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PO Box 1139 (150 Oxford St)
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Facsimile: 61 3 9662 7611
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Some physical and chemical features of two upland crater lakes in tropical north-eastern Australia

D. Walker

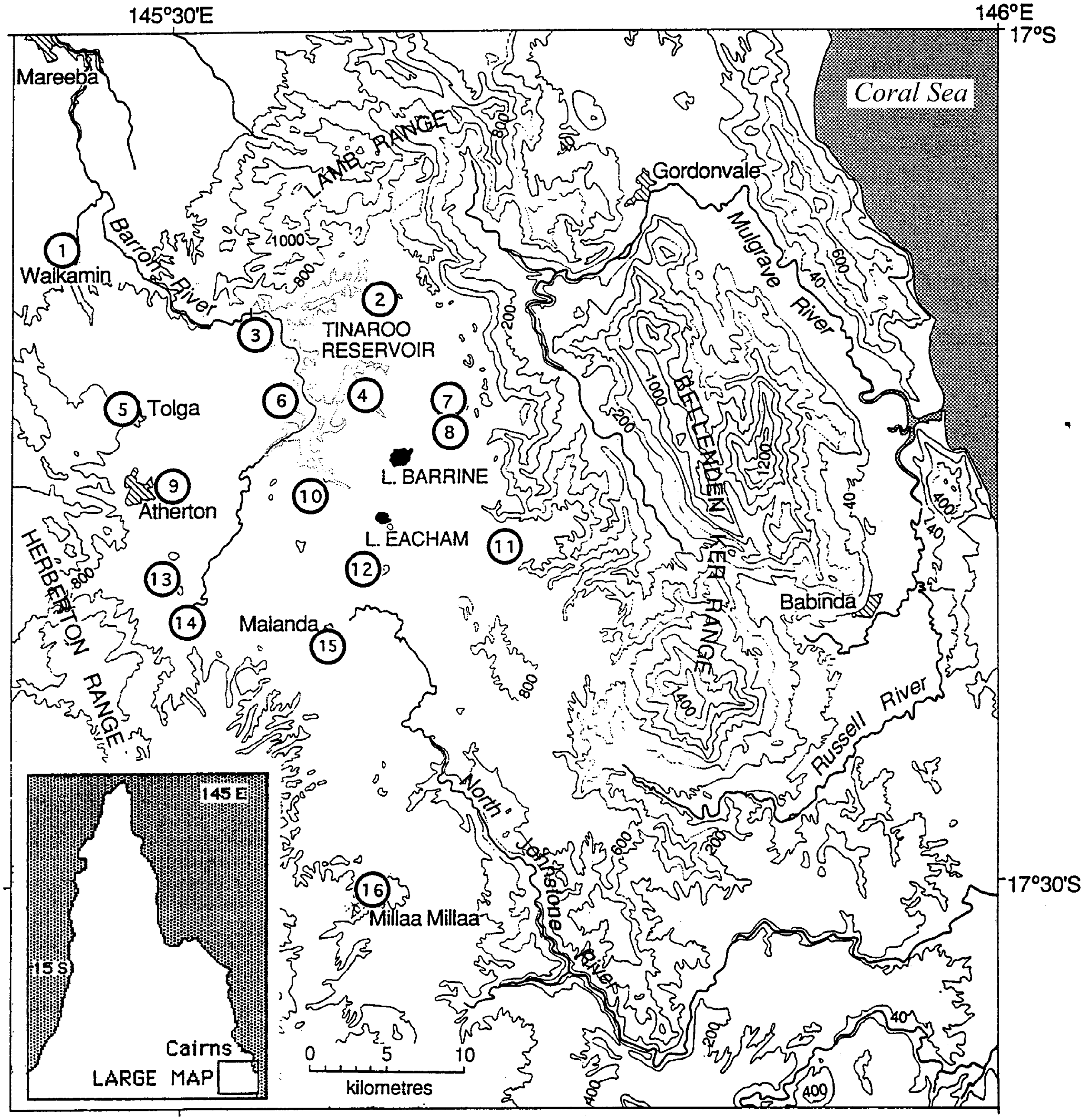

Fig. A1. Locations of Lakes Barrine and Eacham and of the meteorological stations (numbered circles) mentioned in the text or used to stimate rainfall at the lakes.

1, Walkamin
2, Danbulla
3, Tinaroo
4, Barrine (former settlement)
5, Tolga
6, Kairi
7, Severin Forest
8, Top Gate
9, Atherton
10, Yungaburra
11, Gadgarra
12, Peeramon
13, East Barron
14, Barron Vale
15, Malanda
16, Millaa Millaa

Appendix A. Estimating the climate at lakes Barrine and Eacham

Rainfall

Rainfall statistics are available for substantial periods for 12 stations on or near the Tableland (Fig. A1). The best fit between the monthly means for the period 1925 to 1954 and geographical features of the stations is given by

$$R_m = a + (b \times SE) + (c \times OE)$$

where:

R_m is mean monthly rainfall in mm, SE is distance in km along a line SE from Walkamin (the northernmost station) to that line's intersection with the site's latitude,

OE is distance in km from the above intersection to the site (Eastings positive, Westings negative), a, b and c are coefficients of the regression (Table A1).

Despite the low R^2 (adjusted for multiple regression) and some high p values for the wettest months, November to March, no better estimators could be formed no matter how the set of stations was restricted or described (Table 6). The implication is that, during the less wet months, rainfall decreases northwestward across the Tableland and, at any latitude, increases toward the mountain ranges to the east.

By comparison, predictive statistics relating total rainfall to geographical position for each individual month for the period 1980 to 1989 were even less precise no matter how position including altitude was defined. There are evidently big differences in the local pattern of rainfall from month to month and even between the same month in different years which only long-term means smooth. The restriction of the number of stations to the seven closest to Barrine and Eacham did not lessen the difficulty. Therefore, in order to estimate the rainfall at each lake for each month of the decade within which the limnological observations were made, the following procedure was followed. Using a set of seven stations closest to the lakes, a regression was calculated for each individual month using combinations of latitudinal and longitudinal measures and altitude. Those equations with an adjusted R^2 of 0.7 or above (14 of 120) were used to predict the rainfall at the lakes for the specified month. The rest of the estimates were made by inspection of the apparent pattern of rainfall intensity at the seven stations and judgements as to what this might have implied for falls at the lakes. In the 14 twin cases for which independent regression and inspection estimates were made (Table A2), small actual differences in the drier months resulted in the highest percentage differences but some for other times of year (e.g. January 1984) were more significant. In view of the small number of acceptable regression estimates and the greater complexity contributing to the inspection estimates, the latter were adopted for further use.

Comparison of the mean monthly rainfalls for the 1980 to 1989 decade with the longer-term means for 1925 to 1954 for the four stations closest to the lakes, show the former to have been drier in the 'wet' months (December, January, February, March) and in June and July but wetter in the rest of the year, totalling slightly drier (*ca* 8%) for the whole decade. Within that time there was some variation in the intensity of wet and dry seasons from year to year.

Some rainfall data are available from the Queensland National Parks and Wildlife station at Lake Eacham for part of 1983 to 1987 and from Lake Barrine for nine months of 1987. Differences between the observations and the estimates for the same months usually differ, sometimes grossly so, but similar inconsistencies between the actual measures at Eacham and those from the nearby station at Peeramon raise serious doubts about the accuracy of the records from the lakes (Table A3).

Temperature

Regular temperature readings through substantial periods are available only from Atherton (CSIRO) from 1977 and Kairi (DPI) from 1952 . For most purposes, mean monthly values are used and this should be assumed to be the case below unless otherwise indicated. Short gaps in the records from either station were filled by transforming the values from the other one by their long-term proportional differences for the month in question.

For 1977 to 1988, which includes the period of lake observations, the annual average screen (max+min)/2 was 0.5°C higher at Atherton than Kairi but the monthly values for May to August were virtually identical (cross correlation 0.92 $\pm$0.29 (SE) at lag 0). The annual average ground temperature was 0.4°C higher at Atherton but July, September and October were the most different months (Table A4).

Barrine surface water temperatures defined by interpolation between recorded values for August 1982 to September 1988 lie closer to the (max+min)/2 values for Kairi than to those for Atherton in all but one month, though the mean annual difference in this measure between the lake and the two screen stations is only 0.9°C. Mean monthly differences between the lake and the two stations together ranged from 2.3 to 4.9°C around an overall mean of 3.6°C. Similarly, there was little distinction between the differences of mean monthly ground averages for the two stations and Barrine surface temperatures, particularly in the critical winter months June to August.

In estimating temperatures for Lake Barrine, therefore, there was little to choose between Atherton and Kairi as sources. For most purposes, including those specifically relating to the period 1982 to 1988, the Kairi data were used on the grounds that the site was physiographically more similar to, and only slightly more than half the distance from, Barrine and that it was the only source of pan evaporation data. The similarities between Atherton and Kairi temperatures encouraged the view that they represented basically the same local fields and that the Kairi values could reasonably be used, usually without modification, as estimates for Barrine. But during stormy months with high rainfall, Barrine air is probably substantially cooler than that at Kairi, assuming the storms to be summer and mainly from the north or northwest, and I have 'corrected' Kairi temperatures by x0.9 to give Barrine temperatures for these times. Similarly, the long wet (drizzle) periods are likely to impose an even stronger medium-term reduction on the Barrine air temperatures and I have applied a 'correction' of x0.85 to the Kairi values for this.

Evaporation

Pan evaporation data for Kairi (1963 to 1989) provide the best basis for the estimation of evaporation from the lakes' surfaces. Least pan evaporation at Kairi (usually May or June) is either coincident with lowest (max+min)/2 temperature or a month before it. Evaporation usually then rises more steeply than this measure of air temperature, attaining its maximum (usually in November) three months before the temperature maximum. The fall of evaporation is, usually, slightly slower than that of temperature. 'Maxima' and 'minima' of both variables can be single months or virtually spread through as long as three months. Where evaporation has to be derived from temperature, therefore, it is probably best to:

(a) treat evaporation minimum as a single month, one month ahead of temperature minimum and

(b) suppose evaporation maximum to be attained three months before temperature maximum, to be more-or-less sustained for three months, then to descend to the next minimum.

The estimates of monthly mean evaporation at the lakes are derived from the pan data of Kairi by the subjective application of the following modifications to the prime conversion factor of 0.7 (Hounam 1973; Morton 1986) for pan to open water:

(a) relative air temperature ((max+min)/2) at the lake as assessed by deviations from the average for 1980 to 1988; positive deviations support a higher conversion factor and *vice-versa*,

(b) stage in the annual oscillation of surface water temperature; gain in heat supports a higher factor and *vice-versa,*

(c) difference between surface water and air temperatures; differences greater than 4°C (in favour of water) support a lower factor and *vice-versa*, and

(d) relative mean daily wind run (km) at Atherton (CSIRO): positive deviations support a higher conversion factor and *vice-versa*.

Table A1. Rainfall modelling regression parameters for 12 stations on the Atherton Tableland for the years 1925 to 1954.
The Barrine of this table is the former settlement about 5km NNW from the lake.

Geographic statistics	Walkamin	Danbulla	Tinaroo	Barrine	Kairi	Tolga	Atherton	Yungaburra	Gadgarra	Peeramon	E.Barron	Malanda
Inputs												
SE (km SE)	0	5	6	12	14	15	21	21	27	28	30	35
OE (km offset)	0	18	9	12	5	-4	-10	0	10	0	-11	-7

Regression outputs, 12 stations	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
Coefficients												
a (intercept)	232.1	246.9	212.7	27.6	14.3	17.4	6	6.9	5.9	19.2	62.7	134.4
b (x SE)	2.5	3.8	5.1	4.3	2.7	1.8	1.4	1.1	0.98	0.59	0.61	0.58
c (x OE)	2.2	3.8	6	3.7	2	1.5	0.89	0.78	0.68	0.39	-0.12	-0.18
Statistics												
R^2 (adjusted)	0.38	0.48	0.63	0.91	0.91	0.86	0.87	0.88	0.79	0.91	0.42	0.26
F	4.4	6.1	10.4	59.1	58.8	35.3	39.1	40.5	22.1	57.6	5	1.6
p (10^{-4} x N)	400	200	45	<1	<1	<1	<1	<1	3	<1	340	2500

Table A2. Differences between rainfall estimates derived from regression and inspection for the same 14 months at Lakes Eacham and Barrine.

Table A2.

Year	Month	Inspectn (mm)	Regressn (mm)	Difference (% inspectn)	Inspectn (mm)	Regressn (mm)	Difference (% inspectn)
1980	Mar	350	371	6	320	381	16
1980	Jun	55	83	51	60	85	42
1983	Mar	360	393	9	380	412	8
1983	Oct	40	43	7	30	35	17
1984	Jan	200	270	35	210	278	32
1984	Feb	270	286	6	250	291	17
1985	Feb	300	352	17	280	360	29
1986	Sep	14	16	16	14	18	29
1986	Oct	45	49	9	45	40	-10
1987	Aug	25	30	20	20	31	54
1988	Mar	200	214	7	215	228	6
1988	Jun	40	45	13	30	45	51
1989	Aug	7	2	-71	4	2	-50
1989	Dec	150	159	6	150	156	4

In practice there is rarely conflict in the application of these criteria. The chosen corrected factor is constrained between 0.6 and 0.8 (TableA5).

Appendix B. The lake volume model.

1980 to 1988

The main factors determining the water volume of each lake were simulated on a monthly basis for the period January 1980 to December 1988 using the computer package ithink[R] (High Performance Systems Inc.) (Fig. B1).

Inputs

R= rainfall (mm) as estimated for each lake for each month.

Lk= lake area (ha), the surface area read from 1:2000 maps made from approximately 1:9500 aerial photographs when Barrine was full to overflow threshold. Changes in area consequent on volume changes are deemed insignificant. Barrine = 103 ha, Eacham = 46 ha.

Ld= land area (ha), the horizontal projection area of the land between beach and crater rim, read from 1:2000 maps made from approximately 1:9500 aerial photographs. Barrine = 91 ha, Eacham = 27 ha.

E= evaporation (mm) as estimated from an open water surface under the temperature and wind conditions of each month (Appendix A).

T= evapotranspiration (mm) = E x 1.1 for each month .

S= soil water volume (kL), initially set at 10% of the volume of the topmost 50cm of soil in the catchment (i.e. 48000 for Barrine, 13500 for Eacham).

V= initial 'lake-full' water volume (kL), 35716200 for Barrine and 16298800 for Eacham.

Interactions

Direct rain lake (kL) = R x Lk x 10 (units conversion factor).

Direct rain land (kL) = R x Ld x 10 (units conversion factor).

Lake evaporation (kL) = E x Lk x 10 (units conversion factor).

Land evapotranspiration (kL): If (S > -48000 (Barrine) or -13500 (Eacham)), then (T x Ld x 10 (units conversion factor) x 0.5 (desiccation factor)) else (T x Ld x 10 (units conversion factor). The desiccation factor provides for a reduction in evapotranspiration rate when the uppermost metre or more of soil is devoid of water; it ensures a small positive water content of the uppermost 50 cm of soil averaged over the whole decade.

Volume land(kL) = S+ Direct rain land - Land evapotranspiration.

Runoff (kL): If Volume land > -48000 (Barrine) or -13500 (Eacham), then (Soil water volume - 48000 (Barrine) or - 13500 (Eacham)) else 0. Runoff only occurs when the topmost 50cm of soil contains >10% water by volume.

Volume lake (kL).= V + Direct rain land + Runoff - Lake evaporation -Overflow (Barrine) *or* -Seepage (Eacham).

Overflow (kL) (Barrine). If (Volume lake >35716200) then (Volume lake - 35716200) else 0. Provides for the loss of excess water through the outflow creek when its threshold is surpassed.

Seepage (kL) (Eacham). If (Volume lake >16500000) then (Volume lake - 16500000) else (3000). Provides for an arbitrary, constant, loss of 3000kL $month^{-1}$ (i.e.15% of total volume) except when the volume is unusually high, namely >16500000kL i.e. 201200 kL (1.2%) more than its initial value), in which case the excess is assumed to be lost through high-level seepage not usually accessible. The high volume cut-off point is selected so as to optimise the fit with measured lake levels .

Comparisons and validation

The lake volumes for each month of the period January 1980 to December 1988 were converted to water levels by assuming a linear relationship between volume and depth over the uppermost 5 m of each lake. The Eacham levels were then re-scaled by subtracting 40cm so as to make them more readily comparable with the Barrine values; effectively both were zeroed on the Barrine overflow threshold.

Actual water levels at Eacham were measured on a fixed staff at 2- to 6-day intervals from November 1982 to May 1987. The last of these for each month was adjusted by the addition of 60 cm from June 84 onwards to correct a systematic observer error, then by the addition of 90 cm throughout so as to approximate more closely the model numbers (effectively compensating for the submerged section of the staff) and finally made comparable with Barrine model levels by subtracting 40 cm as for the Eacham model results. See the main text (Fig. 5, 6) for the results.

Table A3. Differences between (a) observed rainfalls at Eacham and Peeramon (Each - Peer), (b) observed and estimated rainfalls at Eacham (Each - EEst) and (c) observed and estimated rainfalls at Barrine (Bar - BEst).

Eacham

Year	January Each-Peer (%Each)	January Each-EEst (%Each)	February Each-Peer (%Each)	February Each-EEst (%Each)	March Each-Peer (%Each)	March Each-EEst (%Each)	April Each-Peer (%Each)	April Each-EEst (%Each)
1983							-29	-29
1984	-9	-14	4	7	4	10	-39	-48
1985	-21	-3			-38	-37	-9	-5
1986	-8	-9	-29	-32	1	4	23	25
1987							63	43

Year	May Each-Peer (%Each)	May Each-EEst (%Each)	June Each-Peer (%Each)	June Each-EEst (%Each)	July Each-Peer (%Each)	July Each-EEst (%Each)	August Each-Peer (%Each)	August Each-EEst (%Each)
1983	-28	-6	-57	-61	27	23	-10	0
1986	16	19	19	29	25	38	-52	-46
1987		-76						

Year	September Each-Peer (%Each)	September Each-EEst (%Each)	October Each-Peer (%Each)	October Each-EEst (%Each)	November Each-Peer (%Each)	November Each-EEst (%Each)	December Each-Peer (%Each)	December Each-EEst (%Each)
1983	-33	-17	19	20	28	25		
1986	-23	-17	-10	-2	-23	20	-6	49

Barrine

Year	January Bar-BEst (mm)	January Bar-BEst (%Bar)	February Bar-BEst (mm)	February Bar-BEst (%Bar)	March Bar-BEst (mm)	March Bar-BEst (%Bar)	April Bar-BEst (mm)	April Bar-BEst (%Bar)
1987	-23	-35	84	37	12	10	74	29

Year	May Bar-BEst (mm)	May Bar-BEst (%Bar)	June Bar-BEst (mm)	June Bar-BEst (%Bar)	July Bar-BEst (mm)	July Bar-BEst (%Bar)	August Bar-BEst (mm)	August Bar-BEst (%Bar)
1987	-75	-1500	48	37	4	9	-6	-43

Table A4. Average monthly temperature differences between Atherton and Kairi for the years 1979 to 1988.
Positive values indicate that Atherton was the greater.

Year	Month	Relative air temp	Lake temp cycle stage	Water - air temp (^{O}C)	Relative wind run	Kairi pan evapn (mm)	Correction factor	Estimated lake evapn (mm)
1986	Mar	1.0	falling	3.5	1.1	147	0.60	88
1984	Jul	0.8	minimun	4.5	0.8	96	0.63	60
1985	Sep	0.9	rising	7.0	1.1	158	0.65	103
1982	Aug	0.7	minimun	4.2	1.8	86	0.68	58
1987	Dec	1.3	maximum	0.9	0.9	189	0.68	129
1983	Apr	1.0	falling	2.5	1.0	111	0.70	78
1983	Oct	1.1	rising	5.4	1.1	180	0.75	135
1985	Mar	1.0	maximum	3.7	0.6	120	0.75	90

Table A5. Examples of the derivation of lake evaporation estimates arranged in order of increasing resultant "correction factor"

Year	Month	Relative air temp	Lake temp cycle stage	Water - air temp (^{O}C)	Relative wind run	Kairi pan evapn (mm)	Correction factor	Estimated lake evapn (mm)
1986	Mar	1.0	falling	3.5	1.1	147	0.60	88
1984	Jul	0.8	minimun	4.5	0.8	96	0.63	60
1985	Sep	0.9	rising	7.0	1.1	158	0.65	103
1982	Aug	0.7	minimun	4.2	1.8	86	0.68	58
1987	Dec	1.3	maximum	0.9	0.9	189	0.68	129
1983	Apr	1.0	falling	2.5	1.0	111	0.70	78
1983	Oct	1.1	rising	5.4	1.1	180	0.75	135
1985	Mar	1.0	maximum	3.7	0.6	120	0.75	90

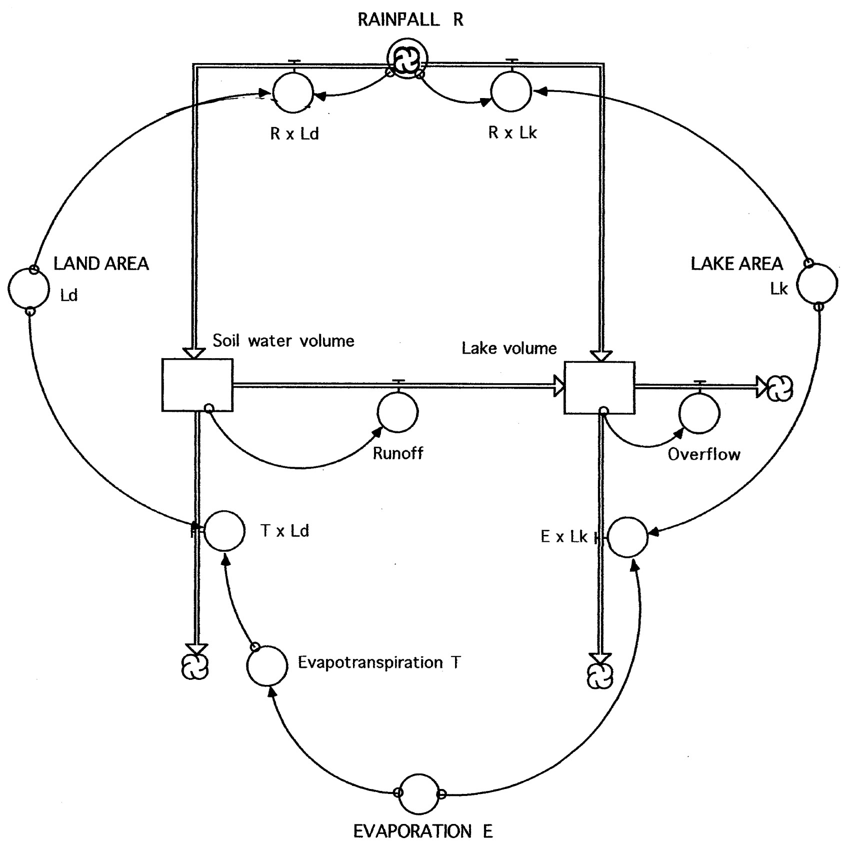

Fig. B1.

1929 to 1980 (Barrine)

Lack of some meteorological data prevented the exact extension of the 1980-88 model to the longer period. Monthly rainfall at Barrine was estimated, as for the shorter period, by inspection of records from nearby stations some of which, however, did not operate over the whole long period. Temperature at Barrine was also estimated as for the shorter period.

For want of wind run data from Atherton before 1980 and of pan evaporation from Kairi before 1965, evaporation at Barrine for 1965 to 1980 was estimated from a regression between estimated evaporation and estimated air temperature there for 1980 to 1988; for 1929 to 1964 the mean monthly estimated evaporations for 1965 to 1988 were used. Neither of these methods is accurate; the regression attains an R^2 of only 0.47 and a comparison of the means with the actual data from which they were derived indicates that a mis-match of $\pm$10% is common although it is only occasionally greater.

The model was initialised with the same values as for the 1980-88 period; in particular the lake was assumed to be full to overflow threshold at January 1929 following recorded high rainfall in the previous two months. The resulting modelled estimate of the January 1980 volume was 0.7% greater than the lake-full volume used for the 1980-88 model input. The average difference between the outputs of this model extended to 1988 and those of the 1980 to 1988 model for their 108 months in common, was 0.02% between extremes of +3.0% and -1.7% of the 1980-88 model results (Pearson's r (lag 0) = 0.98 ± 0.10(SE)).

Appendix C. Additional water chemistry.

Table C1 is the full data set from which Table 4 is drawn.

Table C1. Additional comparisons between partial chemical compositions of water at the centres of Lakes Barrine and Eacham at various statges of thermal stratification.
Chemical concentrations are in mgL^{-1}. Entries in italic are not level-for-level comparisons but illustrate the further development of the variables in the deeper water at Barrine. For analytical methods see Table 2.

Level / Lake	Thermal stratificn	Date	Depth (m)	Temp (^{O}C)	Eh (mV)	O_2 in solutn	Ca	Mg	Na	K	HCO_3	SO_4	Cl	SiO_2 react	Fe tot
Epilimnion															
Barrine		15-Oct-79	10				6.7	2.5	4.5	0.7	41	1.6	3.6	2.1	0.2
Eacham		15-Oct-79	10				2.7	2.2	3.1	0.5	27	1.2	3.3	1.5	0.1
Barrine	(unstrat, no	20-Aug-87	25	20.6		11.8	5.7	2.7	4.3	1.3	29	1.0	7.8	2.0	0.2
Eacham	deep mix)	20-Aug-87	20	20.7	425	11.2	3.3	2.3	2.6	1.0	16	1.5	6.9	1.0	0.2
Barrine	v early strat	7-Sep-87	25	20.7		11.4	5.7	2.6	4.2	1.2	29	1.2	7.8	1.0	0.2
Eacham	v early strat	7-Sep-87	20	21	363	11.4	3.3	2.4	2.6	1.0	16	1.8	7.0	1.0	0.3
Hypolimnion															
Barrine		15-Oct-79	40				6.7	2.4	4.4	0.7	38	2.0	3.8	3.0	0.2
Eacham		15-Oct-79	40				2.7	2.2	3.1	0.6	25	1.3	3.4	2.4	0.1
Barrine	stratified	4-May-83	50	19	554	0.6	6.4	2.0	4.1	0.9	29	1.0	7.0	3.5	0.1
Eacham	stratified	5-May-83	50	19	664	0.2	3.9	1.5	nd	nd	18	1.0		2.0	0.0
Barrine	(unstrat, no	20-Aug-87	40	19.6		0.4	5.7	2.6	4.2	1.3	39	1.0	7.8	4.0	0.4
Eacham	deep mix)	20-Aug-87	40	20.3	422	0	3.3	2.4	2.6	1.0	16	1.5	7.0	2.0	0.3
Barrine	v early strat	7-Sep-87	40	20		1.2	5.7	2.6	4.2	1.2	29	1.5	7.9	2.0	0.2
Eacham	v early strat	7-Sep-87	40	20.3	377	0.6	3.3	2.4	2.6	1.0	15	1.5	7.1	2.0	0.3
Bottom water															
Barrine	stratified	4-May-83	60	19	544	0.4	6.4	1.9	4.1	0.9	29	1.3	7.0	3.5	0.2
Eacham	stratified	5-May-83	60	19	434	0.4	4.0	1.5	3.0	0.7	18	1.0	4.0	1.5	0.0
Barrine	*stratified*	*4-May-83*	*62*	*19*	*399*	*0*	*6.5*	*2.1*	*4.1*	*0.9*	*31*	*1.2*	*7.0*	*4.0*	*0.2*
Barrine	*stratified*	*4-May-83*	*64*	*19*	*269*	*0*	*7.0*	*1.8*	*4.2*	*1.0*	*34*	*1.8*	*7.5*	*6.0*	*>6.0*
Barrine	*stratified*	*4-May-83*	*66*	*19*	*174*	*0*	*6.9*	*1.6*	*4.8*	*1.0*	*39*	*1.5*	*9.8*	*23.0*	*>29.2*
Eacham	stratified	18-Nov-86	62.5	20.2	126	0	3.5	2.1	2.6	0.4	18	2.0	4.5	3.0	1.0
Barrine	*stratified*	*11-Nov-86*	*64*	*19.5*	*109*	*0*	*4.4*	*1.5*	*2.4*	*0.6*	*19*	*1.5*	*4.6*	*5.0*	*1.3*
Barrine	*stratified*	*11-Nov-86*	*66*	*19.5*	*116*	*0*	*6.0*	*2.6*	*4.1*	*1.1*	*26*	*2.5*	*8.4*	*5.0*	*2.5*
Barrine	(unstrat, no	20-Aug-87	60	19.7		0	5.8	2.7	4.2	1.2	30	1.5	7.9	2.0	1.8

Eacham	deep mix)	20-Aug-87	60	19.9	180	0.4	3.3	2.4	2.6	1.0	17	1.5	7.0	1.0	0.3
Barrine	(unstrat, no	20-Aug-87	62	19.6		0	5.8	2.6	4.2	1.2	29	1.0	8.0	2.0	3.5
Eacham	deep mix)	20-Aug-87	62	19.9	172	0.4	3.4	2.4	2.6	1.0	16	1.0	7.0	2.0	0.5
Eacham		20-Aug-87	62.5	20.2	126	0	3.5	2.1	2.6	0.4	18	2.0	4.5	3.0	1.0
Barrine	*(unstrat, no*	*20-Aug-87*	*64*	*19.6*		*0*	*5.9*	*2.6*	*4.2*	*1.2*	*29*	*1.8*	*7.8*	*4.0*	*3.4*
Barrine	*deep mix)*	*20-Aug-87*	*66*	*19.6*		*0*	*6.0*	*2.6*	*4.2*	*1.2*	*29*	*2.5*	*7.9*	*5.0*	*5.5*
Barrine	v early strat	7-Sep-87	60	19.8		0.2	5.9	2.7	4.2	1.2	30	1.3	7.9	2.0	0.5
Eacham	v early strat	7-Sep-87	60	19.6	155	0	3.3	2.4	2.6	1.0	17	1.5	7.0	1.0	0.3
Barrine	*v early strat*	*7-Sep-87*	*62*	*19.8*		*0.2*	*5.7*	*2.6*	*4.2*	*1.3*	*29*	*1.5*	*7.8*	*1.0*	*0.5*
Eacham	*v early strat*	*7-Sep-87*	*62*	*19.6*	*155*	*0*	*3.3*	*2.5*	*2.6*	*1.0*	*16*	*2.0*	*7.0*	*2.0*	*0.6*
Barrine	v early strat	7-Sep-87	64	19.8		0.6	5.5	2.8	4.2	1.2	29	3.0	7.7	2.0	2.8
Barrine	v early strat	7-Sep-87	66	19.6		0	5.7	2.6	4.2	1.2	30	3.0	7.8	2.0	10.5
Barrine	v early strat	23-Sep-85	62	19.2	433	0.4	5.8	3.0	4.3	1.2	30.0	3.5	7.0	4.0	0.4
Eacham	v early strat	30-Sep-85	62	19.1	369	0.4	2.0	2.6	1.7	0.7	16	2.0	3.7	2.0	0.2
Barrine	*v early strat*	*23-Sep-85*	*64*	*19.2*	*425*	*1.6*	*5.7*	*3.1*	*4.3*	*1.2*	*30.0*	*3.5*	*6.9*	*4.0*	*0.5*
Barrine	*v early strat*	*23-Sep-85*	*65.5*	*19.5*	*419*	*1.2*	*5.6*	*3.3*	*4.3*	*1.2*	*30.0*	*3.5*	*7.0*	*4.0*	*0.5*
Barrine	(unstrat, no	15-Aug-88	60	19.7	225	0.2	5.9	3.0	4.3	1.3	32.0	3.5	6.8	3.5	0.8
Eacham	deep mix)	16-Aug-88	60	19.6	212	0.6	2.4	3.2	2.7	1.2	22	2.0	5.3	2.0	0.7
Barrine	(unstrat, no	15-Aug-88	62	19.7	204	0.2	5.9	3.0	4.3	1.3	31.0	3.0	6.9	3.5	1.6
Eacham	deep mix)	16-Aug-88	62	19.7	198	0.4	2.3	3.1	2.7	1.2	24	2.5	5.3	2.5	0.7
Barrine	*(unstrat, no*	*15-Aug-88*	*64*	*19.7*	*187*	*0*	*5.8*	*3.2*	*4.3*	*1.3*	*30.0*	*3.0*	*6.9*	*3.0*	*1.2*
Barrine	*deep mix)*	*15-Aug-88*	*66*	*20.0*	*199*	*o.2*	*5.9*	*3.3*	*4.3*	*1.3*	*31,0*	*4.5*	*6.9*	*4.0*	*2.o*