

THE PLANT ECOLOGY OF SEASONALLY FLOODED
AREAS OF THE PONGOLO RIVER FLOODPLAIN, WITH
PARTICULAR REFERENCE TO *Cynodon dactylon* (L.) Pers.

VOLUME 2, FIGURES, TABLES AND PLATES

BY

HILTON DALTON FURNESS



VOLUME 2

CONTENTS

	Page
CHAPTER 1 <u>Introduction</u>	
Figures	
1.1 Location of the Pongolo Floodplain	1
CHAPTER 2 <u>Review of Pertinent Literature</u>	
CHAPTER 3 <u>Materials and Methods</u>	
Figures	
3.1 Location of study area around Namanini lake	2
3.2 Integration procedure	3
Tables	
3.1 Cover abundance scale	4
3.2 Sociability scale	5
3.3 Periods during which Xylem Pressure Potential measurements were made	6
CHAPTER 4 <u>Description of the Study Area</u>	
Figures	
4.1 The Study Area	7
4.2 Geological cross-section of the Maputaland coastal plain	8
4.3 Geological map of the Pongolo floodplain	9
4.4 Rainfall and evaporation data measured at the Makatini Agricultural Research Station	10
4.5 Mean monthly fluctuations in evaporation, wind run and temperature measured at the Makatini Agricultural Research Station	11
4.6 Mean monthly flow of the Pongolo river above the Pongolapoort Dam (1929-1976)	12
4.7 Flow in the Pongolo river above and below the Pongolapoort Dam (1974-1976)	13
Tables	
4.1 Climatic data measured at the Makatini Agricultural Research Station (1966-1975)	14
4.2 Mean annual rainfall at a number of stations on and in the vicinity of the Pongolo river floodplain	15
4.3 Long term fluctuations in daily-average flow of the Pongolo river	16

4.4	Inundation of Pongolo floodplain lakes	17
4.5	Fluctuations in daily-average-outflow from the Pongolapoort Dam (1972-1976)	18

CHAPTER 5 The Plant Communities

Figures

5.1	Distribution of the plant communities of the seasonally flooded area of the Pongolo river floodplain	19
5.2	Cross-section of the Pongolo river floodplain showing positions of the different plant communities	20
5.3	Position of relevés relative to (a) height below flood level (b) height above maximum retention level	21

Tables

5.1	Character and differential species of the floodplain communities	22
5.2	Communities of the seasonally flooded areas of the Pongolo river floodplain	23
5.3	Comparison of previously recognised plant formations with communities of the present study	24
5.4	Communities of the Pongolo river floodplain delineated on the permanently recognizable species only	25

Plates

5.1	Cultivation along levees and riverbanks of the Pongolo river	26
5.2	The <i>Acacia xanthophloea</i> - <i>Dyschoriste depressa</i> Community	26
5.3	The <i>Cyperus fastigiatus</i> - <i>Echinochloa pyramidalis</i> Community	27
5.4	The <i>Cynodon dactylon</i> Community	27

CHAPTER 6 Crop Growth Rate of *Cynodon dactylon* in Response to Exposure and Grazing

Figures

6.1a-c	Variations in crop growth rate, relative growth rate and standing crop of <i>C. dactylon</i> due to the effects of exposure	28
6.2a-c	Variations in crop growth rate, relative growth rate and standing crop of <i>C. dactylon</i> due to the effects of exposure and grazing	29
6.3	Fluctuations in amount and rate of removal of <i>C. dactylon</i>	30
6.4	Increases in grazeable fraction, ungrazeable fraction and total standing crop of <i>C. dactylon</i> around Namanini lake	31
6.5	(a) Amount of <i>C. dactylon</i> removed by grazing and (b) estimated amount incorporated into the aquatic phase around Namanini lake	32

CHAPTER 7 Nutrient Status of *C. dactylon* in Response to Exposure and Grazing

Figures

7.1a-f	Changes in nutrient content in the grazeable fraction of <i>C. dactylon</i> under grazed and ungrazed conditions	33
7.2a-f	Changes in nutrient content in the ungrazeable fraction of <i>C. dactylon</i> under grazed and ungrazed conditions	34
7.3a-b	Total amounts of nutrients removed by grazing from <i>C. dactylon</i> areas around Namanini lake	35
7.4a-f	Changes in nutrient standing crop of <i>C. dactylon</i> around Namanini lake	36

Tables

7.1	Rates of removal of nutrients by grazers	37
7.2a-c	Changes in the standing crop of some nutrients in <i>C. dactylon</i> areas	38
7.3	Total amounts of nutrients and protein removed by grazing from <i>C. dactylon</i> areas	39

CHAPTER 8 Water Stress as a Factor Influencing Growth of *C. dactylon*

Figures

8.1	Diurnal changes in vapour pressure deficit	40
8.2	Moisture characteristic curve for soil from a <i>C. dactylon</i> area	41
8.3	Changes in soil moisture content	42
8.4	Diurnal changes in xylem pressure potential of <i>C. dactylon</i>	43
8.5	Base-P and P^{min} xylem pressure potential values of <i>C. dactylon</i>	44

Tables

8.1	Precipitation data from the vicinity of Namanini lake	45
-----	---	----

CHAPTER 9 Decomposition of *Cynodon dactylon*

Figures

9.1a-b	Decomposition of fresh and dried <i>C. dactylon</i>	46
9.2a-d	Changes in the concentration of some nutrients of decomposing fresh and dried <i>C. dactylon</i>	47

Tables

9.1	Changes in the chemical composition of inundated <i>C. dactylon</i>	48
9.2	Temperature, nitrate-nitrogen and soluble reactive phosphorus values for Namanini lake	49

9.3	Changes in water level, total area exposed, area colonized by <i>C. dactylon</i> and standing crop of <i>C. dactylon</i> at Namanini lake	50
9.4	Predicted losses of nutrients and mass from <i>C. dactylon</i> (grazeable fraction) at Namanini lake	51

CHAPTER 10 General Discussion and Conclusions

Figures

10.1	Conceptual model of the Pongolo floodplain	52
10.2	Proposed water release programmes	53

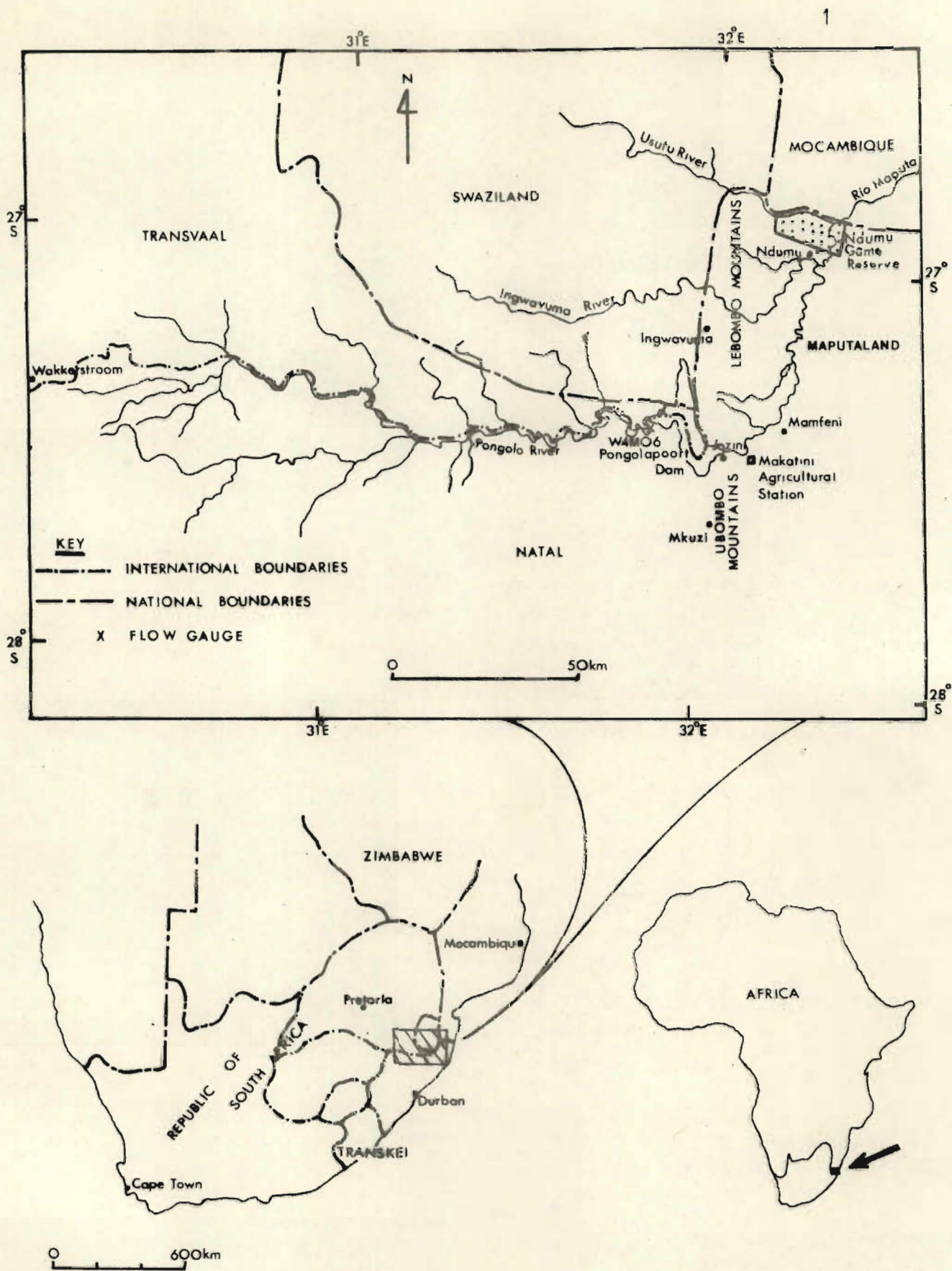


Figure 1.1 Location of the Pongolo Floodplain and its catchment.

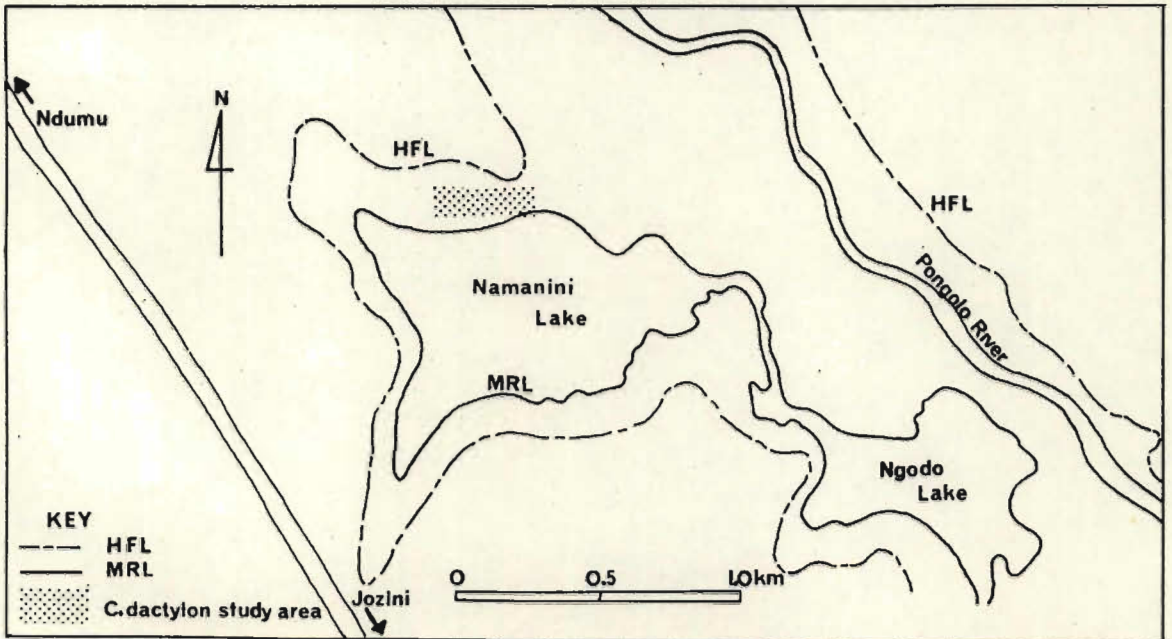
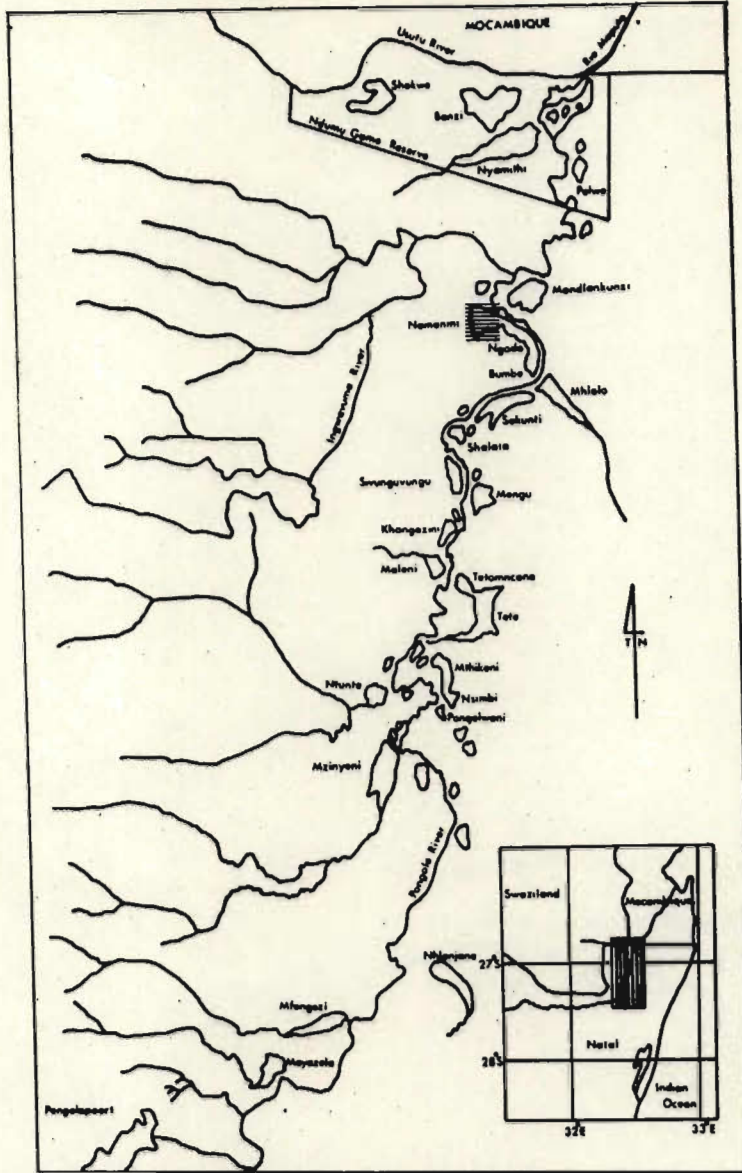


FIGURE 3.1 (a) Location of Namanini lake (▨) on the Pongolo floodplain and (b) *C. dactylon* study area around Namanini lake.

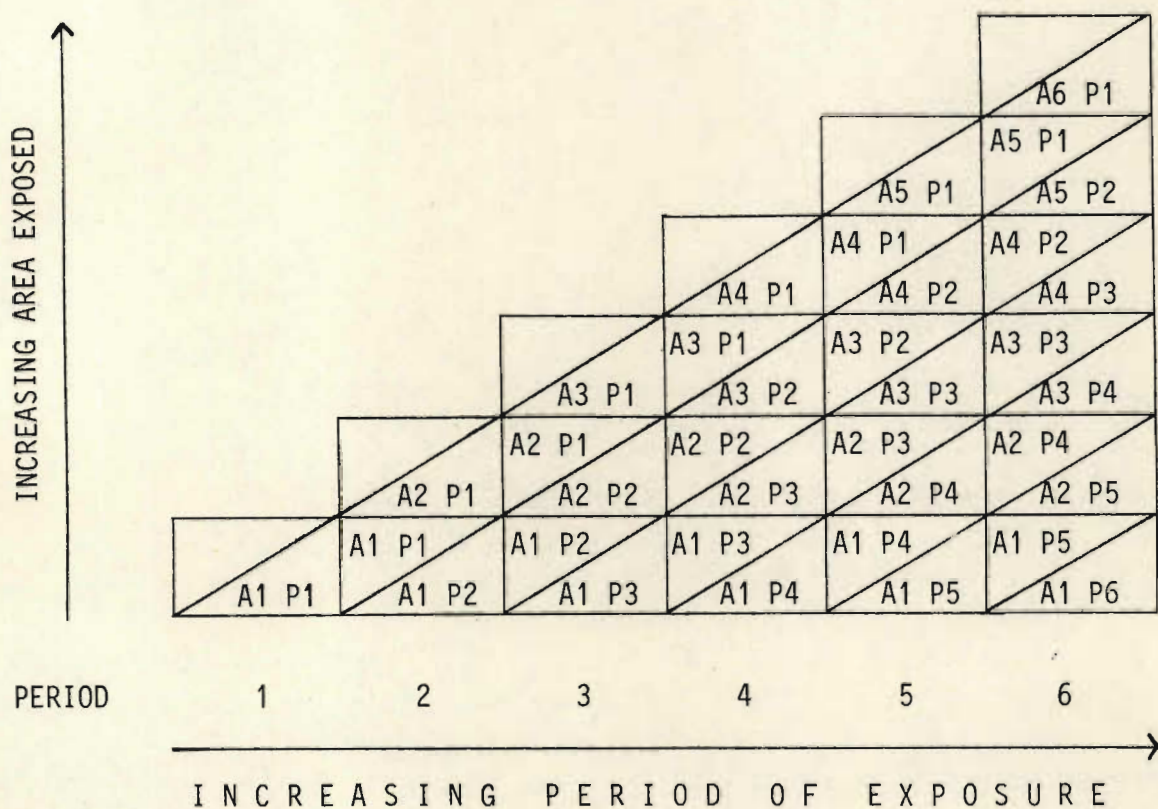


Figure 3.2 Diagrammatic representation of the procedure used to integrate various parameters with area and period of exposure. During period 1 area A was exposed. For computational purposes it was assumed that half of the area (A1) was exposed for the full period (1), and was governed by the processes of that period (P1). During the second exposure period (2) half of area A (A1) was exposed to the processes of period 2 (P2) for the duration of period 2, whilst the other half (A1) which became exposed towards the end of period 1 was exposed to the processes of period 1 (P1) for the duration of period 2. In addition, a new area became exposed, half of which (A2) was also considered to be exposed to the processes of period 1 (P1) i.e. its first period of exposure for the duration of period 2. The sum of the products of area x process for any exposure period reveals the situation for the total area exposed at any time.

TABLE 3.1 Cover abundance scale used in the present survey (after Werger, 1974).

r	Very rare and with a negligible cover (usually just a single individual).
+	Present but not abundant and with a small cover value (less than 1% of the quadrat area).
1	Numerous but covering less than 1% of the quadrat area, or not so abundant, but covering between 1% and 5% of the quadrat area.
2	Very numerous and covering less than 5% of the quadrat area, or covering between 5% and 25% of the quadrat area, independent of abundance.
3	Covering between 25% and 50% of the quadrat area, independent of abundance.
4	Covering between 50% and 75% of the quadrat area, independent of abundance.
5	Covering between 75% and 100% of the quadrat area, independent of abundance.

TABLE 3.2 Sociability scale used to indicate the extent of grouping of individuals and in the synthesis and interpretation of field data (after Werger, 1974).

1	Single individuals
2	Grouped or tufted
3	In troops, small patches or cushions
4	In small colonies or extensive patches, or forming carpets
5	In extensive crowds or pure populations

TABLE 3.3 Periods during which Xylem Pressure Potential measurements were made and times used, for convenience, to plot results graphically.

PERIOD OF MEASUREMENT	PLOTTED TIME
5am - 6am*	06h00
11am - 12am	12h00
5pm - 6pm	18h00
11pm - 12pm	24h00

*On all occasions these measurements were made before sunrise.

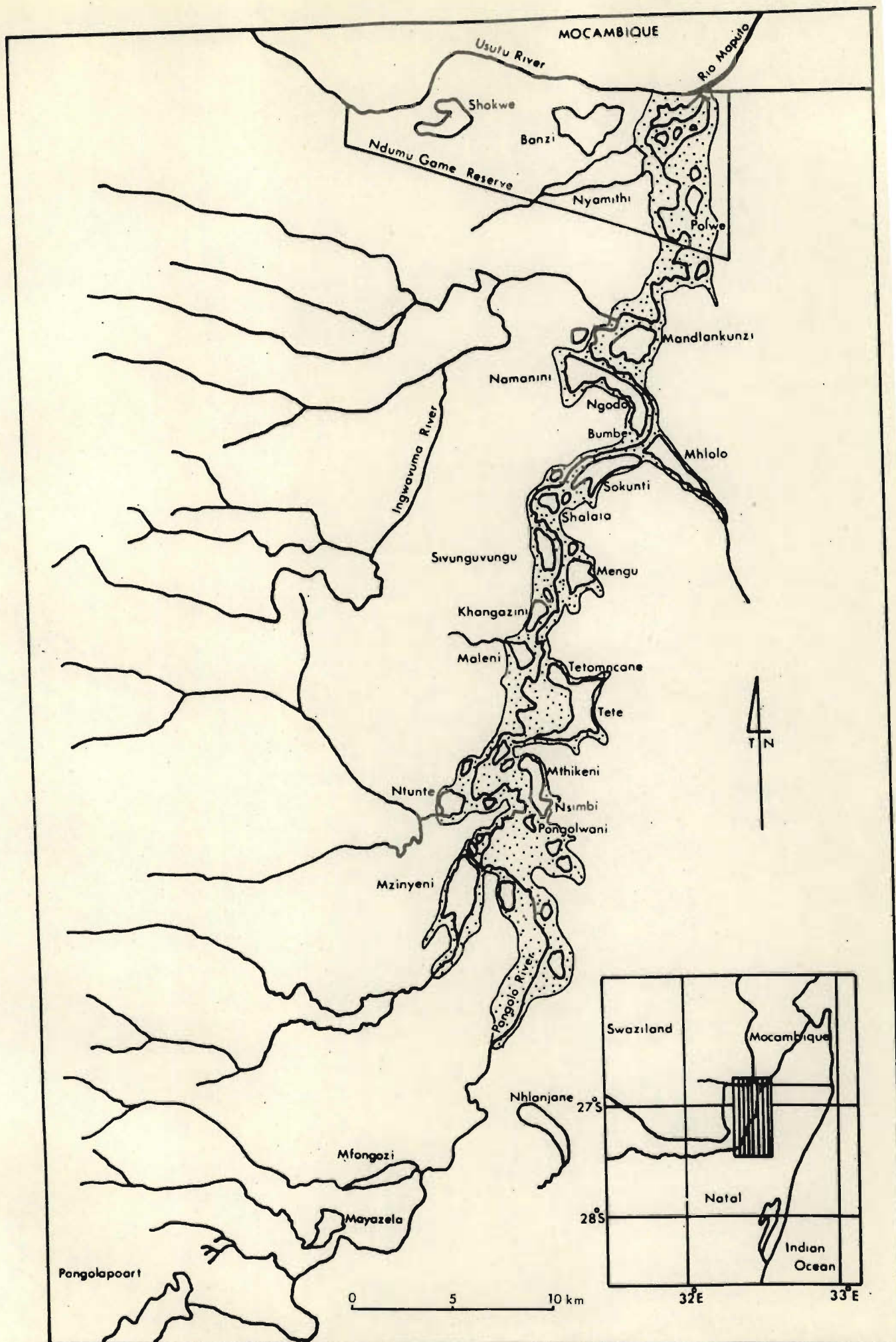


Figure 4.1 The study area (.....) in relation to the Pongolapoort Dam in the south and the Ndumu Game Reserve and Usutu river in the north.

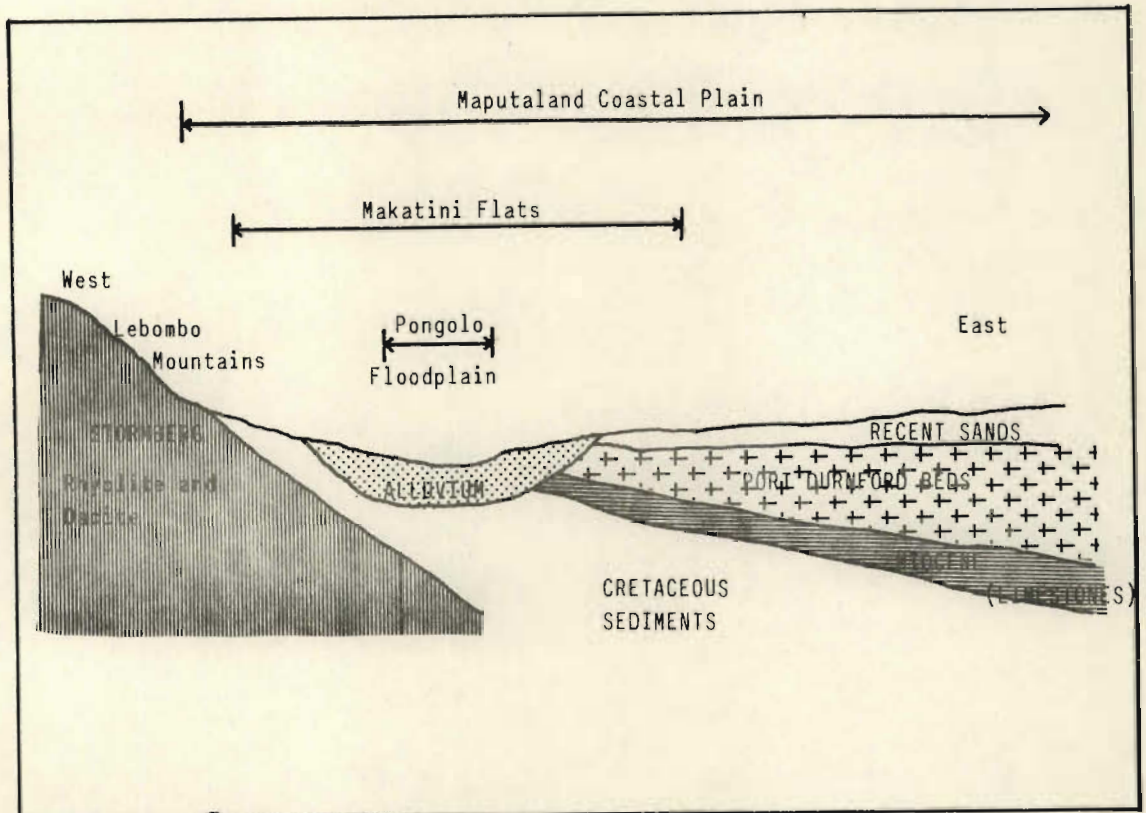


Figure 4.2 An idealised geological section through the Maputaland coastal plain on which the Pongolo river floodplain is situated (after Heeg and Breen, in press). Note the cretaceous sediments which underlie the floodplain and are exposed to the west of it, and the sand deposits to the east of the floodplain on which the sand forests of Maputaland have developed.

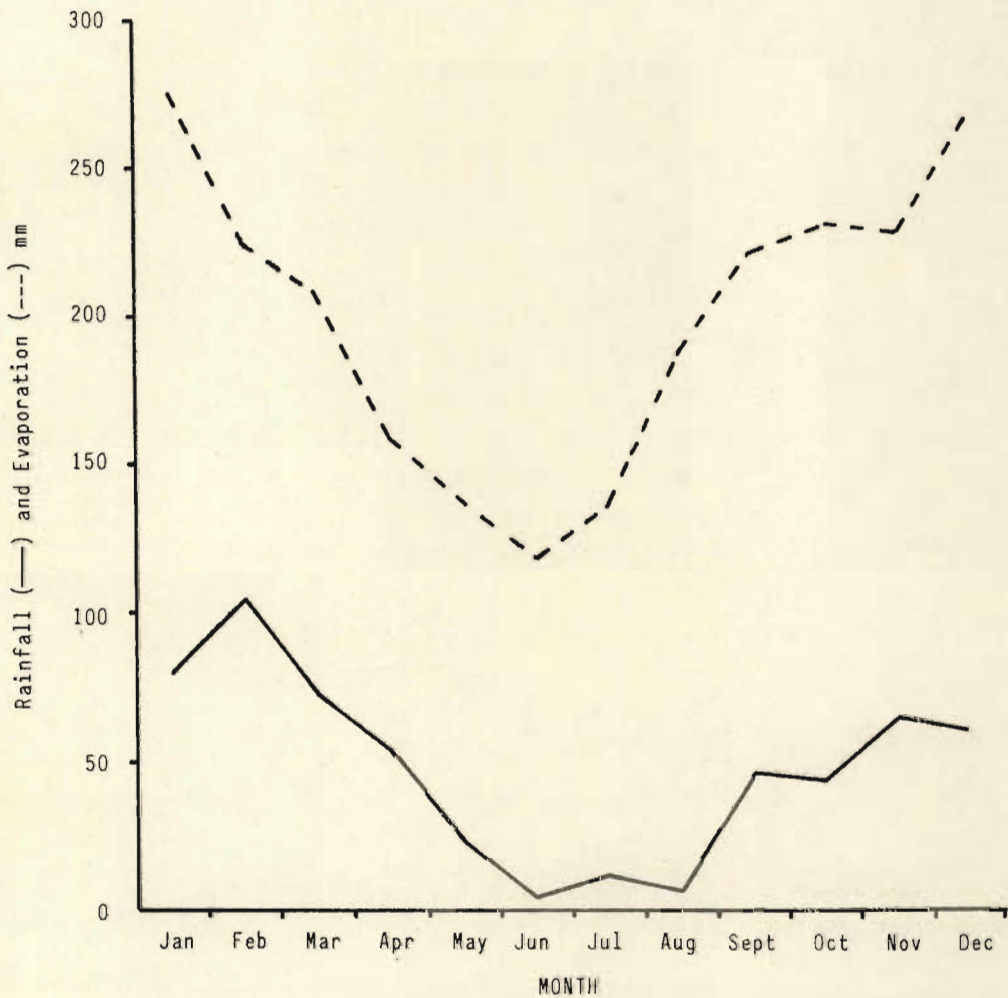


Figure 4.4 Rainfall (—) and Evaporation (---) measured at the Makatini Agricultural Research Station for the period 1966-1975 (Heeg and Breen, in press). Evaporation (Class A pan) always exceeds rainfall by at least 113%.

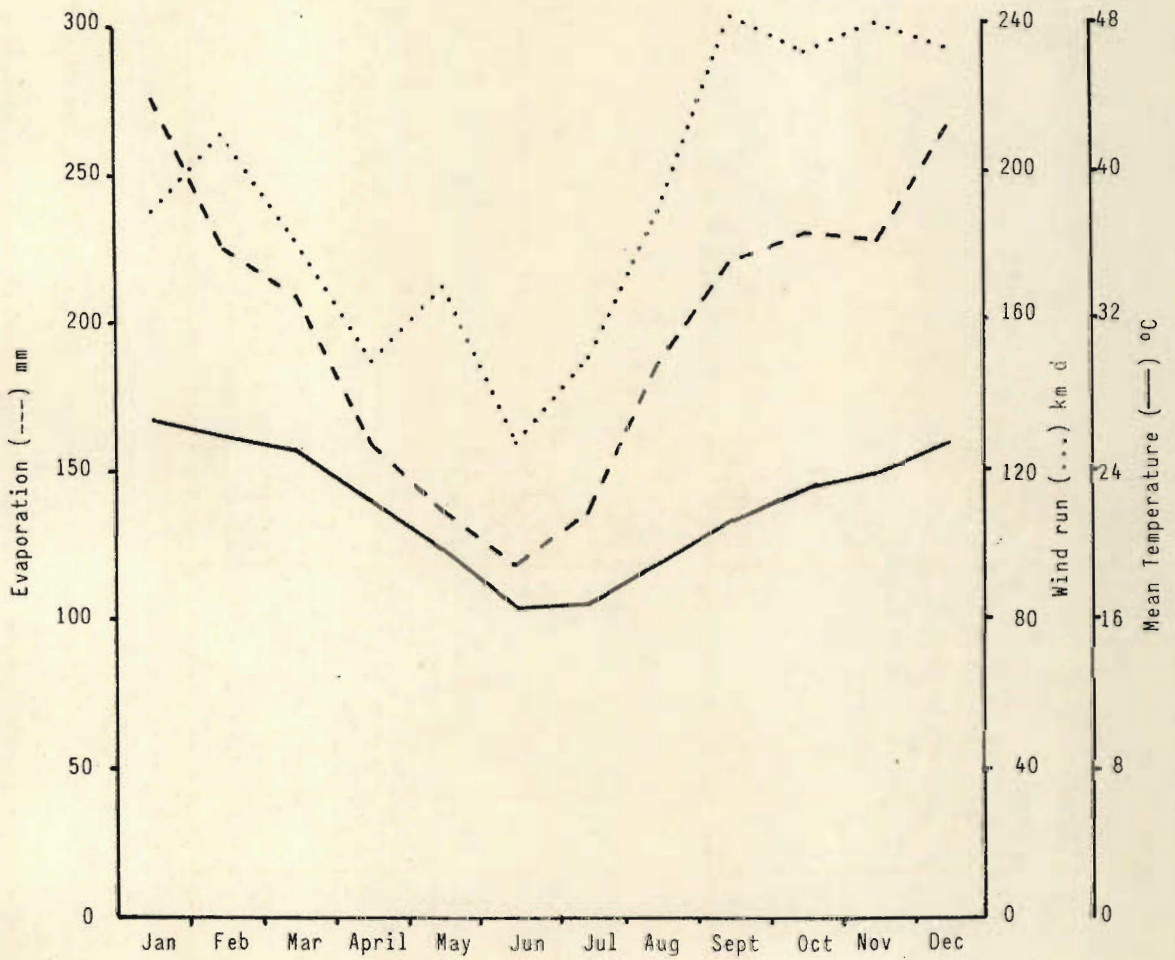


Figure 4.5 Mean monthly fluctuations in evaporation (---) Wind run (.....) and temperature (—) measured at the Makatini Agricultural Research Station (Heeg and Breen, in press).

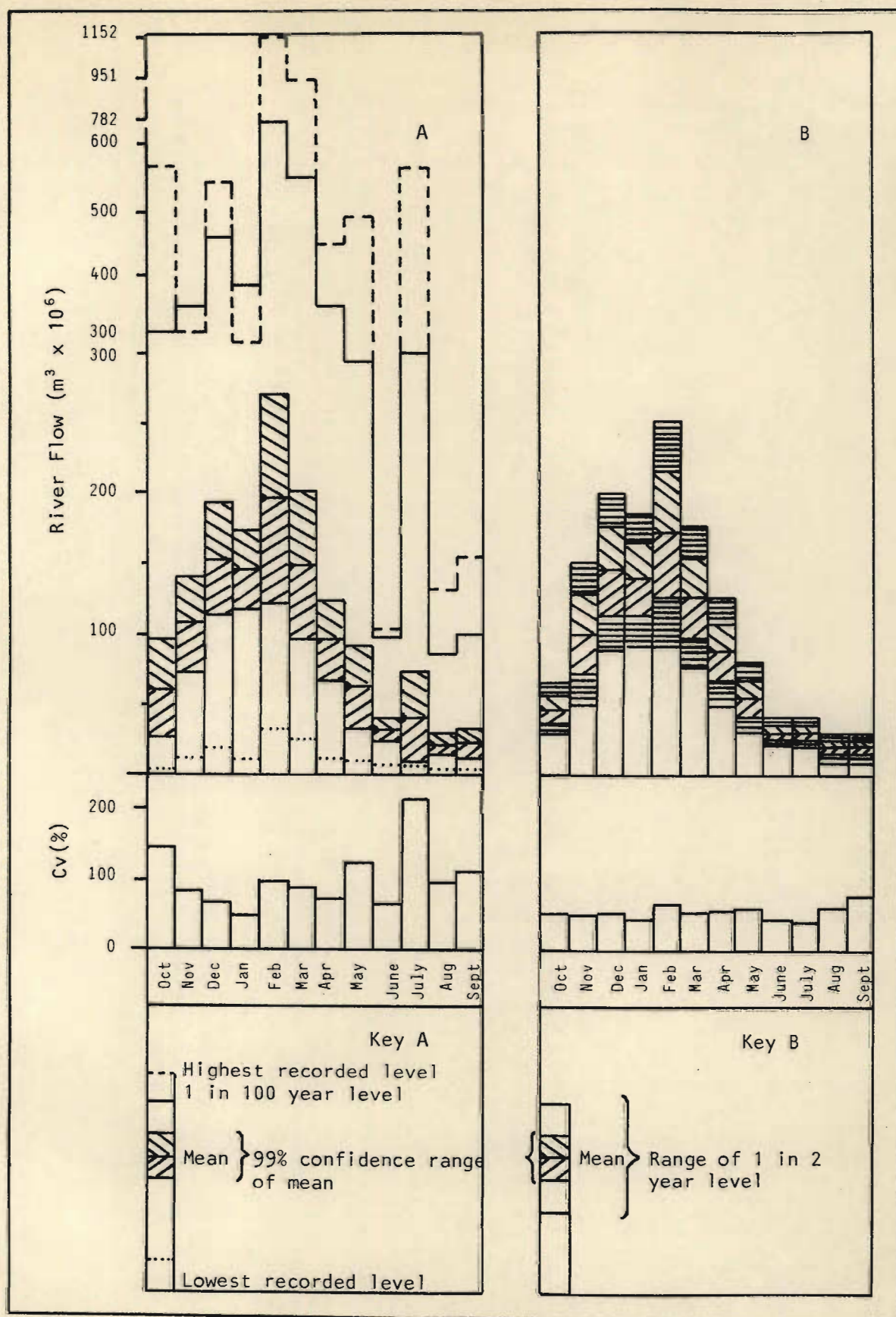


Figure 4.6 Mean monthly flow of the Pongolo river above the Pongolapoort Dam (1929-1976).

(A) Mean and 99% confidence limits (uncorrected data) - note high and variable Cv.

(B) Data in (A) corrected to give less weighting to extremes (after Heeg and Breen, in press)

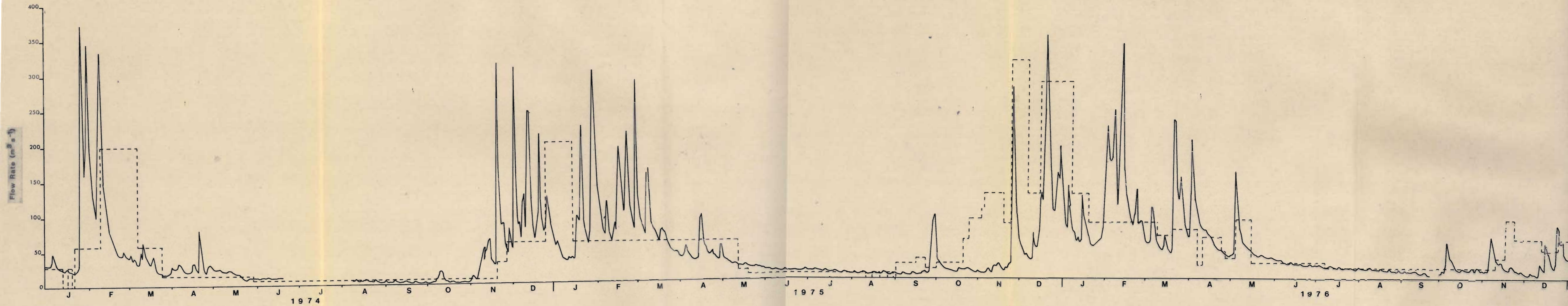


Figure 4.7 Flow ($\text{m}^3 \text{s}^{-1}$) in the Pongolo river above (—) and below (---) the Pongolapoort Dam during the period January 1974 to December 1976.

TABLE 4.1 Climatic data measured at the Makatini Agricultural Research Station during the period 1966 - 1975 (modified from Heeg and Breen, in press).

MONTH	TEMPERATURE (°C)					Rainfall (mm)	Class A pan evaporation (mm)	Wind (km day ⁻¹)	Relative humidity percent	
	Mean Max	Mean Min	Mean	Mean Highest Max	Mean Lowest Min				08h00	14h00
July	25.4	8.3	16.8	31.7	2.3	12.1	136	149.3	86	39
August	26.7	11.4	19.0	34.4	4.2	6.9	187	190.4	78	39
September	28.2	14.5	21.3	36.4	7.5	46.9	220	240.8	70	40
October	29.0	17.0	23.0	39.8	11.3	43.7	229	231.6	72	48
November	29.4	18.4	23.8	37.6	12.4	64.9	227	238.7	71	51
December	31.2	20.1	25.6	38.4	14.5	60.8	266	233.3	72	51
January	32.5	21.3	26.8	40.3	16.3	75.9	276	190.2	74	51
February	31.2	20.5	25.8	36.4	15.1	105.6	225	211.4	76	54
March	30.5	19.6	25.0	36.3	14.8	73.4	208	180.5	81	54
April	28.4	16.6	22.4	33.3	11.7	54.2	159	150.1	84	53
May	26.8	12.9	19.8	33.0	6.2	23.6	137	168.7	86	48
June	25.0	8.4	16.6	30.9	3.5	4.6	118	127.0	86	40
Year	28.7	15.8	22.1	-	-	572.6	2388	192.7	78	47
Period from to	1966 1975	1966 1975	1966 1975	1966 1975	1966 1975	1966 1975	1966/1967 1974/1975	1969 1973	1966 1975	1966 1975

TABLE 4.2 Mean annual rainfall at a number of stations on (*) and in the vicinity of (**) the Pongolo river floodplain. Stations are ranked from north to south.

S T A T I O N	Latitude	Longitude	Altitude (m)	Mean Annual Rainfall (mm)	Number of years
Ndumu Game Reserve**	26°54'S	32°18'E	122	632	16
Ndumu**	26°56'S	32°15'E	75	617	51
Mzinyeni Lake*	27°12'S	32°13'E	55	485	12
Mamfene*	27°23'S	32°12'E	69	553	17
Makatini Agricultural Research Station**	27°24'S	32°11'E	73	571	9
Otobotini**	27°25'S	32°06'E	91	642	52
Pongolapoort Dam**	27°26'S	32°04'E	293	519	14
MEAN				574	

TABLE 4.3 Long term (43 years) average number of days that daily-average flow is equalled or exceeded per annum (after Phélines *et al.*, 1973).

FLOW ($\text{m}^3 \text{ s}^{-1}$)	0	7	14	28	56	85	198
DAYS PER ANNUM	365	291	193	117	66	36	8

TABLE 4.4 Inundation of Pongolo floodplain lakes in relation to river flow during both pre- and post-impoundment periods (modified from Heeg and Breen, in press).

L A K E	Area ha	FLOW ($\text{m}^3 \text{s}^{-1}$)							NUMBER OF DAYS PER ANNUM THAT LAKES RECEIVED FLOODWATER	
		7	28	56	85	142	198	300	Prior to impound- ment construction	After impoundment construction
MAYEZELA	26								4	1
MFONGOZI	21								4	1
NHLANJANE	38								4	1
MZINYENI	74								291	338
PONGOLWANE	10								8	28
NSIMBI	16								36	59
MTHIKENI	45								16	59
NTUNTE	24								16	59
TETE	116								66	134
TETOMCANI	24								66	134
MALENI	47								36	59
KANGAZINI	74								36	59
MENGU	32								36	59
SIVUNGVUNGU	40								36	59
SHALALA	49								8	28
SOKUNTI	101								66	34
MHLOLO	56								16	59
BUMBE	58								117	188
NGODO	22								117	188
NAMANINI	63								117	188
MANDLANKUNZI	255								36	59
POLWE	23								36	59
NYAMITHI	183								36	59

TABLE 4.5 Number of days per annum that daily-average-outflow from the Pongolapoort dam* equalled or exceeded stated values.

FLOW ($\text{m}^3 \text{ s}^{-1}$)	0	7	14	28	56	85	198
1972**	366	265	265	125	102	84	59
1973	365	350	350	299	117	0	0
1974	365	359	185	120	98	332	32
1975	365	352	259	208	201	75	41
1976	366	365	365	188	153	103	7
MEAN 1972 - 1976	365	338	285	188	134	59	28

* Resident Engineer
Department of Water Affairs
P.O. Jozini
Kwa Zulu

**No accurate outflow data available prior to 1972.

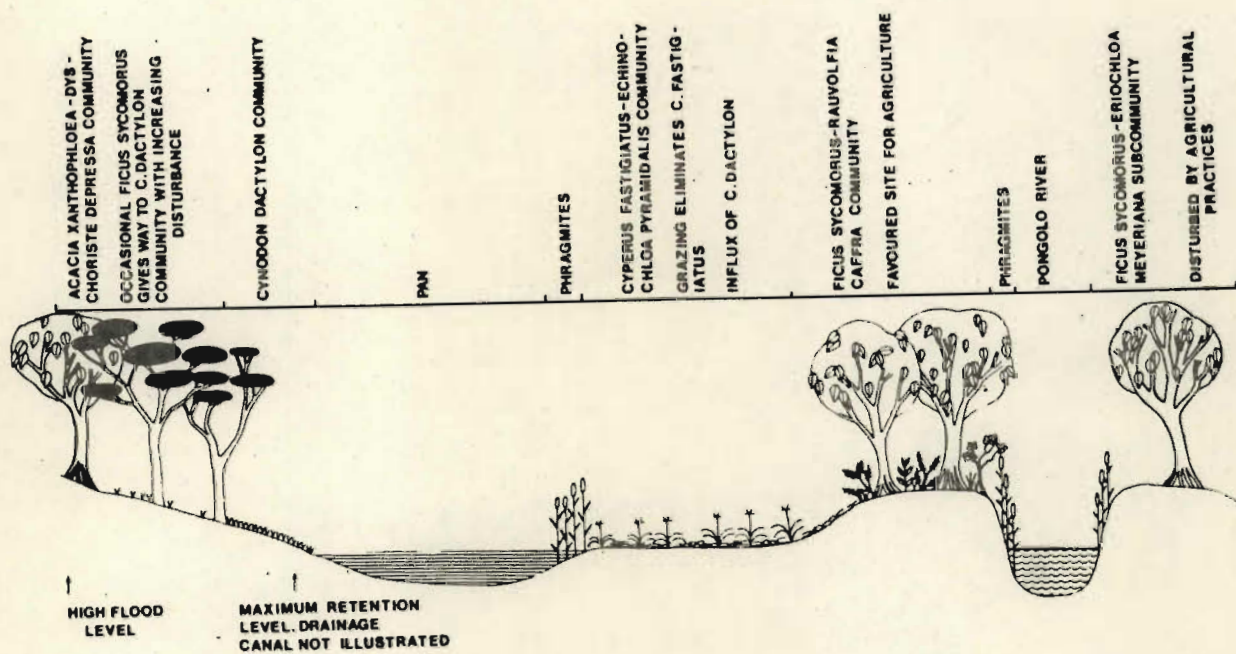


Figure 5.2 Diagrammatic representation of a cross-section of the Pongolo river floodplain showing the relative positions of the different plant communities.

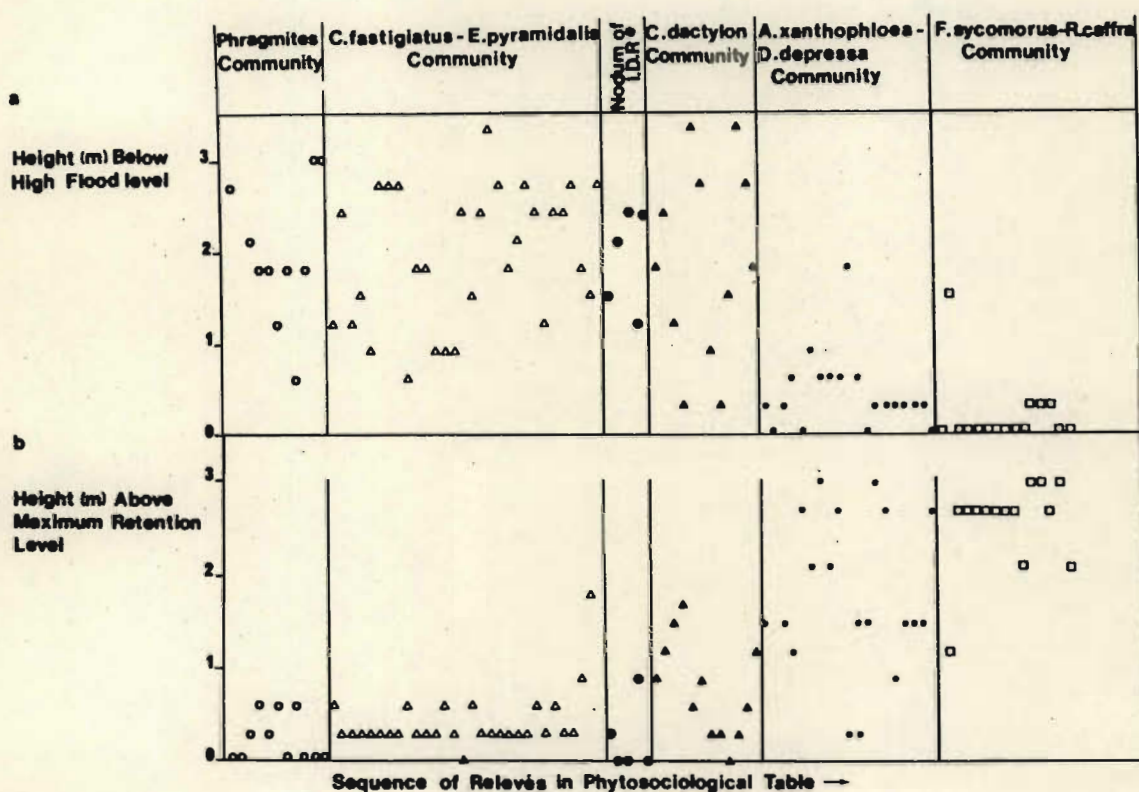


Figure 5.3 Position of the relevés relative to (a) height below flood level; (b) height above maximum retention level. Relevés are ordered in the sequence defined by the phytosociological Table 5.2. *Nodum of indeterminate rank.

TABLE 5.1 Character* and differential† species of the floodplain communities.

<u>COMMUNITY</u>	<u>SPECIES</u>	<u>COMMUNITY</u>	<u>SPECIES</u>
<i>Ficus sycomorus</i> -	<i>Ficus sycomorus</i> *†	<i>Acacia xanthophloea</i> -	<i>Acacia xanthophloea</i> *†
<i>Rauwolfia caffra</i>	<i>Rauwolfia caffra</i> *†	<i>Dyschoriste depressa</i>	<i>Dyschoriste depressa</i> *†
	<i>Trichilia emetica</i> *†		
	<i>Dicliptera heterostegia</i> *†	<i>Cynodon dactylon</i>	<i>Cynodon dactylon</i> *
	<i>Entada spicata</i> *†		
	<i>Adina microcephala</i> *†		
	<i>Syzygium guineense</i> *†	<i>Cyperus fastigiatus</i> -	<i>Cyperus fastigiatus</i> *
	<i>Setaria chevalieri</i> *†	<i>Echinochloa pyramidalis</i>	
	<i>Ipomoea digitata</i> *†		
	<i>Allophylus decipiens</i> *†		
	<i>Kraussia floribunda</i> *†	<i>Phragmites australis</i>	<i>Phragmites australis</i> *†
	<i>Oplismenus hirtellus</i> *†	<i>Phragmites mauritianus</i>	<i>Phragmites mauritianus</i> *†
	<i>Monanthes caffra</i> *†		

TABLE 5.3 Comparison of the formations determined by De Moor *et al.* (1977) with communities of this study.

De Moor <i>et al.</i> (1977)	Present Study
<u>Formation</u>	<u>Community</u>
1 Dry season deciduous forest	<i>F. sycomorus</i> - <i>R. caffra</i>
4 Tall evergreen graminoid marsh	<i>P. mauritianus</i>
4a Tall evergreen graminoid marsh	<i>P. australis</i>
4b Seasonal orthophyll tall grass	<i>C. fastigiatus</i> - <i>E. pyramidalis</i>
4c Microphyllous deciduous shrub savanna	Probably transition between <i>C. fastigiatus</i> - <i>E. pyramidalis</i> and <i>F. sycomorus</i> - <i>R. caffra</i>
5 Seasonal orthophyll meadow	<i>C. dactylon</i>

TABLE 5.4 Communities of the Pongolo River Floodplain delineated on the permanently recognizable species only

	<u>Phragmites australis community</u>	<u>Phragmites mauritianus community</u>	<u>Cyperus fastigiatus-Echinochloa pyramidalis community</u>	<u>Nodum of indeterminate rank</u>	<u>Cynodon dactylon community</u>	<u>Acacia xanthophloea-Dyschoriste depressa community</u>	<u>F. sycomorus - A. xanthophloea sub-community</u>	<u>F. sycomorus - E. meyeriana sub-community</u>	<u>Ficus sycomorus - Rauvolfia caffra community</u>
Phragmites australis (Cav.) Trin. ex Steud.	55221			1					
Phragmites mauritianus Kunth		444554		+					
Echinochloa pyramidalis (Lam.) Hitchc. & Chase	2122	443323	4243241+3234222214+2+1+311	1		1 + +			
Cyperus fastigiatus Rottb.	+		234433332313223333233224322321	+++1		+ r rr			
Cynodon dactylon (L.) Pers.	2 1		+ 1 1 2r2 + 1 + 1	111	543443445343	+2+r 11+1 1+11			
Acacia xanthophloea Benth.						3+32333333233332333	22+		
Dyschoriste depressa Nees						r1r+11+ +2+1 + 2	112		
Ficus sycomorus L.							333	33223	333333343344432
Rauvolfia caffra Sond.							+		33453222312313
Trichilia emetica Vahl.							1	1 2	221222212222
Dicliptera heterostegia Presl ex Nees non Chev.							+2+		22812222r 2 +
Entada spicata (E.Mey.) Druce									11111111r1+ 1
Adina microcephala (Del.) Hiern.									+11r1+ +
Syzygium guineense (Willd.) D.C.									1+111 +
Setaria chevaliere Stapf ex Stapf & C.E.Hubb.			+					+	2+r 1 +r r
Ipomoea digitata L.							++	1r	2+++ + 1
Allophylus decipiens (Sond.) Radlk.									11 1++ r
Grewia caffra						1r	2+	2	1 + + 4 +1+3
Ficus capreifolia Del.		++		1			1+	2r	r + +21 1 2
Kraussia floribunda Harv.							r	+ 1	++1+
Oplismenus hirtellus (L.) Beauv.								+	+1 1 2+
Monanthes caffra (Sond.) Verde.								+	+ 23 1
Jasminum fluminense Vell.							1+r	++	
Sesbania sesban (L.) Merrill		1		+		r	r	1	
Mimosa pigra L.		r	r	r	++ +			1	



Plate 5.1 An aerial view of part of the Pongolo River floodplain showing the extensive cultivation along the levees and riverbank. Only small pockets of the *Ficus sycomorus* - *Rauwolfia caffra* Community remain outside the Ndumu Game Reserve.



Plate 5.2 A view of the *Acacia xanthophloea* - *Dyschoriste depressa* Community taken during the extended summer floods of 1976. At this time the herb layer becomes incorporated into the aquatic system.



Plate 5.3 A good example of the *Cyperus fastigiatus* - *Echinochloa pyramidalis* Community. This stand on the north-western edge of Tete Pan has been reduced in size and in height. Most of the area is now a mixture of *Cyperus fastigiatus*, *Echinochloa pyramidalis* and *Cynodon dactylon* forming a stratum of about 50 cm in height.



Plate 5.4 The *Cynodon dactylon* Community is grazed extensively during the late winter period when pasturage elsewhere is low.

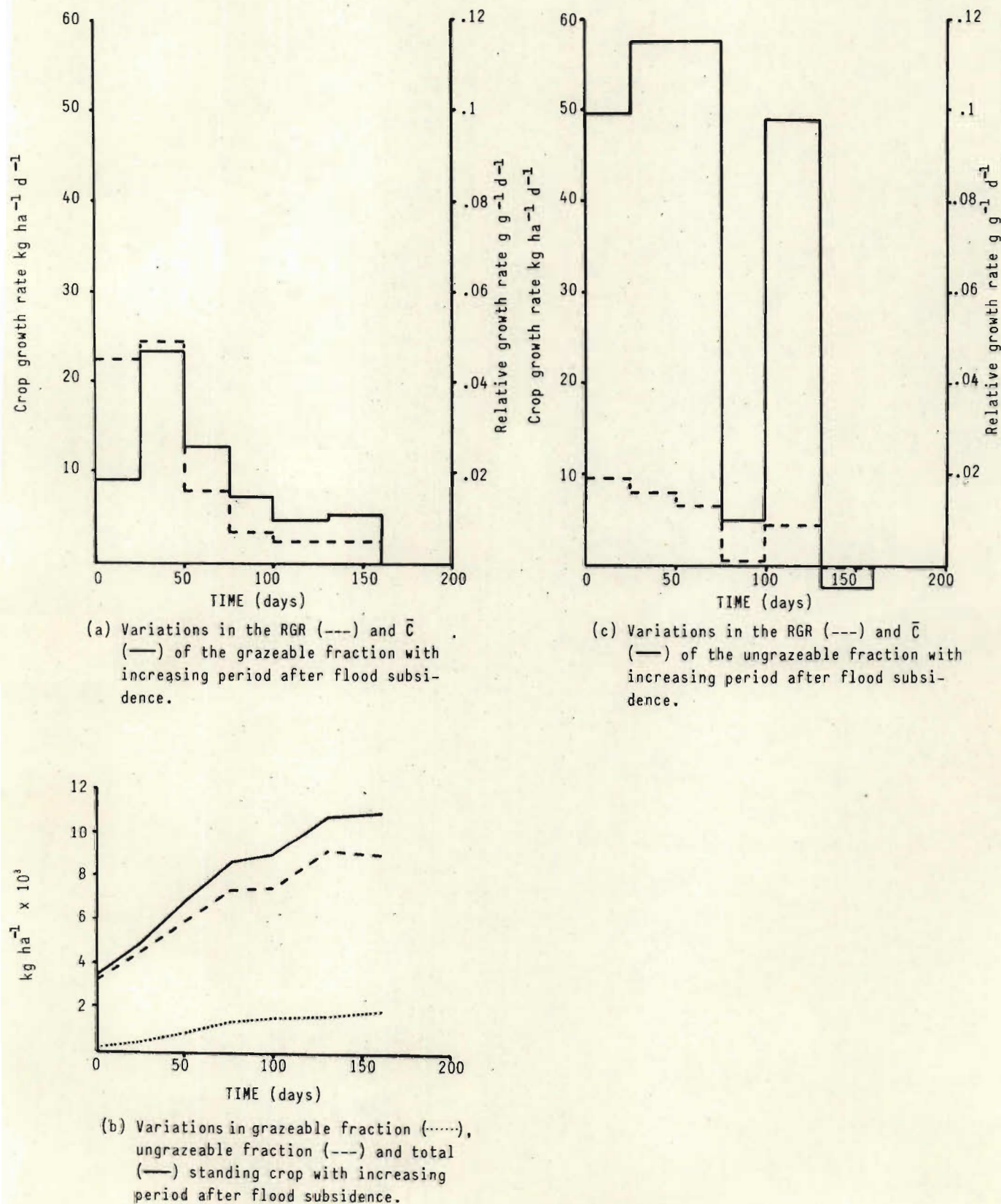
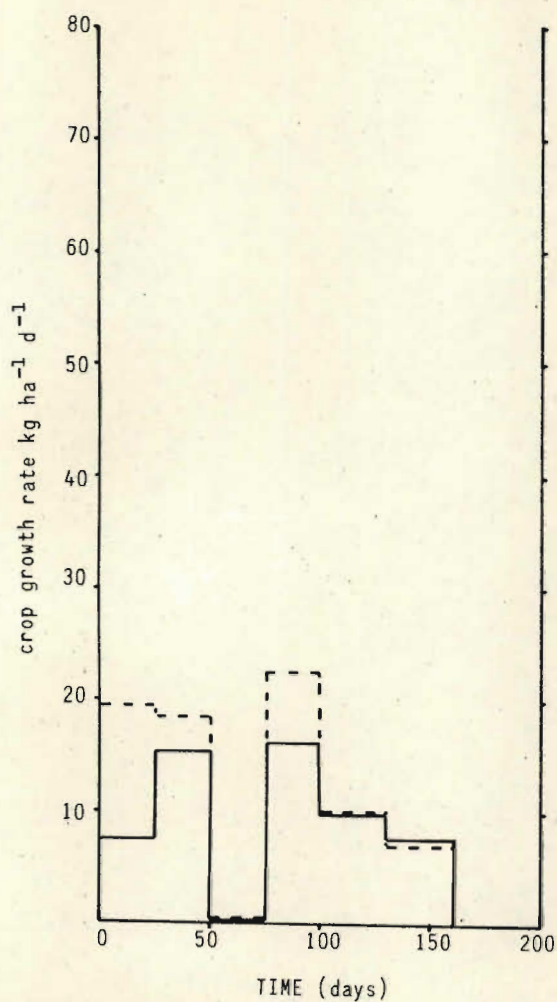
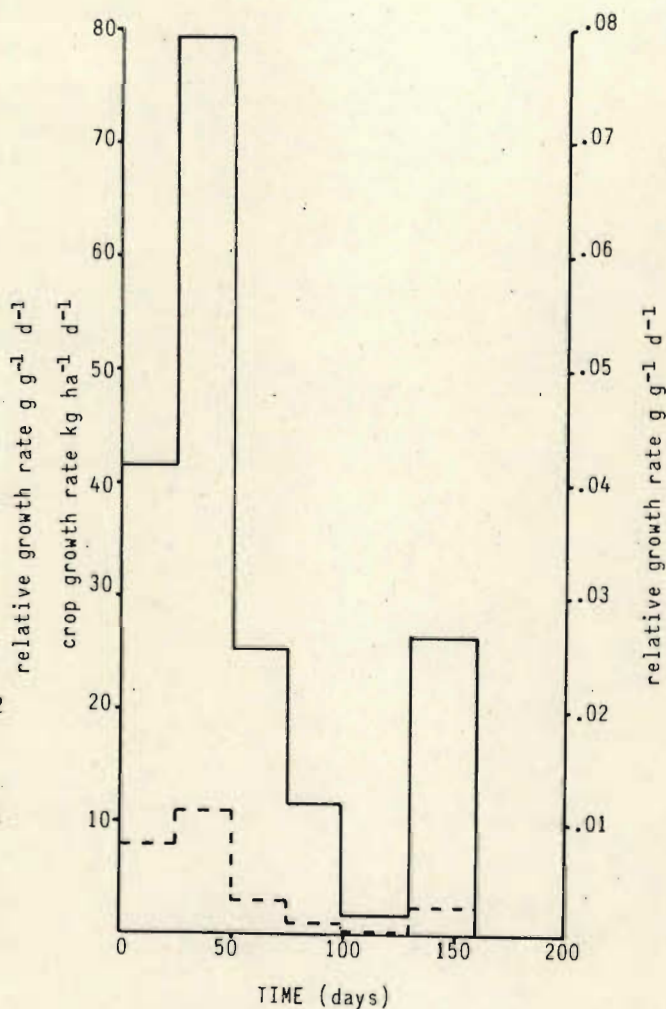


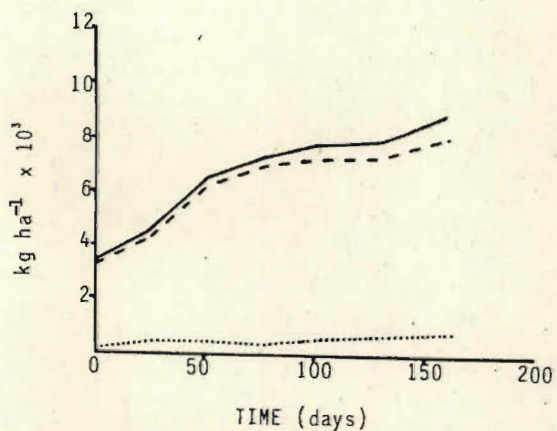
Figure 6.1 Variations in crop growth rate, relative growth rate and standing crop of seasonally inundated *C. dactylon* due to the effects of exposure.



(a) Variations in the RGR (---) and \bar{C} (—) of the grazeable fraction with increasing period after flood subsidence.



(c) Variations in the RGR (---) and \bar{C} (—) of the ungrazeable fraction with increasing period after flood subsidence.



(b) Variations in grazeable fraction (.....) ungrazeable fraction (---) and total (—) standing crop with increasing period after flood subsidence.

Figure 6.2 Variations in crop growth rate, relative grow rate and standing crop of seasonally inundated *C. dactylon* due to the effects of exposure and grazing.

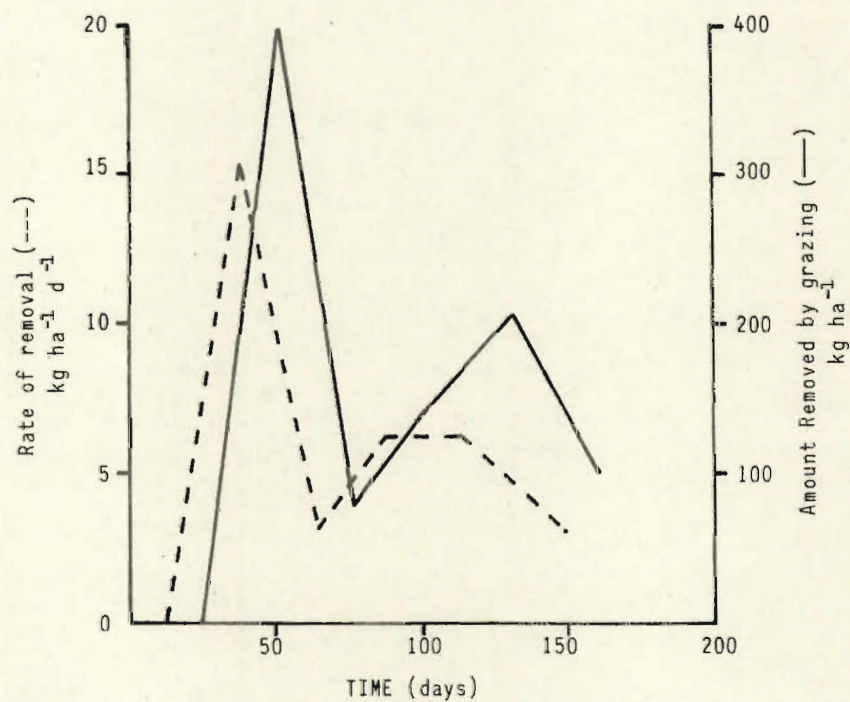


Figure 6.3 Fluctuations in amount (—) and rate (---) of removal of *C. dactylon* with increasing period after flood subsidence.

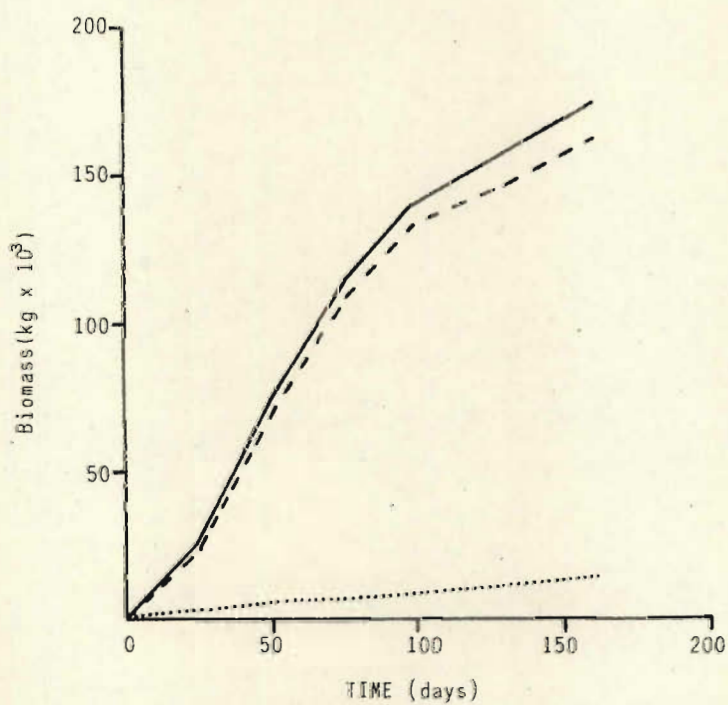
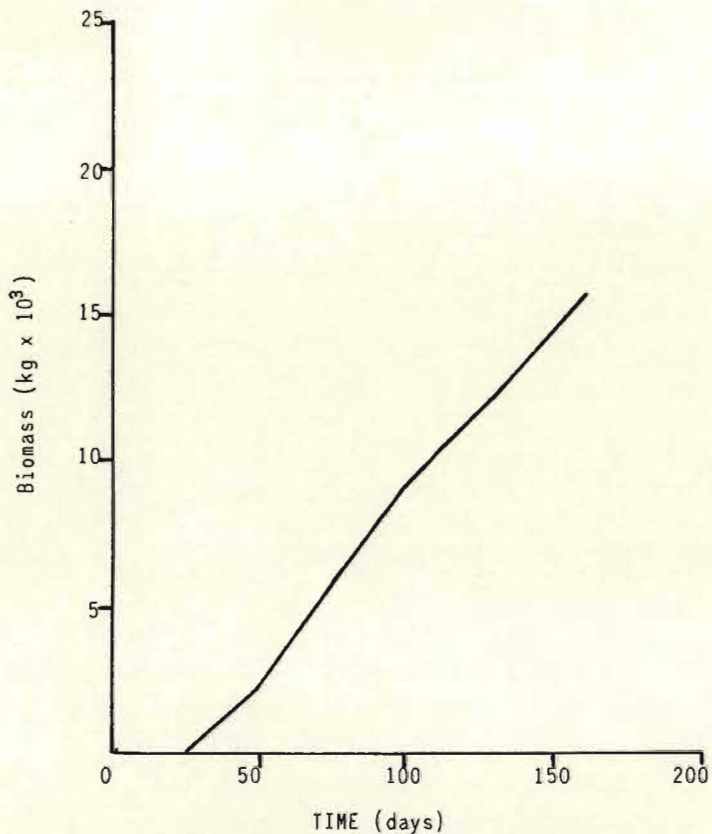
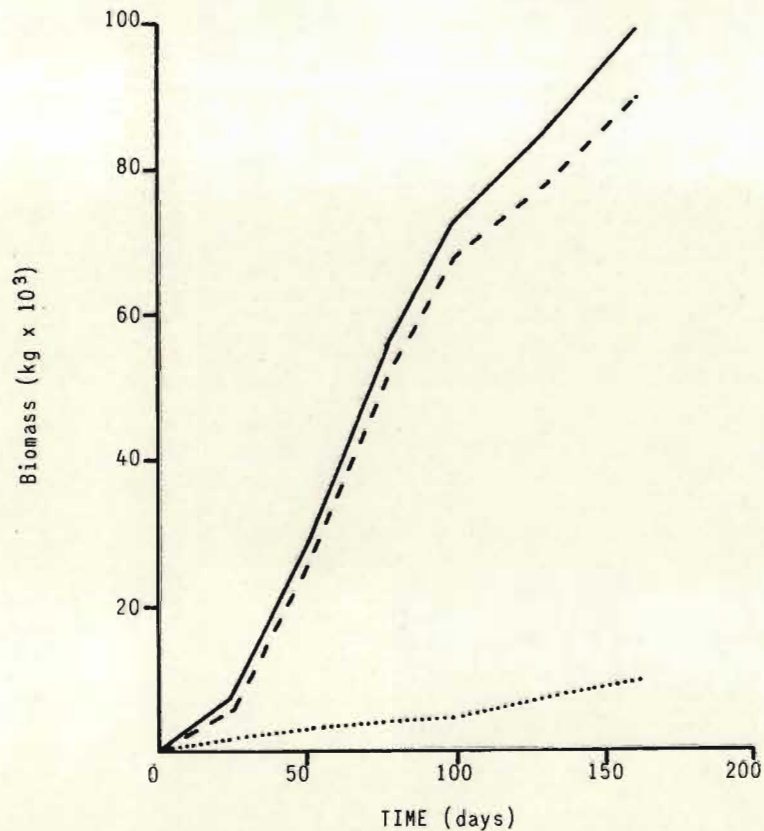


Figure 6.4 Increases in grazeable fraction (...), ungrazeable fraction (---) and total (—) standing crop of *C. dactylon* around Namanini lake with increasing period after flood subsidence.



(a) Total amount of *C. dactylon* removed due to grazing around Namanini lake with increasing period of exposure.



(b) Estimated grazeable (...), ungrazeable (---) and total (—) biomass that could be incorporated into the aquatic phase of Namanini lake, at increasing intervals after exposure.

Figure 6.5 Amount of *C. dactylon* removed by grazing and estimated amount incorporated into the aquatic phase around Namanini lake.

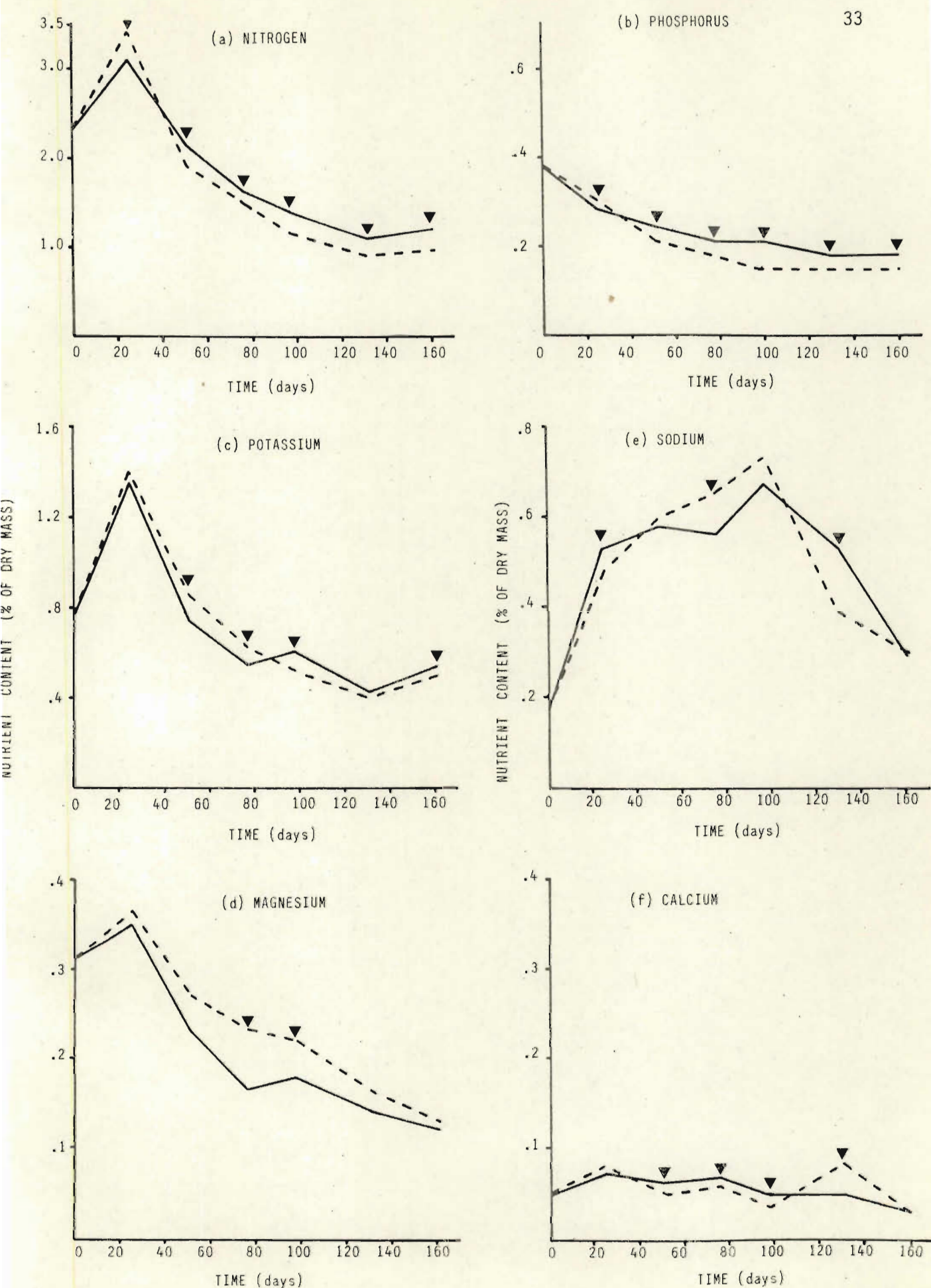


Figure 7.1 Changes in the nutrient content (% of dry mass) in the grazeable fraction of *C. dactylon* in response to increasing period of exposure under both grazed (—) and ungrazed (---) conditions (▼ - indicates a significant difference between grazed and ungrazed areas at

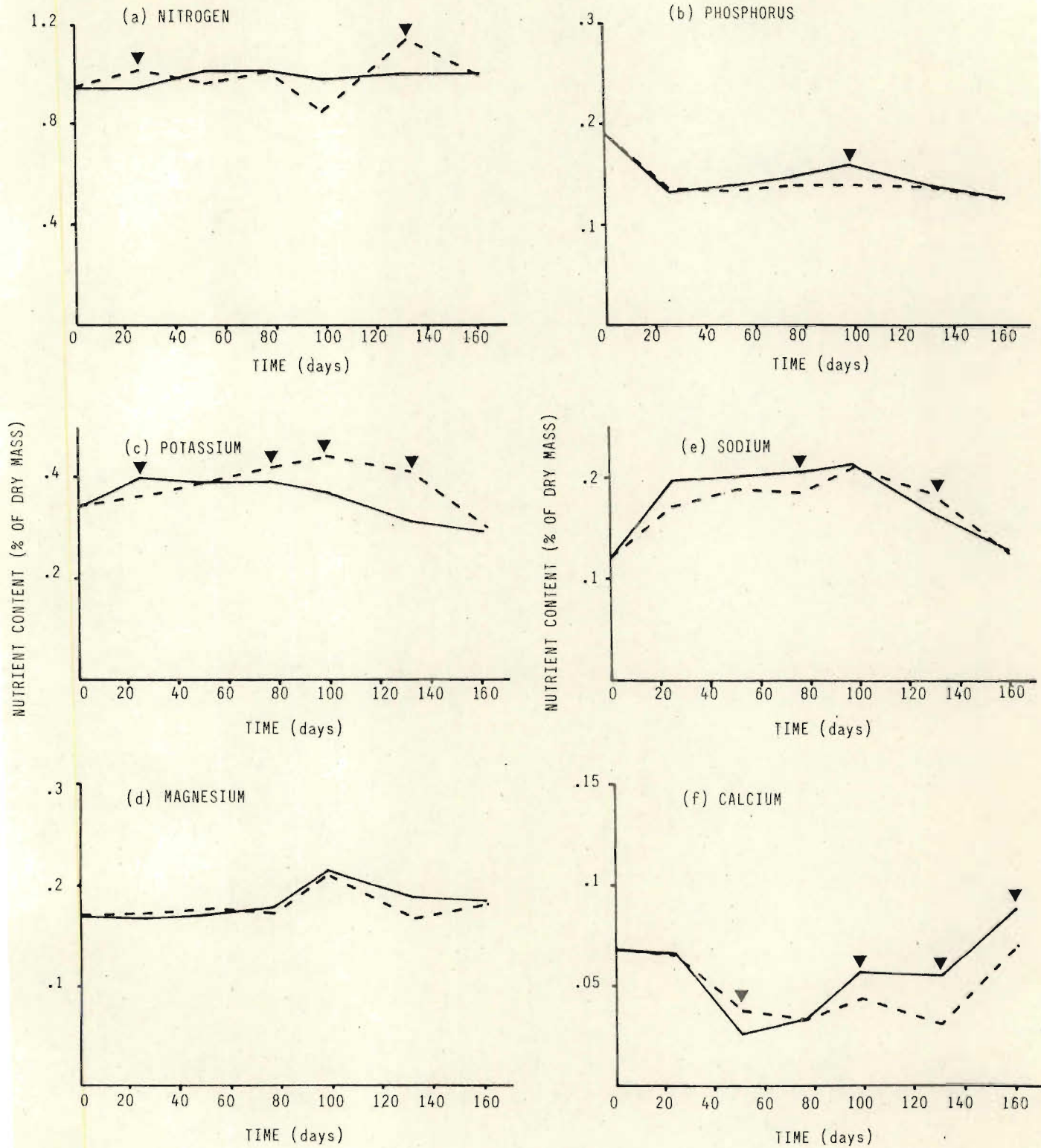


Figure 7.2 Changes in the nutrient content (% of dry mass) in the ungrazeable fraction of *C. dactylon* in response to increasing period of exposure under both grazed (—) and ungrazed (---) conditions (▼- indicates a significant difference between grazed and ungrazed areas at the 95% level).

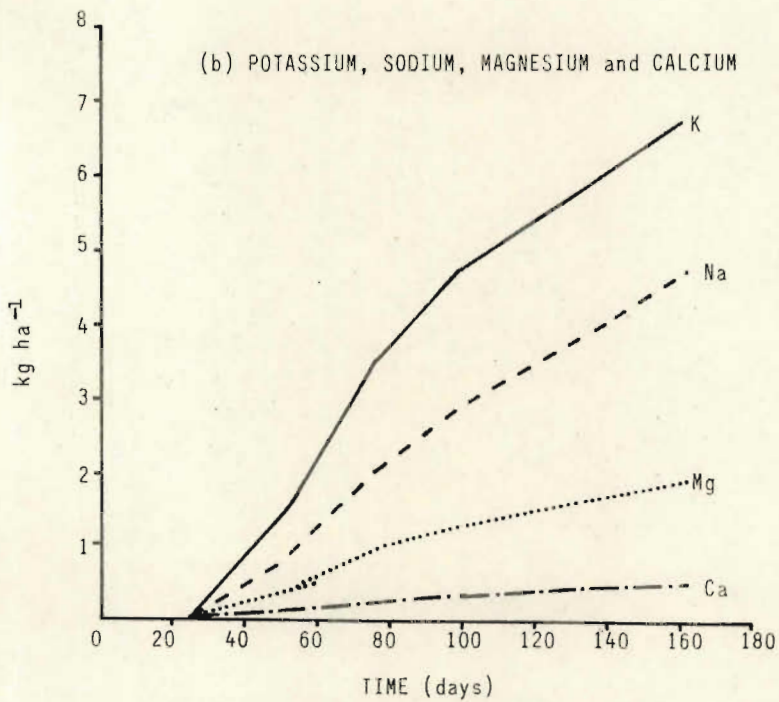
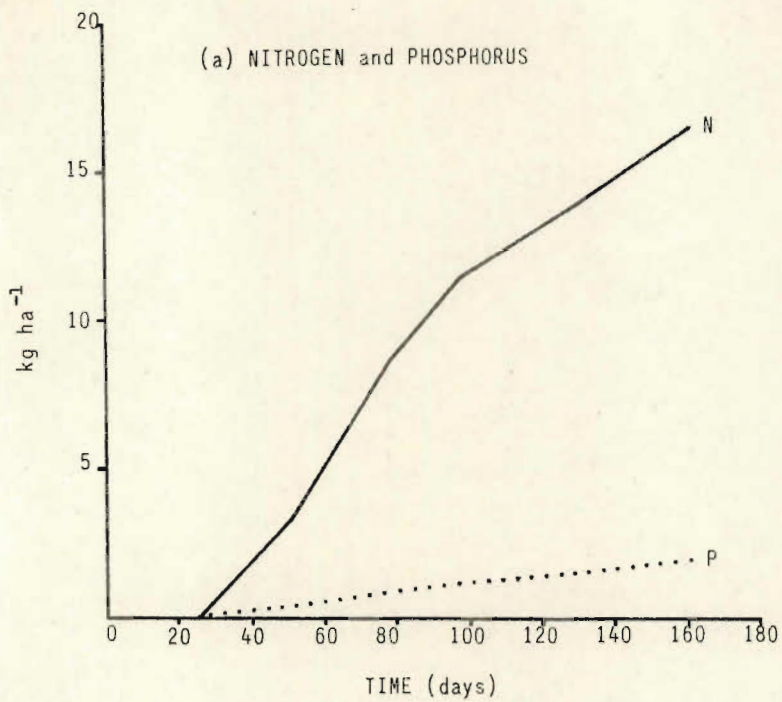


Figure 7.3 Total amounts of nutrients removed by grazing (kg ha^{-1}) from the *C. dactylon* area around Namanini lake at increasing periods after exposure.

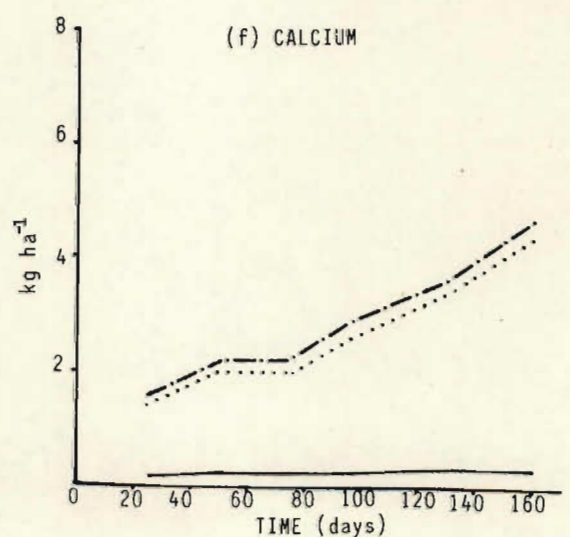
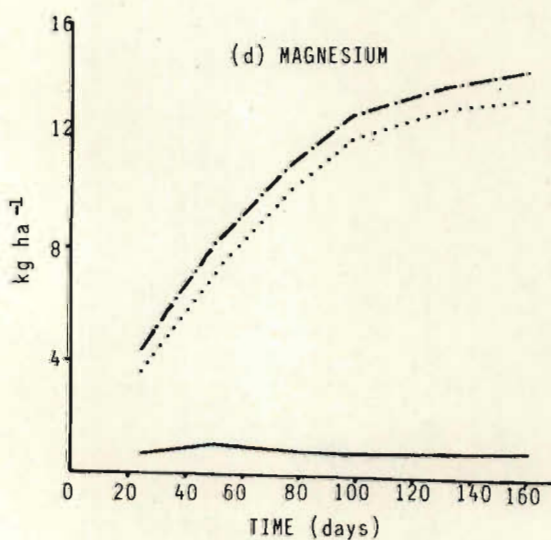
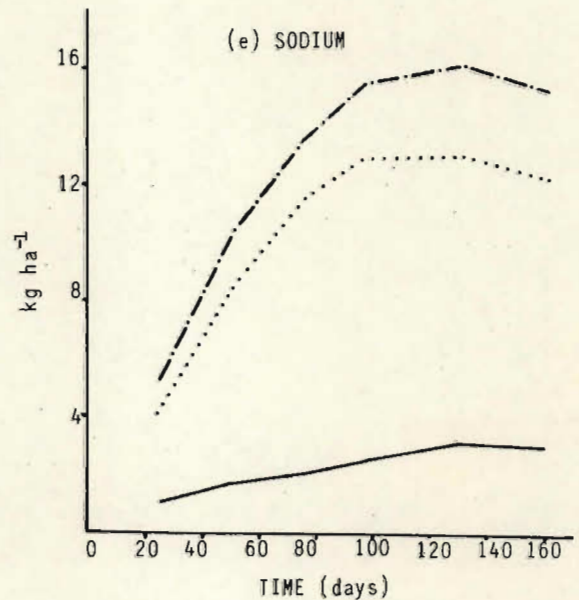
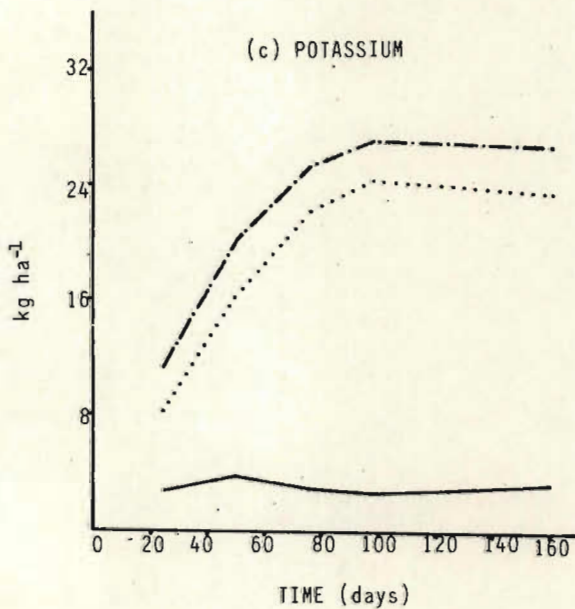
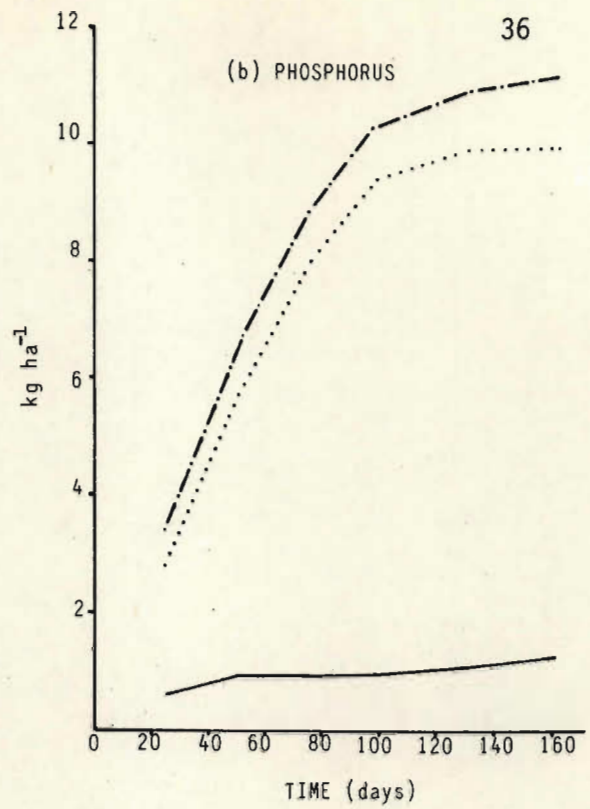
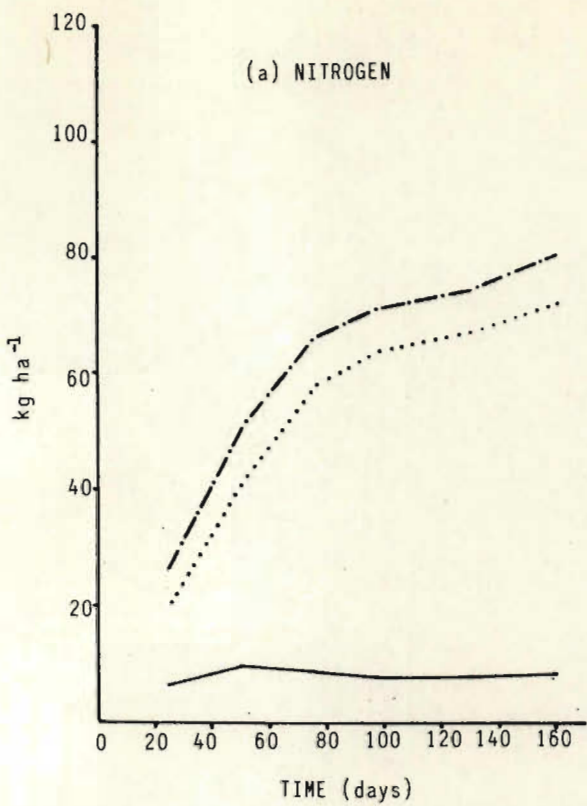


Figure 7.4 Changes in nutrient standing crop (kg ha^{-1}) around Mamanini lake of the grazeable and ungrazeable fractions and total nutrient content of *C. dactylon* with increasing exposure period (Due to integration process used and the interval of 25 days between samples, it was not possible to

TABLE 7.1 Rates of removal ($\text{kg ha}^{-1} \text{d}^{-1}$) of nutrients by grazers from the *C. dactylon* area around Namanini lake as period of exposure increased.

Exposure Period (days)	Rate of Removal ($\text{kg ha}^{-1} \text{d}^{-1}$)					
	N	P	K	Na	Ca	Mg
0 - 25	-	-	-	-	-	-
25 - 51	0.129	0.013	0.055	0.031	0.004	0.015
51 - 76	0.197	0.020	0.083	0.049	0.006	0.022
76 - 98	0.139	0.016	0.056	0.040	0.004	0.016
98 - 131	0.079	0.011	0.032	0.028	0.003	0.010
131 - 161	0.082	0.011	0.033	0.030	0.003	0.010

TABLE 7.2 Changes in the standing crop (kg) of some nutrients in *C. dactylon* areas on the Pogolo river floodplain at increasing periods after exposure.

Exposure Period (days)	Standing Crop (kg)					
	N	P	K	Na	Ca	Mg
(a) Ungrazeable fraction						
0 - 25	1783	250	754	373	126	319
25 - 51	5557	763	2218	1123	265	963
51 - 76	8736	1208	3356	1735	304	1500
76 - 98	10 518	1545	4018	2148	435	1965
98 - 131	11 668	1724	4208	2289	587	2278
131 - 161	12 799	1768	4174	2993	789	2419
(b) Grazeable fraction						
0 - 25	573	53	254	98	14	66
25 - 51	1271	125	520	257	33	142
51 - 76	1274	139	468	322	39	137
76 - 98	1234	156	465	420	42	137
98 - 131	1357	191	538	556	50	163
131 - 161	1499	218	603	552	53	173
(c) Total						
0 - 25	2356	303	1008	471	140	385
25 - 51	6828	888	2738	1380	298	1105
51 - 76	10 010	1347	3824	2057	343	1637
76 - 98	11 752	1701	4483	2568	477	2102
98 - 131	13 027	1915	4746	2845	637	2441
131 - 161	14 298	1986	4777	3545	842	2592

TABLE 7.3 Total amounts of nutrients and protein removed by grazing (kg) from the *C. dactylon* areas of the Pongolo river floodplain* as period of exposure increased.

Exposure Period (days)	Amount Removed (kg)						Protein
	N	P	K	Na	Ca	Mg	
0 - 25	-	-	-	-	-	-	-
25 - 51	450	46	193	110	12	51	2813
51 - 76	1194	120	506	293	34	135	7463
76 - 98	1698	177	707	437	49	194	10 613
98 - 131	2154	238	890	598	66	250	13 463
131 - 161	2591	298	1068	758	82	306	16 194

*Assuming crop growth rate, grazing and nutrient concentrations of *C. dactylon* at Namanini lake were the same for all *C. dactylon* areas on the floodplain.

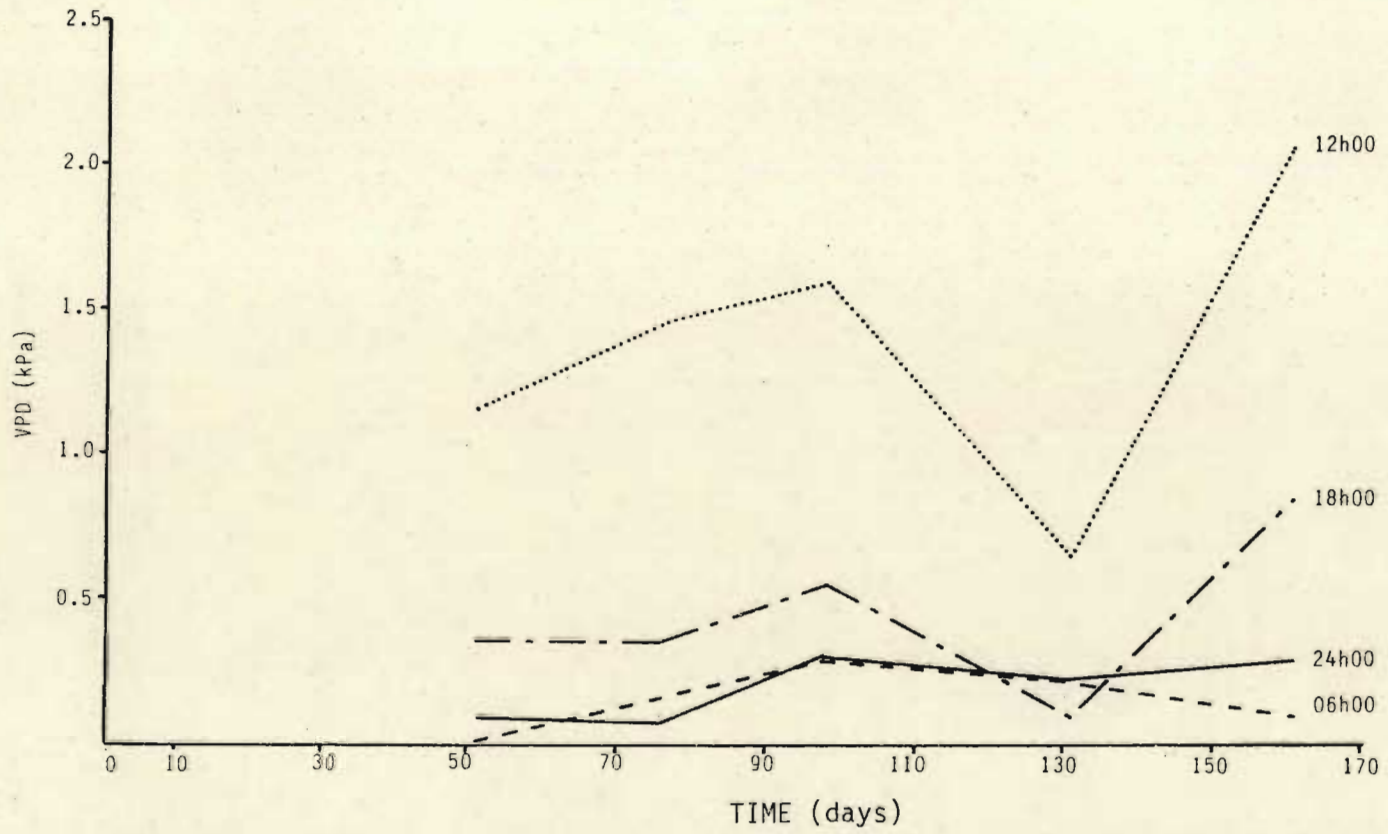


Figure 8.1 Diurnal changes in vapour pressure deficit (VPD) with increasing period after subsidence of floodwater.

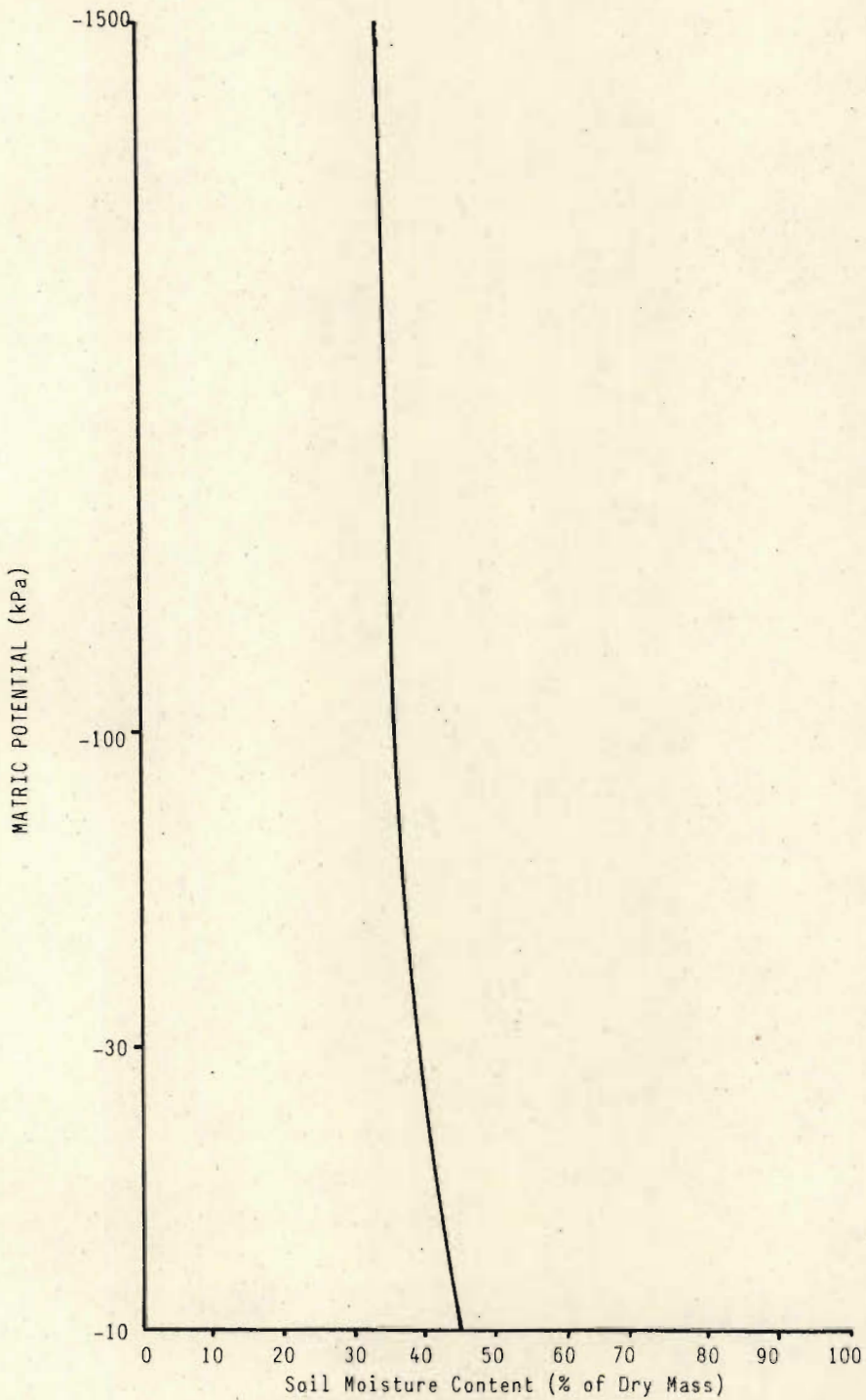


Figure 8.2 Moisture characteristic curve (matric potential vs. water content) of soil from the *Cynodon dactylon* meadow around Namanini lake.

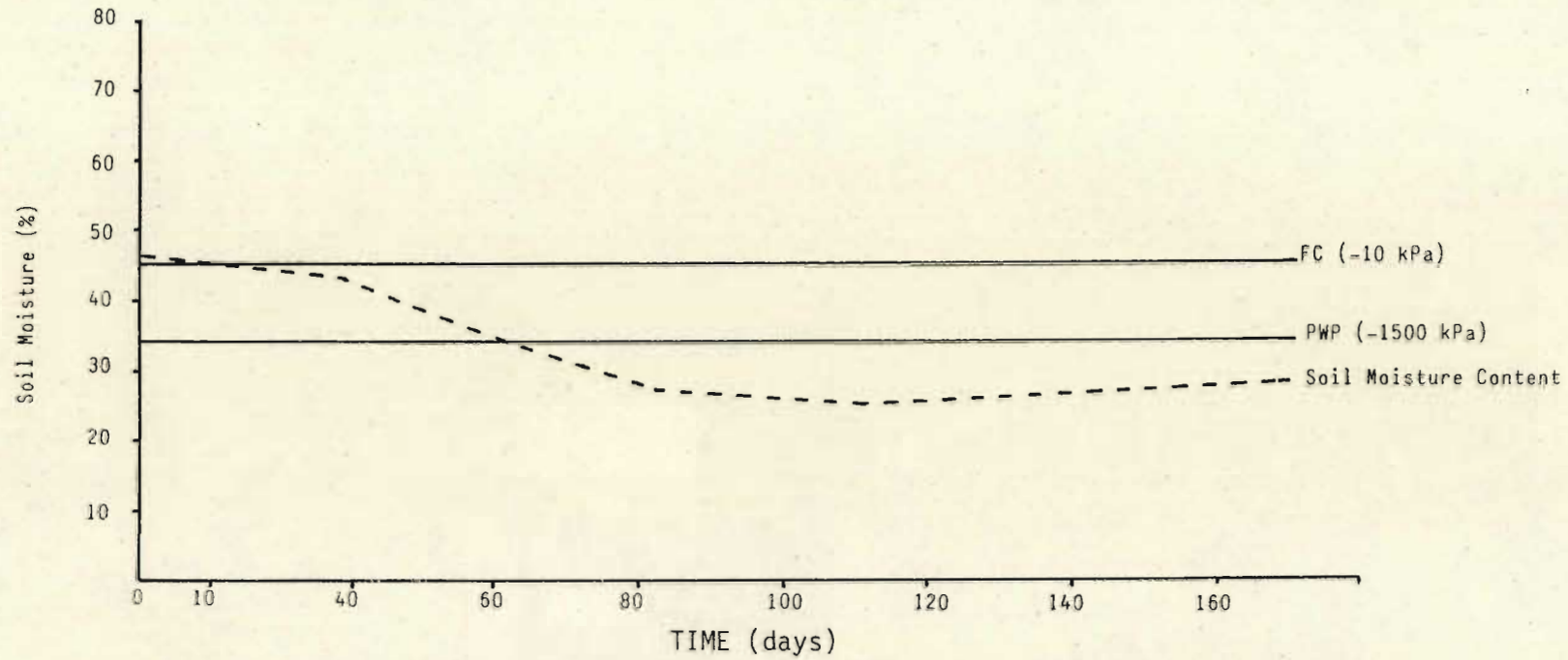


Figure 8.3 Changes in moisture content of a soil from the *C. dactylon* meadow at Namanini lake with increasing period after the subsidence of floodwaters. Permanent wilting point and field capacity are also shown.

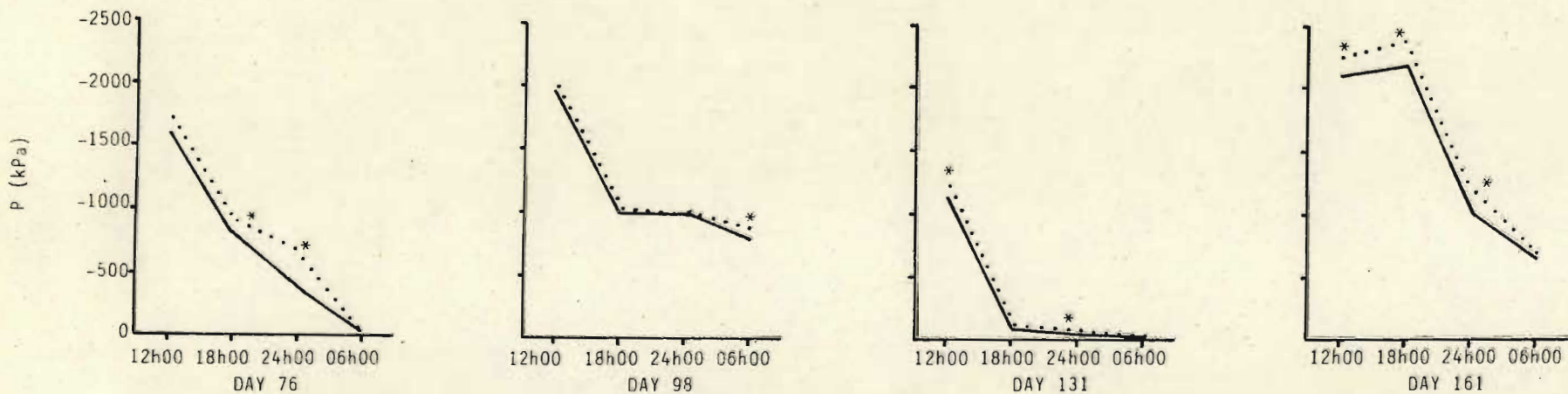
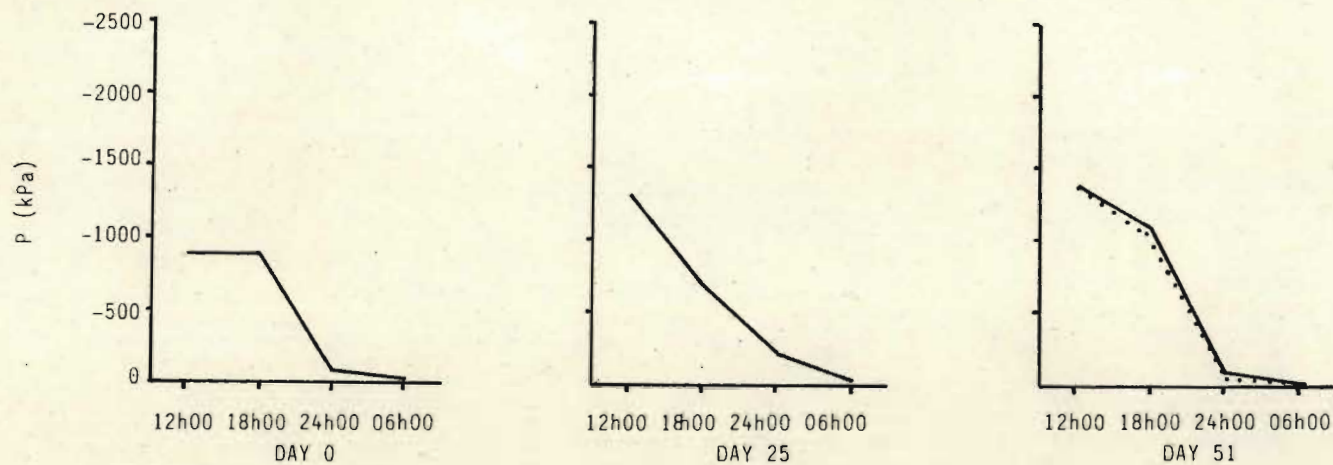


Figure 8.4 Changes in the diurnal cycle of xylem pressure potential (P)[in both grazed (---) and ungrazed (—) *C. dactylon* areas] with increasing period after the subsidence of floodwaters.

(* indicates a significant difference between grazed and ungrazed areas at the 95% level).

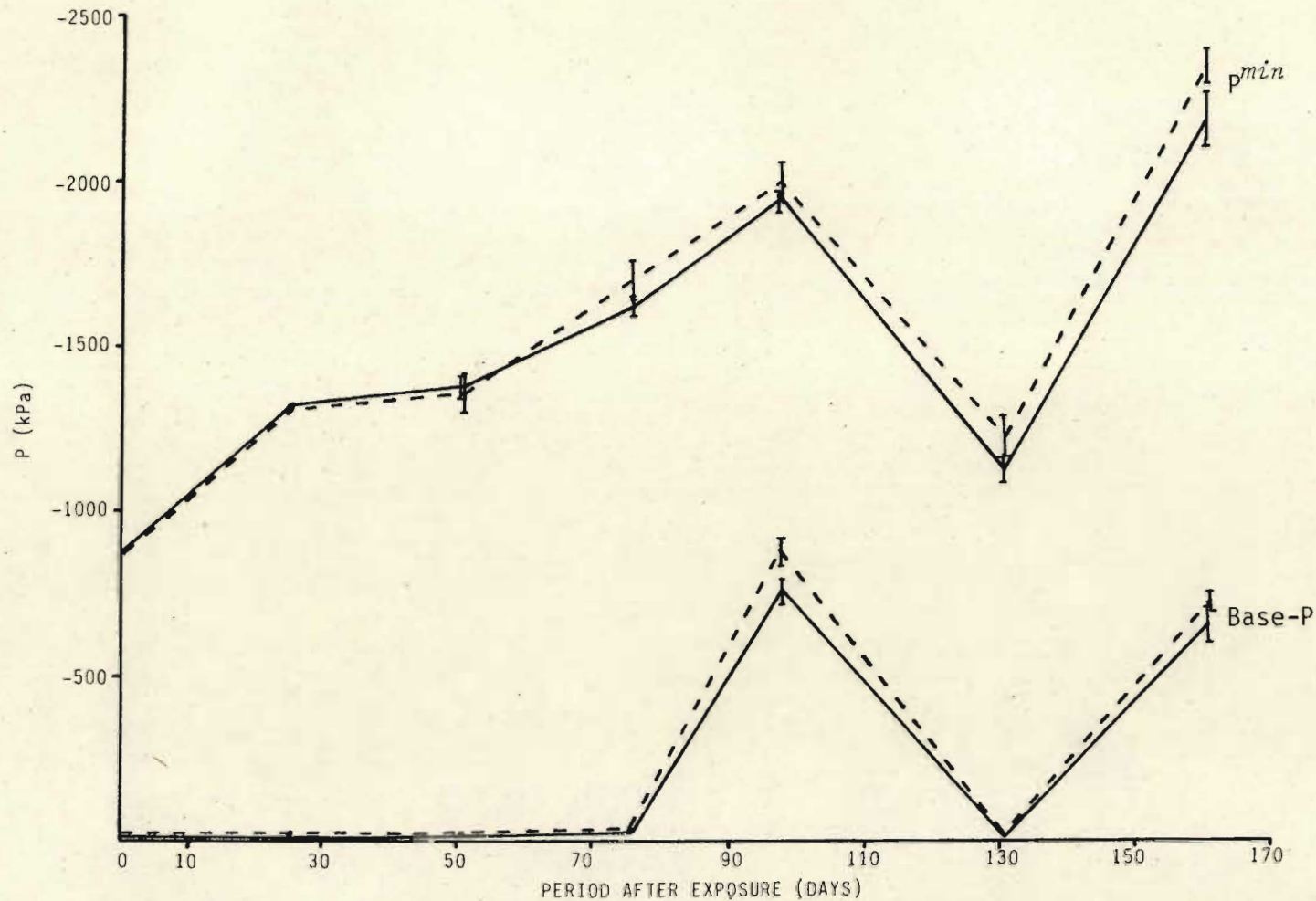


Figure 8.5 Mean predawn (Base-P) and daily maximum (P^{min}) Xylem Pressure Potential (P) in *Cynodon dactylon* grazed (---) and ungrazed (—) areas after increasing periods since floodwater subsided. (Vertical bars indicate 95% confidence limits).

TABLE 8.1 Precipitation data from two weather stations (447/565 in Ndumu Game Reserve and 447/446 at Ndumu) in the vicinity of Namanini lake.

DAYS AFTER FLOOD SUBSIDENCE	STATION 447/565		STATION 447/446
	Rainfall (mm)	Mist/Fog	Rainfall (mm)
1		= ¹	
2		(=) ³	
3		≡ ¹	
4		= ¹	
5-7			
8		= ¹	
9		(=) ¹	
10			
11		= ¹	
12			
13		= ¹	
14			
15		= ¹	
16-19			
20		(=) ¹	
21		(=) ¹	
22		(=) ¹	
23		= ¹	
24			
25		≡ ¹	
26-31			
32		(=) ¹	
33		(=) ¹	
34		(=) ¹	
35		(=) ¹	
36		(=) ¹	
37			
38	0.3		
39		(=) ¹	
40			
41		≡ ¹	
42		(=) ¹	
43		(=) ¹	
44-46			
47		≡ ¹	
48-50			
51		(=) ¹	
52		=	
53			
54		(=) ¹	
55-56			

DAYS AFTER FLOOD SUBSIDENCE	STATION 447/565		STATION 447/446
	Rainfall (mm)	Mist/Fog	Rainfall (mm)
57	0.5	(=) ³	
58		(=) ¹	
59		(=) ¹	
60-64			
65		(=) ¹	
66-69			
70	2.3		
71-72			
73		(=) ¹	
74-75			
76		(=) ¹	
77-86			
87	0.1		
88-97			
98	1.5		
99			
100		= ¹	
101-106			
107		= ¹	
108		= ¹	
109		(=) ¹	
110		(=) ³	
111-120			
121		= ³	
122			
123		(=) ³	
124-130			
131	1.3		
132-142			
143	1.3		
144	11.5		16.0
145	21.0		19.0
146-153			
154	14.6		
155			16.0
156-157			
158	0.4		
159			
160	3.2		
161			

*Mist/fog index

= mist on station

≡ fog on station

1 light

2 medium Intensity

3 heavy

() mist or fog 'nearby'

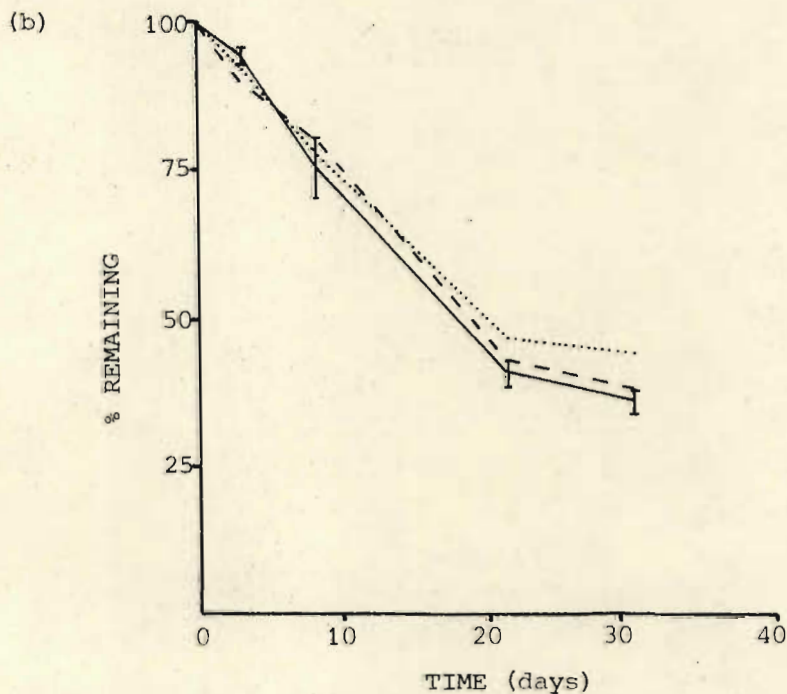
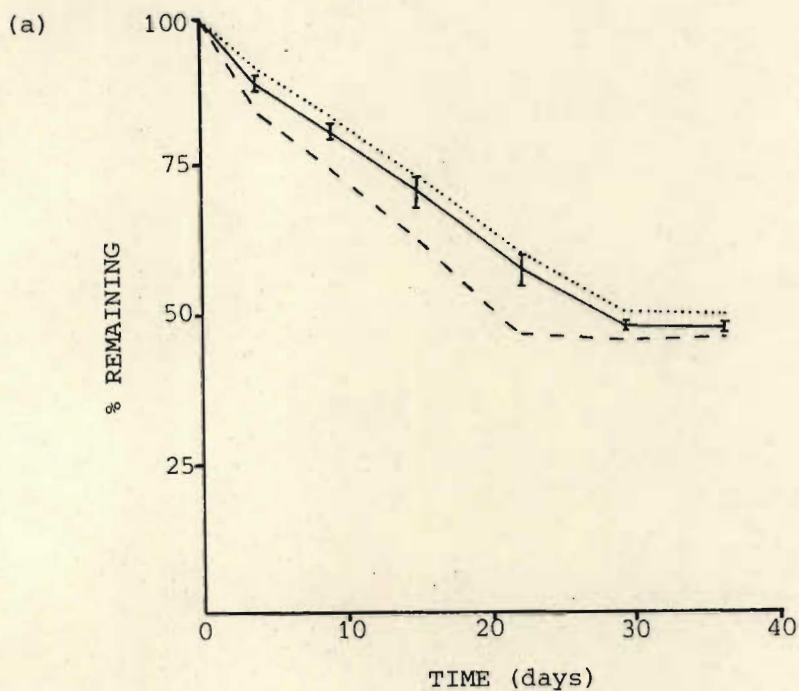


Figure 9.1 Amounts of ash (---), ash free (...) and total dry mass (—) as percentage initial dry mass of fresh (a) and dried (b) *Cymodon dactylon* material remaining after increasing period of decomposition. Vertical bars = 1 standard deviation of the mean for total dry mass.

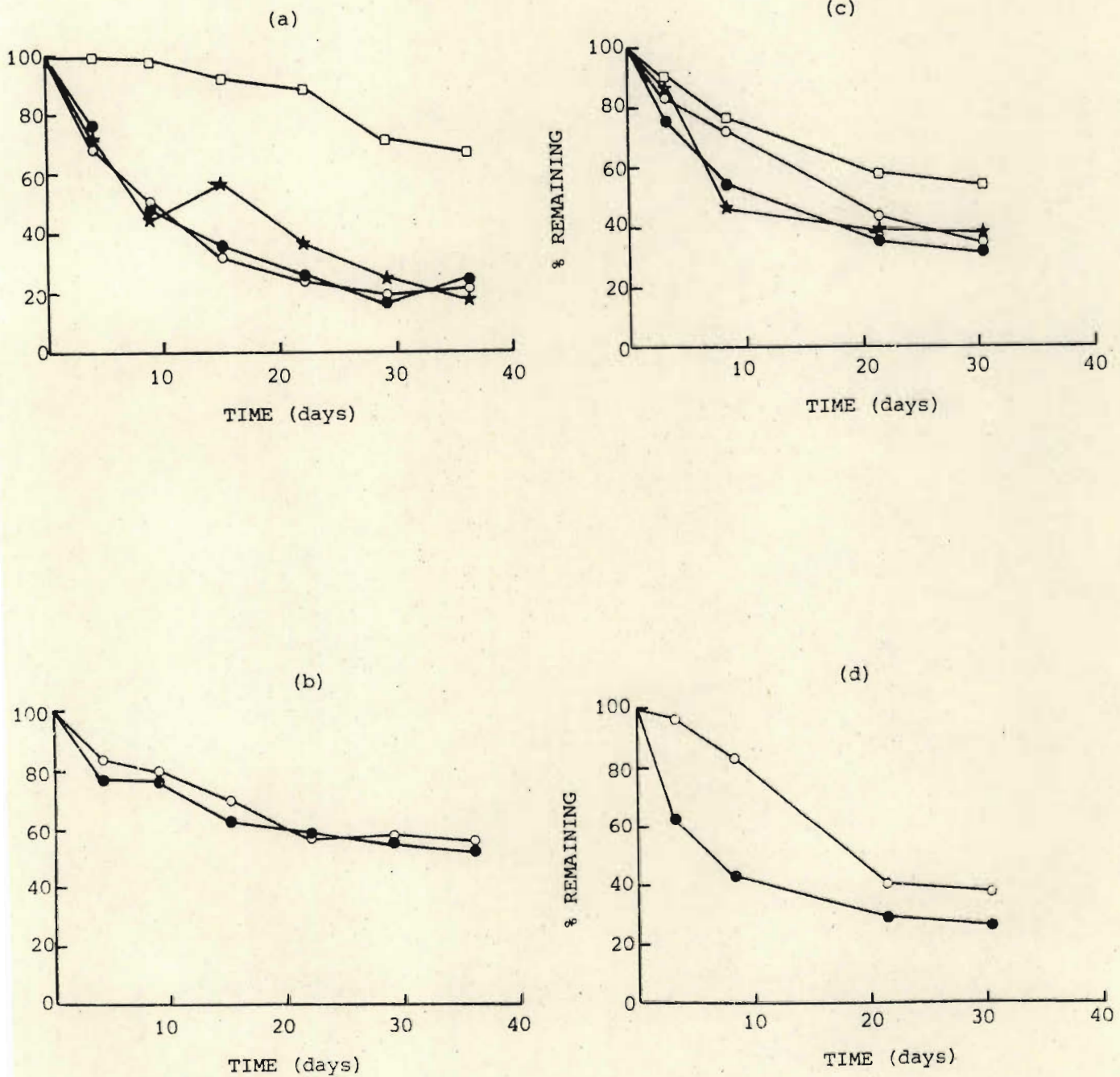


Figure 9.2 Changes in the composition of decomposing *Cynodon dactylon* as percentage of the original stock, in fresh (a & b) and dried material (c & d). The contents of three bags were bulked and subsampled for analysis on each occasion. In (a) and (c) changes in Mg (□); Ca (★); Na (●) and K (○) are shown and in (b) and (d) N (○) and P (●) changes are shown.

TABLE 9.1 Changes in chemical composition of the standing crop of *C. dactylon* following inundation (% of dry mass).

Day after Inundation	N	P	K	Na	Ca	Mg	Ash	Ash Free
0	1.71	0.17	0.65	0.41	0.31	0.17	14.16	85.84
30	1.66	0.08	0.63	0.39	0.27	0.16	12.23	87.88
75	1.56	0.02	0.60	0.23	0.17	0.15	9.38	90.62
120	1.98	0.20	0.66	0.20	0.09	0.27	10.98	98.02
234	2.26	0.38	0.75	0.17	0.05	0.31	11.69	88.31

TABLE 9.2 Range in temperature, nitrate-nitrogen and soluble reactive phosphorus (SRP) measured at Namanini lake.

Parameter measured	Range of values recorded
Temperature (summer)	23°C - 29°C
Temperature (winter)	19°C - 23°C
NO ₃ -N	<2 µg l ⁻¹ - 125 µg l ⁻¹
SRP	<1 µg l ⁻¹ - 25 µg l ⁻¹

TABLE 9.3 Changes in water level, total area exposed, area colonized by *C. dactylon* and *C. dactylon* standing crop with increasing period after floodwaters subside at Namanini lake.

Days after floods subside	Decrease in water level (m)	Area exposed (ha)		<i>C. dactylon</i> standing crop (kg dry mass)
		Total	Colonized by <i>C. dactylon</i>	
0	0	-	-	-
25	1.07	41.9	11.2	2337.5
51	1.96	59.4	16.7	5889.3
76	2.18	71.0	18.8	7161.7
98	2.33	79.4	20.6	8633.4
131	2.52	84.4	21.9	11 546.6
161	2.70	89.5	22.3	14 363.0

TABLE 9.4 Predicted losses of nutrients and mass (kg) from the grazeable fraction of *Cynodon dactylon* growing around Namanini lake during submergence, after increasing periods of exposure prior to inundation.

Period since previous floods (days)	N	P	Ca	Na	K	Mg	Mass
25	27.92	2.77	1.34	10.18	25.73	6.51	1168.77
51	61.97	6.55	3.19	26.70	52.65	5.51	2944.65
76	62.09	7.32	3.76	33.41	47.39	5.29	3580.87
98	60.14	8.17	4.08	43.60	47.09	5.32	4316.68
131	66.23	10.02	4.85	57.65	54.49	6.31	5773.31
161	73.08	11.46	5.12	57.30	61.10	6.68	7181.50

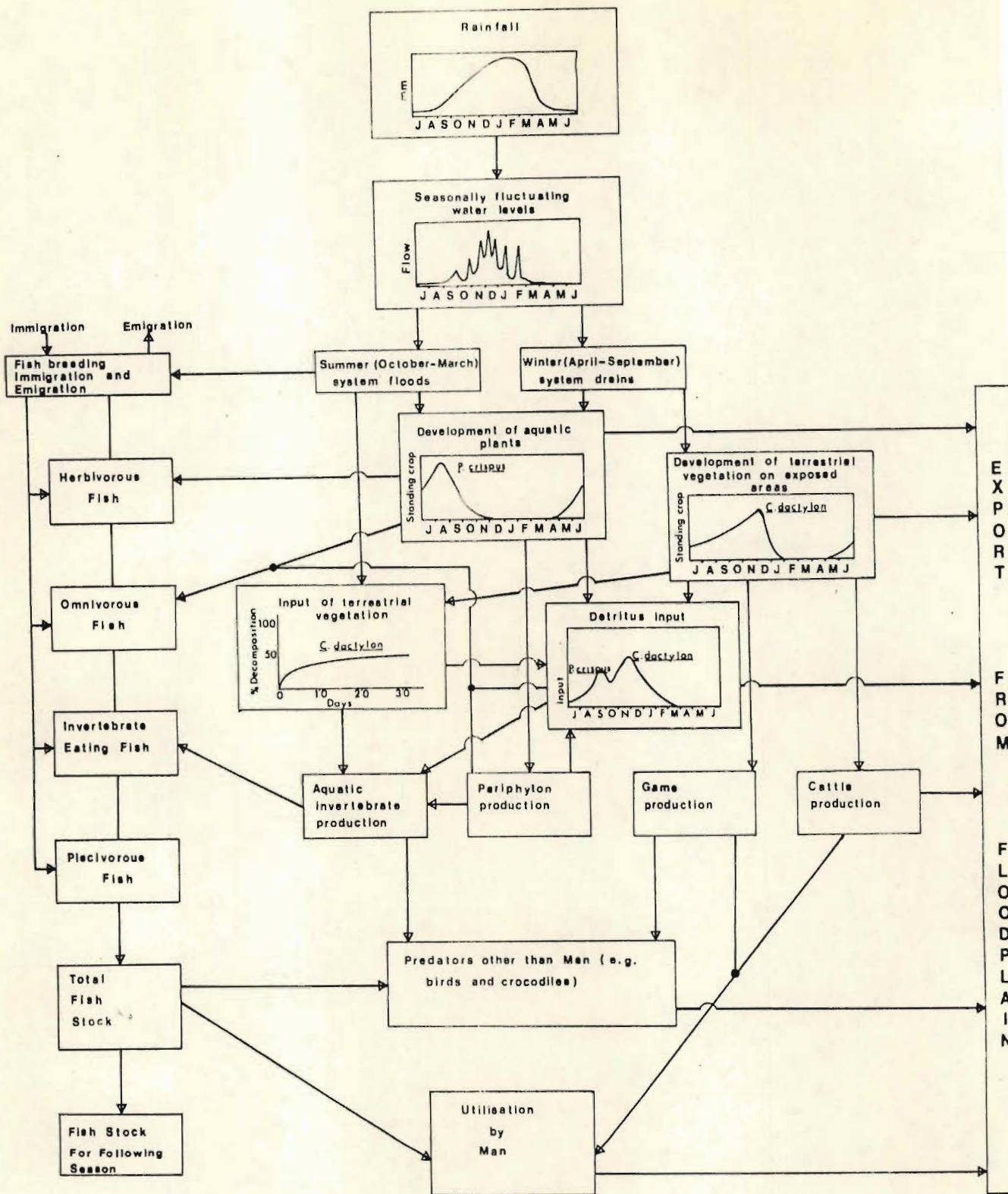


Figure 10.1 Conceptual model of the Pongolo floodplain system showing the major interrelated factors and components. The effect of summer rainfall in bringing about seasonal fluctuations in water level is evident. The effect of water level fluctuations on the growth of primary producers (particularly *C. dactylon* and *P. crispus*) is also shown, as is the importance of these primary producers in maintaining floodplain functioning.

The effects of changes in the flood regime can also be seen : an absence of flooding will prevent an input to the aquatic system from terrestrial vegetation, thereby detrimentally affecting organisms of higher trophic levels (e.g. invertebrates and fish); while an extended period of inundation will reduce or prevent the development of terrestrial vegetation, detrimentally affecting cattle and game production, as well as the input to the detritus pool.

It should be noted that only the major pathways have been considered in constructing this model. Although others occur (e.g. detritus inputs from fish and cattle) their inclusion

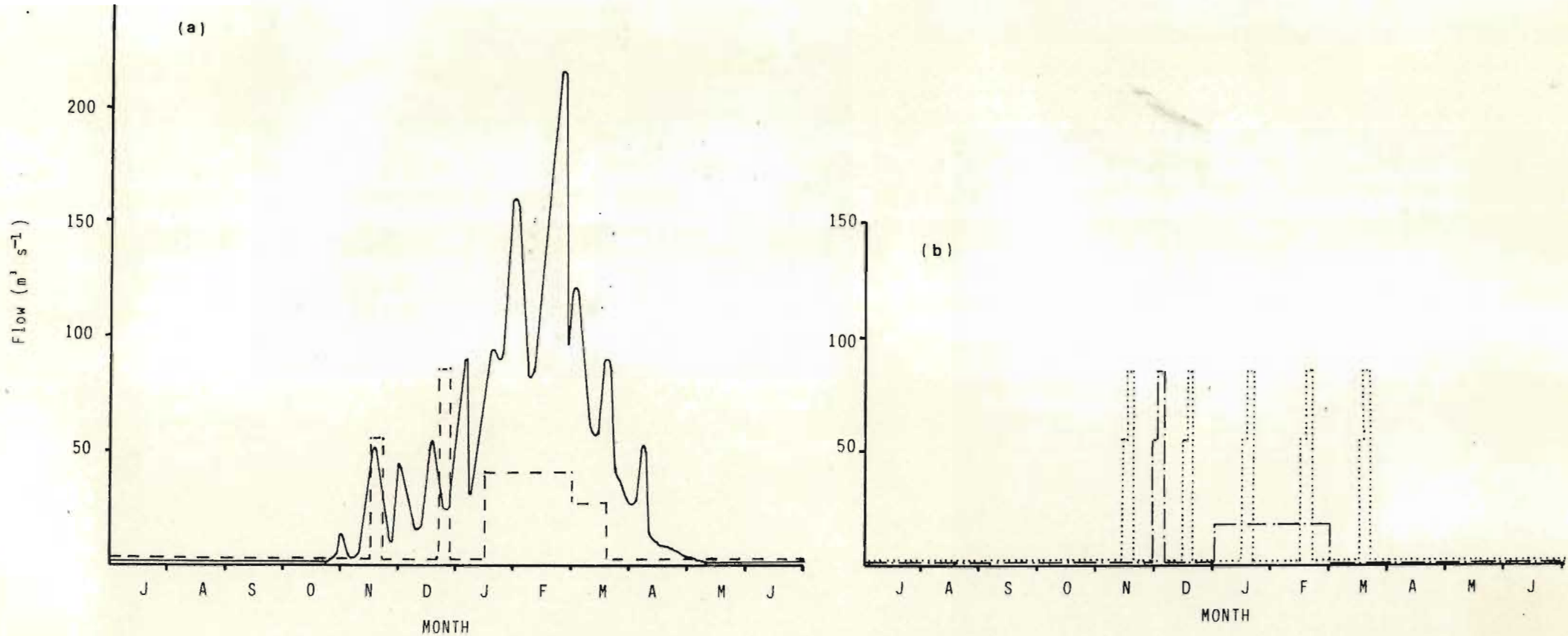


Figure 10.2 (a) Proposed water release programme for the Pongolapoort Dam, designed to maintain the floodplain as a functional unit (---), superimposed on a schematic representation of flow on the Pongolo floodplain prior to the construction of the dam (—). This proposed water release programme will require *c.* 242×10^6 m³ of water (i.e. 10% of the full supply capacity of the dam).

In (b) alternative flooding programmes are presented. Proposal A (— —) requires *c.* 185×10^6 m³ of water (i.e. 7.5% of the full supply capacity of the dam), while proposal B (.....) requires *c.* 146×10^6 m³ of water (i.e. 5.8% of the full supply capacity of the dam). Proposal B can be modified by reducing the flood peaks and duration of flooding (see text section 10.3.1). This modification would require *c.* 100×10^6 m³ of water (i.e. 4% of the full supply capacity of the dam).