551. 582 (94-15) : 551. 579. 5

CLIMATE OF THE WINCHESTER AREA, WESTERN AUSTRALIA, WITH PARTICULAR REFERENCE TO SOIL MOISTURE

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(Revised Manuscript received March 1964)

Abstract: Average annual rainfall over the area is very close to fifteen inches, twelve of which fall during the six months April to September. In about seventy five per cent of years annual totals fall between ten and twenty inches.

Mean maximum temperature exceeds ninety degrees Fahrenheit from December to February and evaporation from the Australian Standard tank exceeds ten inches in each of these months.

Under normal rainfall conditions it is only during June and July that water storage below the water table will be replenished. Where wheat is grown on sandy soil it is estimated that two inches of water would pass through the root zone during these months.

1. INTRODUCTION

Location: An aquifer is situated about one and half to two miles east of Winchester on a block shown as Location No. M1309 on Taxation Litho. 95/80. It is in gently undulating, typical sand plain country, and over most of the catchment yellow sand overlies clay to depths varying from 0 to between 20 and 30 feet. West of the catchment there is a small amount of laterite and broken granite country, while north of it and very slightly lower is another clay catchment from which salt water might possibly overflow into the fresh water aquifer. On both of these catchments are salt lakes, which are normally dry in summer and may contain a few inches of water in winter. Their elevation is approximately 750 feet above mean sea level.

The catchment is very roughly a saucer-shaped depression, the higher country on the east being about 50 feet above the salt lake at the lowest point. The area of the catchment is about 250 acres and the area containing underground water about 130 acres. About 95 per cent of the catchment is cleared and is usually used for pasture or wheat growing.

2. AVAILABILITY OF DATA

Rainfall is recorded at the Winchester Post Office and two other good records are available within a radius of 10 miles. These are for Carnamah, 6 miles further northwest along the Geraldton Highway, and Coorow 10 miles southeast of Winchester on the same Highway (see Fig. 1).

In addition to rainfall, temperature observations are available from Carnamah.

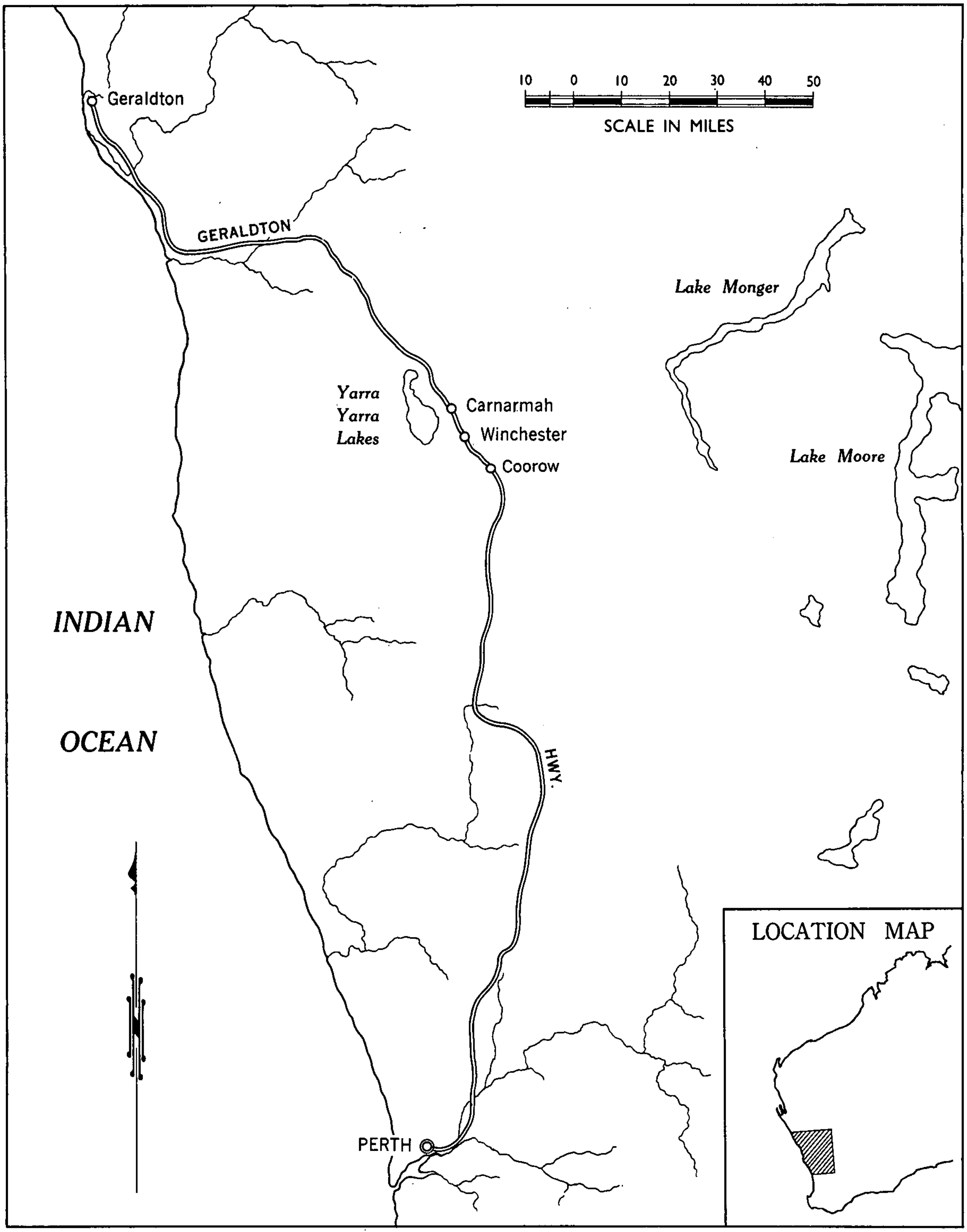

Fig. 1 Location of stations

3. DISCUSSION OF DATA

(a) Average Rainfall

Average rainfalls for Winchester, Carnamah and Coorow are shown in Table 1, the period over which the averages are calculated being listed in the first column of the table. For Winchester annual totals for eight years during this period were incomplete, but all available monthly totals were used for the computation of monthly averages.

Table 1. Average Rainfall (in points)

	No. of years	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yr.
Winchester	46	41	47	88	113	193	311	271	218	101	55	38	20	1496
Carnamah	73	42	54	84	85	201	312	283	219	116	68	42	35	1541
Coorow	49	45	53	81	97	188	320	284	218	112	73	37	35	1543

(b) Distribution of Monthly and Annual Rainfall Totals

Although average monthly rainfall during the dry part of the year is in the vicinity of half an inch, the median figure is much lower and is closer to 10 points from November to February inclusive. In October the median figure is higher, but totals below half an inch are twice as frequent as those exceeding this figure.

Table 2. Percentage Frequency of Monthly Rainfall Totals, Winchester

Rainfall Range (pts.)	Jan. %	Feb. %	Mar. %	Apr. %	May %	June %	July %	Aug. %	Sept. %	Oct. %	Nov. %	Dec. %
0	42	45	20	8	5	0	0	0	0	16	26	31
1-10	8	8	5	11	0	0	0	0	5	3	21	19
11-50	26	18	28	24	5	2	0	7	20	49	26	44
51-100	13	13	21	21	20	0	7	10	38	13	15	0
101-200	8	11	13	18	35	32	23	37	25	11	9	6
201-300	0	0	5	8	23	20	43	25	7	8	3	0
301-500	3	5	8	5	8	37	18	17	5	0	0	0
501-700	0	0	0	5	2	5	7	2	0	0	0	0
701-800	0	0	0	0	2	2	2	2	0	0	0	0
801-900	0	0	0	0	0	2	0	0	0	0	0	0

The frequency of monthly totals in various ranges is shown in Table 2. It is seen that in each of the summer months rainfall exceeds one inch approximately once in ten years, but in 50 per cent of these months it is negligible (i.e. less than 10 points). In March, the frequency of negligible rainfall is reduced by half, to about one year in four, while totals exceeding one inch occur with about the same frequency.

From March onward rainfall increases until June, for which the lowest total is 20 points and the highest 806. This total is also the highest recorded in any month at Winchester.

After June rainfall decreases, slowly at first during July and August and then more rapidly, until in November the frequency of negligible rainfall and of totals over one inch is approximately the same as during the summer months.

The frequency of annual totals over a 30 year period is shown in Table 3. The lowest recorded yearly total is 409 points and the highest 2593.

Table 3. Range of Annual Rainfall, Winchester

Range in points	0-499	500-999	1000-1499	1500-1999	2000-2499	2500-2999
Frequency	1	3	12	10	2	2

(c) Temperature

The average maximum temperature in summer is over 90°F and reaches approximately 96°F in January, and hottest month. By mid-winter it has fallen about 30°, and is approximately equal to the mean minimum in mid-summer.

Details of temperature recorded are shown in Table 4.

Table 4. Temperature, Carnamah

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Mean Maximum °F	95. 7	95. 5	89. 4	82. 3	72. 2	67. 2	64. 2	67. 0	71. 6	77. 9	85. 3	90. 8	79. 9
Mean Minimum °F	63. 5	63. 7	60. 5	56. 0	49. 7	47. 3	44. 7	44. 6	45. 5	49. 4	54. 6	59. 2	53. 2
Highest Maximum °F	114. 1	114. 0	111. 0	102. 0	91. 0	82. 0	82. 0	85. 0	95. 1	104. 0	109. 5	111. 0	114. 1
Lowest Minimum °F	49. 0	48. 0	37. 0	35. 0	35. 0	32. 0	33. 0	34. 3	33. 9	34. 0	39. 0	44. 0	32. 0
Mean 3 p. m. Wet Bulb	67. 5	67. 7	66. 4	62. 9	58. 7	56. 6	53. 8	55. 5	56. 5	59. 4	62. 6	65. 9	61. 1
No. of Days 90° and Over	23. 8	22. 2	18. 7	6. 5	0. 0	0. 0	0. 0	0. 0	0. 6	3. 5	8. 8	16. 8	100. 9
No. of Days 100° and Over	12. 2	9. 4	4. 5	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 1	1. 3	5. 9	33. 4
No. of Days 36° and Under	0. 0	0. 0	0. 0	0. 0	0. 1	0. 5	0. 8	0. 8	0. 3	0. 0	0. 0	0. 0	2. 5

(d) Vapour Pressure

Vapour pressure and saturation deficit based on observations made at Carnamah are shown in Table 5. It is seen that both vapour pressure and saturation deficit are highest in summer and lowest in winter, and that the rate of decrease after the summer maximum is greater than the rate of increase after the winter.

Table 5. Average Vapour Pressure and Saturation Deficit, Carnamah (inches of mercury)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Vapour Pressure	1. 02	1. 02	0. 88	0. 71	0. 54	0. 48	0. 43	0. 45	0. 50	0. 59	0. 74	0. 88
Saturation Deficit	0. 64	0. 62	0. 48	0. 34	0. 19	0. 14	0. 12	0. 14	0. 19	0. 29	0. 42	0. 53

(e) Evaporation and Potential Evapo-Transpiration

Evaporation figures have been extracted from the evaporation chart published by the Bureau of Meteorology and are tabulated in Table 6. The figures in the second line of the table have been calculated from a formula relating evaporation from the Australian standard tank to evapotranspiration from field vegetation (Prescott 1949), the value of the index P/E^m being taken as 1.3.

Table 6. Evaporation and Potential Evapo-Transpiration, Carnamah

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Evaporation	12.3	10.4	9.4	6.5	3.3	1.9	1.9	2.9	3.9	6.2	8.9	11.4	79
Potential Evapo-transpiration	8.50	7.51	6.99	5.30	3.18	2.11	2.11	2.89	3.61	5.12	6.70	8.09	62.11

These figures of course would be reached only where adequate supplies of moisture are available and the catchment is vegetated. As a proportion of it will be fallow during the summer months evaporation from this section will be greatly reduced, and will remain so until a crop has germinated and grown to the stage where it can make significant use of the water available. Again, after the crop matures and dies off evapo-transpiration will be greatly reduced. From that part of the catchment under pasture actual evapo-transpiration will also in general be less than the figures quoted, due to lack of continuous adequate water supplies.

(f) Soil Moisture

On the small uncleared portion of the catchment it is probable that very little, if any, of the year's rainfall will pass the root zone if it is distributed reasonably uniformly, as it is only in June and July that rainfall exceeds potential evapo-transpiration. On the other hand, if the rain falls in a few heavy storms, a higher proportion of it may pass into the storage area below the root zone.

On fallow land, under normal rainfall conditions, it is unlikely that there will be any penetration of rainfall below the first foot or so before April or after September (Roberts 1962), but much of the 12 inches falling between these months should eventually find its way to the water table, provided the land remains fallow throughout the year.

On the land under wheat, it is reasonable to assume that a proportion of April, May and June rainfall will pass out of the root zone before the new crop is able to use it, as on the average the season does not break until May, and the crop will be unable to make full use of the available water in its early stages.

Later this position will be reversed. The crop will be able to use more water than is available, and by the end of the season it will probably have cleared out the moisture down to a depth of five feet. Nothing further will pass to the lower moist region until the whole of the root zone is wetted again by the following season's rain.

From the figures quoted in Table 6, it appears likely that very little of the rain falling on a wheat crop after August will reach the water table.

Table 7 gives an indication of the amount of rainfall which might be expected to pass into the water table through a wheat crop, in a year in which the average rainfall was received, spread more or less uniformly through the respective months.

Table 7. Approximate Water Balance for Wheat Crop on fallow

Month	Evapo-Transpiration (points)		Rainfall (points)			
	Potential	Actual	Average	Monthly Surplus (over E-T)	Cumulative Storage (in root zone)	To Water Table
January	850	42	42	0	0	0
February	751	44	44	0	0	0
March	699	41	91	50	50	0
April	530	30	106	76	126	0
May	318	75	175	100	226	0
June	211	150	316	166	226	166
July	211	211	247	36	226	36
August	289	289	214	0	151	0
September	361	253	102	0	0	0
October	512	60	60	0	0	0
November	670	38	38	0	0	0
December	809	21	21	0	0	0
Year	-	1254	1456	-	-	202

It is assumed that all rain falling in January and February will be lost by evaporation. In March 50 points are assumed to be retained in the soil, 41 points being lost in evaporation. In April only 30 points are evaporated, but with the additional transpiration from the newly germinated crop the total water use for May rises to 75 points. By une the crop is assumed to have grown to the stage where it uses 150 points, and by July it is using the full evapo-transpiration listed in Table 6.

By the end of May a surplus of 226 points has accumulated in the soil, and assuming that its moisture capacity is just under half an inch per foot, this will wet it to a depth of five feet, which is assumed to be the depth of the root zone in sand. In June and July surpluses of 166 and 36 points pass beyond the root zone, but in August there is insufficient rain to offset evapo-transpiration and the root zone will commence to dry out. In succeeding months it becomes drier and no further moisture will pass through it until the end of May in the following year, assuming next year's rainfall distribution to be the same.

In practice, rainfall will not be uniformly distributed through the month, and even in those months where it exceeds average potential evapo-transpiration, the full potential evapo-transpiration may sometimes not be used owing to lack of available water at times. Although this uneven distribution of rainfall may lead to a higher proportion of the annual total passing through the root zone, it will nevertheless be a comparatively small proportion of the annual rainfall in normal years. Also, after July the root zone will dry out more slowly than shown in Table 7, available moisture being retained more strongly in the soil as it decreases. The unrestricted transfer of moisture from the root zone as evapo-transpiration is used as an approximation to actual conditions. However, for practical purposes this zone will be completely dry by the end of the year.

In pasture, where the root zone is shallower, water use may be greater earlier in the year but the depth cleared of water at the end of the season will be less than with wheat. The progress of rainfall through it to the water table will be similar to that through a wheat crop, but will depend to some extent on the type of pasture. If it is composed of annuals, the proportion of rainfall passing through it is likely to be higher than through the wheat crop, due to the shallower depth cleared of moisture at the end of each year. If the pasture is perennial, the root zone will be deeper, more use will be made of the early rains and the proportion of rainfall passing through it for storage at a lower level may be even less than through a wheat crop.

In all three cases, fallow, crop and pasture, a similar process takes place, insomuch as the soil is wet to a certain depth in each year's wet season and the top layer is then dried out. If the next season's rainfall is sufficient to link up with the wetter layer left from the preceding year, any surplus will then move downward. By this process the surplus from one year's rainfall may be regarded as being shunted downward by the surplus (if any) from the following year. The increment reaching the storage level in this way will be greatest from fallow land and least from perennial pasture and native vegetation. The cover most favourable for water storage would probably be fallow, annual pastures, wheat crop (on fallow), wheat crop (ley farming), perennial pasture, and native vegetation, in that order.

Roberts (1962) found that under the heavy rainfall conditions of the Perth area only 55 per cent of the annual rainfall penetrated below 4 feet. Drover (1954) found that with a 19 in. rainfall, only 12 per cent penetrated below 2 ft 6 in. in Muresk loam and 22 per cent in Grass Valley sand.

Under the lighter rainfall of the Winchester area a considerable reduction in these figures might be expected, and it is probable that in a normal year little, if any, of the rain falling on perennial pastures of native vegetation would reach the storage area, while the amount passing through a crop would be or the order shown in Table 7.

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