



## RAINFALL RHYTHM IN TIRUCHIRAPPALLI DISTRICT, TAMIL NADU - A GIS APPROACH

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### ABSTRACT

*The melt of snow and down pour of rainfall are the sources of surface and ground water. The varying uncertainty excess or deficiency in rainfall distribution causes stress on agricultural land use and also in ground water. To increase the agricultural productivity and to meet the demand for drinking water, proper use of available water is essential. The availability of water in most of the areas fully depends on rainfall Spatial Distribution of Rainfall in Tiruchirappalli District, Tamil Nadu between 100<sup>o</sup> 18' and 110 25' north latitudes and 78<sup>o</sup> 08' and 790 0' east longitudes It has a total geographical area of 4403.83 .The tabulated data are analyzed to calculate mean rainfall, coefficient of variations, precipitation ratio.*

**Key words:** Rainfall, Annual, winter, Summer, Southwest Monsoon, Northeast Monsoon

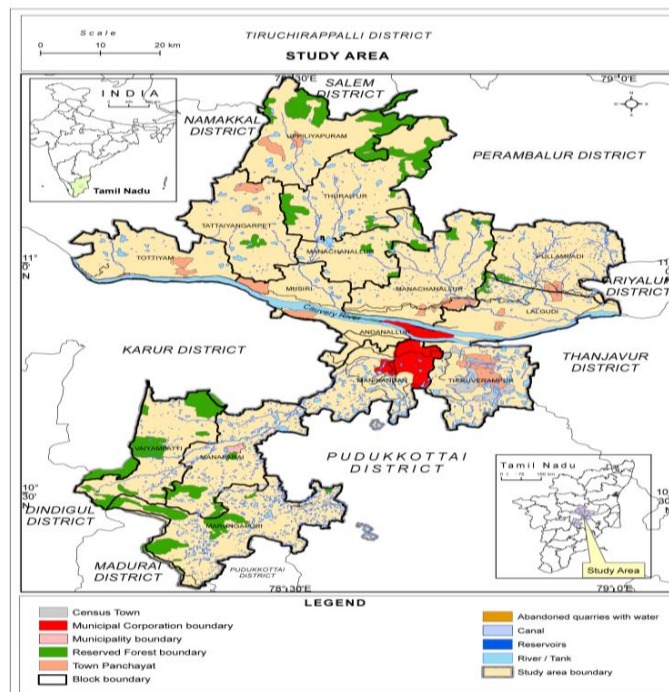
### INTRODUCTION

Agriculture in a region mainly depends on the availability of water. Water in an area is available in the form of surface water, ground water and snow. The melt of snow and down pour of rainfall are the sources of surface and ground water. The varying uncertainty excess or deficiency in rainfall distribution causes stress on agricultural land use and also in ground water. To increase the agricultural productivity and to meet the demand for drinking water, proper use of available water is essential. The availability of water in most of the areas fully depends on rainfall and its

reliability. In order to stabilize the agricultural activity, it is essential to understand the rainfall availability and its distribution over an area. The study on monthly, seasonal and annual rainfall distribution and their variability, precipitation ratio, frequency occurrence, rainy days and rainfall deviation will give the existing climatic condition of an area. The district located in tropical area experiences semi-arid climate. The over exploitation of available ground water resulted desertification of wells and depletion of ground water in most of the areas in Tiruchirappalli district.

## STUDY AREA

Tiruchchirappalli district, one of the three districts carved out of the composite district of the same name is located in the central part of Tamil Nadu between 100 18' and 110 25' north latitudes and 780 08' and 790 0' east longitudes It has a total geographical area of 4403.83 sq.km, which is about 3.40 per cent of the total geographical area of the state. It is bounded by Salem district in the north, Namakkal district in the north-west, Karur district in the west, Madurai and Pudukkottai districts in the south and Thanjavur and Perambalur district in the east. A location map of the district is shown as Fig.1.Tiruchchirappalli district, comprising 504 villages has been subdivided into 8 taluks and 14 blocks for administrative convenience. The detailed administrative set-up of the district is furnished in the following.



## METHODOLOGY

There are thirteen rainfall stations selected for the present study .the daily rainfall data for the period of 1980-2012 have been collected for major stations and available rainfall stations which are installed in last five years .the daily rainfall data has been tabulated as monthly for the respective rain gauge stations. The tabulated data are analyzed to calculate mean rainfall, coefficient of variations, precipitation ratio and frequency .the results are mapped in GIS environment by applying Spline interpolation.

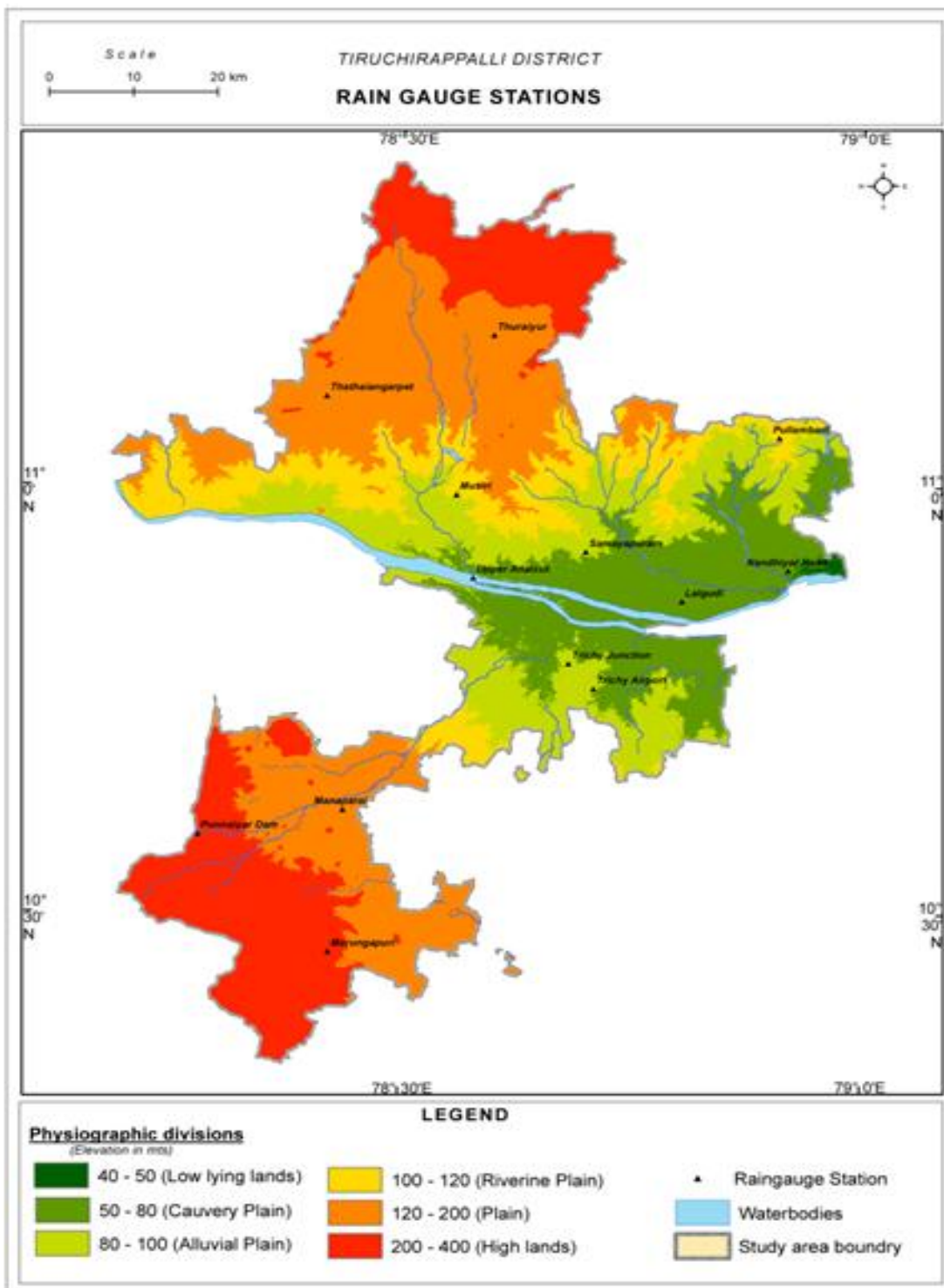
## MEAN RAINFALL

The monthly rainfall data for 32 years (1980–2011) have been collected for 13 stations which are located in and around Tiruchirappalli district namely Tiruchirappalli Airport, Musiri, Thuraiyur, Lalgudi, Pullambadi, Nandhiyar Head, Samayapuram, Manaparai, Marungapuri, Ponnaiyar Dam, Tiruchirappalli Junction, Upper Anaicut and Thathaingarpet (Figure 3 ) Tiruchirappalli district receives nearly half of the annual rainfall (49) during the northeast monsoon because normally, the Tamil Nadu State receives high rainfall during this season. The long term mean annual and seasonal rainfall of the district are given in (Table 3.2). Accordingly, the annual rainfall of the district is 838 mm of which the northeast monsoon contributes 49% followed by southeast monsoon which receives 34 per cent, summer 14% and winter 3% of the total the annual rainfall respectively.

**TABLE :1 SEASONAL RAINFALL OF TIRUCHIRAPPALLI DISTRICT**

Season	Rainfall	
	in mm	in (%)
Winter	26	3
Summer	117	14
Southwest monsoon	289	34
Northeast monsoon	406	49
Total	838	100

*Source: Compiled by Author based on rainfall statistics of the Statistical office, Chennai*



Source compiled by author based on IMD database, Chennai

**TABLE: 2 MEAN ANNUAL AND SEASONAL RAINFALL OF TIRUCHIRAPPALLI DISTRICT**

SI. No.	Station	Winter	Summer	South West Monsoon	North East Monsoon	Mean
1	Marungapuri	37	131	350	436	954
2	Ponnaiyar Dam	38	128	288	402	856
3	Manaparai	37	131	350	436	954
4	Nandhiyar Head	28	97	237	449	811
5	Tiruchirappalli Junction	26	120	312	395	853
6	Upper Anaicut	15	93	247	344	699
7	Tiruchirappalli Airport	28	107	313	465	913
8	Lalgudi	32	123	345	465	964
9	Samayapuram	14	97	238	347	696
10	Musiri	20	106	256	363	745
11	Pullambadi	28	123	296	451	898
12	Thathaiangarpet	9	114	203	315	641
13	Thuraiyur	19	156	329	407	911
<b>Mean</b>		<b>26</b>	<b>117</b>	<b>289</b>	<b>406</b>	<b>838</b>

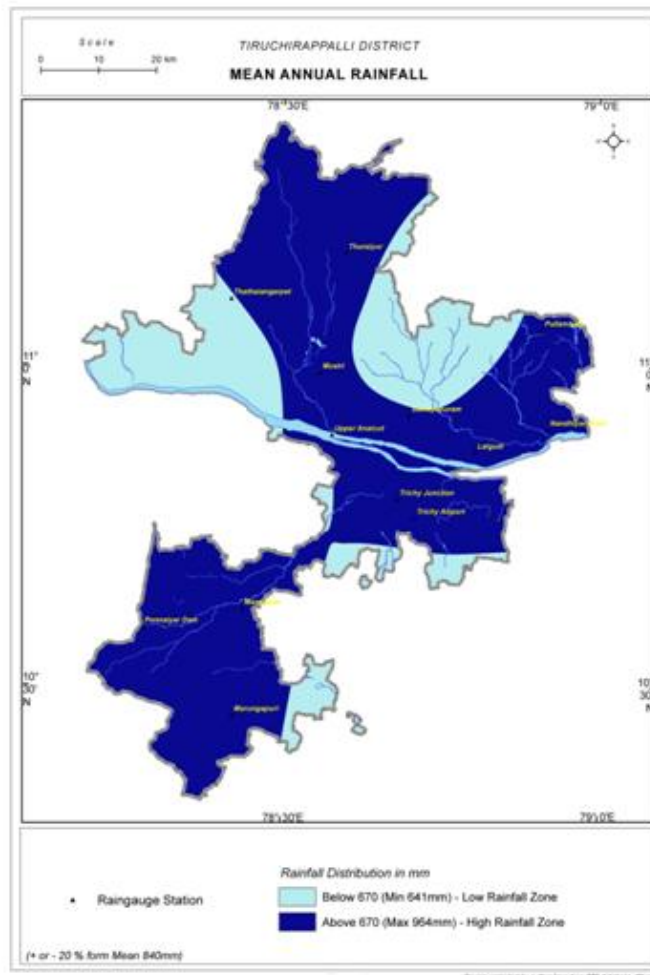
*Source: Compiled by Author*

### **MEAN ANNUAL RAINFALL**

Differentiation for annual, winter, summer, southwest and northeast monsoon season rainfall are shown in Figure 3 the spatial relationship and area. Accordingly, the district is characterized by gradual areal differences in the quantum of rainfall due to the plain topography. The mean annual rainfall varies between 641 mm at Thathiangarpet and 964 mm at Lalgudi in the study area. Based on the mean rainfall of the district, two rainfall zones have been classified. If the zone receives  $\pm 20\%$  of the longterm (838) mean it is to be considered normal zone and if the

rainfall deficit goes more than 20% from normal to be considered low rainfall zone. Table 3.2 shows the seasonal annual rainfall condition of the district.

The Low rainfall zone are represented by Thathaigarpet, Upper Anaicut and Samayapuram. The Normal rainfall zone (more than 670 mm) covers around the low rainfall zone and the raingauge stations includes Thuraiyur, Musiri, Pullambadi, Nandhiyar Head, Lalgudi, Tiruchirappalli Junction, Tiruchirappalli Aiport, Manaparai, Ponnaiyar dam and Marungapuri. Among these stations the low rainfall varies between 641 mm and 699 mm. The normal rainfall zone cover in and around Ponnaiyar Dam and the extreme south covering Marungapuri and the zone through passes south east to northwest covering Nandhiyar Head and Thuraiyur. Considering low rainfall zone, the two major regions, are western rainfall regime and eastern rainfall regime another one is Altogether normal rainfall zone covers 76% of the area and low rainfall zone covers 24% of the study area.



## **WINTER RAINFALL**

Out of mean annual rainfall of the district winter contributes 3% (26 mm) by covering the month of January and February shown in Figure 3.1(a). However, the month of January receives more rainfall than the February due to the receding impact of cyclone during the post monsoon period. During winter the rainfall is very low over Northwest parts of the district. Winter rainfall is higher, exceeding 31mm found over south and eastern part of the district. The low and high areas is intersected by normal (21-31 mm) winter rainfall zone found in the northern and central part of the District.

## **SUMMER RAINFALL**

The rainfall during the summer (March, April and May) is about 117mm which is 14% of the mean annual rainfall. The high rainfall during summer occurs at northern fringes of the district by covering Thuraiyur block. Rainfall decreases towards northeast, east and southeastern part of the study area. The low summer rainfall is (93 mm) registered at Upper Anaicut, found in the southeastern part of the study area. Normal rainfall of summer ranges between 94 mm-and 140 mm extending towards north, south and southeastern part of the study area covering Thuraiyur, Thathaiangarpet, Musiri, Pullambadi, Trichy Airport, Lalgudi, Tiruchirappalli Junction, Manaparai, Ponnaiyar Dam, and Marungapuri rainguage stations (Figure 3.2b).

## **SOUTHWEST MONSOON SEASON**

Generally in India, the southwest monsoon rainfall is the most important phenomenon affecting crop production, accounting for 80-95% of the annual rainfall in most part of the country and is associated with Kharif and partly Rabi crops. In the first week of June, the southwest monsoon cause heavy rainfall along the west coast and gradually extends its influence to the east and north and is established over the entire region of Tamil Nadu by the second week of June. The Arabian Sea branch of the monsoon sheds a large portion of its moisture before coming to the Western Ghats and so Tamil Nadu on the lee side of the Ghats does not receive much precipitation (Figure 3.3c). During this season, Tiruchirappalli district receives about 34% of rainfall and it is mainly associated with southwest monsoon winds. The rainfall of different stations varies between 203 mm, recording at Thathaiangarpet and 350 mm at Manaparai and Marungapuri covers the southern portion of the study area. The rainfall characteristics of summer is totally reversed with the southwest monsoon period. A high rainfall (above 347 mm) trough occurs in

and around northern portion comprising Thuraiyur, Lalgudi, Manaparai and Marungapuri blocks. From here the rainfall decreases radially in all the directions of the district. The normal rainfall varies between 231 and 347 mm is observed over Thathaiyangarpet, Pullambai, Musiri, Samayapuram, Upper Anaicut, Trichy Airport, Trichy Junction, Nandhiyar Head and Ponnaiyar Dam.

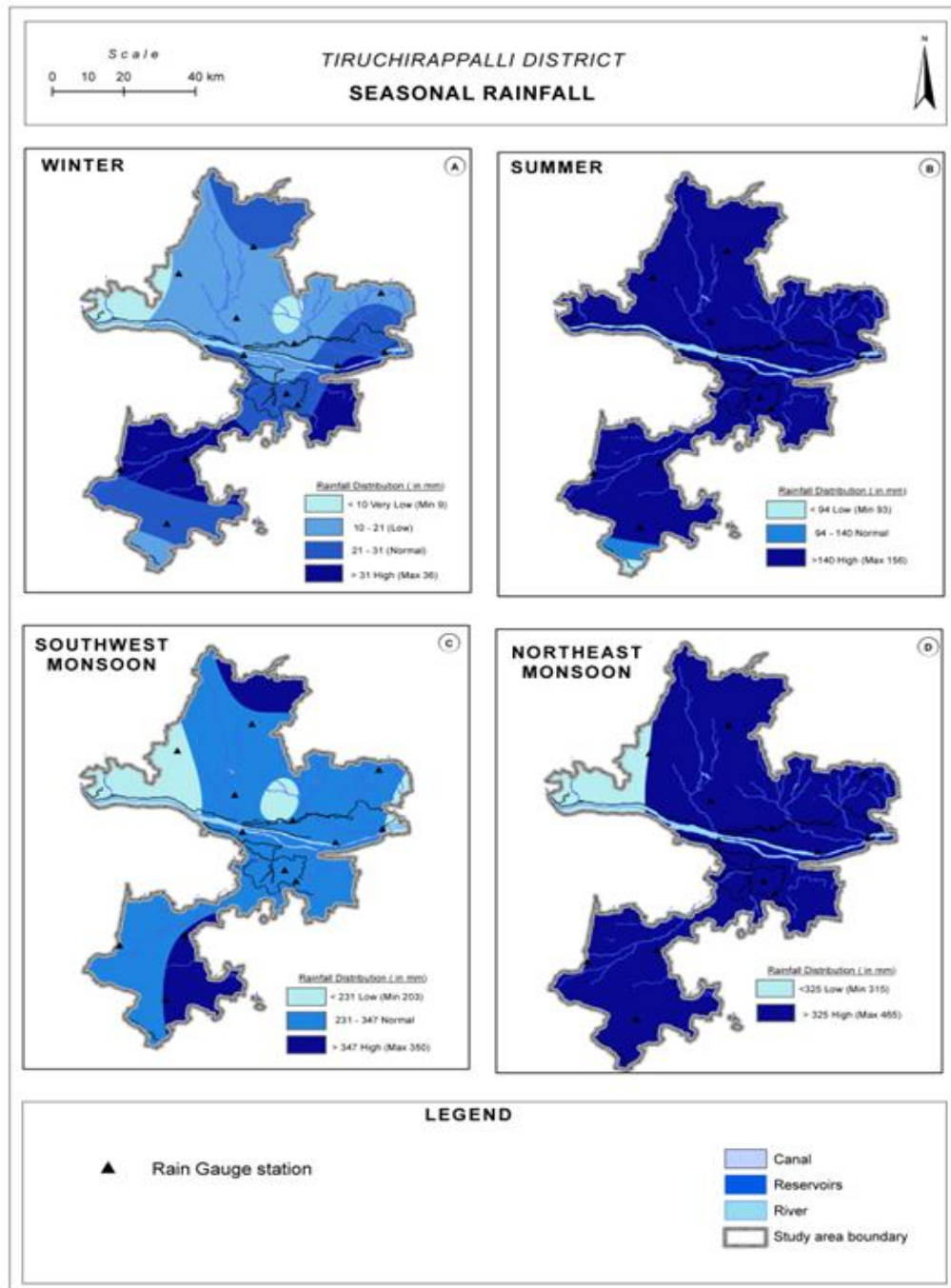
## **NORTHEAST MONSOON SEASON**

Northeast monsoon season (October to November) is the major period of rainfall for TamilNadu accounting for nearly half (48 per cent) of the annual rainfall and which is common in the Tiruchirappalli district too. This season is much more important for Tamil Nadu rather than the southwest monsoon, as the TamilNadu State receives the bulk of its rainfall during this season. As a matter of fact, much of the agricultural rhythm in Tamil Nadu corresponds to the northeast monsoon. The northeast monsoon rainfall is invariably associated with the cyclonic depressions formed in the Bay of Bengal. As such, the distribution of rainfall closely follows the cyclonic tracks. The cyclonic depressions originate in the Bay of Bengal around the Andaman and Nicobar Islands and move in a westerly direction affecting the entire coast from the Thanjavur delta to Chennai. In general, the amount of rainfall is the highest on the coast and decreases westward. The amount of rainfall is low in the southeastern parts due to the reduced effect of the depressions.

Tiruchirappalli is located in the mid and interior part of Tamil Nadu and hence, the district receives low rainfall compared to other district of Tamil Nadu (Resource Atlas of Tamil Nadu, 1985). During this season, the district receives 406mm of rainfall which contributes 48% to the annual rainfall. The northeast monsoon follows almost the same trend of mean annual rainfall. The highest rainfall zone occurred over the northeastern part of the district. Rainfall is very high during this season found over in Tiruchirappalli Airport and Lalgudi (465 mm) and it is lowest over Thathaiyangarpet (315 mm). The Normal rainfall zone (more than 325 mm) is exist by covering Tiruchirappalli Airport, Lalgudi, Nandhiyar Head, Manaparai, Pullambadi and Marungapuri rain gauge stations from where, the rainfall decreases in all the directions except in the south and the southwestern part of the district.

On the other hand the rainfall decreases from Lalgudi to Samayapuram, and decreases till over the northwestern direction from Tiruchy Airport to Upper anaicut. A low rainfall of less than





Source compiled by author based on IMD database, Chennai

325mm is associated with zones covering extreme north, northwestern, southwestern and mid southeastern parts of the district. Most of the rainfall in this season is influenced by depression and storm formed over the Bay of Bengal (Figure 3.4d)

**TABLE:3 MEAN ANNUAL AND SEASONAL RAINFALL VARIABILITY OF TIRUCHIRAPPALLI DISTRICT**

St. No.	Station	Winter	Summer	South West Monsoon	North East Monsoon	Mean
1	Marungapuri	46	82	96	117	157
2	Ponnaiyar Dam	50	103	110	148	346
3	Manaparai	43	92	131	142	296
4	Nandhiyar Head	48	64	106	129	226
5	Tiruchirappalli Junction	47	77	134	120	296
6	Upper Anaicut	43	84	126	122	271
7	Tiruchirappalli Airport	49	76	124	106	196
8	Lalgudi	44	77	113	128	253
9	Samayapuram	44	67	109	115	236
10	Musiri	41	84	122	134	296
11	Pullambadi	52	64	128	136	251
12	Thathaiangarpet	37	81	110	133	169
13	Thuraiyur	40	97	149	146	306
	<b>Mean</b>	<b>45</b>	<b>81</b>	<b>120</b>	<b>129</b>	<b>254</b>

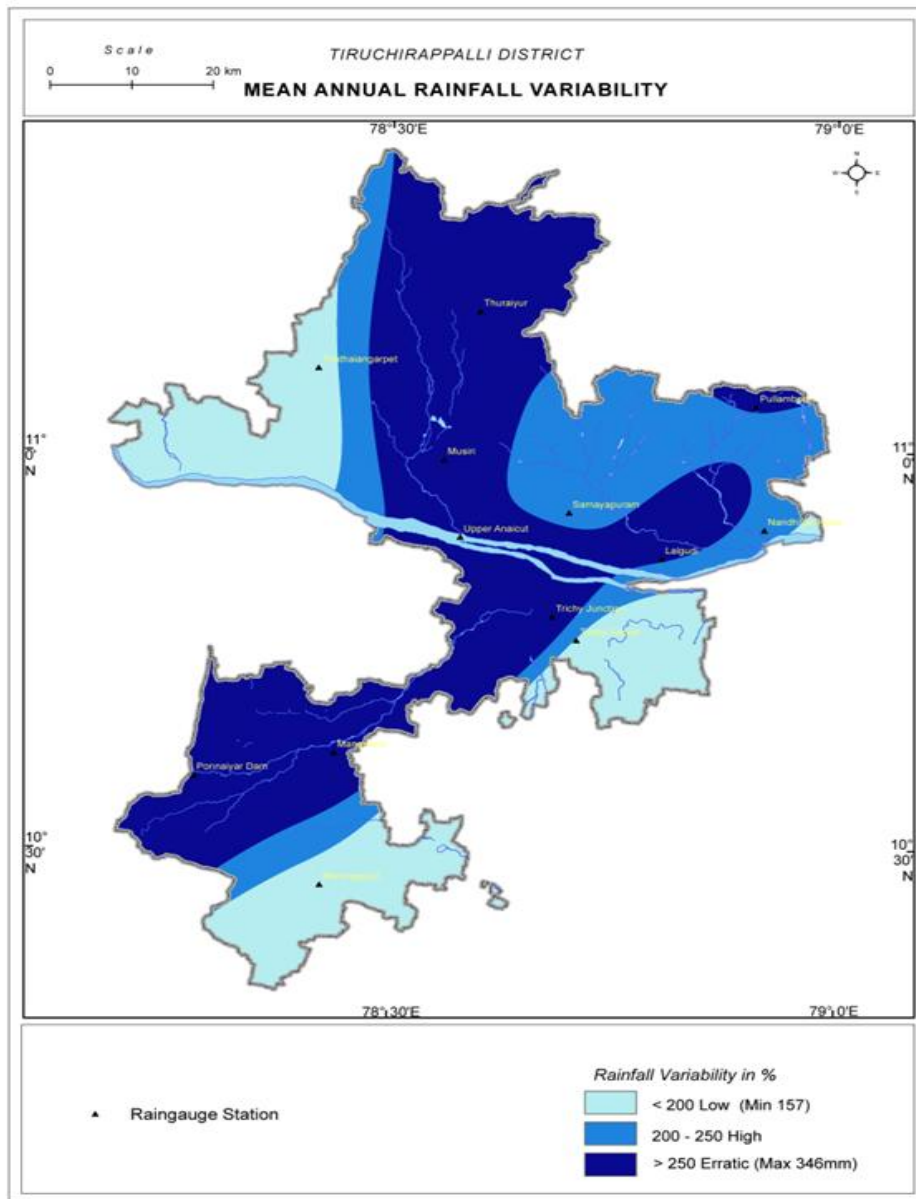
*Source: Compiled by Author*

### **RAINFALL VARIABILITY**

The co-efficient of variability of rainfall in a humid region is quite lower than the co-efficient of variability of rainfall in arid and semi-arid regions. In general if the annual variability is more than 20% there will be a great risk in rainfed farming.

## MEAN ANNUAL RAINFALL VARIABILITY

The district average variability is 254% indicates the erratic nature of rainfall over the study area. Spatially, mean variability varies between 157% and 346% (Marungapuri, and Ponnaiyarr Dam. Figure 3.4. Shows the spatial variance of annual variability over the district. In general the variability is very high over the north east to southeast stretch covering Manachanallur, Thuraiyur, Pullambadi, Manikandan, Manaparai and Vaiyampattai blocks. Beyond this zone the variability gradually declines towards the periphery of the district, where the variability lies between 157% and 250% Table 3.9).



## **WINTER RAINFALL VARIABILITY**

In general variability is least during winter and nowhere the variability exceeds 50%, which shows relatively higher reliability of rainfall during the month of January and February. The lowest variability (37%) is observed over Thathaiyangarpet and Thuraiyur blocks and higher variability (52%) is observed over the parts of Pullambadi and Ponnaiyar Dam Figure 3.5(a).

## **SUMMER RAINFALL VARIABILITY**

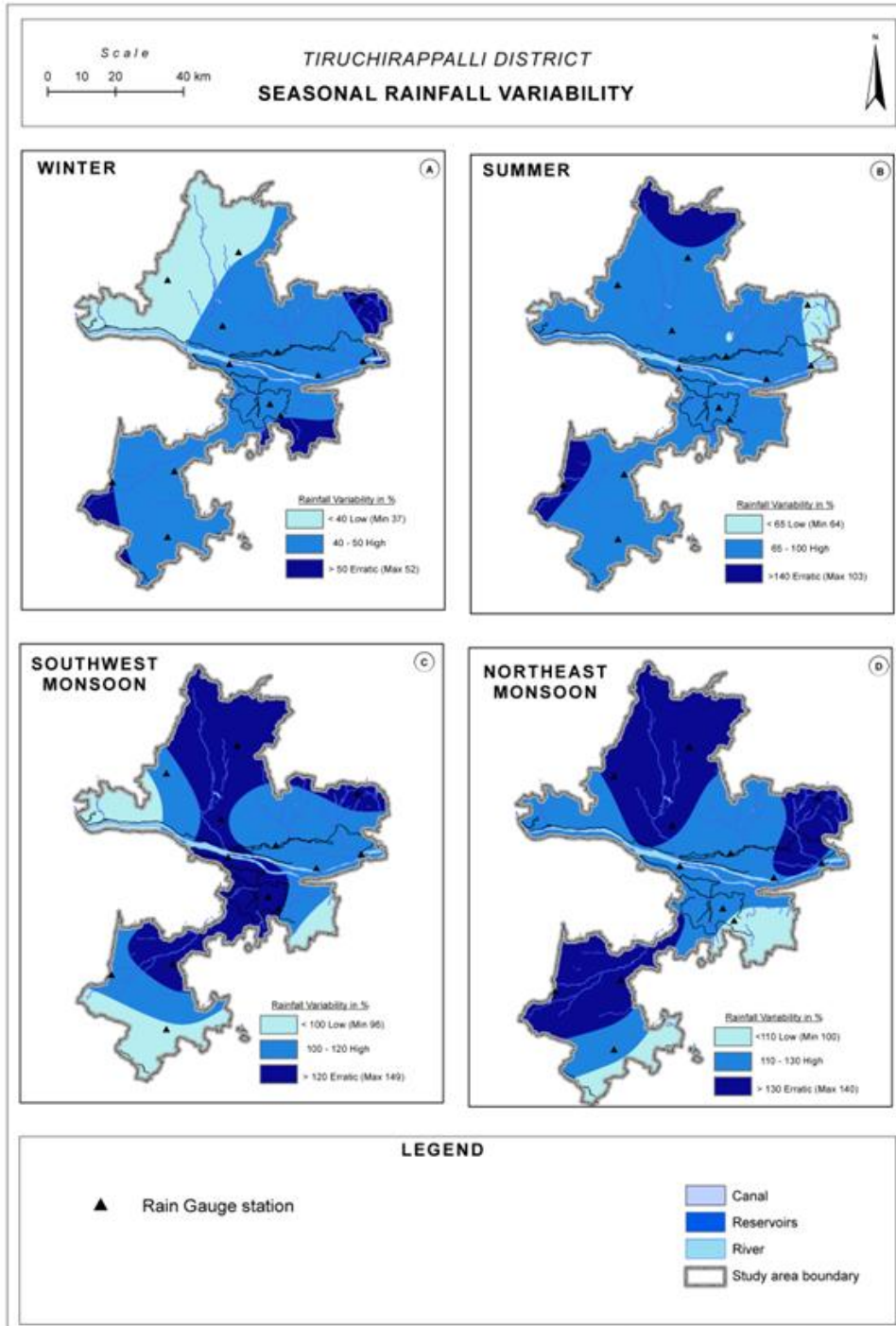
March, April and May are considered to be summer months and the variability during the summer lies around 81% throughout the district. Minimum variability of summer season is 64 % is observed over Nandhiyar Head, and here the summer rainfall is higher (146 mm). The maximum variability (103 %) observed over Ponnaiyar Dam where too the summer rainfall is higher and this shows the contradictory relationship. In most part of the district summer variability lies between 65% and 100%. (Figure 3.5b).

## **SOUTHEAST MONSOON RAINFALL VARIABILITY**

Though the rainfall gradually increases during southwest monsoon period the pattern of variability exhibits poor reliability and the district average variability is 120%. It indicates that, the southwest monsoon has greater fluctuation through the years. Notably the variability is less over Marungapuri where it is 96%. Similarly the variability is less over Tottiyam and Thathaiyangarpet blocks, southeastern parts of both Lalgudi and Thiruverambur blocks. The overall pattern of southwest monsoon variability is (Figure 3.5c) linear trending between north to south

## **NORTHEAST MONSOON RAINFALL VARIABILITY**

There is no much variation between the variability of southwest monsoon and northeast monsoon season. The district average variability is 129% and it goes 148% over Ponnaiyar Dam and declines up to 106% over Tiruchirappalli airport. The overall spatial pattern of northeast monsoon is circular shown in Figure 3.5(d) and the variability decreases from the central part of the district towards reset of the study area. The relationship between rainfall and reliability during northeast monsoon is proportionate i.e. where ever the where rainfall is higher the reliability also is higher and vice versa.



Source compiled by author based on IMD database, Chennai

**TABLE :4 MEAN ANNUAL AND SEASONAL PRECIPITATION RATIO**

SI. No.	Station	Rainfall in mm				
		Winter	Summer	South West Monsoon	North East Monsoon	pre. Ratio (mm)
1	Marungapuri	865	453	436	304	199
2	Ponnaiyar Dam	807	441	331	272	134
3	Manaparai	975	506	304	288	173
4	Nandhiyar Head	878	621	396	338	212
5	Tiruchirappalli Junction	816	607	272	345	148
6	Upper Anaicut	974	564	328	354	182
7	Tiruchirappalli Airport	721	605	317	562	310
8	Lalgudi	897	494	350	314	212
9	Samayapuram	774	606	360	381	188
10	Musiri	829	482	335	339	173
11	Pullambadi	644	760	327	293	197
12	Thathaiangarpet	585	489	279	276	195
13	Thuraiyur	1161	472	282	301	191
<b>District Mean</b>		<b>840</b>	<b>546</b>	<b>332</b>	<b>336</b>	<b>193</b>

*Source: Compiled by Author*

**TABLE :5 MEAN ANNUAL AND SEASONAL PRECIPITATION RATIO**

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*Source: Compiled by Author*

## PRECIPITATION RATIO

The abnormalities of rainfall at any location may be brought out by a simple ratio of precipitation. It is the difference between the maximum and minimum rainfall over the series of years/months expressed in the terms of mean. This ratio may give the stability of rainfall with spatial relationship. Higher the ratio, higher the abnormality in rainfall and vice-versa. The precipitation ratio can be derived by using the following equation

$$\text{Precipitation Ratio} = (P_x - P_n / P_m) \times 100$$

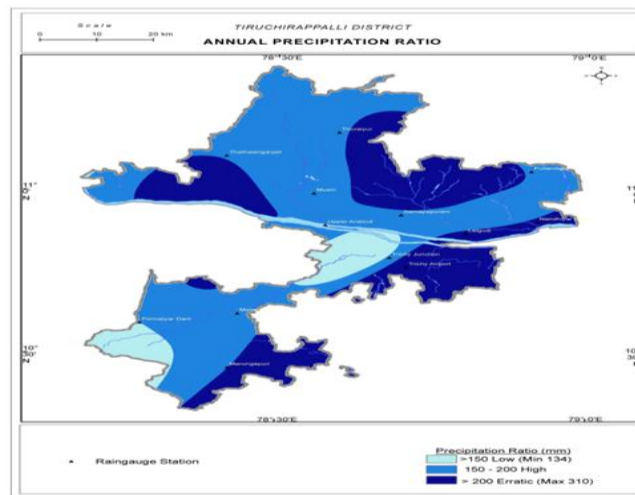
Where  $P_x$  and  $P_n$  represent the maximum and minimum of rainfall over the series of years and  $P_m$  is the mean annual rainfall.

## ANNUAL PRECIPITATION RATIO

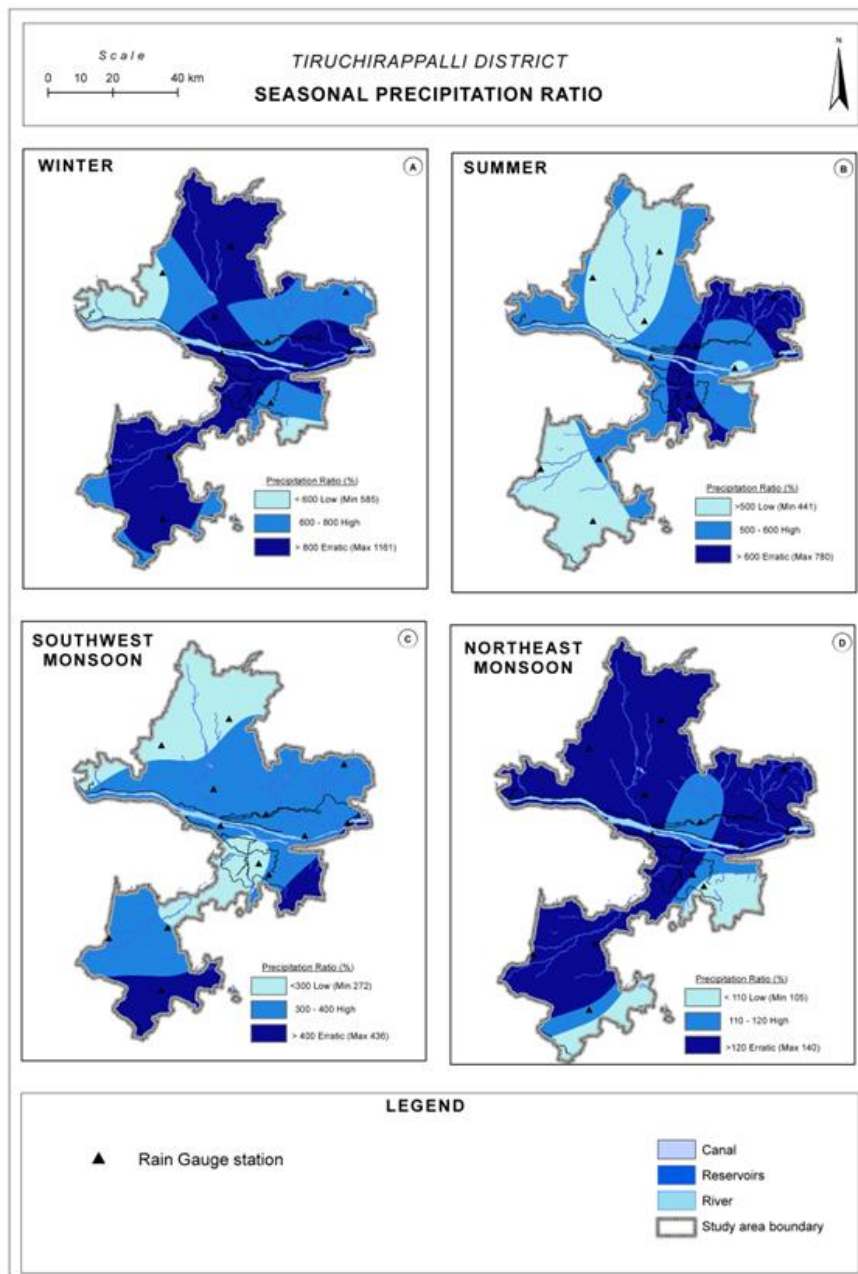
The district average Precipitation Ratio is 193% and it is higher over Tiruchirappalli Airport (310 %), Nandhiyar Head and Lalgudi (212%). The low Precipitation Ratio found over Ponnaiyar Dam (134%) and Tiruchy junction (148%). Precipitation Ratio is not exceeding 200% and not receding 170%. over Manaparai, Marungapuri, Upper Anaicut, Samyapuram, Musiri, Pullambadi, Thathaiangarpet and Thuraiyur. The overall annual pattern of Precipitation Ratio is shown in Figure 3.6. and it reveals elongated shape over northwest to southeast influenced by the fluctuation of monsoon rainfall.

## WINTER PRECIPITATION RATIO

Precipitation ratio during winter is erroneously higher and the district average shows the striking value of 840% during winter the rainfall is quite unstable as shown by precipitation ratio







Source compiled by author based on IMD database, Chennai

between 585% (Thathaiyengarpet) and 1161% over Thuraiyur. The spatial pattern of precipitation ratio during winter is circular (Figure 3.7(a) and precipitation ratio is 600% which increase radially towards reset of the study area.

### SUMMER PRECIPITATION RATIO

Comparison of precipitation ratio of summer and winter shows greater variance. Precipitation Ratio summer is 546%. Though, the Precipitation Ratio is higher during summer, the stability is relatively higher than the winter and it shows the significance of kharif cropping during summer

months. Figure 3.7(b). Shows the spatial pattern of summer precipitation ratio and it is almost similar to the pattern of annual and winter precipitation ratio.

### **SOUTHWEST MONSOON PRECIPITATION RATIO**

The ratio between minimum and maximum rainfall gradually declines by the advancing monsoon season. During the month of June, July, August and September the district average precipitation ratio is estimated as 332% and it is spatially varied between 272% over Tiruchirappalli Junction and 436% over Marungapuri as shown in Figure 3.7(c). Precipitation ratio during southwest monsoon obviously follows the annual pattern due to the higher amount of rainfall received during this season.

### **NORTHEAST MONSOON SEASON PRECIPITATION RATIO**

The abnormality of rainfall during northeast monsoon is quite low comparing with premonsoon season. The district average precipitation ratio is 336% at it goes up to 562% over Tiruchirappalli Airport and it is well below 272% over Ponnaiyar Dam. The spatial pattern of precipitation ratio is shown in Figure 3.7(d) and it reveals no much spatial variation. The entire region comes under the ratio of less than 300 mm which shows the influence of northeast monsoon rainfall over the district.

### **CONCLUSION**

In the district whole, normal mean annual rainfall (above 670 mm) zone covers 76% of the area and low rainfall (below 670 mm) zone covers 24% of the study area. 31% to 41% of the annual rainfall occurrence of the district ranges between 500 and 750 mm, whereas, another 25 to 38% of occurrence is subject to 750 to 950mm annual rainfall. Variability is very high over the north east to southeast stretch covering Mannachanallur, Thuraiyur, Pullambadi, Manikandan, Manaparai and Vaiyampatti blocks. Beyond this zone the variability gradually declines towards the periphery of the district. The abnormality rainfall during northeast monsoon is quite low comparing with Premonsoon season. In normal year the rainy days are higher (above 45) over the blocks of Uppliyapuram, Thuraiyur, Thathaiyangarpet, Thottiyam, Musiri, Manachanallur and Pullambadi. The rainy days are goes below 40 over the rest of the areas. The comparison of rainy days during normal, wet and dry year shows that the rainy days is always higher over the blocks of Tottiyam, Musiri, Anandanallur, Manikandan, Vaiyampatti, Mannachanallur, Thathaiangarpet and part of Pullambadi.

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