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Rainfall Variability Analysis in Namakkal District, Tamil Nadu

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Abstract - Climatic factor plays a major role in Indian agriculture in that rainfall play a key role. Being rainfall is the important factor for agriculture normally has to rely on secondary data. The study area taken for this analysis is Namakkal district of Tamil Nadu. The extent of the area is extends between 11^{0}00' to 11^{0}36'10" north Latitudes and 77^{0}40' to 78^{0}30'00" east longitudes. It is purely a semi arid region and agriculture normally depends on seasonal characteristics of rainfall. This study seeks to understand the rainfall behavior of the study area. The rainfall data used for this analysis is from 1980 – 2013. In this analysis rainfall variability has been calculated to find out the dependability of rainfall over the study area. From the analysis it is to be identified that Paramathy location has more than 50% of CV in both the monsoon season. To understand the long term changes in rainfall trend analysis has also been studied over the area. All the results got from the analysis has been mapped cartographically using GIS. It is a powerful tool for representation and analysis of spatial information related to rainfall analysis. The output has been prepared using Arc GIS 9.3.
Keywords: Climate, Variability, Monsoon, Trend, GIS.

I. INTRODUCTION

Rainfall, being considered as the prime input for agriculture has its own erratic behavior in terms of amount and distribution. For better crop planning, a detailed study on rainfall behavior is vital. Rainfall variability, both in time and space influences the agricultural productivity and sustainability of a region, as opined by Virmani (1994). Rainfall analysis for crop planning was carried out in different regions of the country as reported by Marviya et al. (1991). The annual and seasonal rainfall received and its variability directly influences the success or failure of crops through its beneficial or adverse effect their growth and yield. Therefore, the study of variability of annual and seasonal rainfall is essential in selection of suitable crops and to take appropriate mitigating measures based on rainfall characteristics. Agriculture being mainly rainfed in Namakkal region of Tamil Nadu state is characterized by uneven and erratic distribution of rainfall. Since rainfall is the only source of moisture, the spatio-temporal distribution of rains holds the key in determining the fate of entire crop productivity in the region. There are so many authors studied about the rainfall variability, Krishnakumar and Prasad Rao (2008) reported rainfall variability in Gujarat and Kerala state respectively. Halikatti et al. (2010) reported annual and seasonal rainfall variability at Dharwad, Karnataka. A similar attempt was made to analyze the rainfall distribution pattern in monthly, seasonally and annually for Raichur region.

II. STUDY AREA

The Namakkal District lies in the interior part of Tamil Nadu and extends between 11^{0}00' to 11^{0}36'10" north Latitudes and 77^{0}40' to 78^{0}30'00" east longitudes. (Fig.1).The total geographical area of the district is 3429.3 sq.km, which is divided into five taluks, namely, Namakkal, Tiruchengode, Paramathi, Rasipuram and Kollimalai. Administratively Namakkal district has 15 blocks and 396 panchayat villages. The district area represents 2.64% of the total area of Tamil Nadu state. The district experiences subtropical climate with moderate temperature. The maximum temperature ranges from 24^{0}C to 39^{0}C and the minimum temperature from 13^{0}C to 28^{0}C. The average annual rainfall of the district is 732 mm. The major soil types found in this district is Black soil, Brown soil, Alluvial soil and Mixed soil. The major rivers flowing in the Namakkal district are Cauvery and Thirumanimuthar. The major crop found in this district is Groundnut, Paddy, Cotton, Cumbu, Tapioca, Ragi, Pulses and Millets. The total population of Namakkal district as per 2011 is 1,726,601. The population density of Namakkal district for 2011 is 505 people per sq. km. Average literacy rate are 74.63 per cent .

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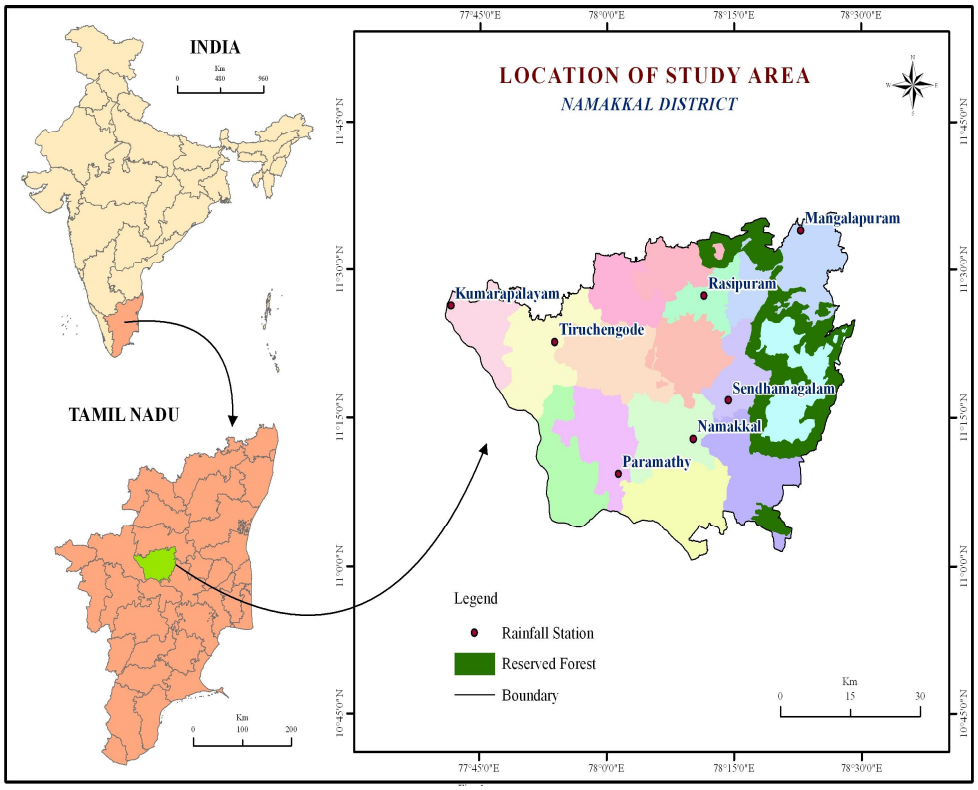

Fig.1. Location of study area – Namakkal district

III. OBJECTIVE OF THE STUDY

1) To study the rainfall variability of the study area
2) To identify the trend of rainfall over the study area

IV. MATERIALS AND METHODS

The rainfall data of the district has been collected from the department of statistics. The rainfall data collected are grouped into monthly, seasonal and annual data. The following formula has been used to identify the variability and trend over the study area,

A. Variability analysis

The first step in working out the Coefficient of Variation (CV) is to find out the standard deviation of the particular time series using the following formula. From the Standard Deviation (SD) and mean rainfall of the particular time series, the Coefficient of Variation is calculated.

$$\text{Standard Deviation} = \sqrt{\frac{\sum x^2 - (\sum x)^2/n}{n-1}}$$

$$\text{Coefficient variation (CV)} = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

Based on the magnitude of the Coefficient of Variation (CV), the dependability of rainfall is normally ascertained. The following percentage of Coefficient of Variation given in Table 2 is dependable for various time series of rainfall based on IMD. Lower values of CV indicate better reliability (Ramana Rao, 1988). For to analyse the trend over the study area linear regression model has been used.

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Table. 1. Rainfall dependability classification

Sl. No	Period	Dependable CV (%)	Non-Dependable CV (%)
1.	Daily Rainfall	<250	>250
2.	Weekly Rainfall	<150	>150
3.	Monthly Rainfall	<100	>100
4.	Seasonal Rainfall	<50	>50
5	Annual Rainfall	<25	>25

V. RESULTS AND DISCUSSION

A. Temporal Variability

1) Annual: Though the amount of rainfall is much important, its variability (Table 2& Fig 2) over time plays a vital role, based on which its dependability for agricultural purposes can be decided. Annual rainfall over the study locations had standard deviation (SD) ranging from 188 mm (Kumarapalaym) to 288 mm (Rasipuram). The highest annual rainfall receiving location Mangalapuram had SD of about 221 mm while lowest annual rainfall receiving location Paramathy had SD of 230 mm during the study period. Coefficient of variation is a measure used here to understand the dependability of rainfall in a particular period. According to the criteria, annual rainfall with less than 25 per cent CV is dependable. In the rainfall location Mangalapuram (25 per cent) is the only station had CV that is dependable while all other locations had CV above 25 per cent.

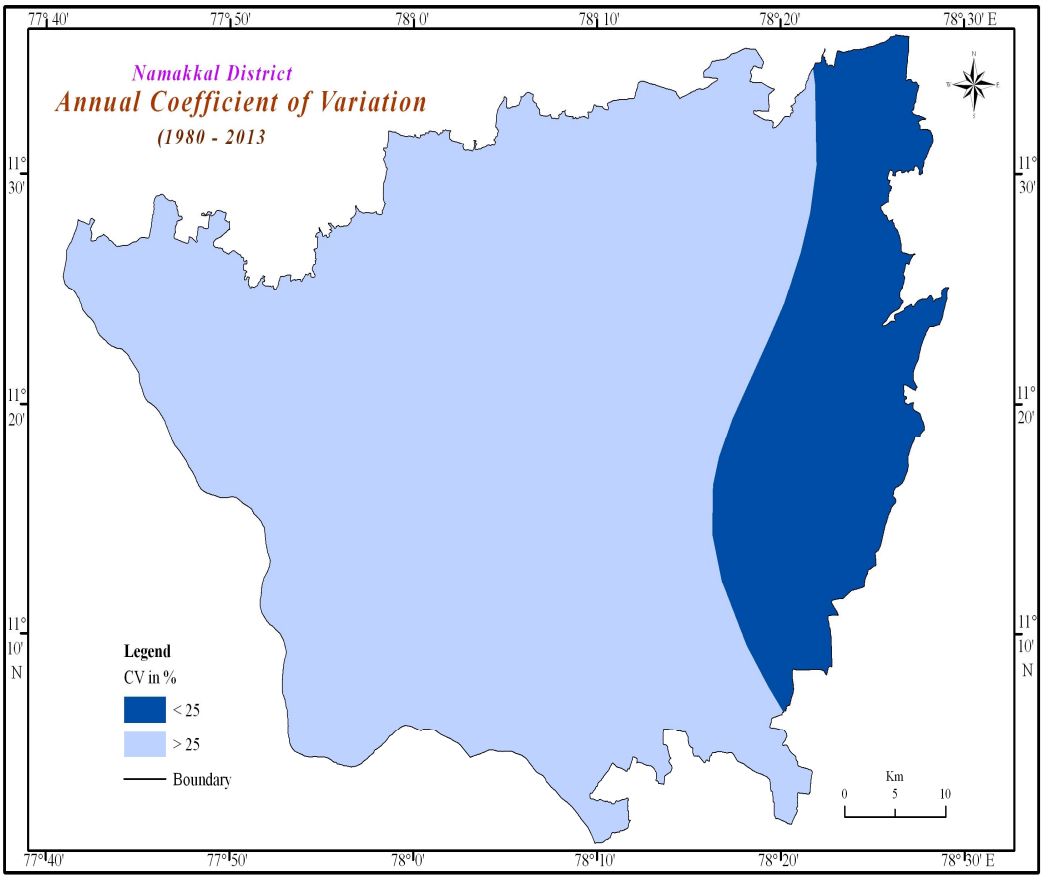

Fig.2 Annual CV – Namakkal district

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2) *Non – Monsoon seasons:* The winter and summer have least amounts of rainfall and so their SD was also low. During winter season the standard deviation (SD) had ranging from 11 mm (Paramathy) to 30 mm (Kumarapalayam). In summer, the minimum SD is found in Paramathy (59 mm) and the maximum is found in Kumarapalayam (95 mm), Namakkal (95 mm) and Tiruchengode (95 mm). According to the criteria, seasonal rainfall with less than 50 per cent CV is dependable. During the study period all the location have CV above 50 per cent indicates that all the location experiences non dependable during the study period. During winter season all the station had CV more than 200 per cent. Creditable CV had found during summer season where it ranging from 54 per cent (Mangalapuram) to the maximum of 68 per cent over Kumarapalayam and Paramathy. (Table 2)

Table.2. Variability of annual and seasonal rainfall (1980 – 2013)

Sl. No.	Locations	Standard Deviation					Coefficient of Variation (%)				
		Annual	Winter	Summer	SWM	NEM	Annual	Winter	Summer	SWM	NEM
1.	Kumarapalayam	188	30	95	104	139	27	230	68	39	50
2.	Mangalapuram	221	19	84	99	163	25	219	54	26	46
3.	Namakkal	277	22	95	152	164	33	265	59	42	51
4.	Paramathy	230	11	59	110	138	46	254	68	65	57
5.	Rasipuram	288	17	81	179	151	34	224	55	45	54
6.	Sendamangalam	203	14	68	138	112	28	224	55	41	43
7.	Tiruchengode	213	16	95	132	146	27	232	53	44	47

3) . *Monsoon seasons:* During SWM, the SD had ranging from 99 mm to 179 mm. The minimum is found in Mangalapuram and the maximum is found in Rasipuram location. Except Mangalapuram station all other location are having the SD of above 100 mm. Out of seven rainfall locations six locations having the CV of less than 50 per cent and comes under dependable category. During the study period Paramathy (65 per cent) is the only station fall under non dependable. During NEM, Namakkal had the highest SD of 164 mm followed by Mangalapuram (163 mm) while Sendhamangalam had the lowest SD of 112 mm. In the study locations Sendhamangalam, Mangalapuram and Tiruchengode had CV of 43 per cent, 46 per cent and 47 per cent

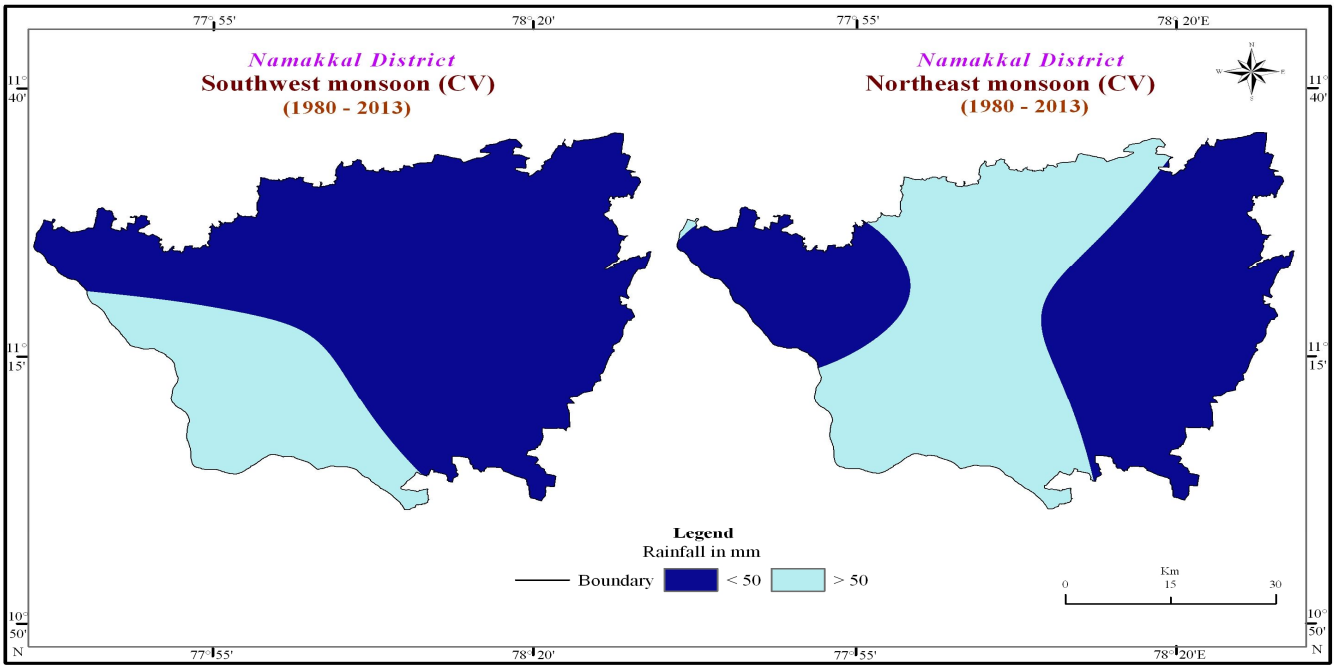

Fig.3. Monsoon season CV – Namakkal district

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respectively. These three stations had CV of less than 50 per cent and come under dependable category as per the criteria followed. Among the locations, Kumarapalayam (50 per cent), Namakkal (51 per cent), Rasipuram (54 per cent) and Paramathy (57 per cent) are non dependable. The Interestingly, Paramathy have CV more than 50 per cent for both the monsoons. The lowest coefficient of variation observed indicates that this monsoon system over the region is a stable one as has been recorded by Dhar*et.al*, (1982). (Table 2& Fig 3)

B. Trend Analysis

1) *Annual:* Trend analysis of the study locations was carried out to understand the long-term changes in rainfall and their magnitude of change. The change in amount of yearly rainfall will directly affect the availability of water. Therefore, it is vital to know whether there is a decrease in rainfall quantity so that, the information can be used for regulating the planning and management of irrigation project and water resources associated issues (Kwanyuen, 2001). Annual trend analysis (Table 5) revealed decrease in 6 out of 7 locations witness a decrease in rainfall. The only locations Paramathy had increasing trend while all other locations had negative trend. Among the locations that witnessed a decreasing trend of rainfall, Rasipuram had the highest decrease (11.38 mm) followed by Namakkal (10.65 mm) (Table 3& Fig 4)
2) *Non monsoon season:* Further the data was segregated seasonally to analyze the trend in the seasonal rainfall. Interestingly, all other seasons had varying trends among the study locations. All the locations had a decreasing trend in winter rainfall ranging from 0.71 mm over Mangalapuram to 0.25 mm over Paramathy and Sendamangalam. During summer, out of 7 rainfall locations 3 had increasing trend during the study period. Among the locations witnessed the increasing trend is maximum over Kumarapalayam (2.03 mm) location and the minimum is found over Mangalapuram (0.66 mm) location. The ranging of decreasing trend is varied from 0.86 mm to 0.43 mm during the study period. Tiruchengode has the highest decrease of rainfall and Rasipuram had the lowest among the rainfall locations in the study area. (Table 3 & Fig.5)

Table. 3. Trend analysis – Annual and seasonal trends of Rainfall (1980 – 2013)

Sl. No	Locations	Winter	Summer	SWM	NEM	Annual
1.	Kumarapalayam	-0.37	2.03	-3.33	-0.95	-2.96
2.	Mangalapuram	-0.71	0.66	-2.16	-0.39	-2.6
3.	Namakkal	-0.52	-0.65	-7.07	-2.34	-10.65
4.	Paramathy	-0.25	0.93	1.66	2	4.34
5.	Rasipuram	-0.61	-0.43	-8.88	-1.16	-11.38
6.	Sendamangalam	-0.25	-0.62	-4.13	0.31	-4.69
7.	Tiruchengode	-0.5	-0.86	-4.6	-1.7	-7.66

3) *Monsoon seasons:* Namakkal district gets maximum rainfall during the monsoon seasons. As per the rainfall data analysed over the study area the district receives maximum rainfall during SWM season. Even though, the district receives maximum rainfall during SWM the only locations Paramathy had positive trend while all other locations had negative trend. Among the negative trend location Rasipuram had a highest decrease of 8.88 mm and the lowest decrease is identified in Mangalapuram (2.16 mm) followed by Kumarapalaym (3.33 mm) during the study period over the study area. During NEM season among the rainfall locations the increasing trend is witnessed only in two stations they are Paramathy (2 mm) and Sendhamangalam (0.31 mm). All other location in the district had a decreasing trend during the study period. Among the decreasing trend the highest decrease is observed over Namakkal (2.34 mm) and the lowest is noticed over Managalapuram (0.39 mm) station (Table 3& Fig 5) It is observed that comparatively less amount of rainfall is received in NEM season than SWM season in the area however two stations Paramathy and Managalapuram shows increasing trend during the study period over the study area.

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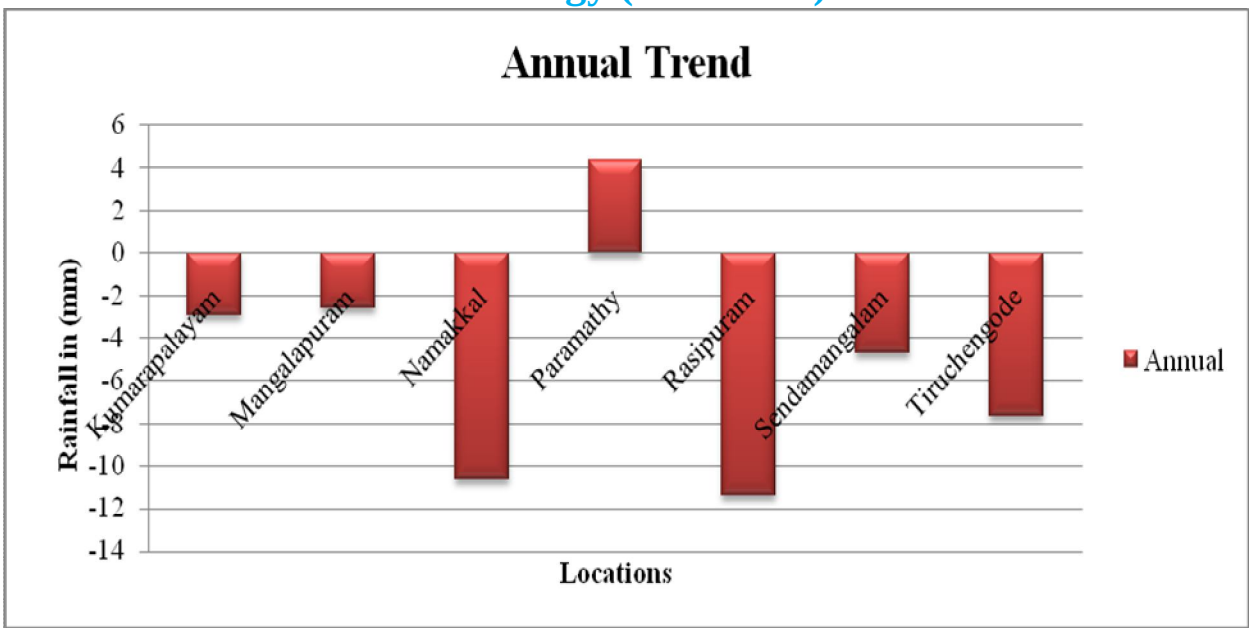

Fig.4. Annual trend – Namakkal district (1980 – 2013)

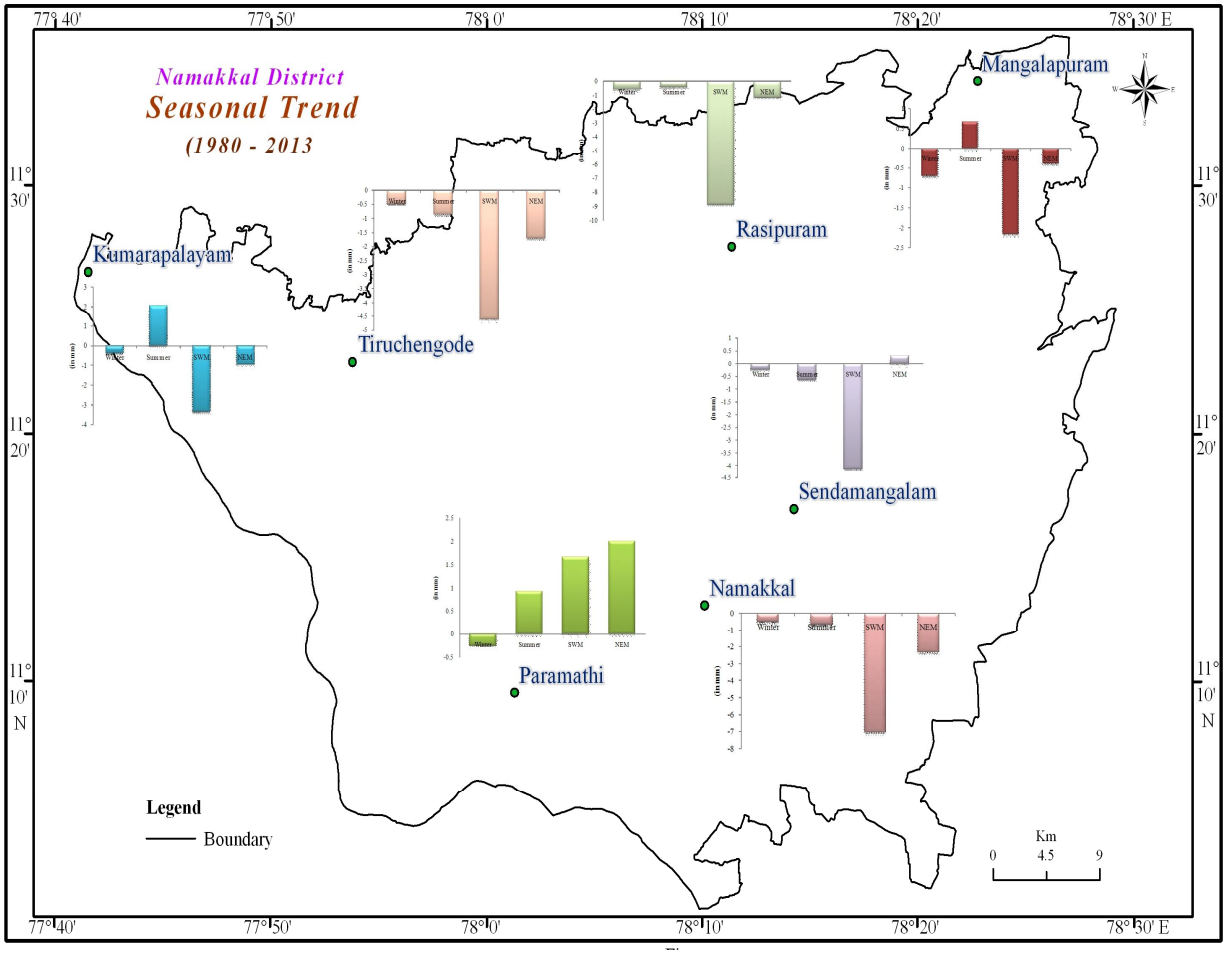

Fig. 5. Seasonal trend – Namakkal district (1980 – 2013)

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VI. CONCLUSION

From the analysis it is evident that, Namakkal area has high spatial and temporal variability in rainfall. Both the seasons contributes equal amount of rainfall over the locations. Among the locations, Mangalapuram has highly dependable rainfall with good distribution while Paramathy has least rainfall and is not dependable. Trend analysis reveals that the NEM rainfall has increased over most of the locations compared to SWM.

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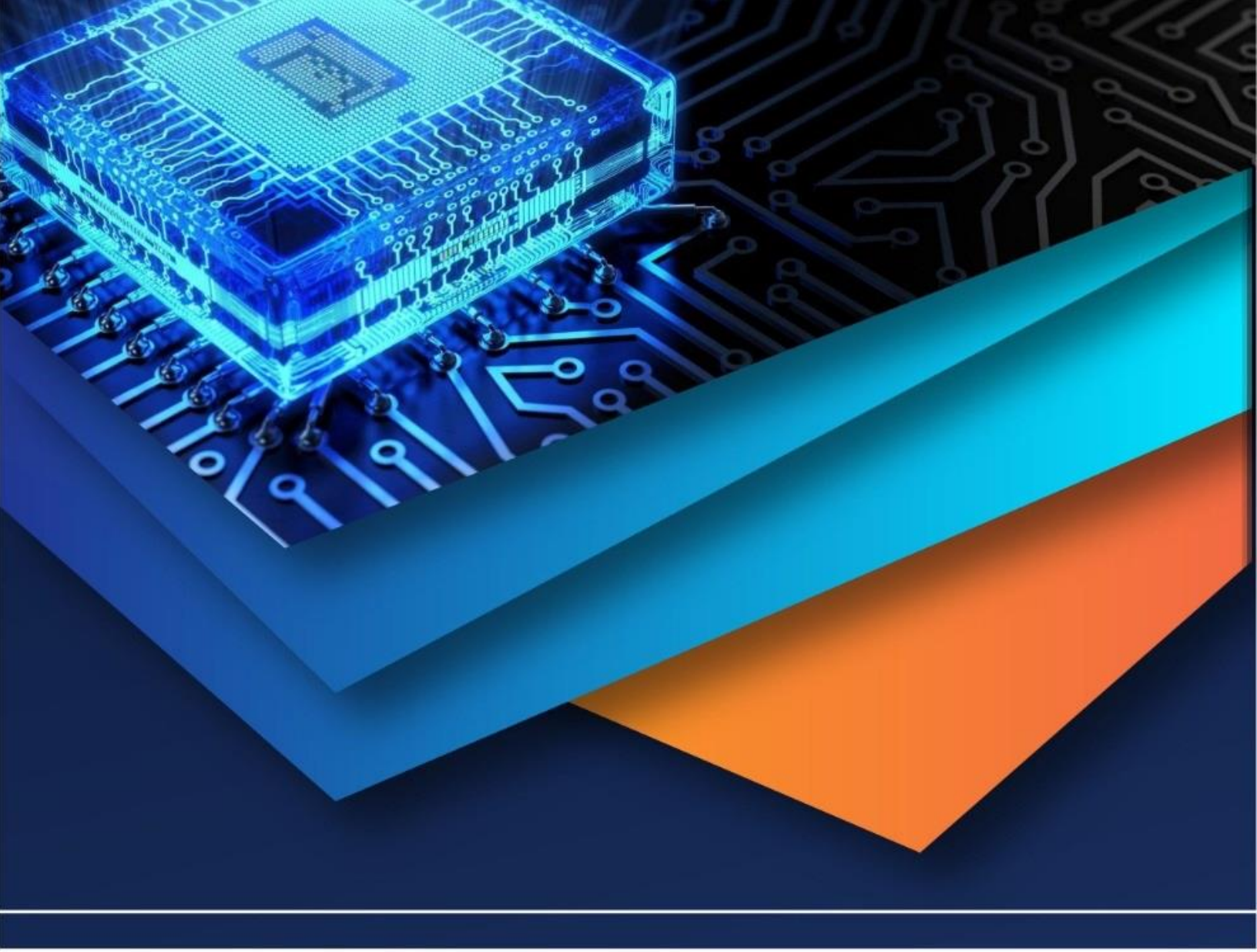

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