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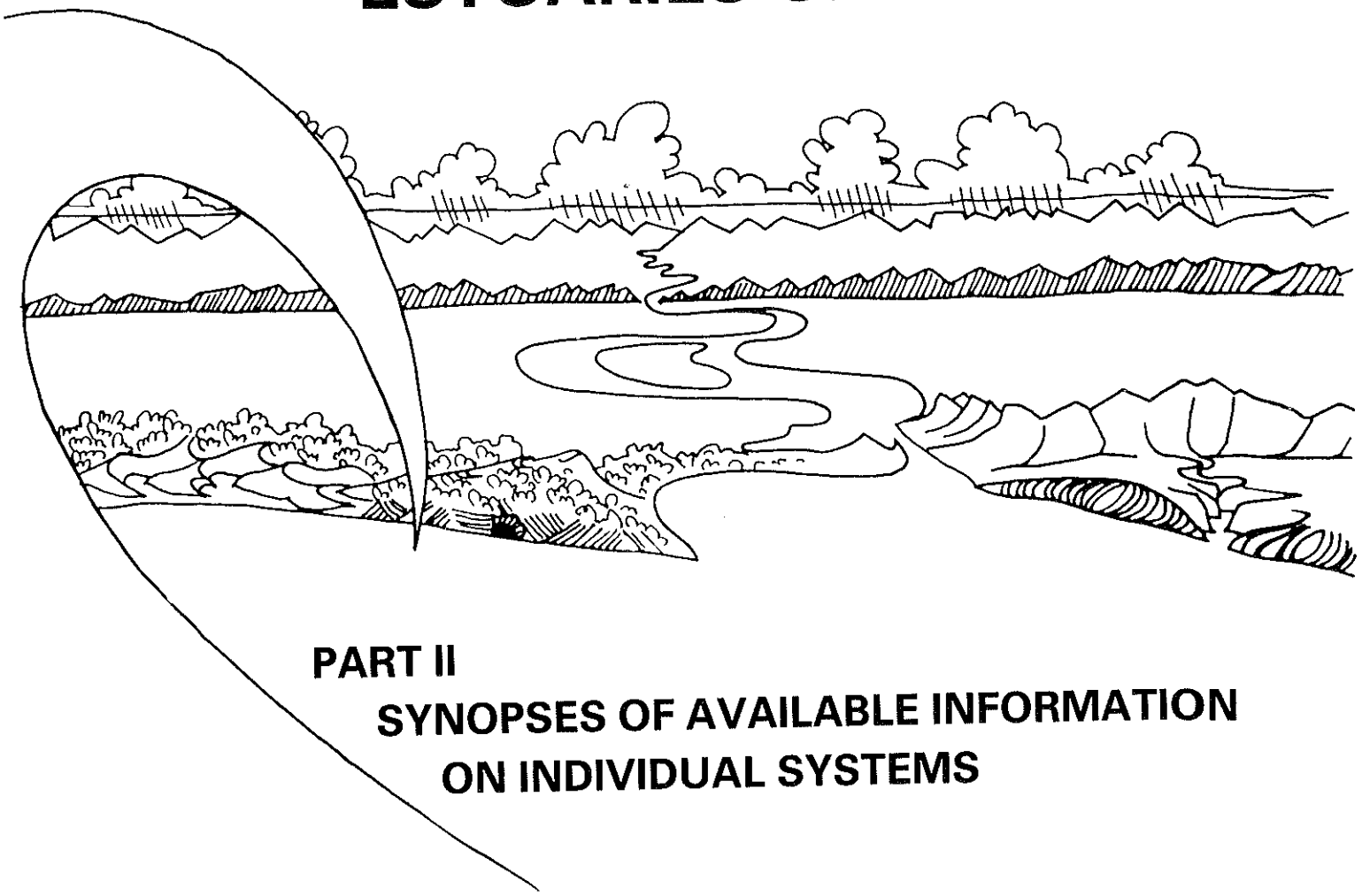
ESTUARIES OF THE CAPE



PART II
SYNOPSES OF AVAILABLE INFORMATION ON INDIVIDUAL SYSTEMS

REPORT NO. 38

GOURITS (CSW 25)

CSIR RESEARCH REPORT 437

Stellenbosch, South Africa
February 1989

ESTUARIES OF THE CAPE

PART II: SYNOPSES OF AVAILABLE INFORMATION ON INDIVIDUAL SYSTEMS

EDITORS:
A E F HEYDORN and P D MORANT
Division of Earth, Marine and Atmospheric Science and Technology,
CSIR, Stellenbosch

FRONTISPIECE: THE GOURITS ESTUARY – ALT. 450 m, ECRU 79-10-16

REPORT NO. 38: GOURITS (CSW 25)

(CSW 25 – CSIR Estuary Index Number)

BY: H J HEYDORN

ESTUARINE AND COASTAL RESEARCH UNIT – ECRU
DIVISION OF EARTH, MARINE AND ATMOSPHERIC SCIENCE AND TECHNOLOGY
CSIR

CSIR RESEARCH REPORT 437

Stellenbosch, South Africa
February 1989

GOURITS

ECRU SURVEY: 8 - 10 June 1987

SURVEY TEAM: Mr I Bickerton
Mr M E R Burns
Mr T J E Heinecken
Mrs H J Heydorn
Mr P J Masson (CDNEC)
Mr D E Malan (CDNEC)

SDD SURVEYS: 5 August 1986
13 September 1986

SURVEY TEAM: Mr L Barwell
Mr P Badenhorst
Mr L van der Merwe

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PREFACE

The Estuarine and Coastal Research Unit was established by the National Research Institute for Oceanology of the CSIR in 1979 with the following aims:

- to contribute information relevant to the development of a cohesive management policy for the South African coastline;
- to compile syntheses of all available knowledge on the 167 estuaries of the Cape from the Kei to the Orange rivers;
- to identify gaps in information, to conduct research to fill these and to stimulate Universities, Museums and other institutions to become involved in this kind of work;
- to undertake investigations on the impacts of proposed developments in the coastal environment, and especially in estuaries.

The Unit was established at the request of the Government, and the Department of Environment Affairs contributes substantially to the running costs.

In 1980 the Unit published its first report under the title "Estuaries of the Cape, Part I - Synopsis of the Cape Coast. Natural Features, Dynamics and Utilization" (by Heydorn and Tinley, CSIR Research Report 380). The report is an overview of the Cape Coast dealing with aspects such as climate, geology, soils, catchments, run-off, vegetation, oceanography, and of course, estuaries. At the specific request of the Government, the report includes preliminary management recommendations.

The present report is one of a series on Cape Estuaries being published under the general title "Estuaries of the Cape, Part II". These reports summarize, in language understandable to the layman, all available information on individual estuaries. It was found, however, that much information is dated or inadequate and that the compilation of Part II reports is therefore not possible without brief prior surveys by the ECRU. These surveys are, however, not adequate to provide complete understanding of the functioning of estuarine systems under the variable conditions prevalent along the South African coastline. The ECRU therefore liaises closely with universities and other research institutes and encourages them to carry out longer-term research on selected estuarine systems. In this way a far greater range of expertise is involved in the programme and it is hoped that the needs of those responsible for coastal zone management at Local, Provincial and General Government levels can be met within a reasonable period of time.

On 1 April 1988 the National Research Institute for Oceanology was incorporated into the new Division of Earth, Marine and Atmospheric Science and Technology (EMA) of the CSIR. In the process of restructuring, the Estuarine and Coastal Research Unit (ECRU) ceased to exist as an entity. However, the tasks undertaken by the ECRU continue to be performed by the Coastal Processes and Management Advice Programme of EMA.

D H SWART
MANAGER, COASTAL PROCESSES AND MANAGEMENT ADVICE PROGRAMME
DIVISION OF EARTH, MARINE AND ATMOSPHERIC SCIENCE AND TECHNOLOGY

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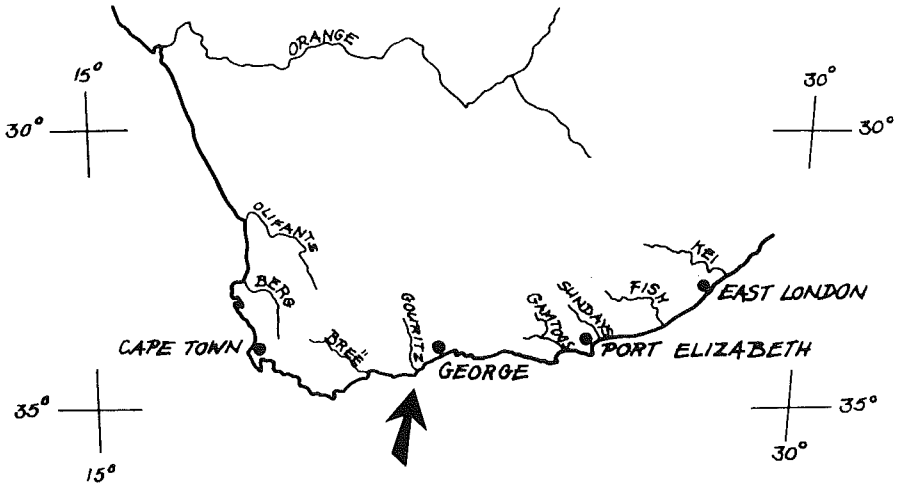
GOURITS

1. LOCATION

The Gourits River is formed by the confluence of the Gamka and Olifants rivers just south of Calitzdorp (Figure 1). It enters the Indian Ocean between Bull Point and Kanonpunt about 33 km south-west of Mossel Bay. The mouth of the river is situated at 35° 21'S; 21° 53'E. There is a small settlement 2 km west of the river called Gouritsmond. A few kilometres to the east are the small holiday resorts of Kanon, Fransmanshoek and Vleesbaai.



1.1 Accessibility

The mouth of the Gourits River is about 27 km south of the N2 highway between Albertinia and Mossel Bay (Figure 1). The western bank is accessible via a tarred road which turns off the highway (N2) about 15 km east of Albertinia and follows the valley down to the mouth. The east bank is accessible via a gravel road (presently being upgraded) which turns off the N2 highway approximately 5 km after crossing the river. A branch of this road continues to Kanonpunt from where a private road leads to a few holiday shacks near the river bank. There is a connection between the access routes on the eastern and western banks via a low-level bridge at 'Die Eiland' about 8 km from the mouth (Centrespread).

The nearest towns are Albertinia (35 km north-west) and Mossel Bay (50 km by road to the east). The Gourits River lies midway between the cities of Cape Town and Port Elizabeth being *ca.* 327 km from the former and *ca.* 333 km from the latter. Except for a few sidings such as Gourits and Cooper, Mossel Bay is the closest railway and shipping terminal. It also has an airport for light aircraft, while P W Botha airport at George (90 km) is the nearest fully equipped airport. There is a licenced municipal landing strip with a 1 km bitumen-surfaced runway 15 metres wide with hangar facilities at Riversdale (70 km north-west) (Geustyn *et al.* 1987) (Figure 1).

1.2 Local Authorities

The western bank of the river is under the jurisdiction of the Langeberg Divisional Council and is in the Riversdale magisterial district, while the eastern bank falls under the Outeniqua Divisional Council and is in the Mossel Bay magisterial district. With the establishment of Regional Services Councils, this position is likely to change in the near future.

2. HISTORICAL BACKGROUND

2.1 Synonyms

GOURITZ South Africa Dept van Beplanning (1971); Bulpin (1980)

GOURITS 1:50 000 Sheet 3421 BD; River flow data (1978); Raper (1987)

2.2 Historical Aspects

According to Bulpin (1980), the Gourits is named after the Gourikwa tribe of Hottentots who once lived along its banks. Raper (1987) states that this river was formerly known by the Portuguese names *Rio das Vaccas* (River of Cows), *Rio Formoso* (Beautiful river) and *Rio dos Vaqueiros* (River of herdsmen). It is also encountered as *Gauritz, Gouris, Gouds* (incorrectly interpreted as the Afrikaans or Dutch *goud,* 'gold'), *Gaauwrits* (incorrectly interpreted as Dutch *gaauw* , 'rapid', *rits,* rustling and translated as 'rapid rustling river'). He goes on to say that the river is generally thought to be named after the Khoekhoen people who lived there. An alternate explanation is that it means 'diarrhoea river', from the mud and debris deposited by flood waters.

The three nearby resorts Kanon, Vleesbaai and Fransmanshoek (Centrespread) owe their names to visits made by three ships. On 11 September 1763 the French warship *La Fortune* was wrecked near the mouth of the Gourits at a place known as Fonteintjies, after a small freshwater spring close to the beach. The rocky point projecting into the sea at this spot is known as Fransmanshoek. Several cannon from the wreck are mounted at the huddle of seaside shacks known as Kanon. Vleesbaai was named on 8 July 1601 when two Dutch ships sailed along this coast searching for signs of one of the Hottentot pastoral tribes who could sell them fresh meat (Bulpin, 1980).

2.3 Archaeology

Records from the southern Cape show that this area has been inhabited by man for more than half a million years. These early people were nomadic hunters and collectors and moved on in search of food from the land and the sea and for water. Much evidence of this is found in the stone artefacts and shell middens found especially in the coastal area. The Gourits River floodplain was an important migration route (Brink *et al.*, 1986).

J Binneman (Albany Museum, *in litt.)* states that the prehistory of this area is to a large extent unknown. Stone artefacts found in river gravels along the banks of the river, include rough hand axes and cleavers, suggesting that the area was inhabited some 500 000 years ago or even earlier. The only important archaeological features identified so far in this area are numerous shell middens on the eastern and western banks of the river near the mouth. These include shell middens of Khoi pastoralist origin and contain pottery which dates within the last 2 000 years. Hunter-gatherer middens are also present and date within the last 10 000 years. Pottery is absent from these middens. Stone features, probably cooking platforms and windbreaks occur with middens on the eastern bank of the river at Kanon. The remains of a stone fish trap (vywer) are also visible near the mouth of the river.

W J van Rijssen, South African Museum *(in litt.),* confirms that three archaeological sites are known between Voëlklip and Cape Vacca on either side of the Gourits River (Figure 1). Two shell middens have been located in the sand dune area in the Groot Rug and date to the late Stone Age. On the rocky shore in the

FIG. 1 : The Gourits River and Catchment (based on 1:1 000 000 World Aeronautical Chart 3422 Cape Town)

vicinity of the hotel he also refers to the remains of a number of tidal fish traps ('visvywers'). Structures such as these are related to middens and can be found frequently along rocky shores. However, the tendency is to use these areas for the construction of tidal swimming pools in regions where development is taking place and thus few intact structures are still to be found along the coast. He goes on to say that no systematic archaeological survey has been conducted in this region and should any large scale development be planned, provision should be made for prior assessment of the archaeological importance of the area concerned.

3. ABIOTIC CHARACTERISTICS

3.1 River Catchment

3.1.1 Catchment area

The Gourits River's catchment stretches from the Karoo down to the coast. It is the third largest catchment in South Africa being only slightly smaller than that of the Olifants River on the west coast, the Orange being the largest. Various quoted sizes are:

45 715 km2 (Crowther, 1987)
44 063 km2 (Heydorn and Tinley, 1980)
45 742 km2 (Noble and Hemens, 1978)
43 500 km2 (River Flow Data, 1978)
45 212 km2 (Midgley and Pitman, 1969)
45 450 km2 (Jezewski and Roberts, 1986)

The Gourits River is fed by numerous large tributaries, the main ones being the Grootrivier, the Gamka and the Olifants (Figure 1). The Grootrivier in turn is fed by the Buffels River which rises on the southern slopes of the Nuweveldberge (*ca.* 2 000 m) and flows southwards through the town of Laingsburg in the Great Karoo. From here it cuts through the Klein Swartberg mountains (*ca.* 1 300 m) and flows into the Little Karoo where it enters the Grootrivier. At this junction it is joined by the Touws River flowing in from the west. From this point the river flows in an easterly direction before bending to the south where it joins the Gourits.

The Gamka River is fed by numerous tributaries (including the Dwyka) arising in the Nuweberge and flows past Beaufort West in a south-westerly direction and then southwards to its confluence with the Olifants which in turn is fed by 12 tributaries arising in the Groot Swartberge (*ca.* 2 280 m) and Kammanassieberge (2 028 m). The Gamka and Olifants join to form the Gourits which then flows southwards through the Langeberge (*ca.* 1 213 m), crosses a 40 km wide coastal plain and enters the sea in Visbaai (Figure 1) (text adapted from Hallward, 1986 and Bulpin, 1980). The approximate length of the Gourits River as measured on the 1:250 000 maps 3322 Oudtshoorn, 3320 Ladismith, 3420 Riversdale and 3220 Sutherland is as follows (starting with the tributaries in the west and proceeding clockwise eastwards).

Touws to Groot	-	62 km
Buffels to Groot	-	70 km
Groot to Gourits	-	115 km
Dwyka to Gamka	-	40 km
Gamka to Gourits	-	235 km
Traka to Olifants	-	110 km
Kammanassie to Olifants	-	95 km
Olifants to Gourits	-	193 km
Gourits to mouth	-	125 km
TOTAL		1 045 km (this excludes the vast number of smaller tributaries).

Roberts (1973) gives the total length including all streams as 4 462 miles (7 139 km). Jezewski and Roberts (1986) state that the length of the longest collector is 410 km, and Crowther (1988) taking the Gamka as the longest collector, gives it as 416 Km.

3.1.2 Geology

According to Muir (1929) the Gourits River traverses four regions.

1. The Klein Karoo which lies to the north of the Langeberge and is 6-8 miles (9 to 12 km) wide. The Groot and Gamka tributaries arise here. This area belongs to the Bokkeveld Group and consists of sandstones and shales. The latter crop out everywhere both on the hills and the plains.

2. The Langeberge - this mountain range runs from east to west and belongs to the Table Mountain Group.

3. The Renosterveld (the 'Hardeveld') lies to the south of the Langeberge. It comprises the Uitenhage Group of thin bedded shales, red and grey mudstones, conglomerates and clays; the Witteberg Group of quartzites and the Bokkeveld Group of shales, quartzites and sandstones.

4. The Strandveld (the 'Duine') forms the 8-20 mile (12-32 km) coastal belt. There are shingle beaches at the Gourits mouth and the mainland is mostly sandy. There are extensive mobile dunes rising in terraces of 300 ft (100 m) in places. The extensive hilly areas of the Strandveld are fixed sand intersected by rocky ridges and outcrops of dune limestone. The Coastal Belt comprises superficial deposits, recent limestones, recent blown sands and sand deposits. The dune limestone is derived from the hardened dunes and is used for building purposes. The channel of the river has cut through the sand and limestone down to the underlying Bokkeveld beds which are exposed. Near the river mouth, the Table Mountain Group (sandstone and quartzites) appears as a narrow strip. There is a large quantity of alluvium at Elberts Kraal on the Gourits River. On the northern boundary of the Strandveld stands the Aasvogelberg belonging to the Table Mountain Group. Figure 2 (from P Bohnen, 1986) depicts some of the major geological features of the lower reaches of the river.

Levin (1987) states that the river course is controlled by folded and strongly jointed rocks of the Cape Supergroup.

According to Pitman *et al.* (1981), the tributaries of the Gourits originate in fine sedimentary areas. The northern Gourits passes through coarse sedimentary areas and nearer the mouth, unconsolidated superficial deposits occur. The soils are largely lithosols except near the mouth where they are arenosols. The marine sand/mud/river sand interfaces as found during the ECRU field trip in June 1987, are shown on the Centrespread.

3.1.3 Rainfall and Run-off

Rainfall

The Gourits River and its tributaries are situated in an area of relatively low rainfall. According to Schulze (1965) the catchment is situated in the semi-arid to arid southern interior of the Cape Province receiving less than 250 mm of rain per year. Only in parts of the mountain ranges (e.g. Swartberge) does the rainfall exceed 750 mm. Except in the mountains, only about one to three rain days per month can be expected. About 10 to 20 thunderstorms occur in this region per year and one occasional heavy storm can sometimes account for as much as half the normal annual rainfall.

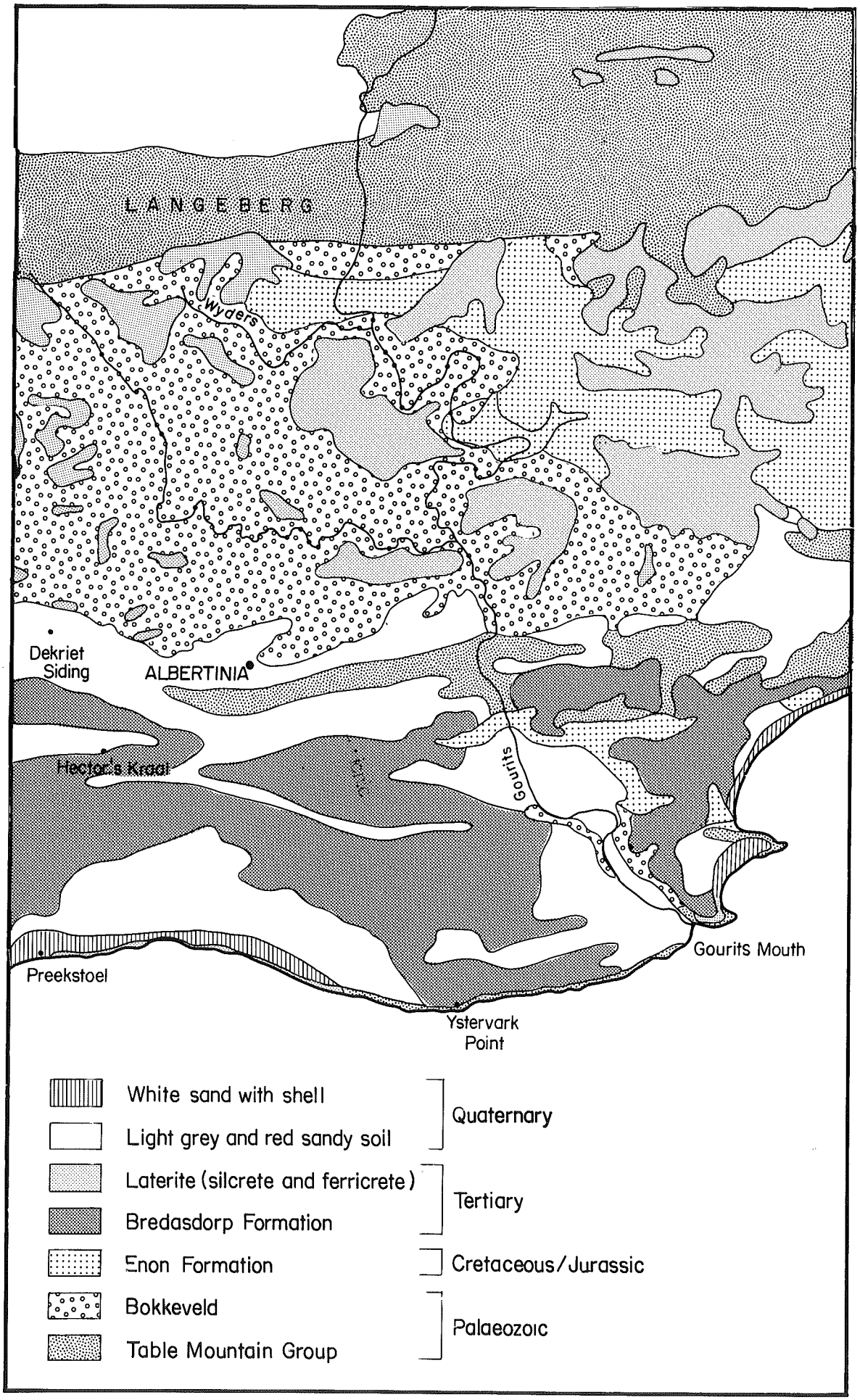


FIG. 2: Geology of Gourits River catchment (after Bohnen, 1986)

About twice a year, in winter and spring the Langeberg and Outeniqua mountains are snow-capped.

According to the South African Weather Bureau (1965) the average rainfall for the 40-year period up to 1960 as measured at 'Die Eiland' (8 km upstream of mouth), was 365,8 mm falling during 39 days of the year (Table 1). Pitman *et al.* (1981) give a figure of 350 mm from 1936 to 1980 while Crowther (1987) gives the mean annual precipitation as 270 mm. Brink *et al.* (1987) maintain that 57 percent of the rain falls from April to September.

TABLE 1: Average rainfall measured at 'Die Eiland' station (11/617), over a 40-year period up to 1960 (South African Weather Bureau Publ. 29, 1965)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
mm	22,5	25,3	36,0	30,0	38,1	23,5	34,9	31,4	32,6	38,2	38,7	19,6	365,8
days	2	3	4	3	4	3	4	3	4	4	3	2	39

Run-off

Midgley and Pitman (1969) and Noble and Hemens (1978) give the mean annual run-off (MAR) for the entire catchment of the Gourits (Catchment J) as 284 953 morgen feet (744 x 106 m^3), up to 1967.

Crowther (1987) calculated the simulated annual run-off for this catchment for the hydro years1 1924-1979 using data from Pitman *et al.*, 1981. His average for this 56-year period is 539 x 106 m^3. As can be seen in Figure 3, 1960 was the wettest year and 1935 the driest. Figure 4 shows the mean monthly simulated run-off. From this it can be seen that March is the month with the highest average simulated run-off, and October with the lowest.

Figure 5 shows the simulated monthly run-offs with peak floods indicated. The highest value during the 56-year period was in March 1960 (1 081,09 x 106 m^3) and the lowest was in February 1946 (0,22 x 106 m^3). This illustrates the great variability both monthly and annually.

Jezewski and Roberts (1986), have calculated that the two-year flood peak discharge for the Gourits River is 1 000 m^3/s. They state that the flooding requirements of the estuary (that is, the single annual flood release, should a storage reservoir be built on the river, having similar flow characteristics to the two-year flood, would have to be 375,840 x 106 m^3 per annum. However, as the Gourits has such a large catchment and flood plain, the adopted figure (7 percent of the MAR) is 37,730 x 106 m^3 per annum. The total fresh water requirements of the estuary (that is, the sum of the appropriate values of the evaporative and flooding requirements) are 39,525 x 106 m^3 per annum. This is 7,3 percent of the virgin MAR. According to the Dept. of Water Affairs (Mr. J. van Breda, pers. comm.) water is not released from the dams in the catchment to fulfil these requirements.

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1 A hydro year extends from October of one year to September of the following year. For example, hydro year 1972 includes October, November, December of 1972 and January to September of 1973.

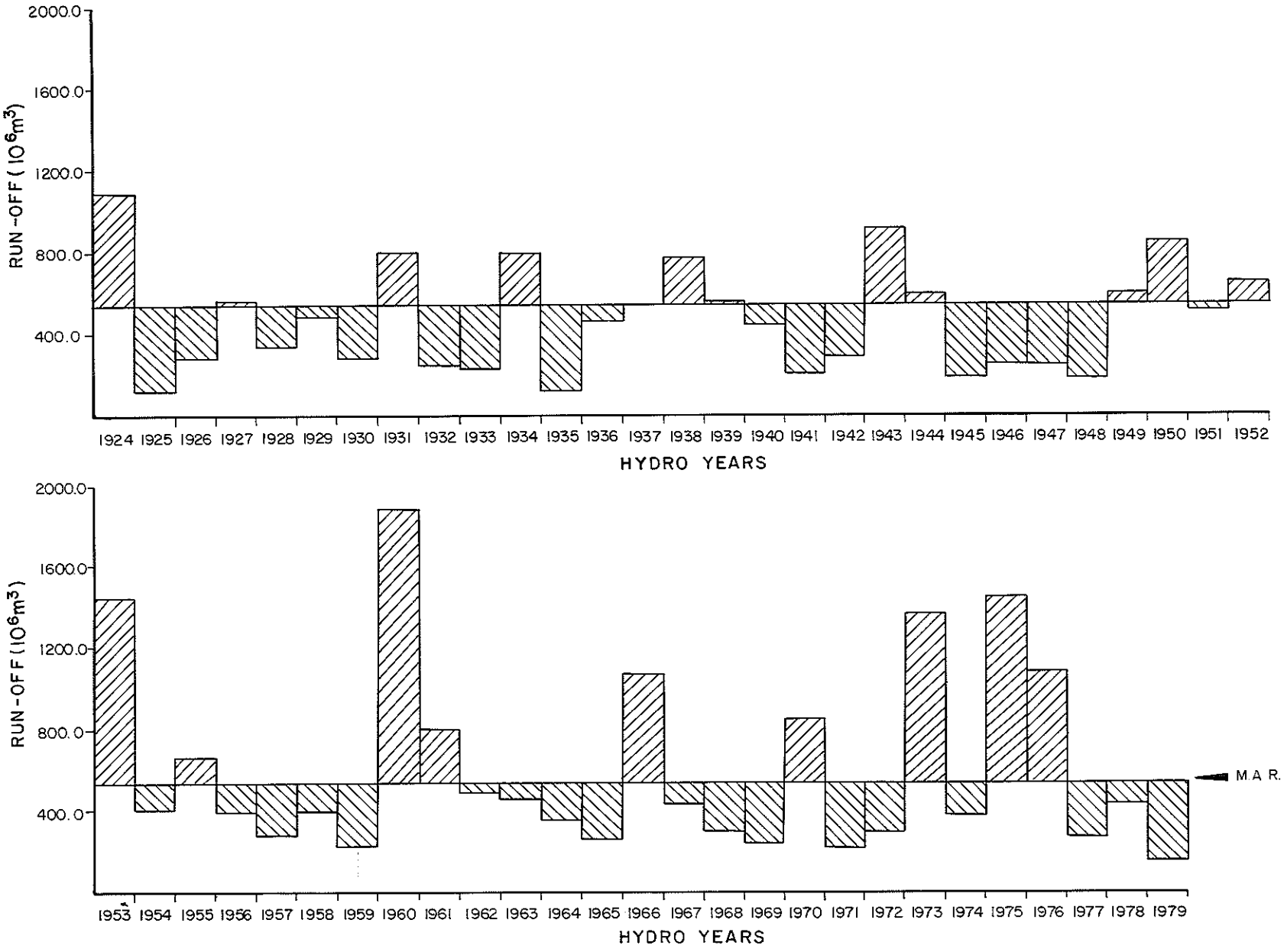


FIG. 3 : Simulated annual run-off for the Gourits catchment 1924 - 1979 (Crowther, 1987)

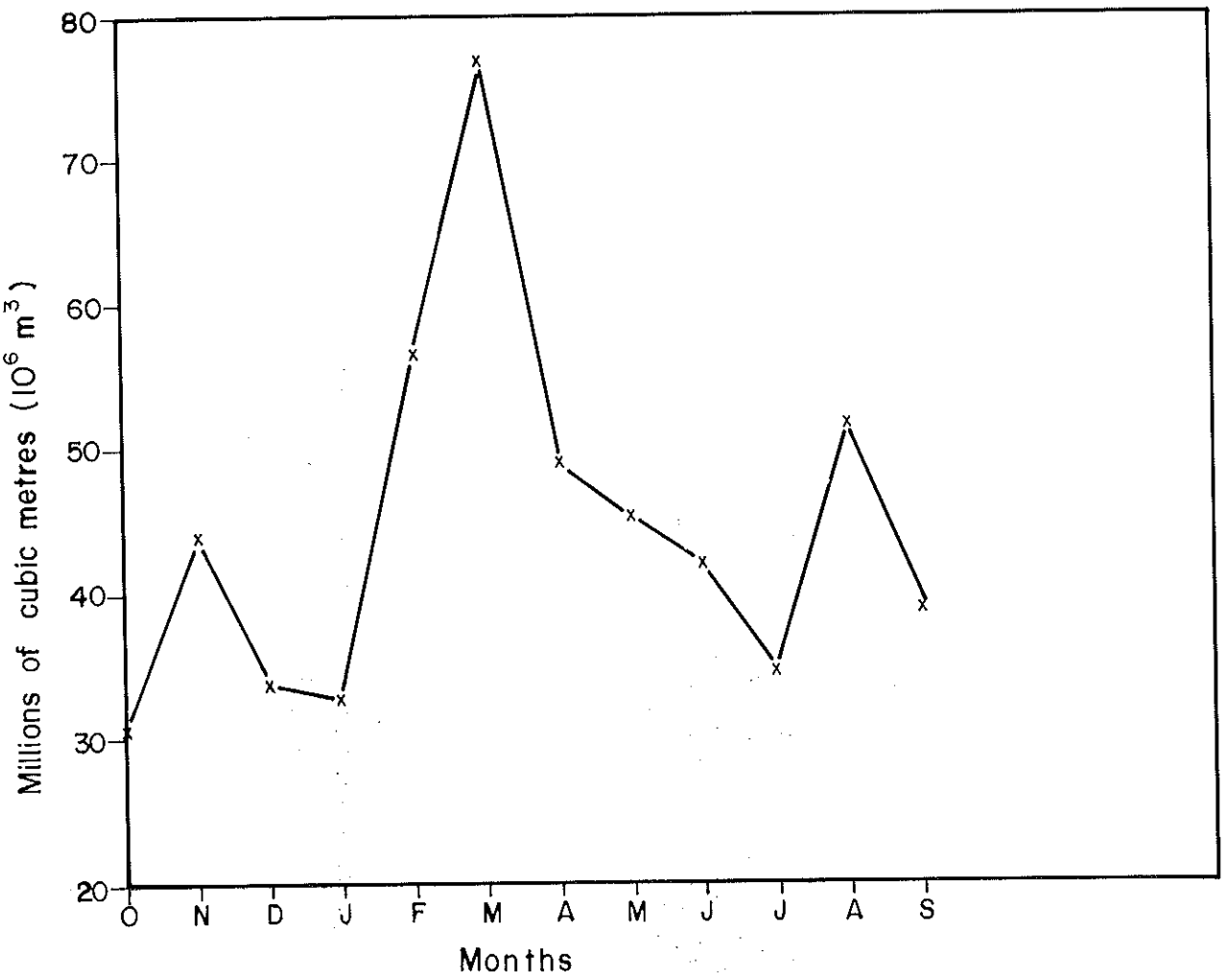


FIG. 4: Mean monthly simulated run-off for the Gourits catchment from 1924 - 1979 (after Crowther, 1987)

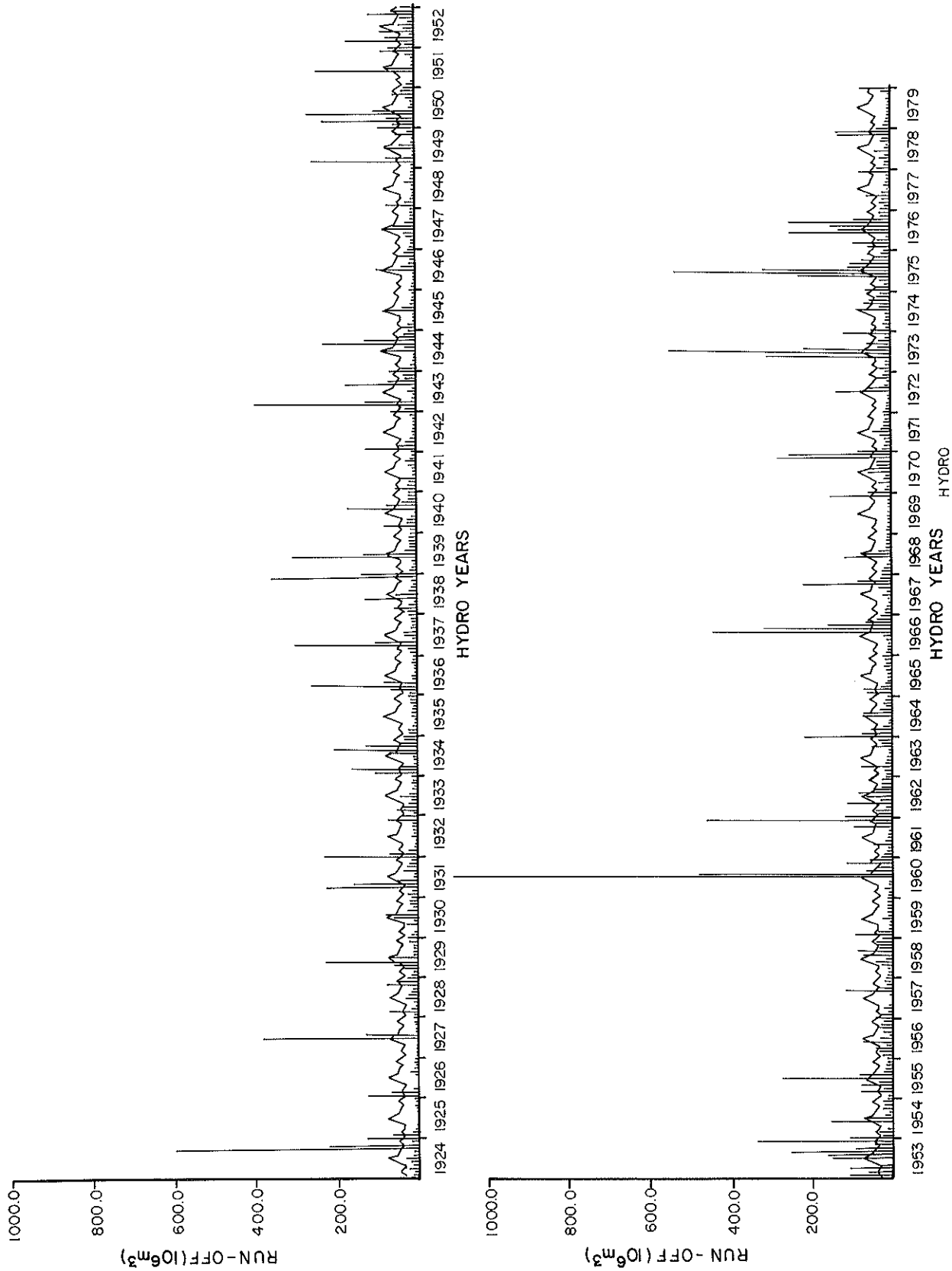


FIG. 5 : Simulated monthly run-off for the Gourits catchment 1924 - 1979 (Crowther, 1987).

3.1.4 Land Ownership/Uses

The Gourits River drains large areas of the Great Karoo and the whole of the Little Karoo. This is the most important area for sheep and goat farming in South Africa. The bulk of the sheep are fine-woolled Merinos while the Dorper is the dominant mutton sheep. Karoo and Angora goats as well as cattle are farmed (Hallward, 1986). The Gourits proper and the Weyers rivers are used to irrigate the fertile, deep soils. The farming activities are limited by the fact that the water supply from the river is erratic due to a weak flow for the greater part of the year and is often brackish. Pumping costs are also very high. (Department Agricultural Technical Services, 1975, *in litt.)*. The main crops are lucerne, wheat and oats and other grains for cattle feed. The Little Karoo also produces the bulk of vegetable seed grown in South Africa (Department Environment Affairs, Forestry Branch, *in litt.)*. Geustyn *et al.*, 1987 state that the land to veld ratio in the Heidelberg/Riversdale region as well as in the Mossel Bay/Albertinia region is 65:35, and 8 bags of wheat and 13 bags of oats are produced per hectare. The carrying capacity of the soil in both areas varies from 2,8 small stock units (sheep and goats) per hectare on cultivated pastures, to 0,3 on natural pastures. A small area at 'Die Poort' (Figure 1) is under vines, apricot and peach orchards. A few citrus orchards are present in the lower catchment, as well as vegetable patches. Ostriches are farmed in the area. Indigenous plants which are utilized in the area include aloes which are tapped by the local inhabitants for the bitter juice used in various medicines (Bulpin, 1980). A few farmers have permits from the CPA Chief Directorate: Nature and Environmental Conservation (CDNEC) to pick wild flowers both for the local market and for export, and also to cut thatching reed (dekriet, *Thamnochortus insignis)*. Figure 6 shows an example of cultivated lands in the catchment.

FIG. 6: Agriculture in the lower catchment (ECRU, 87-06-10).

According to the Forestry Branch of the CDNEC *(in litt.)* there are no plantations of any significance in the Gourits catchment. A few farmers have planted small areas on the Outeniqua Mountains, but most areas have been clear-felled and converted to agricultural lands.

3.1.5 Obstructions

There are 10 large dams and many irrigation systems on the Gourits River and its tributaries. The most important are:

Dam	River	Storage capacity
Floriskraal	Buffels	$62,9 \times 10^6$ m^3
Gamkaspoort	Gamka	$54,3 \times 10^6$ m^3
Kammanassie	Kammanassie	$32,9 \times 10^6$ m^3
Stompdrif	Olifants	$61,2 \times 10^6$ m^3

(From Reservoir inflow records, 1978 and Pitman *et al.*, 1981). Figure 1 shows the positions of these dams.

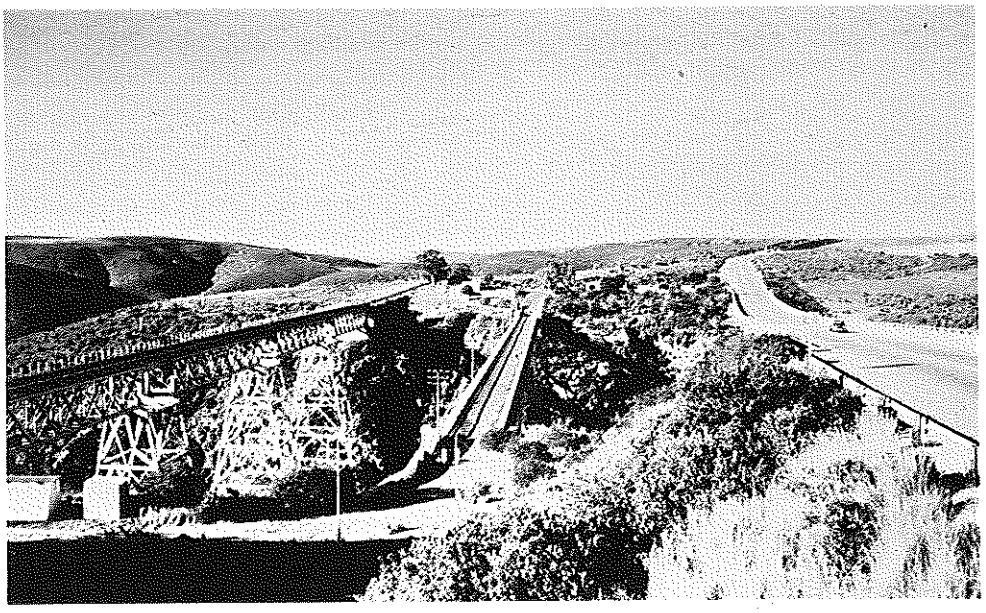


FIG. 7: Twin rail and road bridges crossing the Gourits River with the old disused bridge between them (CPMA, 88-06-23).

The spectacular twin rail and road bridges (Figure 7), 270 m long and 75 m above the Gourits River, span the ravine near the town of Gourits (Figure 1) The road bridge which was built in 1977 is one of the largest pre-stressed concrete strut bridges in the world. The old bridge built in 1892 is still in existence. None of these structures obstruct the flow of water. During the Laingsburg floods in 1981, the level of the water rose considerately as can be seen in Figure 8.

3.1.6 Siltation

During floods much silt is carried down the Gourits River to the mouth (Figure 9). This originates mostly from the Karoo catchment and that of the Valsrivier. It does not threaten the river mouth or the developments on the banks of the river (Department Agricultural Technical Services, *in litt.)*. According to G F van Wyk, formerly of the Department of Nature Conservation, *(in litt.)* the water is silt laden and carries a plume of silt which can be seen for miles out to sea when the river comes down in flood during the summer. This was clearly observed during the floods in January 1981 when a mud-plume (porridge

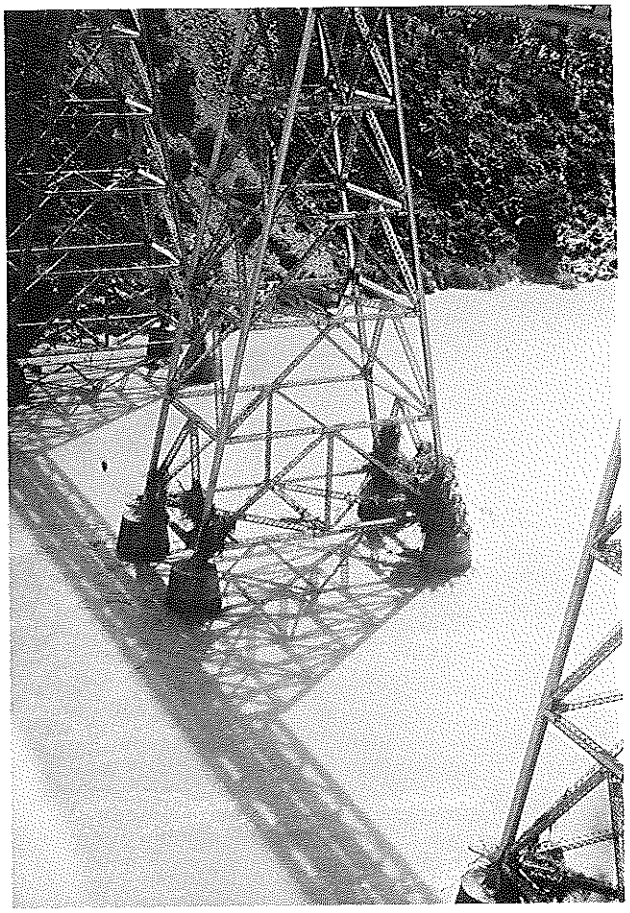


FIG. 8: Pylons of road bridge showing height of water and level of debris during the floods of January 1981 (ECRU, 81-01-27).

consistency) extended 1-2 km seawards and 10-20 km eastwards (T Heinecken, EMA, *in litt.)*. On a LANDSAT image (Figure 10) produced by the satellite remote sensing centre of the CSIR on 7 February 1981, an extensive mud plume is still visible.

3.1.7 Abnormal Flow Patterns

According to a memorandum from the Department of Agricultural Technical Services (75-07-04), the Gourits River flows very slowly for at least 75 percent of the year. However, violent floods occur intermittently.

During the last two decades, major floods have been recorded during August 1971, March 1974 and 1976, June 1976, April and May 1977 (River Flow Data, 1978). More recently, a flood which will not easily be forgotten occurred on 25 January 1981 and a lesser one in August 1986. The 1981 flash flood was described as South Africa's greatest natural disaster (this was prior to the 1987 Natal floods), washing away a large part of the southern Karoo town of Laingsburg, situated on the Buffels River (Figure 1) and according to Hallward (1986), causing 104 people to lose their lives. The total damage was estimated at R10-million (Figure 11). Over 200 mm rain fell during a 3 day-period in the catchment and the flood peak discharge in the Buffels River at the National Road bridge was estimated at approximately 3 700 m^3/s (Roberts and Alexander, 1982). According to provisional estimates, approximately 7 000 cubic metres per second of water and silt flowed past Laingsburg into the Floriskraal Dam (Figure 1) situated below the confluence of the Buffels and Bobbejaans rivers (Estié,

FIG. 9: Silt and debris at river mouth after floods (ECRU, 81-01-27).

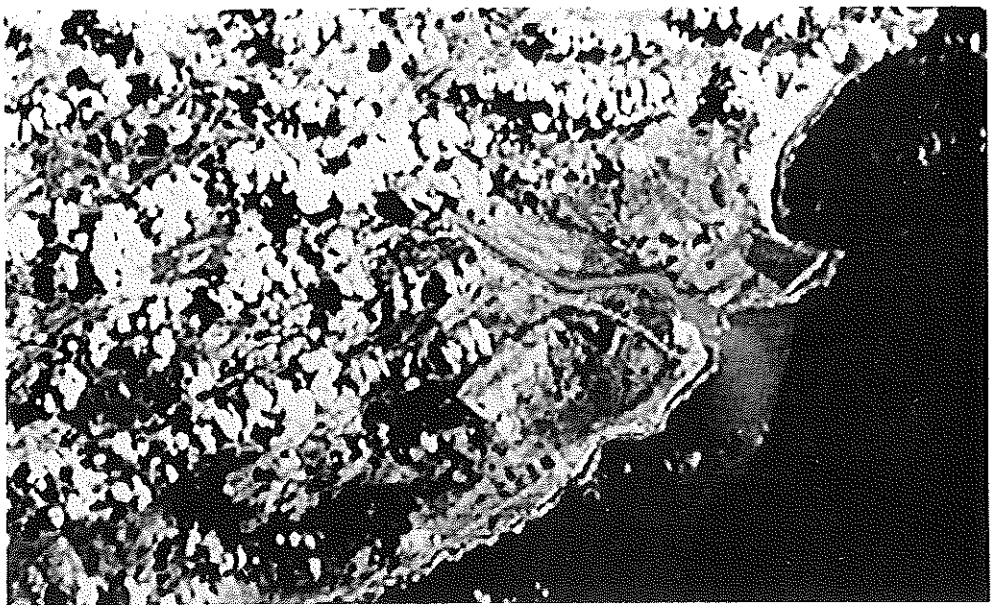


FIG. 10: LANDSAT image of silt plume in the sea at the mouth of the Gourits following floods (Satellite Remote Sensing Centre, CSIR 81-02-07).

1981). The maximum speed of water flow in the middle of the river was at least 6 m/s (Marais, 1981). The flood volume at the Floriskraal Dam was 145 x 10^6 m^3 and at the Gamkapoort Dam, 206 x 10^6 m^3. The calculated peak flow in the Gourits River just south of the gorge through the Langeberg Mountains was 11 400 m^3/s. At this site the sediment deposition was probably 1 m deep on average (Kovács, 1983). The low-level bridge at 'Die Eiland' in the upper reaches of the estuary also washed away during these floods (Figures 12 and 13). The devastation of Laingsburg during this major natural disaster could possibly have been averted or at least substantially reduced had the low lying sections of the town not been built on the floodplain. More importantly, had the Conservation of Agricultural Resources Act 43 of 1983 been heeded and had sound management been practised in the catchment e.g. preventing the destruction of the natural vegetation by overgrazing and ploughing on and in the vicinity of the river banks, the rate of flow of the water would have been broken and thus been less destructive. This would also have reduced the enormous silt load carried downstream.

FIG. 11: Devastation of Laingsburg during the floods of January 1981 *(Die Burger,* January 1981).

In August 1986, there was another major flood and 148 mm rain were measured in a week at Riversdale (Weather Bureau, pers. comm.). The state of the Gourits mouth on 31 August 1986 as well as the silt laden water can be seen in Plate II.

3.2 Estuary

3.2.1 Estuary Characteristics

According to Duvenage (1983) and the Department of Planning report of 1971, the estuary of the Gourits River extends as far as the causeway at 'Die Eiland' about 8 km upstream of the mouth (Centrespread). G F van Wyk *(in litt.)* as well as the Department of Agricultural Technical Services *(in litt.)* regard the limit as 8 miles (13 km) from the mouth. According to the species distribution of the vegetation found on the river banks during the ECRU Survey in June 1987, the limit of estuarine conditions is about 2 km upstream of the bridge i.e. about 10 km from the mouth. The tidal lag at Station 1 (Centrespread) on

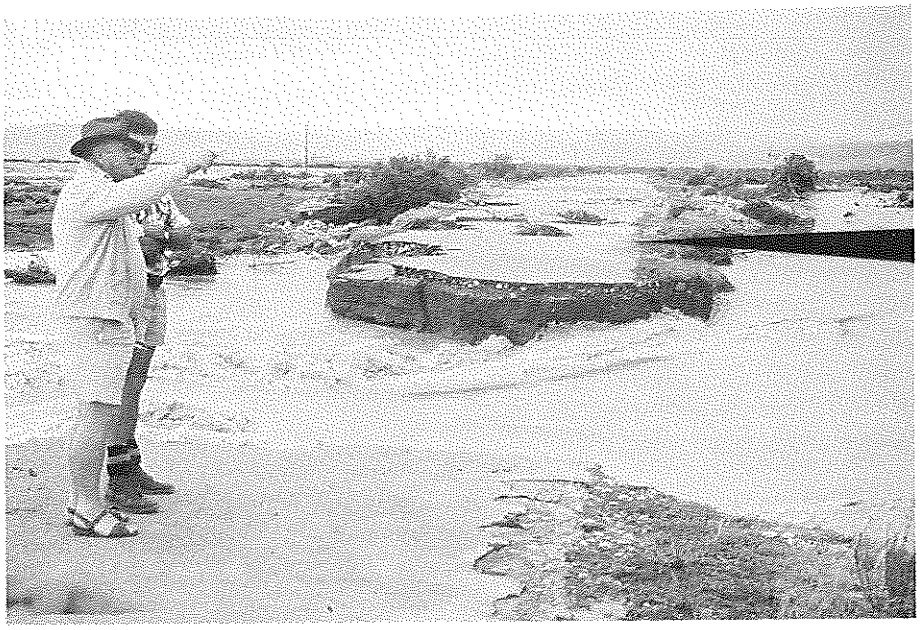


FIG. 12: Remains of the road leading on to the low-level bridge at 'Die Eiland' which was washed away during the 1981 floods (ECRU, 81-01-27).

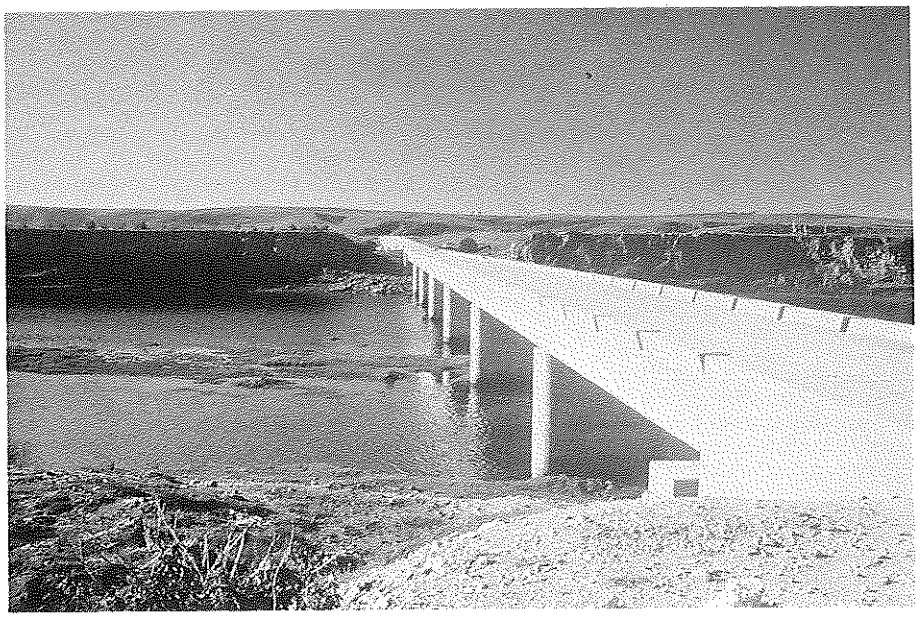


FIG. 13: New bridge built at 'Die Eiland' after the destruction of the low-level bridge in January 1981. The eroded near vertical banks are visible on the far side, with numerous holes being used by European- and Pied Starlings (ECRU, 87-06-10).

87-06-09 was approximately two hours at low tide and at the head of the estuary (Station 4) was about four hours on 87-06-10, two days before spring tide. Duvenage (1983) gives the surface area of the estuary as 188 ha.

The mouth of the river is normally about 18 m wide but during the rainy season and at high tide, it may be wider (Summers *et al.*, 1976). Heydorn and Swart (1987) estimated the width to be 40 m during the floods in August 1986 (Plate II). The banks are gently sloped on the west side and on the east mostly gentle, but the last kilometre has a steep bank with rocky outcrops. Near the causeway, eight km upstream, the banks are almost vertical in places, and about four metres high on both sides (Figure 13).

At the four sampling stations (Centrespread) the depth of the estuary in the main channel in June 1987 varied from 1,3 m at Station 1 to 4 m at Station 4. At other places depths of up to 6 m were measured (e.g. on outer bend of the first meander downstream of the road bridge). More detailed depths in the mouth area are shown in Figures 17, 18 and 19.

3.2.2 Geomorphology and Bottom Materials

During the ECRU Survey in June 1987 the mud/marine sand interface was found to be approximately one-third of the way between Stations 1 and 2. The estuarine mud/river sand interface was found to be approximately two-thirds of the way between Stations 3 and 4 at the bend in the river (Centrespread). The position of the mud/marine sand interface reflects flow conditions in the river. During periods of low flow, the sea will dominate and the interface moves upstream. The interface will move downstram during high flows (Section 3.2.4).

3.2.3 Coastal Hydraulics

(Sections 3.2.3 - 3.2.8 were contributed by L Barwell, EMA)

The functioning of an estuary mouth and therefore the estuary as a whole is influenced by the approaching deep-sea swells. Waves approaching the coast at an oblique angle are responsible for the generation of longshore sediment movement.

Geomorphological features in the vicinity of the Gourits River mouth such as Cape Agulhas to the west and Cape St Francis to the east, influence the approaching deep-sea swells. Owing to this fact, only swells within a sector between 87 and 252 degrees can reach the area off the Gourits River mouth. Data were obtained from VOS (Voluntary Observing Ships) for this sector (Figure 14) and from these data it can be seen that the dominant swell direction is from the south-west with a small component from the east occurring during the summer, autumn and spring months. On average for the whole year, deep-sea swells from the south-western sector occur most frequently with a small component from the east (Figure 14). The maximum swell height for the deep-sea swells within this region, falls within the 7 to 10 m range.

From the deep-sea wave data it can be deduced that oscillation between the eastwards and westwards longshore sediment movement, with a small net transport towards the east, can be expected at the Gourits River mouth. This is confirmed by the fact that, although sandspits periodically occur on both sides of the mouth (Figure 22a), the dominant sandspit growth is from the western side of the river mouth.

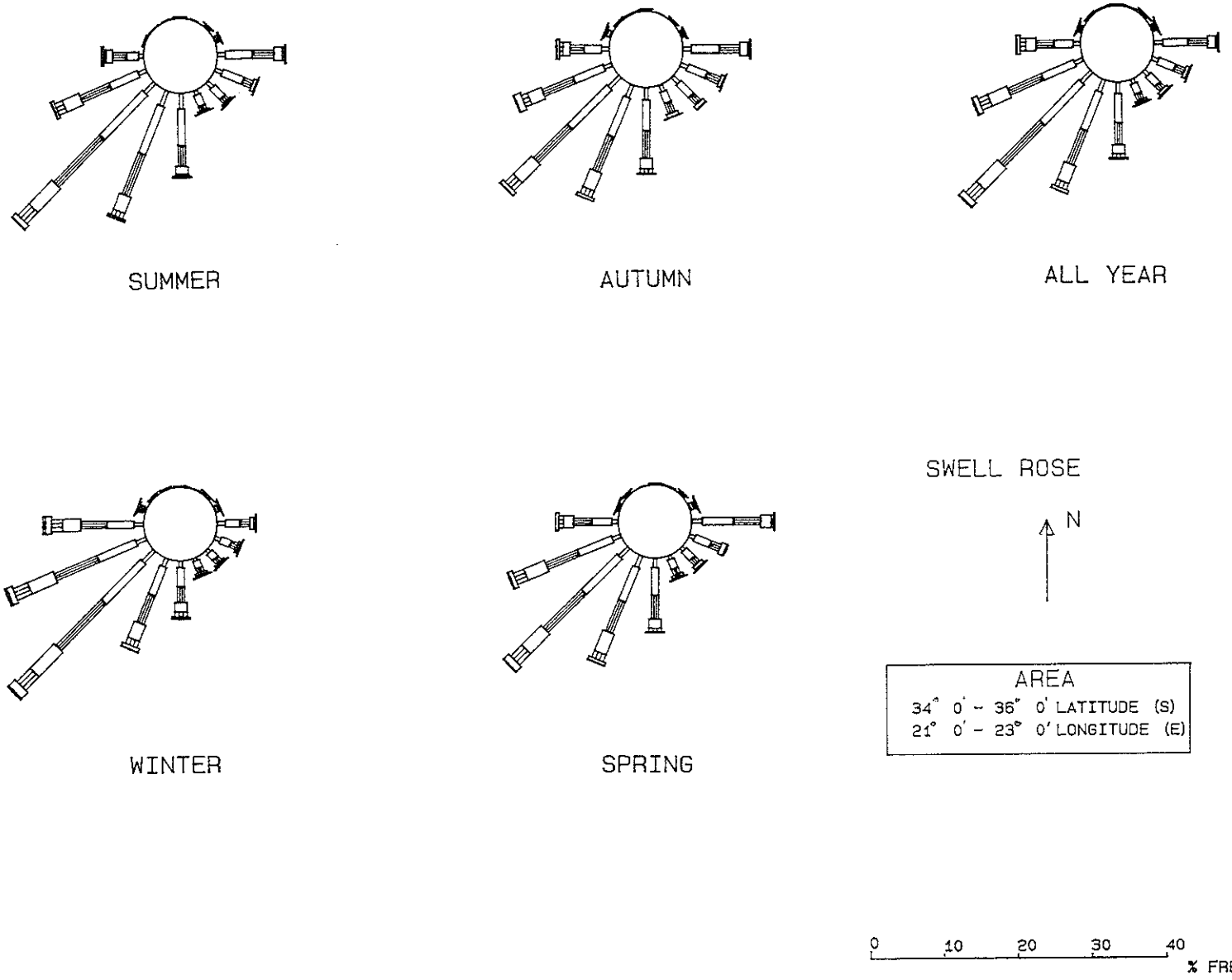


FIG. 14 : VOS Swell roses for the Southern Cape.

3.2.4 Estuary Hydraulics

The study of available aerial photographs indicates that a gradual build-up of sediment in the form of flood tidal deltas within the estuary occurs during times of low river flow, resulting in a near closure of the river mouth. During floods sediment is washed out to sea, forming an offshore delta whence sand is returned to the sandspit during calmer conditions.

Following the January 1981 flood, new sandspits started forming almost immediately and developed through many stages over a period of six years to build up to a state similar to that which existed in 1979, prior to the flood (Figures 21 and 22). This is indicative of a fine balance between the freshwater and ebb-tide forming the scouring mechanism on the one hand and the flood-tide creating the blocking mechanism on the other hand. It is therefore important that this balance is maintained and future developments, such as dams which could result in a reduction of the regular scouring of the river mouth by frequent small floods, should take cognisance of this fact.

3.2.5 Sediments

Sand was sampled at the mouth and adjacent beach on 13 November 1987. The grain size distribution for the samples taken indicate a uniform, medium sand spread along the whole sandspit and beach adjacent to the mouth ranging in diameter from 210 to 468 microns (10^{-6}m), the mean size being 342 microns.

3.2.6 Wind and Aeolian Transport

Wind data obtained from Voluntary Observing Ships (VOS), (Figure 15) indicate that winds are well distributed within the western, southern and south-western sectors with a dominance from the west and south-west during the spring and winter months and a slight dominance from the east during summer. During autumn, winds are balanced between the western, south-western and eastern sectors. On average for the whole year, winds are well distributed within the western, south-western and eastern sectors with the westerly winds having the highest frequency of occurrence and highest velocity.

The VOS data were analysed and an aeolian creep diagram (Figure 16) for the Gourits River area deduced (Swart, 1986). These diagrams indicate how wind-blown sand would approach from different directions towards the centre of an imaginary circle on the ground. From the 'all year' diagram the potential aeolian sand transport rate (cubic metres per year per kilometre) can be calculated for various wind directions.

Calculations indicate that the aeolian sand movement is balanced between the west south-western and eastern sectors during spring, summer and autumn. A net sand movement towards the east is indicated for the winter period. The diagram showing the 'all year' potential aeolian transport rate indicates that a net movement towards the east north-eastern sector occurs.

The existence of sand plumes on the western and eastern sides of the river mouth (Figure 20b) is an indication of the prevailing aeolian sand movement in the area and correlates with that predicted in the creep diagram (Figure 16). The presence of a reasonably large sand plume, or sediment sink, on the eastern side of the river mouth and the fact that a net aeolian sediment movement to the east north-eastern sector was predicted and that the only source of aeolian sand would be from the sandspit to the west of this sand plume, indicate that the mouth must have been closed for various lengths of time in the historical past.

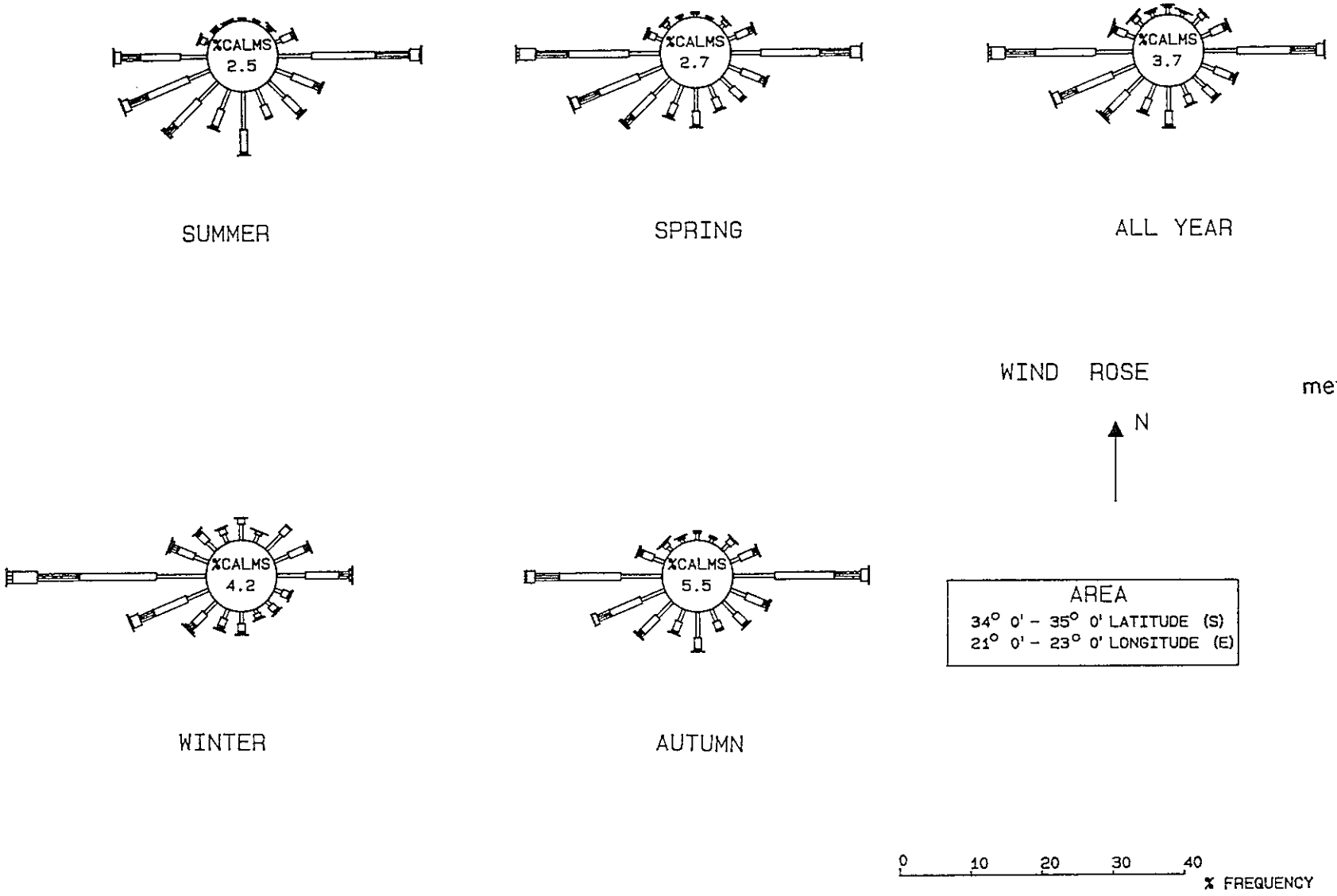


FIG. 15 : VOS Wind roses for the Southern Cape.

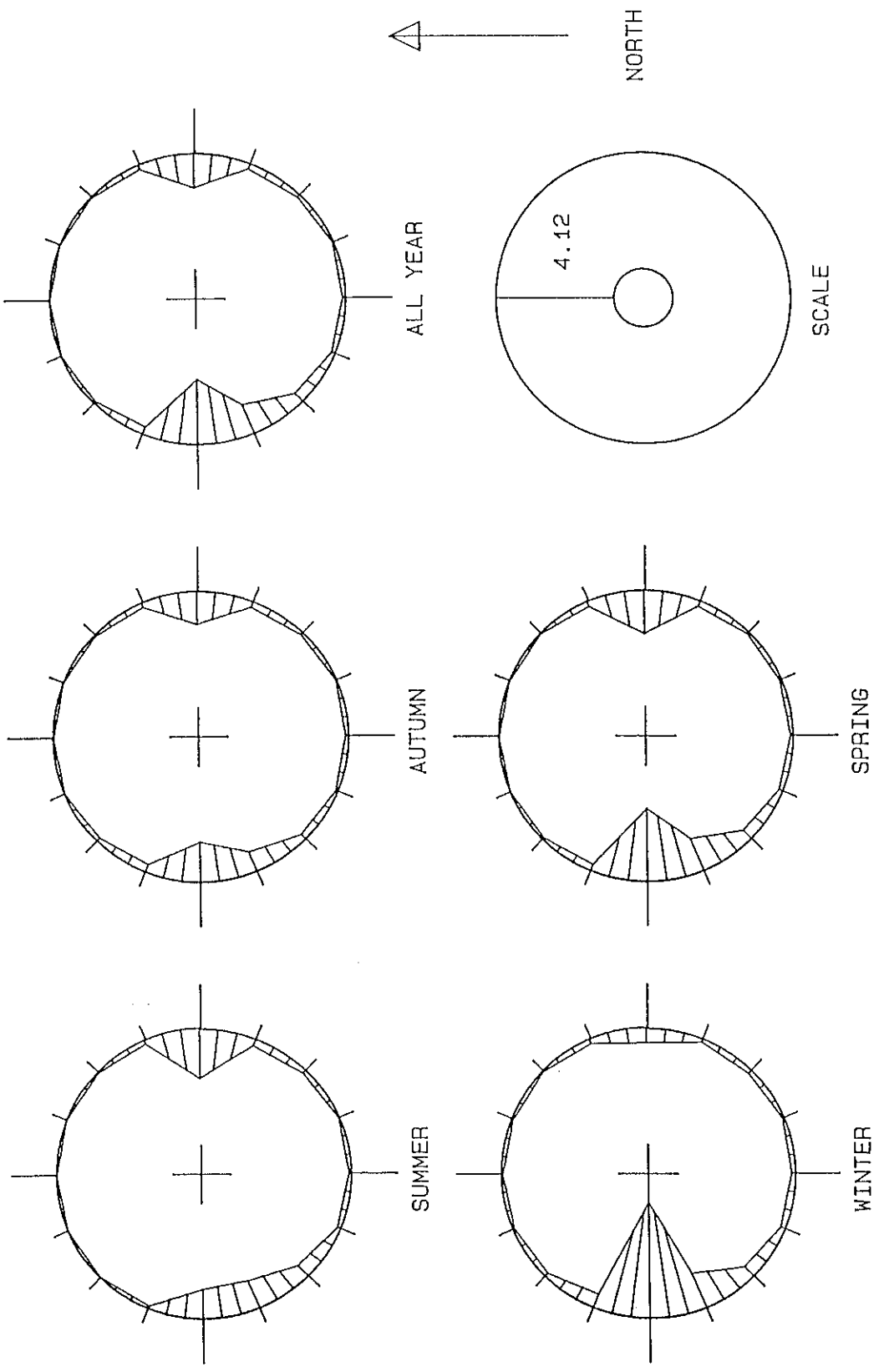


FIG.16 : Aeolian creep diagram for the Gouris

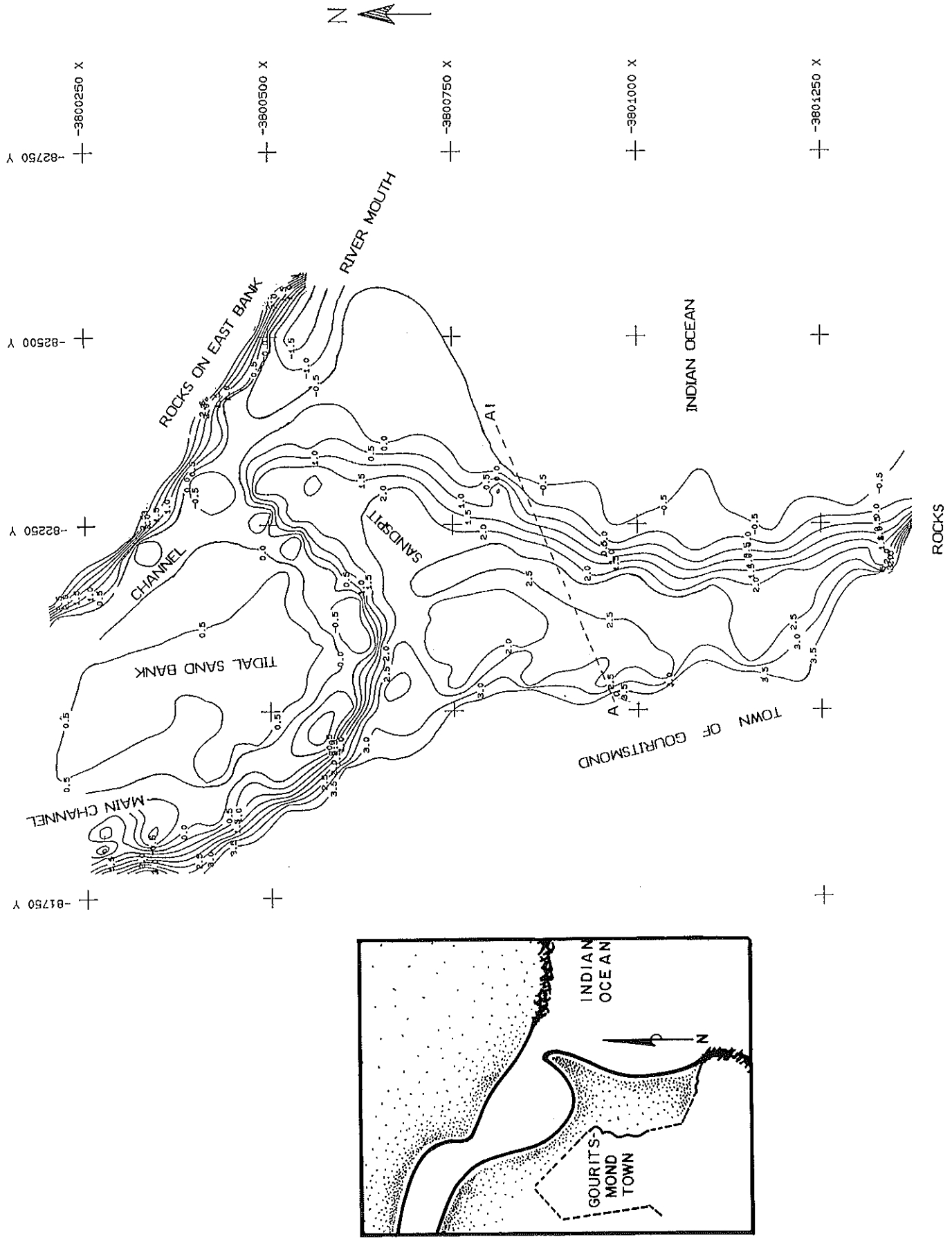


FIG. 17 : Contour map of the Gouritsriver mouth, 5 August 1986

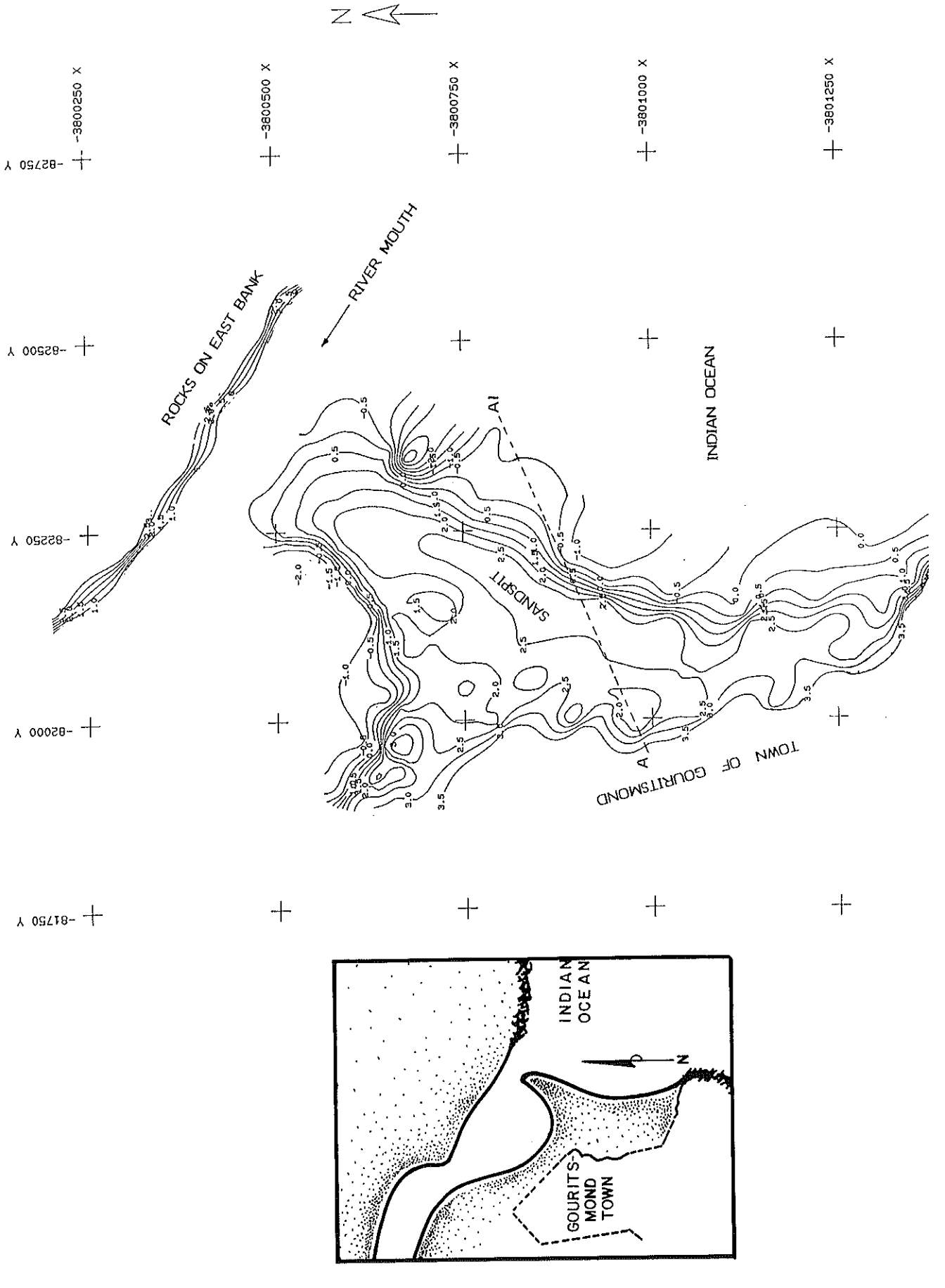


FIG. 18 : Contour map of the Gourits River mouth, 13 September 1986

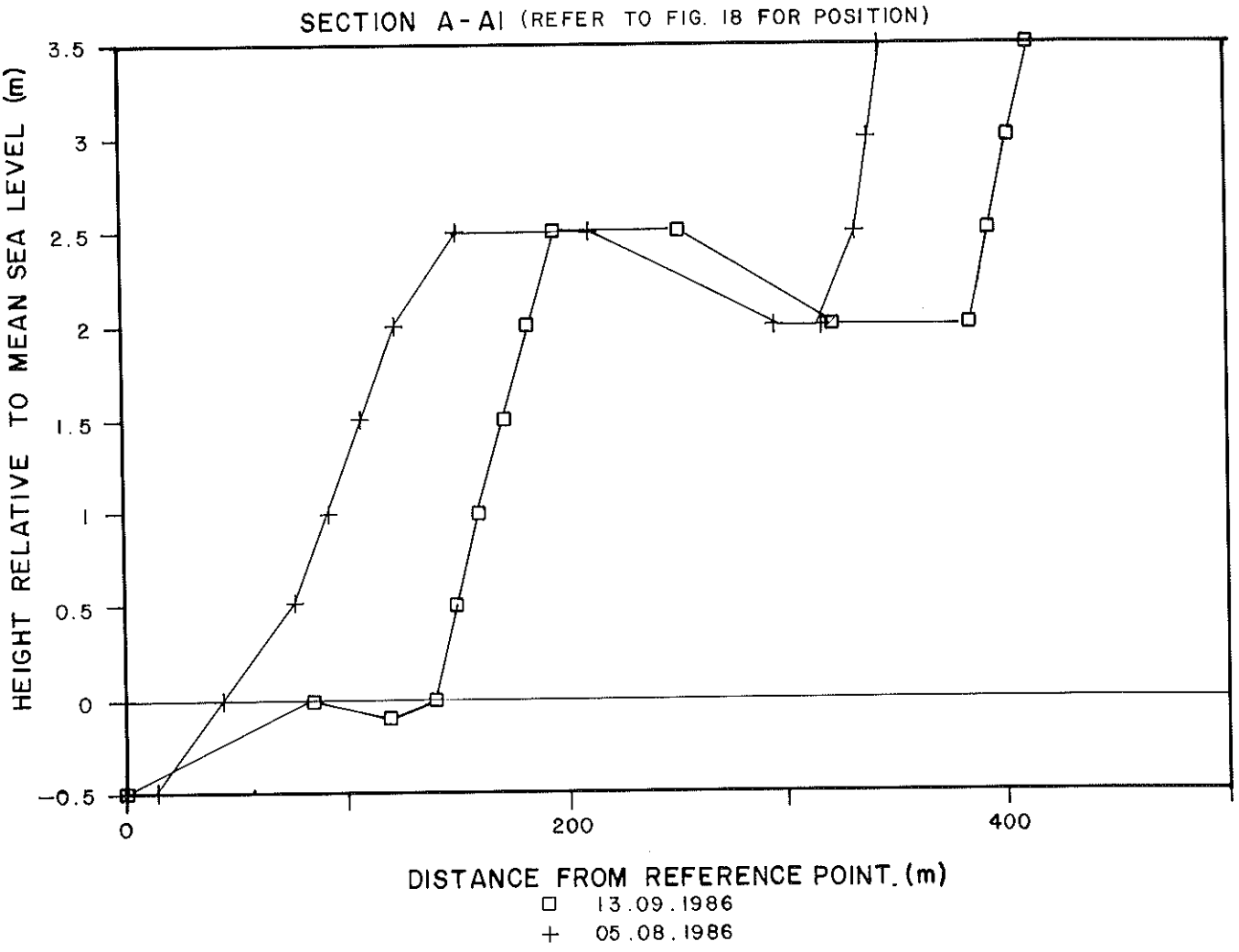


FIG.19: Cross-section of the Western bank at the mouth of the Gourits River

3.2.7 Bathymetry

Although the Gourits River mouth occasionally forms a double spit, as was the situation in 1984 (Figure 22a), the mouth as a rule consists of an extensive sandspit on the western side with rocks lining the eastern shore of the mouth. The mouth is therefore classified as being Type A: a single sandspit with rock on the opposite shore (Heydorn and Tinley, 1980).

A tachymetrical survey of the estuary, estuary mouth and beach area was carried out by the then NRIO on 5 August 1986. A follow-up survey of the sandspit and beach area was done on 13 September 1986 after a minor flood, accompanied by heavy seas. Contour maps and a comparative cross-section of the sandspit were prepared (Figures 17, 18 and 19), (CSIR, 1988).

At the time of the initial survey (5 August 1986) the mouth was located on the eastern side and was about 30 m wide with an average bed level at -0,5 m below the mean sea level (MSL). Upstream of the mouth, the river split into two channels on either side of a large tidal sand bank with the main channel hugging the western side. The average bed level of the main channel was -0,5 m (MSL). The sandspit level varied between +2,0 and +2,5 m (MSL) whereas the sand bank averaged +0,5 m.

The survey on 13 September 1986 indicated a change in the beach slope along the seaward side of the sandspit and a widening of the river mouth to about 100 m. Erosion of the beach and sandspit was caused by high energy waves and a set-back of up to 50 m occurred (Figure 19).

3.2.8 Historical Changes

An analysis of historical maps and photographs shows the Gourits River mouth to be stable within the dynamic mouth area demarcated by rocky platforms on both the western and eastern sides. As shown in Figures 20a, 20b, 21a and 22b, the mouth configuration is typically Type A: single spit with rock on the opposite bank, but reverts to Type C: rocky headlands (platforms) on both sides after major floods (Figure 21b) and Type B: double spit (Figure 22a) during the rehabilitation period following the flood (Heydorn and Tinley, 1980).

The fact that large quantities of potable water are now available to the town of Gouritsmond (see Section 3.2.9), has made it possible for more development to take place. Future development of the land along the western side of the river mouth and estuary, should take cognisance of the dynamic area surrounding the mouth and development should be located well back from the dynamic zone. The extent of this dynamic zone is clearly indicated by comparing the situation at the mouth before and after the 1981 flood (Figures 21a and 21b).

3.2.9 Land Ownership/Uses

The small resort of Gouritsmond is situated on the west bank of the estuary near the mouth. According to Geustyn *et al.* (1987) there are 263 erven of which 173 have houses built on them. There is a caravan park with 100 sites, a small hotel and a shop (Centrespread). Six business sites are available of which four are utilized at present (Langeberg Divisional Council, pers. comm.). Brink, *et al.* (1986) state that there are 60 permanent residents and that during the peak season this increases to 2 800. The town's development was restricted by a shortage of drinking water, which came originally from a spring, situated on the sea side of the beach front road, near the western end of the village. Up to the 1940s, this was the sole source of water. Now a plentiful supply of good quality water is piped from a spring about 14 km inland at Doordrift

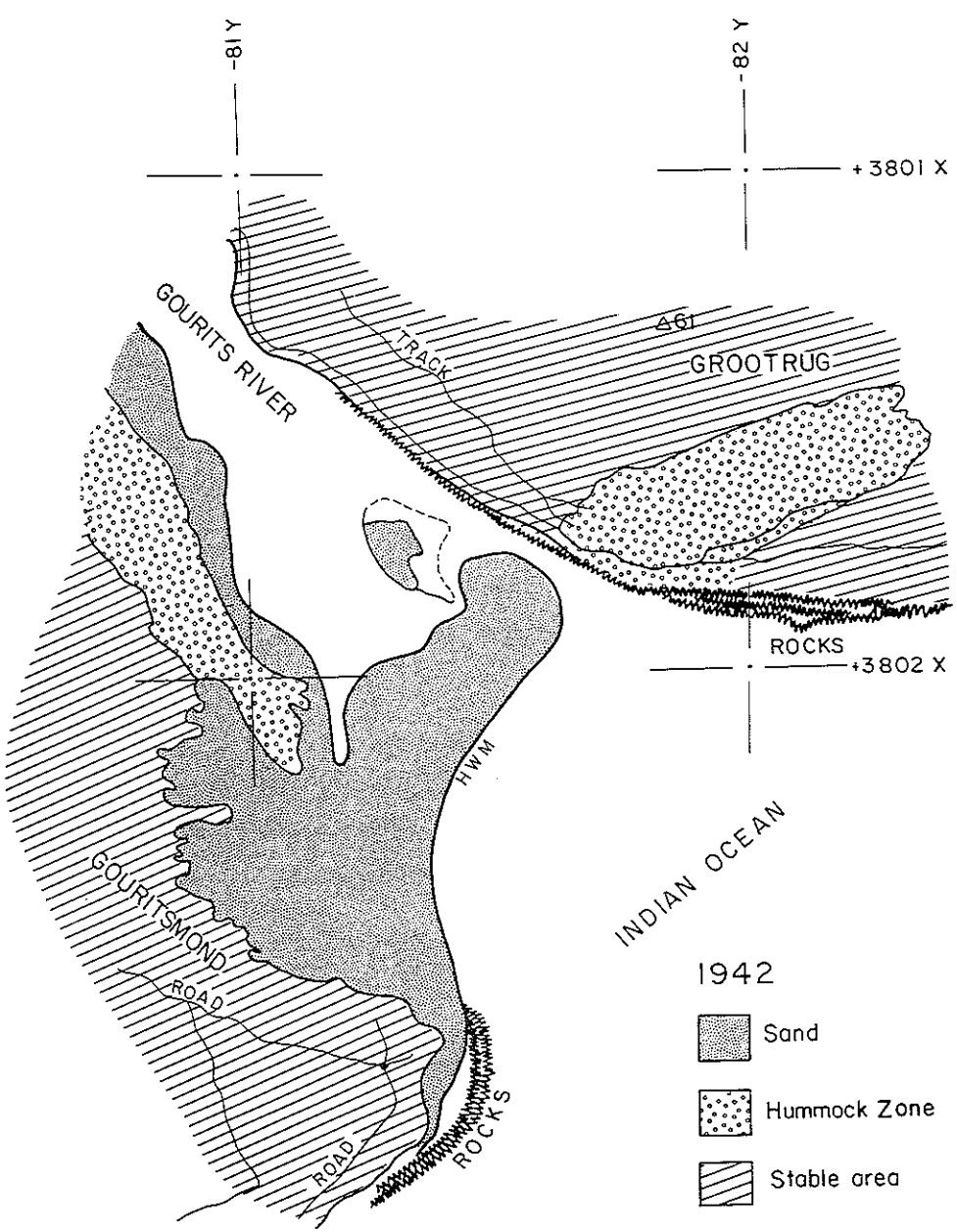


FIG. 20 a : Position of mouth, 1942

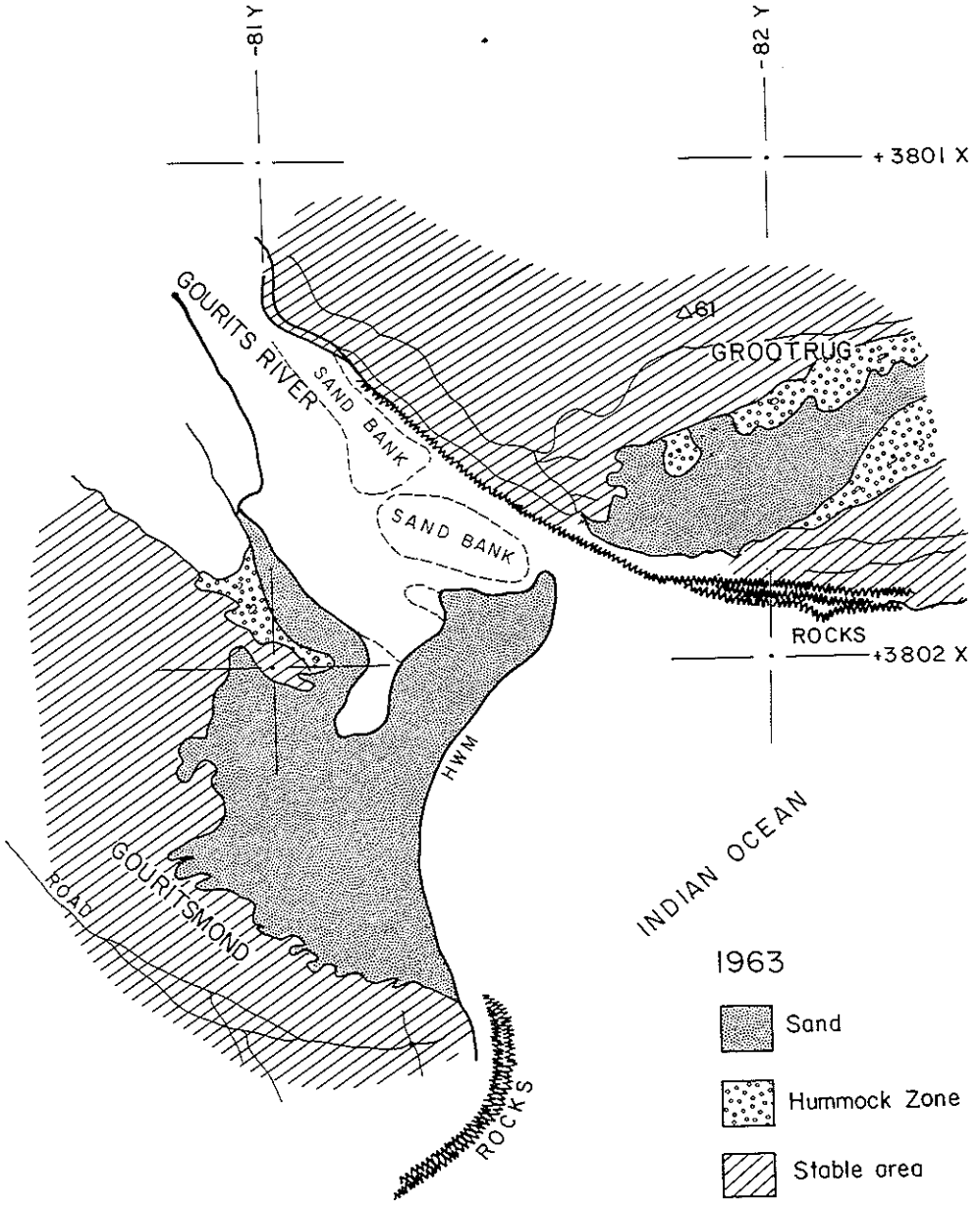


FIG. 20b : Position of mouth, 1963

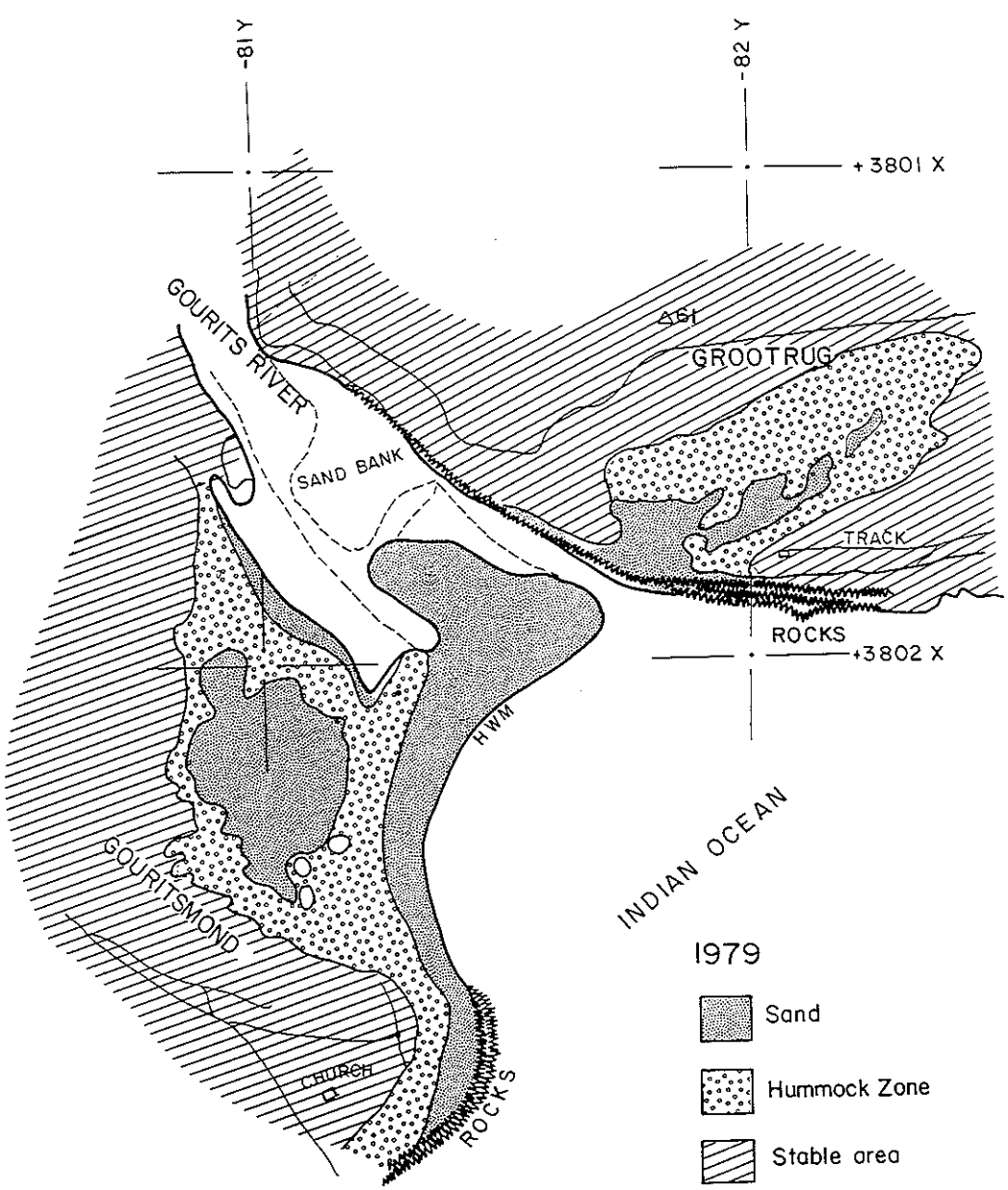


FIG. 21 a. : Position of mouth, 1979

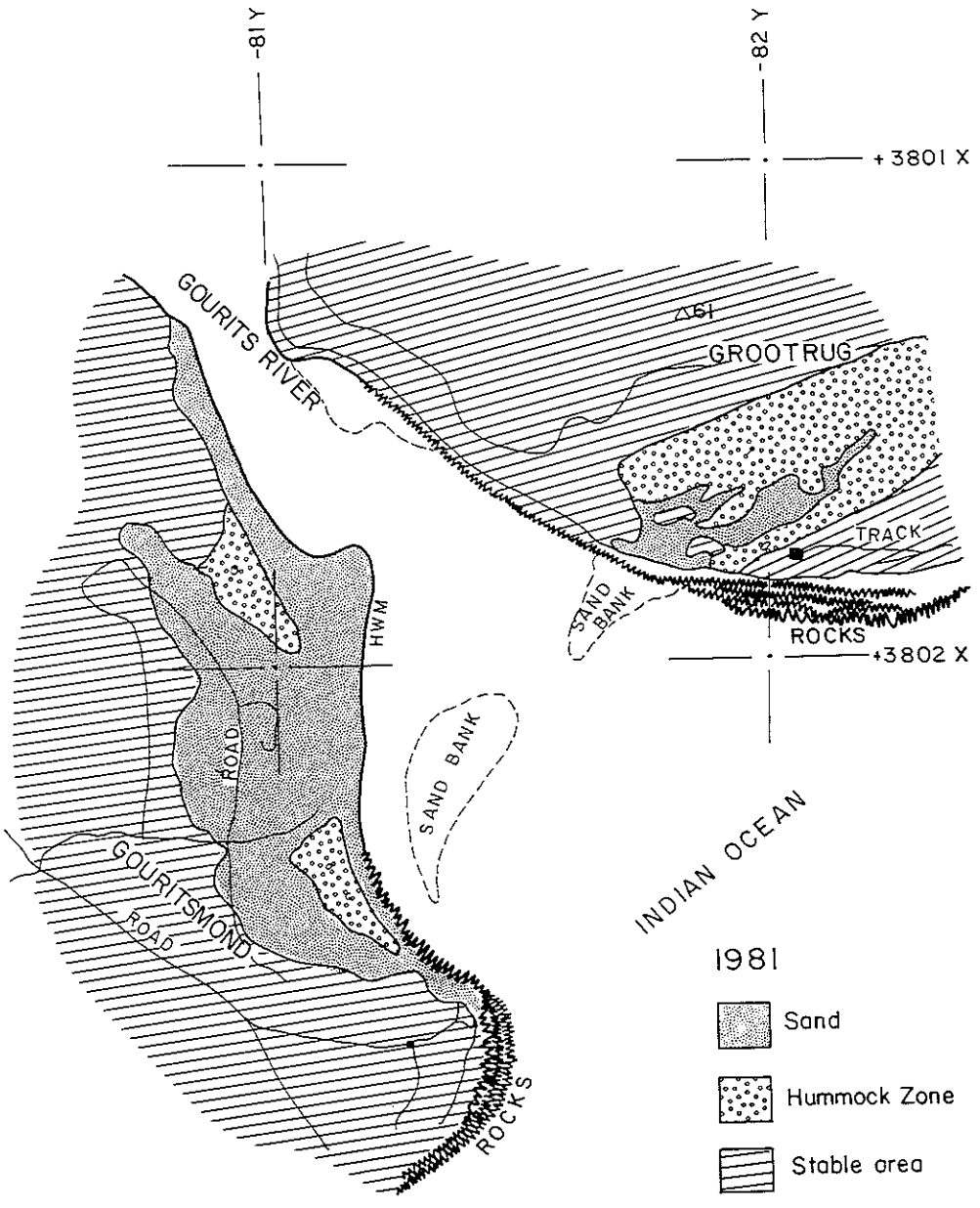


FIG. 21b : Position of mouth, 1981

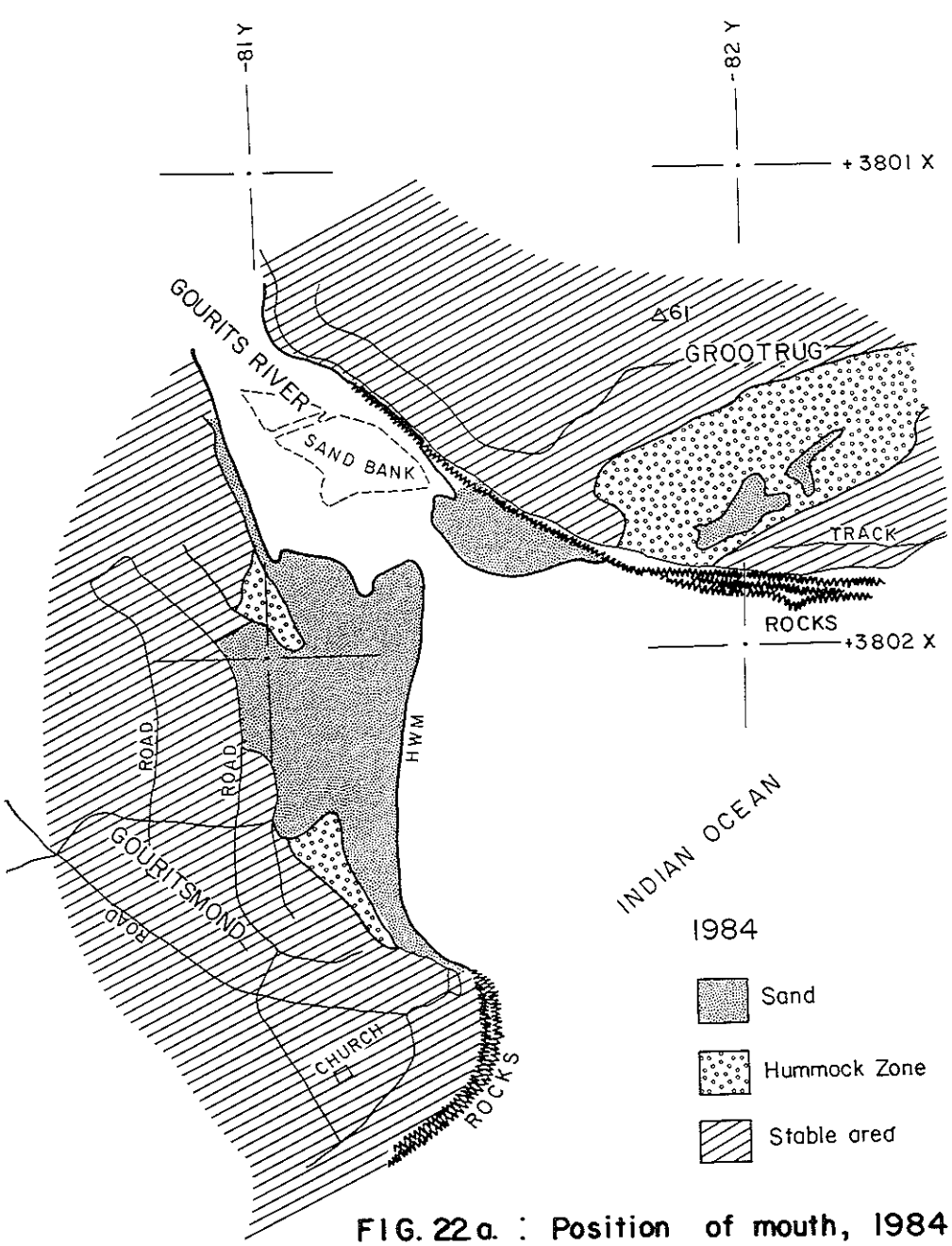


FIG. 22a. : Position of mouth, 1984

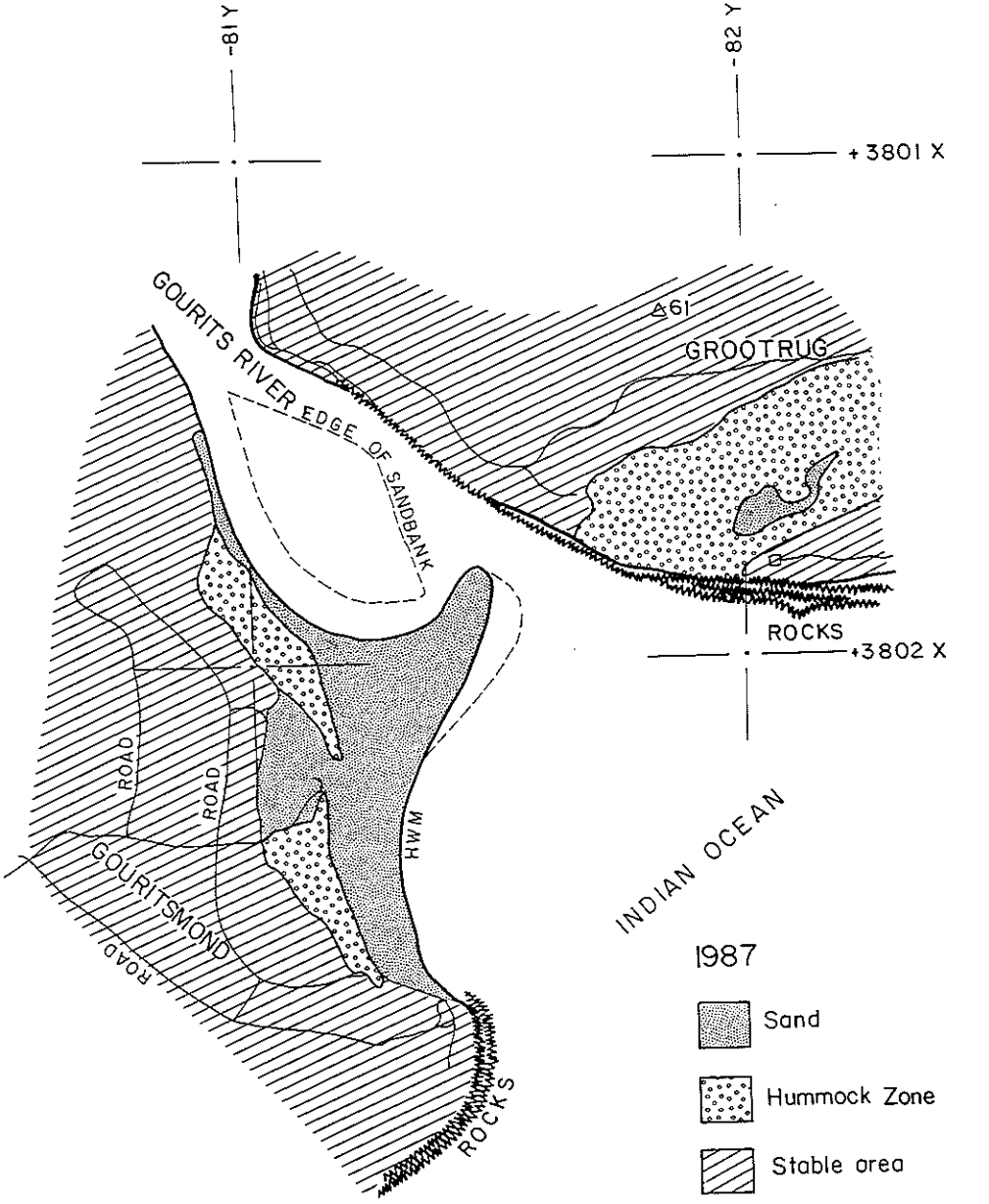


FIG. 22b. : Position of mouth, 1987

(Centrespread) (G P Theron, local resident, pers. comm.). In this region, the ground water is fairly close to the surface especially in areas where the rocks of the Cape Supergroup outcrop. Numerous springs are produced where the water table cuts the topography (Levin, 1987).

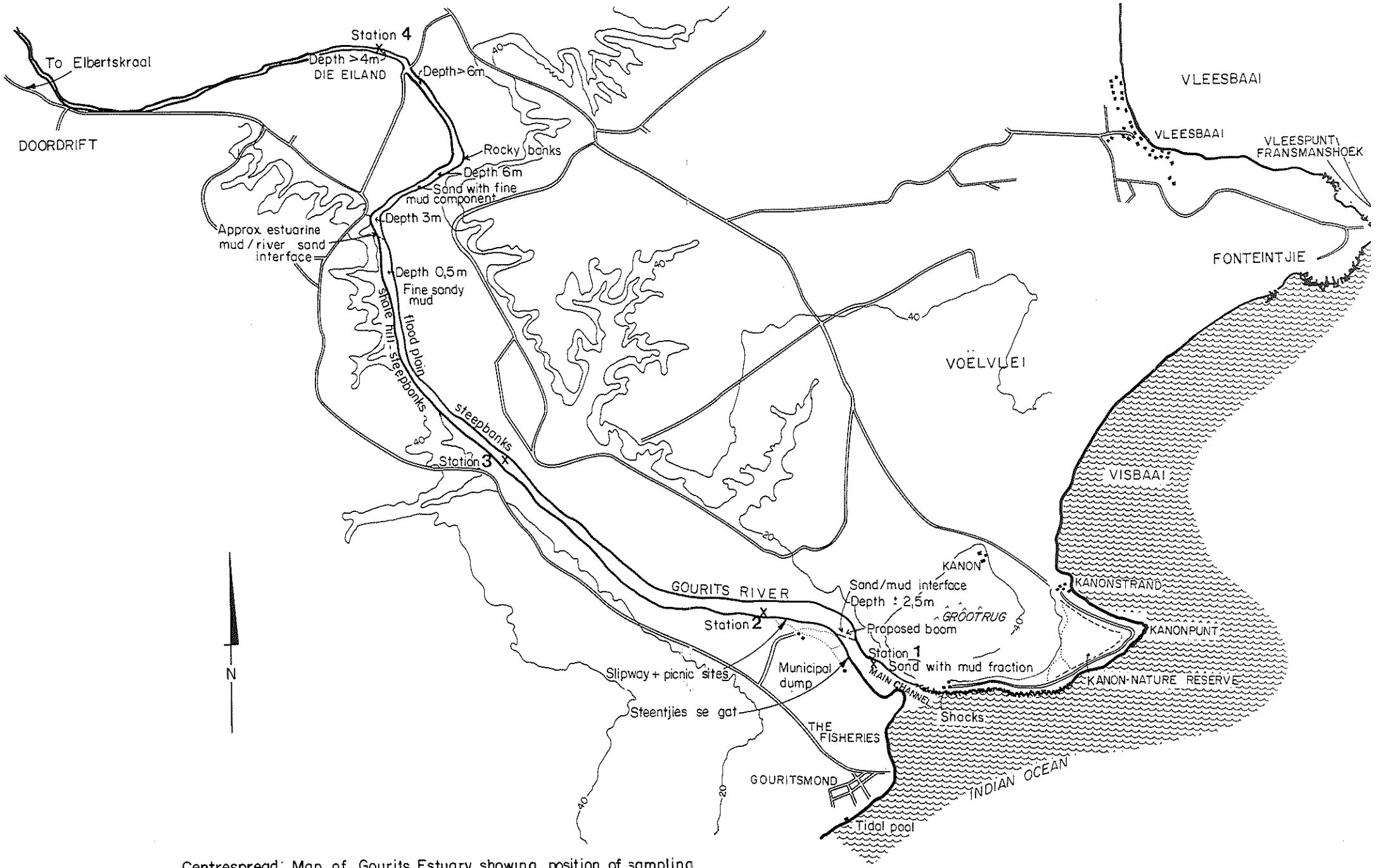
Dunes in front of the new extension to the village have been stabilized by the Divisional Council using dry reeds and by planting seawheat *(Agropyron distichum)*. In addition private residents have planted sour-figs *(Carpobrotus edulis)* in an attempt to stabilize the sand (Langeberg Divisional Council, pers. comm.) (Figure 23).

FIG. 23: Attempts to stabilize sand with vegetation in front of houses on the west bank (ECRU, 83-06-27).

A short distance upstream from the mouth on the west bank there is a track leading to several vantage points for fishermen, including the rocky stretch known as 'The Fisheries', where a Mr Gulliman started an industry mining deposits of amorphous silica which was used for furnace bricks in foundries (Bulpin, 1980). There is a slipway for launching boats and picnic sites in the saltmarsh area on the floodplain (Figure 29). The Municipal rubbish dump is also situated in this vicinity (Centrespread).

About 10 km west of Gouritsmond a new development is taking place, namely the Gouriqua Nuclear Research Facility of the Atomic Energy Corporation (Figure 1). This will be an important stimulus to development in the region (Geustyn, *et al.*, 1987).

The east bank of the estuary is privately owned. At present there are two primitive shacks near the mouth owned by a Mr Zietsman. Some dune stabilization was done by the local inhabitants prior to 1981. Situated further eastwards, is the Kanon private nature reserve owned by Mr J P Mostert and proclaimed in 1971 (Centrespread). It covers 43 ha and contains one of the few remaining tracts of undisturbed strandveld which is confined to the Gourits mouth region (Geustyn *et al.*, 1987). Still further eastwards, there is a huddle of holiday shacks known as Kanon.



Centrespread: Map of Gourits Estuary showing position of sampling stations, water depths, bank elevations and sediment interfaces, June 1987.

SCALE 1 : 35 000

In the broad alluvial valley higher up, the natural vegetation has been cleared in places right up to the edge of the river for the cultivation of crops. (Figure 24). These lands wash away periodically during floods and much valuable topsoil is lost. Irrigation from the river takes place, but the water is often brackish. In November 1988 a heavy salt deposit was seen on bare lands on the west bank of the upper reaches of the estuary, near the illegal weir (Section 3.2.10). At the time, an easterly gale was blowing and the amount of topsoil being removed was excessive as indicated by dust clouds visible many kilometres away (Plate III). There are many freshwater springs used for irrigation in the area to the west of the river and a few private pipelines carry water under the river bed to lands on the eastern side. The main farming activities are sheep and cattle farming and fodder crops. The cattle are mostly for slaughter but a few dairy herds are also kept (Mr P J du Preez, Agricultural and Water Supply Officer, Riversdale, pers. comm.).

FIG. 24: Lands on the eastern side of the upper estuary ploughed right up to the river bank for crop cultivation (ECRU, 87-06-10).

According to Geustyn *et al* (1987) shallow yellow sandy soil and alkaline grey sand underlain by calcified dunes is found in the duineveld . The land to veld ratio is 1:99. The crops include lucerne, siradellon *(sic)* (serradella), and oats supplementing the low yield of the natural pastures. The carrying capacity of the area is *ca.* 0,4 small stock per hectare. Wheat and maize are also cultivated on a small scale.

Similar to the catchment aloes are plentiful; the leaves are cut off on the lower part of the stems and tapped for their sap which is used to produce concentrated bitters for various medicines (Figure 25). Wild flowers are picked for marketing under permit and thatching grass (dekriet - *Thamnochortus insignis)* is also harvested, this being one of the principal areas for the production of thatch in the southern Cape.

The estuary itself is used for watersports such as power boating, water skiing, canoeing, yachting, swimming and angling (Department of Planning, 1971). Bathing is relatively dangerous near the mouth (Cape Provincial Administration, 1973). Prawns, used for bait, are collected from the mudflats in the estuary (Summers *et al.*, 1976).

FIG. 25: Aloe leaves being tapped for their juice (ECRU, 88-11-12).

Activities in and on the estuary are controlled by Proclamation 357 of 1972 relating to the Nature Conservation Ordinance 26 of 1965, in which activities permitted on tidal waters (e.g. use of nets, boats, catching of fish, removal of bait organisms, etc.) are defined. The Nature and Environmental Ordinance 19 of 1974 also applies to this area. These regulations are presently being revised.

3.2.10 Obstructions

Day (1971) stated that there were no man-made obstructions which restrict the flow of water in the estuary. The mouth itself is often constricted by a sand-spit (Section 3.2.4).

Near the head of the estuary, about 8 km upstream from the mouth at 'Die Eiland', a low-level bridge existed for many years. This did not cause an obstruction under normal conditions, but during the floods of 1981, this bridge washed away (Figure 12). It was replaced in 1983 by a bridge built slightly further upstream (Figure 13). This new bridge is at a much higher elevation above the water than the old one and is far more solidly constructed.

During 1987 a group of riparian land owners constructed an earth weir (Figure 26) across the river about 1,5 km upstream of 'Die Eiland' at the approximate head of the estuary. No construction permit was obtained from the Directorate of Nature and Environmental Conservation, under whose jurisdiction this area falls. The effects of this structure have not yet been determined, but it could cause increased erosion of the river bed and, should the weir be damaged or washed away during a flood, this could result in increased siltation in the estuary below the site of the weir. A barrier such as this could also alter the water chemistry and result in a reduction in salinity above the weir and increased salinity below the weir. This could result in changes in both the plant and animal communities (P Badenhorst, EMA, *in litt.*). In effect the water above the weir is still brackish and contributes to the progressively increasing mineralisation of the agricultural land bordering the river (Plate III).

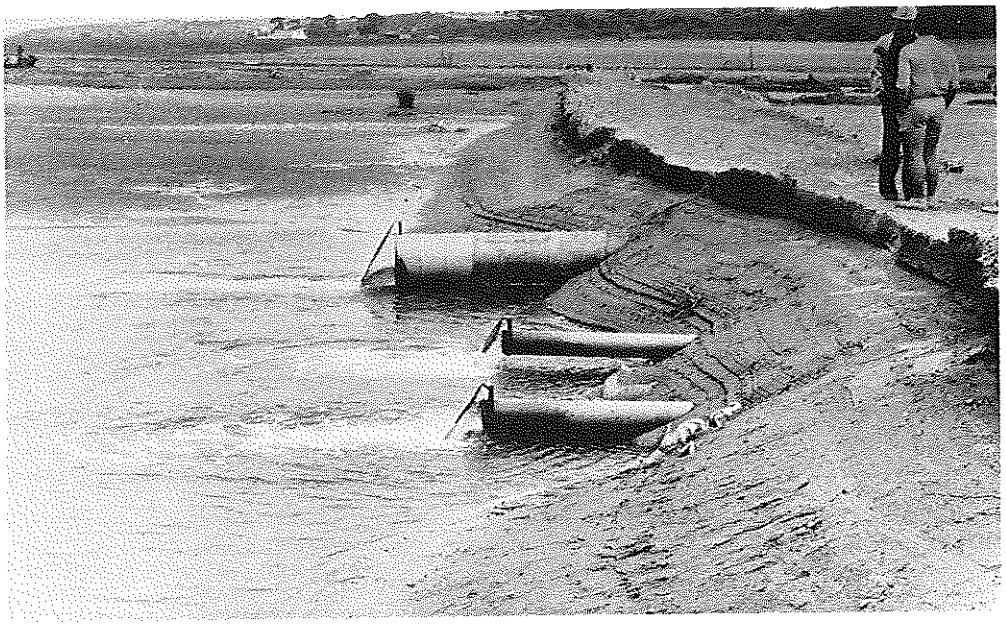


FIG. 26: Illegal earth weir built across the Gourits River about 1,5 km upstream from 'Die Eiland' (H. Lüttig, DWA, 87-09-14).

Note: This weir washed away recently, but another similar one with smaller drainage pipes has been built higher up. (Mr H Lüttig, Dept. Water Affairs, pers. comm.)

3.2.11 Physico-Chemical Characteristics

Very little data are available on the physico-chemical aspects of the Gourits Estuary. Besides one set of records made by G F van Wyk of CDNEC in 1957 (quoted by Day, 1981), the only measurements are those taken during the ECRU field survey in June 1987 (Table 2). At a station 0,8 km from the mouth, G F van Wyk found the salinity as 14,7 parts per thousand, the temperature 24,5° C and the Secchi disc depth as 38 cm. During the ECRU field trip (Table 2) the top and bottom water samples taken at all four stations were generally well oxygenated with dissolved oxygen values being mostly slightly below saturation values for the water temperatures and salinities measured. The exception was the bottom sample at Station 4 (Centrespread) (6,19 mg/l) which was well below the saturation value (9,4 mg/l) for the temperature and salinity measured. This was probably due to the water depth (4 m).

The salinity and temperature data indicate fairly good mixing throughout with the exception of Station 4 where the surface salinity was 8 parts per thousand and the bottom 17 parts per thousand. This appears to have been a salt stratification effect as a result of freshwater run-off overlying saline water of marine origin. There was no indication of marked thermoclines. Saline water seemed to penetrate up to 2 km upstream of the road bridge at 'Die Eiland' during high tide. This point is the absolute upper limit of estuarine conditions as confirmed by the vegetation (Section 3.2.1).

3.2.12 Pollution and Public Health Aspects

Only two references to pollution could be found. The one was an article in *'Die Burger'* of 82-07-16 which reported on the death of fish in the Gourits River, most probably caused by 'a vinegar like substance resulting in oxygen depletion. Thousands of dead moggels *(Labeo umbratus)* were found as far upstream as

TABLE 2: Physico-chemical data for the Gourits Estuary collected during the ECRU survey on 9 June 1987. (Positions of stations shown on Centrespread)

Station number	Time	State of the tide in the sea	Depth (m)	D.O. (mg/l)		Salinity (°/oo)		Temperature (°C)						Water transparency (Secchi) (m)	Water colour	Substratum type
										S (18 hrs)		B				
				S	B	S	B	S	B	Max.	Min.	Max.	Min.			
Station 1	10h15	Spring low at 07h46	1,3	7,98	8,00	33,0	34,0	14,8	15,1	-	-	-	-	1,1	Greenish	Marine sand
Station 2	11h45	Spring high at 13h56	2,1	8,17	8,10	33,0	34,0	14,7	15,0	15,0	12,0	15,0	12,0	1,3	Murky green	Fine silty mud
Station 3	12h45	Spring high at 13h56	1,7	8,03	8,35	30,0	33,0	14,4	14,8	-	-	-	-	1,2	Murky green	Fine light brown mud
Station 4	14h50	Spring high at 13h56	4,0	9,55	6,19	08,0	17,0	13,9	14,0	-	-	-	-	2,0	Green	Sandy mud

S = surface sample
B = bottom sample

Herbertsdale (100 km inland). The other reference was in a press release from the CDNEC on 87-08-19 which reported the death of 14 blue cranes through poisoning on the banks of the Gourits River near Herbertsdale.

The effects of artificial fertilizers, herbicides *etc.* used on the cultivated lands, has not been investigated.

To date there have been no reports of oil pollution in this system. However, should a major oil spill occur, the 'Coastal Oil Spill Contingency Plan No. 6' for the Langeberg zone (Department of Environment Affairs, 1988) recommends that the individual mudflats and saltmarshes should be protected using barriers constructed from sorbent material such as straw bales, and that a boom be put across the river in the position shown on the Centrespread where the river is only 654 m wide.

4. BIOTIC CHARACTERISTICS

4.1 Flora

(This section was contributed by MER Burns, EMA)

4.1.1 Phytoplankton

No information is available on the phytoplankton of the Gourits Estuary.

4.1.2 Algae

Macroscopic algae are not abundant within the estuary and appear to be present only at the mouth, on the rocky eastern bank. *Porphyra capensis* occurs within the upper zone, described by Branch (1981) as the *Littorina* zone, while *Sargassum heterophyllum* is occasionally found in the tidal rock pools.

4.1.3 Aquatic Vegetation

According to Summers *et al.* (1976), *Zostera* was found on the mud banks near the mouth of the river and *Arthrocnemum* (=*Sarcocornia* sp.) on the west bank. Van Wyk (1977, *in litt.*) stated that no *Zostera* was found, possibly because of the turbidity of the water.

During the ECRU Survey on 8-11 June 1987, no macrophyte beds were found within the estuary. Although salinity levels are not unsuitable for the survival of a species such as *Zostera capensis*, the effect of periodic flooding and turbidity of the water are likely to be the major limiting factors precluding its establishment.

4.1.4 Terrestrial and Semi-aquatic Vegetation

Acocks (1975) broadly classified the terrestrial vegetation of the lower reaches of the Gourits River as Coastal Macchia (veld type 47) and Coastal Renosterbosveld (veld type 46). The former occurs west of the river on shallow calcareous sands, overlying limestone of the Bredasdorp formation, while the latter occurs to the east, on clayey soils derived from Bokkeveld shale. Moll *et al.* (1984) identify the macchia component as Limestone Lowland Fynbos and describe it as an open to closed, mid-high shrubland with a canopy cover of 40-90 percent. The south coast Renosterveld is largely a relict vegetation type which has been significantly altered by agriculture. Acocks (1975) and Taylor (1978) speculate that it originally comprised a dense scrub vegetation, dominated by woody elements such as *Olea europaea* var. *africana* and *Sideroxylon inerme*. Its present structure, however, is a low to mid-high, moderately dense shrubland which, although dominated by *Elytropappus rhinocerotis*, has a high species diversity. Muir (1929), in a memoir on the vegetation of the Riversdale area, describes the two main vegetation types represented at the Gourits River as Strandveld and Renosterveld.

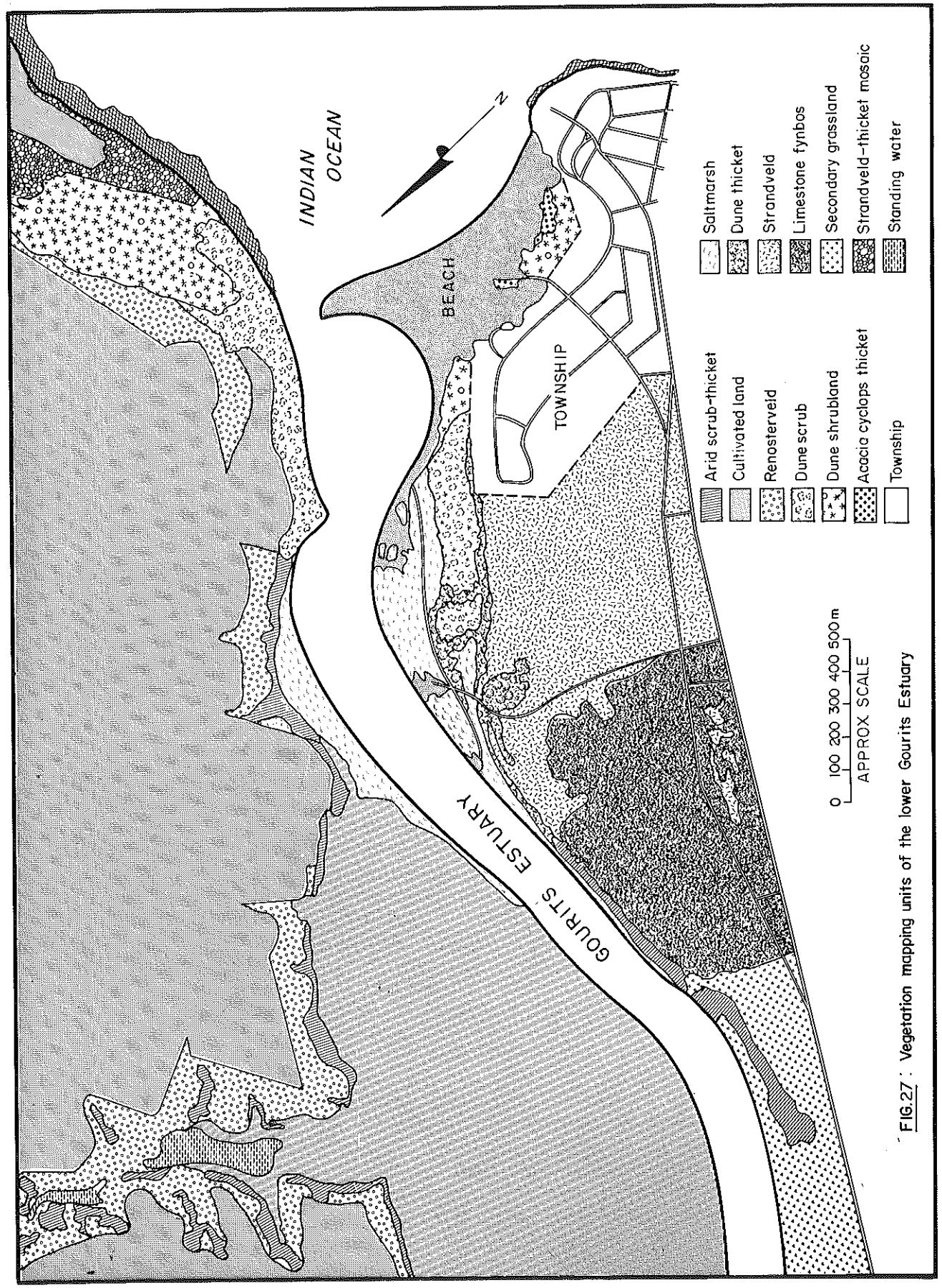


FIG.27 : Vegetation mapping units of the lower Gourits Estuary

The significance of the Gourits River valley as a linking corridor between the arid interior and the coast has been recognized *(inter alia)* by Heydorn and Tinley (1980) and Cowling (In: Geustyn *et al.*, 1986). The valley vegetation, which is described by Acocks (1975) as Gourits River scrub (veld type 23(e)), supports a high percentage of karroid elements which have extended their distribution via the river valley to the coast. The scrub is similar in many respects to that of the Sundays River, with the exception that the tall succulent *Euphorbia* species are replaced almost entirely by aloes, such as *Aloe ferox, A. arborescens* and *A. speciosa* (Acocks, 1975).

Thirteen mapping units were identified during the ECRU Survey in June 1987 and eleven of these have been used to distinguish the important terrestrial vegetation types (Figure 27). They include: arid scrub thicket; renosterveld; strandveld-thicket mosaic; dune scrub; dune shrubland; *Acacia cyclops* thicket, salt-marsh; dune thicket; strandveld; limestone fynbos and secondary grassland. The vegetation types are discussed briefly below and a partial list of component species and description of some of the physical features is provided in Appendix I.

Arid scrub thicket

This mapping unit represents the most seaward extension of the Gourits River scrub (Acocks, 1975) and is limited to the lower slopes of the incised embankments of the river valley. On the east bank, it occurs below renosterveld and has a more scrub-like appearance, while on the west bank, it occupies a similar position as thicket below limestone fynbos. It has a generally degraded appearance due largely to the impact of domestic stock. *Sideroxylon inerme* and *Euclea racemosa* are the dominant tree species, while aloes and the smaller *Euphorbia* species can be locally conspicuous (Plate I). The vegetation is of biogeographical significance since it includes a number of sub-tropical thicket species such as *Rhus longispina* and *Scolopia zeyheri* which are at their southernmost distribution limit (Cowling In: Geustyn *et al.*, 1987).

Renosterveld

The areas which have been mapped as renosterveld represent relict patches of what was once an extensive vegetation type in the region to the east of the estuary. Most of the vegetation has been cleared for crops and the remaining areas are located on slopes which are considered to be too steep for cultivation. The species composition is secondary in response to the impacts of fire and stock pressure and although considered to be relatively diverse, is dominated by *Elytropappus rhinocerotis*. According to Moll *et al.* (1984), dominant genera also include *Eriocephalus, Anthospermum, Passerina, Relhania, Aspalathus, Helichrysum, Pteronia, Selago, Felicia* and *Hermannia*. Towards Kanonpunt, Renosterveld merges along a continuum into the vegetation mosaic which has been mapped as Strandveld and Kaffrarian thicket mosaic.

Strandveld

The area which has been mapped as strandveld consists of a mosaic of bushclumps, restios and shrubs, with a conspicuous graminoid and herbaceous ground layer. It generally fits the description of South Coast Strandveld as described by Moll *et al.* (1984) and differs from the adjoining limestone fynbos community mainly by the absence of ericoid and proteoid elements. It also does not have the appearance which is typically associated with dune fynbos.

The bushclumps, with cover values of up to 100 percent and measuring 1,5-2 m in height, are dominated by *Sideroxylon inerme, Schotia afra* and *Pterocelastrus tricuspidatus*. The restio *Thamnochortus bachmannii* together with *Chrysanthemoi-*

des monilifera and *Phylica axillaris* var. *maritima* are conspicuous in the more open areas of vegetation, while *Themeda triandra, Agathosma muirrii* and other unidentified herbaceous elements comprise the lower ground layer which occurs throughout.

Strandveld-thicket mosaic

This mapping unit occupies much of the Kanonpunt peninsula and is in a relatively well preserved state. While having many characteristics of climax south coast strandveld, its composition and structure closely resemble that of Kaffrarian thicket and it has, therefore, been classified as a mosaic. Tinley (1985) describes this community as dwarf scrub-thicket. The dominant woody species include *Euclea racemosa, Sideroxylon inerme* and *Rhus longispina,* while *Zygophyllum morgsana* is the dominant shrub in the area mapped. Aloes such as *Aloe ferox* and *A. arborescens* are also conspicuous components of this vegetation type.

Dune scrub

A narrow belt of this vegetation type occupies the mantle of dune sand which has been deposited on the lower slopes of the eastern and western banks of the estuary, close to the mouth. Dense scrub, dominated by *Euclea racemosa* alternates with a lower and more sparse ground cover of herbaceous elements such as *Tetragonia decumbens, Trachyandra divaricata, Salvia africana-lutea* and *Restio eleocharis.*

Dune shrubland

Small areas of open dune shrubland occur on both the east and west banks of the estuary at the mouth, where the vegetation provides a degree of stability to previously mobile sand. Total ground cover is relatively low and the vegetation is, therefore, potentially very sensitive to disturbance. Dominant shrub species include *Myrica cordifolia, Chrysanthemoides monilifera* and *Stoebe plumosa* while *Ammophila arenaria, Ehrharta villosa* and *Senecio elegans* are common grass and herbaceous elements.

Acacia cyclops thicket

Scattered clumps of *Acacia cyclops* occur above the beach and adjacent to the parking area south of the estuary mouth. This exotic species, which has the potential to spread rapidly, should be eradicated without delay while its distribution is still relatively limited.

Saltmarsh

As a result of the natural canalization of the Gourits Estuary and the absence of an extensive tidal delta, the saltmarsh vegetation is not particularly well developed. Elevated, dry *Sarcocornia pillansiae* -dominated saltmarsh occurs at the mouth on both the east and west banks (Figure 27). In these areas, *Chenolea diffusa* is relatively conspicuous closer to the estuary, while *Sporobolus virginicus* becomes more important with increasing distance from the water. Isolated patches of *Juncus acutus, Juncus kraussi* and *Phragmites australis* occur in areas where there is apparent seepage of freshwater into the marsh.

Where mudbanks occur in the middle and upper reaches of the estuary, saltmarsh lawns, dominated by *Cotula coronopifolia* and *Triglochin* spp. at the lower tidal levels and *Sarcocornia* sp. at the higher levels, have become established. Such areas are, however, not extensive.

Dune thicket

Dune thicket of up to three metres in height has become established on the western bank of the estuary within the transition zone between the sub-climax dune scrub situated close to the estuary and the climax strandveld vegetation situated further landward. A more favourable soil moisture regime along a possible seepage line in this area is likely to have contributed towards the development of this formation. *Sideroxylon inerme, Euclea racemosa, Pterocelastrus tricuspidatus* and *Cassine aethiopica* are conspicuous elements occurring here, while the presence of *Clausena anisata* is noteworthy, since the Gourits River represents the southernmost distribution limit for this species.

Limestone fynbos

This community occurs on the calcareous Quaternary sands overlying limestone of the Bredasdorp Formation, to the west of the estuary. The vegetation, which is described more fully by Taylor (1978), generally comprises an upper proteoid layer above a mixed ericoid and restioid layer. At the time of the ECRU Survey, however, the area mapped as limestone fynbos exhibited two structural variations as a result of fires in the past. The area between the tarred road and the old gravel road to Gourits River mouth comprises mature protea veld which is approximately 1,5 m tall and has obviously not been burnt for a number of years. The area to the east of the gravel road, extending towards the estuary, includes a much shorter type of vegetation (approximately 0,5 m tall) which is less dense and, in response to fire and grazing, predominantly comprises restioid, ericoid and graminoid elements. Where proteas are present, the most conspicuous species are *Protea repens, P. susannae* and *P. lanceolata,* while *Leucospermum praecox* and *Leucadendron galpinii* also contribute significantly to the upper layer.

Approximately five kilometres upstream from the mouth, the fynbos on the west bank is heavily infested with *Acacia cyclops*. Post-fire regeneration of this species has been exceptionally high and stem densities of 40 000 per hectare were estimated in some areas during the ECRU Survey.

Secondary grassland

The area which has been mapped as secondary grassland has been converted to this state from fynbos by agriculture. Stock farming is practised along the west bank of the estuary and grazing pressure and fire have encouraged grass to become established at the expense of the fynbos elements.

4.2 Fauna

4.2.1 Zooplankton

No data are available on the zooplankton of this estuary.

4.2.2 Aquatic Invertebrates

G F van Wyk (1957, *in litt.)* surveyed the estuary and stated that mudprawns *(Upogebia)* occur abundantly on the western bank near the mouth. In the banks at Steentjies-se-Gat (Centrespread), they were also plentiful. Bloodworms *(Arenicola)* were rare.

C Gaigher of CDNEC *(in litt.)* found *Upogebia africana* at all the stations which he sampled on the west bank for about two km from the mouth as well as on a sandbank in the river a little further upstream. He found *Callianassa kraussi* on the east bank about 6,5 km from the mouth and on the west bank at the bridge at 'Die Eiland' about 8 km from the mouth.

During the ECRU Survey (87-06-09) the following were caught with a beam trawl:

Station 2 - *Siphonosoma* sp. (Sipunculid)
Station 4 - *Hymenosoma orbiculare* (Crown crab)
(See Centrespread for station positions)

4.2.3 Fish

According to Barnard (1943) the following fish occur in the freshwaters of the Gourits River: *Galaxias zebratus* (Cape galaxius), *Sandelia capensis* (Kurpur), *Labeo umbratus* (moggel), *Barbus asper, B. tenuis* and *B. anoplus*. In 1938 he described the type specimen of *Pseudobarbus (Barbus) tenuis* from the Gourits River (Jubb, 1967).

Van Wyk (1957, *in litt.)* found the following fish: harders, kabeljou, white steenbras, elf and possibly leervis. Sea barbels *(Galeichthys* sp.) occur in the river and are eaten with relish by the locals. However, visiting anglers regard them as a pest. In addition to the above-mentioned species, N C van Rensburg while trawling near the mouth on 57-07-01 caught a goby, a puffer fish, a sole and white stompneus. Higher up the river he found eels.

The Gourits is well known to local anglers for periodic runs of Kabeljou during September, October and November when large numbers of these fish move into the estuary and are caught by rod and line (T Heinecken, pers. comm.).

A list of the fish recorded by the CDNEC (Thorne, *in litt.)* in the grid reference 3421 BD on the 1:50 000 map is given in Appendix II.

During the ECRU survey, the following fish were caught in a beam trawl on 87-06-10 (Station positions on Centrespread).

Station 2

Caffrogobius multifasciatus - Prison goby

Station 3

Gilchristella aestuaria - Estuarine round herring
Caffrogobius multifasciatus - Prison goby

Station 4

Solea bleekeri - Blackhand sole

4.2.4 Reptiles and Amphibians

A list of reptiles and amphibians recorded from, or likely to occur in, the locus 3421 BD has been compiled by M E and A L de Villiers of the CDNEC. Eleven amphibians are listed, 3 tortoises, 26 snakes and 12 lizards none of which is a rare or endangered species. Details are given in Appendix III.

4.2.5 Birds

Summers *et al.* (1976) recorded 12 species of waders at the Gourits River mouth on 76-01-09. They counted a total of 292 birds of which 35 were residents and 257 migrants. At Voëlvlei (Centrespread) they recorded a total of 468 waders, one being resident and 467 migrants (see Appendix IV).

Underhill and Cooper (1982 and 1983) list birds counted in July 1980 and January 1981. In January 1981 a total of 1 250 birds of 78 different species was recorded (Appendix IV).

During the ECRU survey in June 1987 as well as in November 1988, many European- and Pied Starlings were observed entering the numerous holes in the steep banks of the estuary in the vicinity of 'Die Eiland' (Figure 13).

4.2.6 Mammals

Few records of mammals are available in the grid reference 3421 BD in which the Gourits Estuary falls. Appendix V gives a list of those recorded and those likely to occur in the environs of the Gourits Estuary (P H Lloyd CDNEC, *in litt.)*. Only three species have actually been recorded, namely, Cape dassie, Cape porcupine and the Cape dune mole-rat. A further 77 species may occur in this area. Of the total number, eight species are listed in Smithers (1986) as being rare or vulnerable, and four are historical records only.

5. SYNTHESIS AND RECOMMENDATIONS

Present state of the system.
The Gourits Estuary is in a relatively undeveloped state. It is characterized by rocky outcrops on the east bank and a flat sandy topography on the west side. The position and width of the mouth and sand banks tend to be dynamic. As yet, little development has taken place at the small resort Gouritsmond, mainly because of a shortage of good quality drinking water in the past. However, as mentioned in Section 3.2.9 this problem has been overcome by piping water from a spring 14 km inland. In the publication "An assessment of the state of the estuaries of the Cape and Natal in 1985/86" (Heydorn, 1986) the Gourits Estuary is classed as Category 3 which means that it can be developed but according to environmentally acceptable guidelines.

On the farms situated further upstream, the main activities are live-stock and fodder farming. These activities are limited by the shortage of freshwater for irrigation. A certain amount is pumped from the estuary, but this tends to be brackish.

Present state of knowledge.
Little research has been undertaken in this area. There are no complete lists of the flora or fauna. The archaeological and historical aspects have received superficial attention. EMA has embarked on a programme to survey selected estuary mouths on a regular basis and the Gourits mouth is one of them.

Problems : present and foreseeable.
According to a memorandum (dated 75-07-04) from the Extension Officer, Department of Agriculture and Technical Services at Riversdale, to the Chief Extension Officer at Swellendam, the main problem with the Gourits River and its tributaries is the irregular flow. For at least 75 percent of the year, it flows very slowly or is stagnant, which is unsatisfactory for major farming activities. The Gourits and the Vals rivers are brackish for most of the year. Any water used for irrigation has to be pumped from the river. The major storage dams in the catchment hinder flow and the Department of Water Affairs has no release policy for this system (Section 3.1.3). Floods are the results of sporadic rainstorms in the Karoo and in the catchment south of the mountain range. When in flood, the river is silt laden, but this is not a threat to the river mouth, or to development on the river banks.

Brink *et al.* (1986) state that environmental problems in the area include invasion by alien plants *(A. cyclops, A. saligna)*, wind erosion, overgrazing and overutilization by animals and man, dune moles in cultivated lands, shortage of trace elements in soils, periodic flooding, brackish soils, poor quality limited water for irrigation, low pH and nutrient values of soils. As mentioned in Section 3.2.9, wind erosion appears to be aggravated by mineralisation and salt deposition on agricultural lands and consequent lack of vegetation cover. (Plate III).

Recommendations

The flat featureless topography at the river mouth with lack of taller vegetation and exposure to strong winds probably have retarded the rate of development of this resort. However, in view of the urban and industrial development at Mossel Bay and in the surrounding district as a result of the MOSSGAS project to the east of Gourits, and the establishment of the Gouriqua Nuclear Research Facility to the west, development pressure is likely to increase in this area. Gourits resort has the potential for rapid development as it now has sufficient quantities of potable water (see Section 3.2.9) which is not the case in many of the nearby resorts (e.g. Vleesbaai). As stated in Section 3.2.8, future development along the western side of the river mouth and estuary should take cognizance of the highly dynamic area adjoining the mouth and development should be located well back from the zone likely to be affected by floods, or storm waves and aeolian sediment movement. Already many new plots are on the market, some of which are in front of the existing houses and are situated in the dynamic frontal dunes (Figure 28). These should not be developed. Instead, the natural dune vegetation should be encouraged to stabilize the sand in this area. Lubke (1988) emphasises the fact that destroying the natural vegetation on a frontal dune may result in never ending problems with the onslaught of sand dunes which have thereby become mobile. Furthermore, destruction of natural vegetation facilitates encroachment by alien vegetation. He suggests that paths be made of logs or stones through the natural vegetation to keep the beach and sand where they belong i.e. at the coastline. A landscape architect should be appointed to assist with the design and planning of new extensions. As much as possible of the natural vegetation should be preserved as this is in particularly good condition, especially the portions to the north of the existing township which are regularly cleared of alien vegetation by the local authority. Landowners should be encouraged to limit the clearing of plots for building to the minimum and to use indigenous rather than exotic plants when designing their gardens, as these are adapted to the local climatic conditions and require little effort for their maintenance. S Sinclair (1985) gives good general advice on this aspect and Lubke (1988) suggests suitable species, how to propogate them and where to obtain seed. A proposed development plan for Gouritsmond was drawn up by a firm of architects for the Divisional Council in January 1975.

Access paths and/or boardwalks should be laid out from the parking- and residential areas down to the beach. Haphazard trampling across the frontal dunes destroys the vegetation cover which in turn leads to sand blow-outs. Likewise the saltmarsh area on the west bank a few kilometres upstream, should be traversed by a few well demarcated tracks to give access to the river and the public should not be permitted to drive over the marsh vegetation. At present vehicles are driven indiscriminately (Figure 29). This area plays a vital role in stabilizing the bank and has an important biological function and should not be disturbed unnecessarily.

Regulation 1048 of 25 May 1984 pertaining to the Conservation of Agricultural Resources Act 43 of 1983 states that no land should be cultivated within the flood area of a river or within 10 m horizontally outside the flood area of a water course. Accordingly agricultural lands adjoining the river on the flood

FIG. 28: Erven situated in the dynamic dune zone on the west bank of the estuary (ECRU, 87-06-10).

plain upstream of the mouth, (Figure 24 and Plate III) should be reinstated as far as possible with natural vegetation. This would act as a buffer and ensure stabilization of the banks which would help reduce the loss of valuable topsoil during floods and periods of high velocity winds (Section 3.2.9). The amount of siltation would thereby also be significantly reduced (Figures 9 and 10).

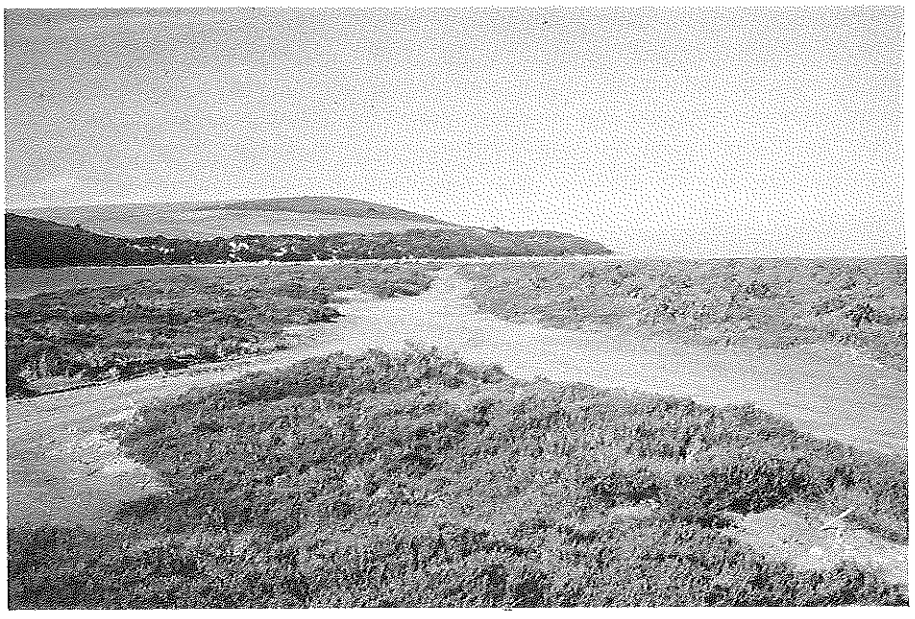


FIG. 29: Haphazard tracks through the salt marsh area on the west bank of the estuary (ECRU, 87-06-10).

The alien vegetation occurring in the area, particularly higher upstream should be eradicated. This includes rooikrantz *(Acacia cyclops)*, prickly pear *(Opuntia ficus-indica)*, and castor oil plants *(Ricinus communis)*. In the catchment there are also large areas of black wattle *(Acacia mearnsii)* which could spread downstream if they are not removed.

The building of weirs or embankments such as mentioned in Section 3.2.10 and shown in Figure 26 should be strictly controlled as such structures could lead to changes in the water chemistry and ecology of the estuary, increase in mineralisation of the lands irrigated with this water (Plate III) as well as increased siltation should they wash away. As mentioned at the end of Section 3.2.10 this has already occurred.

This estuarine system could benefit enormously from the formation of a trust, such as the Zwartkops or Stilbaai Trusts which aim to preserve the estuarine and riverine environments including their bird- and fishlife for the present and future generations.

The importance of the nutrient input from the Gourits and other rivers along this stretch of coast must not be under-estimated. Nutrients enter the sea via the rivers and help support the large fishing industry on the Agulhas Bank. Anchovy and pilchards spawn on the bank; hake, sole and squid are the main commercial species while smaller numbers of kingklip, snoek, monk-fish, horse mackerel, anchovy, pilchards, mud-herring, panga and rock lobsters are also utilized (Geustyn *et al.*, 1987).

The Gourits Estuary, in common with other estuaries whose mouths are open for part or all of the year, is likely to be important as a nursery area for many species of fish which are to a greater or lesser degree dependent on estuarine conditions for part of their life cycle (Wallace *et al.*, 1984). It must therefore be ensured that dam building and any further developments will never reduce the amount of water reaching the mouth to such a degree that the mouth closes for any length of time.

Tinley (1985) states that the Cape Vacca dunefields including the private nature reserve at Kanonpunt, are unique and require protection. This is particularly relevant to the Kanonpunt area which has an excellent example of dwarf dune thicket vegetation which is surprisingly free from infestation by alien vegetation.

A detailed archaeological survey of the area should be undertaken before any further development is permitted, as suggested by W J van Rijssen of the south African Museum (see Section 2.3).

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Date	Job no.	Photo no.	Scale 1:	Type	Source
1942	17142	06102, 06045, 06046	30 000	B&W	Trig. Survey
1963	492	1854	30 000	B&W	Trig. Survey
81-04-09	349	21	20 000	B&W	Univ. of Natal
79-04-21	326	383-85	10 000	Col.	Univ. of Natal
Dec. 1981	391	309/3-311/3	20 000	Col.	Univ. of Natal
Feb. 1987	-	563	10 000	Col.	ECRU/EMA
April 1988	-	-	10 000	Col.	ECRU/EMA

8 GLOSSARY OF TERMS USED IN PART II REPORTS

ABIOTIC: non-living (characteristics).

AEOLIAN (deposits): materials transported and laid down on the earth's surface by wind.

ALIEN: plants or animals introduced from one environment to another, where they had not occurred previously.

ALLUVIUM: unconsolidated fragmental material laid down by a river or stream as a cone or fan, in its bed, on its floodplain and in lakes or estuaries, usually comprised of silt, sand or gravel.

ANAEROBIC: lacking or devoid of oxygen.

ANOXIC: the condition of not having enough oxygen.

AQUATIC: growing or living in or upon water.

ARCUATE: curved symmetrically like a bow.

BARCHANOID (dune): crescent-shaped and moving forward continually, the horns of the crescent pointing downwind.

BATHYMETRY: measurement of depth of a water body.

BENTHIC: bottom-living.

BERM: a natural or artificially constructed narrow terrace, shelf or ledge of sediment.

BIMODAL: having two peaks.

BIOGENIC: orginating from living organisms.

BIOMASS: a quantitative estimation of the total weight of living material found in a particular area or volume.

BIOME: major ecological regions (life zones) identified by the type of vegetation in a landscape.

BIOTIC: living (characteristics).

BREACHING: making a gap or breaking through (a sandbar).

CALCAREOUS: containing an appreciable proportion of calcium carbonate.

CALCRETE: a sedimentary deposit derived from coarse fragments of other rocks cemented by calcium carbonate.

CHART DATUM: this is the datum of soundings on the latest edition of the largest scale navigational chart of the area. It is -0,900 m relative to the land levelling datum which is commonly called Mean Sea Level by most land surveyors.

COLIFORMS: members of a particularly large, widespread group of bacteria normally present in the gastro-intestinal tract.

COMMUNITY: a well defined assemblage of plants and/or animals clearly distinguishable from other such assemblages.

CONGLOMERATE: a rock composed of rounded, waterworn pebbles 'cemented' in a matrix of calcium carbonate, silica or iron oxide.

CUSP: a sand spit or beach ridge usually at right angles to the beach formed by sets of constructive waves.

"D" NET: a small net attached to a "D" shaped frame riding on skids and pulled along the bottom of the estuary, used for sampling animals on or near the bottom.

DETRITUS: organic debris from decomposing plants and animals.

DIATOMS: a class of algae with distinct pigments and siliceous cell walls. They are important components of phytoplankton.

DYNAMIC: relating to ongoing and natural change.

ECOLOGY: the study of the structure and functions of ecosystems, particularly the dynamic co-evolutionary relationships of organisms, communities and habitats.

ECOSYSTEM: an interacting and interdependent natural system of organisms, biotic communities and their habitats.

EDDY: a movement of a fluid substance, particularly air or water, within a larger body of that substance.

ENDEMIC: confined to and evolved under the unique conditions of a particular region or site and found nowhere else in the world.

EPIFAUNA: animal life found on the surface of any substrate such as plants, rocks or even other animals.

EPIPHYTE: a plant living on the surface of another plant without deriving water or nourishment from it.

EPISODIC: sporadic and tending to be extreme.

ESTUARY: a partially enclosed coastal body of water which is either permanently or periodically open to the sea and within which there is a measurable variation of salinity due to the mixture of sea water with fresh water derived from land drainage (Day, 1981).

EUTROPHICATION: the process by which a body of water is greatly enriched by the natural or artificial addition of nutrients. This may result in both beneficial (increased productivity) and adverse effects (smothering by dominant plant types).

FLOCCULATION (as used in these reports): the settlement or coagulation of river borne silt particles when they come in contact with sea water.

FLUVIAL (deposits): originating from rivers.

FOOD WEB: a chain of organisms through which energy is transferred. Each "link" in a chain feeds on and obtains energy from the preceding one.

FYNBOS: literally fine-leaved heath-shrub. Heathlands of the south and south-western Cape of Africa.

GEOMORPHOLOGY: the study of land form or topography.

GILL NET: a vertically placed net left in the water into which fish swim and become enmeshed, usually behind the gills.

HABITAT: area or natural environment in which the requirements of a specific animal or plant are met.

HALOPHYTES: plants which can tolerate saline conditions.

HAT (Highest Astronomical Tide) and LAT (Lowest Astronomical Tide): HAT and LAT are the highest and lowest levels respectively, which can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions; these levels will not be reached every year. HAT and LAT are not the extreme levels which can be reached, as storm surges may cause considerably higher and lower levels to occur (South African Tide Tables, 1980).

HUMMOCK (dune): a low rounded hillock or mound of sand.

HYDROGRAPHY: the description, surveying and charting of oceans, seas and coastlines together with the study of water masses (flow, floods, tides, etc.).

HYDROLOGY: the study of water, including its physical characteristics, distribution and movement.

INDIGENOUS: belonging to the locality; not imported.

INTERTIDAL: generally the area which is inundated during high tides and exposed during low tides.

ISOBATH: a line joining points of equal depth of a horizon below the surface.

ISOHYETS: lines on maps connecting points having equal amounts of rainfall.

ISOTHERMS: lines on maps joining places having the same temperature at a particular instant, or having the same average, extremes or ranges of temperature over a certain period.

LAGOON: an expanse of sheltered, tranquil water. (Thus Langebaan lagoon is a sheltered arm of the sea with a normal marine salinity; Knysna lagoon is an expanded part of a normal estuary and Hermanus lagoon is a temporarily closed estuary (Day 1981)).

LIMPID: clear or transparent.

LITTORAL: applied generally to the seashore. Used more specifically, it is the zone between high- and low-water marks.

LONGSHORE DRIFT: a drift of material along a beach as a result of waves breaking at an angle to the shore.

MACROPHYTE: any large plant as opposed to small ones. Aquatic macrophytes may float at the surface or be submerged and/or rooted on the bottom.

MARLS: crumbly mixture of clay, sand and limestone, usually with shell fragments.

MEIOFAUNA: microscopic or semi-microscopic animals that inhabit sediments but live quite independently of the benthic macrofauna.

METAMORPHIC: changes brought about in rocks within the earth's crust by the agencies of heat, pressure and chemically active substances.

MHWS (Mean High Water Springs) and MLWS (Mean Low Water Springs): the height of MHWS is the average, throughout a year when the average maximum declination of the moon is 23^{o}, of the height of two successive high waters during those periods of 24 hours (approximately once a fortnight) when the range of the tide is greatest. The height of MLWS is the average height obtained by the two successive low waters during the same periods (South African Tide Tables 1980).

MORPHOMETRY: physical dimensions such as shape, depth, width, length etc.

OLIGOTROPHIC: poor in nutrients and hence having a paucity of living organisms.

OSMOREGULATION: the regulation in animals of the osmotic pressure in the body by controlling the amount of water and/or salts in the body.

PATHOGENIC: disease producing.

PERIPHYTON: plants and animals adhering to parts of rooted aquatic plants.

PHOTOSYNTHESIS: the synthesis of carbohydrates in green plants from carbon dioxide and water, using sunlight energy.

PHYTOPLANKTON: plant component of plankton.

PISCIVOROUS: fish eating.

PLANKTON: microscopic animals and plants which float or drift passively in the water.

QUARTZITE: rock composed almost entirely of quartz recemented by silica. Quartzite is hard, resistant and impermeable.

RIPARIAN: adjacent to or living on the banks of rivers, streams or lakes.

RIP CURRENT: the return flow of water which has been piled up on the shore by waves, especially when they break obliquely across a longshore current.

SALINITY: the proportion of salts in pure water, in parts per thousand by mass. The mean figure for the sea is 34,5 parts per thousand.

SECCHI DISC: a simple instrument used to measure the transparency of water.

SHEET FLOW: water flowing in thin continuous sheets rather than concentrated into individual channels.

SLIPFACE: the sheltered leeward side of a sand-dune, steeper than the windward side.

TELEOST: modern day bony fishes (as distinct from cartilaginous fishes).

TROPHIC LEVEL: a division of a food chain defined by the method of obtaining food either as primary producers, or as primary, secondary or tertiary consumers.

TROUGH: a crescent shaped section of beach between two cusps.

WAVE HEIGHT (average energy wave height): an index which reflects the distribution of average incident wave energy at inshore sites along the coast presented as a wave height.

WETLANDS: areas that are inundated or saturated by surface or ground water frequently enough to support vegetation adapted to life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

ZOOPLANKTON: animal component of plankton.

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APPENDIX I: Physical features and species composition of the vegetation mapping units identified at the Gourits River estuary.

Mapping unit	Area (ha)	% of area studied	Cover (%)	Height (m)
Arid scrub-thicket	17,76	2,9	70	5,0 -7,0
Renosterveld	43,15	6,9	25- 60	0,5 -1,5
Strandveld	55,37	9,1	50-100	0,25-2,0
Strandveld-thicket mosaic	6,80	1,1	30- 70	0,3 -1,0
Dune scrub	19,14	3,1	30- 70	0,15-3,0
Dune shrubland	21,51	3,5	50	0,15-2,0
Acacia cyclops thicket	0,73	0,1	70	2,0
Dune thicket	6,22	1,0	70	1,5 -3,0
Limestone fynbos	48,74	8,0	50- 70	0,5 -1,5
Secondary grassland	21,08	3,5	70	0,25
Saltmarsh	21,07	3,5	50-100	0,1 -0,6
Cultivated land	348,40	57,2		
TOTAL	608,97			

Symbols in brackets following each species name, represent Braun-Blanquet Cover-Abundance classes as follows:

r - 1/few individuals, cover less than 0,1 percent of area
+ - occasional plants, cover less than 1 percent of area
1 - abundant, cover 1 - 5 percent of area
2 - any number, cover 6 - 12 percent of area
3 - any number, cover 26 - 50 percent of area
4 - any number, cover 51 - 75 percent of area
5 - any number, cover 76 - 100 percent of area.

Arid scrub-thicket
Acacia cyclops (+); *Aloe arborescens* (1); *Aloe ferox* (1); *Azima tetracantha* (1); *Carissa bispinosa* (+); *Cassine aethiopica* (+); *Cassine tetragona* (+); *Chrysanthemoides monilifera* (+); *Cotyledon orbiculata* (+); *Cussonia thyrsiflora* (+); *Cynanchum obtusifolium* (+); *Euclea racemosa* (+); *Euclea undulata* (+); *Euphorbia burmannii* (+); *Euphorbia mauritanica* (+); *Lycium cinereum* (1); *Maytenus heterophylla* (+); *Protasparagus aethiopicus* (+); *Putterlickia pyracantha* (+); *Rhoicissus digitata* (+); *Rhus glauca* (+); *Rhus longispina* (2); *Schotia afra* (1); *Scolopia zeyheri* (2); *Sideroxylon inerme* (1); *Tarchonanthus camphoratus* (+); *Zygophyllum morgsana* (+); *Polygala myrtifolia* (1); *Clutia daphnoides* (+).

Renosterveld
This community was not inspected in detail and the following list includes some of those species listed by Acocks (1975), Bohnen (1980), Moll *et al.* (1984) and Muir (1926) as Renosterveld elements. Braun-Blanquet values have not been allocated to them:

Aspalathus miscrodon; Aspalathus spinosa; Athanasia trifurcata; Blepharis capensis; Chrysocoma tenuifolia; Crassula ciliata; Crassula ericoides; Cyanella lutea; Dicoma spinosa; Drimia elata; Elytropappus rhinocerotis; Hermannia flammea; Hermannia ovalis; Microloma tenuifolium; Osteospermum imbricatum; Polygala affinis; Polygala fruticosa; Polygala garcini; Pteronia hirsuta; Pteronia

APPENDIX I: (Cont.)

incana; Relhania genustaefolia; Relhania squarrosa; Rhus lucida; Selago corymbosa; Selago fruticulosa; Urginea altissima.

Strandveld
Carissa bispinosa (+); *Cassine tetragona* (+); *Chironia baccifera* (+); *Chrysanthemoides monilifera* (1); *Cotyledon orbiculata* (+); *Eriocephalus africanus* (+); *Euclea undulata* (1); *Euphorbia mauritanica* (1); *Olea europaea* var. *africana* (+); *Pterocelastrus tricuspidatus* (1); *Rhoicissus digitata* (+); *Rhus glauca* (+); *Rhus longispina* (+); *Schotia afra* (1); *Sideroxylon inerme* (1); *Thamnochortus bachmanii* (1); *Themeda triandra* (+); *Zygophyllum morgsana* (+); *Clutea daphnoides* (+); *Indigofera denudata* (+); *Phylica axillaris* var. *maritima* (1); *Agathoma muirii* (+).

Strandveld-Thicket mosaic
Aloe arborescens (+); *Aloe ferox* (+); *Azima tetracantha* (+); *Carissa bispinosa* (+); *Carpobrotus acinaciformis* (+); *Cassine aethiopica* (+); *Cassine tetragona* (+); *Cotyledon orbiculata* (+); *Cussonia thyrsiflora* (r); *Cynanchum obtusifolium* (+); *Euclea racemosa* (3); *Euclea undulata* (+); *Euphorbia mauritanica* (1); *Lachenalia rubida* (+); *Massonia pustulata* (r); *Nylandtia spinosa* (+); *Olea exasperata* (+); *Pterocelastrus tricuspidatus* (+); *Restio eleocharis* (+); *Rhoicissus digitata* (+); *Rhus glauca* (+); *Rhus longispina* (1); *Schotia afra* (+); *Sideroxylon inerme* (2); *Thamnochortus insignis* (+); *Zygophyllum morgsana* (1); *Putterlickia pyracantha* (+); *Clutia daphnoides* (+).

Dune scrub
Ehrharta villosa (+); *Euclea racemosa* (2); *Euphorbia mauritanica* (+); *Gazania rigens* (+); *Restio eleocharis* (+); *Salvia africanalutea* (+); *Senecio elegans* (+); *Sporobolus virginicus* (+); *Tetragonia decumbens* (+); *Trachyandra divaricata* (+).

Dune shrubland
Acacia cyclops (1); *Ammophila arenaria* (1); *Arctotheca populifolia* (+); *Azima tetracantha* (+); *Carpobrotus edulais* (+); *Chironia baccifera* (+); *Chrysanthemoides monilifera* (1); *Ehrharta villosa* (1); *Helichrysum crispum* (+); *Mariscus* sp. (+); *Metalasia muricata* (+); *Myoporum serratum* (r); *Myrica cordifolia* (2); *Rhoicissus digitata* (+); *Rhus crenata* (1); *Rhus glauca* (+); *Senecio elegans* (1); *Solanum quadrangulare* (+); *Stoebe plumosa* (1); *Sutherlandia frutescens* (+); *Tetragonia decumbens* (1); *Tetragonia fruticosa* (+); *Trachyandra divaricata* (+); *Zygophyllum morgsana* (+); *Chrysocoma tenuifolia* (1); *Indigofera* cf. *cardiophyllum* (+); *Aspalathus alopecurus* (+).

Acacia cyclops thicket
Acacia cyclops (4).

Dune thicket
Acacia cyclops (r); *Azima tetracantha* (+); *Cassine aethiopica* (+); *Chionanthus foveolata* (+); *Clausena anisata* (1); *Colpoon compressum* (+); *Euclea racemosa* (2); *Euclea undulata* (+); *Olea exasperata* (1); *Pterocelastrus tricuspidatus* (1); *Rhus longispina* (+); *Sideroxylon inerme* (1).

Limestone fynbos
Acacia cyclops (+); *Chironia baccifera* (+); *Colpoon compressum* (+); *Ehrharta calycina* (+); *Leucadendron galpinii* (1); *Leucospermum praecox* (2); *Metalasia*

APPENDIX I: (Cont.)

muricata (+); *Nylandtia spinosa* (+); *Protea lanceolata* (+); *Protea repens* (+); *Protea susannae* (1); *Pterocelastrus tricuspidatus* (+); *Rhus laevigata* (+); *Thamnochortus insignis* (+); *Themeda triandra* (1); *Selago fruticosa* (+); *Cliffortia ilicifolia* (+); *Elegia muirii* (+); *Berkheya coriacea* (+); *Metalasia muricata* (+); *Cullumia carlinoides* (+); *Staavia radiata* (+); *Selago brevifolia* (+).

Saltmarsh
Chenolea diffusa (2); *Cotula coronopifolia* (2); *Cyperus textilis* (+); *Juncus acutus* (r); *Juncus kraussi* (+); *Phragmites australis* (+); *Sarcocornia pillansiae* (4); *Sarcocornia* sp. (1); *Sporobolus virginicus* (1); *Triglochin* spp (1).

APPENDIX II: Fish species recorded by the CDNEC in the Gourits Estuary (S C Thorne, *in litt.*). Scientific names of marine species from Smith and Heemstra, 1986.

Common name	Species
Estuarine Species:	
The following have been collected:	
Cape stumpnose	*Rhabdosargus holubi*
Cape moony	*Monodactylus falciformis*
Prison goby	*Caffrogobius multifasciatus*
Cape silverside	*Atherina breviceps*
Estuarine round-herring (saline and freshwater)	*Gilchristella aestuaria*
Southern mullet	*Liza richardsonii*
The following are thought to occur:	
Flathead mullet	*Mugil cephalus*
White steenbras	*Lithognathus lithognathus*
Kabeljou	*Argyrosomus hololepidotus*
Spotted grunter	*Pomadasys commersonnii*
Sea-catfish	*Galeichthys feliceps*
Elf	*Pomatomus saltatrix*
Leervis	*Lichia amia*
White stumpnose	*Rhabdosargus globiceps*
Sole spp.	*Solea* spp.
Freshwater species:	
The following have been collected:	
Chubbyhead barb	*Barbus anoplus*
Banded tilapia	*Tilapia sparrmanii*

The above information pertaining to the Gourits River was extracted from a single survey by CDNEC.

Other freshwater species occurring in the Gourits River system are:

APPENDIX II: (Cont.)

Indigenous species	Introduced/Alien species
Cape galaxias *(Galaxias zebratus)*	Mozambique tilapia *(Oreochromis mossambicus)*
Moggel *(Labeo umbratus)*	Smallmouth yellowfish *(Barbus aeneus)*
Smallscale redfin *(Pseudobarbus asper)*	Rainbow trout *(Parasalmo mykiss)*
Slender redfin *(Pseudobarbus tenuis)*	Carp *(Cyprinus carpio)*
Cape kurper *(Sandelia capensis)*	Bluegill sunfish *(Lepomis macrochirus)*
Freshwater mullet *(Myxus capensis)*	Largemouth bass *(Micropterus salmoides)*

The above 12 species may or may not travel down river to the mouth.

APPENDIX III: Reptile and amphibian checklist for the Gourits River locus 3421 BD. Compiled by M E de Villiers and A L de Villiers, CDNEC; from Branch (1981); Broadley (1983); FitzSimons (1943); Greig *et al.* (1979); Greig and Burdett (1976); Passmore and Carruthers (1979); Poynton (1964); Visser (1984))

The following species have either been recorded or are likely to occur in the locus mentioned above. Literature records, sight records and specimen records of the Chief Directorate: Nature and Environmental Conservation, C.P.A., were used for compiling this list.

The list of lizards is far from complete because lizard taxonomy is in a chaotic situation in southern Africa at present and there is a general lack of information on lizard distribution.

Amphibians

Common platanna	- *Xenopus laevis*
Sand toad	- *Bufo angusticeps*
Raucous toad	- *Bufo rangeri*
Plain rain frog	- *Breviceps fuscus*
Cape sand frog	- *Tomopterna delalandii*
Cape river frog	- *Rana fuscigula*
Striped grass frog	- *Strongylopus f. fasciatus*
Spotted grass frog	- *Strongylopus g. grayii*
Common caco	- *Cacosternum boettgeri*
Bronze caco	- *Cacosternum nanum*
Rattling kassina	- *Notokassina wealii*

Reptiles

Tortoises/Terrapins

Angulate tortoise	- *Chersina angulata*
Common padloper	- *Homopus areolatus*
Cape terrapin	- *Pelomedusa subrufa*

Snakes

Delande's blind snake	- *Typhlops lalandei*
Black worm snake	- *Leptotyphlops n. nigricans*
Common brown water snake	- *Lycodonomorphus rufulus*
Yellow-bellied house snake	- *Lamprophis fuscus*
Aurora house snake	- *Lamprophis aurora*
Olive-brown house snake	- *Lamprophis inornatus*

APPENDIX III: (Cont.)

Snakes

Common house snake	- *Lamprophis fuliginosus*
Southern slug eater	- *Duberria l. lutrix*
Mole snake	- *Pseudaspis cana*
Cape many spotted reed snake	- *Amplorhinus multimaculatus*
Rhombic skaapsteker	- *Psammophylax r. rhombeatus*
Whip snake	- *Psammophis notostictus*
Cross-marked grass snake	- *Psammophis crucifer*
Dwarf garter snake	- *Homoroselaps lacteus*
Lineolate shovel-snout	- *Prosymna s. sundevallii*
Eastern Natal green snake	- *Philothamnus natalensis occidentalis*
Herald snake	- *Crotaphopeltis hotamboeia*
Boomslang	- *Dispholidus t. typus*
Common egg-eater	- *Dasypeltis scabra*
Rinkhals	- *Hemachatus haemachatus*
Coral snake	- *Aspidelaps l. lubricus*
Cape cobra	- *Naja nivea*
Pelagic sea snake	- *Pelamis platurus*
Rhombic night adder	- *Causus rhombeatus*
Cape mountain adder	- *Bitis atropos*
Puff adder	- *Bitis a. arietans*

Lizards

Ocellate gecko	- *Pachydactylus geitje*
Marbled gecko	- *Phyllodactylus porphyreus*
Rock agama	- *Agama a. atra*
Silvery didactyle sand lizard	- *Scelotes bipes*
Golden sand skink	- *Acontias meleagris*
Cape three-striped skink	- *Mabuya capensis*
Cape speckled skink	- *Mabuya homalocephala*
Yellow-throated plated skink	- *Gerrhosaurus flavigularis*
Short-legged seps	- *Tetradactylus seps*
Ocellated sand lizard	- *Pedioplanis lineoocellata*
Common Cape girdled lizard	- *Cordylus cordylus*
Cape snake lizard	- *Chamaesaura anguina*

APPENDIX IV: List of waders recorded at Gourits Estuary on 76-01-09. (Summers *et al.*, 1976).

New Roberts number*	Common name		Count
246	White-fronted Plover		33
248	Kittlitz Plover		2
		TOTAL RESIDENTS	35
262	Turnstone		17
245	Ringed Plover		42
254	Grey Plover		27
272	Curlew Sandpiper		64
274	Little Stint		3
271	Knot		20
263	Terek Sandpiper		70
270	Greenshank		10
288	Bar-tailed Godwit		1
290	Whimbrel		3
		TOTAL MIGRANTS	257
		TOTAL WADERS	292

* New Roberts' number from Maclean, 1985

APPENDIX IV: (Cont.)

List of waders recorded at Voëlvlei near Gouritsmond on 76-01-09. (Summers *et al.*, 1976).

New Roberts' number*	Common name		Count
248	Kittlitz's Plover		1
		TOTAL RESIDENTS	1
245	Ringed Plover		4
254	Grey Plover		1
272	Curlew Sandpiper		50
274	Little Stint		400
284	Ruff		19
269	Marsh Sandpiper		1
270	Greenshank		10
266	Wood Sandpiper		1
		TOTAL MIGRANTS	467
		TOTAL WADERS	468

Counts of waders *(Charadrii)* and other birds at the Gourits River estuary July 1980. (Underhill and Coopper, 1983).

New Roberts' number*	Common name		Count
55	White-breasted Cormorant		10
56	Cape Cormorant		12
62	Grey Heron		3
67	Little Egret		1
84	Black Stork		1

Counts of waders *(Charadrii)* and other birds at the Gourits River estuary July 1980. (Underhill and Cooper, 1983)

New Roberts' number*	Common name		Count
262	Turnstone		1
246	Whitefronted Plover		15
249	Threebanded Plover		1
254	Grey Plover		1
255	Crowned Plover		6
258	Blacksmith Plover		2
272	Curlew Sandpiper		5
270	Greenshank		2
297	Cape Dikkop		10
312	Kelp Gull		70
324	Swift Tern		17
713	Cape Wagtail		1

APPENDIX IV: (Cont.)

List of birds recorded by Underhill and Cooper (1982) at the Gourits Estuary in January 1981

New Roberts' number*	Common name	Count
55	Whitebreasted Cormorant	6
62	Grey Heron	11
67	Little Egret	5
71	Cattle Egret	2
84	Black Stork	1
83	White Stork	8
102	Egyptian Goose	10
104	Yellowbill Duck	13
108	Redbill teal	2
228	Redknobbed Coot	10
262	Turnstone	2
245	Ringed Plover	55
246	Whitefronted Plover	15
248	Kittlitz Plover	8
249	Threebanded Plover	4
254	Grey Plover	31
257	Blacksmith Plover	23
286	Ethiopian Snipe	5
272	Curlew Sandpiper	155
274	Little Stint	24
263	Terek Sandpiper	63
264	Common Sandpiper	8
270	Greenshank	51
266	Wood Sandpiper	1
288	Bartailed Godwit	2
290	Whimbrel	26
298	Water Dikkop	4
297	Cape Dikkop	3
312	Kelp Gull	29
322	Caspian Tern	1
327/8	Common/Arctic Tern	3
324	Swift Tern	3
334	Damara Tern	6
428	Pied Kingfisher	7
429	Giant Kingfisher	1
713	Cape Wagtail	27

APPENDIX V: Mammals recorded or likely to occur in the grid square 3421 BD (CDNEC records, P Lloyd *in litt.*).

H = Historical records
R = Species listed in Red Data Book (Smithers, 1986)
A = Aliens

Present

Procavia capensis - rock dassie
Hystrix africaeaustralis - porcupine
Bathyergus suillus - Cape dune molerat

Probable

Miniopterus schreibersii - Schreibers' long-fingered bat
Eptesicus melckorum - Melck's serotine bat
Eptesicus capensis - Cape serotine bat
Myotis tricolor - Temminck's hairy bat
Tadarida aegyptiaca - Egyptian free-tailed bat
Rhinolophus capensis - Cape horseshoe bat
Rhinolophus clivosus - Geoffroys horseshoe bat
Rousettus aegyptiacus - Egyptian fruit bat
Myosorex varius - Forest shrew
Suncus varilla - Lesser dwarf shrew
Crocidura flavescens - Greater musk shrew
Crocidura cyanea - Reddish grey musk shrew
Amblysomus hottentotus - Hottentot golden mole
Chrysochloris asiatica - Cape golden mole
Papio ursinus - Chacma baboon
Cercopithecus pygerythrus - Vervet monkey
Arctocephalus pusillius - Cape fur seal
H *Diceros bicornis* - Black rhinoceros
Tragelaphus scriptus - Bushbuck
Sylvicapra grimmia - Grey duiker
H *Damaliscus dorcas dorcas* - Bontebok
Raphicerus campestris - Steenbok
Raphicerus melanotis - Grysbok
Pelea capreolus - Grey Rhebuck
Lepus saxatilis - Scrub hare
Lepus capensis - Cape hare
Pronolagus rupestris - Smith's red rock rabbit
Otomys irroratus - Vlei rat
Tatera afra - Cape gerbil
Saccostomus campestris - Pouched mouse
Rhabdomys pumilio - Striped mouse
Aethomys namaquensis - Namaqua rock mouse
Dendromus melanotis - Grey climbing mouse
Mus minutoides - Pygmy mouse
A *Mus musculus* - House mouse
Praomys natalensis - Multimammate mouse

Probable

Praomys verreauxii - Verreaux's mouse
A *Rattus rattus* - House rat
A *Rattus norvegicus* - Brown rat
Cryptomys hottentotus - Common mole rat
Georychus capensis - Cape mole rat
Vulpes chama - Cape fox
Ictonyx striatus - Striped pole cat
R *Mellivora capensis* - Honey badger
Aonyx capensis - Cape clawless otter
Genetta genetta - Common genet
Genetta tigrina - Large-spotted genet
Herpestes pulverulentus - Cape grey mongoose
Herpestes ichneumon - Egyptian mongoose
Atilax paludinosus - Marsh mongoose
Cynictis penicillata - Bushy-tailed meerkat
H *Hyaena brunnea* - Brown hyaena
R *Felis lybica* -African wild cat
Felis caracal - African lynx
HR *Panthera pardus* - Leopard

Possible

Miniopterus fraterculus - Lesser long-fingered bat
Kerivoula lanosa - Lesser woolly bat
Eptesicus hottentotus - Long-tailed bat
Nycteris thebaica - Common slit-faced bat
Taphozous mauritianus - Tomb bat
Chlorotalpa duthiae - Duthie's golden mole
Elephantulus edwardii - Cape rock elephant-shrew
Macroscelides proboscideus - Round-eared elephant-shrew
Hydrurga leptonyx - Leopard seal
Mirounga leonina - Southern elephant seal
R *Orycteropus afer* - Antbear
Potamochoerus porcus - Bushpig
R *Mystromys albicaudatus* - White-tailed mouse
Dendromus mesomelas - Brants' climbing mouse
Gerbillurus paeba - Hairy-footed gerbil
Acomys subspinosus - Cape spiny mouse
Dasymus incomtus - Water rat
R *Graphiurus ocularis* - Spectacled dormouse
Otocyon megalotis - Bat-eared fox
Canis mesomelas - Black-backed jackal
R *Poecilogale albinucha* - White-naped weasel
R *Proteles cristatus* - Aardwolf

APPENDIX VI: Guide to available information

ESTUARY / RIVERMOUTH / LAGOON: GOURITS

Guide to available information	Acocks (1975)	Barnard (1943)	Bohnen (1986)	Branch (1981)	Brink et al (1986)	Broadley (1983)	Bulpin (1980)	CPA (1973)	Crowther (1987)	CSIR (1988)	Day (1971)	Duvenage (1983)	Estié (1981)	Fitz Simons (1943)	Geustyn et al (1986)	Geustyn et al (1987)	Greig et al (1979)	Greig and Burdett (1976)
MANAGEMENT: Historical							*											
MANAGEMENT: Conservation/Utilization					*		*	*								*		
MANAGEMENT: Management/Planning					*			*								*		
MANAGEMENT: Legislation																		
MANAGEMENT: Water																		
BIOTIC: Food webs/Ecosystems																		
BIOTIC: Fauna: Mammals																		
BIOTIC: Fauna: Birds																		
BIOTIC: Fauna: Reptiles				*		*								*				
BIOTIC: Fauna: Amphibians																	*	*
BIOTIC: Fauna: Fish		*														*		
BIOTIC: Fauna: Molluscs																		
BIOTIC: Fauna: Crustaceans																*		
BIOTIC: Fauna: Other aquatic invertebrates																		
BIOTIC: Fauna: Terrestrial invertebrates																		
BIOTIC: Fauna: Zooplankton																		
BIOTIC: Flora: Terrestrial vegetation	*		*												*	*		
BIOTIC: Flora: Semi-aquatic vegetation																		
BIOTIC: Flora: Aquatic vegetation				*														
BIOTIC: Flora: Algae																		
BIOTIC: Flora: Phytoplankton																		
BIOTIC: Microbiology																		
ABIOTIC: Chemistry: Pollution																		
ABIOTIC: Chemistry: Eutrophication																		
ABIOTIC: Chemistry: General Chemistry																		
ABIOTIC: Salinity											*	*						
ABIOTIC: Physics: Circulation and mixing																		
ABIOTIC: Physics: Hydrology / Flood regime									*	*			*					
ABIOTIC: Physics: Oceanography																		
ABIOTIC: Physics: Climate																		
ABIOTIC: Geology: Sedimentology										*								
ABIOTIC: Geology: Palaeoenvironment					*													
ABIOTIC: Geology: Geology			*													*		
ABIOTIC: Physiography: Morphology										*		*						
ABIOTIC: Physiography: Dams/Obstructions											*							
ABIOTIC: Physiography: Catchment characteristics									*									
YEAR (DATE OF INFORMATION)	1975	1943	1986	1981	1986	1983	1980	1973	1987	1988	1971	1983	1981	1943	1986	1987	1979	1976

Sources of information: Acocks, Barnard, Bohnen, Branch, Brink et al, Broadley, Bulpin, CPA, Crowther, CSIR, Day, Duvenage, Estié, Fitz Simons, Geustyn et al, Geustyn et al, Greig et al, Greig and Burdett

APPENDIX VI: (Continued)

ESTUARY / RIVERMOUTH / LAGOON: GOURITS

Guide to available information			Hallward	Heydorn	Heydorn and Tinley	Heydorn and Swart	Haughton and Visser	Jezewski and Roberts	Kovács	Levin	Lubke	Maclean	Malan	Marais	Martin	Midgley and Pitman	Moll et al	Muir	Noble and Hemens	Passmore and Carruthers
YEAR (DATE OF INFORMATION)			1986	1986	1980	1987	1937	1986	1983	1987	1988	1985	1987	1981	1985	1969	1984	1929	1978	1979
MANAGEMENT		Historical																		
MANAGEMENT		Conservation/Utilization		*	*			*			*									
MANAGEMENT		Management/Planning		*																
MANAGEMENT		Legislation																		
MANAGEMENT		Water				*													*	
BIOTIC		Food webs/Ecosystems																		
BIOTIC	Fauna	Mammals																		
BIOTIC	Fauna	Birds										*								
BIOTIC	Fauna	Reptiles																		
BIOTIC	Fauna	Amphibians																		*
BIOTIC	Fauna	Fish																		
BIOTIC	Fauna	Molluscs																		
BIOTIC	Fauna	Crustaceans																		
BIOTIC	Fauna	Other aquatic invertebrates																		
BIOTIC	Fauna	Terrestrial invertebrates																		
BIOTIC	Fauna	Zooplankton																		
BIOTIC	Flora	Terrestrial vegetation			*						*						*	*		
BIOTIC	Flora	Semi-aquatic vegetation																		
BIOTIC	Flora	Aquatic vegetation																		
BIOTIC	Flora	Algae																		
BIOTIC	Flora	Phytoplankton																		
BIOTIC		Microbiology																		
ABIOTIC	Chemistry	Pollution																		
ABIOTIC	Chemistry	Eutrophication																		
ABIOTIC	Chemistry	General Chemistry																		
ABIOTIC		Salinity																		
ABIOTIC	Physics	Circulation and mixing																		
ABIOTIC	Physics	Hydrology / Flood regime	*		*	*		*	*					*		*			*	
ABIOTIC	Physics	Oceanography																		
ABIOTIC	Physics	Climate	*		*	*										*				
ABIOTIC	Geology	Sedimentology	*					*												
ABIOTIC	Geology	Palaeoenvironment																		
ABIOTIC	Geology	Geology	*		*		*			*			*		*			*		
ABIOTIC	Physiography	Morphology	*		*	*														
ABIOTIC	Physiography	Dams/Obstructions	*	*				*	*					*						
ABIOTIC	Physiography	Catchment characteristics	*	*	*			*	*					*		*			*	

Sources of information

APPENDIX VI: (Continued)

ESTUARY / RIVERMOUTH / LAGOON: GOURITS

Guide to available information

Group	Subgroup	Item	Pitman et al (1981)	Poynton (1964)	Raper (1987)	Reservoir inflow records (1978)	River Flow Data (1978)	Roberts and Alexander (1982)	Roberts (1973)	Schultze (1965)	Sinclair (1985)	Smith and Heemstra (1986)	Smithers (1986)	S.A. Dept of Planning (1971)	S.A. Dept of Environ Affairs (1988)	S.A. Weather Bureau (1965)	Summers et al (1976)	Swart (1986)	Taylor (1978)	Tinley (1985)
MANAGEMENT		Historical			*															
MANAGEMENT		Conservation / Utilization									*			*						*
MANAGEMENT		Management / Planning																		
MANAGEMENT		Legislation																		
MANAGEMENT		Water	*					*												
BIOTIC		Food webs / Ecosystems																		
BIOTIC	Fauna	Mammals											*							
BIOTIC	Fauna	Birds															*			
BIOTIC	Fauna	Reptiles																		
BIOTIC	Fauna	Amphibians		*																
BIOTIC	Fauna	Fish										*								
BIOTIC	Fauna	Molluscs																		
BIOTIC	Fauna	Crustaceans															*			
BIOTIC	Fauna	Other aquatic invertebrates																		
BIOTIC	Fauna	Terrestrial invertebrates																		
BIOTIC	Fauna	Zooplankton																		
BIOTIC	Flora	Terrestrial vegetation									*								*	*
BIOTIC	Flora	Semi-aquatic vegetation															*			
BIOTIC	Flora	Aquatic vegetation															*			
BIOTIC	Flora	Algae																		
BIOTIC	Flora	Phytoplankton																		
BIOTIC		Microbiology																		
ABIOTIC	Chemistry	Pollution													*					
ABIOTIC	Chemistry	Eutrophication																		
ABIOTIC	Chemistry	General Chemistry																		
ABIOTIC		Salinity																		
ABIOTIC	Physics	Circulation and mixing																		
ABIOTIC	Physics	Hydrology / Flood regime	*			*	*	*												
ABIOTIC	Physics	Oceanography																		
ABIOTIC	Physics	Climate	*							*						*				
ABIOTIC	Geology	Sedimentology																*		*
ABIOTIC	Geology	Palaeoenvironment																		
ABIOTIC	Geology	Geology	*																	
ABIOTIC	Physiography	Morphology							*								*			*
ABIOTIC	Physiography	Dams/Obstructions	*			*														
ABIOTIC	Physiography	Catchment characteristics					*		*											
YEAR (DATE OF INFORMATION)			1981	1964	1987	1978	1978	1982	1973	1965	1985	1986	1986	1971	1988	1965	1976	1986	1978	1985

Sources of information: Pitman et al; Poynton; Raper; Reservoir inflow records; River Flow Data; Roberts and Alexander; Roberts; Schultze; Sinclair; Smith and Heemstra; Smithers; S.A. Dept of Planning; S.A. Dept of Environ Affairs; S.A. Weather Bureau; Summers et al; Swart; Taylor; Tinley

APPENDIX VI: (Continued)

ESTUARY / RIVERMOUTH / LAGOON: GOURITS

		Guide to available information	Underhill and Cooper	Underhill and Cooper	Visser	Wallace et al
MANAGE-MENT		Historical				
		Conservation/Utilization				*
		Management/Planning				
		Legislation				
		Water				
BIOTIC		Food webs/Ecosystems				
	Fauna	Mammals				
		Birds	*	*		
		Reptiles			*	
		Amphibians				
		Fish				*
		Molluscs				
		Crustaceans				
		Other aquatic invertebrates				
		Terrestrial invertebrates				
		Zooplankton				
	Flora	Terrestrial vegetation				
		Semi-aquatic vegetation				
		Aquatic vegetation				
		Algae				
		Phytoplankton				
		Microbiology				
ABIOTIC	Chemistry	Pollution				
		Eutrophication				
		General Chemistry				
		Salinity				
	Physics	Circulation and mixing				
		Hydrology / Flood regime				
		Oceanography				
		Climate				
	Geology	Sedimentology				
		Palaeoenvironment				
		Geology				
	Physiography	Morphology				
		Dams/Obstructions				
		Catchment characteristics				
YEAR (DATE OF INFORMATION)			1982	1983	1984	1984
		Sources of information	Underhill and Cooper	Underhill and Cooper	Visser	Wallace et al

PLATE I:

Arid scrub thicket on the east bank of the Gourits River near the mouth. (ECRU, 87-06-10).

PLATE II:

Mouth of the Gourits River approximately 40 m wide during the floods of August 1986. Note the silt-laden water. (ECRU, 86-08-31).

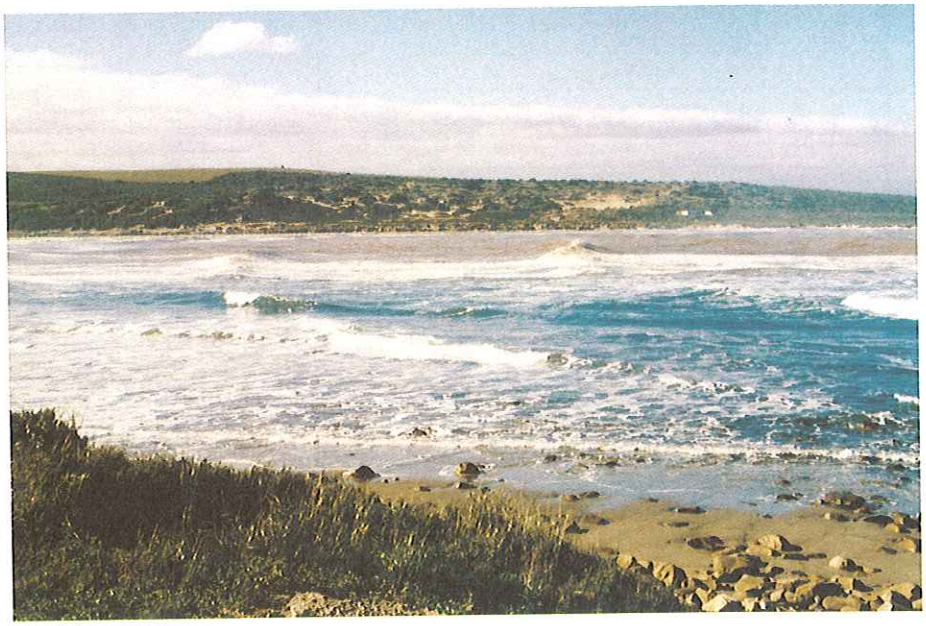

PLATE III:

Lands on the west bank of the upper estuary being irrigated from water taken above the illegal weir. Note the salt crust, lack of vegetation and resulting wind erosion (ECRU, 88-11-17).

LIST OF REPORTS PUBLISHED BY ECRU TO DATE

of the Cape Part I. Synopsis of the Cape Coast. Natural features, and utilization. A E F Heydorn and K L Tinley. *CSIR Research Report*

of the Cape Part II. Synopses of available information on individual

Estuary Name	CSIR Research Report No.
*Spoeg	400
*Buffels	401
*Groen	402
*Swartlintjies	403
Holgat	404
Bitter	405
Gamtoos	406
Rooiels	407
Uilkraals	408
*Kowie	409
Hartenbos	410
(Buffels Wes, Elsies, Sir Lowry's Pass)	411
(Steenbras, Buffels Oos)	412
*Silvermine	413
Sand	414
Zeekoe	415
Eerste	416
Lourens	417
*Bot	418
*Groot (Wes), Sout	419
*Groot Brak	420
*Breë	421
*Swartvlei	422
Swartkops	423
Onrus	424
Heuningnes	425
Olifants	426
Wildevoëlvlei	427
Riet/Diep	428
Houtbay	429
Knysna	430
Keurbooms/Bitou and Piesang	431
Verlorenvlei	432
Krom, Seekoei, Kabeljous	433
Duiwenhoks, Kafferkuils (in prep.)	434
Boknes, Boesmans, Kariega, Kasuka (in prep.)	435
Rufane, Riet, Kleinemondes (in prep.)	436
Palmiet (in prep.)	437
Gourits	438
Quko	439
Klein (in prep.)	440
Groot Berg (in prep.)	

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