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VARIABILITY OF ANNUAL RAINFALL IN TASMANIA

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(WITH TWO TEXT FIGURES)

ABSTRACT

The distribution of average relative variability of average annual rainfall in Tasmania is determined from computed values and discussed. An evaluation is made of the departure of relative variability in Tasmania from the world mean for the variability of all places with the same average rainfall. It indicates that most of the settled areas exhibit a variability greater than the average for regions with similar average rainfall. A tentative comparison of Tasmania with the British Isles, British Columbia, and the south island of New Zealand suggests that in general the relative variability of annual rainfall in Tasmania is also greater than that experienced in some other regions having similar types of climate.

Previous Studies

Although in the importance of annual rainfall to human activity variability ranks second only to average amount, no detailed study has hitherto appeared of rainfall variability in Tasmania. Several Australian studies have encompassed Tasmania, but these have selected so few Tasmanian stations that little emerges concerning areal differentiation. The earliest and perhaps most frequently cited map is that of Griffith Taylor (1918) : it shows average relative variability over a 20-year period for five Tasmanian stations, all of which are coastal, and represents the entire island as having a mean deviation of less than 20 per cent. This map has been reproduced in later works not only by Taylor (1920, 1940) but also by Wadham and Wood (1950), and has been revised without modification of Tasmania by Leeper (1949). Another much-cited map is that by Barkley (1931), which employs standard deviation instead of mean deviation, making the percentages some 25 per cent greater than Taylor's. Moreover, by using district instead of station records, Barkley tends to underestimate variability, so that in general Taylor's map is preferable (Leeper, 1945). Nevertheless, despite this limitation, Barkley's map has been perhaps the most detailed and significant for Tasmania to date, though it contains substantial inaccuracy, particularly in the Midlands. McBride (1947) has presumably generalized Barkley's map, selecting for Tasmania only the 20 per cent isopleth, but neither the source of her map nor its measure of variability is disclosed. Loewe (1948) has applied Maurer's variability index to Miena and six coastal stations in Tasmania, but his maps of Australia are neither detailed for Tasmania nor readily comprehensible (Longley, 1952). Andrews (1932) in his discussion of rainfall reliability in Australia omits Tasmania altogether.

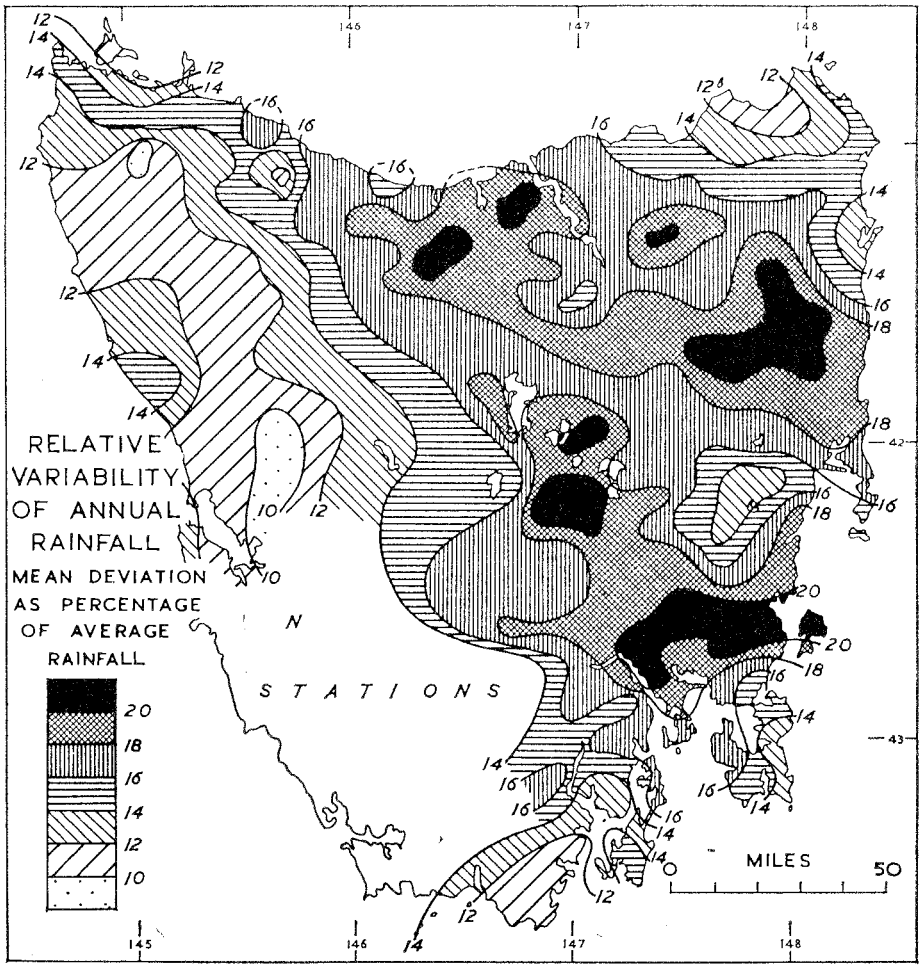

FIG. 1

The Method

The measure used in this study has been average relative variability, defined as the mean deviation expressed as a percentage of the average annual rainfall. This measure is not only simple to calculate and readily comprehensible but owing to its wide application elsewhere it also permits within defined limits comparison between Tasmania and its homoclimes. Conrad (1941) has demonstrated that where the annual rainfall is less than 28 inches—and certainly where it falls below 20 inches—comparisons of average relative variability may be inaccurate and misleading, but he suggests as a solution the representation of anomalies. Conrad established by reference to 360 stations scattered over the world that the relationship between relative variability and annual rainfall approximates to a hyperbolic curve, so that by plotting the actual average relative variabilities

and average rainfalls against the standard curve, anomalies, no longer influenced by the amount, can be calculated. Accordingly, although areas having less than 20 inches cover only small tracts of Tasmania, a map showing isanomals of relative variability of annual rainfall has been constructed. Leeper (1949) has followed the same procedure for Australia but represents Tasmania as having wholly negative anomalies without specifying values. This merely bears out the representation of Tasmania in Conrad's world map of isanomals. It would seem that neither Leeper nor Conrad has evaluated the anomaly of any Tasmanian station. Leeper's map has been re-produced by Wadham and Wood (1950).

The Data

Average relative variability has been calculated for the period from 1910 to 1934 from published yearly rainfall tables (1936). Comparatively few continuous records are available for the years preceding 1910, particularly of the Midlands, the Derwent Valley, the Central Plateau, and the west coast, so that a longer series derived from published data would have produced a less representative distribution of markedly fewer stations. For this reason Hodge (1936) has also used the period 1910-1934 in his study of the variations in annual rainfall for Tasmania and seven divisions of the State. Loewe (1948) has employed a wellnigh comparable 25-year period, 1913-1937, in his evaluation of average and extreme variability indices. It is perhaps noteworthy that for rainfall normals a minimum sample of 25 items is suggested by Conrad and Pollak (1950) as well as by Landsberg and Jacobs (1951). Accordingly, in figure 1 equivariables have been plotted primarily by reference to 71 stations with complete 25-year records, though the mean deviations for 48 stations with shorter records (20 to 24 years) were also plotted to facilitate interpolation and for a further 41 stations as occasional guides. The location of all rainfall stations in Tasmania, including the 160 used in this study, is shown on a map accompanying the yearly rainfall tables. Table 1 gives computed data for 119 stations with records for 20 to 25 years.

Relative Variability

The mean deviation expressed as a percentage of the average rainfall for the period reveals a spatial distribution strikingly different from that of average rainfall (Fig. 1; cf. map of average annual rainfall accompanying the yearly rainfall tables). At the same time, there is a remarkably close correspondence between both the 12 and 16 per cent equivariables of mean deviation and Barkley's respective 15 and 20 per cent equivariables of standard deviation, though this relationship fails to hold for the mean deviation of 20 per cent and the standard deviation of 25 per cent. Whereas in Barkley's map the east-central Midlands have percentages greater than 25 and therefore the highest variability, this region, at least from Oatlands to Swansea, is characterised by comparatively low percentages of mean deviation. Moreover, although in general the familiar principle that the lower the rainfall the greater the variability applies to much of Tasmania, the highest percentages of mean deviation for the standard period occur in the Sheffield area with an average rainfall of 48 inches. Other areas of high variability include the west Tamar, the Fingal valley, and a crescent-shaped area in the

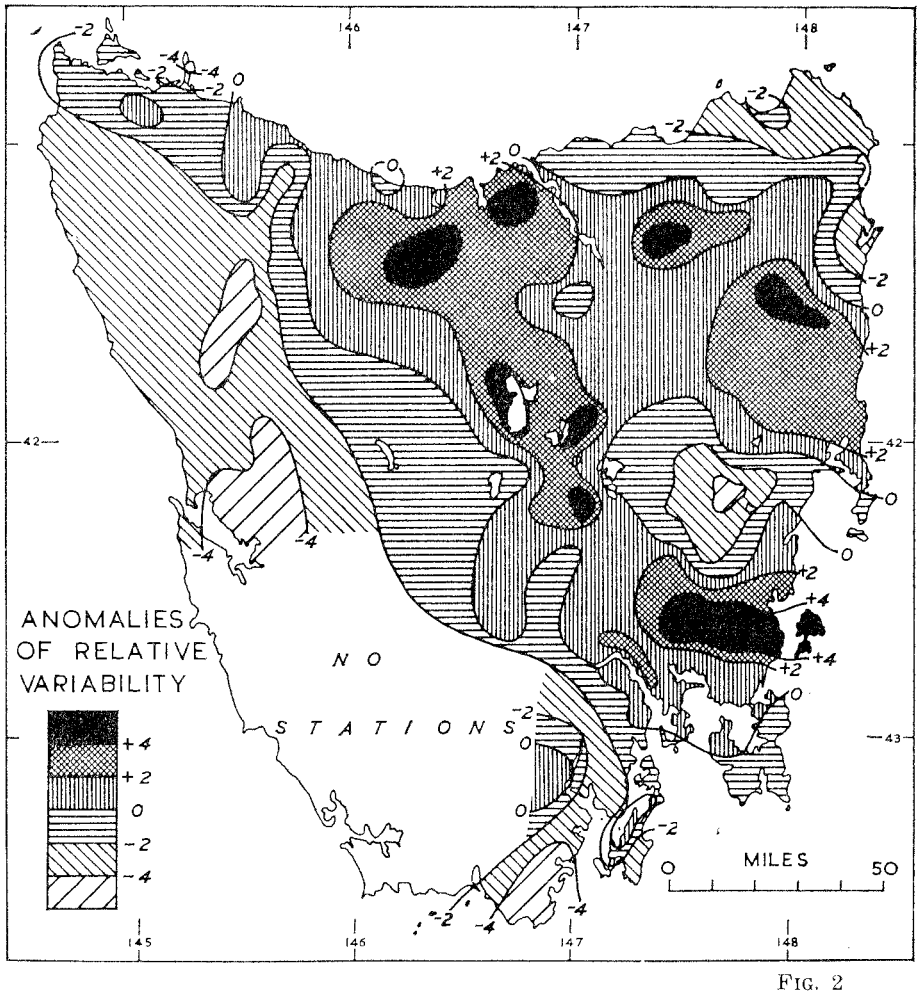

FIG. 2

south-east from Lindisfarne and Cambridge through Campania and Buckland to Orford. To these may be added St. Patrick's River and some eastern areas of the Central Plateau, though here the records are for slightly shorter periods. At the other extreme, the lowest variabilities are virtually confined to the west-coast mining region, where deviations average a little less than 10 per cent.

The general pattern of rainfall variability in Tasmania is attributable to the relative frequency and passage of the main types of depressions and the direction of the accompanying winds in relation to relief. In western Tasmania, where the rainfall is derived mainly from westerly depressions and secondaries, variability is low. But in the east, various other types of depressions bring a substantially higher proportion of the rain: they include not only Southern Ocean depressions intensifying off

the east coast and secondaries developing to the south-east, but also depressions developing in or near Bass Strait or to the east of Tasmania and even depressions of tropical origin. The greater irregularity of these depressions is reflected in the greater variability of rainfall in the east, though the detail of the variability pattern stems largely from the relief. Thus the effect of the occasionally heavy rainfall associated with easterly and south-easterly winds is evidenced by the high variability of the rain-shadow areas of the Buckland basin and the Fingal valley, as well as by the lower variability of the more elevated areas south of Lake Leake. Similarly, both the Sheffield area and the St. Patricks River valley are sheltered not only from the north-westerlies and northerlies, which bring most of the rain to these districts, but also from occasional southerlies and south-easterlies. Finally, the upper reaches of the Ouse and Lake rivers are also local rain-shadow areas, but these are located near the centre of the island and therefore derive their moisture from general rain patterns rather than from stream weather.

The irregularity of south-easterly, rain-bearing winds also accounts for south-eastern Tasmania experiencing the greatest extremes in the standard period. Thus, in the lowest-rainfall year of 1914, Rokeby failed to reach half its average—the only station and the only occasion with a rainfall more than 50 per cent below normal. At the other extreme is the highest-rainfall year of 1916, when Bagdad returned a total amounting to 193 per cent of normal, the greatest excess rainfall recorded in the period. In the same year, many other stations in the south-east, on the Central Plateau, in the Midlands, and on the east coast recorded totals exceeding 150 per cent of normal, notably Richmond with 192 per cent.

An attempt has been made at evaluating the relative variability for Tasmania as a whole by two methods. Hodge (1936) has calculated the yearly rainfall means for seven divisions of the State from the records of "77 representative stations", and then determined the yearly means for the entire State by weighting the divisional means relative to area. His yearly means for Tasmania permit an evaluation of relative variability, though the resultant percentage of 12·7 is, not surprisingly, too low, since district and more especially State averages tend to smooth out local deviations. The second approach involved the measurement of areas between equivariables in figure 1, and by weighting variabilities relative to area, the average relative variability for that portion of Tasmania served by stations was found to be 15·9 per cent. This, however, is too high because it excludes the south-west. If a tentative allowance be made for that region, the average relative variability falls to 15·4.

Anomalies of Variability

In general pattern, the isanomal map showing the extent to which Tasmanian stations depart from the world mean of variability for all places with the same average rainfall confirms the map of relative variability (Fig. 2). Yet it contrasts sharply with the uniform definition of negative anomaly advanced by Conrad and Leeper. Much of the agricultural land in Tasmania experiences a variability greater than the standard world value. Even Scottsdale and Lilydale, though located

near the zero-isanomal, have positive anomalies. In fact, only the far north-west, the far north-east, the central Midlands, and parts of the south-east, exhibit a variability below the world mean. In sum, areas with positive anomalies make up 58 per cent of that portion of Tasmania served by stations or, if negative anomalies be abscribed to the south-west, perhaps 48 per cent of the entire island. However, it should be noted that, aside from Sheffield with its outstanding positive anomaly of 7·3 per cent, the extent of the departure is nowhere very great.

Comparison with Homoclimes

Detailed isanomal maps of regions with Tasmanian homoclimes are not available, but some general comparisons may be made by reference to relative variability. Whereas for most of Tasmania the percentage variability lies between 10 and 22, Glasspoole (1921) has shown that for the British Isles the limits are 6 and 17 and for Ireland alone 6 and 12; the averages for Tasmania, the British Isles and Ireland, calculated by weighting variabilities relative to area, are 15·4, 11 and 9·5 respectively. Seelye (1940) gives the general range for New Zealand as between 10 and 20, but for the south island alone the range is from 8 to 17 and the average—calculated as for Ireland merely from the small-scale published map—12·6. For British Columbia Taylor (1947) gives percentages ranging from 9 to 16 but uses few stations, while Longley (1953) in a detailed application of the coefficient of variation gives a substantially greater range (approximately the equivalent of 10·5 to 27). But any assessment of average variability for so complex a region would seem to require far more stations than even Longley employs, and moreover involves the subjective delimitation of marine west-coast conditions. Since British Columbia is not in any case a very close homoclime, suffice it that the region appears to have a greater range of variability than Tasmania but a comparable average.

One may therefore conclude that the settled areas of Tasmania exhibit a greater variability of annual rainfall than the average for regions with similar average rainfall, and a greater variability than some, if not most, other regions with a similar type of climate.

Acknowledgments

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TABLE I.—Average rainfall, mean deviations of annual rainfall, and anomalies of variability for Tasmanian stations with records for 20 to 25 years, 1910-1934.

Station	Number of years	Average rainfall	Mean deviation	Anomaly
		ins.	%	%
Adventure Bay	24	41·7	12·2	—3·5
Andover	25	23·0	16·5	—1·0
Apsley	20	21·7	18·6	+0·7
Avoca	20	21·5	20·6	+2·6
Bagdad	25	24·4	18·6	+1·3
Beaconsfield	25	29·5	20·6	+4·1
Bellerive	25	22·8	19·1	+1·4
Black River	20	35·2	15·0	—1·1
Boobyalla	20	23·1	18·5	+0·7
Bothwell	25	21·6	17·6	—0·3
Bow Hill	21	25·7	18·8	+1·8
Bradshaw's Creek	25	38·7	15·1	—0·7
Branxholm	24	46·6	14·5	—1·0
Bridport	22	29·9	15·4	—1·1
Broadmarsh	25	22·4	19·5	+1·7
Bronte	24	39·7	15·3	—0·5
Buckland	25	26·0	22·2	+5·3
Burnie	25	39·6	17·0	+1·1
Cambridge	25	20·5	20·1	+1·7
Campbell Town	25	22·2	16·7	—1·1

Station	Number of years	Average rainfall	Mean deviation	Anomaly
		ins.	%	%
Cape Bruni	25	33·3	13·4	—2·8
Cape Grim	25	36·3	14·5	—1·4
Cape Sorell	25	47·4	13·3	—2·1
Carrick	25	27·9	15·9	—0·8
Castra	25	49·3	18·9	+3·5
Caveside	25	40·8	17·8	+2·0
Chain of Lagoons	22	31·7	18·7	+2·4
Cleveland	23	31·8	16·7	+0·4
Cluny	21	22·3	20·6	+2·8
Colebrook	23	24·1	19·5	+2·2
Compton	21	21·5	21·1	+3·1
Cressy	25	25·7	18·4	+1·5
Cullenswood	25	34·6	20·2	+4·1
Currie	25	33·9	13·3	—2·8
Deloraine	23	38·0	19·5	+3·6
Devonport	25	34·7	16·9	+0·8
Eddystone Point	25	30·1	14·3	—2·2
Ellendale	25	35·9	18·9	+2·9
Evandale	25	25·3	19·4	+1·5
Fingal	24	25·9	20·8	+2·4
Frankford	25	42·1	18·1	+2·4
Franklin	24	36·3	15·9	0
Frome Dam	25	44·6	15·5	—0·5
Glenora	25	22·0	16·9	—0·9
Glenorchy	25	26·6	18·5	+1·7
Gould's Country	25	47·8	16·1	+0·7
Gravelly Beach	24	33·7	18·9	+2·8
Hamilton	25	20·8	16·5	—1·9
Hermitage	20	22·2	21·6	+3·8
Hobart	25	26·0	17·3	+0·4
Hythe	25	37·9	10·5	—5·4
Irishtown	25	48·4	15·9	+0·5
Kellevie	23	33·0	17·7	+1·5
Lake Leake	25	31·8	16·4	+0·1
Lake Margaret	22	145·0	9·3	—4·5
Launceston	25	28·7	16·7	+0·1
Lefroy	21	33·0	17·4	+1·3
Lilydale	25	38·9	16·7	—1·1
Lindisfarne	24	19·9	21·6	+2·9
Lisdillon	22	22·8	18·4	+0·7
Lottah	24	69·6	16·5	+1·6
Low Head	25	27·9	16·6	—0·1
Lunnawanna	23	33·0	16·3	+0·1
Maatsuyker Island	25	45·9	14·0	—1·5
Magnet	24	87·3	11·2	—3·4
Marrawah	22	46·6	13·1	—2·4
Mathinna	25	34·5	21·5	+5·4
Miena	22	33·5	22·0	+5·8
Moina	24	70·9	17·9	+3·1
Moorleah	20	47·8	16·6	+1·2
Mount Lyell	25	117·2	9·9	—4·1
Mount Nelson	25	25·8	17·8	+0·9
Mount Seymour	25	24·7	19·8	+2·6
New Norfolk	25	22·0	16·9	—0·9
Northdown	25	31·0	19·2	+2·9
Oatlands	25	23·2	17·7	0
Ormley	25	21·4	20·4	+2·4
Osterley	22	28·8	17·2	+0·6
Port Arthur	25	40·3	14·5	—1·3
Premaydena	24	29·5	16·6	+0·1
Queenstown	25	99·1	10·4	—3·9
Regatta Point	25	65·8	10·8	—4·1

Station	Number of years	Average rainfall	Mean deviation	Anomaly
		ins.	%	%
Renison Bell	23	88·9	10·5	—4·1
Richmond	25	20·7	19·7	+1·4
Ringarooma	25	49·2	17·6	+2·2
Robeville	21	26·5	16·5	+0·3
Rokeby	25	19·7	19·5	+0·8
Rosebery	22	80·8	11·5	—3·2
Ross	25	19·4	16·8	—1·9
Sandford	25	21·9	18·1	+0·3
St. Helens	25	32·0	12·5	—3·8
St. Patrick's River	23	55·9	20·6	+5·4
Scamander	23	26·9	14·9	—1·9
Scottsdale	25	42·6	16·2	+0·5
Sheffield	25	48·7	22·7	+7·3
Sorell	25	21·8	19·3	+1·5
Spreyton	20	37·3	17·2	+1·3
Lovely Banks, Spring Hill	25	20·0	19·5	+0·7
The Springs, Mt. Wellington	25	55·7	14·8	—0·4
Stanley	25	36·9	11·4	—4·5
Steppes	23	28·3	19·4	+2·7
Strahan	22	65·1	11·9	—3·0
Swan Island	25	24·5	14·5	—2·7
Swansea	25	23·4	15·7	—1·9
Tower Hill	25	35·6	19·5	+3·5
Triabunna	25	27·0	19·9	+3·1
Tyenna	23	43·0	12·7	—2·9
Ulverstone	23	37·9	15·7	—0·2
Uxbridge	25	32·2	14·0	—2·2
View Point	21	24·7	17·4	+0·2
Waratah	25	87·0	10·3	—4·2
Westbury	25	33·4	16·5	+0·4
Wihareja	22	31·4	19·0	+2·7
Wilmot	24	49·2	16·6	+1·2
Woodbury	23	18·5	18·1	—0·8
Wood's Quoin	23	29·0	20·8	+4·2
Wynyard	25	40·6	15·8	0
Yolla	25	57·9	12·0	—3·1
Zeehan	25	95·5	11·9	—2·5