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THE CLIMATOLOGY OF THE ST LUCIA AREA

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1. Introduction

The St Lucia area is situated in the coastal lowland bioclimatic zone (Phillips, 1973) between latitudes 27°S and 29°S. Proximity to the sea and a warm ocean current influence the climate to a large extent.

The aim of this paper is to look at the way in which the climate is recorded in the St Lucia area and to assess whether sufficient data are being collected, as well as to review work that has been done on certain aspects of the climate. The main climatological features of the area are also presented.

2. Data collection

Details of all weather data collecting stations are given in table 1, and figure 1 shows the location of all these stations.
The following organisations and bodies collect weather data of relevance to the St Lucia area:

The Weather Bureau in Pretoria has data available for numerous rainfall stations. Some of these have only been operative for a short period, while others such as Makakatana, provide unbroken records for over 50 years. The Weather Bureau also has weather stations which provide data in addition to rainfall. The local weather stations which are currently in operation are Cape St Lucia, Charter's Creek (called St Lucia Lake Research Centre in the Weather Bureau listing) and River View. A weather station was also started at Sodwana Bay in 1979 but was closed down at the end of 1981. Data for weather stations are available from the Weather Bureau in computerized form from 1970 onwards.

The Natal Agrometeorological Section at Cedara collects weather data from farmers in Natal which are summarized periodically. Their latest edition is "A summary of meteorological conditions in Natal, April 1979". A new summary is due early in 1982. Included in their data collection are maximum and minium temperatures, average temperatures, rainfall, evaporation, sunshine hours, wind

Table 1 Weather data collecting stations

Station No. (6)	Station name	Lat	Long	Alt (m)	Dates of data coll	Rainfall	Max & min temps	Wet & dry bulb temps	Grass min temps	Thermo hygrograph	Anemometer	Cloud obs.	Barometer	Sunshine recorder	Evaporation pans	Lightning flashes	Thermograph
339/354 X	Mtubatuba	28°24'	32°12'	60	1914 - 30	*											
339/357 5	Riverview	28°27'	32°12'	46	1957 -	*7	*	*			*	*		*	*		*8
339/415 0	Hill Farm	28°25'	32°14'	76	1919 -	*											
339/426 X	Walls Place	28°06'	32°15'	117	1926 - 37	*											
339/440 3	Palm Ridge	28°20'	32°15'	67	1932 - 77	*											
339/441 5	Dukuduku-bos	28°21'	32°15'	70	1927 -	*	*9										
339/456 1	Endoneni	23°06'	32°16'	55	1923 - 56	*											
339/481 4	Hluhluwe Exp Station	28°01'	32°17'	91	1929 - 38	*											
339/483 8	Hluhluwe Lot 40	28°03'	32°17'	91	1974 - 79 1923 - 72	*											
339/502 6	St Lucia Est.	28°22'	32°17'	70	1921 - 52	*											
339/523 2	Nyalazi-bos	28°13'	32°18'	45	1928 - 45 1954 -	*											
339/538 9	Uloa	28°28'	32°18'	15	1931 -	*											
339/681 0	St Lucia Est. Forest Sta.	28°21'	32°23'	15	1953 _	*											
339/720 3	Cape St Lucia	28°30'	32°24'	107	1919 -	*	*	*		*10	*	*	*				
339/722 7	Nhlozi-bos	28°02'	32°25'	45	1961 - 75	*											
339/731 2)(1) 339/731 A7)	St Lucia lake Research Ct.	28°11'	32°25'	18	1959 -	*	*	*4							*	*	*
339/732 4	Charters Creek	28°12'	32°25'	45	1951 - 59	*											
339/734 8	Makakatana	28°14'	32°25'	30	1928 -	*											
339/756 6	Fanies Island	28°06'	32°26'	45	1951 -	*											
339/856 4	(2) Estuary-bos	28°16'	32°29'	91	1960 -	*											
340/010 0	(3) Meersig-bos	28°10'	32°31'	152	1956 -	*									*11		
340/035 4	Tewate	20°05'	32°32'	10	1981 -	*											
375/444 1	Harrowgate	27°54'	32°15'	80	1938 -63	*											
375/506 4	Vergenoeg	27°56'	32°17'	80	1926 -46 1952 -63	*											
375/688 4	False Bay Park	27°58'	32°23'	40	1951 -	*					*			·	*		
375/801 X	Nebela	27°51'	32°27'	- ·	1935 -38	*											
376/220 X	Ozabeni	27°40'	32°28'	27	1981 -	*											
376/302 7	Sodwana Bay	27°32'	32°41'	29	1979 -81	*	*	*	*	*	*	*	*	*			
412/52	Mseleni Mission	27°20'	32°33'		1934 -49 1962 -72	*											
412/179	Mbazwane	27°27'	32°36'		1963 -	*											
412/383	Rhodes Camp	27°23'	32°43'	-	1968 -	*											
NPA	Estuary Mouth	28°23'	32°25'	-	1972 -	*					*						
	Mr J.H. Brammer	28°08'	32°17'	91	1976 -	*	*										
	Mr H.D. Harrison	28°24'	32°12'	-	1980 -	*	*				*				*		
	Hluhluwe Dam	28°07'	32°11'	-	1964 -	*									*		
	Futululu Research St.	28°25'	32°15'		1981 -	*	*				*			*5			

Notes

1 Located at Charters Creek
2 Now called Mount Tabor
3 Now called Cape Vidal
4 1978 dry bulb temps. only
5 Radiation meter
6 For Weather Bureau Stations only
7 1914 -
8 1963 -
9 1933 - 1940 only
10 1961 -
11 1976 - 1977

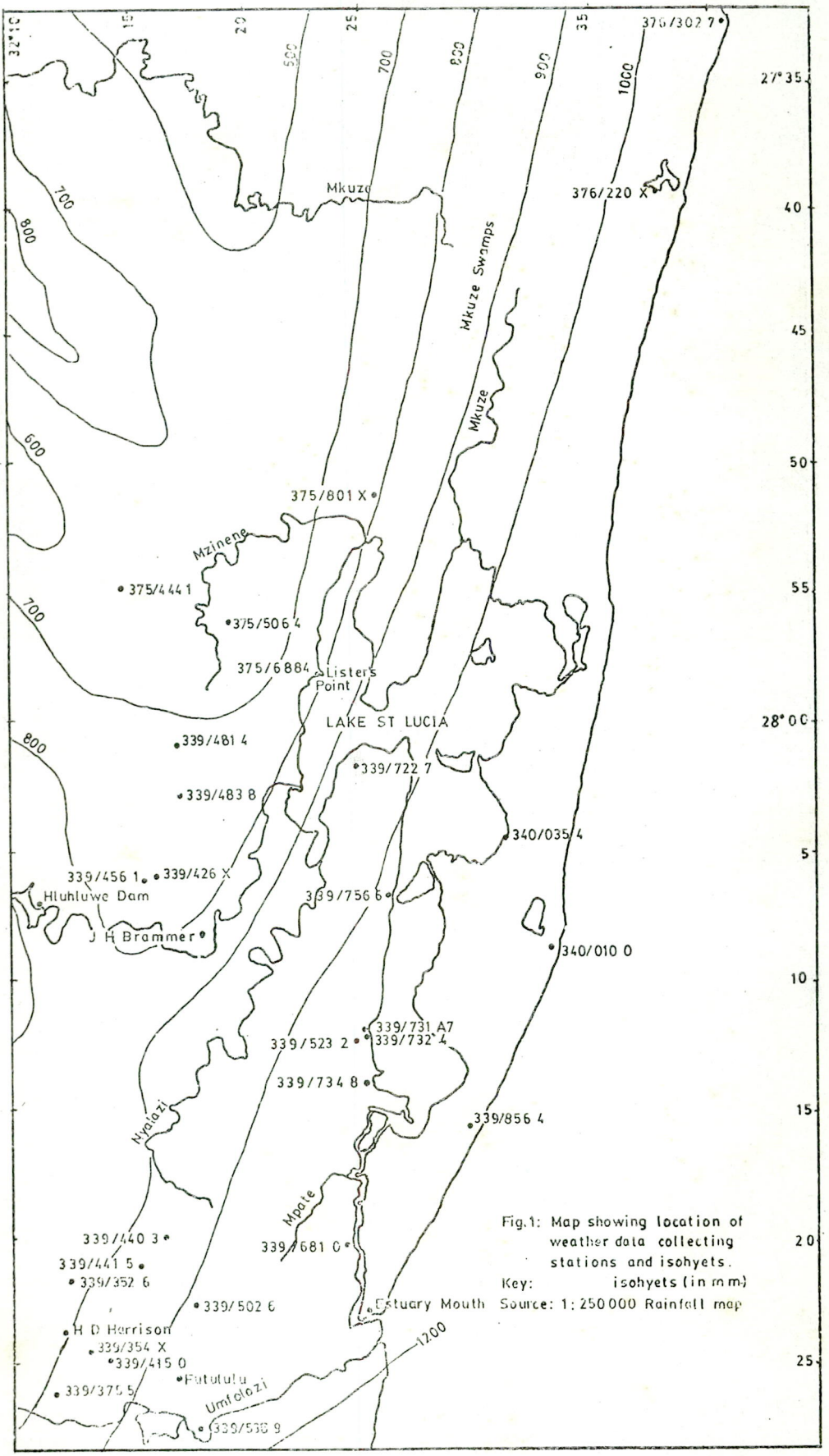


Fig.1: Map showing location of weather data collecting stations and isohyets.
Key: isohyets (in mm)
Source: 1:250000 Rainfall map

run and radiation.

The South African Sugar Association collects weather data from the sugar belt which is computerized. They issue monthly weather reports covering rainfall, temperatures and atmospheric conditions and also have long term monthly meteorological records which are available on request

The Natal Provincial Administration Reclamation Unit and the local Forestry Stations also collect weather data in the area.

3 Weather components

3.1. Precipitation

3.1.1. Rainfall

The most important form of precipitation is rainfall. All rainfall recording stations are mapped (figure 1) and listed (table 1). Data from rainfall stations have been summarized and mean monthly rainfall, mean yearly rainfall, standard deviations, average number of raindays per month and maximum recorded rainfall in 24 hours are available for each station. Table 2 (at end of paper) gives monthly data for stations around Lake St Lucia and these data are graphed in figure 2.

Average annual rainfall for stations in the St Lucia area are given in table 3 and graphed (figure 3). Mount Tabor receives the highest average annual rainfall followed closely by Cape St Lucia and Estuary Mouth.

The warm Mozambique current plays an important role in causing high rainfall along the Zululand coast The Natal coast bulges eastwards into the sea along the Zululand section and the Mozambique current therefore flows very close in-shore. (The St Lucia coastline is the most easterly point in the Republic). The surface air in contact with the warm current heats up comparatively quickly, causing instability and the formation of cumulus clouds along the coastline, which often bring abundant rainfall.

Rainfall stations on the Lake receive their maximum rainfall in summer, but with the exception of False Bay Park, the

Figure 2 Average monthly rainfall and average number of raindays per month for stations around the Lake.
Source: Weather Bureau and NPA Reclamation Unit

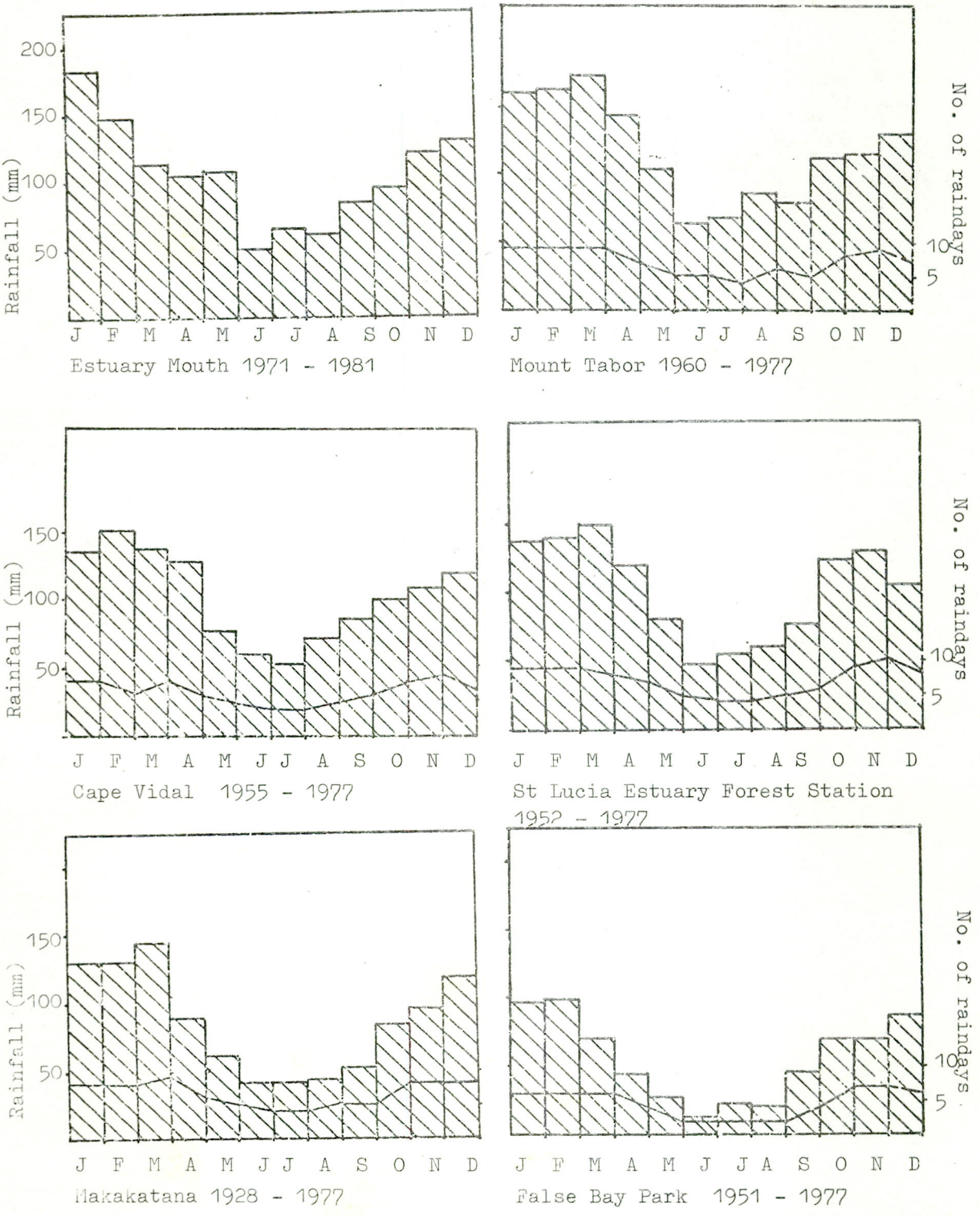
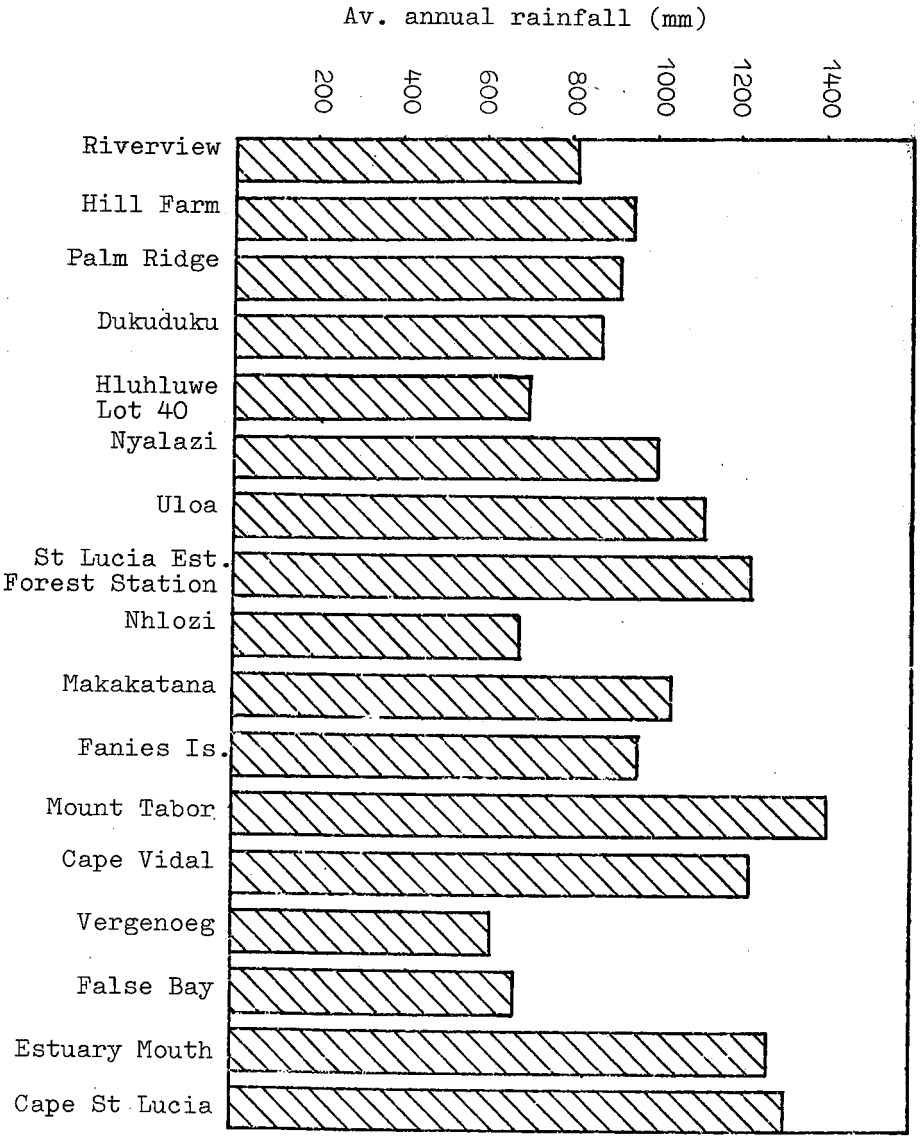


Fig. 3. Average annual rainfall for 17 stations in the St Lucia area



Source: Weather Bureau and NPA Reclamation Unit

monthly winter mean never drops below 40mm. Average number of raindays varies between 2 per month at False Bay Park in winter to 10 per month at St Lucia Estuary Forest Station in November.

Table 3 Average annual rainfall for rainfall stations in the St Lucia area.

Station number	Station name	Average annual rainfall (mm)	Period of record
339/357 5	River View	819	1926 - 1957
339/415 0	Hill Farm	946	1919 - 1977
339/440 3	Palm Ridge	909	1932 - 1977
339/441 5	Dukuduku	861	1926 - 1977
339/483 8	Hluhluwe Lot 40	697	1922 - 1977
339/523 2	Nyalazi	998	1928 - 1977
339/538 9	Uloa	1111	1930 - 1977
339/681 0	St Lucia Estuary Forest Station	1224	1952 - 1977
339/722 7	Nhlozi	675	1961 - 1975
339/734 8	Makakatana	1037	1928 - 1977
339/756 6	Fanies Island	959	1951 - 1977
339/856 4	Mount Tabor	1396	1960 - 1977
340/010 0	Cape Vidal	1224	1955 - 1977
375/506 4	Vergenoeg	607	1923 - 1963
375/688 4	False Bay	667	1950 - 1977
339/720 -	Cape St Lucia Estuary Mouth	1292 1266	1919 - 1950 1971 - 1981

Source : Weather Bureau, unpublished data.

Research work on rainfall

Kriel (1965) produced an isohyet map of the St Lucia area and its catchment. The isohyets were derived by Schultze (1964) in a study of average rainfall in the Republic. These isohyets are shown in figure 1. According to these isohyets, average annual rainfall ranges from over 1200mm at Cape St Lucia to less than 800mm at Lister's Point in False Bay Park. Kriel estimates the annual average rainfall for the Lake to be 1026mm.

In the same report, he notes that seasonal distribution of rainfall varies from the coast to the interior. The coastal areas receive 60% of their average annual rainfall in the summer months while inland, near Hluhluwe 76% of the average annual rainfall occurs during the same period.

Kriel has calculated variability of rainfall at individual stations with long term data of over 30 years. The rainfall for a single station may vary greatly from the mean. The average range for the St Lucia region is about 45% below the mean in the case of a very dry year and about 220% above the mean in a very wet year.

Hutchison & Pitman (1973) have taken data from the five rainfall recordings stations in closest proximity to the Lake, namely Hluhluwe Lot 40 (west of the lake), Cape St Lucia (south of the lake), Makakatana (Western Shores), Cape Vidal (Eastern Shores) and Lister's Point (False Bay) to compute the average lake mean which is given as 890mm. They have produced an isohyet map of the St Lucia area and its catchment, based on data from the Weather Bureau's rainfall recording stations. The isohyet map has subsequently been updated (Hutchison, 1976) using data from additional rainfall stations (figure 4). The isohyet map shows that average annual rainfall ranges from over 1300mm at Cape St Lucia to just under 700mm at False Bay Park. This differs from Schultze's isohyet map. There is therefore a considerable variation in values for annual average rainfall and more work should be done, using data from all the rainfall stations on the Lake to determine more exactly what the mean annual rainfall for each area is.

McGill (1980) uses rainfall data from 1972 - 1977 and gives average monthly rainfall figures from nine catchments and for the Lake itself. To do this, data from four rainfall recording stations were used. McGill calculated the mean annual rainfall for the Lake to be 1261mm. This figure is higher than Hutchison's mean of 890mm as the period under consideration was an exceptionally wet one.

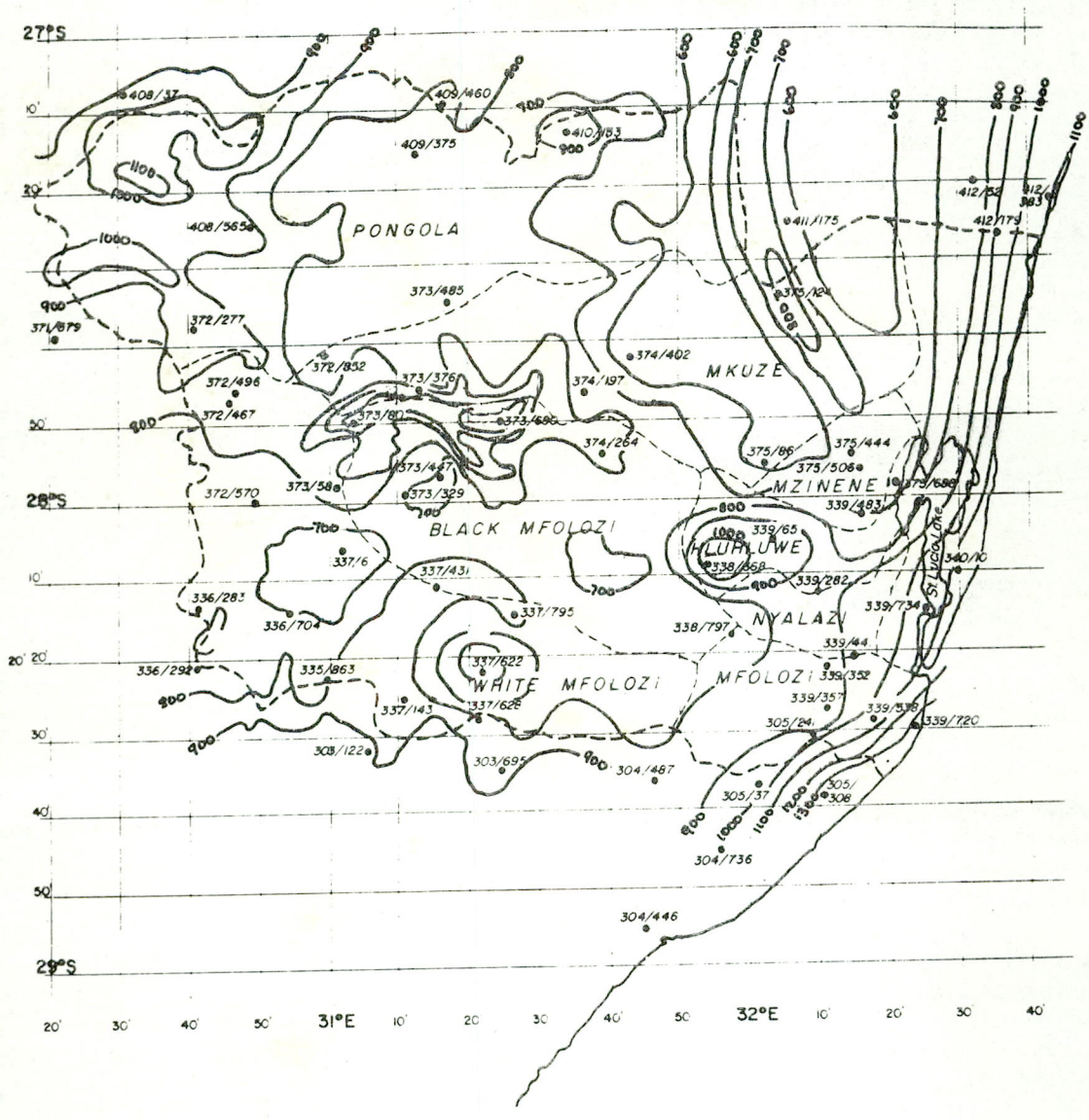
3.1.2. Dew

The occurrence/absence of dew has been recorded at Charter's Creek since January 1978. No analysis has been done of occurrence or abundance of dew.

3.1.3. Fog and mist

Provision is made on the rainfall recording sheets for recording fog and mist at all rainfall stations, but no such records have been made.

Fig. 4: Isohyet map, Lake St Lucia area.
Source: Hutchison, 1976.



3.1.4. Lightning

A lightning recorder has been installed at Charter's Creek, which records the occurrence of lightning on a digital counter. The data from the lightning recorder are being used by the National Electrical Engineering Institute to work out a lightning ground flash density based on flashes /km^2/year. It is a 12 year survey which started in 1975 and already the Institute has produced a lightning flash density map. The St Lucia area falls into the three to four flashes/km^2/year category, which is a medium to low density. The Ermelo-Piet Retief-Vryheid area has the highest flash density of 11 to 12 flashes/km^2/year.

3.1.5. Hail

Hail has been recorded once, on 28th March 1979. It was accompanied by strong winds and torrential rains and was localised to the southern part of the Narrows. (Taylor, 1979).

3.2 Evaporation

The Department of Environment Affairs (Directorate of Water Affairs) has established stations at which evaporation rates are measured using Symons and class A pans.

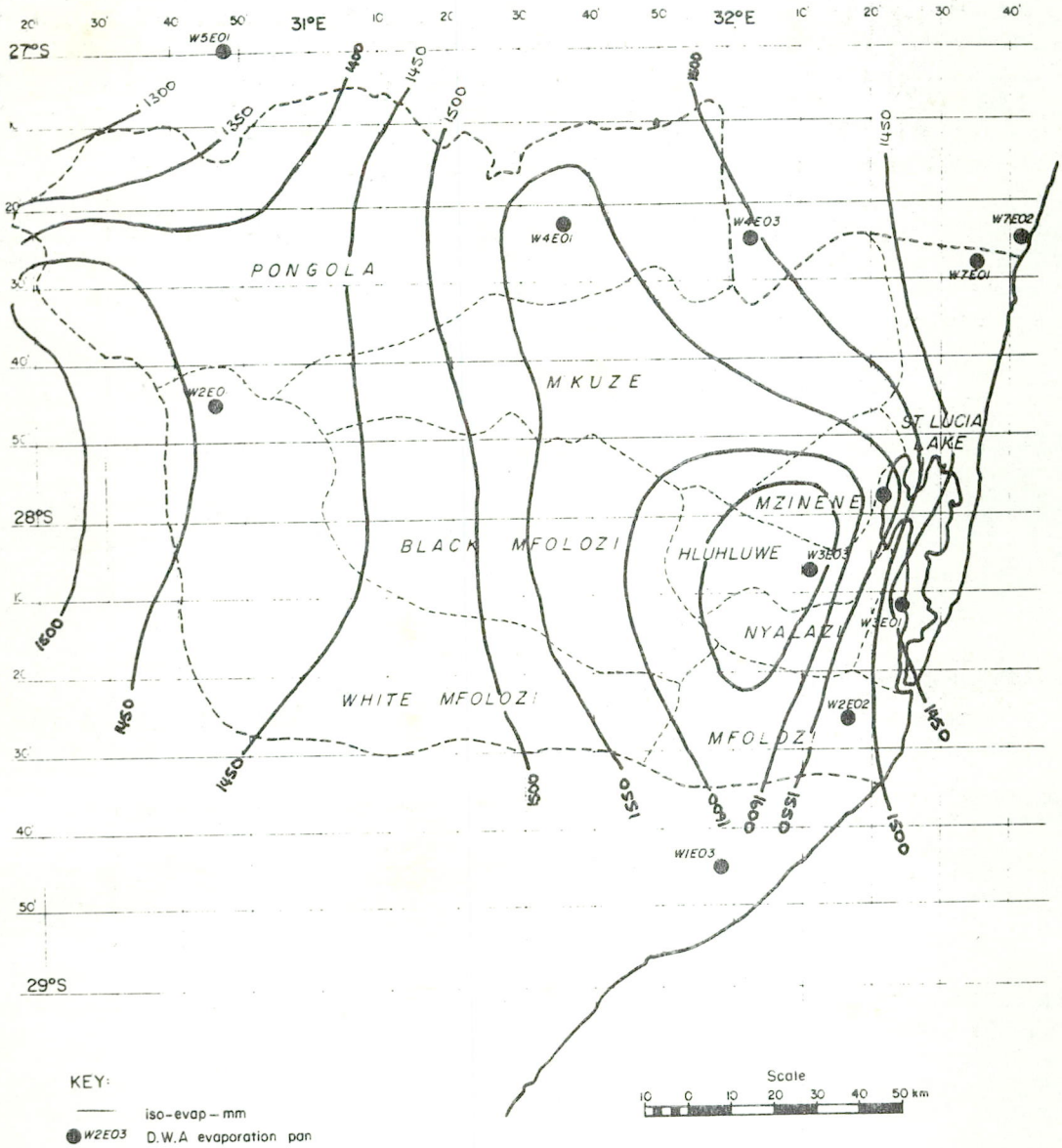
Hutchison (1976) has listed these stations and mapped their positions and mean annual Symons Pan potential evaporation (Table 4).

Hutchison used data from these stations to compile an iso-evaporation map (figure 5). The map shows how potential evaporation increases from the coast (Mbazwane = 1461mm) in a westerly direction reaching a peak in the Hluhluwe river valley (Hluhluwe Dam = 1688mm). Potential evaporation rates tend to decrease further inland from the Hluhluwe Dam.

The mean annual evaporation for the Lake is about 1500mm per annum. No evaporation measuring stations on the Eastern Shores were used to compile the iso-evaporation map and Hutchison & Pitman (1973) suggest in their recommendations that additional evaporation pans should be installed in the eastern catchment of the Lake as well as in the Mkuze and Mosi swamps.

Kriel (1966) estimates that the average annual gross evaporation from a Symons Pans in the St Lucia coastal area is 52" (1290mm). This figure is based on data from

Fig. 5: Iso-evaporation map, Lake St Lucia area.
Source: Hutchison, 1976.



ST. LUCIA LAKE SYSTEM — D.W.A. EVAPORATION STATIONS AND MEAN ANNUAL GROSS EVAPORATION AS MEASURED BY SYMON'S PAN

Charter's Creek alone and Kriel points out that between 1952 and 1963, only four full years of observations are available. Kriel has attempted to use this figure to calculate evaporation loss from the Lake. Total water loss will vary with surface area as well as evaporation rate. He has calculated surface areas for the Lake and resultant nett evaporation losses. These results are largely hypothetical as the Lake does not remain at its upper or lower levels for any length of time. Evaporation is also dependent on amount of solar radiation, water surface temperature, wet and dry bulb temperatures and relative humidity.

Hutchison & Pitman (1973) suggest that more sophisticated methods of measuring water loss from the Lake are required as evaporation from Class A or symons Pan are not a good indication of water loss from the Lake.

Table 4 Details of evaporation measuring stations

Station no.	Station name	Lat.	Long.	Mean annual Symons Pan potential evaporation (mm)	Period of record (years)
WZE02	River View	28°27'	32°17'	1538*	1966-1969
W3E01	Charter's Creek	28°12'	32°25'	1428	1951-1973
W3EØ2	Lister's Point	27°58'	32°23'	1586	1964-1973
W3EØ3	Hluhluwe Dam	27°Ø8'	32°11'	1688	1963-1973
W7EØ1	Mbazwane	27°29'	32°35'	1461	1966-197Ø
W7EØ	Lake Sibaya	27°25'	32°43'	1481	1968-197Ø

* denotes that Symons pan values were calculated by applying a correction factor to the A pan values.

3.3. Wind

Prevailing winds along Natal's coast are mainly north-easterly and south-westerly (Smith, 1964). Wind is directly related to pressure systems and varies in intensity and direction according to the strength of such a system.

North-easterly Winds (the name given to cover N, NNE, NE, and ENE winds) are associated with a low pressure system

moving in a north-easterly, direction along South Africa's coastline. The associated weather is usually fair and warm. The low pressure system associated with the north-easterly wind is followed by a high pressure system with cooler air in circulation. With the passing of a low pressure system, surface winds change abruptly to blow in a south-westerly direction, pressure rises sharply, and cool cloudy conditions occur.

The onset of a south-westerly wind can be very sudden; if the low pressure system is small and fast moving, then the switch in wind direction can occur over a few seconds, and the south-westerly can freshen to gale force almost immediately. This is known as the south-west buster and can cause dangerous conditions at sea.

Also experienced over Natal's coastal areas are Berg winds. These are caused by air moving from a high pressure system over the interior to an elongated low pressure system on the coast After moving over the interior and with descending altitude the wind is hot (38^{o} - 42^{o}C) and dry.

Wind recording stations

Wind speed and direction is recorded at Lister's Point and at the Estuary Mouth. These data have been reduced to four hourly averages and are available from 1969 onwards. Hutchison & Pitman (1973) have summarized the percentage frequency of wind by direction and speed class for the period January 1969 to February 1973 for Estuary Mouth and Lister's Point.

Wind data are also collected at five other places in the vicinity of the Lake (see table 1).

Research

A study on wind energy is currently being carried out by R. Daib, of the University of Natal to assess the potential for wind energy utilization in South Africa. The first phase of the study has already been completed and the findings are summarized (Diab, undated). Using wind data from readily available sources she identified the St Lucia area as being an area with mean annual winds speeds of 6.6 m/s (at 10m above the ground). The second phase of her project was started early in 1981. A site was selected on the dune near Mission Rocks where a 10m mast with an anemometer giving

hourly wind speed and direction was installed in July 1981. It is intended to leave the mast there for a year. A second 25m high mast was erected next to the former with instruments to measure wind speed, direction and temperature. Data are recorded at one minute intervals on a data logger. Readings should be available for a typical winter period, July 1981 and a typical summer period, December 1981.

3.4. Temperature

The weather station at Charter's Creek is equipped with maximum and minimum thermometers and a thermograph, and is the only place on the Lake where temperatures are recorded. Other stations in the area where temperature are read are listed in table 1.

Figure 6 shows annual temperature regimes at Charter's Creek. The average annual temperature is 21.5°C. The warmer months of the year are from January to March and the absolute maximum temperature was 43.5°C in December 1976.

Figure 6 also shows equivalent temperature data for Cape St Lucia which also has an average temperature of 21.5°C. The temperature range is not as extreme as that of Charter's Creek due to the proximity of the sea. Both stations experience their coolest months in June and July and neither station is known to have temperatures less than 2.5°C.

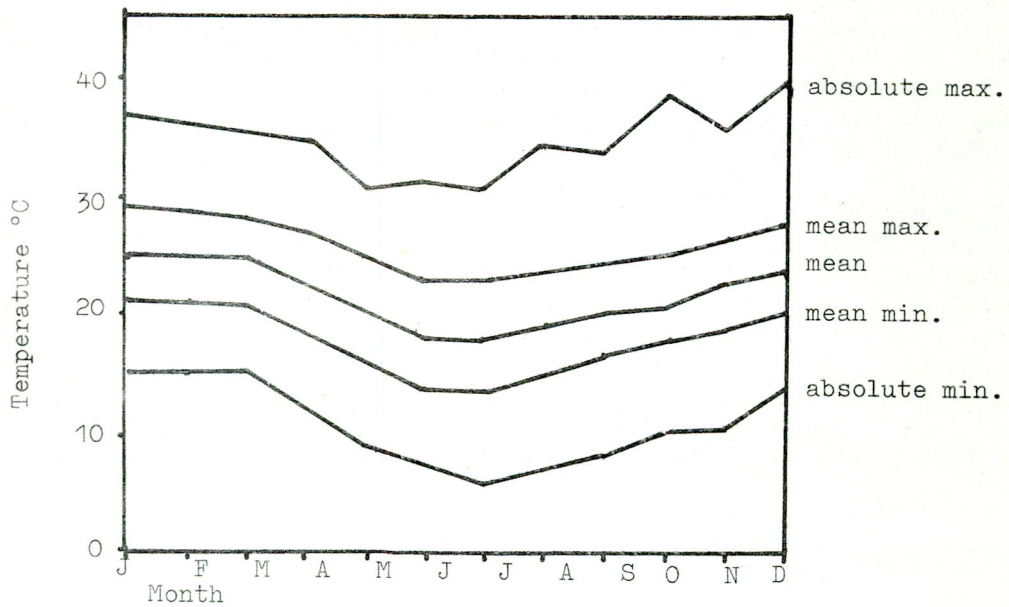
Only one occurance of frost is known and that was recorded at St Lucia Forest Station and at Tewate during the first week of July 1980 (Taylor 1980).

Ground temperatures were measured at Sodwana Bay while the station was operative.

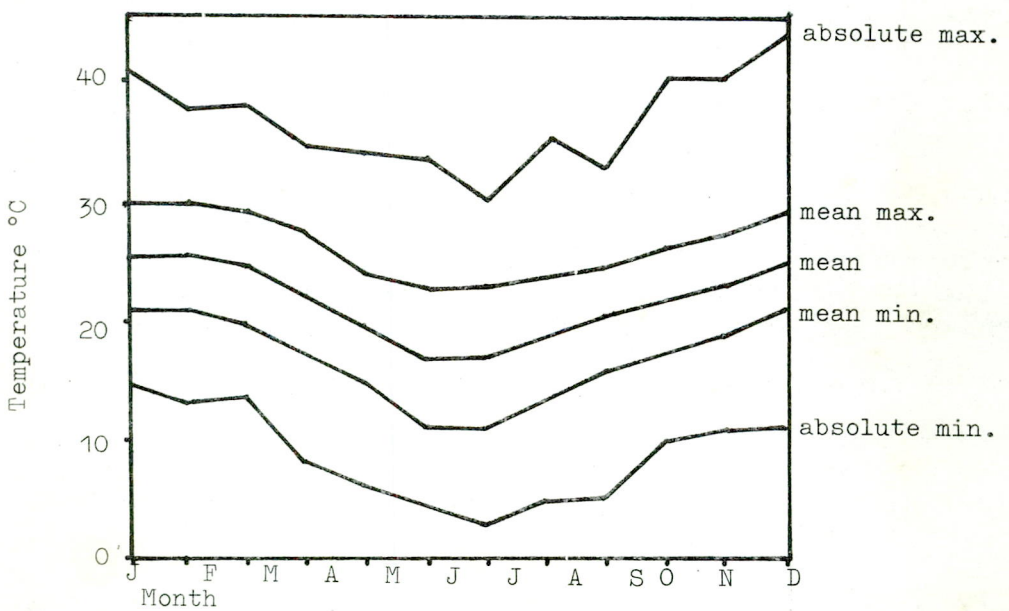
Soil temperatures are measured twice a day at River View at depths of 5cm, 10cm, and 20cm.

Venter (1972) measured the effects of plant cover on temperature at Richards Bay and to do this temperature readings were taken in three types of plant communities. At each station three temperatures were recorded: at 30cm above the ground and at 2.5cm and at 30cm below the ground. Readings are avilable for the period March 1969 to February 1970.

Figure 6: Temperature chart for Cape St Lucia and Charter's Creek.



Cape St Lucia 1919 - 1950



Charter's Creek 1968 - 1979

3.5. Relative humidity

Relative humidity data are collected at River View, Cape St Lucia and more recently, at Futululu Reasearch Station. Data available indicate that in the St Lucia area, relative humidity is high all year round. At 08h00 River View and Cape St Lucia record an annual average relative humidity of 80% and 84% respectively while at 14h00 this figure has dropped to 60% and 70% respectively.

No recordings are made to measure relative humidity on or around Lake St Lucia. Relative humidity is important to know, as it influences other factors such as the rate of evapo-transpiration and the rate of evaporation from the Lake. It is also useful to help determine the best time for veld burning. Continuous recording of relative humidity can be made on a hygrograph or on a thermohygrograph which also records temperature and it is suggested that one of these instruments be installed at Charter's Creek.

3.6. Sunshine

Amount of sunshine was recorded at Sodwana Bay for approximately two years and is still recorded at River View.

3.7. Atmospheric pressure

Atmospheric pressure is measured three times a day at Cape St Lucia and the data are used mainly for weather forecasting purposes at Louis Botha Airport. Barometric pressure recordings were also taken at Sodwana Bay when the weather station was operative.

4. Conclusions

4.1. Collection points

The St Lucia area is adequately supplied with collection points for weather data, with the exception of the Mkuze and Mosi swamps. Data collection are difficult in these areas because of the lack of anyone to read instruments and change graphs.

It is pleasing to note that two new rainfall recording stations have been started on the eastern catchment of the Lake (namely Tewate and Ozabeni).

4.2. Additional weather data at existing stations

Evaporation

Hutchison & Pitman (1973) point out the importance of developing accurate methods of measuring water loss from the Lake. This could involve a considerable amount of additional data collection once a feasible method of calculating evaporation loss has been developed.

Precipitation

Sufficient rainfall data are collected but nothing is known about the occurrence and amount of dew or fog in the area. They could both be a direct source of water for some plants and it is suggested that rainfall recording stations should record the occurence of dew and fog on a regular basis.

Temperature and relative humidity

Only one station on the Lake records temperatures and it would be desirable to have two temperature recording stations to check accuracy of results and for comparative purposes.

Relative humidity data are necessary for the area around the Lake and it is recommended that it is measured at Charter's Creek.

Additional relative humidity and temperature recordings may be deemed necessary if evaporation rates (discussed above) are going to be worked out in detail.

Wind data

Collection is adequate.

Sunshine and atmospheric pressure

There does not appear to be an need for additional data.

4.3. Quality of data

It is important that all stations should record data accurately. The instruments should be checked regularly and records should be taken consistently. If data are lost, this should be noted. Continuity of records is important and every effort should be made to continue the data collection at stations which have been operating for long periods. It is a pity that Sodwana Bay weather station closed down after two years as the data collected there canot be used for calculating long-term averages.

4.4. Data Analysis

All existing weather data should be summarized so that they are easily accessible and easily interpreted. For instance, a great deal of wind data exists for the two wind recording stations on the Lake, but very little is known about patterns of wind direction and velocity.

Care should be taken therefore to ensure that existing weather data are used to the full before new collecting stations are started.

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February 1982.

Table 2 Average monthly rainfall data

Station details: Estuary Mouth NPA Reclamation Unit 28°23'S 32°25'E Average rainfall for the period July 1971 - July 1981

Month	Average (mm)	Av. No of raindays	Standard Deviation
January	182.9		82.1
February	147.5		116.0
March	114.0		76.9
April	100.0		67.8
May	108.7		60.0
June	51.2		49.5
July	65.8		45.0
August	62.5		55.0
September	84.5		57.4
October	93.6		66.5
November	121.3		78.3
December	128.0		73.3

Station details: Mount Tabor (Estuary - bos) 339/856 4 28°16'S 32°29'E Alt 91m Average rainfall for the period Jan. 1960 - Dec. 1977.

Month	Average (mm)	Av.No of raindays	Standard Deviation
January	159.6	9	131.2
February	163.8	9	112.6
March	173.8	9	135.9
April	144.1	7	88.4
May	102.6	5	92.2
June	64.0	5	58.6
July	67.3	4	58.1
August	86.5	6	98.0
September	78.9	5	55.7
October	112.3	8	62.2
November	117.1	9	70.2
December	126.2	7	91.2

Table 2 (continued)

Stations details: Cape Vidal (Meersig - Bos) 340/010 Ø 28°10's 32°31'E Alt = 152m Average rainfall for the period Aug. 1955 - Dec. 1977.

Month	Average (mm)	Av.No of raindays	Standard Deviation
January	135.1	8	103.2
February	149.6	6	97.9
March	135.8	8	97.3
April	126.9	6	73.7
May	76.1	5	70.0
June	58.7	4	61.4
July	52.7	4	43.7
August	72.1	5	65.4
September	85.5	6	67.8
October	99.8	8	49.1
November	112.8	9	73.6
December	119.0	7	91.2

Station details: St Lucia Estuary Forest Station (St Lucia Estuary - Bos) 339/681 Ø 28°21'S 32°23'E Alt = 15m Average rainfall for the period Oct. 1952 - Dec. 1977.

January	138.6	9	102.1
February	139.4	9	96.8
March	148.7	8	128.3
April	121.0	7	89.0
May	80.5	5	98.8
June	47.9	4	52.2
July	54.2	4	57.9
August	58.3	5	61.9
September	76.5	6	53.3
October	123.2	9	74.3
November	130.2	10	115.3
December	105.1	8	80.0

Table 2 (continued).

Station details: Makakatana 339/734 28°14'S 32°25'E Alt = 30m Average rainfall for the period Jan 1928 - Dec. 1977.

Month	Average (mm)	Av.No of raindays	Standard Deviation
January	131.1	8	103.0
February	132.0	8	85.7
March	144.5	9	100.8
April	88.5	6	87.8
May	62.3	5	56.7
June	42.7	4	40.5
July	42.4	4	54.6
August	43.3	5	52.2
September	52.1	5	42.5
October	84.2	8	62.6
November	95.7	8	60.9
December	118.0	8	83.6

Station details: False Bay Park (False Bay Camp) 375/688 4 27°58'S 32°23'E Alt = 40m Average rainfall for the period Dec. 1950 - Dec. 1977.

January	97.6	6	95.4
February	99.2	6	81.8
March	71.7	6	62.2
April	43.6	4	31.4
May	26.8	2	26.7
June	12.5	2	20.4
July	21.5	2	55.4
August	20.8	2	29.3
September	45.2	4	65.9
October	71.2	7	56.9
November	71.4	7	49.1
December	85.9	6	84.3