Rainfall Indexation for Evaluating Rainfall Risk Profile of Indian Subcontinent

Bharath V. [1]
Kotreshwar G. [2]

Abstract

This paper introduced a new set of rainfall indices which can be used as building blocks for designing rainfall derivatives contracts. Such a set was defined as deficit rainy days (DRD)/ excess rainy days (ERD) indices and computed for selected meteorological sub-divisions of India. The study aimed to explore the volatility and other statistical properties of DRD/ERD indices in order to assess the rainfall risk profile of the Indian subcontinent. The methodology proceeded in a step-wise form: Empirical values of DRDs/ERDs over 50 years for selected MSDs of India were derived, and then these index values were analyzed for determining the degree of variability, followed by the examination of the degree of intercorrelation amongst indices of selected meteorological sub-divisions. The paper provided insights on the behaviour of the volatility of the proposed indices and their potential application in designing rainfall derivatives contracts.

Keywords : rainfall risk, rainfall indexation, deficit rainy day (DRDs), excess rainy days (ERDs), rainfall derivatives

JEL Classification : G22,G28,Q14,Q59

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The Indian economy is extremely sensitive to monsoon outcomes. Panagariya (2009) pointed out that India's economy is highly vulnerable to climate change. It is estimated that 70% of agriculture losses occur either due to drought or floods (Parchure, 2002). The extreme weather fluctuations significantly impact agriculture and other enterprises, including power generation, agri-insurance, finance, agri-processing, etc. The effective management of monsoon risk is essential for achieving sustainable development of the economy. Traditional risk management tools like crop insurance are found to be grossly inadequate. Recent innovations in financial markets hold a significant promise. This involves developing rainfall - index - based derivative products as a risk-management instrument to hedge against rainfall risk by many stakeholders. Rainfall derivatives (RDs) are new risk management tools, which could be used in the capital market to minimize the adverse impact of monsoon outcomes on the Indian economy. Choudhary and Nair (2017) opined that rainfall derivatives are the beautiful creation of financial engineering. This instrument is the need of the hour for the Indian economy. This study introduces a new set of rainfall indices, which can be used as building blocks for designing rainfall derivatives contracts.

The proposed study aims to determine rainfall indices for selected meteorological sub - divisions (MSDs) of

[1] *Research Scholar,* DoS in Commerce, University of Mysore, Mysuru, Karnataka - 570 006.
(Email : bharathv@commerce.uni-mysore.ac.in)
[2] *Professor (Rtd.),* Senior Fellow, Indian Council of Social Science Research (ICSSR), New Delhi - 110 067.
(Email : kotreshwar@commerce.uni-mysore.ac.in)

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India based on a new methodology. The study will analyze the statistical properties of computed indices in order to assess the rainfall risk profile. The study also intends to examine the relationship of rainfall indices among the selected meteorological sub-divisions of India.

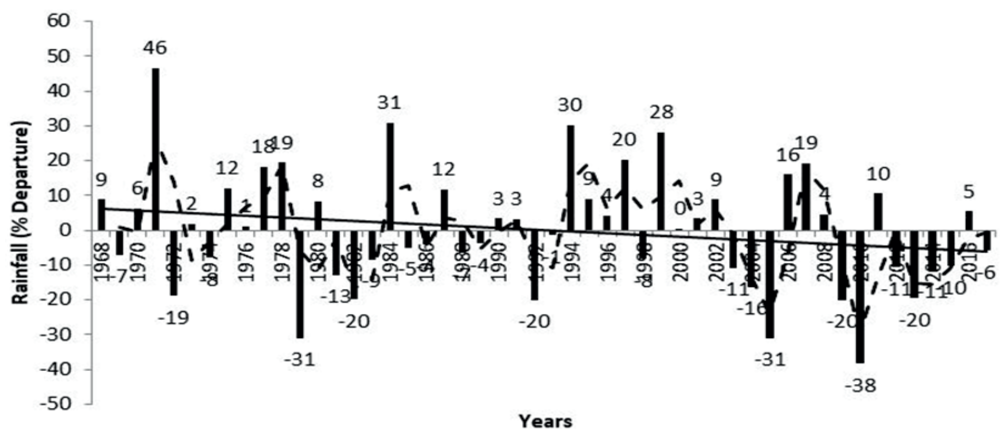
Monsoon Sensitivity in India

Monsoon sensitivity is a term that explains the difference in the amount and pattern of rain over time. The Indian Meteorological Department (IMD) has identified 36 meteorological sub-divisions in the country and installed more rain gauges all over the country to capture the complex variation of monsoon across the country. This will help to understand the behavior of monsoon variability, and it is useful to make a comparable and comprehensive analysis of continuous rainfall time-series data. South-west monsoon is the only season when most parts of the country receive more than 75% of the annual rainfall. It is essential to look into various aspects of the south-west monsoon to understand the variability through an extensive review of previous studies.

Mooley and Parthasarathy (1984) observed that rainfall across India showed a large spatial variability, and there is a need for more rain gauge stations to find variability in rainfall data. Gadgil and Gadgil (2006) examined a substantial loss in agricultural output during severe droughts. Kumar, Rajeevan, Pai, Srivastava, and Preethi (2013) analyzed the variability of droughts all over India using the drought index and showed an increase in the percentage of area affected and intensity of droughts over India in the recent decades. Pai, Guhathakurta, Kulkarni, and Rajeevan (2017) and Guhathakurta and Revadekar (2017) analyzed the variability and trends in the rainfall pattern over the country based on monthly and seasonal data. The study observed that most of the subdivisions in Northern, Central, Eastern, and North - Eastern India showed a downward shift in south - west monsoon rainfall. It was observed that a significant loss occured in agricultural output during the drought years ; the country experienced 33.55% of drought-affected areas during 1951, 1965, 1966, 1968, 1972, and 1974. Kothawale and Rajeevan (2017) analyzed 145 years of all-India monsoon rainfall data, and it showed a weak decreasing trend, and the mean value of seasonal rainfall was significantly reduced during the recent past.

Most of the previous researchers opined that monsoon rainfall has significantly reduced during the recent past. Figure 1 shows that the all-India south-west monsoon rainfall was excess in 23 years, deficit in 24 years, and normal in one year from 1968 – 2017. It was observed that there were relatively more frequent deficit years

Figure 1. All India South – West Monsoon Rainfall : 1968 – 2017



Source : Rainfall Statistics of India Reports from 1968 to 2017

(7 years) in the last 10 years. The linear trend analysis shows a significant decreasing trend in the departure of south - west monsoon rainfall. However, most of the regions in the country are severely affected due to deficit rainfall. Shruthy and Kumar (2017) found that rainfall had a significantly positive impact on crop productivity. Hence, the deficit rainfall is a significant risk source, impacting the revenues and earnings of different sectors.

Emerging weather risk markets indicate the scope for managing rainfall risk using rainfall-index based on financial products. As a first step, a proper methodology for rainfall indexation is to be developed.

Review of Literature

A standard methodology for rainfall indexation is yet to emerge. Skees, Gober, Varangis, Lester, and Kalavakonda (2001) developed a season-based rainfall index based on average monthly payment percentages. The method for calculating the payment percentage is as shown below :

$$\text{Payment Percentage (Drought)} = \frac{\textit{Strike Rain} - \textit{Actual Rain}}{\textit{Strike Rain}} \tag{1}$$

$$\text{Payment Percentage (Flooding)} = \frac{\textit{Actual Rain} - \textit{Upper Strike Rain}}{\textit{Actual Rain}} \tag{2}$$

Equations (1) and (2) were supported and adopted by Veeramani, Maynard, and Skees (2005) for developing rainfall-index based options. Stoppa and Hess (2003) suggested a rainfall index based on several aggregated weights' average rainfall in each growth stage's 10 - day period. National Commodity & Derivatives Exchange (NCDEX) has proposed a rainfall index based on historical cumulative rainfall. First rainfall index for Mumbai city was launched in the year 2005 followed by indices for Belgaum, Erode, Guntur, Karimnagar, Ganganagar, Kottayam, Murshidabad, Rajkot, and Ujjain in 2006. The methodology of estimation of rainfall index is discussed below :

$$RI_{location} = \frac{\Sigma r_{it}}{\Sigma R_{it}} \times \textit{Scale Value} \tag{3}$$

where, r_{it} represents actual rainfall of i^{th} day of the t^{th} season ; R_t represents long period average daily rainfall of i^{th} day of the t^{th} season ; scale or multiplier value is assumed 1000 (rainfall is measured equivalent to 1/1000th of a met, that is, in millimeter). $RI_{location}$ indicates what percentage of cumulative normal expected rainfall is realized, which means higher the rainfall index value than the cumulative average rainfall upto the date of index, more rainfall. A similar estimation method of rainfall index was proposed by Multi Commodity Exchange (MCX) and Weather Risk Management Services Pvt. Ltd. (WRMS). They have jointly developed rainfall indices based on historical annual cumulative rainfall, and it is adjusted with excess and deficit of actual cumulative rainfall, as mentioned in the specific data. The adjustment factor takes into account the impact of historical and actual rainfall during the period.

Kotreshwar (2006), Kotreshwar and Kanakasabai (2006), and Kotreshwar and Arunkumar (2006) explored the conceptual framework for rainfall derivatives based on millimetre rainy days (MRD) index. This index is based on daily average rainfall (in millimetres). The average daily rainfall serves as the reference level (R_x). The following methods are adopted to generate MRDs :

$$\text{For Call Options, } MRD_i = \text{Max. } \{R_x - R_i , 0\} \tag{4}$$

For Put Options, $MRD_i = \text{Max.}\ \{R_i - R_x, 0\}$ (5)

where, R_x indicates a reference level and R_i represents the rainfall measured in terms of millimetres on a daily basis.

Patni (2008) proposed a cumulative rainfall index (R_c) representing a reference base for estimated rainfall in a region or location. It can be defined as :

$$R_C = \Sigma^n_{t=1}\, r_i \quad (6)$$

where, R_C indicates cumulative rainfall index, r_i donates rainfall on i^{th} day from a reference date, and n is the number of days from reference date to the current date.

Shivkumar and Kotrshwar (2013) and Kotreshwar (2015) proposed the process of rainfall indices based on a ticker value defined as monsoon outcome index (MOX) and estimated their statistical properties of MOX series across time and sub - divisions, and the study examined the potential of MOX as a new asset class for inclusion in the portfolio for risk hedging. The following method is used to measure the MOX index :

$$MOX = \frac{\Sigma R_{it}}{\Sigma R_{ct}} \times 1000 \quad (7)$$

where, R_{it} indicates cumulative rainfall for the end of i^{th} month of the t^{th} season ; R_{ct} indicates historical average cumulative monthly rainfall for the t^{th} season, and 1000 is the multiplier value (where rainfall is measured equivalent to $1/1000^{th}$ of a metre, in millimetres). Kotreshwar (2015) modified their suggested methodology to compute rainfall indices as deficit rainy days (DRD) and excess rainy days (ERD). This approach appears to be more relevant to define and evaluate rainfall variability using DRD/ERD measures as standard metrics. The present study is based on this new approach for rainfall indexation.

The review of the existing literature indicates that most of the research studies are of conceptual nature. Few studies were carried out in the area of measuring rainfall indices. Research on rainfall indication in India is still in its nascent stages. The present study intends to analyze the general framework for the standardization of rainfall measures to measure rainfall risk.

Methodology

Deficit/ excess rainfall at a given location needs to be quantified using a standard metric. For this purpose, the historical daily average rainfall for the selected location would serve as the 'base' rainfall for calculating the metric. The rainfall at a location equivalent to being below a defined normal rainfall by one millimetre for one day can be denoted as 'deficit rainfall day' (DRD). Similarly, rainfall at a location equivalent to being above a defined normal rainfall by one millimetre for one day can be denoted as 'excess rainfall day' (ERD). For example, the given historical daily average rainfall for June for a location is 3 mm, and if the actual daily average rainfall is 2 mm, we can approximate the DRDs for June as 30 (1 × 30 days). A south-west monsoon season of 4 months (June – September) might accumulate seasonal minimum of zero or a maximum of over 100 DRDs for a location. A zero DRD means that all the four months recorded excess rainfall. Similarly, a zero ERD implies that all the four months recorded deficit rainfall.

The underlying variable being rainfall, let R_i denote the rainfall (in millimetres) measured on i^{th} day, and R_x denotes the average daily rainfall (in millimetres). The average daily rainfall, R_x, should serve as the reference level for rainfall in millimetres. The value of R_x is based on the past rainfall data for any chosen length of the period. The standard underlying variable would be simply the difference between the daily average value of rainfall (in millimetres), that is, R_x , and the actual value of rainfall (in millimetres) on i^{th} day, that is, R_i. The DRDs generated on a given i^{th} day then is given by :

$$DRD_i = \text{Max. } \{R_x - R_i , 0\} \quad (8)$$

Similarly,

$$ERD_i = \text{Max. } \{R_i - R_x , 0\} \quad (9)$$

In equations (8) and (9), it can be seen that the number of DRDs /ERDs for a specific day is just the number of millimeters that the rainfall deviates from a reference level. The methodology adopted in this paper comprises of the following steps :

(i) Estimation of reference level of rainfall for each of the selected meteorological sub-divisions (MSDs) in India.

(ii) Estimating the DRDs for each month of the south-west monsoon.

(iii) Taking the sum of DRDs for all the four months.

The number of accumulated DRDs (D_n) for a period of $'n'$ days can be determined as follows :

$$D_n = \Sigma^n_{i=1} DRD_i \quad (10)$$

Similarly, the number of accumulated ERDs (E_n) for a period of $'n'$ days can be determined as follows :

$$E_n = \Sigma^n_{i=1} ERD_i \quad (11)$$

Monthly DRDs/ERDs facilitate capturing the element of variability in each month of the south-west monsoon. The DRD values are computed based on equations (8), (9), and (10) for the selected 10 of the 36 MSDs of India (given in the Appendix).

Objectives

(1) To derive empirical values of deficit rainy days (DRD) of selected meteorological sub-divisions of India.

(2) To examine the statistical properties of deficit rainy days (DRD) index of selected meteorological sub-divisions of India.

(3) To analyze the degree of association among DRD indices of selected meteorological sub-divisions of India.

The present study is based on secondary data. The sample data were drawn from the official website of the Indian Meteorological Department (IMD) of India. The study covered monthly average rainfall data of the south-west monsoon season (June – September) for analysis. The study covers the past 50 years (1968 – 2017) of rainfall data. The sample was selected based on severely affected and moderately affected regions identified by Hydrology and Water Resources Information System for India. Then, the sample was drawn based on a simple random sampling method. Out of 36 MSDs, 10 sub - divisions were considered for the study. The selected meteorological sub-divisions of India for the study are depicted in Table 1.

Table 1. ***Selected Meteorological Sub-Divisions of India for the Study***

North	South	Central	East	West
Punjab	Rayalaseema	Vidarbha	Bihar	Gujarat region
(PUNJB)	(RLSMA)	(VDABH)	(BIHAR)	(GUJRT)
Haryana, Chandigarh, & Delhi	North Interior Karnataka	West Madhya Pradesh	Jharkhand	Saurashtra & Kutch
(HARCHDEIL)	(NIK)	(WESTMP)	(JHKND)	(SAUSHTRA)

Source : Indian Meteorological Department of India (2018).

Analysis and Results

The study's preliminary analysis includes computing statistical parameters like mean, median, maximum, minimum, skewness, and kurtosis for deficit rainy days in the south-west rainfall series of selected meteorological sub-divisions for the period of 1968 – 2017, which has been computed and given in Table 2.

Table 2. ***Descriptive Statistics of DRD Values of Selected MSDs in India***

Regions	Sub-divisions	Mean (in MM)	Median (in MM)	Maximum (in MM)	Minimum (in MM)	Skewness	Kurtosis
North	PUNJB	94.64	88.32	274.98	0.000	0.6098	2.995
	HARCHDEIL	93.45	86.69	248.21	0.000	0.3288	2.373
South	RLSMA	75.42	78.84	167.34	**7.430**	0.1930	1.949
	NIK	76.4	76.48	188.16	0.000	0.3550	2.340
Central	VDABH	135.55	117.85	294.44	0.000	0.1920	1.927
	WESTMP	135.97	125.94	315.44	0.000	0.3139	2.016
East	BIHAR	136.01	139.64	407.15	0.000	0.6869	**3.150**
	JHKND	134.07	115.45	401.9	0.000	**1.0270**	4.199
West	GUJRT	**193.84**	**176.38**	**566.66**	0.000	0.6359	2.580
	SAUSHTRA	147.69	125.02	421.90	0.000	0.5990	2.503

Table 2 shows the descriptive statistics of deficit rainy days (DRD) values of selected MSDs in India. The mean of DRD values is highest in Gujarat (193.84 mm) followed by Saurashtra, Kutch, & Diu (147.69 mm). The Central (Vidarbha, West MP) and East (Bihar, Jharkhand) regions have similar mean values. The lowest mean DRD value is in Rayalaseema (75.42 mm) followed by North Interior Karnataka (76.4 mm). It is observed that the West region has the highest mean DRD values compared to the Central and East regions.

The maximum DRD value is highest in Gujarat (566.66 mm) followed by Saurashtra, Kutch, & Diu (421.9 mm) ; Bihar (407.15 mm) ; and Jharkhand (401.9 mm). It is observed that the West region has the highest incidence of drought than other regions followed by the East region.

The rainfall derivatives contracts payoff is based on an underlying index (DRD), which is observed from rainfall data at a specific geographic location. Based on this, the mean DRD values for the selected regions would serve as the 'base' for calculating the contract's payoff. For example, from Table 2, the mean DRD value of south-west monsoon season for Gujarat is 193.84 mm ; this value indicates that every year, Gujarat has been facing a minimum of 193.84 mm of deficit rainfall from the south-west monsoon season. The Gujarat region's DRD values would serve as a benchmark for designing rainfall options and futures contracts for trading in the markets.

Skewness is a measure of the abnormality of the distribution of the data series around its mean. All

Table 3. ***Jarque – Bera Test for Normal Distribution***

Regions	Sub-Divisions	Statistic	Sig. Value
North	PUNJB	3.099	**0.2122**
	HARCHDEIL	1.718	**0.4233**
South	RLSMA	2.6099	**0.2711**
	NIK	1.936	**0.3798**
Central	VDABH	2.707	**0.2583**
	WESTMP	2.8386	**0.2418**
East	BIHAR	3.9852	**0.1363**
	JHKND	11.790	**0.2800**
West	GUJRT	3.7367	**0.1543**
	SAUSHTRA	3.510	**0.1728**

sub-divisions are positively skewed, which means that the distribution has a long right tail. Kurtosis measures the flatness or peakedness of the data series. Out of 10 sub-divisions, the Kurtosis values of eight sub-divisions are less than 3, indicating that the distribution is flat (platykurtic) relative to the normal. Only two sub-divisions (Bihar & Jharkhand) have kurtosis values of more than 3 ; the distribution is peaked (leptokurtic) close to the normal.

It is necessary to find out whether the DRD series display a normal distribution. This helps to determine whether parametric or non-parametric tests can be used to analyze the presence of shocks, homogeneity, and variability in the DRD values. To know the distribution characteristics of the DRD values, Jarque – Bera (JB) test has been applied. Jarque – Bera is a test statistic for testing whether the data series is normally distributed or not. Under this test, the null hypothesis is framed as the data series follows a normal distribution.

Kurtosis values are evidence that there is a platykurtic distribution in the selected DRD values. Hence, the DRD values are normally distributed. Jarque – Bera test results support this. Table 3 shows that all the 10 sub-divisions are above 5% significance value, leading to the null hypothesis's acceptance. The data series are normally distributed, and hence, the parametric test can be used for further analysis.

To analyze the volatility in the DRD index, the standard deviation method has been used. Drought risk is

Table 4. ***Variability in DRD Values of Selected MSDs in India***

Regions	Sub-Divisions	Std. Dev (in MM)	CV (%)
North	PUNJB	64.65	68.31
	HARCHDEIL	64.59	69.11
South	RLSMA	44.39	58.85
	NIK	52.36	68.53
Central	VDABH	86.85	64.07
	WESTMP	85.00	62.51
East	BIHAR	91.57	67.32
	JHKND	83.502	62.28
West	GUJRT	**145.83**	**75.23**
	SAUSHTRA	106.00	71.77

represented by the standard deviation of the DRD index ; the higher the standard deviation, the high is the volatility in the DRD index, and the higher is the drought risk. Table 4 lists the standard deviation values of the sub-divisions under the study. The above results indicate that Gujarat (145.83) has the highest volatility in the DRD values among the selected MSDs, while for Rayalaseema (44.39), it is the least. The results indicate that the West region has high volatility in the DRD values, which means that the West region is at higher drought risk. The South region has low volatility in the DRD values, which indicates that the South region has less drought risk. Opportunity exists to create a hedge for such drought risk such that higher drought risk of one region can be used to offset the lower drought risk regions.

The coefficient of variation (CV) method is used to measure the relative variability in the DRD data series. It represents the ratio of the standard deviation of DRD values to the average DRD values of the MSDs. It is used to compare the degree of variation in the DRD values from one sub-division to another. Table 4 indicates CV of DRD values among sub-divisions. The CV values vary between 58.85% and 75.23%. The CV values of all the sub-divisions have a high degree of variation in DRD values, although Gujarat has a high variability of 75.23% followed by Saurashtra, Kutch, & Diu (71.77%), indicating that the West region has the highest variability in the DRD values.

Table 5 depicts the degree of inter-sub division dependency in DRD values of rainfall data. The pair-wise correlation analysis amongst 10 selected sub-divisions has been carried out. It is found that the correlation values range between a maximum of +0.85 and a minimum of –0.82. The result shows that out of 45 pair-wise

Table 5. *Correlations of the DRD Index of Selected MSDs*

		Bihar	Delhi	Gujarat	Jharkhand	NIK	Punjab	Rayalseema	Saurashtra	Vidarbha
Bihar	Correlation	1.0000								
	Sig.	-								
Delhi	Correlation	0.2399	1.0000							
	Sig.	0.0932**	-							
Gujarat	Correlation	–0.0825	0.5125	1.0000						
	Sig.	0.5686	0.0001*	-						
Jharkhand	Correlation	0.6409	0.2156	–0.0486	1.0000					
	Sig.	0.0000*	0.1325	0.7372	-					
NIK	Correlation	0.01634	0.0665	0.2620	–0.2515	1.0000				
	Sig.	0.9103	0.6459	0.066**	0.0781**	-				
Punjab	Correlation	0.1753	0.8587	0.4560	0.2211	–0.0061	1.0000			
	Sig.	0.2232	0.0000*	0.0009*	0.1227	0.9661	-			
Rayalseema	Correlation	0.0068	0.2669	0.4216	–0.2656	0.5626	0.0908	1.0000		
	Sig.	0.9626	0.0609**	0.0023*	0.0623**	0.0000*	0.5305	-		
Saurashtra	Correlation	–0.1176	0.4162	0.8585	–0.0747	0.1992	0.4365	0.3387	1.0000	
	Sig.	0.4160	0.0026*	0.0000*	0.6061	0.1653	0.0015*	0.0168*	-	
Vidarbha	Correlation	0.0624	0.3720	0.5762	–0.0186	0.3359	0.3417	0.4644	0.4184	1.0000
	Sig.	0.6667	0.0078*	0.0000*	0.8979	0.0171*	0.0151*	0.0007*	0.0025*	-
West MP	Correlation	0.1610	0.4370	0.5011	0.2296	0.0585	0.4227	0.2556	0.3719	0.5806
	Sig.	0.2638	0.0015*	0.0002*	0.1087	0.6865	0.0022*	0.0732**	0.0078*	0.0000*

Note. ** Correlation is significant at the 0.01 level.

* Correlation is significant at the 0.05 level.

interrelationships, 16 pairs have a very weak positive correlation, and 21 pairs have a strong positive correlation. The remaining 8 pairs have a negative correlation. Region-wise, nearer sub-divisions have a high positive correlation and vice versa.

The majority of the inter-sub divisions have a weak (i.e., near to zero and negative) correlation with 5% and 10% significance values. Hence, DRD indices across inter-meteorological sub-divisions are significantly uncorrelated. DRDs can be used as a distinct asset class. Stakeholders like agri-insurance companies, having sold rainfall-based index insurance policies across a wide geographical area, can minimize their exposure by building a diversified portfolio of DRD indices.

Conclusion and Implications

Drought is a major source of risk to the Indian economy. Besides agriculture and allied sectors, power generation, manufacturing, transportation, insurance, and other industries also get affected due to adverse monsoon outcomes. In this background, the study aims to develop the framework of standard indexation that can serve as a basis for designing a rainfall index based on insurance and derivative contracts. Drought index, that is, deficit rainy days (DRD) index, has been developed to measure the drought risk with special reference to the south-west monsoon. These indices' statistical properties have been analyzed by using mean, standard deviation, and coefficient of variation. The results reveal that the mean and standard deviation values of DRDs are significantly different among the selected meteorological sub-divisions. The variability in the DRD values amongst the sub-divisions is high. The correlation method is used to analyze the pair-wise interrelationship among MSDs.

The present research study has major implications for policymaking in the field of rainfall risk management. The study's research inputs will help create a market for trading rainfall derivatives like futures and options that stakeholders can use to minimize adverse monsoon events.

The SEBI has initiated a discussion on proposing new standardized weather derivative products that can be used to minimize weather-related risks in India. The study would provide some inputs to develop standard metrics for measuring deficit/excess rainfall as DRDs/ERDs. This rainfall indexation would serve as a benchmark for designing rainfall options and futures contracts for trading in over-the-counter and organized markets.

Limitations of the Study and Scope for Further Research

The study is based upon monthly rainfall data collected from rainfall statistics of India report collected from Indian Meteorological Department's (IMD) website. Conversely, if the rainfall data were collected on a daily basis, the results could be more accurate.

The study analyzed the statistical properties of deficit rainy days (DRD) for selected meteorological sub-divisions. Further research can also be taken to analyze the statistical properties of excess rainy days (ERDs) of the meteorological sub-divisions.

Authors' Contribution

Dr. G. Kotreshwar proposed the idea and developed a quantitative design to undertake the empirical study. The numerical computations were done by Bharath V. using Eviews 11 software. Bharath V. wrote the manuscript in consultation with the primary author.

Conflict of Interest

Both the authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest, or non-financial interest in the subject matter, or materials discussed in this manuscript.

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Appendix

DRD Values for South - West Monsoon for 50 years (1968 – 2017)

(For Selected Meteorological Sub-Divisions (MSDs) of India)

MSD/Year	JHKND	BIHAR	HARCH DEIL	PUNJAB	WEST MP	GUJRT	SAUSHTRA	VDABH	RLSMA	NIK
1968	134	139	156	106	156	242	209	173	138	95
1969	109	0	77	102	69	174	212	174	101	41
1970	83	92	83	90	113	70	23	96	29	28
1971	0	112	26	48	92	182	45	260	129	120
1972	249	407	106	109	236	389	296	259	147	158
1973	116	168	48	32	42	70	126	121	35	65
1974	128	39	132	145	168	567	363	284	68	75
1975	79	145	0	0	34	118	97	0	28	20
1976	152	134	38	0	38	0	17	121	90	91
1977	46	166	4	0	34	37	52	54	74	71
1978	71	46	0	30	86	143	150	111	33	4
1979	326	286	209	180	276	255	197	103	78	2
1980	21	29	79	76	210	214	153	87	97	13
1981	167	103	127	188	71	25	45	6	16	0
1982	265	262	145	196	166	289	221	230	118	62
1983	167	147	25	52	90	0	14	18	10	0
1984	75	59	8	9	275	180	108	254	157	121
1985	76	43	51	27	168	428	253	247	138	165
1986	132	13	118	33	189	446	281	96	125	80
1987	100	24	248	275	267	512	422	294	122	75
1988	180	59	0	16	31	91	105	11	45	32
1989	94	119	87	80	208	102	123	106	90	68
1990	76	94	36	40	35	167	246	36	69	108
1991	93	156	141	125	193	334	283	183	85	105
1992	211	317	79	91	195	126	75	114	97	93
1993	166	140	124	160	79	223	255	105	39	78
1994	68	174	54	29	0	0	4	0	167	140
1995	71	114	39	13	110	353	227	151	48	96
1996	147	147	63	80	68	70	213	196	23	29
1997	31	26	56	76	77	155	92	170	79	70
1998	144	95	0	88	149	126	107	143	18	1
1999	0	12	141	169	140	431	345	78	109	99
2000	157	146	123	130	315	392	254	115	42	9
2001	115	152	87	101	301	111	81	236	90	145
2002	81	57	171	151	247	323	239	257	147	182

2003	113	18	2	22	88	10	46	85	30	188
2004	170	241	181	176	221	179	148	260	121	76
2005	326	252	94	82	216	38	124	74	8	17
2006	35	160	137	50	38	17	38	66	105	90
2007	77	38	154	138	84	41	0	16	7	20
2008	90	74	31	87	223	138	87	155	29	100
2009	232	284	201	127	238	348	131	284	71	24
2010	402	196	35	60	124	72	17	30	31	31
2011	162	77	107	80	0	179	65	85	95	100
2012	112	190	158	199	76	350	330	57	90	179
2013	206	285	84	98	49	46	41	26	24	62
2014	120	175	227	242	188	251	88	218	84	111
2015	213	259	129	118	128	285	128	179	54	157
2016	91	164	101	89	52	216	159	146	105	56
2017	230	166	151	118	146	180	49	206	36	72

About the Authors

Bharath V. is a Research Scholar in the Department of Studies in Commerce, University of Mysore, Mysuru, Karnataka. His specialization is in finance and financial markets, and his research publications are in the areas of financial derivatives and risk management.

Dr. Kotreshwar G., Professor (Rtd.), University of Mysore is currently working at ICSSR as a Senior Fellow. He has authored 10 books in the area of finance and has published 41 research papers in various reputed journals. His research interest is in the field of rainfall risk management.