

Byram Index

The drought index is a useful measure of dryness for heavy fuels such as logs. It is also related to the inflammability of scrub foliage as soil dryness takes its effect.

Studies were undertaken to identify points on the drought scale where these fuels become inflammable and affect safety and control over prescribed burning. These points are warnings that detailed checking of field conditions is warranted before continuing prescribed burning in that forest type. The points are guidelines on drought effect they are not a substitute for fire danger rating which gives the suitability of day to day weather for prescribed burning.

Six scrub types were devised. These vary in structure, i.e. height and density and to some extent in species. No detailed subdivision has been possible for northern jarrah forest which is classified as Class 6. The other five types refer to differences between southern jarrah-marri and karri and again within karri. These differences are:

- (a) drying rates for leaf litter
- (b) inflammability of the scrub layer
- (c) presence of aerated fuel such as trash and grass types

DROUGHT INDEX GUIDELINES FOR PRESCRIBED BURNINGDrought IndexForest Type

50	Suitable for burning inflammable flats particularly ti-trees.
80	Suitable for edge burning in jarrah forest. Above 80 risk of logs lighting and re-ignition.
120	Type 6. Prescribed burning in Northern jarrah forest type.
160	Types 3 & 4. Southern forest. Relatively open scrub jarrah marri, marri karri.
200	Type 2. Southern forest. Dense but short scrub e.g. A. strigosa thickets.
250	Type 5. Southern forest. Netic Karri-wattle thickets.
300	Tall dense trymalium and karri wattle.

The Byram Index is dependent on Temperature and Rainfall and is calculated on a daily basis.

Aim

The aim of the analysis is to find out how efficiently a centrally located Station can predict the drought index for outlying areas. To-day with the centralization which is taking place, it is important that a method for predicting the Index for outer areas is formulated. Also if centralized this would reduce costs as fewer weather stations would need to be maintained and release Officers for other duties. So the area variability for the index must be known so that predictions may be made accurately.

Method

The Byram index for a number of months for Manjimup, Tone River, Nannup and Mt. Barker was tabulated and statistical comparisons made.

Results

For the months of December and November 1970 a one way classification analysis was applied (see Appendix 1 to see if at least two of the four means was different. The test was significant at the 5% level so I concluded that at least two of the means were different. A difference of two means test was then applied to the two extremes Mt. Barker and Nannup. At the 5% level of significance the number for the month of December 1970 for Nannup was greater than for Mt. Barker.

The zone test was then applied to the two closest regions Manjimup and Tone River, and this too was significant, i.e. Manjimup mean Tone River mean.

As this type of analysis did not seem to be giving conclusive results as far as prediction is concerned, a correlation, regression study was commenced. The first two centres I tried to correlate were Manjimup and Tone River for the month of December 1970. The regression equation which resulted was

$$Y_{\text{(Tone River)}} = 0.96 + 0.48 X_{\text{(Manjimup)}}$$

with a correlation coefficient of 0.99.

This at first suggests a very good relationship but the validity of this relationship was placed in doubt by the fact that Manjimup temperatures were used in calculation of the index for Tone River. As temperatures of the two areas are very closely correlated then this could explain this result.

A correlation, regression study was then made between Nannup and Manjimup for the months of November, December 1970. Appendix 111. For November the regression equation obtained was $y = 1.35 + 0.4682x$, where y = index for Nannup, x = index for Manjimup with a $R = 0.9769$. This is a good result and indicates a relationship but this could be due to the fact that the Index has just passed through zero and real differences have not yet had enough time to become apparent.

With this possible relationship in mind, the zone study was made for December.

The regression equation resulting was

$$y = 0.5538x + 2.2809 \text{ with the coefficient being}$$

$$R = 0.7940$$

To find the significance of the results the following test was used

$$T = \frac{R \sqrt{n-2}}{\sqrt{1-R^2}}$$

November

H_0 - Correlated by chance

H_1 - Relationship exists

$$N = 30, \quad R = 0.999$$

$$t = \frac{0.98 \sqrt{28}}{\sqrt{1-(0.98)^2}} = \frac{0.98 \cdot 5.3}{\sqrt{1-0.96}}$$

$$t = \frac{5.20}{\sqrt{0.04}} = \frac{5.20}{0.2} = 26$$

At 5% level CR is $t > 1.701$

as $26 > 1.75$

then accept H_1 , good relationship.

December

$$N = 31 \quad R = 0.794$$

$$t = \frac{0.794 \sqrt{29}}{\sqrt{1-(0.794)^2}} = \frac{0.794 \cdot 5.48}{\sqrt{0.37}} = 7.3$$

$$CR = T > 1.70$$

is still significant.

However it is obvious that the correlation is weakening and further studies are needed to see if this trend continues, i.e. decreasing R , if so then this will mean that this type of analysis will also not be able to provide a means of estimating the Byram Index from a central point for surrounding areas.

So far then no analysis has been able to allow the estimation of the Index over a large area and it does seem probable that some district officers as well as the headquarters will have to maintain their own Byram Index for their particular area.

APPENDIX 1

BYRAM INDEX ANALYSIS

Month December 1970

Index $\frac{1}{2}$ 100

Mt.Barker	Manjimup	Tone River	Nannup	
1.87	1.42	1.85	3.04	
1.89	1.48	1.90	3.10	
1.48	1.50	1.92	3.17	
0.82	1.52	1.94	3.22	
0.87	1.56	1.98	3.26	
0.96	1.64	2.06	3.38	
1.16	1.81	2.22	3.47	
1.23	1.89	2.29	3.14	
1.33	2.04	2.43	3.10	
1.43	2.12	2.51	3.14	
1.53	2.19	2.57	3.24	
1.54	2.21	2.59	3.38	
1.58	2.25	2.63	3.46	
1.67	2.33	2.71	3.50	
1.75	2.43	2.80	3.54	
1.82	2.47	2.84	3.58	
1.85	2.49	2.86	3.64	
1.90	2.54	2.90	3.68	
1.97	2.59	2.95	3.72	
2.02	2.65	3.01	3.77	
2.09	2.73	3.08	3.90	
2.14	2.81	3.15	4.00	
2.26	2.92	3.25	4.06	
2.29	2.93	3.28	4.14	
2.36	2.94	3.31	4.19	
2.43	2.95	3.33	4.22	
2.50	3.00	3.38	4.26	
2.53	3.08	3.46	4.32	
2.59	3.19	3.57	4.36	
2.71	3.30	3.67	3.50	
2.85	3.38	3.74	3.47	
Total 57.42	74.36	86.21	111.95	329.94
Mean 1.85	2.40	2.78	3.61	2.56
S of Squares 115.23	188.72	249.21	409.33	962.49

See Walpole Page 296

$$SST = \text{Sum of squares of all Values} - \frac{(\text{total})^2}{\text{Total no. of obs.}}$$

$$SSC = \frac{(\text{Column Totals})^2}{\text{No. of obs. in Col.}} - \frac{(\text{total})^2}{\text{Total No. of obs.}}$$

$$SSE = SST - SSC$$

$$SST = 962.49 - \frac{(329.94)^2}{124} = 84.58$$

$$SSC = 928.76 - 877.91 = 50.85$$

$$SSE = 33.73$$

Source of Variation	S. of Squares	Degrees Freedom	Mean Sq.	F
Column Means	50.85	3	16.95	13.6
Error	33.73	27	1.25	
Total	84.58	30		

H_0 No diff. between means

H_1 At least two means are different.

Critical value $F > 4.5$

$13.6 > 4.5$ i.e. reject H_0

i.e. Suggests at least 2 of the means are in fact different.

Difference Between Two Means Tests

(2 extremes)

	Mt. Barker	Nannup
Total	57.42	111.95
Mean	1.85	3.61
S of Sq.	115.23	409.33

N = 31

$$6^2 = \frac{\sum x^2 - \frac{(\sum x)^2}{N}}{N - 1}$$

$$6_{M.B.}^2 = \frac{115.23 - 106.36}{30} = 0.3$$

$$6_N^2 = \frac{409.33 - 404.28}{30} = 0.17$$

$$H_0 = U_{m2} = U_N$$

$$H_1 = U_N > U_{m2}$$

$$Z = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{6_1^2}{N} + \frac{6_2^2}{N}}}$$

$$CR = Z > Z_{\alpha} \quad \text{at } 5\% \quad Z_{\alpha} = 1.65$$

$$Z = \frac{3.61 - 1.85}{\sqrt{\frac{0.47}{31}}} = \frac{1.76}{0.1232} = 14.28$$

$$\text{i.e. } 14.28 > 1.65$$

$$\text{i.e. reject } H_0 \text{ accept } H_1$$

$$\text{i.e. Nannup mean } > \text{ Mt. Barker mean.}$$

APPENDIX 111

Correlation Study Between Nannup and Manjimup

	Manjimup	Nannup (y)
Σx	20.11	40.99
Σx^2	16.67	62.06
$\bar{x}$	0.67	1.37

$$\Sigma x_i y_i = 31.77$$

$$R = \frac{N \Sigma x_i y_i - \Sigma x_i \Sigma y_i}{\sqrt{(N(\Sigma x_i^2 - (\Sigma x_i)^2)(\Sigma y_i^2 - (\Sigma y_i)^2))}}$$

1st Calc.

$$R = 0.9769$$

$$b = \frac{N \Sigma x_i y_i - \Sigma x_i \Sigma y_i}{N [\Sigma x_i^2 - (\Sigma x_i)^2]}$$

$$b = 1.3459$$

$$a = \bar{y} - b\bar{x}$$

$$a = 1.37 - 1.3459 - 0.67$$

$$a = 0.4682$$

$$Y = 1.35 + 0.4682$$