ISSN 2348-1196 (print)
International Journal of Computer Science and Information Technology Research ISSN 2348-120X (online)
Vol. 3, Issue 2, pp: (532-539), Month: April - June 2015, Available at: www.researchpublish.com

Assessment of Rainfall Patterns and Meteorological Drought in Northern Dry Agro Climatic Zone Of Karnataka

[1]Nandeesha, [2]Dr.Ramu

[1]Reserach Scholar, [2]Associate Professor
[12]University of Mysore, Department of Geo information Technology, India

Abstract: **Rainfall Assessment and meteorological Drought assessment is very essential in identifying climate and water supply trends and thus to detect the probability of occurrence and the anticipated severity of drought. Drought occurs when precipitation is lower than normal. When this phenomenon extends over longer period of time, precipitation is inadequate to demand of human activities. To assess the meteorological drought Percentage of Departure is carried through Thiessen-polygon method and Standardized Precipitation Index (SPI)are useful index for drought monitoring based monthly precipitation data. Talukwise precipitation data were analysed to derived meteorological drought condition in the Northern Dry Agro Climactic zone of Karnataka. Geographical information system the powerful tools is used to drawn and represent the results. Northern Dry zone an Agro Climactic zone of Karnataka indicate severe dryness and hence, the irrigation requirement can be evaluated on the rainfall deficits & its severity. Northern dry agro climatic zones of Karnataka is one of major agriculture based region the rainfall pattern and occurrence of meteorological drought plays an important role in agriculture production in Karnataka state.**

Keywords: **Meteorological Drought, SPI, Agro Climatic zone, Thiessen-polygon.**

I. INTRODUCTION

Drought is an extended period when a region receives below average precipitation. Drought has many effects on human activities, human lives and various elements of the environment. Conventionally, decrease of precipitation is considered as the origin of drought. This leads to a reduction of storage of water and fluxes involved in the hydrological cycle depending on the choice of the hydrological or agricultural.

Drought is an unexpected reduction in precipitation over period of time in an area which is not necessarily arid. Characterizing periods of deficit and drought has been an important aspect of planning and management of water resources systems for many decades. Drought is one of the most harmful natural disasters that affected the human population. Low precipitation levels can lead to severe hydrologic deficits. These deficits may impact on low crop yields for agriculture, replenished ground water resources, depletion in lakes/reservoirs, and shortage of drinking water and, reduced fodder availability etc, which can negatively impact on local populations. Consequently, the ability to forecast and predict the characteristics of droughts, especially their frequency, monitoring and severity are important. Drought assessment and monitoring is necessary for water resource management as well as for the agricultural industry.

Unlike other natural disasters like flood, earthquakes droughts have a slow evolution time. The effect of droughts required considerable amount of time to come in to effect with respect to their initiation and when they are perceived by ecosystems and hydrological systems. An effective tool is used to monitor current drought conditions is a drought index. Several drought indices have been developed around the world in the past based on rainfall as the single variable, including the widely used Deciles, Standardized Precipitation Index (SPI), and Effective Drought Index (EDI). There is also the well-known Palmer Drought Severity Index (PDSI), which considers temperature along with rainfall. In this study, percentage of departure and SPI drought index has been chosen to assess the drought condition due to its simplicity, its ability to represent drought on multiple time scales, and because it is based on probability. Temperature, wind and relative humidity are also important factors. Types of Droughts are meteorological, agricultural and hydrological drought. One of the major challenges of agricultural systems is how to reduce the impacts of droughts. Drought impact on agricultural systems, economically as well as environmentally. From an environmental perspective, droughts can deprive crops and soils of essential precipitation as well as increase the salt content in soils and irrigation systems. To overcome the impacts of drought an effectively and timely monitoring system is required. Effective monitoring of droughts can aid in developing an early warning system. An objective evaluation of the drought condition in a particular area is the first step for planning water resources in order to prevent and reduce the impacts of future occurrences of drought.

Standardized Precipitation Index (SPI) (McKee, 1995) with characteristic of a variety of time scale flexibility. It is a potential Meteorological drought index which is easily calculable, requires modest data, independent of the magnitude of mean rainfall and comparable over a range of climatic zones (Agnew, 2000). It overcomes the traditional drought indices like PDSI. It can be also applied for any location by using a transformation of precipitation from a skewed distribution to the normal distribution, which makes it a suitable indicator accepted around the world. Guttman (1997) explained the advantages of SPI being probabilistic in nature and thus, its usability in risk and decision analysis over other drought indices. The identification of extreme drought with SPI presents a better spatial standardization as compared to the PDSI (Hughes and Saunders, 2002). The use of SPI is standardized to a variety of time scales i.e. 1, 2, 3, 6, 12 24, 26, 48 months.

Table.1 SPI Value and Class

SPI Value	Class
2.0+	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-.99 to .99	Near normal
-1.0 to -1.49	Moderately dry
-1.5 to -1.99	Severely dry
-2 and less	Extremely dry

To study the meteorological vulnerability of each Northern Agro climatic zone fo Karnataka, taluk-wise, rainfall data were analysed for its distribution in three prominent monsoon seasons viz., South-West and North-East and Pre-monsoon period. For each season, to identify vulnerability were classified as normal, (+19 to -19% of normal rainfall), excess (more than 20 % if normal) moderately deficit (-20% to 49%) and severely deficit (-50% to -99%) and no rainfall.

2. STUDY AREA

The Karnataka State is divided into the 10 various agro-climatic zones. Northern Dry agro climatic zone of Karnataka is one of main drought prone agro climatic zone of in the state is located in the Northern part Karnataka State comprises of 9 Districts of Bijapur, Bellary, Dharwad, parts of Belgaum, Gadag, Bagalkote, Koppal and some parts of Raichur districts comprises of 35 Taluks. The study area is shown in Fig.1.

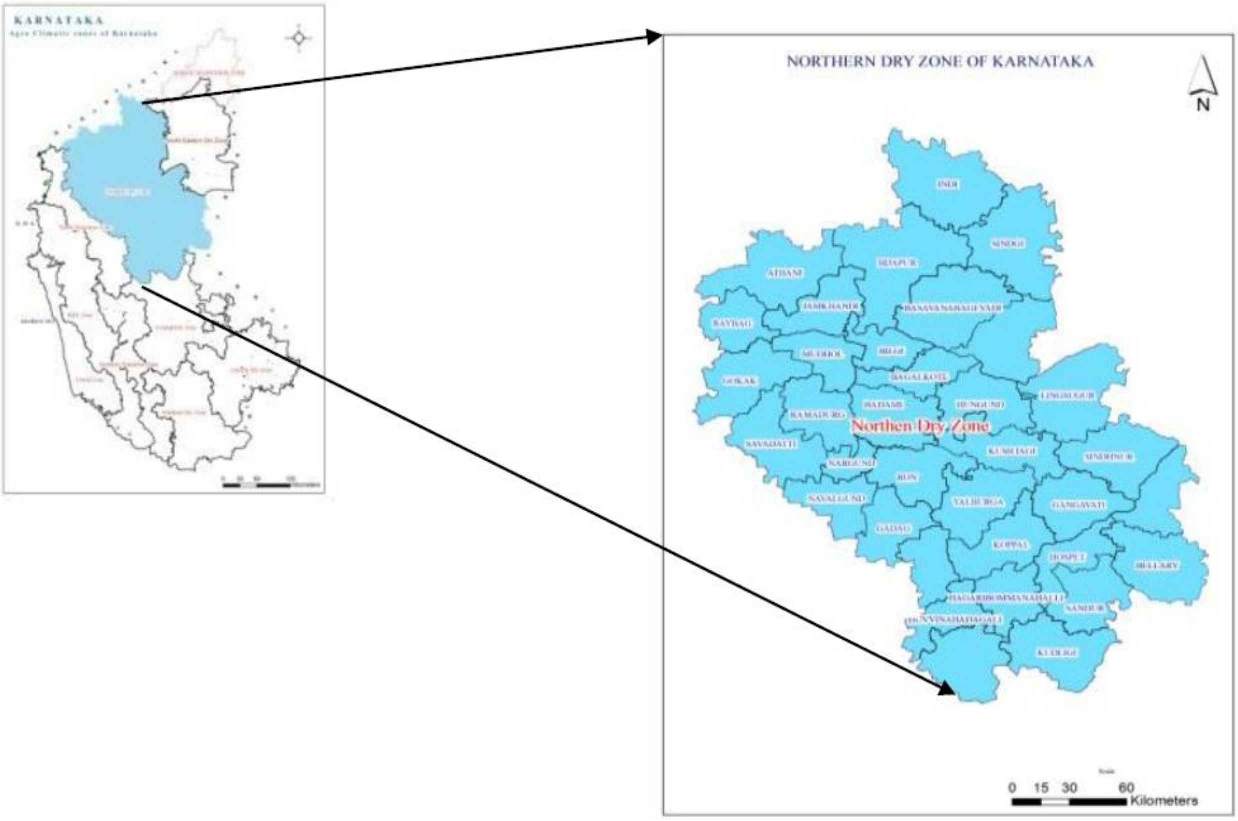

Fig.1 Study Area

2.1 Geography: Northern Dry zone is located at $17^0$25N latitude, 76^0 65'E longitude at an altitude of 300-460m above mean sea level. It is bounded on the North Eastern dry zone by North and south by the Central zone on the west by Northern transition zone and, on the east by Andrapradesh.

2.2 Climate: The climate of Northern Dry agro climatic zone of Karnataka is arid to semi-arid with fairly dry and hot summer. Winter is fairly cold and sets in, 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 36^0 C. The average rainfall is 613 mm.

2.3 Soil : The soil is alluvial in origin. The soils are shallow to deep black clays in major areas shallow, well drained grey to dark grey and brown clay loam to silty clay loamy soils moderately and severely eroded. 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.

3. MATERIAL AND METHODOLOGY

The Rainfall datasets were acquired from Drought Monitoring Cell, Karnataka for the period of 1970-2014. The seasonal and yearly rainfall values were worked out using thessen polygon method.

The SPI is computed by fitting historical precipitation data to a probability density function for a specific time period and location. Typically, the gamma distribution is applied. The cumulative distribution function of a Gamma distribution is then transformed to a normal distribution with a mean of zero and standard deviation of one. Negative values of the SPI are showing severity of dryness and positive values of are showing degree of wetness. Its main feature is that it could be computed at different time scales (1, 3, 6, 9, 12, 24 and 48 months) to monitor droughts with respect to different usable water resources. Short-term SPI could be used to detect agricultural drought, and long-term SPI could be used for water supply management.

The positive value of SPI represents wet conditions whereas the negative values show drought conditions. The intensity of drought is signified by the standardized numbers ranging from 0 to (-2 and less). Enormous studies had been carried out to get the percentage of Meteorological drought, which can overcome the limits of the most widely known Meteorological drought index ever i.e. SPI.

The Thiessen-polygon method of calculating the average precipitation over an area is superior to the arithmetic-average method as some weightage is given to the various stations on a rational basis. Further, the raingauge stations outside the basin are also used effectively. Once the weightage factors are determined, the calculation of rainfall is relatively easy for a fixed network of stations.

The rainfall departure from normal rainfall it is expressed by the following equation: (A-N)/N*100 Where, A = Actual rainfall, N = Normal Rainfall

Thiessen-polygon method the rainfall recorded at each station is given a weight age on the basis of an area closest to the station. The procedure of determining the weighing area is as follows: consider a basin area as in Fig.2 containing 35 rain gauge stations. The zone area is drawn to scale and the positions of the all 35 stations marked.

Fig.2 Thessen Polygon Area with taluk headquarters Rain gauge Stations.

Geographical Information System is a powerful tool to assessing and manipulation and interpretation of data. In the present study crigging the interpolation method was used to draw isohyets of percentage of years of meteorological drought for Northern dry zone

4. RESULT AND DISCUSSION

In this paper, the drought assessment has been carried out for monitoring the drought severity in the Northern Dry agro climatic zone of Karnataka. Table 2 shows Season wise rainfall pattern and drought year for the year 1970-2014 for Northern Dry agro climatic zone of Karnataka, which gives the drought severity of the particular month for the assessment of drought. In reference with the above sample calculation, the most severe case happened in the month of Oct with lowest rainfall value. As the rainfall increases, less is the severity of drought.

Table –2 Seasons wise and Annual Rainfall and drought statistic

Table.2 Rainfall Pattern in Northern Dry Agro Climatic zone of Karnataka and Drought years

Particulars	1970-2014			
	PM	SWM	NEM	ANNUAL
Mean Rainfall	87	381	144	613
Contribution (%)	14	62	23	100
Minimum Rainfall	8	112	15	252

ISSN 2348-1196 (print)
International Journal of Computer Science and Information Technology Research ISSN 2348-120X (online)
Vol. 3, Issue 2, pp: (532-539), Month: April - June 2015, Available at: www.researchpublish.com

Maximum Rainfall	325	933	412	1409
Standard Deviation	63	166	91	223
C.V(%)	72	44	64	36
No Drought (ND)	24	30	25	31
Moderate Drought (MD)	8	9	8	9
Severe Drought (SD)	11	4	10	2
Class (ND: <-25%, MD: -25 To -50, SD: -50 To -99)				

Pre Monsoon rainfall is contributing 14 % of rain to the annual rainfall of the Karnataka. The Percentage departures of pre-monsoon rainfall in Northern dry Agro Climatic zone of Karnataka, histograms are presented in Fig.3. Northern dry zone records 26 years of (–) negative departure.

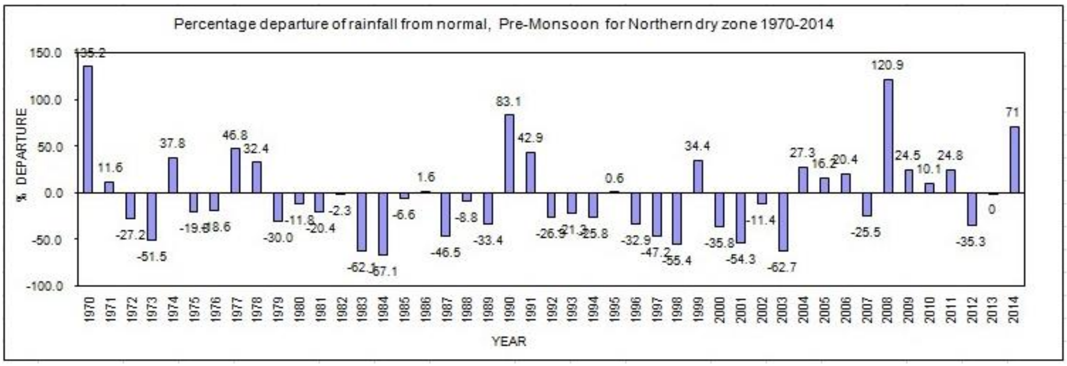

Fig.3 Percentage of Departure of Rainfall for Pre-Monsoon Rainfall Pattern

South west Monsoon rainfall is contributing 62 % of rain to the annual rainfall of the Karnataka. The Percentage departures of South west-monsoon rainfall in Northern dry Agro Climatic zone of Karnataka, histograms are presented in Fig.4. Northern dry zone records 25 years of (–) negative departure.

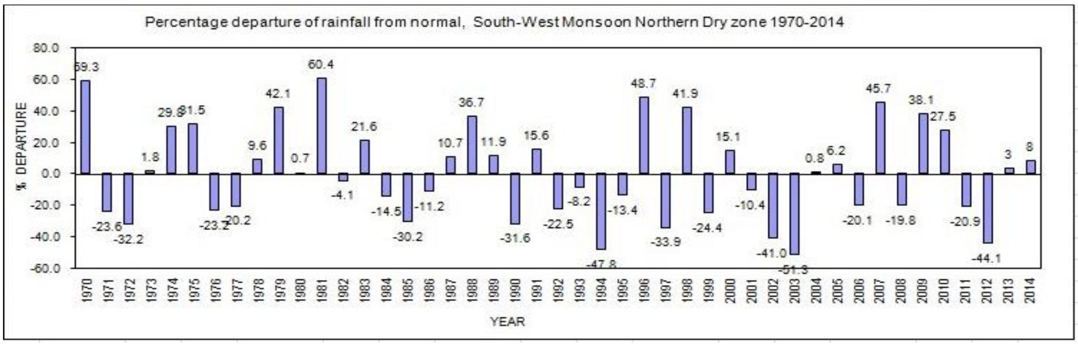

Fig.4 Percentage of Departure of Rainfall for South west monsoon Rainfall Pattern

North East Monsoon rainfall is contributing 23 % of rain to the annual rainfall of the Karnataka. The Percentage departures of South west-monsoon rainfall in Northern dry Agro Climatic zone of Karnataka, histograms are presented in Fig.5 Northern dry zone records 22 years of (–) negative departure.

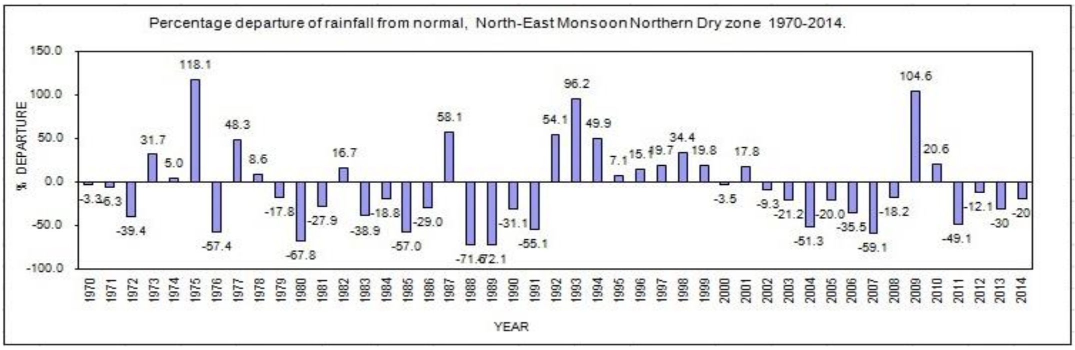

Fig.5 Percentage of Departure of Rainfall for North East Monsoon Rainfall Pattern

Annual rainfall is contributing 22 % of rain to the annual rainfall of the Karnataka. The Percentage departures of South west-monsoon rainfall in Northern dry Agro Climatic zone of Karnataka, histograms are presented in Fig.6 Northern dry zone records more than 23 years of (–) negative departure for annual rainfall.

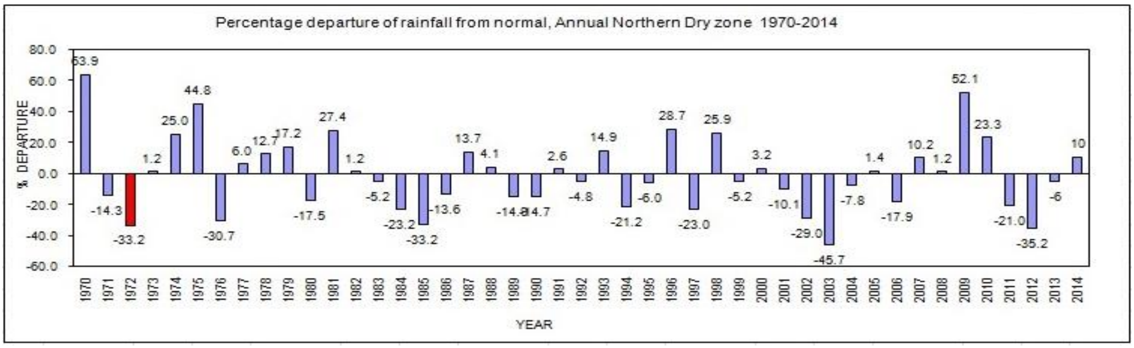

Fig.6 Percentage of Departure of Rainfall for Annual Rainfall Pattern

The variation of rainfall for season wise and annual rainfall was determined. Total numbers of drought years, years were determined using the standard procedure (IMD, 1971). By Procedure of drought area identification by the Irrigation Commission (1972), Government of India defined drought years as those years for which annual rainfall is less than or equal to 75% of the normal [*Srinivasan*, 1993]. However, if sufficient irrigation availability in that area the same is excluded from classification as drought area.

As per irrigation commission of Govt. of India (1972), drought years have been defined as those years for which annual rainfall is less than or equal to 75 % of the normal (Annual Rainfall). Based on long period data, if such droughts occur in certain area on frequency of more than 20 % of years, that area is designated as a Drought Prone area.

Table.3 Percentage of Drought years for percentage of Departure and Standardized Preicipiataion Index.

Sl.No	Taluks	% Drought Year RF	% Drought Years SPI
1	Harappanahalli	9	9
2	Bellary	23	21
3	Hadagali	14	16
4	Hosapete	16	16
5	Hagaribommanahalli	33	19
6	Kudligi	23	14
7	Sandur	16	16
8	Siruguppa	21	16
9	Gangavati	26	19
10	Koppala	30	21
11	Kustagi	28	14
12	Yelburga	26	19
13	Lingasugur	26	16
14	Sindhanur	23	12
15	Athani	26	12
16	Gokak	42	16
17	Ramdurga	33	16
18	Raibagh	26	5
19	Soundatti	33	16
20	Badami	28	21
21	Bagalkote	21	19
22	Bilgi	23	12
23	Hungunda	19	7
24	Jamkhandi	30	9
25	Mudhol	26	19
26	Basavanabagewadi	23	12
27	Bijapura	26	77
28	Indi	19	9

29	Muddebihal	21	9
30	Sidgi	16	7
31	Gadag	19	19
32	Mundargi	35	16
33	Nargunda	26	12
34	Ron	28	23
35	Navalgund	23	16

In the Fig.7 shows that the Northern dry zone records 3624280 Sq. Km of area is more 20% of the years are drought prone, 1040966 Sq.km of area under the 15-20 percentage of years of moderate drought and 118396 Sq km of area under 10-15 percentage of years of low drought condition of an total geographical area of 4783642 Sq.km. and more than 30 taluks were shown more than 20 percentage of years are severe drought and only in parts of Indi, Sindagi, Humnabad, Sandur taluks are about 15-20 percentage of years of moderate drought and only in parts of Harappanahalli shows 10-15 years of low drought condition in the northern dry agro climatic zone of Karnataka.

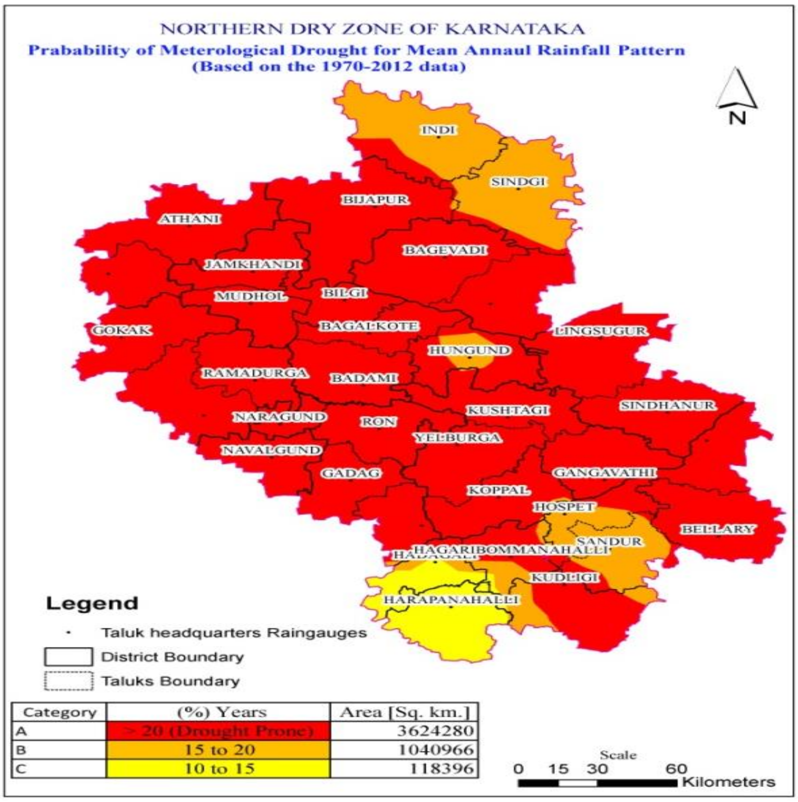

Fig.7 Probability of Meteorological Drought for Mean Annual Rainfall Pattern

5. CONCLUSION

The Northern dry zone comprises of 35 taluks of is one of 9 Districts. Northern dry zone is one of the highest areas under rain fed and drought prone. Agriculture is predominant about 66 percent of the workforce is dependent on agriculture. Further, 70 per cent of population is still living in rural areas and are completely depending on agriculture for their livelihood. Agriculture production in the northern dry zone is spread over three seasons namely, Kharif (June to ctober), Rabi (October to March) and summer. These seasons account for nearly 70%, 22% and 8% of annual food grain production respectively. Some of the important crops grown are Cereals like rice, Jowar, Bajra, Maize, Wheat, pulses like Tur, Bengalgram, Horsegram, Blackgram, Greengram, Cowpea etc; oil seeds like sugarcane, cotton and tobacco. From the study its conclude that an average 23 years are negative departure in the rainfall pattern in various season and also more than 30 taluks were recorded more than 20 percentage of the year are drought condition. The percentage of drought years for the Rainfall pattern and Standardized precipitation index a powerful index is used to assess the meterological drought it records more or equal and linear percentage of drought years in many taluks comes under the Northern Dry Zone.

6. ACKNOWLEDGEMENT

I would like to express my special thanks of gratitude to my guide (Dr.Ramu) who gave me the guidance to do this research paper (Assessment of Rainfall Patterns and Meteorological Drought in Northern dry Agro climatic zone of Karnataka), which also helped me in doing a lot of Research and i came to know about so many new things I am really thankful to them. Secondly I would also like to thank my parents and friends who helped me a lot in finalizing this research paper within the limited time frame.

REFERENCES

[1] "Drought in India", Poorest Areas Civil Society (PACS) Programme,2008.

[2] W. C. Palmer, "Meteorological Drought", U.S. Weather BureauManuscript No. 45 58pp February, 1965.

[3] W.M. Alley, "The Palmer Drought Severity Index as a measure ofhydrological drought", Water Resources Bulletin Vol. 21 p105 - 114,1985.

[4] T. Karl, F. Quinlan and D.S. Ezell, "Drought termination and amelioration: its climatological probability", Journal Clim Appl Met Vol.26 p1198 - 1209, 1987.

[5] Z. Sen, "Probabilistic formulation of spatio-temporal pattern", TheorAppl Climatological Vol. 6 p197 - 206, 1998.

[6] X. Lana, C. Serra and A. Burgueno, "Spatial and temporal characterization of annual extreme droughts of Catalonia (North Spain)",Int J Clim Vol. 18 p93 - 110, 1998.

[7] K. Stahl and S. Demuth, "Linking stream flow drought to occurrence of atmospheric circulation pattern", Hydrol Sci Journal Vol. 44(5) p665 -680, 1999.

[8] T. B. McKee, N. J. Doesken and J. Kleist, "The Relationship of Drought Frequency and Duration to Time Scales", Proceeding of the Eight Conference on Applied Climatology 17-22 January, Anaheim, California, 1993.

[9] M. Rouault and Y. Richard, "Intensity and Spatial Extension of Drought in South Africa at Different time Scale", Water SA Vol. 29(4) October, 2003.

[10] Gg A. Loukas and L. Vasiliades, "Probabilistic analysis of Drought spatiotemporal characteristics in Thessaly region, Greece", Natural Hazards and Earth System Sciences Vol. 4 p719 - 731, 2004.

[11] S. Shahid and H. Behrawan, "Drought risk assessment in the western part of Bangladesh", Nat Hazards Vol. 46 p391 - 413, 2008. World Academy of Science, Engineering and Technology International Journal of Environmental, Ecological, Geological and Marine Engineering Vol:7 No:3, 2013 125 International Scholarly and Scientific Research & Innovation 7(3) 2013 International Science Index Vol:7, No:3, 2013 waset.org/Publication/9996966

[12] O. Yldz, "Assessing temporal and spatial characteristics of droughts in the Hirfanli dam basin, Turkey", Scientific Research and Essays Vol. 4 (4) p249 - 255, 2009.

[13] D. C. Edossa, M. S. Babel and A. D. Gupta, "Drought Analysis in the Awash River Basin, Ethiopia", Water Resour Management Vol. 24 p1441 - 1460, 2010.

[14] P. Angelidis, F. Maris, N. Kotsovinos and V. Hrissanthou, "Computation of Drought Index SPI with Alternative Distribution Functions", Water Resour Manage Vol. 26 p2453 - 2473, 2012.

[15] D. C. Edwards and T. B. McKee, "Characteristics of 20th century drought in the United States at multiple timescales", Climatology Report Colorado State University, Fort Collins, No. 97-2, 1997.

[16] H. C. S. Thom, "A Note on the Gamma Distribution", Monthly Weather Review Vol. 86(4) p117 -122, 1958.

[17] M. Abramowitz and A. Stegun, "Handbook of mathematical formulas, graphs, and mathematical tables", Dover Publications Inc New York, 1965.