



RESEARCH ARTICLE

Centurial Rainfall Analysis for Drought in Coimbatore City of Tamil Nadu, India

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ABSTRACT

An analytical study was done at Agro Climate Research Centre, Tamil Nadu Agricultural University by using monthly precipitation data for Coimbatore from 1918 to 2017. The collected data was used to compute the seasonal and annual rainfall trend and to study the temporal pattern of drought using Standardized Precipitation Index (SPI). Decadal Precipitation Ratio (PR) was worked out to study the rainfall stability for South West Monsoon (SWM), North East Monsoon (NEM) and annual period. Moderate drought category occurred for nine years during SWM and five years during NEM. Severe drought event occurred for three years during SWM and seven years during NEM. Extreme drought category occurred for one year during SWM and two years during NEM. In 1947, moderate drought was experienced during SWM and severe drought occurred during NEM. In 1952, moderate drought was observed during both the monsoon period. In 2016, severe drought was experienced during both SWM and NEM. Highest The highest PR value of 125 with less than 25 rainy days was recorded for annual rainfall during 2008-2017 which indicated more idiosyncrasy of rainfall.

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INTRODUCTION

Moment of climate change leads to extreme weather events and are becoming more frequent and unpredictable. Significant changes in the frequency and intensity of extreme events can result from relatively small fluctuations in the average distribution of climate variables such as precipitation, temperatures etc., (Ahmad *et al.*, 2016). Among the extreme meteorological events, drought has the least predictability and affecting more people than any other hazard. Drought is the most widespread hydro-meteorological syndrome of 'prolonged period of water scarcity affecting natural resources, environment and thereby, the people'. The study of temporal & spatial variations of rainfall would help to design a viable cropping pattern for a particular area (Veeraputhiran *et al.*, 2015). Environmental changes, viz., climate change, land-use changes and natural resource degradation have aggravated drought occurrences and vulnerability, thus disrupting the normal socio-economic settings. Monsoon failure causing crop failure, drying up ecosystems and shortage of drinking water results in undue hardship to the rural and urban communities. (Gupta *et al.*, 2011).

Droughts are generally measured in terms of deficiency in the rainfall or streams flows below

a predefined reference level. The magnitude of departure from the reference level during a drought spell is known as the severity of the drought. In India, large parts of the country perennially reel under recurring drought. Around 68 % of the total area is vulnerable to drought and about 35 % of which receives rainfall between 750 mm and 1125 mm is considered drought-prone while 33 % that receive less than 750 mm is chronically drought-prone. In India, the most drought-prone regions are the arid and semi-arid regions (Appa Rao, 1991). The severity and intensity of drought is more in arid to extremely arid region (Adnan *et al.* 2017).

The rainfall stability analysis by employing precipitation ratio over the southern zone of Tamil Nadu exhibited typical rainfall variability (Ramaraj *et al.*, 2015). Meteorological droughts were studied for predicting the expected rainfall at different probability levels for planning a suitable cropping pattern. There are many indices to measure meteorological dryness, such as simple rainfall deviation from historic normal, Palmer Drought Severity Index (PDSI) and Standardized Precipitation Index (SPI). Among these indices, SPI is widely used in recent years because of its computation simplicity and interpretation fidelity. In this context, an attempt

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has been made to analysis the nature of distribution of rainfall and to assess the frequency and drought intensity for Coimbatore city of Tamil Nadu, India.

MATERIAL AND METHODS

Location of the study area

Tamil Nadu Agricultural University is located at 11°N latitude and 77° E longitude with an elevation of 426.72m above mean sea level covering an area of 323.88 ha(Figure 1).

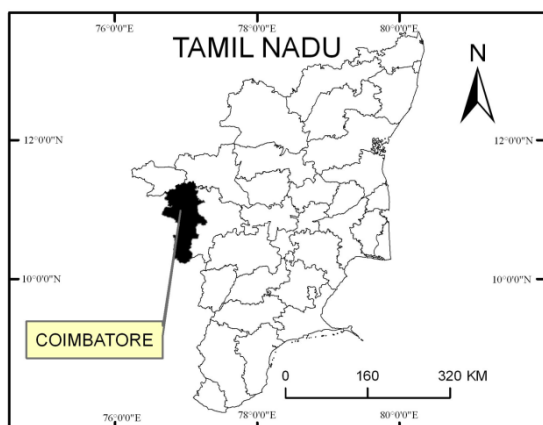


Figure 1. Study area for drought analysis

Data analysis

Monthly rainfall data over a period of 100 years from 1918-2017 was collected from Agromet observatory, Tamil Nadu Agricultural University, Coimbatore. The data was sliced for different seasons such as Cold Weather Period (CWP - January and February), Hot Weather Period (HWP - March to May), South West Monsoon (SWM - June to September) North-East Monsoon (NEM - October to December) and annual period to study the rainfall variability and stability.

Standardized Precipitation Index (SPI)

McKee et al. (1993) developed the Standardized Precipitation Index (SPI) for the purpose of defining and monitoring drought. The SPI assigns a single numeric value to the precipitation, which can be compared across regions and time scales with markedly different climates. SPI is calculated from the long term record of precipitation in each location (at least 30 years).

Meteorological and agricultural droughts, which have an impact on precipitation and soil moisture respectively, are usually linked to short term time scales which are 3 and 6-month SPI's. The long term time scale which are 12-month SPI or more are associated with hydrological droughts which have an impact on streamflow and reservoir levels. The short term durations are important to agricultural interest while long terms are important to water supply management interest. The different timescale helps

to identify the types of drought from meteorological to hydrological drought (Adnan et.al., 2015).

The SPI program developed by National Drought Mitigation Centre of the University of Nebraska was utilized and the criteria defined by McKee et al.(1993) for a “drought event” and classification of the SPI to define drought intensities for any time steps used for interpretation. The classification was given in Table 1.

Precipitation Ratio

The abnormalities of rainfall at any location may be brought by a simple ratio of precipitation. It is the difference between the maximum and minimum rainfall of the annual rainfall series expressed in terms of mean. This ratio may give the stability of rainfall with special relationship. Higher the ratio, higher is the abnormality in rainfall and vice versa (Rathod and Aruchamy, 2010).

$$PR = (P_{max} - P_{min}) / P_{MAR} \times 100$$

Where, PR = Precipitation Ratio

PMax = Maximum mean annual rainfall

PMin = Minimum mean annual rainfall

PMAR = Mean annual rainfall

RESULTS AND DISCUSSION

The seasonal rainfall viz cold weather period(Jan-Feb), hot weather period (Mar- May), Southwest monsoon (jun-sep) and Northeast monsoon (oct-dec) area depicted in Figure 2. The average cold

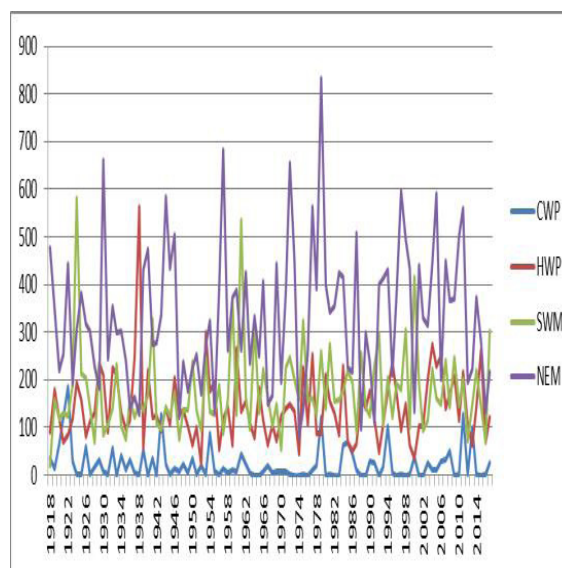


Figure 2. Seasonal rainfall of coimbatore for 100 years

weather period rainfall recorded was 23.1mm with a maximum value of 185.2 mm (1922). The average hot weather period rainfall recorded was 142.1mm with a maximum value of 563.8 mm (1938). The

average southwest and northeast monsoon rainfall recorded was 176.2mm/335.4mm respectively with 51/44 per cent coefficient of variation indicating

Table.1 Classification of Standard Precipitation Index values and their intensities

SPI	Intensity
2.00 and more	Extremely wet
1.99 to 1.50	Very wet
1.49 to 1.00	Moderate wet
-0.99 to 0.99	Near normal
-1.00 to -1.49	Moderate drought
-1.50 to -1.99	Severe drought
-2.00 and less	Extremely drought

high dependability of rainfall. The average annual rainfall recorded was 676.8 mm with 45 rainy days(Figure 3.)

Standardized Precipitation Index (SPI)

SPI values for Southwest and Northeast monsoon season are shown in Figure 4 and 5. The results

on SWM season indicated that out of 100 years moderate drought occurred for nine years viz., 1930,1935,1943,1947,1952,1957,1987,2002 and 2012, a severe drought occurred for three years viz., 1928,1970 and 2016 while extreme drought occurred only in 1918.

For NEM season, a moderate drought occurred for five years (1923, 1937, 1949, 1952 and 1967), severe drought occurred for seven years (1936, 1938, 1947,1955,1975,1991 and 2016) whereas extreme drought occurred for two years in 1974 and 1988. The consecutive cropping season for both SWM and NEM were severely affected by drought during 1947(Moderate drought-SWM/Severe drought-NEM), 1952(Moderate drought-SWM/NEM) and 2016 (Severe drought –SWM/NEM).

Rainfall stability analysis-Precipitation Ratio

Precipitation ratio during southwest monsoon showed higher value compared to northeast and annual period. The highest value of 298.8 occurred

Table 2.Precipitation ratio for SWM, NEM and annual rainfall for Coimbatore

Year	SWM				NEM				ANNUAL			
	max	min	mean	PR	max	min	mean	PR	max	min	mean	PR
1918-27	581.2	19.7	187.9	298.8	475.8	190.5	323.6	88.2	1085.6	519.1	690.7	82.0
1928-37	234.8	68.6	132.4	125.6	662.3	139.0	281.6	185.8	966.2	423.7	609.7	89.0
1938-47	327.9	73.8	150.2	169.2	584.5	120.8	356.4	130.1	900.0	329.8	659.5	86.5
1948-57	246.4	87.5	152.2	104.4	683.8	131.8	287.1	192.3	902.9	309.2	585.8	101.4
1958-67	536.5	98.1	228.0	192.3	424.2	147.7	307.6	89.9	813.0	392.5	655.7	64.1
1968-77	324.2	53.4	178.0	152.1	654.0	82.8	333.9	171.0	1049.4	285.4	651.8	117.2
1978-87	275.0	90.2	179.6	102.9	832.4	215.6	411.1	150.0	1299.8	506.2	740.9	107.1
1988-97	295.2	105.6	185.3	102.3	595.4	97.2	316.8	157.3	912.1	482.8	665.9	64.5
1998-2007	417.1	93.0	199.7	162.3	589.8	134.7	413.4	110.1	989.3	525.6	781.8	59.3
2008-2017	301.1	68.4	169.2	137.6	560.0	134.6	322.0	132.1	1103.5	271.8	665.2	125.0

during 1918-1927 period where the range between maximum and minimum rainfall quantity vary to a wide extent.

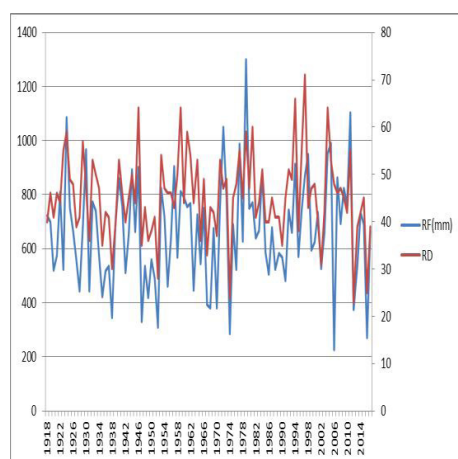


Figure 3. Annual rainfall and no. of rainy days for coimbatore for 100 years

Comparison of precipitation ratio of southwest and northeast monsoon shows greater variance. The highest value of 192.3 occurred during 1948-1957 decadal period indicating lower annual normal rainfall (287.1 mm). More event of moderate and severe drought occurred during the particular decade. Though the Precipitation Ratio is higher during the season, the stability is relatively higher than the southwest monsoon and it shows the significance of lifeline monsoon for the farmers to take farming activity.

The ratio between minimum and maximum rainfall gradually declines by the advancing of northeast monsoon season for the annual period which showed less idiosyncrasy for that period. The abnormality rainfall during annual time scale is quite low comparing with the monsoon season. In normal year the rainy days were higher and vice versa for abnormal years as opined by Alaguraja

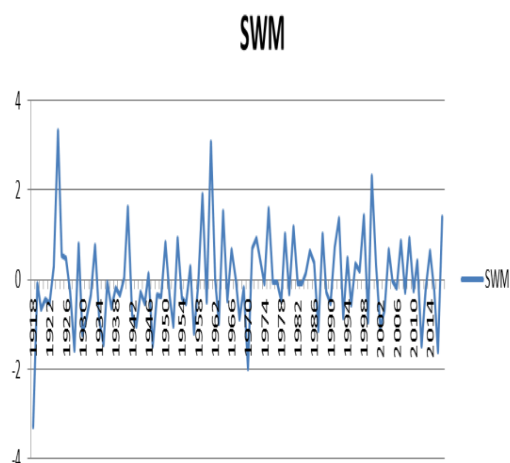


Figure 4. SPI values for southwest monsoon for Coimbatore

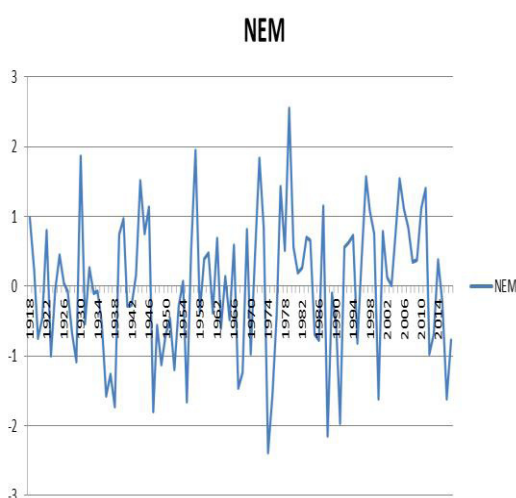


Figure 5. SPI values for northeast monsoon for Coimbatore

Palanisamy, 2016. The highest PR value of 125 with less than 25 rainy days was recorded for annual rainfall during 2008-2017 which indicated more peculiarity of rainfall.

CONCLUSION

Temporal drought patterns were examined which revealed many interesting results on the variability in the occurrence of drought in the region. Results on temporal pattern of drought during SWM season showed that out of 100 years moderate drought occurred for nine years (1930,1935,1943,1947,1952,1957,1987,2002 and 2012), a severe drought occurred for three years(1928,1970 and 2016) while extreme drought occurred only in 1918. For NEM season, moderate drought occurred for five years (1923, 1937, 1949, 1952 and 1967), severe drought occurred for seven years (1936, 1938, 1947,1955,1975,1991 and 2016) whereas extreme drought occurred for two years in 1974 and 1988. The consecutive cropping season for both SWM and NEM were severely affected by drought during

1947(Moderate drought-SWM/Severe drought-NEM), 1952(Moderate drought-SWM/NEM) and 2016 (Severe drought -SWM/NEM). It was found that SPI is a valuable tool for assessing drought characteristics like frequency and severity. The results of the study are also relevant to climate change studies to understand the historic patterns and build future scenarios of drought, occurrences. Highest precipitation ratio value of 125 with less than 25 rainy days was recorded for annual rainfall during 2008-2017 which indicated more idiosyncrasy of rainfall

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