The Pharma Innovation Journal 2021; SP-10(8): 20-25

www.ThePharmaJournal.com

The Pharma Innovation

**ISSN (E): 2277- 7695**
**ISSN (P): 2349-8242**
**NAAS Rating: 5.23**
TPI 2021; SP-10(8): 20-25

www.thepharmajournal.com
Received: 27-05-2021
Accepted: 12-07-2021

**Archana GH**
Department of Environmental Sciences and Natural Resource Management Sam Higginbottom university of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

**Shweta Gautam**
Department of Environmental Sciences and Natural Resource Management Sam Higginbottom university of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

**Corresponding Author**
**Archana GH**
Department of Environmental Sciences and Natural Resource Management Sam Higginbottom university of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

# Analysis of regional drought severity over central dry zone of Karnataka by using SPI

**Archana GH and Shweta Gautam**

**Abstract**
Drought is one of the most complex and least understood natural disasters that badly affect growing or living conditions Rainfall is to be believed as a normal, wet and dry condition of the climate. It is one of the most important water associated hazards. It has great impact on agricultural, hydrological, economic, environmental and social systems. Understanding these impacts is crucial for drought planning, mitigation, and response. It also helps decision makers identify and reduce vulnerability to drought. Drought monitoring is a key component of drought preparedness and the standardized precipitation index (SPI) has several characteristics that are an upgrading over other indices, with its simplicity and flexibility. The objective of this study was to analyze drought severity using SPI method for observing and describing drought based on thirty (30) year precipitation data of central dry zone of karnataka (1985 - 2014). Positive SPI values point to normal condition to wet condition and negative values indicate normal condition to dry condition. SPI method resulted in showing extreme drought events in the year 1985, 1989, 1990 and 1995, whereas the major extreme drought event occurred in 1985 was really caused by the low rainfall. The results show that the annual drought classification system proved to be efficient in the identification of events. The results of this study will be useful in understanding the historic patterns and build future scenarios of drought for risk management and climate change adaptation planning. Further research should include relating dryness patterns with pastoral systems, cropping pattern and crop production.

**Keywords:** Drought, standardized precipitation index (SPI), Central dry zone of Karnataka

## Introduction
Drought is a prolonged deficiency of rainfall that results in water shortage for some activity or a period of abnormally dry weather sufficiently prolonged for the lack of precipitation to cause a serious moisture deficit and hydrological imbalance. Drought can be considered as strictly meteorological phenomena and it means various things to various people based on their interest for example to meteorologist drought means below normal rainfall, to agrarian it means shortage of moisture in the root zone, to hydrologist it means below average water level in streams, lakes, reservoirs and the like, to the economist it means a water shortage that adversely affects the established economy. Meteorological drought is the earliest and the most explicit event in the process of occurrence and progression of drought conditions.
In the past (1970-2014), India has experienced twenty four large scale droughts in 1891, 1896, 1899, 1905, 1911, 1915, 1918, 1920, 1941, 1951, 1965, 1966, 1972, 1974, 1979, 1982, 1986, 1987,1988, 1999, 2000, 2002, 2009 and 2012 with increasing frequencies during the periods 1891-1920, 1965-1990 and 1999-2012.
Karnataka has the highest proportion (79 percent) of drought prone areas among all the major states in the country (State Perspective and Strategic Plan (SPSP, 2009). Karnataka also has the second lowest (154.2 mham/yr) replenishable groundwater resources among the major states after Rajasthan. Karnataka is second only to Rajasthan in terms of total geographical area prone to drought. Nearly 90 percent of the population in the semi arid region is dependent on agriculture for their livelihoods. Agricultural production declined to 6.4 million tons against the target of 10.405 million tons and the availability of crop residues for livestock was substantially reduced and low (GoK, 2003).
Assessment of drought is one of the most important steps in risk management of drought analysis. Rainfall is the primary driver of meteorological drought. There are numerous indicators based on rainfall that are being used for drought monitoring (Smakhtin and Hughes, 2007). Standardized Precipitation Index (SPI) is one of the methods commonly used to monitor drought and anomalously wet periods. It was introduced by McKee *et al*. (1993) [7].

with the purpose of assigning a single value to monthly rainfall that allows comparing the values across different climatic and geographic regions at a given period.

## Materials and Methodology

### Study area

The Karnataka state is divided into the 10 Agro-climatic zones. Central Dry zone of Karnataka is one of second most drought prone agro climatic zone next to northern dry zone. The zone is located in the southern part of Karnataka state (Fig 1) comprises of five districts i.e. Chitradurga, Davanagere, Tumukur, Hassan and Chikkamagalur districts. These districts comprise of 17 talukas is given in Table 1.

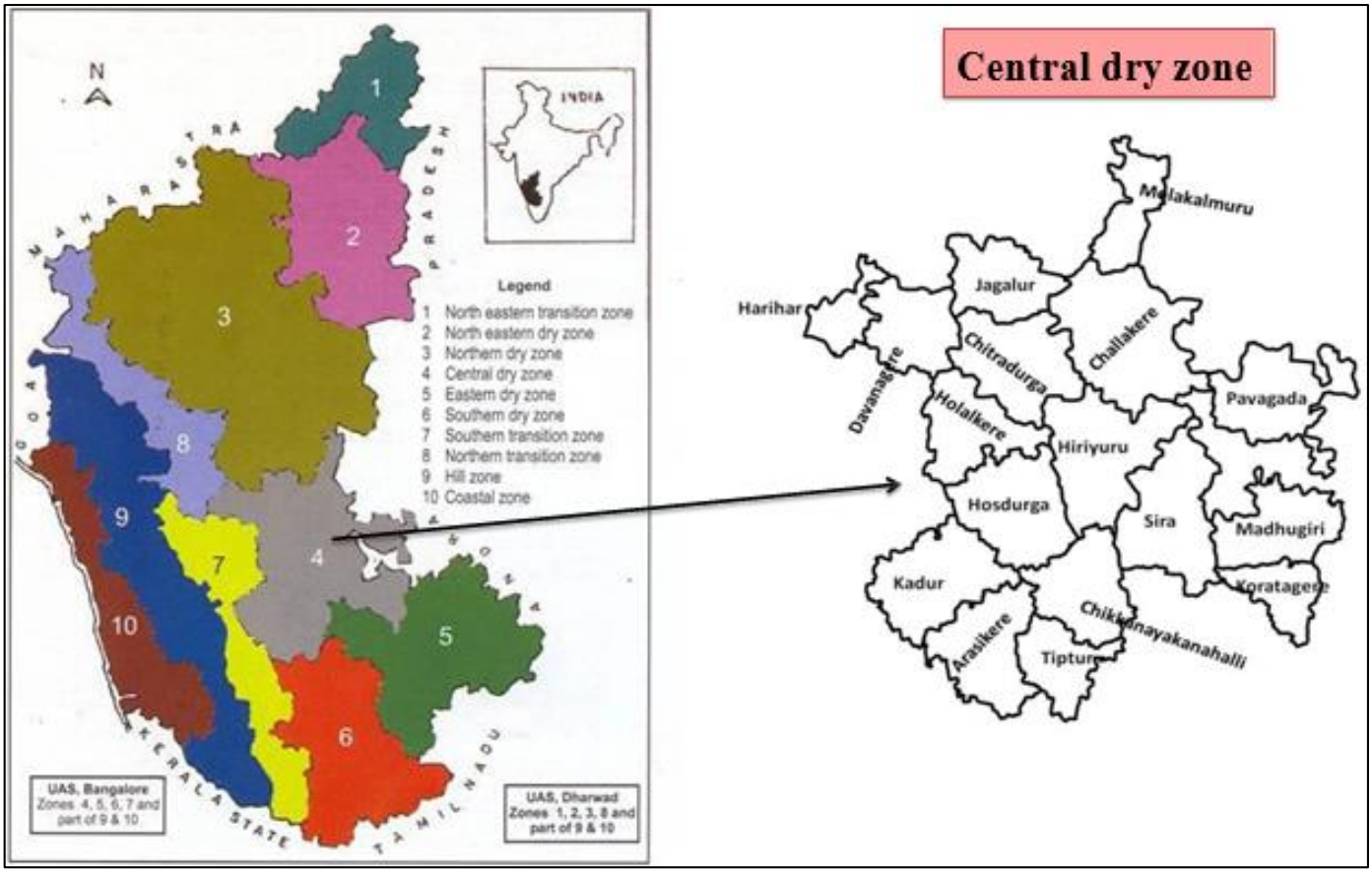


**Fig 1:** Talukas of central dry zone of Karnataka

### Climate and weather conditions

The climate of Central dry agro climatic zone of Karnataka is arid to semi-arid with fairly dry and hot summer. Winter is cold, sets in the month of November, and continues till the middle of February. Summer is hot and dry which commences from mid of February and ends by the month of June with mean maximum temperature around 360 C. This zone comprises of moderate dry and humid areas and the annual rainfall ranges from 453 to 717 mm with average rainfall of 607 mm and nearly 80% rainfall received in May-October. Water holding capacity of soil for this area is 100-150 mm. Length of growing period is 90-100 days.

**Soil:** The soil of this zone is alluvial in origin. The common types of soil groups in this zone are shallow to deep red clays, well-drained grey to dark grey and brown clay loam to silty clay loamy soils. The texture of the soil is sandy loam and black. The soil is deep enough to respond well to manuring and variety of crops of the tropical and sub-tropical regions. The major crops grown are Finger millet, Hybrid Sorghum, Pigeon pea and Groundnut.

**Table 1:** study area

| Districts | Taluk | Latitude (0N) | Longitude (0E) |
|---|---|---|---|
| Chitradurga | Challakere | 14.365 | 76.652 |
| | Chitradurga | 14.306 | 76.338 |
| | Hiriyur | 13.988 | 76.621 |
| | Holalkere | 14.062 | 76.147 |
| | Hosadurga | 13.801 | 76.334 |
| | Molakalmur | 14.873 | 76.769 |
| Davanagere | Davanagere | 14.392 | 75.992 |
| | Harihara | 14.407 | 75.77 |
| | Jagaluru | 14.536 | 76.291 |
| Tumukur | Chikkanayakanahalli | 13.529 | 76.567 |
| | Koratagere | 13.51 | 77.247 |

| | | | |
|---|---|---|---|
| | Madhugiri | 13.697 | 77.188 |
| | Pavagada | 14.143 | 77.204 |
| | Sira | 13.747 | 76.893 |
| | Tiptur | 13.296 | 76.477 |
| Hassan | Arasikere | 13.293 | 76.241 |
| Chikkmagalur | Kadur | 13.557 | 76.023 |

**Data collection**

Thirty years precipitation data has been collected from Karnataka State Natural Disaster Monitoring Centre (KSNDMC) for this study from 1985 to 2014. Variations in the yearly precipitation for thirty years from 1985 to 2014 is shown in Fig. 2.

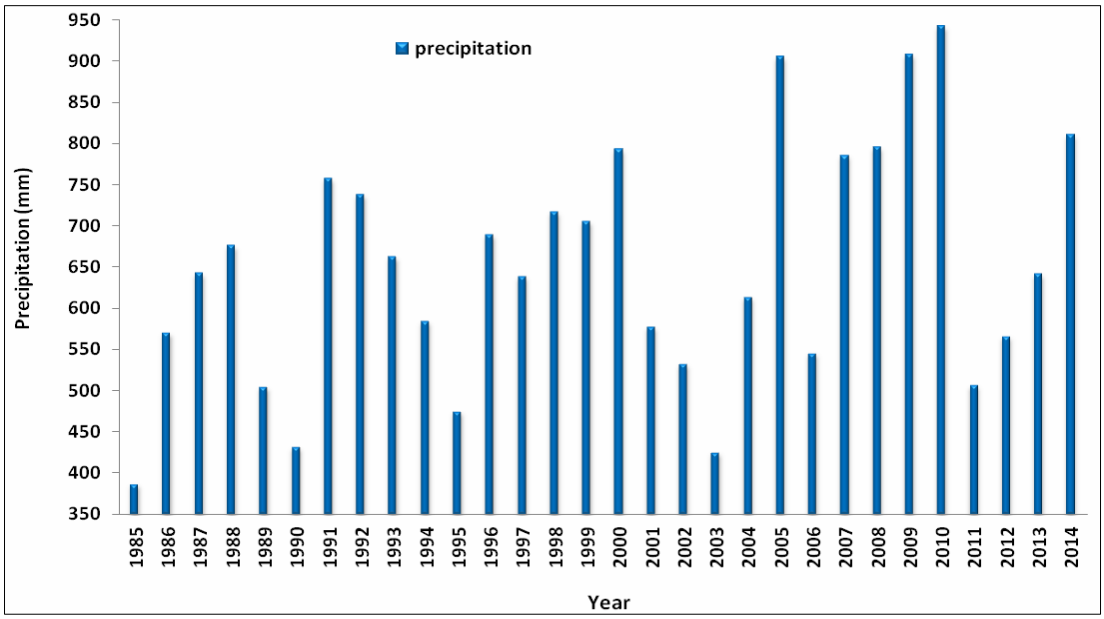


**Fig 2:** Annual precipitation from 1985 to 2014 for central dry zone of Karnataka

**Software used: - MDM**: (Meteorological Drought Monitoring) The "MDM" software application is free software for calculating precipitation-based indices. It has a user-friendly environment. In this tool, eight meteorological indices would be calculated. There are –Standard precipitation index (SPI), Percent of normal (PNI), Deciles index (DI), China Z index (CZI), Modified CZI (MCZI), Effective drought index (EDI), Rainfall anomaly index (RAI), Z score index (ZSI). Among these indices standardized precipitation index (SPI) was used to analyze drought severity in the study area between 1985 to 2014.

**Standardized Precipitation Index (SPI)**

Researchers at Colorado State University (McKee *et al*. 1993; McKee *et al*. 1995) [7] designed the SPI in 1993 to be a relatively simple, year-round index applicable to the water supply conditions important to Colorado and as a supplement to information provided by the PDSI and a second drought index, the Surface Water Supply Index (Shafer and Dezman 1982).

To calculate the SPI, a long-term precipitation record at the desired station is first fitted to a probability distribution (e.g. gamma distribution), which is then transformed into a normal distribution so that the mean SPI is zero (McKee *et al.*, 1993, 1995; Edwards and McKee, 1997) [7]. The SPI may be computed with different time steps (e.g.1 month, 3 months, 24 months). Guttman (1998) showed that the use of SPI at longer time steps was not advisable as the sample size reduces even with originally long-term data sets. The use of different timescales allows the effects of a precipitation deficit on different water resource components (groundwater, reservoir storage and soil moisture, stream flow) to be assessed. Positive SPI values indicate greater than mean precipitation and negative value indicates less than mean precipitation. The SPI may be used for monitoring both Dry and Wet conditions. A drought event starts when SPI value reaches −1.0 and ends when SPI becomes positive again. The positive sum of the SPI for all the months within a drought event is referred to as 'drought magnitude'.

This index is presently used as one of the indices for drought monitoring in the entired United States (http://www.drought.unl.edu/monitor/spi.htm). In addition, a number of studies evaluated the performance of this index (e.g. Wu *et al*. (2001) in China, Ansari (2003) in Iran, etc.). This study used the McKee *et al*. (1993) [7] SPI classification system (Table 2) to define drought severity resulting from the SPI.

**Table 2:** SPI classification used in this study

| SPI values | Class |
|---|---|
| >2 | Extremely wet |
| 1.5 to 1.99 | Very wet |
| 1.0 to 1.49 | Moderately wet |
| -0.99 to 0.99 | Near normal |
| -1.0 to -1.49 | Moderately drought |
| -1.5 to -1.99 | Severely drought |
| <-2 | Extremely drought |

## III. Result and Discussion

### Drought severity in talukas of Chitradurga district

It is very interesting to note that number of drought years identified for different talukas of Chitradurga district. The identified drought years are segregated under different drought severity categories according to the severity value (Table 2) of SPI index resulted, 8 years (1985, 1989, 1993, 1994, 1995, 2003, 2011, and 2013) under moderate drought category, 6 years under severe drought category (1985, 1990, 1995, 2003, 2011, 2013) and 2 years (1985, 1995) under extreme drought category. The extreme droughts are not experienced in some talukas except Challakere, Chitradurga and Hosadurga talukas is presented in the table 3. It may be concluded from the result that, the district have overall drought for 9 years (1985, 1989, 1990, 1993, 1994, 1995, 2003, 2011 and 2013) out of 30 years of study period, while remaining years shows wet and normal categories.

**Table 3:** Drought severity of Chitradurga district.

| Taluk name | Moderate drought (MD) | Severe drought (SD) | Extreme drought (ED) | Total drought |
|---|---|---|---|---|
| Challakere | 1985, 1989, 1993, 1995 | 2011 | Not occurred | 5 |
| Chitradurga | 1989, 1995 | 1985, 1990, 2003, 2011 | Not occurred | 6 |
| Hiriyur | 1985, 1994, 2011 | 1990, 2003 | 1995 | 6 |
| Holalkere | 2003 | 1995 | 1985 | 3 |
| Hosadurga | 1989, 1995 | 1990, 2003, 2013 | Not occurred | 5 |
| Molakalmur | 1994, 1995, 2011, 2013 | 2003 | 1985 | 6 |
| | Total MD occurred in Chitradurga district = 8 | Total SD occurred in Chitradurga district = 6 | Total ED occurred in Chitradurga district = 2 | 9 |

Note: - Repeated years taken as single count.

### Drought severity in talukas of Davanagere district

Analyzing SPI value, the moderate drought occurred in 1986, 1995, 2003, 2012 (4 years) in Davanagere taluk. There was severe drought condition occurred in the year 1989 (1 year) as shown in fig 3.

According to fig (3) in Harihara taluk, the moderate drought year was recorded in 1985 and severe droughts were recorded in the year 1989 and 2003.

In fig (3), it can be seen that the year 1985 and 1990 experienced moderate drought condition in Jagalur taluk, while the year 1986 and 1995 experienced severe drought condition.

Davanagere, Harihara, Jagalur are these talukas of Davanagere district where overall moderate drought conditions experienced during the year 1985, 1986, 1990, 1995, 2003, 2012 (6 years) and total severe drought condition experienced in the year 1985, 1989, 1995, 2003 (4 years). There was no extreme drought occurred in the district during the study period.

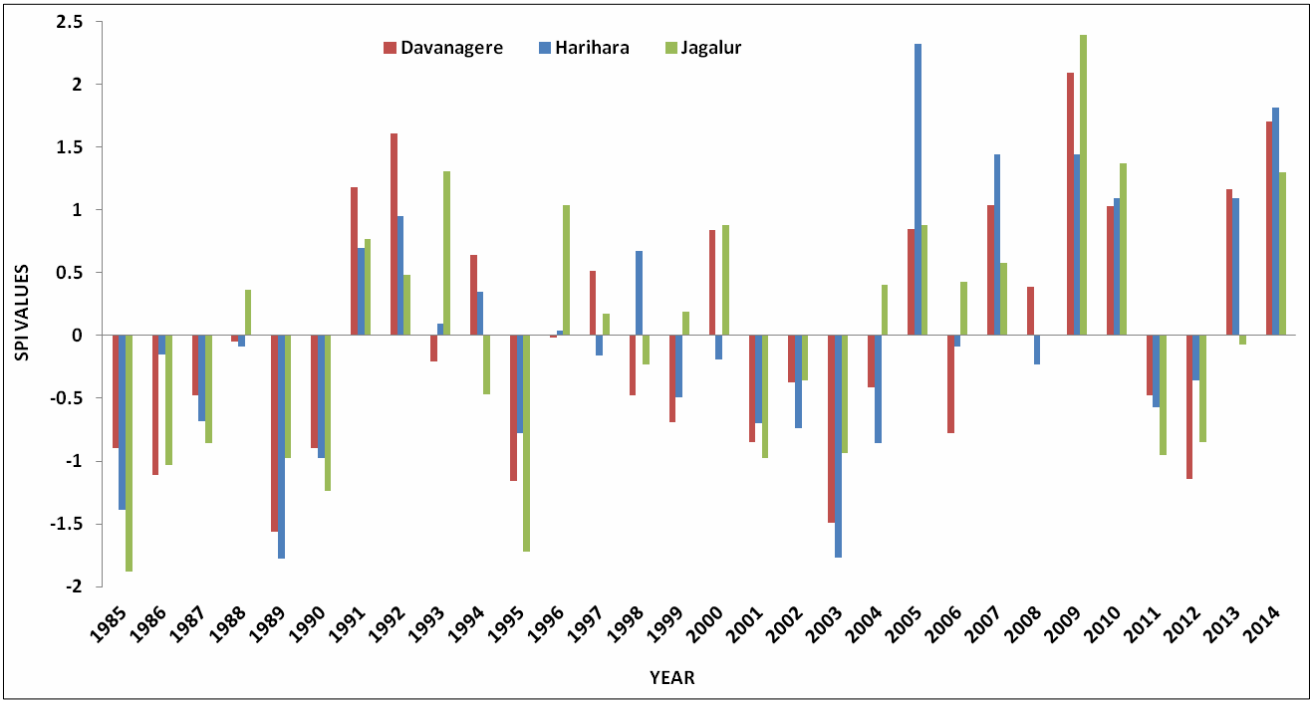


**Fig 3:** Drought severity in Davanagere district

### Drought severity in talukas of Tumkur district

The results show the occurrences of droughts in different years at different talukas of Tumkur district. However most of the moderate drought experienced in the years of 1987, 1990, 1997, 2002, 2003, 2006, 2011, 2012 (8 years) and severe drought experienced in the years of 1986, 1990, 1992, 1999 (4 years) and extreme drought experienced in the years of 1985, 1989, 1990 (3 year). It may be concluded from the result that, the district have drought for 13 years (1985, 1986, 1987, 1989, 1990, 1992, 1997, 1999, 2002, 2003, 2006, 2011 and 2012) out of 30 years as shown in table (4), while remaining years shows wet and normal conditions.

**Table 4:** Drought severity of Tumkur district

| Taluk name | Moderate drought (MD) | Severe drought (SD) | Extreme drought (ED) | Total drought |
|---|---|---|---|---|
| Chikkanayakanahalli | 2003 | 1990, 1992 | 1989 | 4 |
| Koratagere | 2002, 2003, 2006, 2012 | 1986 | 1985 | 6 |
| Madhugiri | 1987, 1990, 1997, 2002, 2003 | 1999 | Not occurred | 6 |
| Pavagada | 2002,2003, 2011 | 1986 | 1985 | 5 |
| Sira | 2003, 2006 | 1990 | 1985 | 4 |
| Tiptur | 2006, 2012 | 1986 | 1985, 1990 | 5 |
| | Total MD occurred in Tumkur district = 8 | Total SD occurred in Tumkur district = 6 | Total ED occurred in Tumkur district = 2 | 13 |

**Note:** Repeated years taken as single count.

**Drought severity in Arasikere taluk of Hassan district**

Arasikere taluk of Hassan district which faced moderate drought condition during the year 1988, 1996, 2001 (3 years) and severe drought condition during the year 2012, while the year 1990 shows extreme drought condition is presented in fig (4). Overall drought condition prevailed on 5 years out of 30 years during 1985 to 2014.

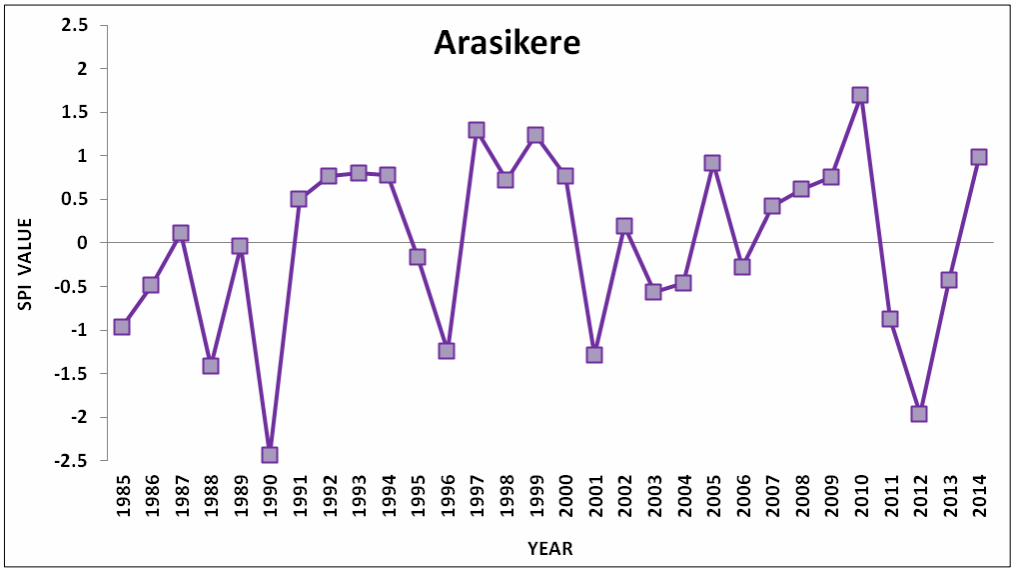


**Fig 4:** Drought severity in Hassan district Drought severity in Kadur taluk of Chikkamagalur district:

Drought of different severities at Kadur taluk of Chikkamagalur district is showed that the moderate drought condition prevailed during the year 1990, 1995, 2003 (3 years) and 2001 was experienced severe drought condition, while extreme drought occurred in the year 1985.

Overall Chikkamagalur district experienced 5 years of drought condition out of 30 years of study period as shown in fig 5.

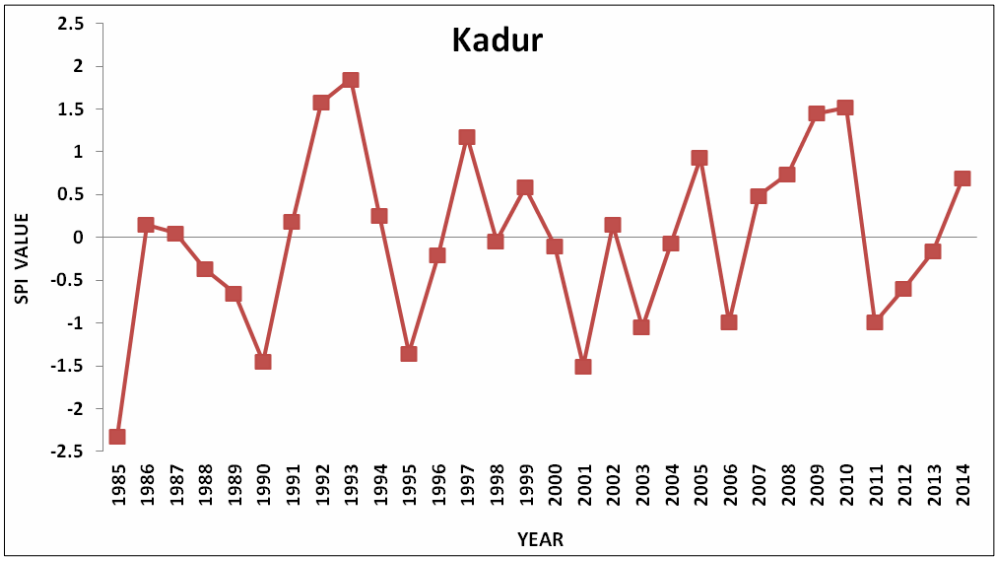


**Fig 5:** Drought severity in Chikkamagalur district

## Conclusion

The SPI method gives best result without other climatic parameters like minimum and maximum temperature, humidity, evapotranspiration and sun hours as it uses only precipitation data and gives accurate result. This method is better for agricultural applications since it is simple and effective. Analysis of drought severity based on monthly rainfall data over central dry zone of Karnataka was indicated that 10 talukas shows extreme drought events out of 17 talukas. During the 30 years of study period 12 years shows severe drought and 4 years shows extreme drought. In case of 1985 all the 7 talukas of study area were simultaneously under the grip of drought. It may be concluded from the result that occurrence of moderate, severe and extreme drought affects the agricultural crop production, water resources and socio economic life. Lessons learnt from the past droughts may be helpful for adaptation strategies for future droughts.

## Acknowledgment

The authors are grateful to the KSNDMC for providing precipitation data and staff members, SHUATS advises to do better this research.

## References

1. Ahmad L, Parvaz S, Majid M, Kanth R. Analysis of historical rainfall data for drought investigation using standard precipitation index (SPI) under temperate conditions of Srinagar, Kashmir. Pakistan. J Meteorol 2016;13(25):29-38.
2. Chouhan H, Vaibhav G, Bhaskar R, Chouksey NA, Agarwal SP. Assessment and characterization of meteorological drought using standardized precipitation index in the upper Luni river basin, Rajasthan. Intl. J. Emerging Technol 2017;8(1):265-271.
3. Joshi CH, Jagtap S. Monitoring the 1996 Drought Using the Standardized Precipitation Index. American Meteorological Society 1999;80(3):429-438.
4. KSNDMC. Drought Vulnerability Assessment in Karnataka (A Composite Index: using Climate, Soil, Crop Cover and Livelihood components) KSNDMC. Bengaluru 2017, 114.
5. Nandeesha, Ramu. Assessment of rainfall patterns and meteorological drought in Northern Dry Agro Climatic Zone of Karnataka. Intl. J. Computer Sci. Information Tech. Res 2015;3(2):532-539.
6. Palchaudhuri M, Biswas S. Analysis of meteorological drought using standardized precipitation index - A case study of Puruliya district, West Bengal, India. Intl. J. Envt. Ecologic. Eng 2013;7(3):167-174.
7. McKee TB, Doesken NJ, Kleist J. The relationship of drought frequency and duration to time scales. In Proceedings of the 8th Conference on Applied Climatology Boston, MA: American Meteorological Society 1993;17(22):179-183.