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Letters to the Editor

551.524.3

AN INDEX TO ASSESS SEVERITY OF SUMMER OVER CENTRAL INDIA

1. Physical indices of thermal environment have been a subject of vital interest to physiologists, physicians and to the common man. Day time high summer temperature over tropics, besides causing physical discomfort, often leads to deaths due to hyperthermis (sunstroke).

In the present study, an index has been developed to assess the severity of summer season and to examine relationship, if any, between the severity of summer and monsoon rainfall.

2. Twelve stations, *viz.*, Nagpur, Akola, Chandrapur, Indore, Raipur, Jabalpur, Gwalior, Bhopal, Guna, Satna, Ambikapur and Jagdalpur have been considered for the main summer months, April and May. These stations represent practically all thermal regimes in central India. Daily maximum temperatures for 20 years (1971-90) constitute the date set.

Rainfall - summer severity relationship has been studied by considering summer monsoon (June - September) rainfall for each of these stations.

3. For the purpose of development of the index, day temperature equal to or greater than 41°C has been considered. The Summer Severity Index (SSI) is given by :

$$SSI = \Sigma n_i W_i T_i / \Sigma n \qquad (1)$$

where, n_i are number of days with temperature T_i and W_i are the corresponding weights given to temperature as shown below :

Temperature (°C)	*Weights*
41.0 to 41.9	0.02
42.0 to 42.9	0.06
43.0 to 43.9	0.10
44.0 to 44.9	0.14
45.0 to 45.9	0.18
46.0 to 46.9	0.22
≥ 47.0	0.28

For describing the intensity of summer the following scales were used :

Index Range	*Category*
$SSI < \overline{X} - \sigma/2$	Mild
$\overline{X} - \sigma/2 \leq SSI \leq \overline{X} + \sigma/2$	Moderate
$\overline{X} + \sigma/2 \leq SSI \leq \overline{X} + \sigma$	Severe
$\overline{X} + \sigma < SSI$	Extreme

Where, $\overline{X}$ refers to the mean value of the index and σ its standard deviation.

4. The mean values of SSI and its standard deviation are shown in Fig. 1. East Vidarbha and adjoining areas of Madhya Pradesh stand out conspicuously as the regions experiencing severe summer. Gwalior and adjoining areas too have summer of comparable intensity. Chandrapur and adjoining areas appear to experience most severe summers in central India. On the contrary, west Madhya Pradesh and Surguja and adjoining

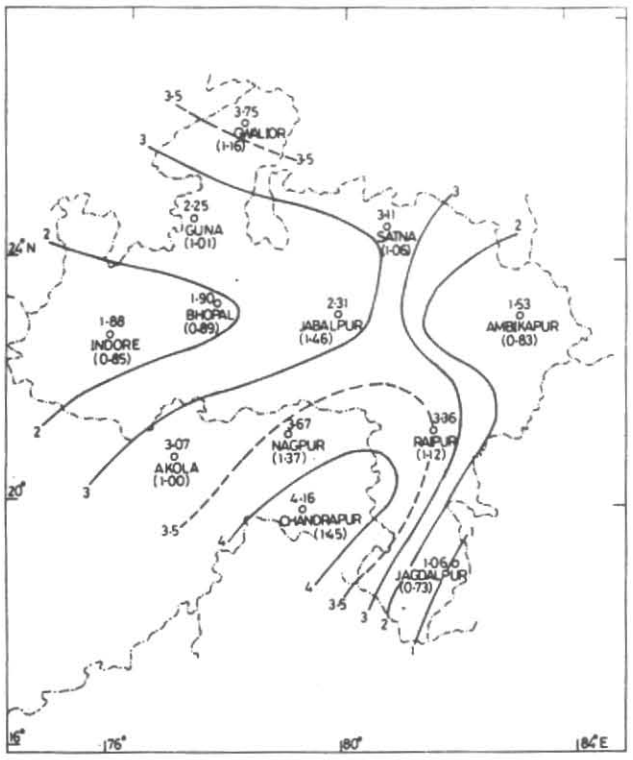

Fig. 1. Mean distribution of summer severity index (SSI) with SD indicated in brackets

TABLE 1

Relative intensity (%) of summer

Station	Intensity			
	Mild	Moderate	Severe	Extreme
Nagpur	40.0	35.0	10.0	15.0
Indore	40.0	30.0	10.0	20.0
Jagdalpur	20.0	45.0	15.0	20.0
Ambikapur	35.7	50.0	0.0	14.3
Gwalior	44.4	16.7	11.1	27.8
Raipur	33.3	27.7	27.7	11.3
Guna	52.6	21.1	5.2	21.1
Bhopal	33.3	33.3	16.7	16.7
Satna	40.0	25.0	15.0	20.0
Jabalpur	40.0	20.0	15.0	25.0
Chandrapur	27.7	44.5	5.5	22.3
Akola	37.5	25.0	12.5	25.0

TABLE 2

Spatial correlation of simultaneous occurrence of summer intensity

S. No.	Station Name	Stations at S.No.											
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	Akola	1.00											
(2)	Ambikapur	0.68	1.00										
(3)	Chandrapur	0.68	0.43	1.00									
(4)	Bhopal	0.74	0.66	0.39	1.00								
(5)	Guna	0.78	0.71	0.54	0.88	1.00							
(6)	Gwalior	0.78	0.72	0.49	0.78	0.92	1.00						
(7)	Indore	0.72	0.53	0.34	0.88	0.79	0.66	1.00					
(8)	Jabalpur	0.83	0.49	0.60	0.72	0.76	0.71	0.67	1.00				
(9)	Jagdalpur	0.73	0.40	0.55	0.53	0.61	0.63	0.41	0.83	1.00			
(10)	Nagpur	0.68	0.27	0.39	0.12	0.18	0.11	0.04	0.00	0.08	1.00		
(11)	Raipur	0.69	0.54	0.61	0.61	0.77	0.71	0.52	0.73	0.77	0.21	1.00	
(12)	Satna	0.86	0.68	0.49	0.81	0.82	0.85	0.73	0.87	0.76	0.07	0.71	1.00

districts in east Madhya Pradesh experience mild summers. However, because of the sea breeze effect (Banerjee *et al.* 1975) mild summers are felt at Jagdalpur and surrounding areas. Sharp transition from mild to severe summer southeast of the region gives rise to strong gradient in the isopleths there.

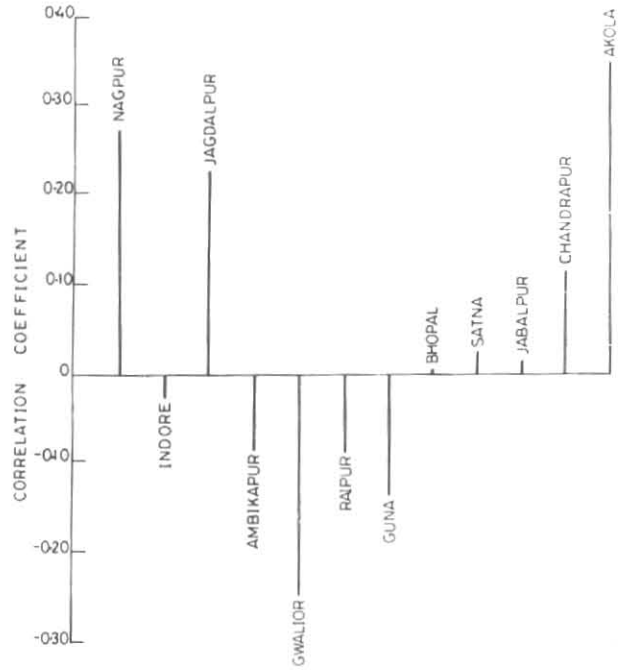

Fig. 2. Correlation between SSI and monsoon rainfall

4.1. Percentage number of occasions of summer of different intensities is given in Table 1. Over central India, by and large, the summers are either mild or moderate in character. However, at Raipur severe summers are more frequent. But what is noteworthy is that at Gwalior, Jabalpur and Akola the summers of extreme nature exceed 25%.

4.2. Summer conditions being widespread in nature, it is natural that the SSI at different stations in central India should be correlated with one another. An attempt has been made to find out if, when one station experiences severe summer, other stations in the region are also simultaneously affected and if so, to what degree. Inter-correlation matrix for these stations is given in Table 2. Nearly all inter correlation coefficients were found significant. This is particularly the case with Akola when we find nearly whole of central India experiencing simultaneous summer severity. This station as such could serve as a representative station for central India to describe summer intensity.

4.3. The monsoon winds are driven by differential heating between the Indian sub-continent and the adjoining water bodies. The summer index developed in the present study is used to find its association, if any, with the monsoon rainfall. Linear correlation, worked out between the SSI and monsoon (June - September) rainfall is depicted in Fig. 2.

The theory developed in the study, has been applied for 1991 and 1992 summers. During 1991, the summer at Indore belonged to extreme category and was severe at Chandrapur, Raipur and Jabalpur. At the rest of the stations, summer in 1991 was either of mild or moderate category. In general, it may be said that the summer in 1992 was rather subdued in nature compared to the summer of 1991. This is corroborated by the newspaper reports about mild summer in general and absence of large number of sunstroke cases (which to some extent also represent summer severity) from various places in central India.

5. The following conclusions are drawn from this study :

(*i*) Chandrapur and surrounding areas experience extreme summer in Vidarbha and Madhya Pradesh.

(*ii*) The mildest summers are felt over Jagdalpur and neighbourhood.

(*iii*) No statistically significant relationship exists between the summer severity and monsoon rainfall.

Reference

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