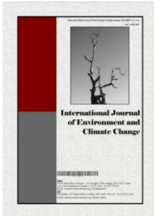

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Drought Characterization Over Periyar Vaigai Command Area in Tamil Nadu

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Authors' contributions

This work was carried out in collaboration with all authors. Authors NKS and APR designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors KS, RJ, SPR and VG managed the data analyses of the study. Authors APR and KS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

India encountered numerous drought years in the decades. It is a matter of concern with increased frequency as well as intensity, mainly due to factors related to changing climate in recent years. In India livelihoods of more than 75% of the population are directly or indirectly dependent on agriculture sectors. The strong and recurrent link between drought and farmer's livelihoods has highlighted the importance to understand the drought scenario of a place for designing coping strategies. To address the issue, this paper was formulated to characterize the drought scenario over Periyar Vaigai Command (PVC) area. To summarize the results, the locations Edayapatti and Periaaruvi had the highest number of annual drought occurrence (8) while the location Madurai airport had the lowest (2) based on the analysis of 30 years. On comparing the monsoons, there are no wide variations in drought characteristics between Southwest monsoon (SWM) and Northeast monsoon (NEM). Anomalies in rainfall during the monsoon seasons were studied through SPI, consecutive drought years were well presented through SPI, which gives relevant information for

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crop planning. In both the monsoons, the locations Viraganur, Pulipatti and Usilampatti witness consecutive droughts. The highest of three consecutive years (1999, 2000 and 2001) were witnessed in Usilampatti during the major NEM season.

Keywords: Categorization; anomaly; SPI and monsoons.

1. INTRODUCTION

Rainfall being a nature's blessing and drought a curse for the whole living world is a decisive weather phenomenon for ensuring or threatening our food security. In semiarid tropics, climate-triggered risks are heavy for crop production [1]. Agricultural production in India is highly dependent on rainfall; hence, drought has a direct effect on it. Drought reduces the country's foodgrain production in certain years by as much as 15 – 20% of the yield of a normal year [2]. Characterization of these weather events would certainly be helpful in the frame of the strategies to minimize the risk toward sustainable production.

Drought is a slow-onset natural hazard, often referred to as a 'creeping disaster' with effects that accumulate over a considerable period, e.g., weeks to months. Both the ecological and economic systems are adversely affected by the drought. A strong nexus of drought, desertification and degradation exists. Drought originates from a deficiency of precipitation that results in a water shortage situation for a certain activity. Impacts of drought are cumulative and the effects magnify in consecutive years. Drought is also referred to as a climatic anomaly characterized by a deficient supply of moisture resulting either from sub-normal rainfall, erratic rainfall distribution, higher water need, or a combination of all three factors [3].

All the regions of India suffer from drought incidences of varying periodicity, with 13 states repeatedly declared as drought-prone [4]. Drought has become a frequent phenomenon in India, due to the rise in pollution and climatic changes. In India, 'chronically drought-prone areas' is around 33% and receive less than 750 mm of rainfall, while 35%, classified as 'drought-prone' receive rainfall of 750 - 1125 mm. Tamil Nadu is located at the southern tip of India; the spatial, seasonal and inter-annual variability of rainfall follows a complex pattern especially in the southern zone of Tamil Nadu.

The problems of drought-prone regions vary in magnitude, temporally and spatially. Hence drought risk assessment is the necessity to cope up with this devastating drought, which affects society a lot. Meteorological drought over an area is defined as a situation when the monsoon seasonal (June – September) rainfall over the area is less than 75% of its long-term average value. It is further classified as 'moderate drought'. If the rainfall deficit is 26 - 50% and 'severe drought' when the deficit exceeds 50% of the normal (www.imd.gov.in).

Drought indices are one of the very important tools to monitor and to assess drought because they simplify complex inter-relationships between many climate parameters. There is extensive literature on the quantification of drought by using various indices, models and water balance simulations [5,6]. Precipitation has been used to develop a variety of indices because it is a key variable to study meteorological drought. Among the meteorological indices, Standardized Precipitation Index (SPI) is more commonly used. The SPI has certain advantages over others such as the use of rainfall data alone and also its variable time scale, which allows it to describe drought conditions important for a range of meteorological, hydrological and agricultural applications [7]. In the present study rainfall from 18 stations of PVC areas were analyzed to determine the patterns of rainfall as the agricultural activities in the PVC area are mainly rain-fed dependent on monsoon rains.

2. MATERIALS AND METHODS

2.1 Data

Daily rainfall data of different places of the northwestern zone is collected from India Meteorological Department and used for the study. Data was converted into weekly, monthly and seasonal, and variability over the different time series was worked out. The potential evaporation data is collected from reports of the India meteorological department.

2.2 Study Area

Periyar Vaigai Command area (Fig. 1) was taken for the study. Periyar Vaigai irrigation system is a trans-basin Scheme, which made it possible to divert waters from the Periyar basin in the state of Kerala to the Vaigai basin in Tamil Nadu. The Periyar reservoir system is evolved based on the concept of uniform release through the Periyar tunnel meeting the irrigation requirement at Periyar - Vaigai command.

2.3 Rainguage Locations and their Geographic Coordinates

Daily rainfall data for a period of 30 years from 1981 to 2011 was collected for the 18 locations are given below in Table 1. The locations data were collected from the Department of Economics and Statistics, Government of Tamil Nadu and Ground Water Division of Water Resource Department, Government of Tamil Nadu.

2.4 Drought Analysis

Drought indices are one of the very important tools to monitor and to assess drought because they simplify complex inter-relationships between many climate parameters. There is extensive literature on the quantification of drought by using various indices, models and water balance simulations. Precipitation has been used to develop a variety of indices because it is a key variable to study meteorological drought. Here IMD criteria and SPI was utilized to study drought.

2.5 India Meteorological Department (IMD) Criteria for Drought Assessment

According to IMD droughts are classified based on rainfall deficit from normal. The two major categories of drought are

I. Moderate drought with a deficit of 26 – 50 percent from normal and
II. Severe drought with more than (>) 50 percent deficit from normal.

2.6 Standard Precipitation Index (SPI)

Standardized Precipitation Index (SPI) is more commonly for drought assessment and monitoring. Mathematically, the SPI is based on the cumulative probability of a given rainfall event occurring at a station. The historic rainfall data of the station is fitted to a gamma distribution, as the gamma distribution has been found to fit the precipitation distribution quite well. The SPI has certain advantages over others such as the use of rainfall data alone and also its variable time scale, which allows it to describe drought conditions important for a range of meteorological, hydrological and agricultural applications. The Standard Precipitation Index (SPI) was proposed by McKee et al. [7] to quantify precipitation deficits/surpluses on a variety of time scales (usually between 1-month and 24-month sums). Because the SPI is normalized, wetter and drier climates can be represented in the same way, and wet periods can also be monitored using the SPI.

Table 1. Rainfall stations and their geographic coordinates

Locations	Latitude	Longitude
Andipatti	09°59'53" N	77°37'21" E
Edayapatti	10°04'04" N	78°04'16" E
Gudalur	09°40'30" N	77°15'00" E
Kallandiri	10°02'12" N	78°12'03" E
Madurai airport	09°50'10" N	78°05'22" E
Madurai south	09°53'29" N	78°07'23" E
Melur	10°01'52" N	78°20'20" E
Mettupatti	10°06'42" N	78°06'22" E
Periaaruvi	10°05'50" N	78°06'40" E
Periapatti	10°01'50" N	78°09'40" E
Pulipatti	10°05'90" N	78°17'21" E
Reddiyarchatram	10°25'49" N	77°52'10" E
Sathiyar dam	10°04'16" N	78°06'42" E
Sholavandan	10°01'35" N	77°57'44" E
Tallakulam	09°56'04" N	78°06'59" E
Thirumangalam	09°48'36" N	77°58'48" E
Usilampatti	09°58'12" N	77°48'00" E
Viraganur	09°53'44" N	78°12'40" E

The different time scales for which the index is computed address the various types of drought: the shorter seasons for agricultural and meteorological drought, the longer seasons for hydrological drought [8]. Due to its robustness and convenience to use, SPI has already been widely used to characterize dry and wet conditions in many countries and regions, such as Canada [9]; Italy [10,11]; United States [12]; Iran [12,13]; Korea [14,15]; and China [16].

Table 2. Classification of Standard Precipitation index values and their intensities [7]

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

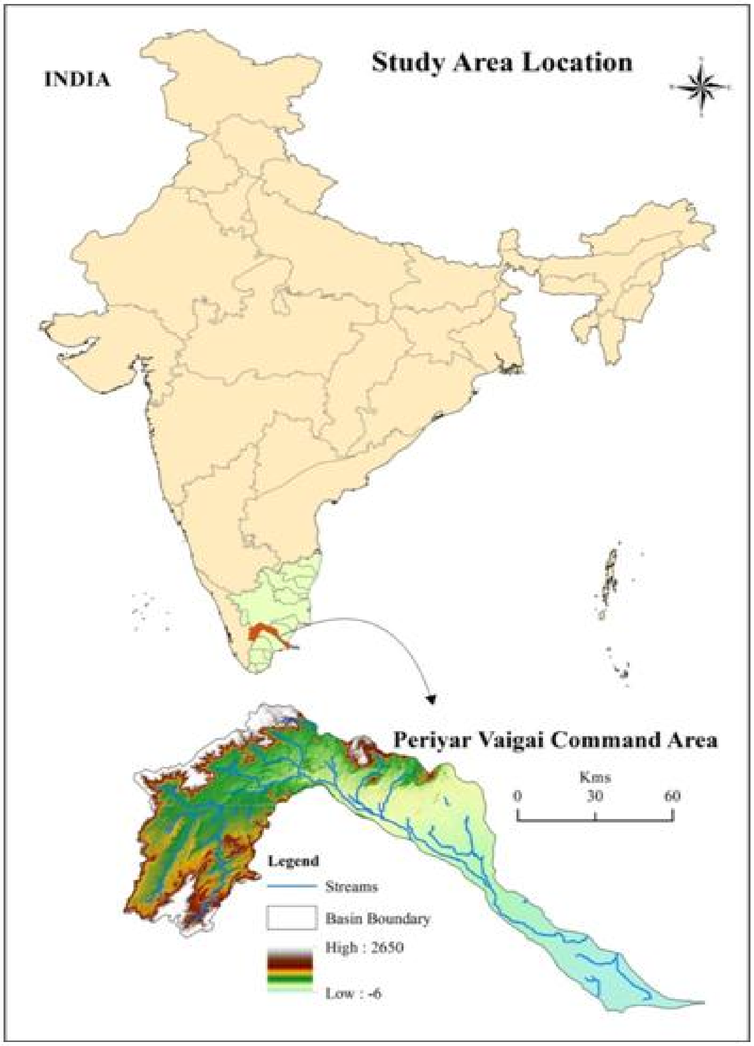

Fig. 1. Periyar vaigai command (PVC) area map

The SPI program developed by the National Drought Mitigation Centre of the University of Nebraska was utilized and The criteria defined by McKee et al. [7] 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 2.

3. RESULTS AND DISCUSSION

3.1 Rainfall Scenario of PVC Area

Annual rainfall normal (Table 3 and Fig. 5) was worked out for all the locations with the data available for the study period 1981 to 2011. The variation in the amount of rainfall among the locations well indicates the spatial variability while its coefficient of variation (CV) explains its temporal variability. The normal annual rainfall of PVC area is 865 mm with a standard deviation of 237 mm. The coefficient of variation is 28 percent. In the PVC area, Usilampatti had the highest normal rainfall of 1052 mm and Edayapatti had the lowest of 564 mm. Among the locations, for the historical period, the least of 132 mm annual rainfall was recorded at Viraganur while the highest amount of rainfall 2010 mm was recorded at Usilampatti. Normal for annual rainy days (Table 4) was worked out for all the locations with the data available for the study period 1981 to 2011. The normal annual rainy days of PVC area are 45 with a standard deviation of 10 days. The coefficient of variation is 22 percent. Among the locations of PVC area, least 35 rainy days were recorded at Edayapatti while the highest of 52 rainy days were recorded at Gudalur. Historically, Gudalur recorded the highest of 101 rainy days during 2004, it is the highest in the entire study area and the less distributed one was at Viraganur, 9 rainy days during 2008 and Coefficient of annual rainy days varied from 14 to 47 percent.

3.2 Seasonal Rainfall

To understand the seasonal variation of rainfall, the daily rainfall data of different places of PVC area (Table 5, Figs. 6 and 7) were aggregated into four seasons *viz*., Cold weather period (CWP), Hot weather period (HWP), Southwest Monsoon (SWM) and Northeast monsoon (NEM). Among the monsoons, NEM contributes a higher percentage of rainfall to annual rainfall followed by SWM, HWP and CWP. Both the monsoons together contribute more than 75 per cent of the annual rainfall received over PVC area. NEM rainfall over the PVC area varied between 564 mm (Usilampatti) to 257 mm (Edayapatti) and the locations Periaaruvi and Sholavandan registered a rainfall of 487mm and 474 mm respectively. During SWM highest amount of rainfall was recorded over Periaaruvi 365 mm and the least amount of rainfall was recorded at Edayapatti 201 mm. During Hot weather period (summer) Usilampatti has recorded the highest rainfall amount of 195 mm and the lowest rainfall of 91 mm was observed in Edayapatti.

To understand the seasonal distribution of rainfall through rainy days, the numbers of rainy days during the monsoon seasons (Table 7) were studied. Comparatively, NEM (20) had more rainy days than SWM (16), which demarcates a good distribution during NEM that supports major cropping activities. The number of rainy days during SWM varied from 11 to 23 and that of NEM is 16 to 22 with a standard deviation of 5 and 7 days respectively. The coefficient of variation varied between 23 to 53 percent and 26 to 52 percent during SWM and NEM periods respectively.

3.3 Drought characterization through IMD Criteria

The annual rainfall scenario over PVC area (Table 3 and Fig. 2) was categorized based on the criteria devised by IMD. From the results, it is evident that the number of drought years varies from one location to another showcasing the spatial variation. The varying number of drought years over the locations explains the temporal variation.

Among the locations, Edayapatti and Periaaruvi had the highest number of drought occurrences (8 years) while the location Madurai airport had the lowest number of drought occurrences (2 years) based on the analysis of 30 years. Gudalur, Melur, Pulipatti and Reddiyarchatram had the next highest number of drought years (7). All other locations had 5 or less than 5 years of drought occurrence. Although annual drought is an important meteorological indication about the status of rainfall and water resources availability, the seasonal status of rainfall deficit is of prime concern for crop planning.

During SWM, the total number of drought years (Table 4) varied between 5 (17 percent of years) (Madurai south and Tallakulam) to 12 (40 percent of years) while segregating the years as severe and moderate drought, later one varied from 1 to 7 and former one varied from 1 to 9, representing 3 to 23 percent and 3 to 30 percent of the years under the respective categories. To a maximum, 40 percent of the years were drought over Edayapatti.

As northeast monsoon is the major monsoon for Tamil Nadu and the PVC area, it holds more importance and plays a key role in agriculture over the area. Among 30 years of study, 17 to 40 percent of the years (5 to 12 years) over PVC area were drought years. Among the drought years, up to 11 years were moderate and up to 6 years were severe drought years (up to 37 and 20 percent). This result was given in Table 5. On comparing the monsoons, considerably wide variations were not observed between SWM and NEM.

Edayapatti has less rainfall and high variability and high drought frequency (40 percent of the years). On comparing the monsoons, there are no wide variations in drought characteristics of the SWM and NEM. This analysis was presented in Fig. 1.

3.4 Characterization through SPI

Anomaly in rainfall during the monsoon seasons were studied through SPI, The number of years with positive anomaly and the negative anomaly was derived along with the number of moderate and severe drought years for individual locations. The abstract of the analysis was presented in Tables 6 and 7.

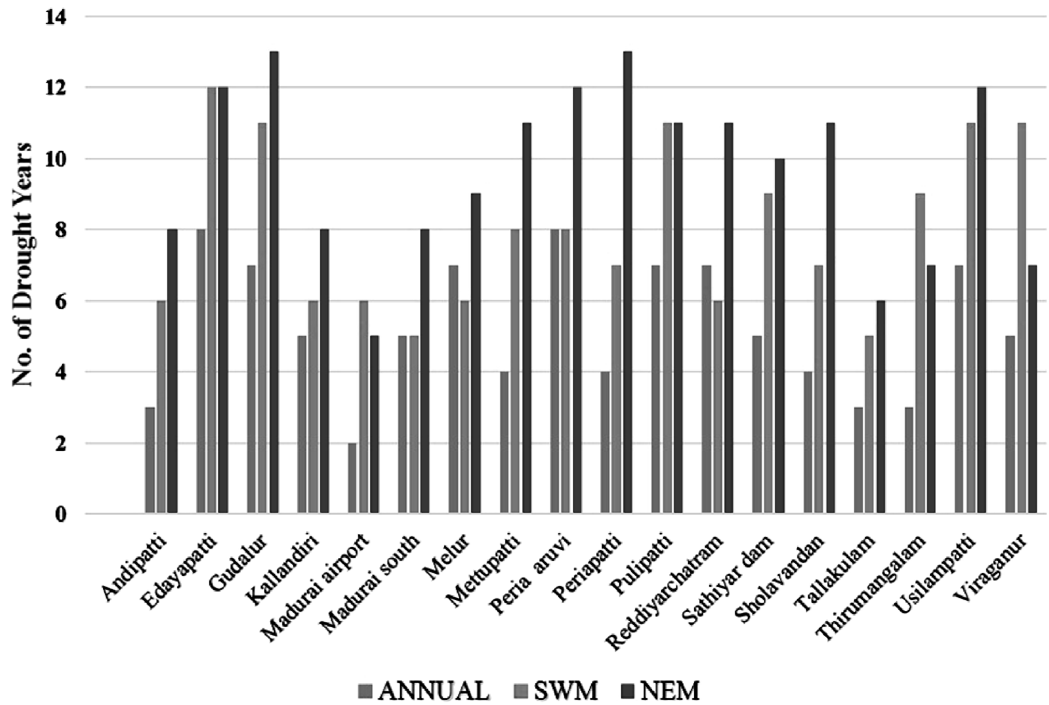

Fig. 2. Drought years and their severity based on IMD criteria

Table 3. Annual drought years and their severity based on IMD criteria

Locations	Moderate	Severe	Total drought Years
Andipatti	1986, 2003	1984	3
Edayapatti	1982, 1984, 1988, 1991, 1995	1996, 1997, 2001	8
Gudalur	1981, 1988,1999, 2003, 2006	1982, 2002	7
Kallandiri	1982, 1983, 1994, 2001, 2006		5
Madurai airport	1982, 2001		2
Madurai south	1982, 1986, 1988, 1995, 2002		5
Melur	1982, 1983, 1985, 1988, 2001, 2003, 2006		7
Mettupatti	1982, 1986, 1995, 2009		4
Periaaruvi	1985, 1988, 1994, 2002, 2003, 2006, 2007	2009	8
Periapatti	2006, 2009	1981, 1982	4
Pulipatti	1982, 1985, 2001, 2002, 2003, 2006, 2009		7
Reddiyarchatram	1982, 1983, 1984, 1986, 1991, 2001, 2009		7
Sathiyar dam	1982, 1984, 1992, 2007, 2009		5
Sholavandan	1985, 1995, 2003, 2004		4
Tallakulam	1982, 1988, 1994		3
Thirumangalam	1985, 1994, 1999		3
Usilampatti	1982, 1985, 2000, 2001, 2002, 2007	1999	7
Viraganur	1982, 1988, 2006, 2007	2008	5

For the SWM (Fig. 3), the number of years with positive anomaly varied from 15 to 20 and the number of years with negative anomaly varied from 10 to 15 with an average of 18 positive and 12 negative anomaly years. In the case of NEM (Fig. 4), the number of years with positive anomaly varied from 12 to 18 and the number of years with negative anomaly also varied from 12 to 18 with an average of 16 positive and 15 negative anomaly years. From this, the variability of both monsoons are evident and the rainfall anomaly is almost equally distributed during the

NEM period than SWM where the number of positive years were comparatively more than negative years.

Further, the years were categorized into moderate, severe and extreme drought years based on the SPI index. Interestingly, during both SWM and NEM the locations Andipatti, Sathiyar dam and Sholavandan witnessed extreme drought conditions in the past 30 years of the study period. But the years of occurrence varied, in Andipatti extreme drought was witnessed in both SWM and NEM during 1984, in Sathiyar dam extreme drought was experienced during SWM of 1984 and NEM of 1985. In the case of Sholavandan, extreme drought was witnessed during SWM of 1997 and NEM of 1988. Except for these three locations all other locations have never experienced extreme droughts.

Table 4. Southwest Monsoon drought years and their severity based on IMD criteria

Locations	Moderate	Severe	Total	% Drought years	% Moderate years	% Severe years
Andipatti	5	1	6	20	17	3
Edayapatti	6	6	12	40	20	20
Gudalur	2	9	11	37	7	30
Kallandiri	5	1	6	20	17	3
Madurai airport	4	2	6	20	13	7
Madurai south	1	4	5	17	3	13
Melur	5	1	6	20	17	3
Mettupatti	6	2	8	27	20	7
Periaaruvi	6	2	8	27	20	7
Periapatti	3	4	7	23	10	13
Pulipatti	7	4	11	37	23	13
Reddiyarchatram	5	1	6	20	17	3
Sathiyar dam	7	2	9	30	23	7
Sholavandan	4	3	7	23	13	10
Tallakulam	4	1	5	17	13	3
Thirumangalam	6	3	9	30	20	10
Usilampatti	5	6	11	37	17	20
Viraganur	7	4	11	37	23	13

Table 5. Northeast Monsoon drought years and their severity based on IMD criteria

Locations	Moderate	Severe	Total	% Drought Years	% Moderate Years	% Severe Years
Andipatti	5	3	8	27	17	10
Edayapatti	6	6	12	40	20	20
Gudalur	9	4	13	43	30	13
Kallandiri	5	3	8	27	17	10
Madurai airport	3	2	5	17	10	7
Madurai south	6	2	8	27	20	7
Melur	8	1	9	30	27	3
Mettupatti	8	3	11	37	27	10
Periaaruvi	6	6	12	40	20	20
Periapatti	11	2	13	43	37	7
Pulipatti	6	5	11	37	20	17
Reddiyarchatram	7	4	11	37	23	13
Sathiyar dam	7	3	10	33	23	10
Sholavandan	7	4	11	37	23	13
Tallakulam	2	4	6	20	7	13
Thirumangalam	4	3	7	23	13	10
Usilampatti	10	2	12	40	33	7
Viraganur	2	5	7	23	7	17

Table 6. Drought categorization through SPI for SWM

Location	Minimum SPI value	Maximum SPI value	Frequency of -ve SPI value	Frequency of +ve SPI value	Moderately drought years	Severe drought years	Extreme drought years	Total drought years
Andipatti	-2.56	1.76	11	19	1994, 2003	0	1984	3
Edayapatti	-1.53	1.99	12	18	1982, 2001, 2002, 2006	1994	0	5
Gudalur	-1.01	2.49	11	19	2008, 2011	0	0	2
Kallandiri	-1.86	1.83	10	20	1991, 1994, 1997, 1999	2006	0	5
Madurai airport	-1.86	2.04	14	16	1982, 1999	1994, 2009	0	4
Madurai south	-1.86	1.76	10	20	0	1994, 2002, 2006	0	3
Melur	-1.86	2.14	14	16	2001	2006	0	2
Mettupatti	-1.79	1.62	12	18	1986, 1999, 2001	1994, 2006	0	5
Periaaruvi	-1.86	2.37	13	17	2002, 2005, 2009	0	0	3
Periapatti	-1.53	1.48	12	18	1982, 1987, 2006	1981	0	4
Pulipatti	-1.86	1.73	13	17	2001, 2002, 2010	2006	0	4
Reddiyarchatram	-1.86	1.96	11	19	1999, 2001, 2006	1982	0	4
Sathiyar dam	-2.21	1.90	11	19	1982, 1997, 2006	2011	1984	5
Sholavandan	-2.66	1.79	13	17	1994, 1995	0	1997	3
Tallakulam	-1.86	2.10	11	19	2002, 2005	1994	0	3
Thirumangalam	-1.86	1.82	10	20	2002, 2005, 2006	1994, 1997	0	5
Usilampatti	-1.86	2.35	15	15	1999, 2002, 2003, 2007	2011	0	4
Viraganur	-1.15	2.28	10	20	2006, 2008, 2009, 2010	0	0	4

Table 7. Drought categorization through SPI for NEM

Location	Minimum SPI value	Maximum SPI value	Frequency of -ve SPI value	Frequency of +ve SPI value	Moderately drought years	Severe drought years	Extreme drought years	Total drought years
Andipatti	-2.72	1.64	12	18	1985	0	1984, 1988	3
Edayapatti	-1.53	1.86	14	16	1985, 1988	1994, 1995	0	4
Gudalur	-1.01	2.14	12	18	2008, 2011	0	0	2
Kallandiri	-1.86	2.38	15	15	1985, 1995, 2001	1984	0	4
Madurai airport	-1.86	2.26	15	15	1995	1984, 1985	0	3
Madurai south	-1.86	2.10	15	15	1984, 1985, 1988	1995	0	3
Melur	-1.86	2.08	15	15	1985, 1988	1995	0	3
Mettupatti	-1.69	1.86	16	14	1981, 1988, 2008, 2009	1984, 1985	0	6
Periaaruvi	-1.86	2.42	15	15	1988, 2003, 2006, 2009	0	0	4
Periapatti	-1.86	1.40	15	15	1982	0	0	1
Pulipatti	-1.86	2.52	16	14	1984, 1985, 1995, 2009	0	0	4
Reddiyarchatram	-1.86	1.74	14	16	1984, 1985, 1995	0	0	3
Sathiyar dam	-2.05	2.28	18	12	1984, 1988	0	1985	3
Sholavandan	-2.26	1.79	14	16	2000, 2003	1985, 1995	1988	5
Tallakulam	-1.86	2.01	16	14	1981, 1984, 1985, 1995	1988	0	5
Thirumangalam	-1.86	1.75	15	15	1984, 1985, 1999	1988, 1995	0	5
Usilampatti	-1.86	2.52	12	18	1985, 1988, 1999, 2000, 2001	0	0	5
Viraganur	-1.32	2.38	12	18	1988, 2006, 2008, 2009	0	0	4

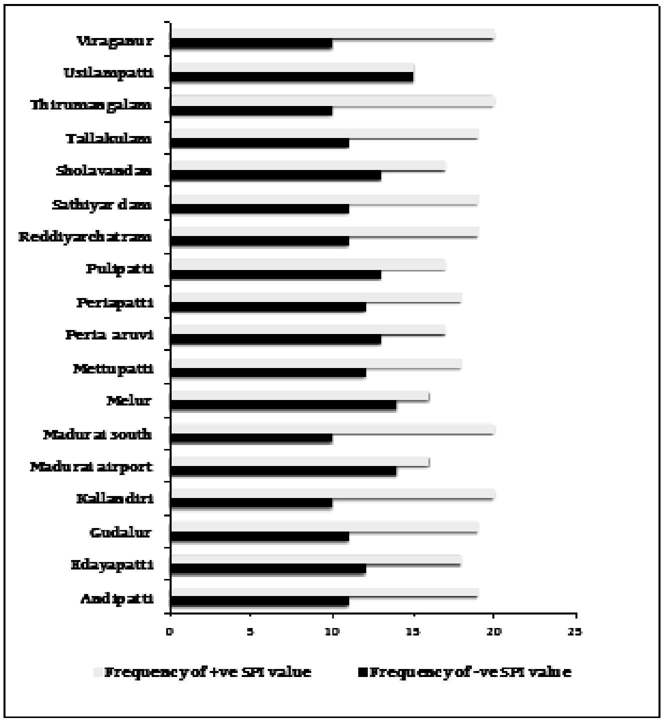

Fig. 3. Frequency of positive and negative SPI values of SWM over PCV area

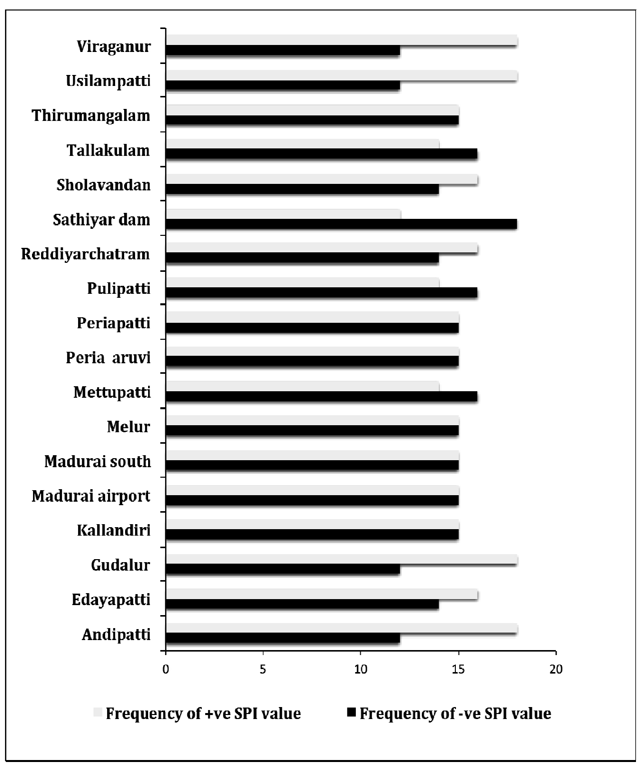

Fig. 4. Frequency of positive and negative SPI values of NEM over PCV area

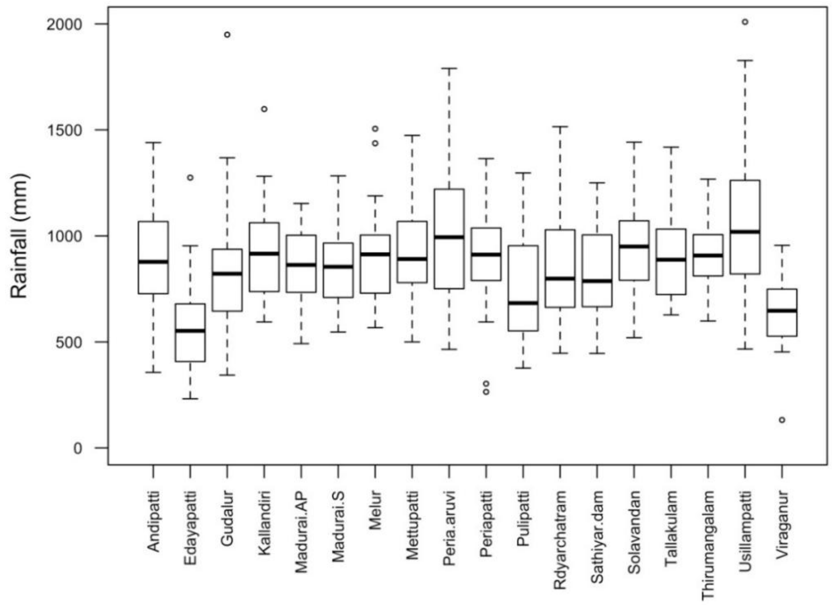

Fig. 5. Annual rainfall and its variability over the locations of PVC area

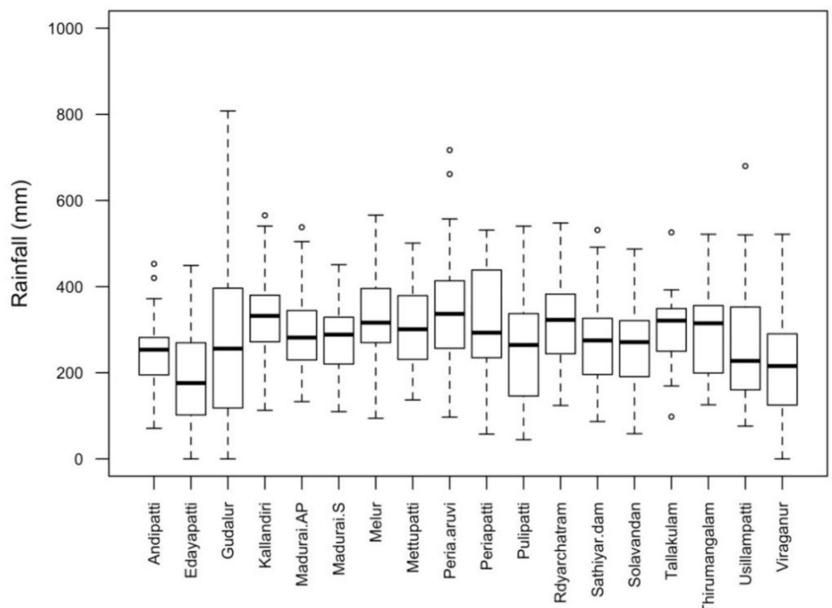

Fig. 6. South West Monsoon rainfall and its variability over the locations of PVC area

Except for Andipatti, Gudalur, Periaaruvi, Sholavandan and Viraganur, all other locations experienced severe drought during the SWM period. The location Madurai south witnessed severe drought during 1994, 2002 and 2006 marking highest number of occurrences among the locations. All other locations witnessed one or two years of severe drought conditions. In the case of NEM, 9 out of 18 locations alone witnessed severe drought conditions. During NEM, almost all 9 locations witnessed severe drought either once or twice. Interestingly during NEM, consecutive droughts were experienced in Edayapatti (1994, 1995), Madurai airport (1984, 1985), Mettupatti (1984, 1985) were such consecutive severe drought years are missing during SWM.

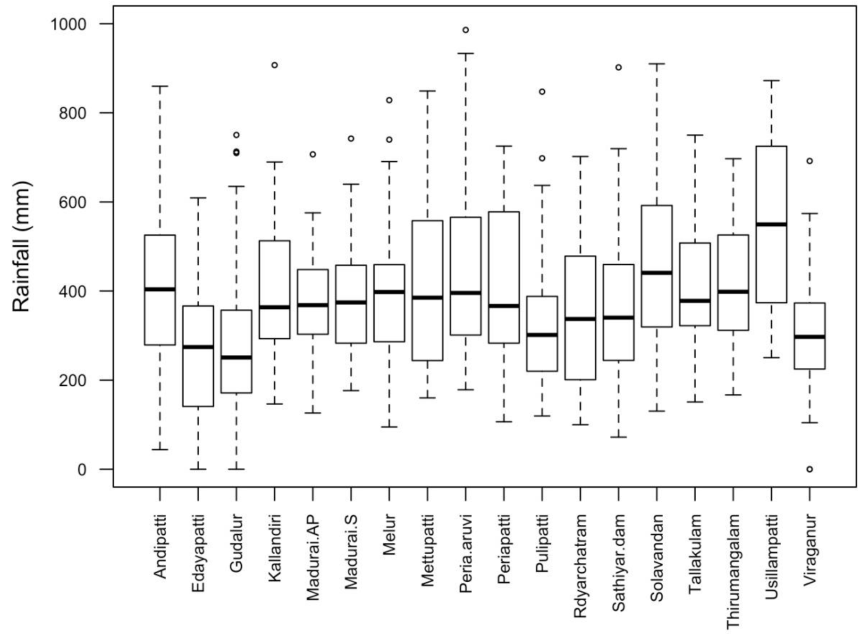

Fig. 7. North East Monsoon rainfall and its variability over the locations of PVC area

Moderate drought was experienced in both monsoons and as an exception, the location Madurai south alone had no moderate droughts occurrence during SWM (it had the highest of 3 severe drought occurrences). Most of the locations had witnessed 2 to 4 moderate drought years in both the monsoons. Typically in NEM, Usilampatti had 5 such years out of which 3 consecutive years were drought-affected 1999, 2000 and 2001.

It is important to note the consecutive years with moderate drought. During SWM, the locations Edayapatti (2001, 2002), Pulipatti (2001, 2002), Sholavandan (1994, 1995), Thirumangalam (2005, 2006) and Usilampatti (2002, 2003) witnessed two consecutive drought years. Viraganur alone witnessed three consecutive years (2008, 2009, and 2010) making it more prone to such drought than other locations.

During the period of NEM, consecutive drought years were observed in most of the locations and interestingly the years 1984 and 1985 stands out as consecutive drought years in Madurai south, Pulipatti, Reddiyarchatram, Tallakulam, Thirumangalam showing its spatial spread. The locations Mettupatti (2008, 2009) and Viraganur (2008, 2009) also had consecutive droughts and Usilampatti had three consecutive years (1999, 2000, and 2001).

The analysis based on SPI reveals a good insight into the distinctive features of the monsoons. SPI showed considerable variation in the drought occurrences between the monsoons. Consecutive drought years were well presented through SPI, which gives relevant information for crop planning in certain locations that have consecutive drought situations. Similar results with variability between monsoons over a southern zone of Tamil Nadu [17,18].

4. CONCLUSION

The drought situation of a location is an important parameter for making decisions on the choice of crop and livestock. Drought over the PVC exhibited considerable variation over space and time. Among the locations, Edayapatti has high drought frequency. On comparing the monsoons, there are no wide variations in drought characteristics between SWM and NEM. Consecutive drought years were well presented through SPI, which gives relevant information for crop planning. In both the monsoons, the locations Viraganur, Pulipatti and Usilampatti witness consecutive droughts. These drought characteristics will help to understand the spatial variation over the PVC area and obviously will guide in crop selection. Further, length of growing period, water balance has to be studied to devise successful farming options for the PVC area.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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