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Climatological droughts in the tropical monsoon climate of Kerala, India

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ABSTRACT

Yearly water balance were worked out for the State of Kerala from 1871-2000 to study the frequency and intensity of droughts and climatic shifts in the tropical monsoon climate. The most dry year during the study period was 1876; 1984 was the least dry year. The number of disastrous droughts was higher (46.9 %) during summer when compared to severe, large and moderate droughts. The decade 1981-90 was the worst drought decade while 1951-60 the least. There was a marginal shift from B_4 to B_3 humid climatic type over a period of 130 years indicating that the State experienced relative dryness. It was more evident from 1951-2000.

Key words : Water balance, aridity index, humidity index, moisture index, droughts, climatic shifts

Climate is one of the natural resources that plays an important role in influencing agriculture and other human activities. Rainfall over Kerala State is derived from the two monsoons viz., Southwest and Northeast and the behaviour of the above two monsoons affects the crop production and has a bearing on the State economy. It is, more so, in the case of plantation crops as the effects of weather on crop production are seen not only in the same year but also in subsequent years.

The water balance approach in climatic studies is a basis for understanding the wetness and dryness of a place, based on the evaluation of water need. Subrahmanyam (1958) first suggested application of water balance approach for a study of aridity and drought based on the pioneering work of the Thronthwaite and Mather (1955). Similar studies were reported by several workers across the country (Subrahmanyam and Subramaniam, 1964; Subrahmanyam and Sastri, 1969; Subrahmanyam and Hema Malini, 1979; Subramaniam and Prasada Rao, 1980 and Subramaniam *et al.*, 1984). However, such studies are not reported in the tropical monsoon climates like Kerala. In the context of climatic variability, the climatic analysis on droughts and climatic shifts play a vital role. Hence, an attempt has been made to study the frequency and intensity of droughts and climatic shifts over Kerala.

MATERIALS AND METHODS

The source of monthly rainfall data over Kerala from 1871 to 1994 is from the IITM publication entitled "Monthly and seasonal rainfall series for all-India homogeneous regions and meteorological subdivisions: 1871-1994" (Parthasarathy *et al.*, 1995). From 1995 to 2000, the monthly rainfall data were collected from the daily weather reports published by the IMD, Trivandrum. Yearly water balance for the State as a whole were computed for a period of 130 years (1871-2000) using the Thronthwaite and Mather (1955) book - keeping water balance procedure, given by Subrahmanyam (1982). The monthly Aridity Index (Ia), Moisture Index (Im) and humidity Index (Ih) were computed from 1871 to 2000 using the formulae given below:

$Ia = WD/PE \times 100$
$Ih = WS/PE \times 100$
$Im = Ih - Ia$

Where, AE-Actual evapotranspiration, PE-Potential Evapotranspiration, WS-Water Surplus, WD-Water deficit.

Intensity of droughts was worked out as per the procedure given by Subrahmanyam and Subramaniam (1964) and later modified by Subrahmanyam and Sastri, 1969). It is classified on the basis of the percentage departure of aridity index from the median as Moderate, Large, Severe and Disastrous according to the following scheme, where s is the standard deviation:

Departure of Ia from median	Drought intensity
$<1/2\sigma$	Moderate
$1/2\sigma$ to σ	Large
σ to 2σ	Severe
$>2\sigma$	Disastrous

Yearly march of the aridity index corresponding five-year-moving-average and trends were also computed to understand the trends in the aridity index. Similar exercise was done in the case of moisture index for knowing any climatic shift in the State during the study period.

RESULTS AND DISCUSSION

Kerala State experiences water deficiency (433mm) from December to April as per the climatic normal (1871-2000). However, it is severe only from January to April if pre monsoon showers fail. Thereafter, soil moisture accretion starts from April/May to first week of June depending upon pre-monsoon rainfall and onset of monsoon. Water surplus across the State is noticed from June to November with the progress of southwest and later due to post-monsoon rainfall. The soil moisture use is noticed from December to April. During the most dry year (1876), the State of Kerala experienced water deficiency (778 mm) from October to May against the normal of 433 mm. In 1876, a severe dry spell of seven months was noticed from November to May instead of four months (January to April) normally seen. Even

Table 1 : Water balance parameters of most dry year, last dry year and climatic normal over Kerala during 1871-2000

Most dry year (1876)													
Items	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
PE	139	153	184	188	176	65	70	85	112	110	116	129	1527
P	0	0	38	44	75	597	786	243	111	55	37	2	1988
AE	26	11	42	45	75	65	70	85	112	101	80	37	749
WD	113	142	142	143	101	0	0	0	0	9	36	92	778
WS	0	0	0	0	0	383	716	158	0	0	0	0	1257
Least dry year (1984)													
PE	135	162	148	162	169	17	45	97	114	93	118	125	1385
P	41	73	113	221	116	714	533	231	145	251	76	21	2535
AE	94	99	120	162	141	17	45	97	114	93	113	79	1174
WD	41	63	28	0	28	0	0	0	0	0	5	46	211
WS	0	0	0	0	0	607	488	134	31	158	0	0	1418
Climatic Normal (1871-2000)													
PE	139	152	184	188	176	66	70	85	112	110	116	129	1527
P	11	17	36	110	243	688	642	377	225	284	156	38	2827
AE	58	37	45	112	176	66	70	85	112	110	116	107	1094
WD	81	115	139	76	0	0	0	0	0	0	0	22	433
WS	0	0	0	0	0	542	572	292	113	174	40	0	1733

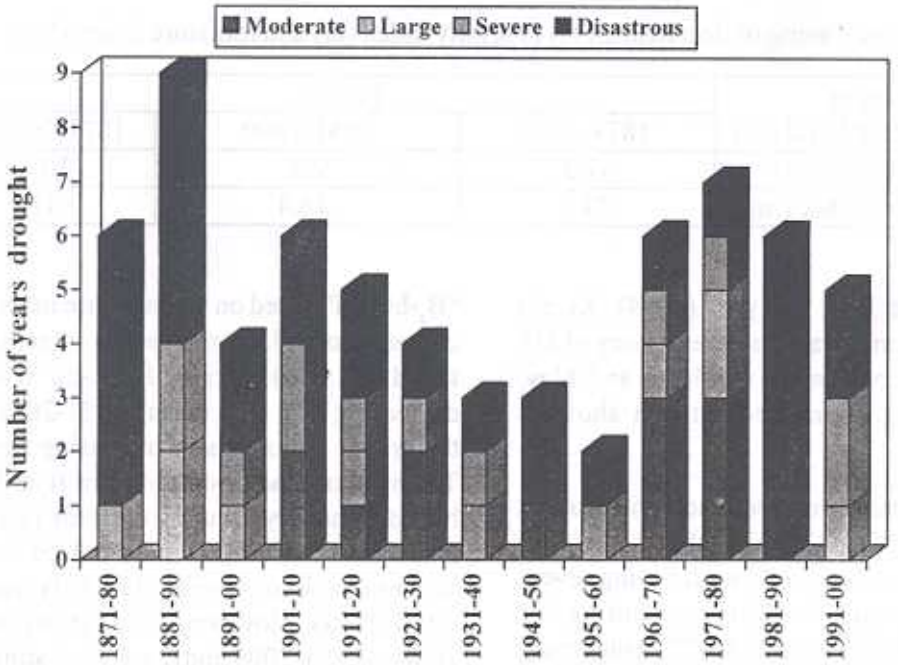

Fig. 1: Decade-wise frequency and intensity of droughts over Kerala during 1871-2000

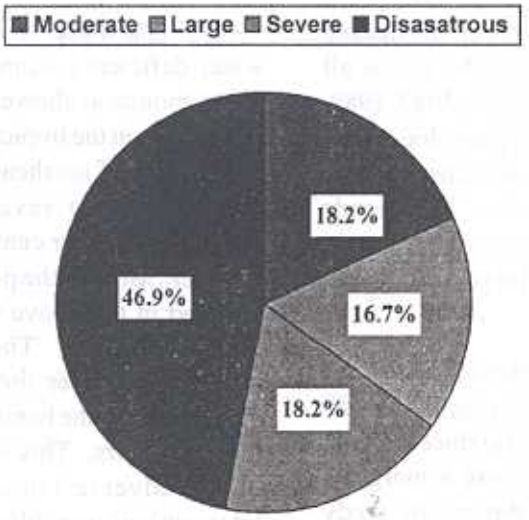

Fig. 2 : Percentage intensity and occurrence of droughts over Kerala during 1871-2000

Table 2 : Increasing or decreasing (%) of aridity index (Ia) and moisture index (Im)

Increasing or decreasing trend (%)	Period		
	1871-1950	1951-2000	1871-2000
Aridity index (Ia)	-7.2	2.3	-2.5
Moisture index (Im)	23.6	-18.4	-0.41

during the least dry year (1984), Kerala suffered a moderate water deficiency of 211 mm from November to March and May, depending upon pre-monsoon showers (Table 1).

The State experienced 66 drought years out of 130, of which 31 was disastrous, 11 large, 12 each having severe and moderate droughts accounting for 46.9%, 18.2% each and 16.7% respectively (Figures 1&2). The decade 1881-90 experienced the maximum number of drought years (9) of which five were disastrous droughts. However, the decade 1981-90 was the disastrous decade as all the six years (1982, 1983, 1986, 1987, 1989, 1990) fell under that category due to the lack of northeast monsoon rains together with pre-monsoon showers. The decade 1951-60 experienced only two drought years, one each under large and severe category.

The aridity index showed a marginal decreasing trend (7.2 %) during 1871-1950 while increasing trend (2.3%) since last fifty years (Table 2). There was a marginal (2.5%) declining trend during the study period as a whole (1871-2000). The State of Kerala falls under the climatic type of "B_4-humid" based on the moisture index of climatic normal. It showed an increasing trend (23.6%) during 1871-50 while decreasing (-18.4%) during 1951-2000 as the aridity index was in increasing trend. The moisture index shifted from B_4 to B_3 - humid climatic type during the study period. It revealed that Kerala state moved from wetness to dryness since last fifty years (1951-2000). However, it was stable over all from 1871-2000 and a marginal shift in climate was noticed from B_4 to B_3 within the category of B type.

The State of Kerala experiences water deficiency from December to May, if pre-monsoon showers fail, which is not uncommon in the tropical monsoon climates. The failure of northeast and pre-monsoon showers led to severe and disastrous droughts in 65 per cent of the years during summer. Most of the plantation crops were affected in the above situation as noticed during 1982-83. The striking climatic phenomenon over the State was relative dryness within the humid climatic type since last fifty years. This is perhaps indicative of the adverse impact of man - made interventions on ecological balance during the last 50 years in the developmental process of the State.

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