George, 6530
Kimberley	Private Bag X5052, Kimberley, 8300
Langebaan	P O Langebaan Road, 7375
Port Elizabeth	H.F. Verwoerd Airport, Private Bag X5991, Walmer, 6065
Springbok	P O Box 221, Springbok, 8240
Upington	P O Box 1205, Upington, 8800
Orange Free State	
Bethlehem	Private Bag X15, Bethlehem, 9700
Bloemfontein	J.B.M. Hertzog Airport, Private Bag X20562, Bloemfontein, 9300

<u>Source</u>: (i) After Trinco, O.M. and Valente, A.M., 1992. <u>Direct Access to Key People in Southern Africa 1992</u>, Penrose Publishers, Johannesburg, 312 p.

(ii) Fieldwork.

<u>See also</u>: Anonymous, 1994. Weather observations and communications in the South African Weather Bureau, <u>Caelum</u>, March 1994, p. 1 - 28.

<u>Note</u>: (i) General weather forecasts for Natal/KwaZulu (including sea conditions), can be obtained by phoning the Durban Weather Bureau office: 031-3074121. Aviation forecasts can likewise be obtained by phoning the Durban Weather Bureau office: 031-4081441.

(ii) The names of airports have been changed to reflect their locality. For example, Jan Smuts Airport is now known as Johannesburg International Airport. There are two other such airports, namely: Cape Town International Airport and Durban International Airport. All other airports listed in the table have the same name as the relevant city, for instance, East London Airport.

(b) Second order weather stations, manned by voluntary staff. Climatological observations are made at 08h00 and 14h00 SAST. Besides standard equipment, some second order stations are also equipped with one or more autographic instruments (usually a thermograph, hygrograph, barograph and sunshine recorder, or an autographic rain gauge).

(c) Third order weather stations, manned by voluntary staff. Climatological observations are carried out once a day at 08h00 SAST. Besides the usual equipment, these stations are supplied with one or two autographic instruments (usually only a thermograph). A few stations also have a grass minimum thermometer, as well as dry and wet-bulb psychrometers.

(d) Rainfall stations, manned by voluntary observers. Precipitation only is measured once a day at 08h00 SAST.

9.2.1 Weather station identification numbers*

An identification number consisting of two parts is allocated to every rainfall and climate station, for instance, 145/59. The first part of the number refers to the section in which the station falls. The second part of the number indicates the position of the station within the given section. Each section consists of a ½ degree latitude by a ½ degree longitude, and is further divided into one minute intervals of latitude and longitude. The 900 resulting intersections of the grid determine the position of stations within a particular section, where the intersections are numbered from top to bottom and in progressive longitudinal order. The intersections are approximately 1,6 km apart. Provision is therefore made for one station identification number every 2,6 km^2. Where more than one station falls in this area, use is made of A, B, C etc. to differentiate the stations, for example, 145/59; 145/59A; 145/59B and 145/59C. Such a procedure is also employed where a station is moved to a new location (provided that the number remains unchanged).

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* Useful background information can be found in the following: Anonymous, 1987. 1987 station register weather observational network, Weather Bureau, Department of Environment Affairs, Pretoria, 164 p.

To determine the stations available for any part of the country, the key map of stations should be examined. The following numbers cover Natal/KwaZulu in part or in full.

						447	448
	406	407	408	409	410	411	412
	370	371	372	373	374	375	376
333	334	335	336	337	338	339	340
299	300	301	302	303	304	305	
267	268	269	270	271	272		
237	238	239	240	241			
208	209	210	211				
	181	182	183				

The map is available from the Weather Bureau and is also found, for instance, in the following publication: Anonymous, 1992. Yearly weather report for the year 1991, Weather Bureau, Department of Environment Affairs, Pretoria, 75 p. and map*. Readers should note that summarized annual statistics are available for the years 1926 onwards (in the form of yearly weather reports). The 1991 report accordingly, provides both monthly and annual statistics for maximum and minimum temperatures and for rainfall, but only annual totals or means for other climatological parameters.

<u>**The following should be examined for details on the use of instrumentation and the recording of data, as per the Weather Bureau:**</u>

- Anonymous, undated. Technical manual: Climate Branch, Weather Bureau, Department of Transport, Pretoria, 15 p.

- Anonymous, 1990. Technical manual: Chapter KLIM 2, Weather Bureau, Department of Environment Affairs, Pretoria, 69 p. (The technical manuals originally published in the 1970s and 1980s are now being updated with Chapter KLIM 10 being the last in the series).

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* The Computing Centre for Water Research, University of Natal, Pietermaritzburg (see later in the chapter) has digitised the relevant map and the data may be obtained by contacting the Centre.

- Anonymous, 1991. Meteorological observations and instruments, Weather Bureau, Department of Environment Affairs, Pretoria, 16 p.

9.3 Primary climatological data sources

The major climatological (mainly rainfall) database in South Africa is maintained by the Weather Bureau (Department of Environment Affairs), Private Bag X097, Pretoria, 0001. Some of the data available from the Weather Bureau are outlined in Table I3. It should be noted that offices of the Department of Water Affairs and Forestry, Private Bag X313, Pretoria, 0001 (Water Branch as well as Forestry Branch) maintain their own separate rainfall stations. In the former case, these gauges are found at streamflow and dam gauging (evaporation) stations. The data are available in the Hydrological Information System (HIS) database of the Department of Water Affairs and Forestry. A publication listing the various stations is available*. The Department of Water Affairs and Forestry uses the Weather Bureau rainfall database for in-house hydrological modelling purposes, where considerable work has been undertaken involving the estimation of missing daily (and monthly) rainfall data for over 2 550 stations in southern Africa. There are some 8 600 daily rainfall stations for South Africa and Namibia (both open and closed), spanning a period of 160 years**.

Table I3: Some climatological data available from the Weather Bureau.

Parameter	Data
Air temperature	Monthly minimum and maximum; absolute monthly minimum and maximum; lowest monthly maximum and highest monthly minimum; mean monthly minimum and maximum; mean monthly temperature
Grass minimum temperature	Absolute minimum with dates; mean minimum temperature

* See Anonymous, 1990. List of hydrological gauging stations July 1990, VOL 2, Part 1: gauging stations in stored/standing water, 177 p., and Part 2: meteorological stations, 153 p., Hydrological Information Publication No. 15, Directorate of Hydrology, Department of Water Affairs, Pretoria.

** See Adamson, P.T., 1987. The South African rainfall database: a user guide with special reference to estimating missing daily data, Technical Report No. TR 133, Department of Water Affairs, Pretoria, 191 p. See also, De Villiers, G. du T., 1980. A short note on errors in rainfall measurement, Water SA, VOL 6(3), p. 144 - 148.

Table 13: Some climatological data available from the Weather Bureau (continued).

Parameter	Data
First and last dates of frost (light or ground frost: 2,5 to 0°C; moderate frost: 0 to -2,5°C; heavy frost: <-2,5°C)	First and last dates with minimum < +2,5°C; first and last dates with minimum <0°C; first and last dates with minimum <-2,5°C
Number of days with thunder, hail, snow and fog	Arithmetic data
Humidity	Mean monthly and annual dry and wet bulb temperatures and relative humidity percentages at 08h00; 14h00 and 20h00 SAST
Cloudiness	Octas at 08h00; 14h00 and 20h00 SAST; mean hours of daily cloud per month
Sunshine	Number of days with 0%; 1 - 10%; 11 - 49%; 50 - 89%; 90 - 100% sunshine; percentage of possible hours on a daily and monthly basis
Evaporation/wind (Class A pan)	Mean mm per day 08h00 - 08h00 SAST/wind speed in m s^{-1} for the period 08h00 - 20h00 SAST and 20h00 - 08h00 SAST
Wind direction and speed	Percentage frequency of wind direction (N; NNE; NE; ENE; E; ESE; SE; SSE; S; SSW; SW; WSW; W; WNW; NW; NNW at 08h00, 14h00 and 20h00 SAST; mean wind speed in m s^{-1} according to the above directions at 08h00; 14h00 and 20h00 SAST; maximum wind speed and direction - all on a daily and monthly basis
Percentage frequency of wind speed (Beaufort scale used for speed intervals)	Wind speed estimated according to Beaufort numbers 0 - 9, at 08h00; 14h00 and 20h00 SAST; mean wind speed at 08h00; 14h00 and 20h00 SAST
Rainfall	Daily, monthly, annual and seasonal totals; daily, monthly, annual and seasonal means

Source: After the Weather Bureau, Department of Environment Affairs, Pretoria, 1993.

9.3.1 Some Weather Bureau data publications of relevance

- Anonymous, 1949. District rainfall for the Union of South Africa, Report No. WB 6, Weather Bureau, Department of Transport, Pretoria, 51 p. + app.

- Anonymous, 1949. Surface winds of South Africa, Report No. WB 8, Weather Bureau, Department of Transport, Pretoria, 96 p.

- Anonymous, 1950. Sunshine and cloudiness in South Africa, Report No. WB 14, Weather Bureau, Department of Transport, Pretoria, 42 p.

- Anonymous, 1954. Climate of South Africa Part 1: climate statistics, Report No. WB 19, Weather Bureau, Department of Transport, Pretoria, 160 p.

- Anonymous, [1955]. Climate of South Africa Part 2: rainfall statistics, Report No. WB 20, Weather Bureau, Department of Transport, Pretoria, 189 p.

- Anonymous, 1956. Climate of South Africa Part 3: maximum 24-hour rainfall, Report No. WB 21, Weather Bureau, Department of Transport, Pretoria, 28 p.

- Anonymous, 1957. Climate of South Africa Part 4: rainfall maps, Report No. WB 22, Weather Bureau, Department of Transport, Pretoria, 20 p. + app. and maps.

- Anonymous, 1960. Climate of South Africa Part 5: district rainfall, Report No. WB 23, Weather Bureau, Department of Transport, Pretoria, 51 p.

- Anonymous, 1960. Climate of South Africa Part 6: surface winds, Report No. WB 26, Weather Bureau, Department of Transport, Pretoria, 202 p.

- Anonymous, 1965. Climate of South Africa Part 9: average monthly and annual rainfall and number of rain days up to the end of 1960, Report No. WB 29, Weather Bureau, Department of Transport, Pretoria, 360 p.

- Anonymous, 1968. Solar radiation and sunshine, Report No. WB 32, Weather Bureau, Department of Transport, Pretoria, 71 p.

- Anonymous, 1972. Climate of South Africa Part 10: district rainfall for South Africa and the annual march of rainfall over southern Africa, Report No. WB 35, Weather Bureau, Department of Transport, Pretoria, 116 p. (See also in this publication: Supplementary to Appendix B: monthly and annual district rainfall in millimetres, 1971 to 1975, no pagination. It should be noted that Part 10 was written by M.P. Van Rooy, although this is not indicated on the cover or title page).

- Anonymous, 1975. Climate of South Africa Part 12: surface winds, Report No. WB 38, Weather Bureau, Department of Transport, Pretoria, 79 p.

- Anonymous, 1977. Climate of South Africa Part 11: extreme values of rainfall, temperature and wind for selected return periods, Report No. WB 36, Weather Bureau, Department of Transport, Pretoria, 29 p. (See also: Errata, 2 p.).

- Anonymous, 1979. Climate of South Africa Part 13: upper-air statistics: wind, temperature, geopotential and humidity, Report No. WB 39, Weather Bureau, Department of Transport, Pretoria, 99 p. (Written by E.E. Katsiambirtas, although this is not indicated on the cover or title page).

- Anonymous, 1986. Climate of South Africa: climate statistics up to 1984, Report No. WB 40, Weather Bureau, Department of Environment Affairs, Pretoria, 475 p.

- Anonymous, 1990. Climate of South Africa Part 14: upper-air statistics 1968 - 1987, Report No. WB 41, Weather Bureau, Department of Environment Affairs, Pretoria, 136 p.

- Hayward, L.Q. and Steyn, E.E., 1967. Aeronautical climatological summaries: descriptive memoranda for the airports: Johannesburg/Jan Smuts, Cape Town/D.F. Malan, Durban/Louis Botha, Bloemfontein/J.B.M. Hertzog and Port Elizabeth/H.F. Verwoerd, Report No. WB 31, Weather Bureau, Department of Transport, Pretoria, 73 p.

- Longley, R.W., 1976. Weather and weather maps of South Africa, Technical Paper No. 3, Weather Bureau, Department of Transport, Pretoria, 76 p.

- Schulze, B.R., 1984. Climate of South Africa Part 8: general survey, Report No. WB 28, Weather Bureau, Department of Transport, Pretoria, 331 p.

Note: The publication by Schulze (1984) is a most useful, although dated reference work on South African climatological phenomena and contains detailed statistics with relevant text. In this regard, see also Anonymous (1986).

9.3.2 Some (regularly) published climatological data available from the Weather Bureau

(a) Less formal publications

- Daily weather bulletin (1950...)

  Example:

  Anonymous, 1992. Daily weather bulletin for the month June 1992, Weather Bureau, Department of Environment Affairs, Pretoria, no pagination.

- Monthly weather report (1950 - April 1990)

  Example:

  Anonymous, 1990. Monthly weather report for the month April 1990, Weather Bureau, Department of Environment Affairs, Pretoria, 92 p.

- The Monthly weather report was replaced by the Climate summary for southern Africa series (May 1990, VOL 1(1)...)

  Example:

  Anonymous, 1992. Climate summary for southern Africa: May 1992 (preliminary data), VOL 3(5), Climate Information Service of South Africa, Weather Bureau, Department of Environment Affairs, Pretoria, no pagination.

- Ten day rainfall report (?June 1961...)

  Example:

  Anonymous, 1992. Rainfall totals for the 10 days ended at 08:00 on 1 May 1992, Weather Bureau, Department of Environment Affairs, Pretoria, 3 p.

Note: Data on solar radiation (up to 1976)* as well as upper-air (radiosonde) data (up to 1975) were originally published in book form. The data are now available from the Climate Data Bank of the Weather Bureau.

(b) More formal publications

- RGSCS Bulletin (August 1993, VOL 1(1)...)
  The Bulletin (issued monthly) is produced by the Research Group for Statistical Climate Studies (RGSCS), which is associated with the Weather Bureau. The publication provides a summary of the climate "history" for a given month or season - together with mean rainfall and temperature forecasts for various months - which are based on dynamical/statistical procedures and models. Sea-surface temperature predictions are also given. The publication is of value inter alia for drought studies and for economic/social risk assessments**.

- Weather Bureau Newsletter (?1949, No. 1...)
  Some climatological data plus a discussion of the weather for the month in question, as well as data on the state of major dams in South Africa can be found in the Newsletter, which is published monthly by the Weather Bureau.

9.3.3 Department of Water Affairs and Forestry data publications of relevance

- Anonymous, 1985. Evaporation and precipitation records: monthly data up to September 1980, Hydrological Information Publication No. 13, Directorate of Hydrology, Department of Water Affairs, Pretoria, 580 p.

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* See for example: Anonymous, 1955. Quarterly radiation bulletin: World Meteorological Organization Regional Association 1, Working Group on Radiation, VOL 1(1), Weather Bureau, Department of Transport, Pretoria, 32 p. (The last bulletin of this series was VOL 10, published in 1963). See also, Anonymous, 1977. Annual radiation report: data for 1976, Weather Bureau, Department of Transport, Pretoria, 65 p.

** The RGSCS, which is now known as the Research Group for Seasonal Climate Studies, is a member of the South African Long-lead Forecast Forum (SALFF). Background information on the research programme can be found in: Van Heerden, J., Rautenbach, C.J. de W. and Truter, M.M., 1995. Tegnieke vir seisoenale en langtermyn-reënval voorspelling in Suid-Afrika, WRC Report No. 306/1/95, Water Research Commission, Pretoria, 51 p. + app.

- Kriel, J.P., 1968. Monthly rainfall and evaporation records of evaporation stations up to September 1967 [data for the year 1967 - 1968 have been added], Hydrographic Survey Publication No. 9, Division of Hydrology, Department of Water Affairs, Pretoria, 255 p.

The following publications dealing with various aspects of weather in South Africa should also be consulted for climatological information:

- Anonymous, 1944. Weather on the Coasts of Southern Africa: from River Congo to Cape Delgado, VOL 2. Local information, Part 1. Introduction, 61 p., Part 2. Union of South Africa from Olifants River to Mossel Bay, 83 p., Part 3. Union of South Africa from Mossel Bay to East London, 55 p., Part 4. Union of South Africa from East London to Kosi Bay, 52 p., Part 5. Portuguese East Africa (Mocambique) and Mocambique Channel, 63 p., Part 5a. Madagascar, 58 p., and Supplement, Meteorological Services of the Royal Navy and the South African Air Force, Cape Town.

- Anonymous, 1975. South African Sailing Directions, VOL 1. General Information, The Hydrographer, South African Navy, Cape Town, 95 p. (The publication, which is being updated, contains useful information on South African coastal climatology).

- Anonymous, [1985]. Condensed synoptic climatology of South Africa, Weather Bureau, Department of Transport, Pretoria, 19 p.

- Preston-Whyte, R.A. and Tyson, P.D., 1988. The Atmosphere and Weather of Southern Africa, Oxford University Press, Cape Town, 374 p.

- Schulze, B.R., 1971. Part 1. General. Chapter 1. The climate of Marion Island, In: Van Zinderen Bakker, E.M., Winterbottom, J.M. and Dyer, R.A. (eds), Marion and Prince Edward Islands: Report on the South African Biological and Geological Expedition/1965 - 1966, A.A. Balkema, Cape Town, p. 16 - 31.

- Schulze, B.R., 1972. Chapter 15. South Africa, In: Griffiths, J.F. (ed), World Survey of Climatology, VOL 10: Climates of Africa, Elsevier, Amsterdam,

p. 501 - 586. (The chapter contains climatological data for South Africa, Botswana, Lesotho, Namibia and Swaziland).

- Schulze, R.E. and McGee, O.S., 1978. Climatic indices and classifications in relation to the biogeography of southern Africa, In: Werger, M.J.A. and Van Bruggen, A.C. (eds), Biogeography and Ecology of Southern Africa, Monographiae Biologicae VOL 31, W. Junk, The Hague, p. 19 - 52.

- Tyson, P.D., 1986. Climatic Change and Variability in Southern Africa, Oxford University Press, Cape Town, 220 p.

- Van Heerden, J. and Hurry, L., 1987. Southern Africa's Weather Patterns: an Introductory Guide, second edition, Acacia Books, Pretoria, 95 p. (A further edition is in preparation).

9.3.4 Other sources of climatological data

Further sources of data include the South African Sugar Association Experiment Station, Private Bag X02, Mount Edgecombe, 4300; the Natal Parks Board, P O Box 662, Pietermaritzburg, 3200; the (CSIR) Cathedral Peak Forestry Research Station, Private Bag X1, Winterton, 3340; the Department of Hydrology, University of Zululand, Private Bag X1001, KwaDlangezwa, 3886; the Department of Agricultural Engineering, University of Natal, Private Bag X01, Scottsville, 3209, and the Computing Centre for Water Research, also at the University of Natal, Pietermaritzburg (see Table 14). Some of these sources supply data to the Weather Bureau, while in other cases, data are only available from the organization concerned. Non-scientific agencies (such as municipalities) as well as private individuals also record relevant information.

Table I4: Climatological and other data available from the Computing Centre for Water Research, University of Natal, Pietermaritzburg.

Parameter	Data
Temperature	Daily maximum and minimum temperature; monthly mean, maximum and minimum temperature
Evaporation (Class A pan and converted Symons pan data)	Daily evaporation data; monthly mean evaporation
Rainfall	Digitised autographic rainfall data; daily rainfall; monthly rainfall and statistics; annual rainfall and statistics; rainfall station information; 1' x 1' grid of estimated mean annual precipitation (MAP) and median monthly and annual rainfall covering southern Africa
Daily rainfall model parameters	Parameters for the Zucchini and Adamson model for generating daily rainfall at 2 550 stations in southern Africa
Weather Bureau blocks	Co-ordinates of SW and NE corners of all Weather Bureau blocks; number of stations per Weather Bureau block which have at least 15 years of good data
Homogeneous climate zones	Digitised boundary points of 712 homogeneous climate zones; details of "representative" rainfall and temperature stations for the 712 zones and monthly mean, maximum and minimum temperature for each station
Altitude (An important physiographic factor affecting rainfall, temperature and evaporation)	1' x 1' altitude (grid point estimates off 1 : 50 000 maps) covering southern Africa; 5' x 5' altitude summary (ie means) of the above primary data; 5' x 5' altitude of Africa south of the Equator; 30' x 30' altitude of the world; 1° x 1° altitude of the world
Distance from the sea (Continentality - a factor affecting rainfall, temperature and evaporation)	1' x 1' estimates of continentality (up to 300 km inland)
RSA outline	Latitude and longitude of the outline of South Africa
Irrigation requirements (712 climate zones)	Estimates of irrigation requirements for any location, crop, soil and planting date combination
Index of soil moisture stress days (712 climate zones)	Estimates of the number of soil moisture stress days for a range of crops, soils and planting dates
Actual evapotranspiration deficit (712 climate zones)	Estimates of the difference between potential and actual evapotranspiration for a range of crops, soils and planting dates

Source: After the Computing Centre for Water Research, University of Natal, Pietermaritzburg, 1993.

Note:

(i) Various computer programs are available at the Centre, to derive the necessary data. Programs are also available for certain hydrological models including the ACRU agrohydrological modelling system.

(ii) The Zucchini and Adamson model is briefly discussed later in the chapter.

For further information consult the following:

- Brown, E. and Wescombe, R.E., 1988. National register for weather, climate and atmosphere numeric data sources, Centre for Information Services, CSIR, Pretoria, 226 p. (Second edition revised and computerized).

- Brunt, A.G., Chalmers, L. and Hetem, J.E., 1985. National register for weather, climate and atmosphere numeric data sources, Report No. CSTI 88, National Programme for Weather, Climate and Atmosphere Research, Foundation for Research Development, CSIR, Pretoria, 210 p.

- James, A.G. and Fuller, H.L.M., 1987. Register of southern African hydrological data sources, South African Water Information Centre, CSIR, Pretoria, 287 p.

9.3.5 Climatological data available from the Department of Agriculture, Cedara

Approximately 125 stations in Natal/KwaZulu currently supply Cedara with climatological information such as rainfall, air temperature, humidity and evaporation, as well as wind and sunshine data. The network consists mainly of farms and a few agricultural/forestry estates, agricultural research stations, prisons and forestry research stations. The data are available on computer from the Institute for Soil, Climate and Water, c/o the Department of Agriculture, Private Bag X9059, Pietermaritzburg, 3200. Regular reports containing both short and long term data were compiled up until 1991 inclusive. The reports were produced by the Cedara and subsequently by the Pretoria office of the Institute.

Examples:

- Koch, F.G., 1991. Meteorological report Natal Region: season 1989/90, SIRI Report No. GB/A/91/38, Soil and Irrigation Research Institute, Department of Agricultural Development, Pretoria, 66 p.

- Koch, F.G., 1991. Long term meteorological data for the Natal Region, SIRI Report No. GB/A/91/33, Soil and Irrigation Research Institute, Department of Agricultural Development, Pretoria, 191 p.

Maps of various climatic parameters for given areas are also available from the Institute for Soil, Climate and Water, Private Bag X79, Pretoria, 0001. The maps (at several scales) are generated in terms of a Geographic Information System (GIS), which is linked to the National AgroMet (climate) Data Bank maintained by the Institute. (See also the discussion of Land Type maps in the chapter on soils and soil erosion).

9.4 Rainfall maps

Rainfall data may be derived using isohyetal maps of mean annual rainfall, produced as overlays to the 1 : 250 000 scale Gauss Conformal Projection topographic or topo-cadastral maps supplied by the Department of Regional and Land Affairs. The isohyetal overlays can be obtained from the Water Research Commission, P O Box 824, Pretoria, 0001. Topographic or topo-cadastral maps can be purchased in Natal/KwaZulu from the Department of Regional and Land Affairs, P O Box 396, Pietermaritzburg, 3200, or from the Government Printer, Private Bag X85, Pretoria, 0001. The following isohyetal overlays (which correspond exactly to the same topographic or topo-cadastral maps) cover the whole of Natal/KwaZulu, including that part of KwaZulu situated in the Transvaal. Note that both sets of maps have corresponding titles. For example, the rainfall isohyetal overlay map 2930 Durban fits the 1 : 250 000 scale topographic or topo-cadastral 2930 Durban map. The digital images of all the isohyetal maps have been retained on magnetic tape and are available on request. Users should contact the Computing Centre for Water Research.

North			
2728	Frankfort 2730 Vryheid	2632	Mkuze
2828	Harrismith	2830A; 2830B	Richards Bay
2928	Drakensberg	2930	Durban
3028	Kokstad	3030	Port Shepstone
South			

See also:

(i) Anonymous, 1989. SA rainfall statistics mapped, SA Waterbulletin, VOL 15(3), p. 6 - 11.

(ii) Dent, M.C., Lynch, S.D. and Schulze, R.E., 1989. Mapping mean annual and other rainfall statistics over southern Africa, WRC Report No. 109/1/89, Water Research Commission, Pretoria, various pages and map.

As part of the project, South Africa was divided into 712 homogeneous rainfall zones inter alia on the basis of mean annual precipitation, altitude and aspect. For further information see: Dent, M.C., Lynch, S.D. and Tarboton, H., 1990. Detailed delimitation of rainfall regions in southern Africa, Water SA, VOL 16(1), p. 1 - 4. In an earlier study, Schulze (1982) - see below - divided Natal/KwaZulu into 21 rainfall regions, with rainfall data for the early/late summer and winter periods. Previous classifications of rainfall regions in South Africa include Schumann and Hofmeyr (1938), and Anonymous (1972)*. Detailed rainfall maps plus other data (including temperature and potential evapotranspiration) can be found in Schulze, R.E., 1982. Agrohydrology and climatology of Natal, ACRU Report No. 14, Agricultural Catchments Research Unit, Department of Agricultural Engineering, University of Natal, Pietermaritzburg, 136 p. Out of date rainfall maps are presented in Anonymous, 1957. Climate of South Africa Part 4: rainfall maps, Report No. WB 22, Weather Bureau, Department of Transport, Pretoria, 20 p. + app. and maps.

A more recent although still outdated source was the 1 : 250 000 scale South African rainfall maps series compiled in 1965 by the then Hydrological Research Division of the Department of Water Affairs, using data obtained from the Weather Bureau. Readers

* See Schumann, T.E.W. and Hofmeyr, W.L., 1938. The partition of a region into rainfall districts with special reference to South Africa, Quarterly Journal of the Royal Meteorological Society, VOL 64, p. 482 - 488., and Anonymous, 1972. Climate of South Africa Part 10: district rainfall for South Africa and the annual march of rainfall over southern Africa, Report No. WB 35, Weather Bureau, Department of Transport, Pretoria, 116 p. See also, Landman, W.A. and Klopper, E., 1994. Homogenization of the rainfall districts of South Africa, RGSCS Bulletin, VOL 2(2), p. 27.

should also carefully examine the relevant Hydrological Research Unit, University of the Witwatersrand publications inter alia for rainfall and evaporation data as well as maps*.

Zucchini and Adamson (1984)** developed an important daily rainfall model for South Africa. The model can be used to quantify daily, monthly and annual rainfall statistics. The seasonality of rainfall, the risk of storms, and the probabilities of droughts of various intensities and durations can also be assessed. The model can likewise be used to estimate the probability of a given rainfall event, or sequences of events for a period of one day or longer. The model was calibrated for approximately 2 550 stations in southern Africa, where at least 30 years of daily rainfall data were available (up to 1981).

McNeill, Brandao, Zucchini and Joubert (1994)*** re-examined the model. The purpose was to overcome difficulties inherent in applying the model in specific areas where the nearest calibrated site was some distance away. The daily rainfall process was itself modelled, to estimate the most important properties of daily rainfall (in terms of 16 model parameters). The revised model was calibrated for 5 070 stations with at least 20 - 30 years of daily rainfall data (up to 1992). In very low data-density areas, rain stations with at least five years of daily rainfall information were included. Such data were weighted to reflect the limited rainfall information. Accordingly, the model can be used to generate artificial rainfall sequences and to study rainfall characteristics at any given locality or area in southern Africa. Estimates of the 16 parameters are available for approximately 500 000 grid points covering southern Africa on a 1° x 1° grid (with a resolution of some

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* See Middleton, B.J., Lorentz, S.A., Pitman, W.V. and Midgley, D.C., 1981. Surface water resources of South Africa, VOL V: drainage regions MNPQRST. The eastern Cape Part 1 (Text), various pages, and Part 2 (Appendices), various pages, HRU Report No. 12/81, Hydrological Research Unit, University of the Witwatersrand, Johannesburg, as well as Pitman, W.V., Middleton, B.J. and Midgley, D.C., 1981. Surface water resources of South Africa, VOL VI: drainage regions UVWX. The eastern escarpment Part 1 (Text), various pages, and Part 2 (Appendices), various pages, HRU Report No. 9/81, Hydrological Research Unit, University of the Witwatersrand, Johannesburg. (Note that these reports have been updated. See Section 10.11 in the chapter on the surface water resources of Natal/KwaZulu).

** See Zucchini, W. and Adamson, P.T., 1984. The occurrence and severity of droughts in South Africa, WRC Report No. 91/1/84, 198 p. + app. and maps, and Appendix 6, WRC Report No. 91/1/84(A), various pages, Water Research Commission, Pretoria.

*** See McNeill, L., Brandao, A., Zucchini, W. and Joubert, A., 1994. Interpolation of the daily rainfall model: executive summary, WRC Report No. 305/1/94, Water Research Commission, Pretoria, 19 p. and floppy diskette. See also, Zucchini, W., Adamson, P. and McNeill, L., 1992. A model of southern African rainfall, South African Journal of Science, VOL 88(2), p. 103 - 109., as well as Lynch, S.D. and Dent, M.C., 1990. Appropriate record lengths for the estimation of mean annual and mean monthly precipitation in southern Africa, Water SA, VOL 16(2), p. 93 - 98.

1,5 km). The data file of estimated parameter values can be obtained from the Computing Centre for Water Research.

9.5 Record lengths for rainfall and evaporation in South Africa

9.5.1 Rainfall

Data for the various provinces are presented in Table 15. The rain gauge network generally, is inadequate in many parts of southern Africa (South Africa, plus Lesotho and Swaziland). The distribution of stations is especially sparse in the western, north western and central Cape, the north eastern Transvaal and in large areas of the homelands, as well as in the national states (for instance, Transkei). Stations are largely clustered around zones of formal human habitation - a pattern which has important implications in mountainous regions such as Lesotho - where there is a bias towards the lower altitudes of the vital catchment areas.

Table 15: Number of stations with various lengths (years) of rainfall records in South Africa, 1984.

Province	Length of record (years)			
	>100	75 - 100	50 - 74	<50
Natal/KwaZulu	1	4	92	926
Transvaal	0	1	207	2 493
Cape	5	88	407	3 500 +
Orange Free State	0	0	155	1 355
Total	6	93	861	8 274 +

Source: After Schulze, R.E. and Scott, D.F., 1988. Chapter 5. River flows and estuaries. Surface water hydrology, In: Macdonald, I.A.W. and Crawford, R.J.M. (eds), Long-term Data Series Relating to Southern Africa's Renewable Natural Resources, South African National Scientific Programmes Report No. 157, Foundation for Research Development, CSIR, Pretoria, p. 183 - 200.

Note: Years with incomplete records have been omitted.

9.5.2 Evaporation

Midgley, Pitman and Middleton (1983)* provided statistics on the availability of long term data-sets for pan evaporation in South Africa for the period up to 1980. Midgley et al found that nine stations in South Africa had a record length of 50 - 74 years; 61 stations had a record length of 25 - 49 years, and more than 300 stations had a record length of less than 25 years. The pan evaporation network is least adequate where evaporation is likely to be highest, namely, in the arid and semi-arid areas of South Africa. There are currently 57 operating evaporation stations in Natal/KwaZulu. Schulze and Maharaj (1991)** examined A-pan evaporation across South Africa. They defined 12 regions of relatively uniform evaporation response in which inter alia, regional wind and vapour pressure deficit characteristics were assumed to be relatively uniform. Nearly all of Natal/KwaZulu is in evaporation regions 2 and 3.

9.6 Cloud types and precipitation

The prospects for precipitation from various types of clouds are outlined in Table 16.

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* See Midgley, D.C., Pitman, W.V. and Middleton, B.J., 1983. An addendum to "Surface Water Resources of South Africa" (1981), Water Research Commission, Pretoria, various pages. (The publication contains a map showing mean annual evaporation - Symons pan - for South Africa. Detailed monthly tabulated data are also presented).

** See Schulze, R.E. and Maharaj, M., 1991. Mapping A-pan equivalent potential evaporation over southern Africa, Proceedings of the Fifth South African National Hydrological Symposium, South African National Committee for the International Association of Hydrological Sciences and the Division of Water Engineering of the South African Institution of Civil Engineers, 7 - 8 November 1991, Stellenbosch, 8 p.

Table 16: Cloud genera and associated prospects for precipitation in South Africa.

Weather Bureau classification	Identification	Precipitation prospects
C_H (high altitude >6 000 m clouds of the following genera)		
Cirrus (Ci)	Detached white clouds (composed of ice crystals), with a fibrous (hair-like) appearance and with tufts or hooks at the ends. Patchy, even if plentiful. Formed by high level ascent, with their shape due to wind shear	Very limited possibility
Cirrocumulus (Cc)	Consists of thin and very small white cloud patches, ripples or waves with a delicate appearance. Very uncommon cloud associated with Cirrus and Cirrostratus at the same level. If the association is not evident, the cloud is probably Altocumulus. Cirrocumulus is made up of ice crystals and is formed by convection, developing from Cirrus or Cirrostratus	Very limited possibility
Cirrostratus (Cs)	Transparent, thin white cloud veil of fibrous or smooth appearance. Almost continuous layer, frequently shows halo phenomena, partially obscuring the sun. The cloud is sometimes diffuse, giving the sky a "milky" appearance. Cirrostratus is composed of ice crystals and is formed by widespread high level ascent	Very limited possibility
C_M (mid-altitude 2 000-6 000 m clouds of the following genera)		
Altocumulus (Ac)	White (sometimes grey), cloud patches composed of flattened globules which may be arranged in groups, rows or waves. Altocumulus may be lens shaped near mountains or islands. Many borderline cases between Altocumulus and high Stratocumulus. The cloud is Altocumulus if the small well-defined and regularly arranged elements have (when observed at a height >30° above the horizon), an apparent width of <5° or the apparent width of three fingers at arm's length. Altocumulus consists of ice crystals, snow flakes or water droplets and is formed by convection, or due to standing waves near mountains and islands	Very limited possibility (most forms of Altocumulus). Virga may be evident on occasion

Table 16: Cloud genera and associated prospects for precipitation in South Africa (continued).

Weather Bureau classification	Identification	Precipitation prospects
Altostratus (As)	Greyish or bluish cloud sheets of striated or uniform appearance, generally partially or totally covering the sky. A low and thick sheet of Altostratus can be differentiated from a similar layer of Nimbostratus where the Nimbostratus is of a darker grey with a more uniform under-surface than Altostratus. The position of the sun or the moon can usually be seen behind the thinnest part of Altostratus - whereas the sun or moon cannot be seen through Nimbostratus. Altostratus may extend for several hundred kilometres, with considerable vertical height. Altostratus consists of water droplets and/or ice crystals and is formed by widespread ascent	Some possibility of intermittent light rain from thin Altostratus; high possibility of continuous rain or snow from thick Altostratus
Nimbostratus (Ns)	Amorphous dark grey cloud mass with a low ragged base, usually covering the sky. The cloud is thick enough to hide the sun or the moon. Nimbostratus consists of water droplets with ice crystals in the upper levels of the cloud. The cloud is formed by widespread ascent or due to the thickening and descent of Altostratus. Nimbostratus can be differentiated from thick Stratus since Nimbostratus produces precipitation. Although precipitation can fall from Stratus, it is in the form of drizzle or snow-grains. Clouds with the appearance of Nimbostratus should be regarded as Cumulonimbus if precipitation is in the form of heavy showers, or is accompanied by lightning, thunder, hail or a squall	High possibility of continuous rain or snow
C_L (low-level <2 000 m clouds of the following genera)		
Stratocumulus (Sc)	Grey or white cloud globules or ridges with dark parts which may or may not be merged. Stratocumulus consists of water droplets and is formed by the lateral spread of Cumulus (often in the evenings), or due to turbulent mixing below a stable air layer. The difference between Stratocumulus and Stratus is that the former has a regularly divided, strongly waved and non-fibrous structure, whereas Stratus has no apparent relief. Due to the effects of perspective, a large number of Cumulus clouds should not be confused with a layer of Stratocumulus	Some possibility of light rain or drizzle

Table 16: Cloud genera and associated prospects for precipitation in South Africa (continued).

Weather Bureau classification	Identification	Precipitation prospects
Stratus (St)	Generally grey clouds, amorphous and uniform in shape with a fairly uniform base. Stratus resembles fog and may cover the summits of higher lying ground. Stratus can also appear as tufts below Altostratus and Nimbostratus. Stratus is often thin and the outline of the sun and the moon is accordingly visible. The cloud consists of water droplets and is formed by low level ascent and cooling, due to precipitation which has saturated the air, or fog/mist which has lifted	Some possibility of drizzle or snow-grains
Cumulus (Cu)	Dense, detached clouds with sharp outlines which develop vertically in the form of towers or domes. The sunlight portion of the cloud is brilliant white, while the base is often grey. Cumulus consists of water droplets and is formed as a result of convection, due to surface heating and instability	Very limited possibility in Cumulus with little vertical extent; high possibility of light showers or snow from large Cumulus
Cumulonimbus (Cb)	Usually results from the evolution of Cumulus. The cloud should be regarded as Cumulus as long as the hard "cauliflower" outlines are maintained and no fibrous structure is evident. The cloud is Cumulonimbus if it is dense in the form of a huge mountain with towers. The upper part of the cloud spreads out ahead of the cloud mass in the shape of an anvil or large plume which can extend up to 13 000 m or more. Cumulonimbus is associated with lightning, thunder, a squall or hail. The base of Cumulonimbus is usually dark. The cloud consists of water droplets, supercooled water droplets and ice crystals	High possibility of precipitation as heavy rain showers or hail

<u>Source</u>:

(i) After Anonymous, 1982. Weather codes for land stations (surface observations), Weather Bureau, Department of Transport, Pretoria, 36 p.

(ii) After Preston-Whyte, R.A. and Tyson, P.D., 1988. <u>The Atmosphere and Weather of Southern Africa</u>, Oxford University Press, Cape Town, 374 p.

<u>Note</u>:

(i) Both Cumulus and Cumulonimbus clouds (especially the latter), can have considerable vertical development albeit with a low cloud base.

(ii) The amount of cloud in the sky is estimated as: completely cloudless sky ($\frac{0}{8}$); cloud cover in eighths ($\frac{1}{8}$ - $\frac{7}{8}$) or completely overcast ($\frac{8}{8}$).

(iii) More detailed descriptions of the types of clouds (with photographs or drawings) can be found in most standard textbooks on meteorology/climatology.

9.7 Mean annual precipitation over Natal/KwaZulu*

The highest mean annual precipitation (MAP) of 1 400 - 2 000 mm is found in the High Drakensberg and the Little Berg (physiographic regions 1 and 2); various high altitude plateaux and massifs (1 200 - 1 400 mm), as well as in the environs of Richards Bay (1 200 - 1 400 mm). The lowest MAP in Natal/KwaZulu is found in the north east on both sides of the Lebombo Mountains (physiographic regions 37 and 42); parts of the Basin Plainlands of northern Natal, and in some of the deeply incised river valleys. Most of Natal/KwaZulu experiences a precipitation maximum in January. Parts of the North Coast reach a maximum in February up to the beginning of March, while a small area west of Dundee has maximum rainfall in late December. A brief overview of synoptic conditions resulting in rain over Natal/KwaZulu is provided in Tables 17 and 18. Fog is a feature of high-lying Mistbelt areas in Natal/KwaZulu during the summer months. In certain cases, especially in the Drakensberg, the fog component of the total precipitation input into the hydrological cycle is of considerable importance. Snow has been recorded on the

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* Discussion based on Schulze, R.E., 1982. Agrohydrology and climatology of Natal, ACRU Report No. 14, Agricultural Catchments Research Unit, Department of Agricultural Engineering, University of Natal, Pietermaritzburg, 136 p. For a brief, although more detailed discussion, see Schulze, B.R., 1984. Climate of South Africa Part 8: general survey, Report No. WB 28, Weather Bureau, Department of Transport, Pretoria, 331 p. See also, Van der Eyk, J.J., MacVicar, C.N. and De Villiers, J.M., 1969. Soils of the Tugela Basin: a study in subtropical Africa, Natal Town and Regional Planning Commission Report, VOL 15, Pietermaritzburg, 263 p. and maps. (Climate data in the latter publication are presented in terms of broad physiographic regions, namely, the Montane region; the Highlands; the Interior Basins; the Interior River Valleys; the Lower Tugela Valley; the Midlands Mistbelt; the Coastal Hinterland, and the Coastal Lowlands). Climate data are also found in Edwards, D., 1967. A plant ecological survey of the Tugela River Basin, Memoir No. 36, Botanical Survey of South Africa, Botanical Research Institute, Department of Agricultural Technical Services, Pretoria/Natal Town and Regional Planning Commission Report, VOL 10, Pietermaritzburg, 285 p., as well as in Moll, E.J., 1976. The vegetation of the Three Rivers Region, Natal, Natal Town and Regional Planning Commission Report, VOL 33, Pietermaritzburg, 134 p. See also, Tyson, P.D., Preston-Whyte, R.A. and Schulze, R.E., 1976. The climate of the Drakensberg, Natal Town and Regional Planning Commission Report, VOL 31, Pietermaritzburg, 82 p., plus Schulze, R.E., 1979. Hydrology and water resources of the Drakensberg, Natal Town and Regional Planning Commission Report, VOL 42, Pietermaritzburg, 179 p., as well as Thorrington-Smith, Rosenberg and McCrystal, 1978. Towards a plan for KwaZulu: a preliminary development plan, VOL 1, The written report, 341 p., and VOL 2, Atlas of maps and illustrations, various pages, KwaZulu Government, Ulundi. A useful description of coastal climates in South Africa can be found in Tinley, K.L., 1985. Coastal dunes of South Africa, South African National Scientific Programmes Report No. 109, Foundation for Research Development, CSIR, Pretoria, 300 p. and map.

Drakensberg for every month of the year, although in any given year approximately eight snowfalls are likely to be reported, with a peak occurrence in June and July.

Table 17: Characteristics of synoptic rain-producing types for Natal/KwaZulu.

Synoptic category	Features
Tropical-temperate Trough	Link between Tropical Easterly Wave and Mid-latitude Low • well defined cloud band • axis of surface wind convergence over Natal/KwaZulu • heavy summer rainfall
Westerly Wave	Strong Ridging High and upper air Westerly Wave • deep layer of moist air • cloud extends beyond Drakensberg • cut-off low is intense form • extended rain over 2/3 days • can produce floods
Ridging High	Ridging of South Atlantic High south of the subcontinent • absence of upper air forcing • advection of cool unstable air below 700 hPa level • stratiform cloud deck below Drakensberg • orographic rainfall
East Coast Low	Absence of link between low off the coast and interior trough • convection less spatially organized than for trough • convection dynamically induced • severe thunderstorms if anticyclonic circulation over the interior
High Pressure	Dominant anticyclone over subcontinent • subsidence throughout troposphere • weak thermal advection • slack pressure gradient • no rain
Easterly Flow	Advance of high to the east • winds back to north easterly • drying in upper air over most of Natal/KwaZulu except northern sectors • winds onshore along northern coast advecting moist tropical air • rain in northern coastal sector
Mid-latitude Cyclone	Absence of Ridging High • rapid succession of cold fronts • south westerly winds • low temperatures and cloud cover • short period of rainfall in winter
Tropical Cyclone	Intense tropical low advancing from Mocambique Channel over coast • intense rain if over the coast and suppresses rain if further away

Source: After Preston-Whyte, R.A., Diab, R.D. and Washington, R., 1991. Diurnal variation of rainfall events by synoptic type in Natal, South African Geographical Journal, VOL 73(1), p. 22 - 28.

See also:

(i) Diab, R.D., Preston-Whyte, R.A. and Washington, R., 1991. The distribution of rainfall by synoptic type over Natal, South Africa, International Journal of Climatology, VOL 11(8), p. 877 - 888.

(ii) Jury, M.R., Levey, K.M. and Makarau, A., 1996. Mechanisms of short term rainfall variability over southern Africa, WRC Report No. 436/1/96, Water Research Commission, Pretoria, 50 p.

Table 18: Frequency of occurrence (percentage) of synoptic categories and their contributions to integrated annual rainfall over Natal/KwaZulu, 1965 - 1985.

Synoptic category	Frequency (percentage)	Rainfall (percentage)
Tropical-temperate Trough	15,0	28
Westerly Wave	7,2	24
Ridging High	21,1	15
East Coast Low	14,5	14
High Pressure	33,8	9
Easterly Flow	5,1	3
Mid-latitude Cyclone	3,1	1
Tropical Cyclone	0,2	0
Unclassified	-	6

Source: After Preston-Whyte, R.A., Diab, R.D. and Washington, R., 1991. Diurnal variation of rainfall events by synoptic type in Natal, South African Geographical Journal, VOL 73(1), p. 22 - 28.

9.8 Temperatures in Natal/KwaZulu

The low-lying areas of north east Natal/KwaZulu, the coastal areas, and the deeply incised river valleys experience the highest mean daily temperatures (Schulze, 1982). Low temperatures are found in the High Drakensberg, the Little Berg, and other land at high altitude. Daily temperatures in a region are mainly influenced by latitude, altitude and distance from the sea. In the case of Natal/KwaZulu, altitude is the primary determinant of mean daily temperature. Throughout the year for example, there is at sea level, only a small difference between the mean daily temperature in the far north and in the far south of Natal/KwaZulu. Between sea level and an altitude of 1 800 m, over a distance of 150 km by contrast, there is a difference in January of some 9°C.

9.9 Floods

A flood can be defined as a flow which "overtops" the natural or artificial banks of a stream or river*. Accordingly, a flood is not purely a hydrological concept, but rather a geomorphological and water resources management concept, since complex interactions of topography, man-induced changes and hydrology are involved (Newson, 1975, quoted in Schulze, 1979)**. Damage caused by floods generally depends on the magnitude of the flood, namely: the peak discharge (the maximum rate of flow during discharge), the flood volume (above a given discharge), and the duration of the flood (the period of time during which the discharge exceeds a certain limit). The extent to which rainfall of a given intensity and duration causes flooding depends mainly on the size of the river catchment over which such rain falls (Schulze, 1979). Flood producing rains which cause localized flooding are due to short duration, high intensity storms, whereas widespread floods (such as the September 1987 floods in Natal/KwaZulu - see the bibliographic database), occur where sustained heavy rain over a period of several days saturates the soil in a large area.

The Department of Civil Engineering at the University of Pretoria, Pretoria, 0002, has developed a national flood advisory policy for South Africa***. The system (presently being evaluated by the Department of Water Affairs and Forestry), will enable warnings of heavy rain and the likelihood of floods to be issued to any registered user in South Africa. In Natal/KwaZulu this would include for instance, the Ambulance and Emergency Medical Services Metro centres, as well as local authorities involved with civil protection

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* Some aspects of palaeofloods are currently being investigated with a view to the further understanding of floods as (hydrological) natural events. See Zawada, P. and Hattingh, J., 1994. Studies on the palaeoflood hydrology of South African rivers, South African Journal of Science, VOL 90(11/12), p. 567 - 568.

** See Schulze, R.E., 1979. Hydrology and water resources of the Drakensberg, Natal Town and Regional Planning Commission Report, VOL 42, Pietermaritzburg, 179 p.

*** See Alexander, W.J.R., 1993. Flood warning systems, SA Waterbulletin, VOL 19(2), p. 8 - 10. (According to statistics compiled by the Department of Water Affairs and Forestry, South Africa experienced some 184 "noteworthy" floods in the period 1911 - 1988).

(discussed in the chapter on the surface water resources of Natal/KwaZulu). Land below the 1 : 50 year flood line is particularly at risk, including for example, squatter housing in the Durban Functional Region; as well as the main Indian residential area of Ladysmith which is periodically flooded by the Klip River (approximately 28 floods in 110 years)*. It should be noted that the Disaster Relief Fund, Private Bag X901, Pretoria, 0001 (established in terms of the Fund-raising Act No. 107 of 1978), is used to provide financial assistance to the victims of natural and other disasters (including floods, tornadoes and veld fires). Some R90 million in emergency aid monies has been disbursed in recent years**. The Disaster Relief Fund is currently administered by the (post-1994 election) Department of Welfare and Population Development. The South African Insurance Association, P O Box 62155, Marshalltown, 2107, should be contacted for general information on insurance claims for floods and fires.

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* In terms of Section 169A of the Water Act No. 54 of 1956, no township may be established or extended unless flood line data are clearly indicated on the lay-out plan, to the satisfaction of the relevant local or regional authority. Such data concern the 1 : 20 year flood line, in respect of a watercourse with a catchment area >1 km^2; and secondly, the 1 : 50 year flood line in respect of low-lying land without surface drainage (on which water from an area >5 km^2 collects naturally). The local authority must also take the necessary action to regulate floodplain development in order to minimize the risk of loss of life and damage to property when a flood exceeding the specified magnitude occurs. There is a 40% risk that a 1 : 20 year design flood will be equalled or exceeded at least once within a 10 year period; a 64% risk within a 20 year period, and a 92% risk in a 50 year period. There is an 18% risk that a 1 : 50 year design flood will be equalled or exceeded at least once within a 10 year period; a 33% risk within a 20 year period, and a 64% risk within a 50 year period (Anonymous, 1986. Management of the Water Resources of the Republic of South Africa, Department of Water Affairs, Pretoria, various pages).

** See Smith, D.J.G., Viljoen, M.F. and Spies, P.H., 1981. Guidelines for assessing flood damage in South Africa, Water Research Commission, Pretoria, 64 p., as well as De Villiers, G. du T. and Maharaj, R., 1994. Human perceptions and responses to floods with specific reference to the 1987 flood in the Mdloti River near Durban, South Africa, Water SA, VOL 20(1), p. 9 - 13., and Smith, D.I., 1994. Flood damage estimation - a review of urban stage-damage curves and loss functions, Water SA, VOL 20(3), p. 231 - 238. See in addition: Viljoen, M.F., Du Plessis, L.A. and Booysen, H.J., 1996. Die ontwikkeling van vloedskadefunksies en 'n rekenaarprogram om die voordele van vloedbeheer-en vloedskadebeheermaatreëls te bepaal, Deel 1: samevattende verslag, WRC Report No. 490/1/96, Water Research Commission, Pretoria, 109 p. + app., as well as Du Plessis, L.A. and Viljoen, M.F., 1996. Die ontwikkeling van vloedskadefunksies en 'n rekenaarprogram om die voordele van vloedbeheer-en vloedskadebeheermaatreëls te bepaal, Deel 2: besproeiingsgebied, WRC Report No. 490/2/96, Water Research Commission, Pretoria, 246 p. + app., plus Booysen, H.J. and Viljoen, M.F., 1996. Die ontwikkeling van vloedskadefunksies en 'n rekenaarprogram om die voordele van vloedbeheer-en vloedskadebeheermaatreëls te bepaal, Deel 3: stedelike gebied, WRC Report No. 490/3/96, Water Research Commission, Pretoria, 137 p. + app. (An important part of the envisaged national flood policy concerns the assessment of flood damage for both urban and rural areas. A financial analysis is necessary in order to determine the costs and benefits of flood control as well as prevention measures).

Two important references on flood producing rainfall in Natal/southern Africa are the following:

- Schulze, R.E., 1979. Section E: Flood producing rainfall in Natal: Chapter 16. A survey of potential flood producing rainfall in Natal, In: Schulze, R.E., Field Studies, Data Processing, Techniques and Models for Applied Hydrological Research, VOL 1, ACRU Report No. 7(1), Agricultural Catchments Research Unit, Department of Agricultural Engineering, University of Natal, Pietermaritzburg, p. 365 - 424.

- Schulze, R.E., 1980. Potential flood producing rainfall of medium and long duration in southern Africa, Water Research Commission, Pretoria, 37 p.

See also:

- Anonymous, 1972. Design flood determination in South Africa, HRU Report No. 1/72, Hydrological Research Unit, University of the Witwatersrand, Johannesburg, various pages.

- Anonymous, 1991. A history of notable weather events in South Africa: 1500 - 1900, Caelum, December 1991, p. 1 - 125.

- Midgley, D.C. and Pitman, W.V., 1978. A depth-duration-frequency diagram for point rainfall in southern Africa, HRU Report No. 2/78, Hydrological Research Unit, University of the Witwatersrand, Johannesburg, 9 p. + app.

- Wiederhold, J.F.A., 1969. Design storm determination in South Africa, HRU Report No. 1/69, Hydrological Research Unit, University of the Witwatersrand, Johannesburg, various pages.

- With regard to the Drakensberg, see Schulze, R.E., 1979. Hydrology and water resources of the Drakensberg, Natal Town and Regional Planning Commission Report, VOL 42, Pietermaritzburg, 179 p. (Further literature on floods is provided in the bibliographic database).

9.10 Droughts

The definition of drought (as a "non-event" vis-a-vis floods) is problematic. Thomas (1965, quoted in Schulze, 1979)* described three types of droughts, namely, meteorological, agricultural and hydrological drought. A meteorological drought can be defined as a prolonged and abnormal moisture deficiency, while agricultural drought occurs when soil moisture is so depleted that the yields of plants are considerably reduced. Both meteorological and agricultural drought can be terminated by rainfall. Hydrological drought, by contrast, refers to a period during which the actual water supply is less than the minimum water supply necessary for normal operations in a particular region. Drought is therefore a relative rather than an absolute condition. Important factors to consider are the timing of the onset of drought within the annual cycle, the areal extent and severity, the duration of "droughts", and their probability of occurrence (for instance, a drought of given duration and intensity) (Yevjevich, 1967, quoted in Schulze, 1979).

De Jager and Schulze (1977)** and Schulze (1979), in terms of agricultural drought in Natal/KwaZulu, refer to a rainfall of less than 25 mm in a period of 21 days (during the months October to April). This definition however, must be related to the season (Schulze, 1979). In summer, during the growing season when evapotranspiration rates are high, the impact of reduced rainfall on the water balance is much more severe than in winter, when soils are dry, evapotranspiration rates are low and the vegetation is dormant. The concept of agricultural drought, with reference to Natal/KwaZulu, was further developed by Schulze (1982)***. Other factors assessed, were soil moisture depletion indices and the corresponding effects on crop yields.

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* See Schulze, R.E., 1979. Hydrology and water resources of the Drakensberg, Natal Town and Regional Planning Commission Report, VOL 42, Pietermaritzburg, 179 p.

** See De Jager, J.M. and Schulze, R.E., 1977. The broad geographic distribution in Natal of climatological factors important to agricultural planning, Agrochemophysica, VOL 9(4), p. 81 - 91.

*** See Schulze, R.E., 1982. Agrohydrology and climatology of Natal, ACRU Report No. 14, Agricultural Catchments Research Unit, Department of Agricultural Engineering, University of Natal, Pietermaritzburg, 136 p. (The Institute for Soil, Climate and Water in Pretoria (see earlier), has developed a technique to monitor the spatial extent and severity of moisture status on a monthly basis, reflecting prevailing seasonal conditions. The monitoring technique (based on the DECILE system used in Australia), compares current monthly rainfall with the long term mean annual rainfall (using 20 or more years of data). More than 4 500 stations in South Africa were used in the analysis. Monthly colour maps produced in terms of a GIS system are available from the Institute, illustrating changes in water status and the duration of such changes. Satellite imagery is now being used to enhance mapping capacity. The maps are especially useful for drought studies and drought management).

In terms of meteorological drought, Schulze (1982) examined precipitation in the "average" dry year (statistically, the average dry year approximates the driest year in six). Schulze found that the percentage of average dry year precipitation : mean annual precipitation (MAP) for the various rainfall regions in the province, was generally of the order of 80% of MAP, except in the north west and in the north east - where percentages drop to below 65% of MAP. Accordingly, the average dry year in such areas is much more severe than elsewhere in Natal/KwaZulu. "Drought" in essence, is a spatially variable phenomena. For a more severe drought, Schulze analysed the percentage of precipitation in the driest year (season) in 10, in relation to mean (long term) precipitation in the early and late summer season respectively; while for very severe annual droughts, the percentage of rainfall in the (statistically) driest year in 20 was examined in relation to MAP. Maps illustrating the data are presented in Schulze (1982). It is important to differentiate between aridity and drought, where the former describes a condition which is climatically more or less permanent, whereas drought (even of a few years' duration) is a temporary condition (Landsberg, 1975, quoted in Schulze, 1982). The effect of drought on human society depends on a host of variables, especially preparedness for drought conditions. Drought impacts on various sectors of the economy in different ways, and it is often those who can least afford losses, who are most affected. The direct human implications of droughts have not received much attention in the South African literature (see the bibliographic database).

Note:

The National Consultative Forum on Drought (later known as the National Rural Development Forum), P O Box 32434, Braamfontein, 2017 (partly funded by the Independent Development Trust), produced a number of unpublished reports dealing with the 1992/93 drought and drought assistance to black communities in South Africa. Three examples are provided below:

- Anonymous, 1992. The current drought situation in South Africa, Drought Update No. 5, December 1992, National Consultative Forum on Drought, Auckland Park, 45 p.

- Anonymous, 1992. Drought Watch No. 7, Week No. 51, December 1992, National Consultative Forum on Drought, Auckland Park, 12 p.

- Anonymous, 1993. Report on drought conditions for the National Consultative Forum on Drought, 26 January 1993, National Consultative Forum on Drought, Auckland Park, 8 p.

See also: (i) Adams, L., 1993. A rural voice: strategies for drought relief, Indicator South Africa, VOL 10(4), p. 41 - 46.

(ii) Vogel, C., 1994. (Mis)management of droughts in South Africa: past, present and future, South African Journal of Science, VOL 90(1), p. 4 - 6.

The publication Agricultural News issued by the Directorate of Agricultural Information, Department of Agriculture, Private Bag X144, Pretoria, 0001, is a most useful source of data on droughts (and floods) with reference to agriculture in South Africa. A further important source is the annual report of the Department. Relatively little (formally published) material is available on the 1992/93 drought, which continued into the 1994/95 season. The (national) Department of Agriculture (Chief Directorate: Economics), has established a Drought Action Co-ordinating Centre (which works in conjunction with an Interdepartmental Management Committee for Co-ordinated Drought Action) - also involving the Department of Water Affairs and Forestry - in order to plan drought assistance to farmers and rural communities*. The Centre inter alia co-ordinates the Emergency Drinking Water Scheme which consists of three separate schemes, namely, an Emergency Drilling Scheme, an Emergency Pipeline Construction Scheme, and the Emergency Transport of Drinking Water Scheme - all aimed at the agricultural sector. The drilling of boreholes (see the chapter on groundwater) and the emergency construction of pipelines is undertaken by the Directorate of Soil Conservation and Drilling Services, Department of Agriculture, Private Bag X515, Silverton, 0127. Emergency drinking water assistance is granted where at least 12 farmers or an agricultural community in a given magisterial district (then designated as an emergency drinking water district), are only able to provide less than 15 ℓ capita^{-1} day^{-1} of water for human needs, and less than 40 ℓ

* Discussion after the Chief Directorate: Economics, Department of Agriculture, Pretoria, 1995. (Readers should bear in mind that the discussion is somewhat historical. Drought assistance to farmers is being reviewed, and it is likely that most of the relief schemes (in their present form) will be amended or possibly discarded).

Large Stock Unit $(LSU)^{-1}$ day^{-1} for animal requirements. The number of animals on the farms must be in accordance with the long term grazing capacity of the veld.

Other drought relief packages include the Disaster Drought Assistance Scheme for Stock Farmers which is applicable in extensive grazing and cropping areas. The Scheme consists of four components, namely: a rebate on the transport of stock feed; a payment for the maintenance of a nucleus herd (defined in terms of one-third of the long term grazing capacity of the veld); a monthly incentive with regard to stock reduction (also in terms of the one-third criteria), and financial assistance for the lease of grazing in areas not subject to the same Scheme. Farmers may not participate in more than one drought relief measure which addresses the same need. All State assistance must be used to reduce future vulnerability to droughts. A special stock feeding scheme is applicable to small-scale farmers (mainly those with less than 12 LSUs). The Interim Veld Recovery Scheme (discussed in the chapter on soils and soil erosion), forms part of the livestock strategy for drought alleviation. The Veld Recovery Scheme is an interim measure - pending a formal South African drought policy - where emphasis is placed on the <u>recovery</u> of the veld, as opposed to more immediate help for livestock farmers.

Further measures include a temporary employment creation scheme for small-scale (subsistence) farmers who have lost all their crops. The employment creation scheme is applied until new crops can be reaped (funds permitting). The latter scheme consists of projects which will help to reduce the long term drought risk of the area (for example, donga reclamation). A Water Quota Subsidy Scheme is available for irrigation farmers supplied by water and irrigation boards. A monthly subsidy is paid to the farmers as compensation for reduced water quotas and hence lost production. The subsidy falls away if 50% or more of the "usual" annual water quota is available. It should be borne in mind that the various schemes (if relevant), do not necessarily apply in all parts of the country at any given time.

The Directorate of Geohydrology of the Department of Water Affairs and Forestry (as described elsewhere in this publication), has been involved with emergency borehole drilling and other water supply programmes in the homelands and in the national states for some while. The Department (in terms of drought relief), acts only in areas where there is no effective local authority for the provision of water to non-agricultural communities. The impact of the 1994/95 drought in Natal/KwaZulu was varied, although (normally high rainfall) towns such as Stanger and Empangeni/Richards Bay were subject to severe water restrictions. Restrictions were also in operation in Kokstad and Matatiele. No restrictions were imposed in the Pietermaritzburg or Durban areas.

9.11 Extreme wet and dry periods in South Africa

According to Tyson (1990)* rainfall over most of the summer rainfall region of South Africa has varied in a systematic manner since 1900. Based on data from 33 widely spaced stations in the summer rainfall region (where extreme variations were smoothed from the record), it is evident that four extended wet periods have occurred. These were 1916/17 - 1924/25; 1933/34 - 1943/44; 1953/54 - 1961/62, and 1971/72 - 1980/81 (the latter, the most persistently wet period). Five extended dry periods have been recorded, namely: 1905/06 - 1915/16; 1925/26 - 1932/33; 1944/45 - 1952/53; 1962/63 - 1970/71, and 1981/82 - 1987/88. Both dry and wet periods occurred in a quasi-periodic and statistically significant variation of about 18 years, with approximately nine years of an extended wet period following about nine years of an extended dry period. The wettest year seldom coincides with the middle of a wet (or dry) period. Extreme years may occur at the beginning of the period in a sudden switch for instance, in the 1916/17 - 1924/25 wet period (the latter, the wettest October - September rainfall year in the period 1905 - 1987); and in the 1933/34 - 1943/44 wet period, or in the 1981/82 - 1987/88 dry period (see underlined example). It is also fairly common for an extreme wet year such as 1966/67 to occur in an otherwise excessively dry period (the 1960s generally). Two or three years of very high or very low rainfall may likewise occur, on average, during any one dry or wet period. Furthermore, dry periods are more uniformly dry than the wet periods are wet. The quasi 18 year oscillation in summer rainfall may extend into the 1990s with a possible run of generally wetter than normal years, although this remains to be seen. It should be noted that Alexander (1993)** found evidence of a 20 year cycle in the gross yield of several South African dams including Midmar Dam. Certain consequences of extreme wet and dry periods in South Africa are briefly outlined in Table 19.

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* See Tyson, P.D., 1990. Modelling climatic change in southern Africa: a review of available methods, South African Journal of Science, VOL 86(7/10), p. 318 - 330.

** See Alexander, W.J.R., 1993. Floods or droughts?, Water Resource and Flood Studies Newsletter, September 1993, p. 1 - 4. A more formal discussion can be found in Alexander, W.J.R., 1995. Floods, droughts and climate change, South African Journal of Science, VOL 91(8), p. 403 - 408.

Table 19: Some consequences of extended wet and dry periods in southern Africa.

Drier conditions	Wetter conditions
Pressure on water resources	Few strains on water resources
Reduction of arable land area	Increase in arable land area
Decreased carrying capacity of land	Increased carrying capacity of land
Erratic crop yields	More stable yields
Widespread crop failures	Good crop yields
Widespread livestock losses	Stable animal husbandry industry
Increased agricultural debts	Diminished agricultural debts
Reduced Gross Domestic Product (GDP) and per capita food production; fluctuating food price index	Improved GDP; more stable food price index
Pressure on agro-industrial and transport sectors of the economy	Relief for these sectors
Increased rural unemployment; low purchasing power	Purchasing power restored; employment conditions improved
Increased social unrest	Increased social stability
Drought relief programmes and aid	Less aid needed
Deterioration of natural vegetation	Veld recovery
Tendency for desertification	Desertification arrested
Karoo advancement	Restoration of ecosystems
Increased soil erosion	Decreased soil erosion
Lowered water tables	Raised water tables

Source: After Tyson, P.D., 1990. Modelling climatic change in southern Africa: a review of available methods, South African Journal of Science, VOL 86(7/10), p. 318 - 330.

See also: Vogel, C.H., 1994. Consequences of droughts in southern Africa (1960 - 1992), Ph.D. Thesis, Department of Geography and Environmental Studies, University of the Witwatersrand, Johannesburg, 264 p.

Note: A useful general publication on drought in South Africa is the following: Du Pisani, A.L. (ed), 1990. Proceedings of the SARCCUS workshop on drought, June 1989, Southern African Regional Commission for the Conservation and Utilization of the Soil (SARCCUS), Pretoria, 63 p.

9.12 Wind

Scientific wind data can only be derived from properly equipped weather stations, although the Beaufort scale (Table I10), can be used by the average observer to estimate wind speed with some degree of accuracy, at any given point or time.

Table I10: Beaufort scale of wind for a standard height of 10 m above flat ground.

A = Beaufort number
B = Probable wave height in m

A	Descriptive term	Mean velocity		Specifications		B
		knots	$m\ s^{-1}$	land	coast	
0	Calm	<1 1	0 - 0,2 0,3	Calm; smoke rises vertically	Calm	-
1	Light air	1-3	0,3 - 1,5	Direction of wind shown by smoke drift but not by windvanes	Fishing smack just has steerage way	0,1
2	Light breeze	4-6	1,6 - 3,3	Wind felt on face; leaves rustle; ordinary vanes moved by wind	Wind fills the sails of smacks which then travel at about 1-2 knots	0,2
3	Gentle breeze	7-10	3,4 - 5,4	Leaves and small twigs in constant motion; wind extends light flag	Smacks begin to careen and travel at about 3-4 knots	0,6
4	Moderate breeze	11-16	5,5 - 7,9	Raises dust and loose paper; small branches are moved	Good working breeze, smacks carry all canvas with good list	1
5	Fresh breeze	17-21	8,0 - 10,7	Small trees in leaf begin to sway; crested wavelets form on inland waters	Smacks shorten sail	2
6	Strong breeze	22-27	10,8 - 13,8	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty	Smacks have double reef in mainsail; care required when fishing	3
7	Near gale	28-33	13,9 - 17,1	Whole trees in motion; inconvenience felt when walking against wind	Smacks remain in harbour and those at sea lie-to	4
8	Gale	34-40	17,2 - 20,7	Breaks twigs off trees; generally impedes progress	All smacks make for harbour	5,5

Table I10: Beaufort scale of wind for a standard height of 10 m above flat ground (continued).

A	Descriptive term	Mean velocity		Specifications		B
		knots	m s^{-1}	land	coast	
9	Strong gale	41-47	20,8 - 24,4	Slight structural damage occurs (chimney pots and slates removed)	-	7
10	Storm	48-55	24,5 - 28,4	Seldom experienced inland; trees uprooted; considerable structural damage occurs	-	9
11	Violent storm	56-63	28,5 - 32,6	Very rarely experienced; accompanied by widespread damage	-	11,5
12	Hurricane	≥64	≥32,7	-	-	14

<u>Source</u>: After Anonymous, 1982. Weather codes for land stations (surface observations), Weather Bureau, Department of Transport, Pretoria, 36 p.

<u>Note</u>:

(i) 1 knot = 1 nautical mile h^{-1} = approximately 0,514 m s^{-1}. Note that the wind speed (in m s^{-1}) is based on an empirical formula, adjusted to a height of 10 m above flat ground.

(ii) Wind direction is the direction <u>from</u> which the wind is blowing (expressed in tens of degrees from <u>True North</u>). Both wind speed and direction should be averaged over 10 minutes.

9.13 The length of daylight in South Africa

Data on the times of sunrise and sunset for five South African cities are presented in Table I11.

Table I11: Times of sunrise and sunset at selected South African cities.

Month/day		Cape Town		Bloemfontein		Durban		Port Elizabeth		Johannesburg	
		Rises	Sets	Rises	Sets	Rises	Sets	Rises	Sets	Rises	Sets
January	1	0539	2001	0521	1917	0459	1901	0511	1933	0520	1904
	8	0544	2001	0525	1918	0503	1902	0516	1933	0524	1905
	15	0550	2000	0530	1918	0509	1901	0522	1932	0529	1905
	22	0557	1957	0536	1916	0515	1859	0529	1929	0535	1903
	29	0604	1955	0543	1914	0522	1857	0536	1927	0541	1901
February	5	0611	1949	0549	1910	0528	1852	0543	1921	0546	1858
	12	0618	1942	0554	1905	0533	1847	0550	1914	0551	1853
	19	0625	1934	0559	1858	0539	1840	0557	1906	0555	1848
	26	0631	1927	0605	1851	0545	1833	0603	1859	0600	1842
March	5	0637	1918	0609	1844	0549	1826	0609	1850	0603	1835
	12	0642	1910	0613	1837	0553	1818	0614	1842	0607	1828
	19	0647	1901	0617	1829	0558	1810	0619	1833	0611	1821
	26	0652	1849	0621	1819	0602	1800	0624	1821	0613	1813
April	2	0658	1840	0626	1812	0607	1752	0630	1812	0617	1806
	9	0703	1832	0628	1805	0610	1745	0635	1804	0620	1759
	16	0709	1823	0633	1757	0615	1737	0641	1755	0624	1752
	23	0714	1815	0637	1749	0619	1729	0646	1747	0627	1745
	30	0719	1808	0641	1744	0624	1723	0651	1740	0630	1740
May	7	0725	1800	0645	1737	0628	1716	0657	1732	0634	1735
	14	0730	1754	0650	1732	0633	1711	0702	1726	0638	1730
	21	0735	1750	0654	1729	0637	1708	0707	1722	0642	1728
	28	0739	1747	0658	1726	0641	1705	0711	1719	0645	1725
June	4	0743	1744	0701	1724	0644	1703	0715	1716	0648	1723
	11	0747	1744	0704	1724	0648	1703	0719	1716	0651	1723
	18	0750	1744	0706	1725	0650	1703	0722	1716	0653	1724
	25	0751	1745	0708	1727	0651	1705	0723	1717	0655	1726
July	2	0752	1748	0709	1729	0652	1707	0724	1720	0656	1728
	9	0751	1751	0708	1732	0652	1710	0723	1723	0655	1731
	16	0749	1755	0707	1735	0650	1714	0721	1727	0654	1734
	23	0745	1800	0704	1739	0647	1718	0717	1732	0651	1738
	30	0740	1804	0700	1743	0643	1722	0712	1736	0647	1741
August	6	0735	1809	0655	1746	0638	1726	0707	1741	0643	1744
	13	0728	1815	0649	1750	0632	1730	0700	1747	0638	1747
	20	0720	1819	0642	1754	0625	1734	0652	1751	0632	1751
	27	0712	1824	0636	1757	0618	1737	0644	1756	0626	1753

Table I11: **Times of sunrise and sunset at selected South African cities (continued).**

Month/day		Cape Town		Bloemfontein		Durban		Port Elizabeth		Johannesburg	
		Rises	Sets	Rises	Sets	Rises	Sets	Rises	Sets	Rises	Sets
September	3	0703	1829	0628	1801	0610	1742	0635	1801	0619	1756
	10	0653	1833	0620	1805	0601	1745	0625	1805	0611	1759
	17	0643	1838	0611	1808	0552	1749	0615	1810	0604	1802
	24	0634	1844	0603	1812	0544	1753	0606	1816	0556	1805
October	1	0625	1848	0556	1816	0536	1757	0557	1820	0549	1807
	8	0616	1853	0547	1819	0528	1801	0548	1825	0542	1811
	15	0606	1859	0539	1824	0519	1806	0538	1831	0535	1815
	22	0557	1904	0531	1828	0511	1810	0529	1836	0527	1818
	29	0550	1910	0526	1833	0505	1816	0522	1842	0522	1822
November	5	0543	1917	0520	1838	0459	1821	0515	1849	0517	1827
	12	0537	1924	0515	1844	0454	1827	0509	1856	0513	1832
	19	0533	1931	0511	1850	0450	1833	0505	1903	0510	1837
	26	0530	1937	0509	1855	0448	1838	0502	1909	0508	1842
December	3	0528	1943	0509	1900	0447	1844	0500	1915	0508	1847
	10	0528	1949	0510	1905	0448	1849	0500	1921	0509	1852
	17	0530	1954	0512	1910	0450	1854	0502	1926	0511	1857
	24	0533	1958	0515	1914	0453	1858	0505	1930	0514	1901
	31	0538	2000	0520	1916	0458	1900	0510	1932	0519	1903

Source: Anonymous, 1982. Weather codes for land stations (surface observations), Weather Bureau, Department of Transport, Pretoria, 36 p.

See also: Archer, C.B., 1992. Dates and durations of the seasons, Weather Bureau Newsletter, No. 517, April 1992, p. 2 - 3.

Note:

(i) The approximate times of sunrise and sunset for the following cities can be calculated using a small adjustment.

East London:	Port Elizabeth time	- 10 minutes
Kimberley:	Bloemfontein time	+ 6 minutes
Pietermaritzburg:	Durban time	+ 2 minutes
Pretoria:	Johannesburg time	- 1 minute

(ii) Complete tables for South Africa are available in Anonymous (1982 - above), and also in: Anonymous, 1973. Times of sunrise, sunset and local apparent noon on every day of the year, at any place in South Africa, South African Council for Scientific and Industrial Research in association with the Science Research Council of the United Kingdom, [Pretoria], 31 p. See also, Buys, M.E.L., 1978. Duration of daylight in South Africa, Technical Communication No. 144, Department of Agricultural Technical Services, Pretoria, 38 p.

(iii) The elevation of the noonday sun above the horizon at given latitudes in the southern hemisphere is as follows:

Season	Latitude	Elevation
Summer solstice	23°S	90,0°
Winter solstice	23°S	43,0°
Summer solstice	30°S	83,5°
Winter solstice	30°S	36,5°
Summer solstice	50°S	63,5°
Winter solstice	50°S	16,5°
Summer solstice	70°S	43,5°
Winter solstice	70°S	0°

Source: After Preston-Whyte, R.A. and Tyson, P.D., 1988. The Atmosphere and Weather of Southern Africa, Oxford University Press, Cape Town, 374 p.

See also: Booth, P.J. (ed), 1991. Astronomical handbook for southern Africa 1992, Astronomical Society of Southern Africa, Cape Town, 54 p. (The handbook is published annually and includes data inter alia on the sun, as well as phases of the moon and times of moon rise and set. Some information is also provided on South African Standard Time).

(iv) Civil twilight refers to the time during which the sun is between 0°5′ and 6° below the horizon. Nautical twilight is the time during which the sun is between 6° and 12° below the horizon, while astronomical twilight refers to the time during which the sun is between 12° and 18° below the horizon.

(v) The following outline report should be examined with regard to (biologically active) ultraviolet-B radiation monitoring in South Africa: Archer, C.B., 1993. The Medunsa/SAWB ultraviolet monitoring network, Weather Bureau Newsletter, No. 537, December 1993, p. 2 - 3. The UV-B radiation classification system used by the Weather Bureau is as follows. It should be noted that UV-B is measured in terms of its effect on the human skin. The measurement does not refer to UV-B per se.

Classification of daily sunburn values.

Daily sunburn value (minimum erythema dose unit - MED)	Effect
<8	Moderate
8 - 14	High
15 - 24	Dangerous
>24	Very dangerous

Note: Daily sunburn unit data are provided on a monthly basis for Pretoria, Cape Town and Durban in issues of the Weather Bureau Newsletter, in terms of the following categories: 0 - 7 (moderate); 7 - 14 (high); 14 - 24 (dangerous), and >24 (very dangerous). The 0 - 7 - 14 - 24 >24 system has now been adopted by the Weather Bureau (Archer, C.B., 1994. Personal communication, Weather Bureau, Pretoria).

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