

Appendix C – CLIMATIC DATA

C.1 Introduction

Climate has an obvious effect on the design and performance of farm dams. The main parameters are daily rainfall, rainfall intensity and evaporation.

This section illustrates the data that is available. The Bundaberg region is used as an example but similar data can be sourced for other sugar growing areas.

C.2 Long-term Rainfall Data

Long-term rainfall data is available from various source. The RainMan software package is useful in calculating statistic probabilities of rainfall occurrence. As an example, Tables C-1 and C-2 give long-term monthly rainfall data for Bundaberg and Childers. Figures C-1 and C-2 shows the same data graphically.

C.3 Rainfall Intensity

Rainfall intensity data is needed to design farm dams, bywashes and other structures which convey storm runoff. Storms last for different durations. Larger storms occur less frequently. For each storm, the rainfall intensity can be expressed as an average rate (mm/hr) throughout the storm. Hence, this data is expressed in intensity-frequency-duration (IFD) tables and graphs.

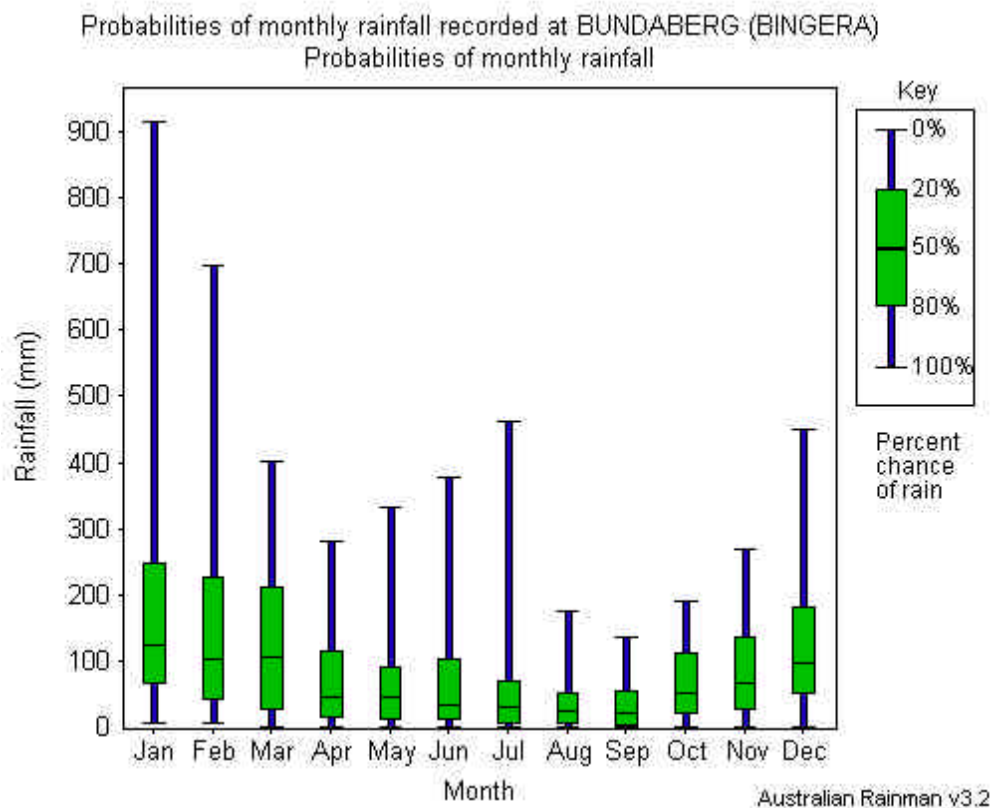
Table Table C-3 and Table C-4 give IFD data that has been calculated for Bundaberg and Childers. For Bundaberg, this data suggests that a 1-in-20 year storm that lasts for 2 hours would have an average intensity of 46.95 mm/hr. The total rainfall would be 94 mm.

TABLE C-1 – MONTHLY RAINFALL PROBABILITIES FOR BUNDABERG (BINGERA)

Probabilities of monthly rainfall recorded at BUNDABERG (BINGERA)
 Amounts of rain (mm) received or exceeded in 100%, 90% ... 0% of years.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lowest on record	4	3	2	0	0	0	0	0	0	1	2	0	340
90% years at least	45	22	22	12	13	4	3	3	1	12	14	32	689
80% years at least	70	47	38	24	17	10	8	9	5	20	27	50	774
70% years at least	92	71	56	35	29	18	16	13	9	31	37	64	918
60% years at least	118	99	83	45	42	28	21	19	16	40	50	78	973
median, 50% years	140	124	107	55	52	36	27	25	25	48	67	97	1045
40%years at least	176	156	137	73	71	44	40	31	36	61	88	131	1171
30% years at least	212	202	181	101	96	67	51	40	46	73	104	158	1259
20% years at least	276	255	231	141	114	94	74	54	60	95	136	195	1431
10% years at least	452	431	300	183	160	152	120	76	93	142	169	260	1623
Highest on record	1162	816	519	346	397	499	466	142	277	281	354	490	2362
Mean	195	172	136	82	73	62	51	33	37	63	84	127	1117
Standard Deviation	178	156	109	74	67	78	69	30	41	53	68	97	369

Clewett *et al.* (1999)



Clewett *et al.* (1999)

FIGURE C-1– MONTHLY RAINFALL PROBABILITIES FOR BUNDABERG (BINGERA)

TABLE C-2 - MONTHLY RAINFALL PROBABILITIES FOR CHILDERS

Probabilities of monthly rainfall recorded at CHILDERS POST OFFICE
 Amounts of rain (mm) received or exceeded in 100%, 90% ... 0% of years.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lowest on record	5	6	4	0	0	0	0	0	0	3	0	6	448
90% years at least	45	38	18	10	10	3	3	3	2	13	23	36	646
80% years at least	69	54	32	24	16	11	8	7	8	26	34	55	770
70% years at least	89	83	53	31	24	18	15	15	14	34	46	68	875
60% years at least	114	103	72	40	38	27	26	21	20	47	57	99	981
median, 50% years	134	120	96	55	51	34	31	27	29	58	78	111	1028
40%years at least	156	149	119	71	64	41	38	30	40	75	92	127	1116
30% years at least	191	179	163	87	72	59	48	40	49	89	111	172	1201
20% years at least	233	258	204	103	92	99	73	51	66	120	134	206	1332
10% years at least	364	363	311	168	133	124	104	68	82	140	167	264	1502
Highest on record	731	751	779	293	340	246	380	171	262	236	286	538	1914
Mean	170	165	130	72	61	53	47	33	38	70	86	139	1064
Standard Deviation	132	139	126	63	54	54	58	30	38	51	58	107	315

Clewett *et al.* (1999)

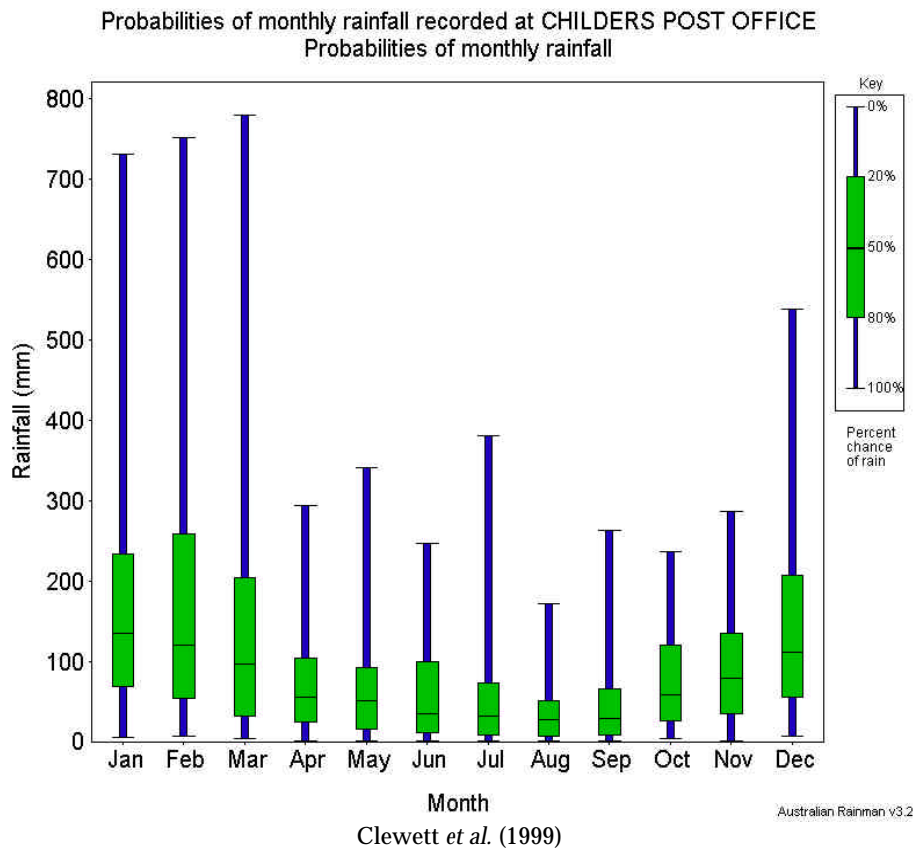


FIGURE C-2- MONTHLY RAINFALL PROBABILITIES FOR CHILDERS

TABLE C-3 - INTENSITY-FREQUENCY-DURATION DATA FOR BUNDABERG

Rainfall Intensity (mm/h) for Bundaberg

Duration	Average Storm Recurrence Interval (years)						
	1	2	5	10	20	50	100
5m	112.73	144.46	182.51	203.60	233.83	274.19	305.53
6	105.83	135.56	171.08	190.73	218.93	256.58	285.78
7	100.07	128.12	161.53	179.99	206.52	241.90	269.34
8	95.14	121.77	153.39	170.83	195.93	229.39	255.33
9	90.85	116.24	146.31	162.88	186.74	218.53	243.18
10	87.07	111.37	140.07	155.87	178.65	208.98	232.49
11	83.70	107.03	134.52	149.64	171.45	200.49	222.98
12	80.67	103.13	129.54	144.05	164.99	192.87	214.46
13	77.92	99.60	125.03	138.98	159.14	185.98	206.75
14	75.42	96.38	120.92	134.37	153.82	179.71	199.74
15	73.13	93.43	117.15	130.15	148.95	173.96	193.32
16	71.02	90.71	113.68	126.26	144.47	168.68	187.41
17	69.06	88.20	110.48	122.67	140.32	163.80	181.96
18	67.24	85.86	107.50	119.33	136.48	159.27	176.90
20	63.96	81.65	102.13	113.32	129.55	151.12	167.79
25	57.35	73.14	91.32	101.22	115.62	134.73	149.49
30	52.28	66.64	83.07	91.99	105.00	122.25	135.56
35	48.25	61.47	76.51	84.67	96.58	112.36	124.53
40	44.95	57.23	71.15	78.68	89.69	104.29	115.53
45	42.18	53.68	66.66	73.67	83.94	97.54	108.02
50	39.82	50.66	62.84	69.41	79.05	91.81	101.63
55	37.77	48.04	59.54	65.73	74.83	86.86	96.13
60	35.98	45.75	56.65	62.52	71.14	82.54	91.32
75	31.15	39.68	49.40	54.66	62.36	72.55	80.42
90	27.63	35.26	44.09	48.91	55.90	65.19	72.37
2.0h	22.82	29.21	36.77	40.94	46.95	54.95	61.15
3.0	17.38	22.32	28.39	31.78	36.61	43.07	48.10
4.0	14.31	18.43	23.61	26.53	30.66	36.21	40.54
5.0	12.31	15.89	20.46	23.06	26.72	31.64	35.50
6.0	10.88	14.08	18.21	20.57	23.88	28.35	31.86
8.0	8.97	11.63	15.15	17.18	20.01	23.85	26.86
10.0	7.72	10.03	13.14	14.95	17.45	20.86	23.54
12.0	6.83	8.89	11.70	13.34	15.61	18.70	21.14
14.0	6.16	8.04	10.69	12.25	14.40	17.35	19.68
16.0	5.62	7.37	9.88	11.38	13.43	16.25	18.50
18.0	5.19	6.82	9.22	10.66	12.63	15.34	17.51
20.0	4.83	6.37	8.66	10.06	11.95	14.57	16.67
22.0	4.52	5.98	8.18	9.53	11.36	13.90	15.94
24.0	4.26	5.64	7.77	9.08	10.85	13.31	15.29
36.0	3.20	4.28	6.06	7.19	8.70	10.83	12.57
48.0	2.59	3.49	5.04	6.04	7.38	9.29	10.86
60.0	2.17	2.95	4.33	5.25	6.46	8.20	9.65
72.0	1.87	2.56	3.81	4.65	5.76	7.37	8.72

TABLE C-4 - INTENSITY-FREQUENCY-DURATION DATA FOR CHILDERS

Rainfall Intensity (mm/h) for Childers

Duration	Average Storm Recurrence Interval (years)						
	1	2	5	10	20	50	100
5m	110.31	142.11	181.55	204.03	235.97	279.15	313.07
6	103.52	133.34	170.27	191.31	221.21	261.63	293.37
7	97.85	126.01	160.85	180.69	208.90	247.02	276.94
8	93.00	119.75	152.81	171.62	198.38	234.54	262.92
9	88.78	114.31	145.82	163.74	189.24	223.70	250.73
10	85.07	109.51	139.66	156.80	181.19	214.15	240.01
11	81.76	105.24	134.17	150.62	174.03	205.65	230.46
12	78.78	101.40	129.24	145.06	167.59	198.02	221.88
13	76.09	97.92	124.78	140.04	161.76	191.11	214.12
14	73.63	94.75	120.71	135.45	156.46	184.81	207.05
15	71.38	91.84	116.98	131.26	151.59	179.05	200.58
16	69.30	89.17	113.55	127.39	147.11	173.74	194.62
17	67.38	86.69	110.37	123.82	142.97	168.83	189.11
18	65.60	84.39	107.43	120.50	139.13	164.27	183.99
20	62.38	80.24	102.11	114.51	132.20	156.06	174.77
25	55.89	71.87	91.39	102.45	118.23	139.51	156.20
30	50.93	65.47	83.20	93.23	107.56	126.89	142.02
35	46.98	60.38	76.69	85.91	99.09	116.85	130.77
40	43.74	56.21	71.36	79.92	92.16	108.65	121.57
45	41.03	52.72	66.90	74.90	86.36	101.79	113.87
50	38.72	49.74	63.09	70.63	81.42	95.94	107.32
55	36.72	47.17	59.81	66.94	77.15	90.90	101.66
60	34.97	44.92	56.93	63.71	73.41	86.48	96.71
75	30.17	38.82	49.42	55.44	64.01	75.59	84.66
90	26.70	34.39	43.95	49.40	57.14	67.60	75.82
2.0h	21.95	28.35	36.44	41.09	47.65	56.56	63.57
3.0	16.61	21.52	27.89	31.60	36.79	43.86	49.45
4.0	13.62	17.68	23.06	26.20	30.59	36.59	41.35
5.0	11.67	15.18	19.89	22.66	26.52	31.79	35.99
6.0	10.29	13.41	17.63	20.13	23.59	28.35	32.13
8.0	8.44	11.03	14.58	16.70	19.63	23.67	26.88
10.0	7.24	9.48	12.59	14.46	17.03	20.58	23.42
12.0	6.39	8.37	11.17	12.85	15.16	18.36	20.92
14.0	5.79	7.60	10.18	11.74	13.88	16.85	19.23
16.0	5.31	6.98	9.39	10.86	12.86	15.64	17.88
18.0	4.92	6.48	8.75	10.13	12.02	14.65	16.76
20.0	4.60	6.06	8.20	9.52	11.31	13.81	15.82
22.0	4.32	5.70	7.74	8.99	10.70	13.08	15.00
24.0	4.08	5.39	7.34	8.54	10.17	12.45	14.29
36.0	3.11	4.12	5.69	6.66	7.98	9.84	11.35
48.0	2.54	3.38	4.71	5.54	6.67	8.26	9.56
60.0	2.16	2.88	4.03	4.77	5.76	7.16	8.31
72.0	1.87	2.51	3.54	4.20	5.08	6.34	7.38

C.4 Pan Evaporation

Although there are other calculations such as the Penman formula, evaporation is usually determined from water loss measurements from an open pan. In Australia, the Class 'A' pan is the standard. Table C-5 shows the daily pan evaporation losses for the Bundaberg region (Donnollan *et al.*, 1998, p4).

TABLE C-5 – PAN EVAPORATION DATA FOR BUNDABERG POST OFFICE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pan Evaporation (mm/day)	6.0	5.5	4.5	3.6	3.0	2.8	3.0	3.6	4.2	4.6	5.1	5.7

C.5 Net Open Water Evaporation

The net open water evaporation is the total amount of water lost due to evaporation after taking into account mean rainfall, and the surface conditions of open water storages. Open water bodies generally lose less water than evaporation pans, therefore a pan coefficient is applied to the pan evaporation value to account for this. For the Bundaberg area, a pan coefficient of 0.8 is applicable. Table C-6 shows the monthly net open water evaporation for the Bundaberg region. The total value in the bottom right cell indicates that less than 100 mm is lost to evaporation in a mean year.

TABLE C-6 – NET OPEN WATER EVAPORATION

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pan Evaporation, Ep (mm)	164	129	121	102	90	84	96	115	126	143	153	164	1487
Open Water Evaporation, Eo (mm)	131	103	97	82	72	67	77	92	101	114	122	131	1189
Mean rainfall, R (mm)	195	172	136	82	73	62	51	33	37	63	84	127	1115
Net Evaporation, En (mm)	-64	-69	-39	0	-1	5	26	59	64	51	38	4	74

Eo = Ep x pan coefficient (0.8 for Bundaberg)

En = Eo - R

C.6 References

Clewett, JF, Smith PG, Partridge, IJ, George, DA, and Peacock A. 1999. *Australian Rainman Version 3.2: An integrated software package of Rainfall Information for Better Management*. Q198071. Department of Primary Industries. Queensland

Donnollan, TE, Wilson, PR, Zund, PR, and Irvine SA. 1998. *Land Resource Bulletin: Soils and Irrigated Land Suitability of the Bundaberg Area, South East Queensland*. Department of Natural Resources. Queensland.