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Spatial and Temporal Distribution of Rainfall in Pudukkottai District of Tamil Nadu

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ABSTRACT

Rainfall is one of the important climatic parameter influencing the cropping pattern, productivity, development of society and environmental factors of the particular region. It is an important to study the rainfall characteristic which includes the spatial and temporal variability of the adjudicating agriculture. It also projects the development and sustainability of agriculture. The present study is dealt with the rainfall characteristics of the rainfall of Pudukkottai districts which includes spatial and temporal distribution and variability through different seasons and precipitation ratio. The study is based on 32 years of daily rainfall data from 1980 to 2011 for 22 rain gauge stations located in Pudukkottai district. The study concludes that the very high rainfall of 1,125mm in the year 2008 received by the districts and 84.7% of the annual total average of the rainfall during the season of northeast and southwest monsoon. It also concludes that the experience of the high concentration of rainfall at south and southeastern parts of the districts and it experience of the low concentration of the rainfall at north and northeastern parts of the area where the study done.

Keywords: Rainfall, Rainfall Variability, spatial, temporal, precipitation ratio and Pudukkottai district.

INTRODUCTION

The rainfall is very important agro-climatology factor and a key component of the water cycle is responsible for the fresh water on the Earth. It gives reasonable conditions to numerous sorts of biological communities and water for the yield water system. Being India is an agrarian nation, the water usage is imperative. India receives the rainfall from monsoon but the unequal and unpredictable distribution of spatial and temporal rainfall leads to mismatch the Indian economy. Also the Indian economy is mainly depends on agriculture and the livelihood of the Indian farmers, especially they mostly depend on the Monsoon rains. In India, either directly or indirectly 70% of population is depending on farming. As an agricultural sector they largely depend on the monsoon rainfall, so very good understanding of monsoon is urgent need. The normal yearly precipitation in India is around 1200 mm. The vast majority of this precipitation is gotten amid four months (June, July, August and September) of the Southwest Monsoon season. The measure of yearly precipitation shifts from place to put, as well as from season to season. Rainstorm is extremely uncertain on the grounds that the rain arrives sooner than required or past the point of no return and furthermore it might be too substantial precipitation in a few sections and excessively lighter in different parts. In India, the rainfall pattern changing its traditional notion of dry area receives low rainfall and wet area receives moderate to heavy rainfall (Subimal et al., 2016). Unequal pattern of the Northeast monsoon rainfall over Tamil nadu is the most important season which receives more than 40% of rainfall (Indira., 2013). The purpose of the study is to understand the spatial and temporal pattern of the rainfall in Pudukkottai district of

Tamil Nadu. (Aruchamy.S., 2010) has been studied the rainfall trends and pattern of Kongu Upland, Tamil Nadu, India using GIS Techniques. GIS is an effective tool for the calculation and creation of rainfall map (Jegankumar et al., 2012)

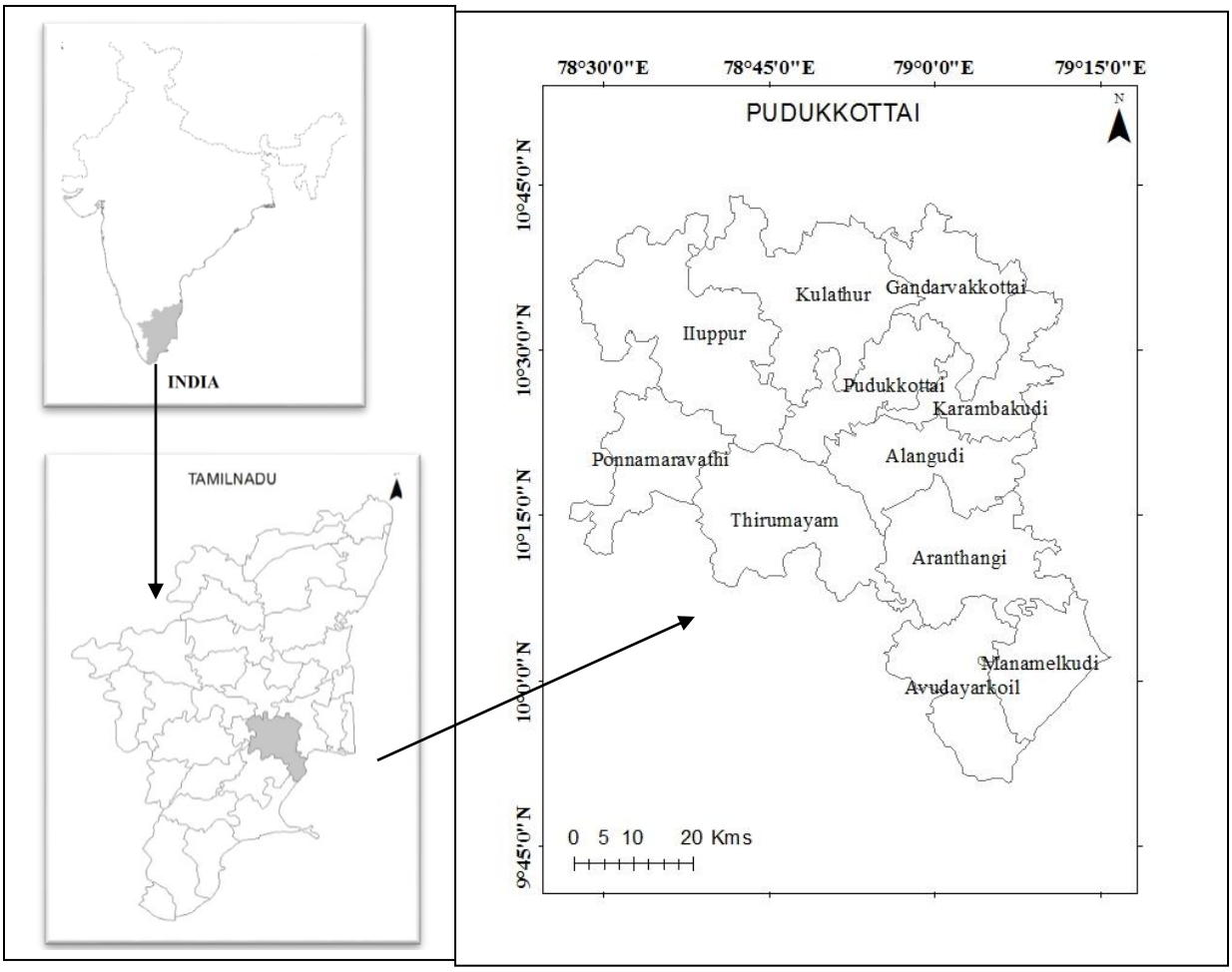

Fig. No. 01

STUDY AREA

Pudukkottai district is one of the districts of Tamil Nadu, exactly lies between $9^0$50’ and 10^0 40’ North latitude and 78^0 25’ and $79^0$15’ East longitude. Pudukkottai district is bounded by the

marine hedge of Bay of Bengal in the east, Thanjavur and Thiruchirapalli districts on the north and west, Sivagangai and Ramanathapuram districts on the south. Total administered area of the Pudukkottai district is 4663.29 sq.km with a coastal length of 42 kms. It is the 10th largest state in terms of area in Tamil Nadu. The area is created by 3 Revenue Division, 12 Taluks, 13 squares, 763 income towns, 497 town panchayats, 2 districts and 8 Town Panchayats. Add up to populace of Pudukkottai region according to 2011 enumeration is 16,18,345 with 8,15,157 females and 8,03,188 guys populace. It positions 22nd as far as populace in Tamil Nadu according to 2011 evaluation. The area of the examination region is given in the Fig. No. 01.

OBJECTIVES

- To study the rainfall pattern of Pudukkottai District.
- To find the spatial distribution of rainfall in Pudukkottai district.
- To find the temporal distribution of rainfall in Pudukkottai district.
- To find the monthly rainfall variability in Pudukkottai district.

MATERIAL

There are twenty two rain gauge stations spread over the Pudukkottai district which are taken for the present study, shown in the Fig. No. 02. The daily rainfall data for the period of 32 years from 1980 to 2011 have been collected from the Ground water board, Chennai.

METHODOLOGY

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There are 22 rain gauge stations have been taken into consideration shown in the Fig. No. 02. The daily rainfall data has been tabulated to calculate mean rainfall, coefficient of variation using a formula CV = (Standard Deviation / Mean) X 100 and precipitation ratio using a formula Precipitation Ratio = $(P_x – P_n)/P_m$ X 100**.** The collected data has been processed and analyzed by preparing charts and map with the help of Inverse Distance Weighted (IDW) interpolation in GIS 10.1 software.

RESULT AND DISCUSSION

The result of the study discovered the various truth about the spatial and temporal distribution of rainfall in the state. The outcomes of the study are discussed below:

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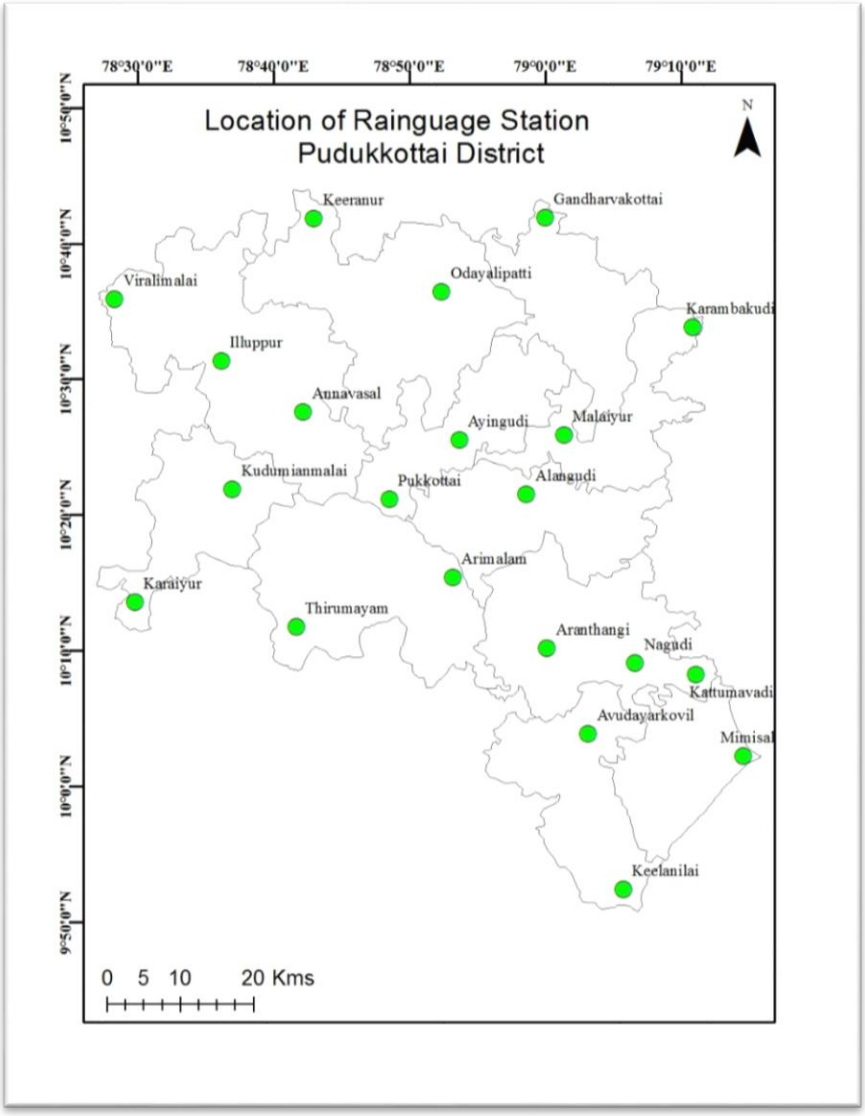

Fig. No. 02

MEAN ANNUAL RAINFALL

There are 22 rain gauge stations is located in the Pudukkottai district are taken for the study. The long term mean annual rainfall for Pudukkottai district is 805.1 mm. The maximum rainfall recorded at Aranthangi with 996.5 mm and minimum rainfall recorded at Odayalipatti with 517.2 mm show in the Table No. 01.

Station	Mean annual rainfall	Mean Winter	Mean Summer	Mean SWM	Mean NEM
PUDUKKOTTAI	820.9	33.8	87.4	336.7	362.8
PERUNGALUR	834.4	31.6	95.2	313.8	393.8
KEERANUR	866.7	30.5	107.1	321.2	407.9
ODAYALIPATTI	517.2	10.0	52.5	162.9	291.8
ANNAVASAL	687.4	24.3	79.1	271.7	312.3
ILLUPPUR	782.9	22.6	103.4	313.4	343.5
KUDUMIAN MALAI	906.1	34.6	114.7	356.7	400.2
VIRALIMALAI	710.2	29.9	94.9	275.4	310.0
ALANGUDI	718.3	31.3	68.2	261.1	357.8
MALAIYUR	635.8	29.2	49.4	213.8	343.5
KARAMBAKUDI	819.2	52.0	81.1	242.6	443.5
THIRUMAYAM	931.5	41.2	101.2	390.7	398.3
KEELANILAI	887.9	8.6	106.7	426.0	346.6
ARIMALAM	804.3	35.6	77.4	305.8	385.4
KARAIYUR	668.8	21.2	64.1	257.6	326.0
ARANTHANGI	996.5	49.8	85.7	349.3	511.7
NAGUDI	710.5	51.1	67.0	185.8	407.0
AYINGUDI	739.1	48.1	53.8	214.1	423.1
KATTUMAVADI	890.5	55.9	117.5	214.0	503.2

MIMISAL	931.8	43.9	133.6	165.8	588.6
GANDHARVAKOTTAI	925.1	30.1	111.1	309.4	474.5
AVUDAYARKOIL	927.9	38.8	104.5	288.5	497.4
Average	**805.1**	**34.3**	**88.9**	**280.7**	**401.3**

Annual and Season rainfall **Table No. 01**

Out of the 22 rain gauge stations, rainfall is observed as the very high (>900) at Mimisal (931.8mm), Gandharvakottai (925.1mm), Avudayarkoil (927.9mm), Aranthangi (996.5mm), Thirumayam (931.5mm) and Kudumianmalai (906.1mm). Compared to all the 22 rain gauge stations Aranthangi has received very high annual average in the Pudukkottai district during the study period. The following regions receive the rainfall in the range between 800mm to 900mm which is considered to be high in the study region: Pudukkottai (820.9mm), Perungalur (834.4mm), Keeranur (866.7mm), Karambakudi (819.2mm), Keelanilai (887.9mm), Arimalam (804.3mm) and Kattumavadi (890.5mm). Illupur (782.9mm), Viralimalai (710.2mm), Alangudi (718.3mm), Nagudi (710.5mm) and Ayingudi (739.1mm) regions receive moderate rainfall of range 700mm to 800mm. Annavasal (687.4mm), Malaiyur (635.8mm) and Karaiyur (668.8mm) regions receive low rainfall of range 600mm to 700mm. Odayalipatti is the only rain gauge station receives very low rainfall of 517.2mm (<600mm) in the study area. Fig. No. 03. shows that Southwestern parts of the district received the very high rainfall where Avudayarkoil, Aranthangi Mimisal regions are located and the rainfall gradually reduces towards northeast where Odayalipatt is located and the rain becomes very low.

SOUTHWEST MONSOON

During the period of southwest monsoon the average rainfall is 280.7mm which is about 34.9% of the average annual rainfall of the Pudukkottai district. Out of the 22 rain gauge stations average rainfall during this season is found to be the very high at Kudumianmalai, Thirumayam and Keelanilai. High rainfall at Gandharvakottai, Aranthangi, Arimalam, Illuppur, Pudukkottai,

Mean Annual Rainfall

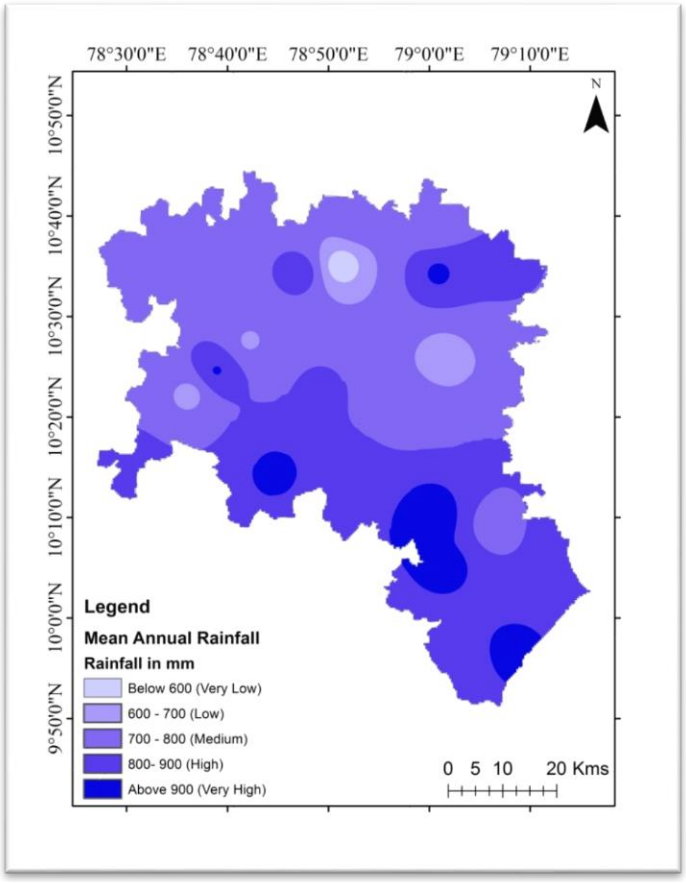

Fig. No. 03

Perungalur and Keeranur in the range of 300mm to 350mm. The moderate rainfall occurs at Annavasal, Viralimalai, Alangudi, Karaiyur and Avudayarkoil in the range of 250mm-300mm. The region of Malaiyur, Karambakudi, Ayingudi and Kattumavadi received low rainfall in range of 200mm-250mm and very low rainfall that is less than 200mm received at Nagudi, Mimisal and

Odayalipatti. Keelanila and Odayalipatti received very high (426.01mm) and very low (162.89mm) rainfall respectively during this season in the study area. Fig. No. 04 shows that southwestern parts received high to very high rainfall and it gradually reduced to low to very low rainfall in the northeastern parts of the study area.

NORTHEAST MONSOON

The north east monsoon is major rainy season in Tamil Nadu as well in the region of Pudukkottai district. This season prevail in the period from October to December and gets maximum rainfall through the depressions originate from Bay of Bengal. Farmers are highly depended on this season if rainfall in the study area and it extremely supports for samba cultivation. This season average rainfall is 401.3mm and it contributes 49.8% of total mean annual rainfall. The rainfall varies during the season from minimum rainfall of 291.8mm at Odayalipatti and maximum of 588.6mm rainfall at Mimisal is received. The very low rainfall is received at Illupur(343.5mm), Malaiyur(343.4mm), Keelanilai (346.4mm), Karaiyur (325.9mm), Odayalipatti(291.8mm), Annavasal (312.9mm) and Viralimalai (310.0mm) during this retreating monsoon season. Low rainfall received at Perungalur (393.8mm), Thirumayam (398.3mm), Arimalam (385.3mm), Pudukkottai (362.8mm) and Alangudi (357.7mm) during this season. The region of Karambakudi (443.5mm), Keeranur (407.9mm), Kudumianmalai (400.2mm), Nagudi (406.9mm) and Ayingudi (423.0mm) received moderate rainfall during the season. Gandharvakottai (474.4mm) and Avudayarkoil (497.4mm) are received high rainfall during the season. Aranthangi (511.6mm), Kattumavadi (50.31mm) and Mimisal (588.6mm) are the rain guage station received very high rainfall during this retreating monsoon season. Fig.No. 04 shows that very high rainfall occurred at southeastern parts of Pudukkottai district where Mimisal, Aranthangi and Kattumavadi are

located and the rainfall gradually decreased towards northeastern parts of the study area where the rainfall is very low.

WINTER RAINFALL

The winter season average rainfall is 34.3mm which is only 4.3% of average annual rainfall of the Pudukkottai district. Winter season rainfall varies from minimum of 8.5mm to maximum of 55.9mm. Very high rainfall of winter season records at Kattumavadi (55.9mm), Karambakudi (52mm), Nagudi (51mm), Aranthangi (49.8mm), Ayingudi (48mm) and Mimisal (43.85mm). The region received high rainfall is Thirumayam (41.2mm), Arimalam (35.6mm) and Avudayarkoil (38.8mm). Pudukkottai (33.7mm), Perungalur (31.5mm), Alangudi (31.3mm), Kudimianmalai (34.5mm), Gandharvakottai (30.1mm) and Keeranur (30.4mm) received moderate rainfall during this winter season. Low rainfall received at Viralimalai (29.8mm), Malaiyur (29.1mm) and Annavasal (24.3mm). Very low rainfall recorded during this season at Karaiyur (21.6mm), Illupur (22.5mm), Odayalipatti (9.9mm) and Keelaninai (8.5mm). Fig. No. 04 shows that Eastern and Southeartern parts of the district received very high rainfall and it gradually decreased from very low to low rainfall at North and Northwestern parts of the district.

SUMMER RAINFALL

This season is hottest compared to other season, the rainfall during this season largely depends on conventional rainfall. The average rainfall for this season is estimated to be 88.8mm which is only 11% of the annual average rainfall. The highest amount of rainfall is recorded at the Mimisal (133.6mm) and low amount of rainfall is recorded at Malaiyur (49.4mm). The region received

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very high rainfall during summer seasons are Mimisal (133.6mm) and Kattumavadi (117.5mm). Avudayarkoil (104.5mm), Thirumayam (101.2mm), Illuppur (103.4mm), Kudumianmalai (114.7mm), Keeranur (107.1mm) and Gandharvakottai (111.1mm) are the region high rainfall during summer season. Pudukkottai (87.4mm), Perungalur (95.2mm), Viralimalai (94.1mm), Aranthangi (85.7mm) and Karambakudi (81.1mm) received moderate rainfall during the season. Annavasal (79.1mm), Alangudi (68.2mm), Arimalam (77.4mm), Nagudi (67mm) and Karaiyur (64.1mm) received low rainfall. Very low rainfall received during this season at Aingudi (53.8mm), Odayalipatti (52.5mm) and Malaiyur (49.4mm). From the Fig. No. 04 coastal and western region of the district received high to very high rainfall during the summer season. The rainfall decreased towards the North and Northeastern parts of the district where it received low to very low rainfall.

Mean summer, Mean Winter, Mean NE Monsoon and Mean SW Monsoon

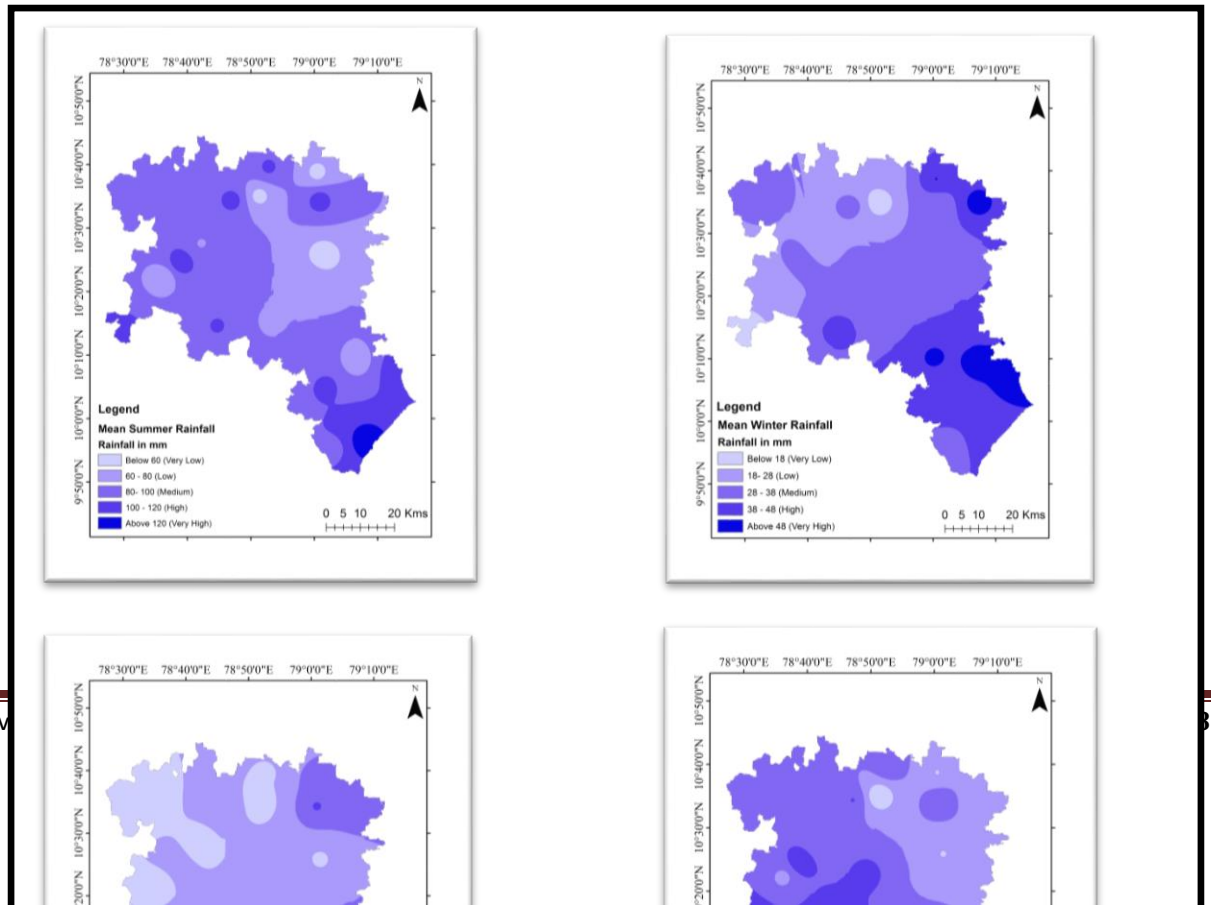

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Fig. No. 04

RAINFALL VARIABILITY

The coefficient of variability is calculated by dividing standard deviation by mean value of the rainfall. The result will be shown in percentage. In other words Variability defined as the deviation from mean or ratio of the standard deviation to the mean rainfall.

CV = (Standard Deviation / Mean) X 100

ANNUAL RAINFALL VARIABILITY

Annual rainfall variability of the study area is 47% and it stretches between 27% to 75%

Annual Rainfall Variability

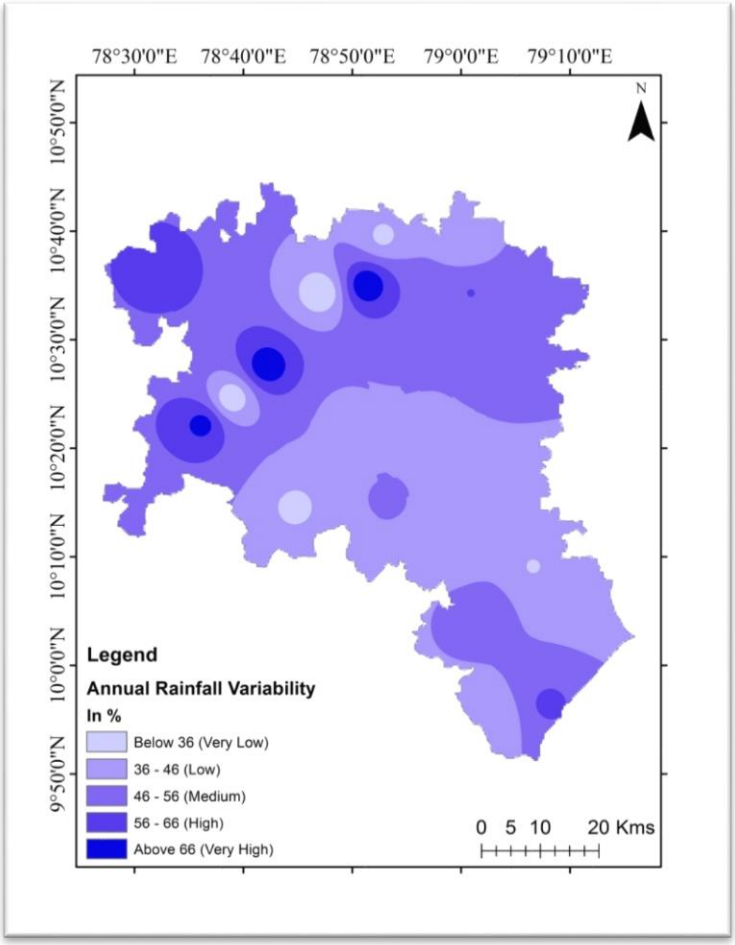

Fig. No. 05

The maximum variability of rainfall recorded at Odayalipatti (75%) and minimum variability of rainfall recorded at Keeranur (27%). Very high rainfall variability concentrated in north and north central parts of the study area that is Odayalipatti and Annavasal. Low rainfall variability experienced at central, south and northwestern parts of the study area. The mean annual variability is shown in Fig. No. 05 and annual and seasonal variability is shown in Table No. 02.

Station	Annual	Summer	Winter	NEM	SWM
PUDUKKOTTAI	42.577186	44.91646	1.229523	34.58914	37.82768

PERUNGALUR	39.1879	87.49272	41.54182	31.59164	39.38851
KEERANUR	27.074737	70.52059	22.19085	32.14934	48.80308
ODAYALIPATTI	74.951156	38.38981	29.27484	54.42592	58.45312
ANNAVASAL	73.842129	14.21522	28.60276	30.76233	67.40021
ILLUPPUR	34.065811	76.94473	3.292515	27.61178	43.93813
KUDUMIAN MALAI	28.281295	61.43923	16.27062	33.12957	38.64257
VIRALIMALAI	60.0	60.64769	43.80352	51.19057	71.96134
ALANGUDI	40.280128	58.49312	14.81073	33.43912	31.5031
MALAIYUR	49.0	53.88878	34.20727	38.75212	55.92227
KARAMBAKUDI	49.3	49.0613	22.25816	30.53178	55.11774
THIRUMAYAM	34.085671	58.63601	23.92063	33.02497	32.78394
KEELANILAI	46.14628	103.8441	116.8002	14.84796	57.10989
ARIMALAM	47.034853	79.25596	7.532049	26.80672	41.38146
KARAIYUR	69.321051	52.06131	38.44308	26.05437	41.60135
ARANTHANGI	39.738153	55.70316	18.76333	14.4332	30.00536
NAGUDI	35.660475	39.18746	27.32859	22.98368	29.21325
AYINGUDI	39.242576	57.39698	6.554575	26.86337	31.52764
KATTUMAVADI	36.541041	35.51179	7.643757	29.75126	30.58672
MIMISAL	58.024047	35.06425	30.79986	31.31384	41.01415
GANDHARVAKOTTAI	56.207065	94.60828	76.36659	33.16184	33.55722
AVUDAYARKOIL	53.572842	29.35388	46.43632	35.34805	39.13306

Average	**46.992542**	**57.11967**	**29.91235**	**31.48921**	**43.49417**

Annual and Seasonal rainfall variability **Table No. 02**

SUMMER RAINFALL VARIABILITY

The summer variability of the Pudukkottai district is 57.11% and it varies between 14.2% and 103.8%. Summer is warmest season of the study area where the rainfall occurrence is largely due to convection effect. Lowest variability experienced at Annavasal and maximum variability experienced at Keelanilai. From the Fig. No. 06 North central parts and southeastern parts of the study area experiences low rainfall variability. Central parts experiences moderate variability of rainfall in the study area. Southern parts and northwestern parts of the study area experiences high to very high rainfall variability.

WINTER RAINFALL VARIABILITY

High rainfall variability can be seen in winter season compared to other season because of occurrence of low rainfall. The mean rainfall variability of winter season is 29.9% and varies between 1.22% and 116.8%, maximum variability is found in Keelanilai and lowest at Pudukkottai shown in the Table No. 02. A large portion of the central parts encounters low to low precipitation inconstancy and Southern and Northern parts of the examination territory encounters high to high precipitation fluctuation appeared in Fig. No. 06.

SOUTHWEST MONSOON RAINFALL VARIABILITY

The precipitation changeability of the southwest rainstorm is around 43.4%. The precipitation changeability of the southwest storm season differs in the vicinity of 29.2% and 71.9%. The maximum rainfall variability is found at Viralimalai and minimum rainfall variability is found at Nagudi shown in the Table No. 02. From the Fig.No. 06 North and north western parts experiences high to very high rainfall variability and most of the central parts of study area experiences low to very low rainfall variability during the southwest monsoon season.

NORTHEAST MONSOON RAINFALL VARIABILITY

The variability of rainfall during the northeast monsoon season is very less than the other seasons because the study area receives more than 49.8% of the average annual rainfall. The average rainfall variability for this northeast monsoon season is 31.4% and it varies between 14.4% and 54.4%. The maximum rainfall variability found at Odayalipatti and minimum rainfall variability found at Keelanilai shown in the Table No. 02. North and central parts of the study area experiences high rainfall variability. South and southeastern region experiences low rainfall variability shown in the Fig. No. 06.

PRECIPITATION RATIO

The abnormalities of rainfall at any location can be found using a simple ratio called precipitation ratio. The equation used to figure precipitation proportion is as take after, Precipitation Ratio = (Px – Pn)/Pm X 100 Higher the proportion is the higher the variation from the norm in precipitation and the lower in proportion shows the less irregularity.

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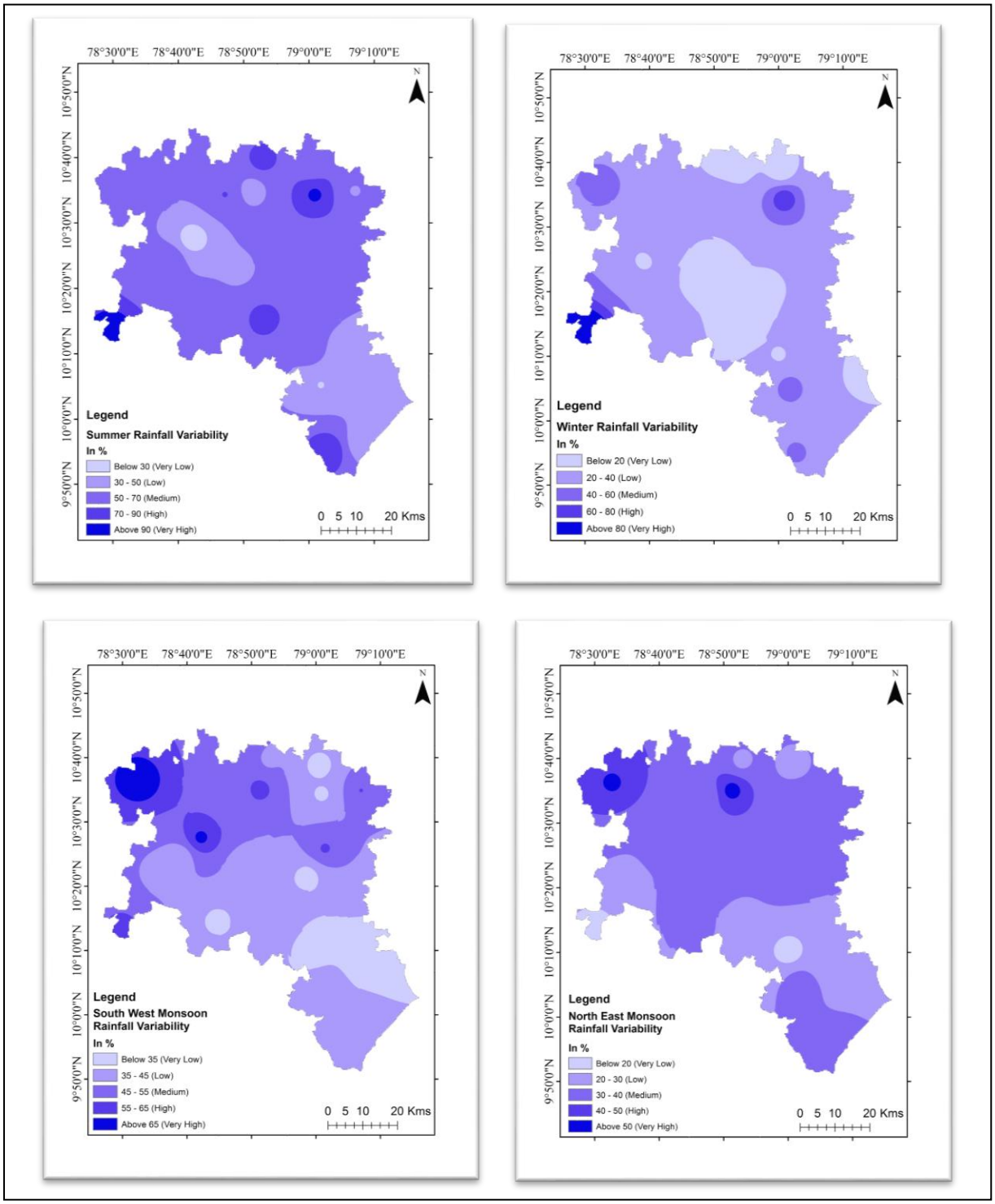

Fig. No. 06

Yearly normal precipitation file is 179.5% where most extreme irregularity of precipitation i.e higher precipitation proportion is recorded at Odayalipatti (264.4%) and yearly least precipitation proportion is found at Keelanilai (116.9%) appeared in the Table No. 03.

During the summer the average precipitation ratio of the study area is 110.5% it varies at maximum of 197.6% at Keelanilai and minimum of 26.8% at Annavasal. Winter precipitation ratio of the study area is 42.3% and it varies between 1.7% and 165.1%. The maximum ratio recorded at Keelanilai and minimum ratio found at Pudukkottai. Average south west monsoon season precipitation ratio is 93.9% and it varies between 156.9% at Viralimalai and 65.1% at Alangudi. Average precipitation ratio of northeast monsoon season is 59.3% and it varies from 27.0% found at Aranthangi and 102.1% found at Viralimalai. Fig No. 07 shows annual precipitation ratio of Pudukkottai district, where high to very high precipitation ratio found at central and northern region of the study area, low to very low precipitation ration experiences at southeastern parts of the study area.

MONTHLY RAINFALL DISTRIBUTION

The average annual rainfall increases from June to November and rainfall decreases from December to May shown in the Fig No.08. The study area received average maximum rainfall in the month of November (168mm) followed by October (140.8mm) due to north east monsoon season and average minimum rainfall received during the month of March (14.5mm). Amongst the various rain guage stations for the period of 1980 to 2011 the October month maximum rainfall received at Mimisal (234.6mm) and minimum rainfall received during the month of January at Keelanilai (0.75mm).

Station	Annual	Winter	Summer	SWM	NEM
PUDUKKOTTAI	175.0715	1.738809	89.26453	87.76268	68.42001
PERUNGALUR	154.6363	58.74901	168.5363	73.47605	62.82513
KEERANUR	140.4207	31.3826	141.025	109.2151	56.70589
ODAYALIPATTI	264.411	41.40088	76.07092	118.7584	96.54101
ANNAVASAL	207.6616	40.45041	26.88415	123.6444	55.79091
ILLUPPUR	161.3048	4.656319	149.5602	101.044	48.18383
KUDUMIAN MALAI	165.705	23.01013	122.0127	83.91726	57.83457
VIRALIMALAI	202.4769	61.94753	106.3824	156.9509	102.1636
ALANGUDI	162.7836	20.94554	114.5817	65.13365	66.52458
MALAIYUR	218.288	48.37638	97.85995	129.0417	76.49034
KARAMBAKUDI	161.634	31.4778	98.07489	130.2358	59.9082
THIRUMAYAM	149.2666	33.82375	117.1565	69.43614	57.32408
KEELANILAI	116.9015	165.1805	197.657	121.4886	28.26047
ARIMALAM	224.0597	10.65193	157.2109	96.0958	52.94318
KARAIYUR	233.2431	54.36673	96.02397	78.59627	45.27038
ARANTHANGI	234.9746	26.53535	111.3161	70.84866	27.03355
NAGUDI	162.0804	38.64847	71.65455	69.43566	45.17888
AYINGUDI	175.4837	9.269569	113.0258	75.60987	52.52488

KATTUMAVADI	158.4425	10.8099	70.99237	66.77572	59.47534
MIMISAL	171.1787	43.55758	63.02313	87.90347	55.67231
GANDHARVAKOTTAI	170.4085	107.9987	186.1399	65.78548	65.95498
AVUDAYARKOIL	137.7764	65.67087	57.46218	85.16111	63.72135
Average	**179.4641**	**42.30221**	**110.5416**	**93.92349**	**59.3067**

Precipitation ratio **Table No. 03**

Annual Precipitaion Index

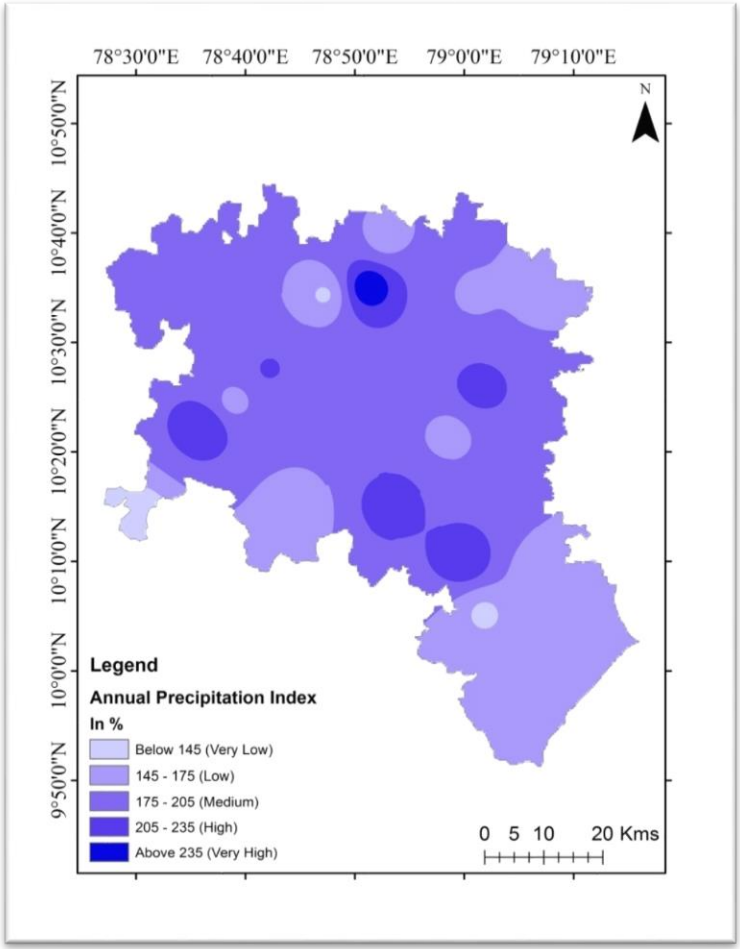

Fig. No. 07

CONCLUSION

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This examination was directed to investigate the spatial and transient variety of precipitation in Pudukkottai area. In spite of the fact that normal yearly precipitation is 805.1mm it encounters a wide spatial variety. This investigation reason that most extreme precipitation got amid North east rainstorm took after by South west storm both the season gives for over 84.7% of the aggregate yearly precipitation in the regions and least precipitation got amid winter season where it answerable just 4.3% of the yearly precipitation.

Monthly Distribution of Rainfall

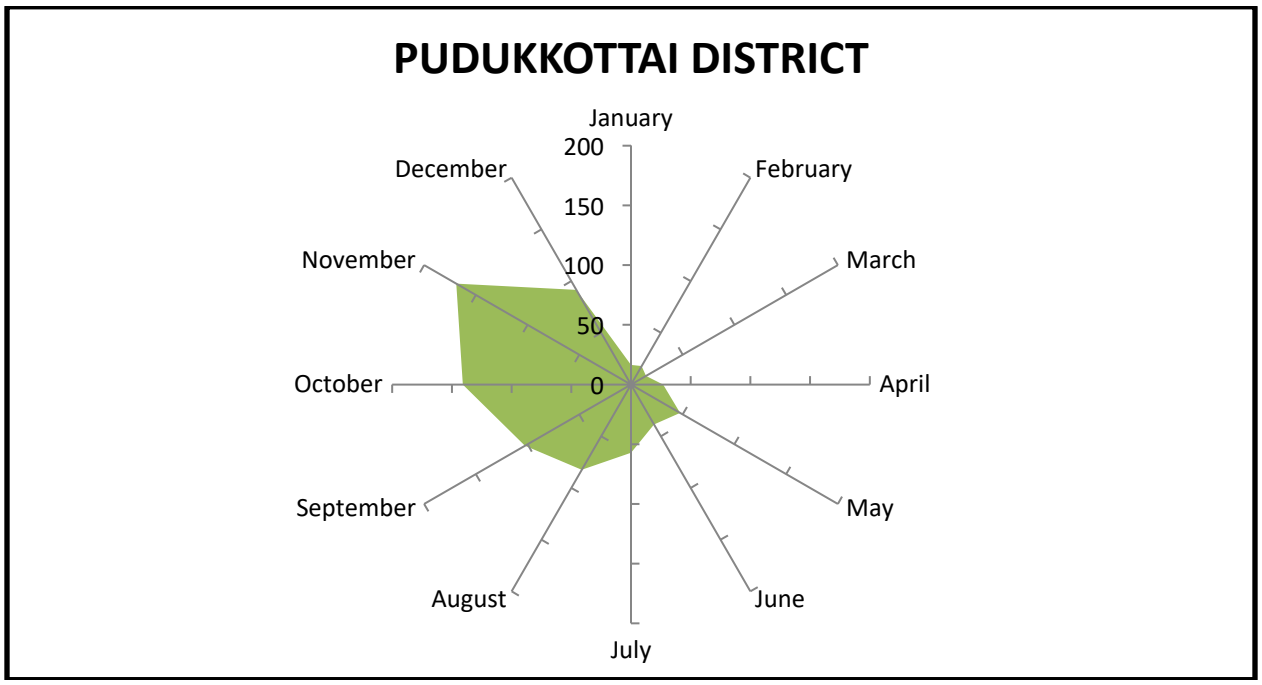

Fig. No. 08

High to very high rainfall concentrated in the south, southwestern and northwestern parts of the study area where Aranthangi, Mimisal, Kattumavadi, Kudumianmalai and Viralimalai received very high average annual rainfall whereas Odayalipatti, Malaiyur and Alangudi received low average annual rainfall. The study area received average maximum rainfall in the month of

November (168mm) followed by October (140.8mm) due to north east monsoon season and average minimum rainfall received during the month of March (14.5mm). Temporal analyze of the rainfall in the study area concludes that wettest year 2004, 2005, 2008, 2010 and 2011 where rainfall exceeds 900mm. In the year 2008 entire district received very high rainfall of 1125mm. In the year 1984, 1985, 1996, 1997, 1998, 2000, 2002, 2003, 2007 and 2009 received moderate rainfall in the range of 700mm to 900mm. 1981, 1983, 1986, 1987, 1992, 1993, 1994, 1999 and 2001 received low rainfall in the range of 500mm to 700mm. Driest years are 1980, 1982, 1988, 1989, 1990, 1996 and 2006 where rainfall received very low in the range of less than 500mm. In the year 2006 the study area received only 140.9 mm of rainfall which is considered as extremely dry. Though the heavy downpours during the southwest monsoon and northeast monsoon it extremely support for Naravai and samba cultivation in the Pudukkottai districts

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