

Mapping of Rainfall Distribution Using GIS; An Case Study of Tenkasi District, Tamil Nadu

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ABSTRACT

Mapping of rainfall distribution of Tenkasi District is attempted with twenty-eight-year daily rainfall data, for this active rainfall stations were selected with available maximum daily rainfall data. The data were tabulated for monthly, seasonally and annually to compute long term mean, variability and precipitation ratio. The results were interpolated and mapped with GIS software, which brings the uniqueness in spatial pattern. The results highlighted that except area around Senkottai most of the area falls under rain shadow during southwest monsoon. Spatial pattern depicts that area around Senkottai receives ample of rainfall in both monsoon seasons. About 54.95 percent of rainfall received during northeast monsoon, and 17.20 per cent rainfall showered during southwest monsoon along the vicinity of Senkottai. The variability of the study area less than 50 per cent.

Key words: Winter, Summer, GIS, Monsoon, interpolation,

Introduction

Water is an inevitable basic element for all living beings in earth and also precipitation in the form of rainfall is considered as most pure source of surface water. The role of monsoons is very significant in the agricultural sector. In a tropical country like India farmers largely depends on the rain especially monsoon to irrigate their crops. The rainfall received in an area is an important factor in determining the amount of water available to meet various demands, such as agricultural, domestic water supply and for hydroelectric power generation (Sharad, 2012). The annual, seasonal and monthly rainfall analysis will be helpful in understanding general phenomenon of rainfall events of the region. (Swetha, 2014). Besides the use of statistics in the rainfall trend analysis mapping of the rainfall distribution in terms of monthly, seasonal and annually enables to comprehend the spatial variation of rainfall (Jegankumar et.al,2012,Kandaswamy et.al,2015). Man-Kendall test was used for studying the rainfall pattern in the capital city of India in which the results show a decreasing trending of rain during various seasons (Arun Rana et al, 2012). It was also used in analyzing the long term rainfall pattern of whole India and in which no significant trend

was found to be following in the country (Kumar et.al,2010). A study was conducted on the characteristics of daily, weekly and seasonal rainfall using quantitative measures in sub-himalayan and Gangetic plains of West Bengal. The analysis shows that the foothills received more rainfall than the plain region. The trend analysis of rain in the same area reveals there is no definite pattern for rainfall in the region which implies that there is some change in normal climatic conditions (Avik Ghosh, 2010). Different mathematical models also enable the prediction of the rainfall pattern and Markov Chain analysis is the notable among them (Meshach et.al, 2017). This model also helps in the analysis of weekly rainfall trends and to predict the wet and dry spells (Senthilvelan et.al,2012). The rainfall prediction in terms of wet and dry spells is significant in India since it is highly dependent on rainfall for irrigation and to increase the yield of seasonal crops (Nityanand et.al,2009). Spatial analysis of rainfall distribution and its variability helps in the identification of drought prone areas (Sandeep et.al,2018, Tarek et.al,2016). In an attempt to support crop planning and management rainfall pattern and variability measures of rainfall was carried out in Roorkee region in which to In the present study GIS has been used to analyze the precipitation trend annually, seasonally and monthly using interpolation technique. This kind of analysis will be helpful for the people to understand the rainfall characteristics of the study area.

Study Area

Tenkasi is a recently formed district of Tamil Nadu in 12 November 2019 by the bifurcation Tirunelveli District. Tenkasi District is located between 8°45'N and 9°25' N latitudes, 77°08'E and 77°51' E longitudes. It covers an area of about 2916.13 km². The district is bounded by Virudhunagar in the north, Toothukudi in the east, Tirunelveli in the south and Kerala state towards the west. A western portion of the district shares its boundary with the districts of Kollam and Pattanamthitta of the neighboring state Kerala. The western part of the district covers the hill ranges of Western Ghats. The hill in the Western Ghats attains a height of 1,836 m above Mean Sea Level. The plains occupying the central, eastern and southern parts of the district have an average elevation of 92m above Mean Sea Level. The district is drained mainly by Chittar and its tributaries.

. At present Tenkasi District contains 8 taluks such as Tenkasi, Kadayanallur, Sankarankoil, Senkottai, Sivagiri, Veerakeralputhur, Alangulam and Tiruvengadam. According to 2011 census, the population of Tenkasi District is 1,407,627 and a population density of 480/km². The study area is well known for its tourist destinations. Courtalam falls

is one such destination which is situated in the western border of Tenkasi. The location and the study area is given in the Figure 1.

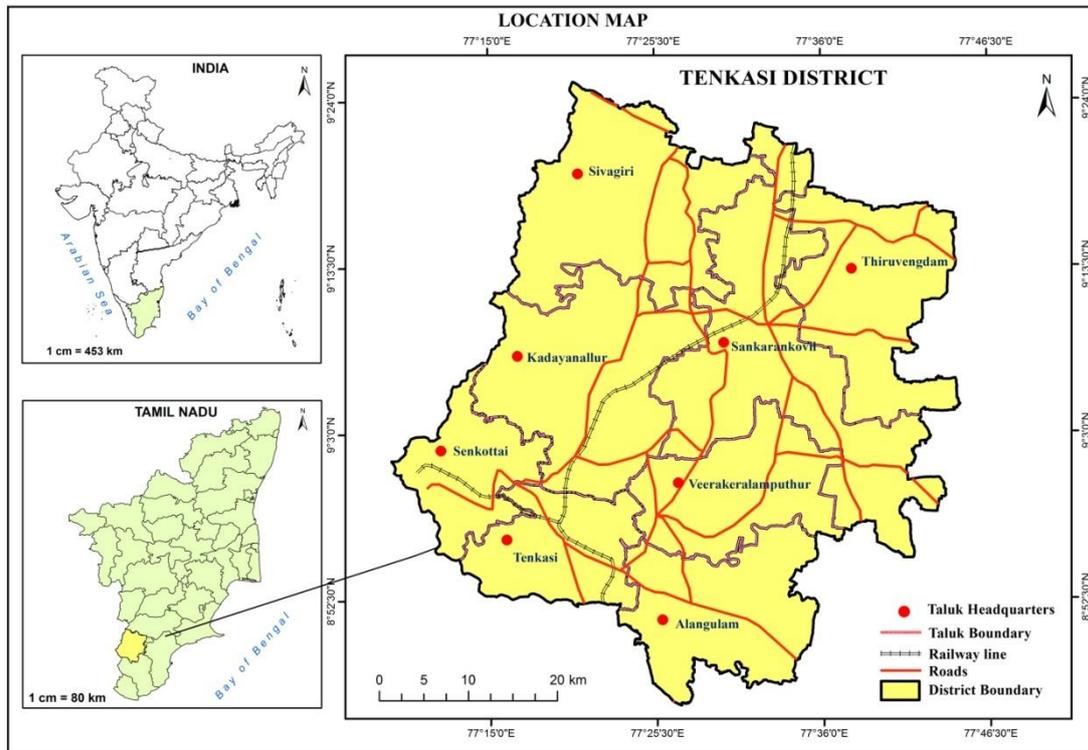


Figure 1 Study Area

Aim & Methodology

Aim of the study to bring out the spatial pattern of rainfall in Tenkasi District of Tamil Nadu. It is new district bifurcated from Tirunelveli District. Its location is unique, it located in the vicinity of the Senkottai pass connects between Tamil Nadu and Kerala in the South part of Western Ghats. In this study long term rainfall data (1990 – 2018) is used to compute monthly, seasonal and annual rainfall and GIS is used to map the spatial pattern of the rainfall of the study area.

Mean annual rainfall

The mean annual rainfall has been calculated based on the long-term rainfall data span from 1990 to 2018, the daily rainfall data collected from the Department of Economics and Statistics, Government of Tamil Nadu. The data tabulated and the spatial distribution maps were prepared by using spline interpolation with GIS software. The mean annual rainfall ranges between 561.91 mm to 1494.63mm. the maximum rainfall occurred in Senkottai, which is lies on the southern pass of Western Ghats and the minimum rainfall occurred around Alagiapandiapuram. The overall average of the study area is 793.84 mm. In

Tenkasi 54.95 per cent of rainfall contributed by north east monsoon, 17.20 per cent shared by southwest monsoon. The summer and winter contribute 28 per cent of rainfall. The following table list the rainfall stations and seasonal and annual rainfall of the study area.

Table 1. Seasonal and Annual Average Rainfall Tenkasi District

Rainfall Stations	Winter	Summer	Southwest Monsoon	Northeast Monsoon	Annual Mean
Alagiapandiapuram	37.26	104.89	53.46	366.31	561.91
Alangulam	53.56	156.75	85.78	427.53	723.62
Karuppanandi	58.66	111.27	161.58	352.18	683.69
Senkottai	107.52	290.20	423.15	673.77	1494.63
Ayyakudi	47.59	127.54	103.66	360.13	638.92
Sivagiri	91.29	197.89	121.84	527.69	938.71
Vasudevanallur	62.22	132.29	56.56	383.94	635.00
Sankarankoil	46.50	143.26	86.33	398.17	674.26
Average	63.07	158.01	136.54	436.22	793.84

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The mean annual spatial distribution shows the maximum rainfall occur around Senkottai in the west and southwest of the Ayyakudi, similar pattern prevails in the northern part of the study area above Sivagiri. The rainfall decreases from west to east and the minimum rainfall found around Alagiapandiapuram. Sankarankoil and Alangulam receives 600 to 1000 mm of rainfall. The mean annual rainfall distribution shown in the figure 2.

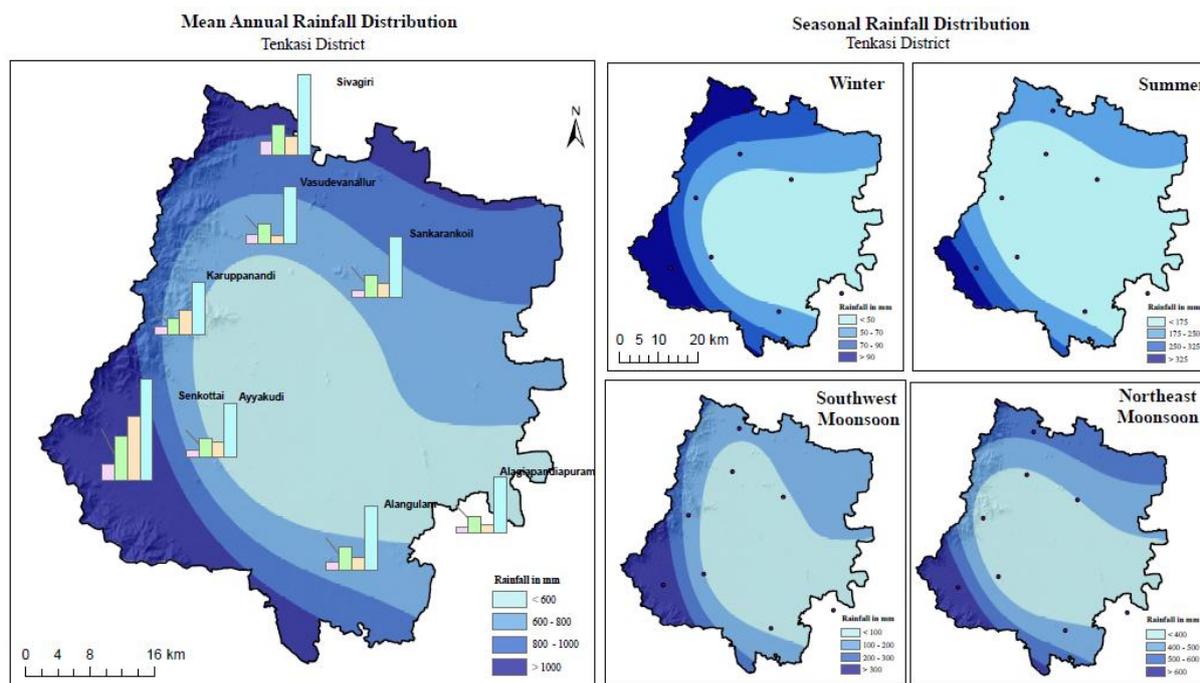


Figure 2. Mean Annual and Seasonal Rainfall Distribution, Tenkasi District

Seasonal Rainfall Distribution

Since the location of the study area found in the rain shadow region of Western Ghats, it clearly indicated by the spatial distribution of seasonal rainfall, except Senkottai other rainfall stations significantly receive lesser rainfall during monsoon seasons. Both the monsoon seasons contribute more than 70 per cent of rainfall ie 572 mm to the total rain, the balance rainfall was contributed during summer and winter. The seasonal rainfall and distribution depicted in table 1 and figure 2.

Winter

The months January and February as taken for the winter rainfall calculation, the winter average is about 63.07 mm, the maximum rainfall occur in Senkottai (107.52 mm) and minimum in Alagiapandiapuram. The spatial pattern indicates that the maximum rainfall fall found in the adjoining areas Western Ghats and the rainfall distribution decline towards east. Rainfall during winter ranges between 37.26 mm and 107.52 mm.

Summer

The summer season contributes 19.90 per cent of rainfall, it is slightly higher to southwest monsoon, this may also early rains of southwest monsoon form west coast. The summer rainfall spans between 104.89 mm and 290.20 mm. Senkottai receives the maximum rainfall and minimum found in Alagiapandiapuram in east part of the study area. During this season the central part of the study area receives lower amount of rainfall and the southwest fringes around Senkottai receives higher rainfall. The seasonal average is about 158.01 mm.

Southwest monsoon

The southwest monsoon prevails between June and September in the study area, during this period the study area receives about 136.54 mm as seasonal average. Rainfall during this season flexes between 53.6 mm and 423.15 mm. Along the vicinity of the Senkottai, Ayyakudi and Karuppanandi receives higher rainfall to compare to other stations., which indicates the influence of southwest monsoon along this area. The spatial pattern depicts the higher rainfall fall found around Senkottai, Sivagiri and decreases towards inside.

Northeast monsoon.

The northeast monsoon for the study area takes a long journey from east coast to the study area, between October and December. During this season the southern and northern part of the study area receives higher rainfall, which is above 500 mm and the central part remain

receiving less than 500 mm. About 436.22 mm is the seasonal average, in the retreating monsoon season rainfall of the study area stretches from 336.31 mm to 673.77 mm. Senkottai and Sivagiri receives above 500 mm. Sankarankoil, Vasudevanallur and Ayyakudi receives above 300 mm. The northeast monsoon season shares about 54.95 percent of rainfall to the study area.

Rainfall Variability

The rainfall variability is calculated between mean and standard deviation of the data, generally the higher rainfall indicate lower variability and lesser rainfall exhibits higher variability. The spatial distribution of annual variability shows the western and northeastern part of the study area receives higher rainfall, which indicated by the lesser variability. The higher variability found in the southern and north central part of the study area, the rainfall variability of the study area found between less than 35 and more than 45 percentage. The annual variability of the study area is about 43 %. Senkottai has the lowest variability and Vasudevanallur have higher variability about 48.9 percentage. The Seasonal and Annual Rainfall Variability of Tenkasi District shown in Table 2 and Figure 3.

Table 2 Seasonal and Annual Rainfall Variability of Tenkasi District

Rainfall Stations	Winter	Summer	Southwest Monsoon	Northeast Monsoon	Annual Mean
Alagiapandiapuram	114.0	79.2	113.3	55.4	46.2
Alangulam	114.2	77.7	94.4	61.0	46.6
Karuppanandi	126.8	78.1	71.4	47.6	37.6
Senkottai	127.6	71.3	62.5	57.3	40.7
Ayyakudi	138.8	71.9	82.4	63.8	42.0
Sivagiri	108.8	62.6	53.2	49.7	40.6
Vasudevanallur	138.8	75.1	106.7	63.0	48.9
Sankarankoil	130.5	63.4	71.5	64.1	41.2
Average	124.9	72.4	81.9	57.7	43.0

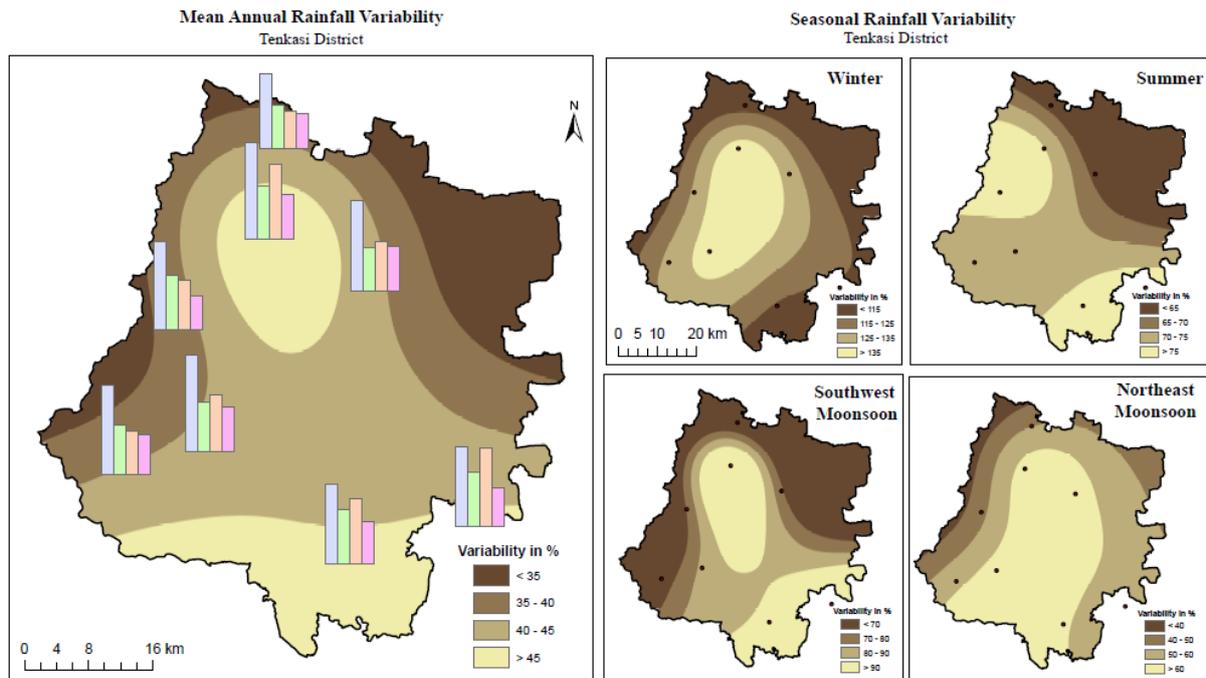


Figure 3. Spatial Distribution of Seasonal and Annual Rainfall Variability of Tenkasi District

Winter

The winter variability of the study areas is about 124.9 percentage, it is higher to compare other seasons. The higher winter variability indicates the occurrence of lesser rainfall to compare other seasons. The lesser variability found in the periphery of study area. The variability of the winter increasing towards central and Southern part of the study area. The lesser variability found in the Sivagiri in the north and the higher variability found in Vasudevanallur, which is found northwest interior part of the study area.

Summer

During the summer season the rainfall variability of the study area is about 72.4 percentage. Less than 65 percentage of variability found in Sankarankoil and Sivagiri. More than 75 percentage of rainfall variability found in Vasudevanallur, Karuppanandi, Alangulam and Alagiapandiapuram. The spatial pattern of summer variability shows lesser in the northeast and the higher variability found around southeast and western part of the study area, moderate category of variability found around Senkottai and Ayyakudi.

Southwest Monsoon

During the southwest monsoon the influence of monsoon winds from west reduces the variability in the western and northeastern part of the study area, around Senkottai and Sivagiri variability records below 70 per cent. Towards southeast and the central part shows higher variability ie mother than 80 per cent. Rainfall variability of the season flexes between 62.5 per cent in Senkottai and 113.3 per cent in Alagiapandiapuram. The higher variability of this season than northeast indicates that, the southeast season receives lesser rainfall than north east season.

Northeast Monsoon

The seasonal variability of the northeast monsoon season is about 57.7 percentage and it is ranges from 55.4 per cent to 63.8 per cent. The higher variability found in Ayyakudi and more than 60 per cent of variability prevails over Ayyakudi, Sankarankoil and Vasudevanallur. Less than 60 per cent of variability found in Senkottai, Alagiapandiapuram, Sivagiri. The spatial distribution of variability shows that is higher in the central and southern part of the study area and lesser variability found in the west margins of the study area.

Precipitation Ratio

Precipitation ratio is calculated between mean rainfall, maximum and minimum rainfall, it is expressed in percentage, generally the precipitation ratio used to measure the rainfall abnormalities of an area. Annual precipitation ratio of the study area is about 180.61 per cent and it stretches between 173 and 190 per cent. The spatial distribution indicates that less than 175 per cent found in the northwest and southwest part of the study area and the higher variability found in the southern and northeastern part of the study area. Area abound Senkottai, Sankarankoil and Sivagiri have lesser precipitation ratio, which indicates that lesser abnormalities in the rainfall distribution.

Winter

The higher precipitation ratio found among other seasons indicates that lesser rainfall occurrence during winter with higher abnormalities. It ranges between 381.20 – 553.23 in the study area and the seasonal precipitation ratio is 474.67 per cent.

Summer

The summer precipitation ratio of the study area is about 262.59 per cent and it spans between 225.26 and 309.92 percentage. During summer 309.92 per cent found around Alangulam and the minimum found in Sankarankoil (225.26 per cent). The spatial pattern of the season indicates vicinity around Senkottai and Sankarankoil falls under lesser

abnormality zone and the central and southern part of the study area have higher precipitation ratio, which may have higher abnormality in spatial pattern.

Southwest Monsoon

The spatial pattern of precipitation of southwest monsoon indicates less than 300 per cent found in the western part were southwest monsoon have significance influence around Senkottai, Tenkasi and Ayyakudi. The higher zone found in the southeast part of the study area around Alagiapandiapuram. The seasonal precipitation ratio is about 321.45 per cent and it found between 188.85 (Sivagiri) and 518.75 (Alagiapandiapuram)

Northeast Monsoon

Since the study area receives more than 50 per cent of rainfall occurring in this season, the western and southeastern part have lesser precipitation ratio and the higher precipitation ratio falls in southwest and around Sankarankoil. About 221.78 per cent is the seasonal precipitation ratio of the study area. During northeast monsoon it stretches between 158.64 (Karuppanandi) and 278.90 per cent (Sankarankoil). Precipitation ratio of this season much lower than all other three seasons indicates that during this season there may not be a significant abnormality in spatial pattern.

Table 2 Seasonal and Annual Precipitation ratio of Tenkasi District

Rainfall Stations	Winter	Summer	Southwest Monsoon	Northeast Monsoon	Annual Mean
Alagiapandiapuram	475.37	264.84	518.75	191.31	180.71
Alangulam	461.21	309.92	417.58	187.14	190.50
Karuppanandi	553.23	256.76	288.77	158.64	184.47
Senkottai	417.42	236.36	233.49	274.96	179.66
Ayyakudi	505.12	267.91	240.41	259.21	190.68
Sivagiri	381.20	242.87	188.85	186.13	173.08
Vasudevanallur	550.30	296.77	379.10	237.90	166.96
Sankarankoil	453.51	225.26	304.64	278.90	178.83
Average	474.67	262.59	321.45	221.78	180.61

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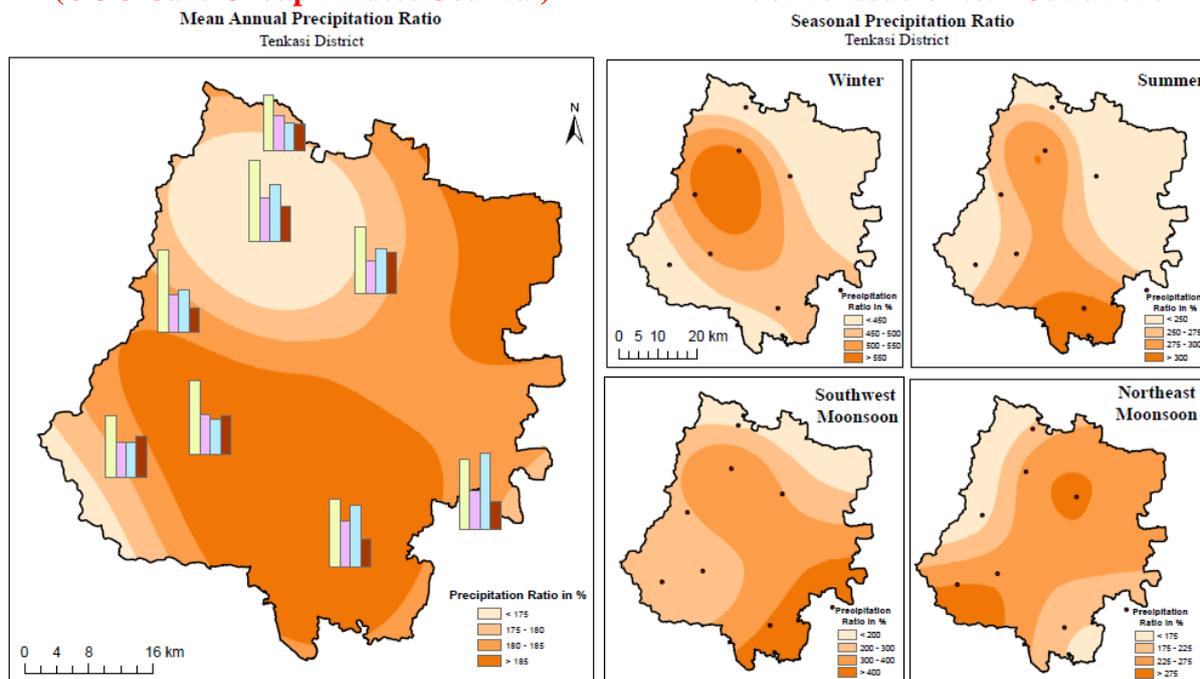


Figure 4 Seasonal and Annual Precipitation ratio of Tenkasi District

Conclusion

A period of twenty-eight-year daily rainfall data is collected from the Department of Economics and Statistics and tabulated accordingly to analyse and map the rainfall pattern of the study area. The study reveals that about 54 per cent of rainfall is contributed during northeast monsoon (436.22 mm), Southwest monsoon brings 17.20 per cent of rainfall and Sumer & winter together shares 27.85 per cent. Which indicates that the study area much influenced by northeast monsoon than southwest monsoon. Senkottai pass in the study area play an important role to bring monsoon during southwest monsoon from Kerala. The central portion of the study area remain area of receiving less rainfall than western corridor of the study area. The rainfall variability of the study area is under 50 percent, which indicates the study area may have chances of rain during monsoon seasons.

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