

# Rainfall Trends and Pattern of Sweta Nadhi Basin, Salem District, Tamil Nadu, India Using GIS

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## Abstract

The study of rainfall pattern is very important for the agricultural planning of any region. Rainfall being the predominant form of precipitation causing stream flow, especially the flood flow in a majority of rivers in India. In the present study, an attempt has been made to assessment the rainfall variation and monitoring with respect to spatial distribution in sweta basin. In this work were exiguities by GIS Technique. To achieve the aim of rainfall variations during winter (Jan. & Feb.), summer (Mar. to May), southwest monsoon (Jun. to Sep.) and northeast monsoon (Oct. to Dec.) were analyzed for the period from 1980 to 2010. The study is based on 30 years of the monthly rainfall data for 16 rain gauge stations. While analyzing the long term average of monthly and annual rainfall, the annual rainfall of the region is 746.77mm, of which the winter, summer, southwest and northeast monsoon records 10.39, 111.65, 274.88and 349.85mm respectively. The results suggest that the model reproduces the number and spatial distribution maps of rainfall extremes with some accuracy, but that mean rainfall and rainfall variability is estimated over dry regions of Sweta basin, Swetha nadhi is the minor basin of Vellar major basin, South India.

**Keywords: Rainfall, Spatial Distribution, Annual and Seasonal Rainfall, Rainfall Variability, Precipitation Ratio And Sweta Nadhi Basin.**

## I. INTRODUCTION

The study of rainfall pattern is very important for the agricultural planning of any region. Monsoon depressions and cyclonic storms are the most important synoptic scale disturbances which play a vital role in the space– time distribution of rainfall over India (Sikka, 1977). Rain is an important natural phenomenon which can influence the human life. In fact, the rain that falls into certain area can viewed as a result of many factors, which can divided into three segments: space, time and other factor. To determine the rainfall pattern in certain area, it needs the rainfall data from observation station which spread in observed area. The rainfall data which measured by rain gauge only can show the quantity of water caused by rain, but not the factor caused the rain. These data help us to predict the quantity of rainfall, but could not help us to uncover the hidden factor beside the rainfall. By identify the dominant factors caused the rainfall; we can interpret the rainfall data better and can help us to make the better prediction in the future. To prepare a proper crop and water management plan and to design irrigation drainage, erosion control and flood control structure, the knowledge of rainfall pattern, total rainfall, its distribution and daily/monthly or annual maximum and minimum rainfall are essential. Hence, the present study has been taken to understand the rainfall Pattern of Sweta Nadhi Basin , which includes the spatial distribution and variability through different seasons, precipitation ratio and dependability. Geographical Information System (GIS) plays a vital role in interpolating and displaying various attributes of rainfall.

### A. Study Area:

The sweta nadhi basin lies in the districts of Namakkal, Salem, Trichy and Perambalur of Tamil Nadu state. This river origin from northern portion of Kollihills in Namakkal district. It is partly in central part of salem and some area covered by Thiruchirappalli district then it is partly in the eastern part of Perambalur district. It is located between 11<sup>o</sup> 15' N and 11<sup>o</sup> 45' N latitudes and 78<sup>o</sup> 15' E and 78<sup>o</sup> 00' E longitudes (as read form the survey of India Topographic sheets 58 I/6,I/7.I/10,I/11,I/14) as shown in Figure.1. This river basin situated in Namakkal distict in East, Salem district in south, Trichirappalli district in north and Perambalur district in west. It is based on study area, major three relief order like hill, upland, and plain. The river originated in the northern portion of Kolli hills, part of Manmalai, adjoining Kollihills and Palakkadu malai with Pachamalai. The area of study area of Sweta Nadhi 1034 Sqkm with in 82 Revenue villages, The 34 revenue villages in Salem district, 27 revenue villages in Namakkal district, 17 revenue villages in Perambalur district and remaining 4 revenue villages in Tiruchirappalli district. The major taluks of basin Gangavalli, Rasipuram and Veppanthattai. The Sweta Nadhi is one of the tributaries of the Vellar Basin The river flows in the west to East direction with length with of 116 km and basin breath is 35 km. The physiographic feature has controlled by structural hills, denudational and pediplain and fluvial process in the study area.

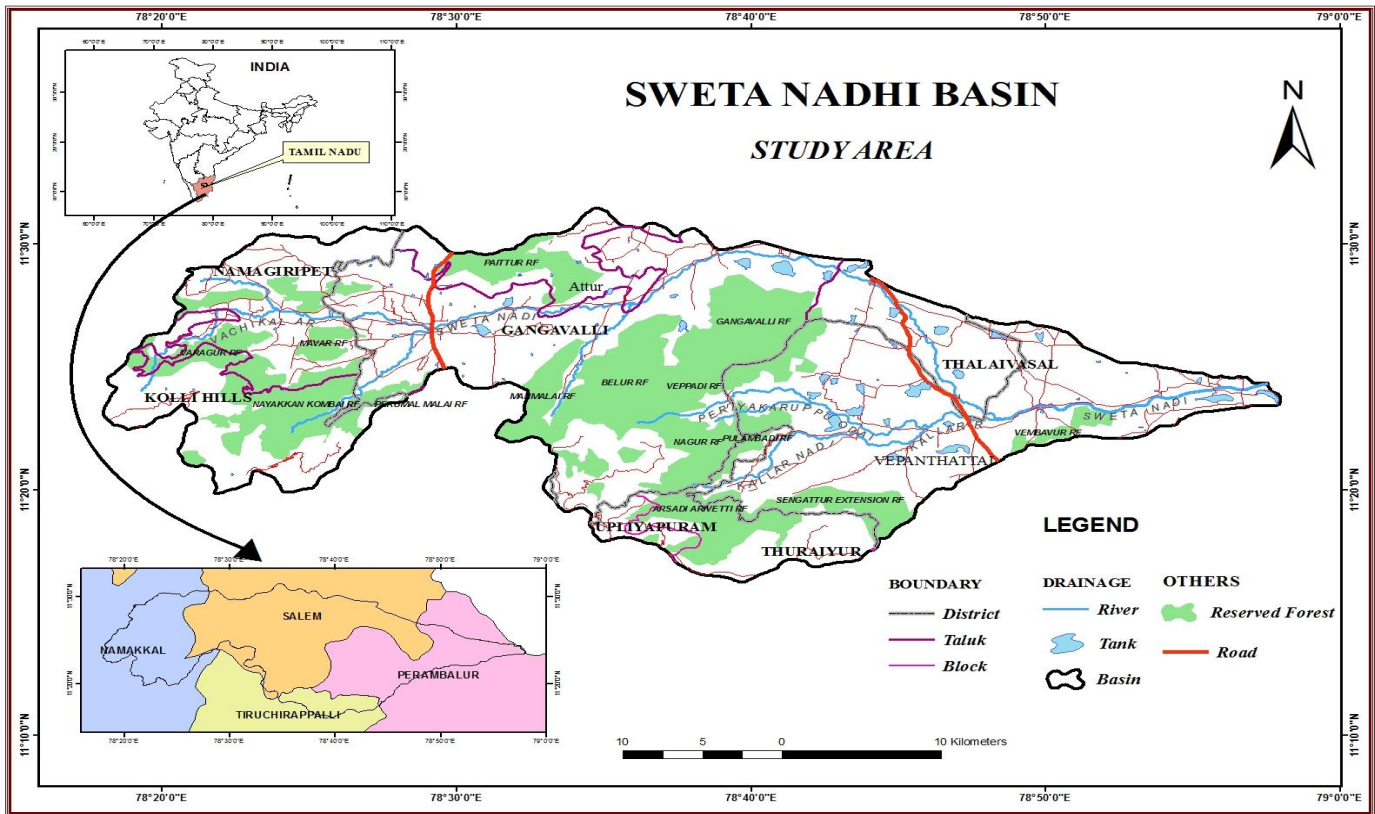


Fig. 1: Location Map of The Study Area

## II. MATERIALS AND METHODS

The monthly rainfall data for 30 years (1980 – 2010) have been collected for 16 stations which are located in (3 stations) and around (13 stations) Sweta Nadhi Basin as shown in Figure.2. The long term mean monthly, Seasonal and annual rainfall has been calculated. The coefficient of variability has been worked out simple cartographic and GIS interpolation techniques are employed to map spatio-temporal variation rainfall of the basin. The tabulated data are analyzed to calculate mean rainfall, coefficient of variation, Precipitation ratio and frequency. The results are mapped in GIS environment by applying spline interpolation.

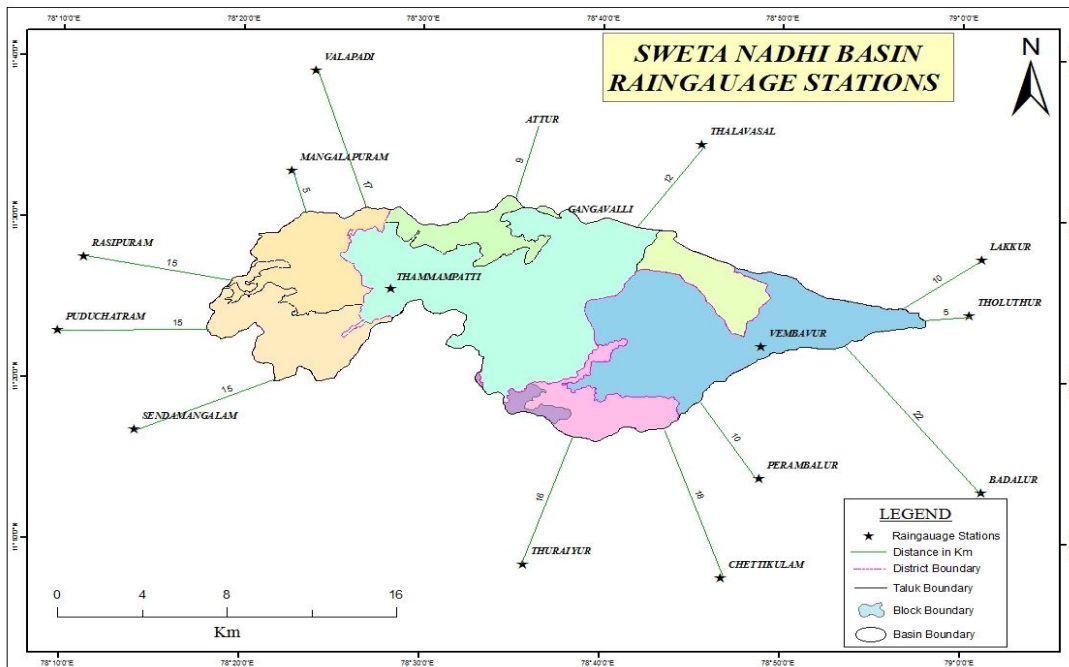


Fig. 2: Location Map of The Rain Gauge Stations

### III. RESULTS AND DISCUSSION

– Mean Annual Rainfall

The long term mean annual of the basin 774.67 mm of which the winter, summer, southwest and northeast monsoon contributes 1.4 %, 15 %, 37.2 % and 46.5% of the annual rainfall respectively the results of the analysis are given in Table.1. The study area is characterized by sharp areal differences in the quantum of rainfall due to the varying nature of topography and the influence due to orientation and configuration of Eastern Ghats (Pachamalai and Kolli hills). It is interesting to note that among 16 rainfall stations the maximum of 1073.32 mm records at Tholuthur (outskirts of the basin) and 1016.31 mm records at Gangavalli station inside the basin. Whereas the minimum of 513.73 mm of rainfall at Thalavasal, Where the station located in the northeastern part of the study area as shown in Figure.2. Hence, the spatial difference in the rainfall distribution within a shorter distance (about 39 km) is too large. The well marked hills (pachamalai Hills) in occupy in the central part of study area so vital role in the spatial distribution of rainfall. The Spatial distribution rainfall decline from the central part of the study area as shown in Figure.3. Finally mouth of the basin part having high rainfall.

Table – 1  
The Long-Term (1980 - 2010) Mean Seasonal and Annual Rainfall (In Mm)

Sl.no	Stations	Winter	Summer	South West Monsoon	North East Monsoon	Mean Annual
1	Thammampatti	6.5	110.8	262.0	376.3	755.60
2	Vembavur	17.2	95.2	223.3	400.6	736.29
3	Perambalur	21.8	99.9	238.9	429.3	789.90
4	Sendamangalam	6.2	124.0	325.9	246.3	702.43
5	Rasipuram	9.8	141.9	392.9	265.8	810.46
6	Mangalapuram	8.8	145.2	367.7	343.5	865.16
7	Valapadi	4.1	120.0	292.2	291.6	707.94
8	Thalavasal	4.5	18.7	151.8	338.7	513.73
9	Lakkur	23.6	88.3	343.4	457.0	912.23
10	Tholuthur	26.7	118.4	396.7	531.6	1073.32
11	Chettikulam	12.2	98.4	249.6	352.1	712.26
12	Thuraiyur	15.6	132.6	312.5	372.7	833.40
13	Badalur	1.8	102.6	153.2	370.4	628.00
14	Puduchatram	1.1	153.4	189.1	230.4	574.07
15	Attur	7.9	108.4	314.0	333.3	763.55
16	Gangavalli	2.3	199.0	395.9	419.1	1016.31
	Mean	10.6	116.0	288.1	359.9	774.67
	Percentage	1.4	15.0	37.2	46.5	100.0

Source: Compiled by Author based on the data of Directorate of Economics and Statistics, Chennai.

**Rainfall zones:**

- (1) High rainfall zone - (above 1000 mm ): Gangavalli, Tholuthur (Middle part of the basin).
- (2) Moderate rainfall zone- ( 900 – 1000 mm ): Lakkur eastern part of the study area
- (3) Normal rainfall zone - ( 800 – 900 mm ): Raipuram, Thuraiyur, Mangalapuram
- (4) Low rainfall zone - ( 700 – 800 mm ): Sendamangalam, valapadi, chettikulam, Vembavur, Thammampatti, Attur, Perambalur
- (5) Very low rainfall zone - ( below 700 mm ): Thalavasal, Puduchatram

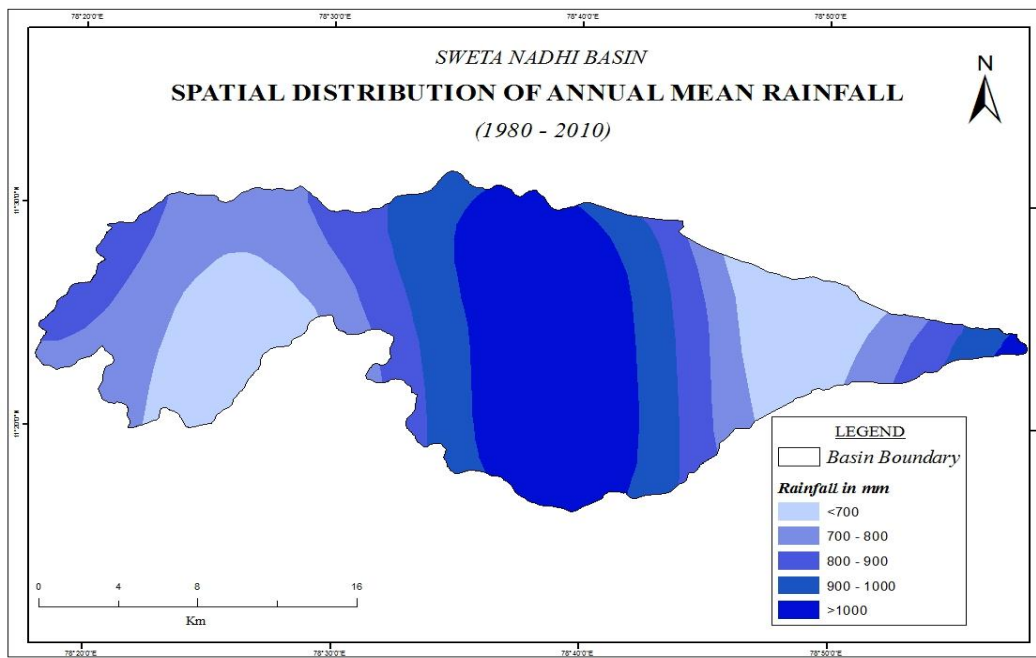


Fig. 3: Mean Annual Rainfall

#### A. Mean Seasonal Rainfall

##### 1) Winter

Winter according to the trends changes in the climatic element, the year is divided into four well marked seasons. The southwest and northeast monsoons are the two main seasons for agricultural activities. However, the northeast monsoon accounts for largest share in total annual rainfall within short spell as shown in Figure.4. The winter rainfall in the months of January end February is only 1.4 %. During winter season the station Tholuthur receives the highest rainfall of 26.7mm outside of the basin (eastern portion of the basin) decreases following order of moderate, normal, low and very low rainfall regimes towards the central part of the study area. The lowest rainfall of 1.1 mm is recorded at Puduchatram, Badalur (1.8), Gangavalli (2.3), which located in the outskirts of the basin. The spatial pattern of winter rainfall is unique and totally different from other seasons as shown in Figure.4 (a).

##### 2) Summer

Summer receives more rainfall than the other seasons. Since, the rainfall is confined to summer convection the variations in rainfall depend on purely local phenomena and the summer rainfall is associated with thunderstorm showers, the summer rainfall contributes 15 % of annual rainfall of the basin. A holding of high rainfall zone moves to the eastern and western in and around the Gangavalli middle part of the basin which receives 199 mm of rainfall. From here, the rainfall decreases toward the eastern and western part of the study area. There is much variation in the rainfall amount deriving summer and winter as shown in Figure.4 (b).

##### 3) Southwest Monsoon

The study area receives 37.2 % of rainfall during this season. It is mainly associated with southest monsoon rain bearing winds and elevation of topography (Kolli malai and Pachamalai hills). During this season the rainfall of different stations. A branch of wind belongs to southwest monsoon is able to teach over the basin. The uniformity in the distribution of rainfall in space is well reflected in close similarity between the rainfall amounts received at different stations during this season. For instance, in the Gangavalli, Tholuthur, Rasipuram, Mangalapuram, Lakkur and some fewer parts the seasonal rainfall amounts all over the basin were deficit of above 350 per cent as shown in Figure. 4 (c). Areas between southwestern part of the study area have low rainfall because that areas between kolli hills and around the Thammampatti stations become rain shadow during this period. Thammampatti, Vembavur, Thalavasal and Puduchatram the same condition occurs in Vembavur station because this area belongs to pachamalai hills.

##### 4) Northeast monsoon

The retreating monsoon is called northeast monsoon, it is prevail in the period from October to December. Form this monsoon, east west of Peninsular India and interior parts of Tamil Nadu receive rain: Thorough the depressions originate from Bay of Bengal. The study area receives 46.5 % of total mean annual rainfall from northeast season and the results of the analysis are given in Table.1. Indicates the northeast monsoon season rainfall of the study area.

The rainfall varies during the season from 230 mm at Puduchatram to 531.6 mm at Tholuthur gradually decrease to increases the east dissection of the study area. During this period Puduchatram (230.4), Sendamangalam (246.3), Rasipuram (265.8) and Valapadi (291.6) in the western part of the study area receives less rainfall compare with other part of the basin as shown in Figure.4 (d).

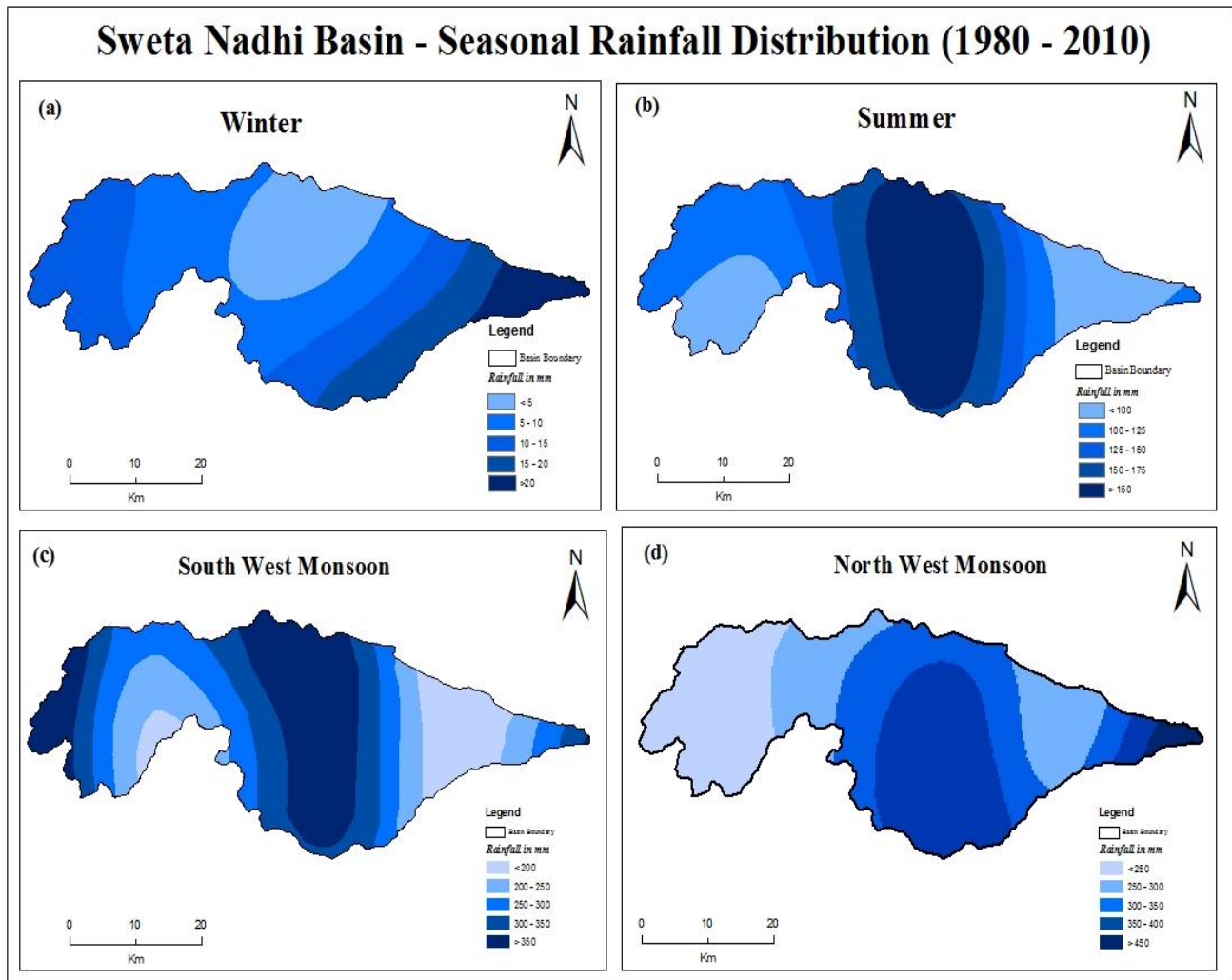


Fig. 4: Seasonal Rainfall

### B. Rainfall Variability

According to Trewartha, the variability of rainfall may be defined as the deviation from the mean. The coefficient of variation (cv) defined as the standard deviation divided by the mean value of rainfall the results of the analysis are given in Table.2. It shows the variability of rainfall in percentage. The higher the variability percentage, the lower is the dependability and vice versa. The isolines have been draw on the basis of values compiled for 16 stations in order it bring out the spatial pattern Table.2. The annual variability varies from 9.8 % to 125.6 % in the basin as shown in Figure.5. Minimum variability – Tholuthur, Lakkur, Thammampatti, Maximum variability – Thalavasal, Badalur, Puduchatram, Vembavur. Low variability – Mangalapuram, Thuraiyur, Rasipuram, Perambalur, Chettikulam, Sendamangalam and Gangavalli.

#### 1) Winter Variability

Among all seasons as shown in Figure.6 (a), the winter variability of rainfall is high which ranges between 44 % to 318 %. During this season, the variability is triple fold than summer, southwest and northeast monsoon. Accordingly, the dependability of rainfall is also relatively very less. From the spatial distribution of winter variability, the western portion of the basin notably at major areas has very low variability fall under less than 150 %. Winter variability decrease to increases towards the central part of the basin because Gangavalli 318 % high winter variability occurs this place. This high variability in winter season of among all season states that the occurrence of less rainfall during winter.

#### 2) Summer Rainfall variability

The summer variability of the basin is 20.7 percent it varies between 51.7 % to 177.6 % of variability. The very low variability

occupies in the central part of the study area and western part of the basin high and very high variability occurs in eastern part of the study area. The rest of low and normal are majorly distributed in southwest and southeast some areas occupy the distribution of the variability. While comparing winter and summer the lowest variability class does not much variation whereas the highest variability class is three fold less than winter which shows that there is a large variation in spatial distribution as well as trend in general the central part of the basin and eastern part receive more rain which was indicated by the less variability as shown in Figure.6 (b).

Table – 2  
The Long-Term (1980 – 2010) Annual And Seasonal Rainfall Variability

sl.no	Stations	Winter	Summer	South west monsoon	North east monsoon	Mean annual
1	Thammampatti	236.8	82.5	65.7	60.4	29.1
2	Vembavur	275.3	101.6	83.1	77.0	52.6
3	Perambalur	197.3	85.3	45.9	57.5	26.3
4	Sendamangalam	235.1	57.8	48.0	50.4	23.4
5	Rasipuram	206.9	57.4	51.9	59.0	27.0
6	Mangalapuram	227.4	56.3	33.7	50.2	28.8
7	Valapadi	109.9	98.1	64.9	85.2	101.1
8	Thalavasal	48.3	174.2	192.7	169.6	171.2
9	Lakkur	44.0	177.6	297.1	199.0	30.4
10	Tholuthur	172.1	94.2	48.7	60.0	35.8
11	Chettikulam	235.6	98.5	64.1	58.5	23.7
12	Thuraiyur	214.8	69.4	36.5	43.8	27.8
13	Badalur	91.2	70.4	57.0	74.8	125.6
14	Puduchatram	46.6	144.1	273.9	228.5	82.0
15	Attur	184.6	60.5	36.9	49.9	33.9
16	Gangavalli	318.0	51.7	37.3	47.6	9.8
	Mean	177.7	92.5	89.8	85.7	51.8
	Average	39.9	20.7	20.2	19.2	100.0

Source: Compiled by Author based on the data of Directorate of Economics and Statistics, Chennai.

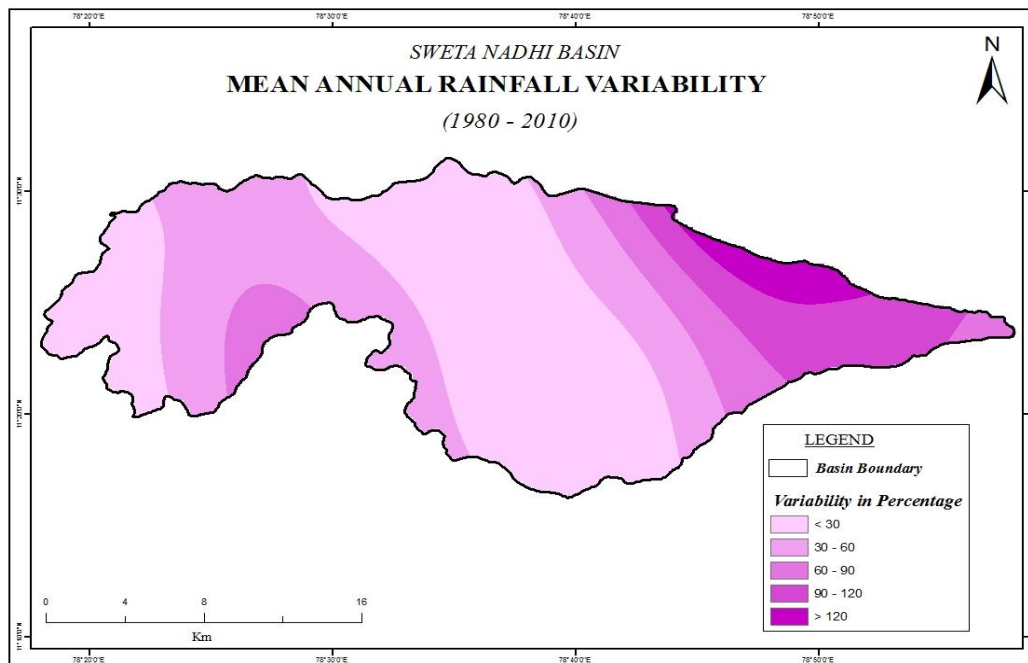


Fig. 5: Mean Annual Rainfall Variability

### 3) Southwest monsoon variability

Among the 16 stations the variability is relatively low in Mangalapuram 33.7 % which is located about 5 km away from north western rim of the basin whereas the high is at Lakkur above 70 %, located at the eastern part of the basin about 10 km away from the rim of the basin less than 40% of variability us found Gangavalli, Attur, Thuraiyur and Mangalapuram. The major portions of middle part of the basin and few in eastern and western rim of the basin were covered by 50 – 60 percentage of variability as shown in Figure.6 (d). Less than 40 % variability occurs in middle southern part and western part in rim of the basin above 70% variability found in northeastern part of the basin.

4) Northeast monsoon variability

The rainfall variability of northeast monsoon resembles almost the characteristics and general pattern of mean annual rainfall variability. The variability of northeast monsoon has shown the strengthen of the northeast monsoon. The spatial pattern clearly indicates that the prominent hills located in the study area create rain shadow effect in the northeast monsoon season. The region variability of northeast monsoon season varies from 220 (Puduchatram) to 43.8 (Thuraiyur) as shown in Figure.6 (d).

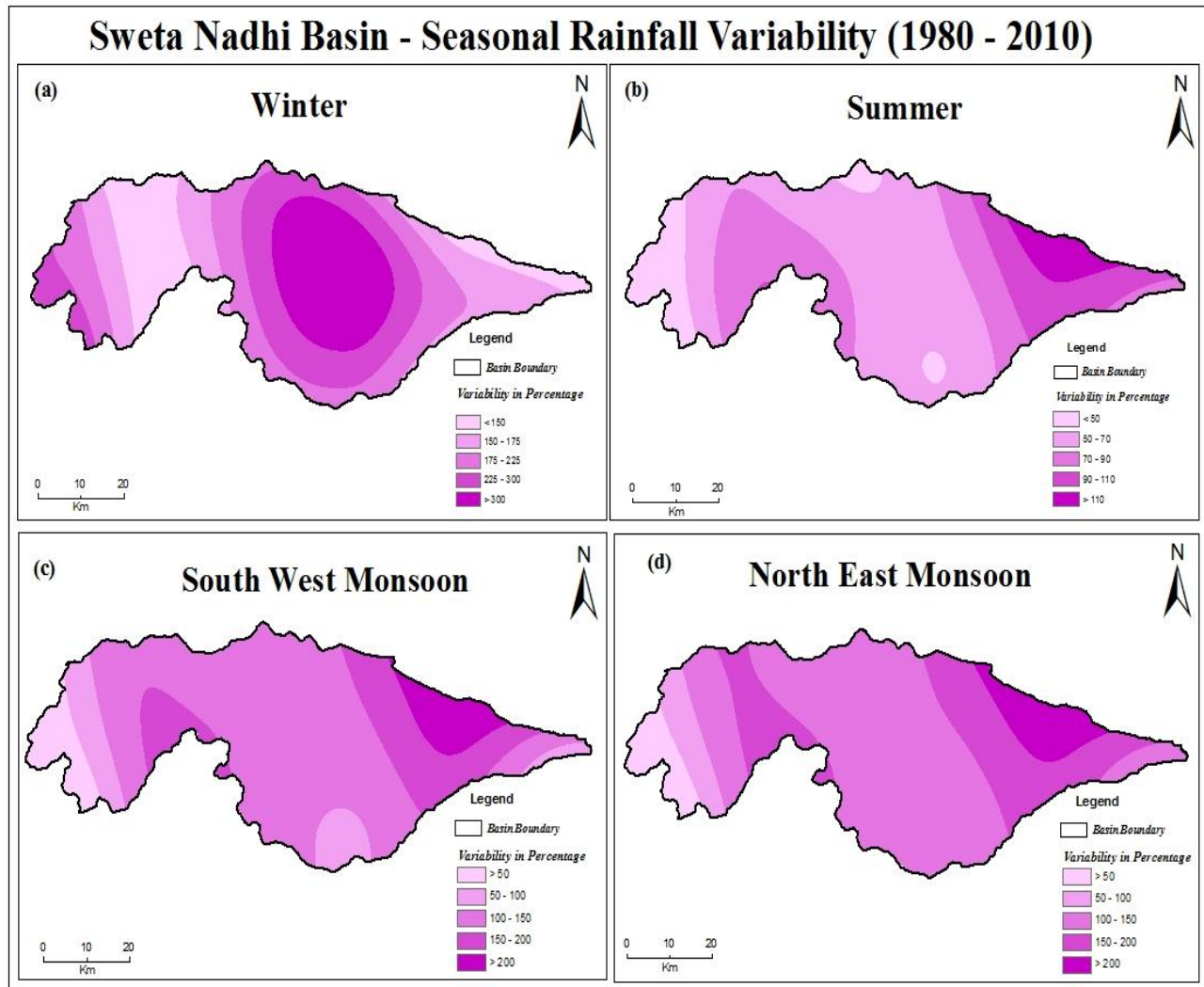


Fig. 6: Seasonal Rainfall Variability

C. Precipitation ratio

The abnormalities of rainfall at any location may be brought by simple ratio of precipitation. It is the difference between maximum and minimum rainfall of over the series of expressed in terms of mean. This ratio may give the stability of rainfall with special relationship. Higher the ratio, higher in abnormality in rainfall and vice versa. It is the difference between the maximum and minimum rainfall of over the series of years expressed in the terms of mean. The formula used to calculate precipitation ratio is as follow and the results of the analysis are given in Table.3

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

Where,

$P_x$  = Maximum of Rainfall

$P_n$  = Minimum of Rainfall and  $P_m$  is the mean rainfall

The maximum annual ratio abnormality recorded at Valapadi 350.4 % and minimum abnormality recorded at Attur 36.7%.

The rainfall ratio distributed well uniformly expect in the eastern part of the basin as shown in Figure.7 and the results of the analysis are given in Table.3. From here, the abnormality increases towards west to east direction. Valapadi, Thalavasal and Vembavur. A half of the basin is under higher abnormality which explains the agriculture is gamble. The rest of the basin uniformly distributed well in over the basin.

Table – 3  
The Long-Term (1980 – 2010) Precipitation Ratio

sl.no	Stations	Winter	Summer	South west monsoon	North east monsoon	Mean annual
1	Thammampatti	1056.0	281.4	298.9	215.8	71.2
2	Vembavur	1042.4	402.6	1400.0	1400.0	303.2
3	Perambalur	800.6	384.3	204.0	203.2	53.1
4	Sendamangalam	898.4	226.6	167.5	206.7	50.0
5	Rasipuram	651.6	211.7	262.5	258.1	46.1
6	Mangalapuram	1034.5	305.1	169.8	214.9	57.5
7	Valapadi	356.1	700.0	696.9	700.0	350.4
8	Thalavasal	300.0	289.3	116.3	210.3	305.3
9	Lakkur	824.6	434.9	178.7	241.0	56.0
10	Tholuthur	584.9	448.2	233.3	307.0	52.4
11	Chettikulam	936.8	440.0	247.6	267.8	63.1
12	Thuraiyur	956.5	280.4	168.5	231.8	54.6
13	Badalur	333.3	0.5	137.1	160.4	126.3
14	Puduchatram	437.5	183.9	200.4	208.3	147.1
15	Attur	629.1	170.7	141.8	159.0	36.7
16	Gangavalli	733.9	311.9	122.5	186.6	45.2
	Mean	723.5	317.0	296.6	323.2	113.6
	Percentage	43.6	19.1	17.9	19.5	100.0

Source: Compiled by Author based on the data of Directorate of Economics and Statistics, Chennai.

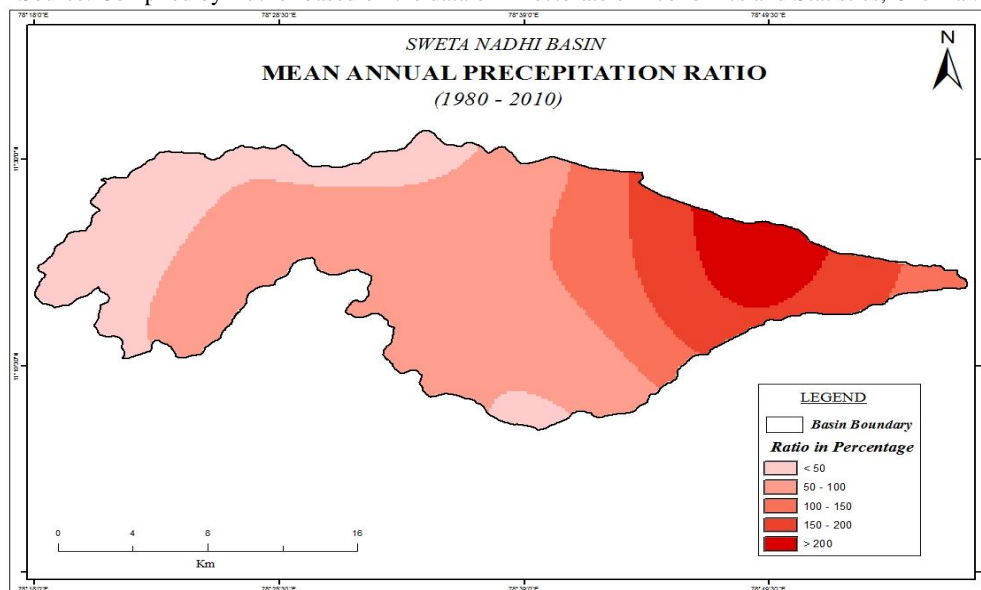


Fig. 7: Mean Annual Precipitation Ratio

#### 1) Winter Precipitation ratio

The seasonal precipitation ratio is shown in the as shown in Figure. 8 (a). It depicts the seasonal precipitation ratio. During winter season the percentage precipitation ratio of this basin is 43.6 %, it varies at maximum of 1056 % at Thammampatti and minimum of 300 % at Thalavasal. Western parts of the basin have above 800 % of high precipitation ratio compared with other part of the basin. The precipitation zone of less than 200 occurs in north and eastern rim of the basin, other places covered by gradual decrease to increase towards north to south direction of study area.

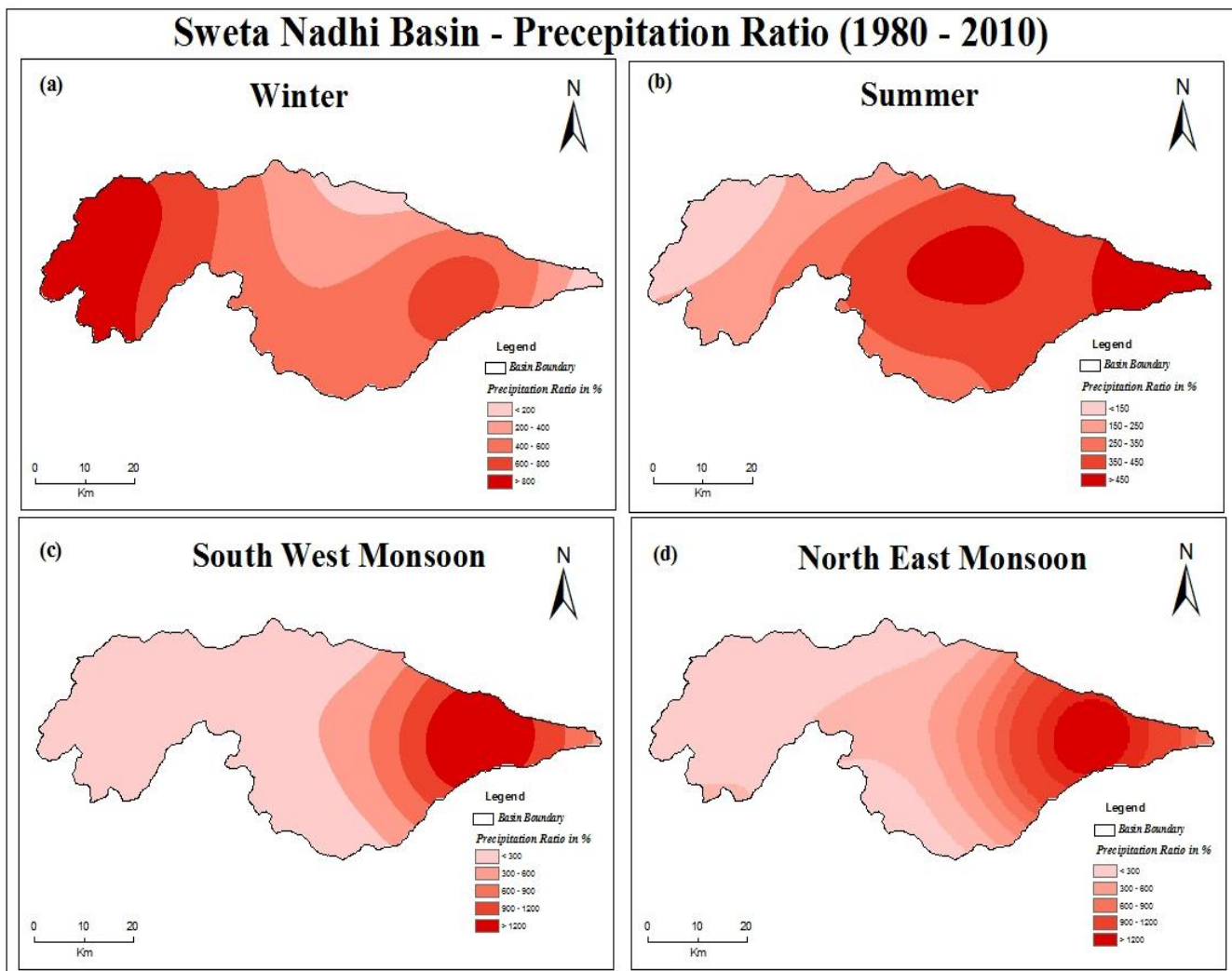


Fig. 8: Seasonal Precipitation Ratio

#### 2) Summer Precipitation ratio

The summer precipitation ratio of the study area is 19.1 per cent and it varies between 0.5 to 700. Valapadi, Tholuthur, Chettikulam, Lakkur, Vembavur express high precipitation ratio of more than 450 % following areas show high abnormality during this season they are Badalur, Attur, Puduchattram, Rasipuram and Sendamangalam. Other part of the region have moderate to normal anomalies to compare the other areas as shown in Figure.8 (b)

#### 3) Southwest Precipitation ratio

Southwest monsoon is an important monsoon season for the study area, it contributes 17.9 percentage rainfall precipitation ratio to annual total. The lower category of less than 300 percent is found in central and western part of the study area as shown in Figure 8 (c). The normal, moderate, high rainfall precipitation ratio occurs in eastern part of the study area.

#### 4) Northeast Precipitation ratio

Northeast monsoon and southwest monsoon precipitation ratio does not much variation to the total annual rainfall. The seasonal average precipitation is 19.5 % prevails in this basin during this period reveals of high precipitation ratio of more than above 1200 percentage covered by eastern part of the basin gradual decreases towards western part of the basin as shown in Figure.8 (d).

### IV. CONCLUSION

GIS is effectively used in this attempt to compute and produce maps. The rainfall which is an important factor for the use of water resources is a difficult variable to estimate the condition of Sweta Nadhi basin and its agriculture activities.

The spatial distribution pattern is different because of the hills (Pachamalai and Kollihills) belongs the study area. The variability indicates more than 150 % of variability in the winter season expect 5 stations only and other three season the

variability was below 150 % which indicates the dependable rainfall is available during this period. Therefore this is also substantiates that are under agriculture is under uncertainty and gamble and then Similarly precipitation ratio is carried out to bring out the anomalies in the distribution and the rainfall frequency is calculated to understand the occurrences. observing the precipitation ratio of the eastern part of the study area us under higher abnormality which indicates low stability. The overall observation shows the results of annual and seasonal rainfall is western and eastern part of the study area is not favorable for agricultural resources for reason rainfall spatial distribution low and very low throughout year. The entire basin is subjected to larger temporal fluctuations rather than the spatial distribution of rainfall.

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