

Analysis of Rainfall through Space - Time during 1999-2014 in Salem District, South India

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Abstract— The present study deals about the Rainfall assessment using various recent techniques with the help of remote sensing and GIS in Salem District, South India. The rainfall assessment carried over a period of 16 years from 1999 to 2014, which are clearly analyzed by using mean annual rainfall, mean seasonal rainfall, mean annual rainfall variability, mean seasonal rainfall variability, mean annual precipitation ratio and mean seasonal precipitation ratio methods. The methodology adopted based on literature study and which has given an accurate results. Therefore, the output shows that the study area has received 1 %, 19%, 41% and 39% of precipitation in winter, summer, southwest and northeast season respectively and the average annual rainfall is relatively more in N and NE and it is gradually decreases the eastern, western and southern parts of the study area. The rainfall variability indicates more than 100% in winter season except Nangavalli which is indicate the not dependable rainfall and other three season's rainfall variability less than 100% except Veeraganoor station, which is indicate the dependable rainfall available during these period. The precipitation ratio is less abnormality during SW and NE season and high abnormality during summer and winter season. Finally, rainfall variation assessment depicts that the rainfall conditions in Salem district is normal and fluctuation depends upon time and space.

Keywords— Variability, Precipitation Ratio, time, Space.

I. INTRODUCTION

Agricultural activities are the one of the main aspects of a country economic growth. . Rainfall is a main source of Agriculture productions. So, Rainfall play a vital role for Socio-Economic growth of an area, region and Country. Generally rainfall has a fluctuating character in year-to-year. Rainfall is a dynamic input for hydrologic studies and it is serious for obtaining accurate results (Suk *et al.* 2011). Monsoon rainfall has been playing a vital role in the nature and economy of Indian continent (Zaheer *et al.* 2015). Forecasting and monitoring of precipitations are very important for management of future droughts or floods

(Wei- Chiang Hong and Ping-Feng Pai 2007, Rico-Ramirez *et al.* 2015). The amount of rainfall is varied from either in space or in time (Mahalingam *et al.* 2014). Rainfall is exclusive variable, which reflects numerous factors regionally and globally (Jegankumar *et al.* 2012). Therefore, this study will assist the people to predict meteorological condition variation in spatial and temporally of Salem district. Water resource management is understanding by to know about the local precipitation patterns and which can vary in space and time considered on factors from different spatial scales such as macroscopic atmospheric circulation and topographical changes (Hwa-lung *et al.* 2015). Rainfall variation and the detection of rainfall extremes is a function of scale, so high space and time resolution data are ideal to identify extreme events and exact prediction of future variability (Williamset *al.* 2010, Renji Remesan and Holman, 2015). Rainfall is a main triggering factor for natural hazards like landslide and flood, 90% involved and which are closely connected to the strong rainfall (Hengxine *et al.* 2003, Theodosios Kritikos and Tim davis 2014, Bai Shi-biao *et al.* 2013, Sang-Soo Jeon 2014). Climatology is one of the main factor, which is directly or indirectly influences by hydrology predictions (Azadeh ahmadi *et al.* 2014, Mari R.Tye and Daniel Cooley. 2015). Representation of precipitation changes in based on elevation in an area indicated that the possibilities of orographic precipitation found in the hilly regions (Zekai sen and Zeyat habib 2000). Remote sensing and Geographical Information System has been used to create model in identification of rainfall-based assessment (Okan fistikoglu and Nilgun B. Harmancioglu 2002). India receives more rainfall during SW monsoon than the other seasons (Thilagavathi *et al.* 2014, Priyadharshini and Arucham 2015, Tharanitharan Venkatesan and Srinivasan Krishnamoorthy, 2014). Built-up catchments are naturally characterized by high spatial variability and quick runoff which are in short response times (Susana ochoa-rodriquez *et al.* 2015). Gurugnanam *et al.* (2012) have analyzed that, the average rainfall of Salem district received less than 200mm during 1998-2007, which was very less than actual rainfall.

II. MATERIALS AND METHODS

The daily rainfall data collected from the year 1999 to 2014. The daily rainfall data calculated into monthly, then the monthly data divided into season and monsoon wise data. Totally there are 17 rain gauge stations in the study area, which are Veeraganoor, Yercaud, Thammampatti, Valapadi, Omalur, Pillukurichi, Salem City, Athur, Gangavalli, Salem Junction, Edapadi, Kolathur, Anaimaduvu Reservoir, Kullampatti, Mettur, Nangavalli and Sankagiri. The 17 rain gauge stations are given Fig.3. Finally, rainfall data analyzed for mean annual and mean seasonal rainfall, mean annual and mean seasonal rainfall variability, mean annual and mean seasonal precipitation ratio of 16 years interval of 1999-2014. The flow chart methodology of rainfall assessment is given in Fig.1. Finally, the spatial distribution maps prepared from the attributed rainfall data.

Study Area

The present study is carried out in Salem District (Fig.-2), which is located in-between latitude $11^{\circ}39'52''$ and Longitude $78^{\circ}8'45''$ and the total area covered by 5232 Km^2 . The average Mean Sea Level is 278m. The study area situated at north side of Nagaramalai hill, West side of Kanjamalai hill, East side of Godumalai hill, , South side of Jarugumalai hill, North East side of Shervaroy hills and South West side of Kariyaperumal Hills.

Mean Annual Rainfall

Since from 1999 to 2014 the study area receives mean annual rainfall of 816 mm, and it ranges from 329 mm (Veeraganoor) to 1492 mm (Yercaud). The mean annual rainfall data is given in Table 1. The rain gauge stations Yercaud, Thammampatti, Valapadi, Omalur, Salem, Athur, Mettur, Kullampatti, and Nangavalli receives high rainfall than average rainfall, and Anaimaduvu station receives nearly equal rainfall than average rainfall. The rest of the stations receives low rainfall than average rainfall. The mean annual rainfall spatial distribution map computed by inverse distance weighted (IDW) method using Arc GIS 10.2 software. The spatial distribution map of mean annual rainfall is given in Fig.4. The map clearly represent that, the mean annual rainfall variation between one stations to other stations. According to the rainfall data, the spatial distributions divided into five classes with 250 mm interval, which are very low (<500 mm), low (500-750 mm), moderate (750-1000 mm), high (1000-1250 mm), very high (>1250 mm). Yercaud station only receives a very high (>1250 mm) rainfall in the area of 109 km^2 . Mettur and adjacent part of Yercaud hill receives high (1000-1250 mm) rainfall in the area of 579 km^2 . The very high and high rainfall levels occurs in the high altitude areas only. Most

part of the study area falls under the moderate (750-1000 mm) level rainfall including Nangavalli, Omalur, Kullampatti, Salem City, Valapadi, Anaimadu Reservoir, Athur and Thammampatti in the area of 3664 km^2 . Low (500-750 mm) level rainfall locates in Gangavalli, Salem Junction, Pillukuruchi, Sankagiri, Edapadi and Kolathur. These locations situate in eastern and western part of the study area. Low level rainfall cover an area of 710 km^2 . Very low (<500 mm) level rainfall cover an area of 168 km^2 and it is mainly found in Veeraganoor and its adjacent parts. The moderate to very low rainfall areas are low altitudes and plain regions.

Seasonal Rainfall

Winter Season

The winter season rainfall contributes very less (1%) than other seasons and it ranges from 1mm to 12 mm (Table 1). The highest rainfall in winter season occurs in the Yercaud station, which is high altitude region and the remaining areas receives less than 10 mm rainfall. The average winter season rainfall is 5 mm. Yercaud, Thammampatti, Pillukurichi, Edapadi, Kullampatti, and Mettur stations receives high rainfall than average rainfall and the rest of the stations receives low rainfall than average rainfall. The spatial distribution map of the winter season is given in Fig. 5. The spatial distribution of winter season rainfall divided into five classes with 2.5 mm interval, which are very low (<2.5 mm), low (2.5-5 mm), moderate (5-7.5 mm), high (7.5-10 mm) and very high (>10 mm). The very low (<2.5 mm) level rainfall occurs in Nangavalli, Salem Junction and Veeraganoor stations in the area of 323 km^2 . Low (2.5-5 mm) level rainfall covers an area of 3711 km^2 and the locations are Kolathur, Mettur, Omalur, Salem city, Sankagiri, Valapadi, Anaimaduvu Reservoir, Attur and Gangavalli stations. Moderate (5-7.5 mm) level rainfall covers an area of 905 km^2 and the locations are adjacent area of Yercaud, Edapadi and Kullampatti. High (7.5-10 mm) rainfall locates in Pillukurichi and some part of Yercaud, in the area of 269 km^2 . The very high (>10 mm) rainfall region is Yercaud station and it covers 24 km^2 .

Summer Season

The summer season contributes 19% of rainfall, it is higher than winter season rainfall. During the summer season, the rainfall ranges from 47 mm (Veeraganur) to 264 mm (Yercaud) with average rainfall of 156.5 mm (Table 1). The spatial distribution map of the summer season is given in Fig. 6. Yercaud, Omalur, Salem city, Salem junction, Edapadi, Kolathur, Anaimaduvu, Mettur, Kullampatti, and Nangavalli receives high rainfall than average rainfall, and Sankagiri station receives nearly equal rainfall than average

rainfall and rest of the stations receives low rainfall than average rainfall. The spatial distribution of summer season rainfall divided into five classes with 55 mm interval, which are very low (<55 mm), low (55-110 mm), moderate (110-165 mm), high (165-220 mm) and very high (>220 mm). The very low level rainfall (<55 mm) station is Veeraganoor and its cover an area of 30 km². Low level rainfall (55-110 mm) occurs in Gangavalli and adjacent parts of Veeraganoor stations in the area of 497 km². Moderate level rainfall (110-165 mm) occurs in Pillukurichi, Edapadi, Sankagiri, Salem Junction, Anaimaduvu, Valapadi, Athur and Thammampatti stations in the area of 1968 km². High level rainfall (165-220 mm) occur in Kullampatti, Kolathur, Mettur, Nangavalli, Omalur and Salem city in the area of 2604 km². Very high level rainfall (>220 mm) occur in Yercaud station in the area of 129 km².

Southwest Monsoon

The southwest monsoon contributes 41% of rainfall, it is higher than summer season. During the southwest monsoon, rainfall ranges from 92 mm (Veeraganur) to 718 mm (Yercaud) with the average rainfall of 332.4 mm (Table 1). The spatial distribution map of the southwest monsoon is given in Fig. 7. Yercaud, Valapadi, Omalur, Salem, Athur, Anaimaduvu, Mettur, and Nangavalli stations receives high rainfall than average rainfall, and the rest of the stations receives low rainfall than average rainfall. The spatial distribution of southwest monsoon divided into five classes with 150 mm interval, which are very low (<150 mm), low (150-300 mm), moderate (300-450 mm), high (450-600 mm) and very high (>600 mm). The very low (<150 mm) level rainfall occurs in Gangavalli and Veeraganoor stations in the area of 134 km². Low (150-300 mm) level rainfall covers an area of 1089 km² and the locations are Kolathur, Pillukurichi, Sankagiri, Thammampatti and adjacent parts of Gangavalli station. Moderate (300-450 mm) level rainfall covers an area of 3299 km² and the locations are Mettur, Nangavalli, Kullampatti, Edapadi, Salem Junction, Anaimaduvu reservoir, Valapadi and Athur. High (450-600 mm) level rainfall locates in Omalur, Salem city and adjacent part of Yercaud in the area of 615 km². The very high (>600) level rainfall region is Yercaud station and it covers an area of 93 km².

Northeast Monsoon

The northeast monsoon contributes 39% of rainfall which is higher than winter and summer season. During the northeast monsoon, rainfall ranges varies 190 mm (Veeraganur) to 496 mm (Yercaud) with the average rainfall of 322.5 mm (Table 1). The spatial distribution map of the

northeast monsoon is given in Fig. 8. Yercaud, Thammampatti, Valapadi, Salem, Athur, Mettur, Kullampatti, and Nangavalli receives high rainfall than average rainfall, and the rest of the stations receives low rainfall than average rainfall. The spatial distribution of northeast monsoon rainfall divided into five classes with 80 mm interval, which are very low (<240 mm), low (240-320 mm), moderate (320-400 mm), high (400-480 mm) and very high (>480 mm). The very low (<240 mm) level rainfall occurs in Veeraganoor station with the area of 130 km². Low (240-320 mm) level rainfall covers an area of 2141 km² and the locations are Kolathur, Pillukurichi, Edapadi, Sankagiri, Omalur, Salem Junction, Anaimaduvu reservoir and Gangavalli stations. Moderate (320-400 mm) level rainfall covers an area of 2663 km² and the locations are Mettur, Nangavalli, Kullampatti, Salem city, Valapadi and Athur. High (400-480 mm) level rainfall occurs in Thammampatti and adjacent part of Yercaud in the area of 280 km². The very high (>480 mm) level rainfall region is Yercaud station in the area of 15 km².

Rainfall Variability

Rainfall variability defined as the deviation from mean or ratio of the standard deviation to the mean rainfall and in other words variability of co-efficient of variation (Rathod, 2010). The rainfall variability calculated using the co-efficient of variations of selected 16 years data. The co-efficient of variation (CV) defined as the standard deviation divided by the mean value. The results of rainfall variability is given in Table 4.8. Jegankumar *et al.* 2012; Priyadharshini and Aruchamy, 2015 have emphasized that the higher value is the variability percentage, the lower value is the dependability and vice versa. For the monthly case less than 100% of co-efficient of variation is dependable, while more than 100% of co-efficient of variation is not dependable rainfall.

$$CV = (SD/Mean) \times 100 \quad \text{Where } SD = \text{Standard deviation}$$

Mean Annual Variability

The mean annual rainfall variability is 43 % and its range from 19% to 119% (Table 2). The minimum variability occurs in Yercaud and Thammampatti and the maximum variability occurs in Veeraganoor. The stations Veeraganoor, Gangavalli, Salem junction, Kolathur and Mettur have high rainfall variability than average rainfall variability and the other stations have low rainfall variability than average rainfall variability. The spatial distribution map of the mean annual rainfall variability is given in Fig. 9. The spatial distribution of rainfall variability divided into five classes

with 25% interval, which are very low (<25 %), low (25-50 %), moderate (50-75 %), high (75-100 %), very high (>100 %). The very low (<25 %) rainfall variability occurs in Yercaud, Salem city, Omalur and Thammampatti stations in an area of 232 km². Low (25-50 %) rainfall variability covers an area of 3987 km² and occurs in Pillukurichi, Edapadi, Kullampatti, Nangavalli, Vallapadi, Sankagiri, Anaimaduvu reservoir and Athur station. Moderate (50-75 %) rainfall variability covers an area of 709 km² and occurs in Kolathur, Mettur, Salem junction and adjacent parts of Gangavalli. High (75-100 %) rainfall variability locates in Gangavalli in the area of 221 km². The very high (>100 %) rainfall variability region is Veeraganoor station in the area of 80 km².

Winter Season Variability

The average rainfall variability of winter season is 208 % and its range from 0% to 374% (Table 2). The stations Veeraganoor, Omalur, Salem junction, Kullampatti and Sankagiri have high rainfall variability than average rainfall variability and the other stations have low rainfall variability than average rainfall variability. The spatial distribution map of the winter season rainfall variability is given in Fig.10. The spatial distribution of rainfall variability divided into five classes with 75% intervals, which are very low (<75 %), low (75-150 %), moderate (150-225 %), high (225-300 %), very high (>300 %). The Very low (<75 %) rainfall variability occurs in Nangavalli station and it covers an area of 60 km².

Low (75-150 %) rainfall variability covers an area of 355 km² and occurs in Vallapadi, Anaimaduvu reservoir and adjacent part of Nangavalli station. Moderate (150-225 %) rainfall variability covers an area of 3467 km² and occurs in Kolathur, Mettur, Pillukurichi, Yercaud, Salem city, Athur, Thammampatti and Gangavalli. High (225-300 %) rainfall variability locates in Edapadi, Kullampatti and covers an area of 1127 km². The very high (>300 %) rainfall variability regions are Omalur, Salem junction, Veeraganoor, Sankagiri stations and its cover an area of 220 km².

Summer Season Variability

The average rainfall variability of summer season is 70 % and its range from 45% to 174% (Table 2). The stations Veeraganoor, Valapadi, Gangavalli, Kolathur have high rainfall variability than average rainfall variability and rest of the stations have low rainfall variability than average rainfall variability. The spatial distribution map of the summer season rainfall variability is given in Fig.11. The spatial distribution of rainfall variability divided into five classes with 60% intervals, which are very low (<60 %),

low (60-90 %), moderate (90-120 %), high (120-150 %), very high (>150 %).

The very low (<60 %) rainfall variability occurs in Yercaud, Omalur, Salem city, Pillukurichi, Edapadi, Kullampatti, Sankagiri, Anaimaduvu reservoir, Athur and Thammampatti stations and covers an area of 2217 km². Low (60-90 %) rainfall variability covers an area of 2464 km² and the locations are Mettur, Nangavalli, Valapadi and adjacent parts of Kolathur station. Moderate (90-120 %) rainfall variability covers an area of 343 km² and the location is Gangavalli. High (120-150 %) rainfall variability locates in adjacent parts of Veeraganoor station in the area of 138 km². The very high (>150 %) rainfall variability region is Veeraganoor station and it covers an area of 67 km².

Southwest Monsoon Variability

The average rainfall variability of southwest monsoon is 45 % and its range from 22% to 128% (Table 2). The stations Veeraganoor, Gangavalli, Salem junction, Kolathur and Kullampatti have high rainfall variability than average rainfall variability and the other stations have low rainfall variability than average rainfall variability. The spatial distribution of the southwest monsoon rainfall variability is given in Fig.12. The rainfall variability divided into five classes with 25% intervals, and the classes are very low (<25 %), low (25-50 %), moderate (50-75 %), high (75-100 %), very high (>100 %).

The very low (<25 %) rainfall variability occurs in Yercaud, Anaimaduvu reservoir and Valapadi Stations in an area of 126 km². Low (25-50 %) rainfall variability covers an area of 4282 km² and occurs in Mettur, Nangavalli, Omalur, Pillukurichi, Edapadi, Kullampatti, Sankagiri and Athur stations. Moderate (50-75 %) rainfall variability covers an area of 462 km² and occur in Kolathur, Salem junction and adjacent parts of Gangavalli station. High (75-100 %) rainfall variability locates in Gangavalli station and covers an area of 237 km². The very high (>100 %) rainfall variability region is Veeraganoor station and it covers an area of 123 km².

Northeast Monsoon Variability

The average rainfall variability of northeast monsoon is 59 % and its range from 32% to 120% (Table 2). The stations Veeraganoor, Gangavalli, Salem junction, Kolathur and Nangavalli have high rainfall variability than average rainfall variability and the other stations have low rainfall variability than average rainfall variability. The spatial distribution map of the northeast monsoon rainfall variability is given in Fig.13. The spatial distribution of rainfall variability divided into five classes with 20% intervals and the classes are very low (<40 %), low (40-60

%), moderate (60-80 %), high (80-100 %), very high (>100 %).

The very low (<40 %) rainfall variability occurs in Yercaud, Omalur, Salem city and Thammampatti stations in the area of 188 km². Low (40-60 %) rainfall variability covers an area of 3705 km² and occurs in Pillukurichi, Edapadi, Kullampatti, Sankagiri, Valapadi, Anaimaduvu reservoir and Athur stations. Moderate (60-80 %) rainfall variability covers an area of 936 km² and occurs in Kolathur, Mettur, Nangavalli, Salem junction and adjacent parts of Gangavalli station. High (80-100 %) rainfall variability locates in Gangavalli station in the area of 269 km². The very high (>100 %) rainfall variability region is Veeraganoor station and its cover an area of 130 km².

Precipitation Ratio (PR)

The precipitation ratio or abnormalities of rainfall has been calculated using a simple ratio of precipitation. Precipitation ratio is the difference between maximum and minimum rainfall of over the study period of mean value. The precipitation ratio may give the stability of rainfall with spatial pattern. Higher value of PR is the high abnormality in rainfall and the lower PR value is the less abnormality in rainfall. The PR formula is given below.

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

Where; P_x = Maximum of Rainfall

P_n = Minimum of Rainfall

P_m = Mean Rainfall

The result of precipitation ratio analysis are given in Table 3.

Mean Annual Precipitation Ratio

The mean annual precipitation ratio of the study area is 132 % with maximum abnormality in Veeraganoor (301%) and minimum abnormality in Omalur (53 %) (Table 3). The spatial distribution map of the mean annual precipitation ratio is given in Fig. 14. The spatial distribution of precipitation ratio divided into five classes with 50% interval, which are very low (<100 %), low (100-150 %), moderate (150-200 %), high (200-250 %) and very high (>250 %).

The very low (<100 %) PR occurs in Yercaud, Omalur, Salem city, Sankagiri and Thammampatti Stations in the area of 1150 km². Low (100-150 %) PR covers an area of 3143 km² and the stations are Pillukurichi, Mettur, Nangavalli, Edapadi, Valapadi, Anaimaduvu reservoir and Athur stations. Moderate (150-200 %) PR covers an area of 626 km² and the stations are Kolathur, Kullampatti, Salem junction and surrounding parts of Gangavalli station. High (200-250 %) PR locates in Gangavalli station with 205

km². The very high (>250 %) PR region is Veeraganoor station and its cover an area of 104 km².

Winter Season Precipitation Ratio

The average winter season precipitation ratio of the study area is 748 %, and it ranges from 0% to 1437.5 % (Table 3). The spatial distribution map of the winter season precipitation ratio is given in Fig. 15. The spatial distribution of winter season precipitation ratio divided into five classes with 300% intervals and the intervals are very low (<300 %), low (300-600 %), moderate (600-900 %), high (900-1200 %) and very high (>1200 %). The very low (<300 %) PR occurs in Nangavalli and Salem city stations in the area of 67 km². Low (300-600 %) PR covers an area of 1563 km² and occurs in Kolathur, Mettur, Valapadi, Anaimaduvu reservoir and Athur stations. Moderate (600-900 %) PR covers an area of 2666 km² and occurs in Pillukurichi, Edapadi, Kullampatti, Yercaud and Gangavalli stations. High (900-1200 %) PR locates in adjacent parts of Omalur, Salem junction, Sankagiri and Veeraganoor stations in the area of 765 km². The very high (>1200 %) PR stations are Veeraganoor, Omalur, Salem junction, Sankagiri and it covers an area of 170 km².

Summer Season Precipitation Ratio

The summer season precipitation ratio of the study area is 210 %, and it ranges from 70% to 486 % (Table 3). The spatial distribution map of the summer season precipitation ratio is given in Fig.16. The spatial distribution of summer season precipitation ratio divided into five classes with 100% intervals and the intervals are very low (<100 %), low (100-200 %), moderate (200-300 %), high (300-400 %) and very high (>400 %). The very low (<100 %) PR occurs in Sankagiri in the area of 48 km². Low (100-200 %) PR covers an area of 1864 km² and occurs in Kolathur, Kullampatti, Yercaud, Anaimaduvu reservoir and Thammampatti stations. Moderate (200-300 %) PR covers an area of 3075 km² and occurs in Mettur, Nangavalli, Omalur, Pillukurichi, Edapadi, Salem Junction, Salem city, Valapadi, Athur and Gangavalli stations. High (300-400 %) PR locates in adjacent parts of Veeraganoor stations which covers an area of 158 km². The very high (>400 %) PR region is Veeraganoor station and it covers an area of 85 km².

Southwest Monsoon Precipitation Ratio

The average southwest monsoon precipitation ratio of the study area is 138 %, and it ranges from 62 % to 330 % (Table 3). The spatial distribution map of the southwest monsoon precipitation ratio is given in Fig. 17. The spatial distribution of southwest monsoon precipitation ratio divided into five classes with 80% intervals and the

intervals are very low (<80 %), low (80-160 %), moderate (160-240 %), high (240-320 %) and very high (>320 %). The very low (<80 %) PR occurs in Valapadi and Yercaud, in the area of 110 km². Low (80-160 %) PR covers an area of 4285 km² and the stations are Mettur, Nangavalli, Omalur, Pillukurichi, Edapadi, Anaimaduvu reservoir, Athur and Thammampatti. Moderate (160-240 %) PR covers an area of 634 km² and the stations are Kolathur, Kullampatti, Sangagiri, Salem junction and Gangavalli. High (240-320 %) PR locates in adjacent parts of Veeraganoor station in the area of 185 km². The very high (>320 %) PR region is Veeraganoor station and it covers an area of 15 km².

Northeast Monsoon Precipitation Ratio

The average northeast monsoon precipitation ratio of the study area is 189 %, and it ranges from 48% to 278% (Table 3). The spatial distribution map of the northeast monsoon precipitation ratio is given in Fig.18. The spatial distribution of northeast monsoon precipitation ratio divided into five classes with 60% intervals and the intervals are very low (<60 %), low (60-120 %), moderate (120-180 %), high (180-240 %) and very high (>240 %). The very low (<60 %) PR occur in Salem city in the area of 7 km². Low (60-120 %) PR cover an area of 131 km² and the stations are Omalur, Thammampatti and adjacent parts of Salem city. Moderate (120-180 %) PR covers an area of 2515 km² and the stations are Yercaud, Valapadi, Athur and Sankagiri. High (180-240 %) PR locates in Kolathur, Mettur, Nangavalli, Pillukurichi, Edapadi, Kullampatti and Anaimaduvu reservoir stations in the area of 2281 km². The very high (>240 %) PR regions are Veeraganoor and Gangavalli stations and it covers an area of 296 Km².

III. CONCLUSION

The analysis of the rainfall data has shown that the average rainfall ranges from 329mm to 1492mm. it is clearly evidenced that the high altitude area likely yercaud stations has received more rainfall than plain regions. In general, the rainfall is found to be relatively higher in the hilly regions and lower in the plain regions. The average annual rainfall is relatively more in N and NE and it is gradually decreasing in Eastern, Western and Southern parts. It is found that the southwest monsoon is considerably more active in northern, northeastern and northwestern part than other direction, whereas the northeast monsoon is more active in north and northeastern part. The relative percent of rainfall during summer relatively more on northern, northeastern and eastern part, whereas winter seasons are relatively more on northern and eastern part. The Southwest season has

contributed more than the other season of rainfall. The rainfall variability indicates more than 100% in winter season except Nangavalli, which is indicating the not dependable rainfall and other three season's rainfall variability less than 100% except Veeraganoor station, which is indicating the dependable rainfall available during these period. The precipitation ratio is less abnormality during SW and NE season and high abnormality during summer and winter season. Based on mean annual precipitation ratio eastern part of the study area having high abnormality, Central and western part of the study area have less abnormality. Finally, rainfall variation assessment depicts that the rainfall conditions in Salem district has normal and fluctuation depends on time and space.

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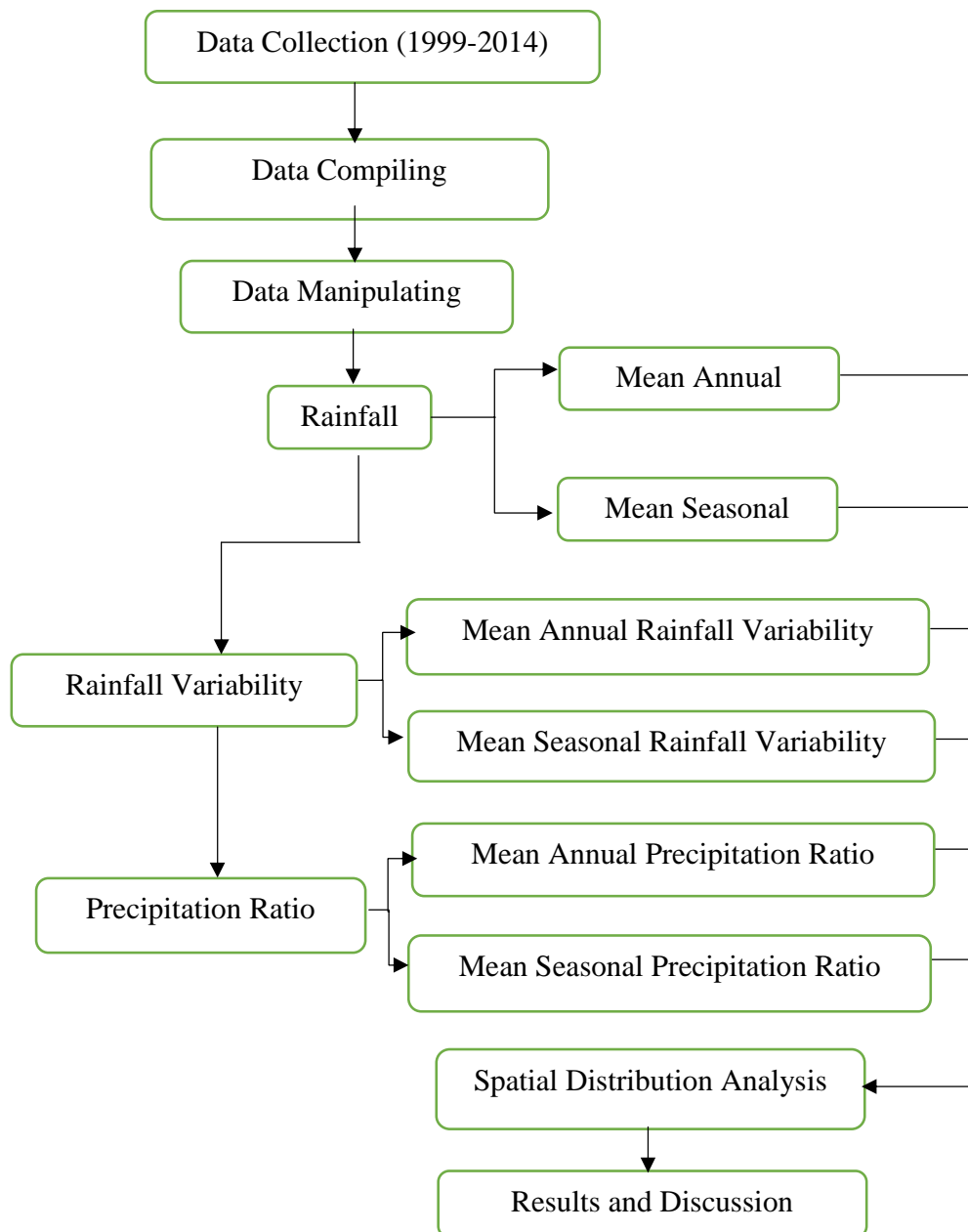


Fig.1:Flow chart-Methodology

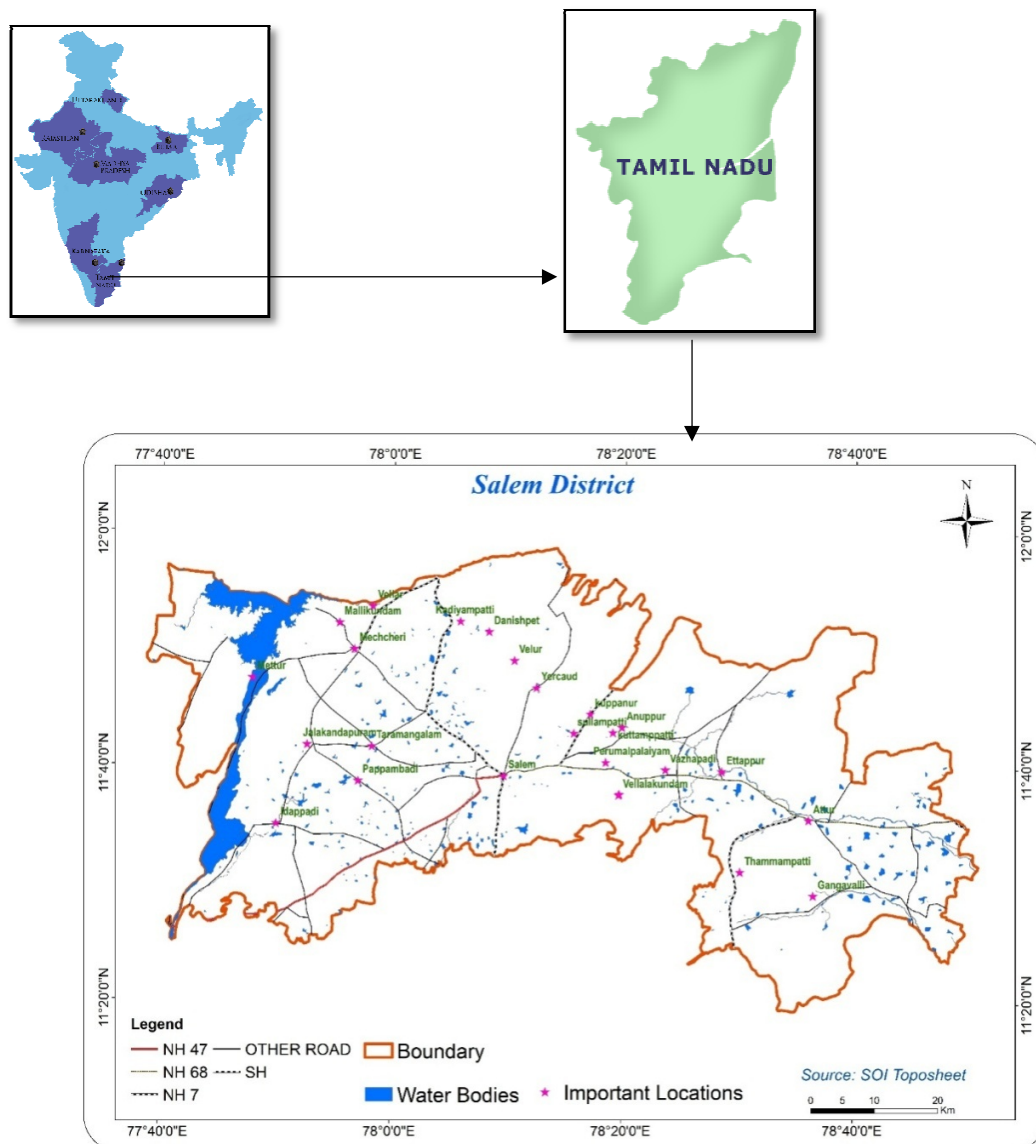


Fig.2: Location map of the Study Area

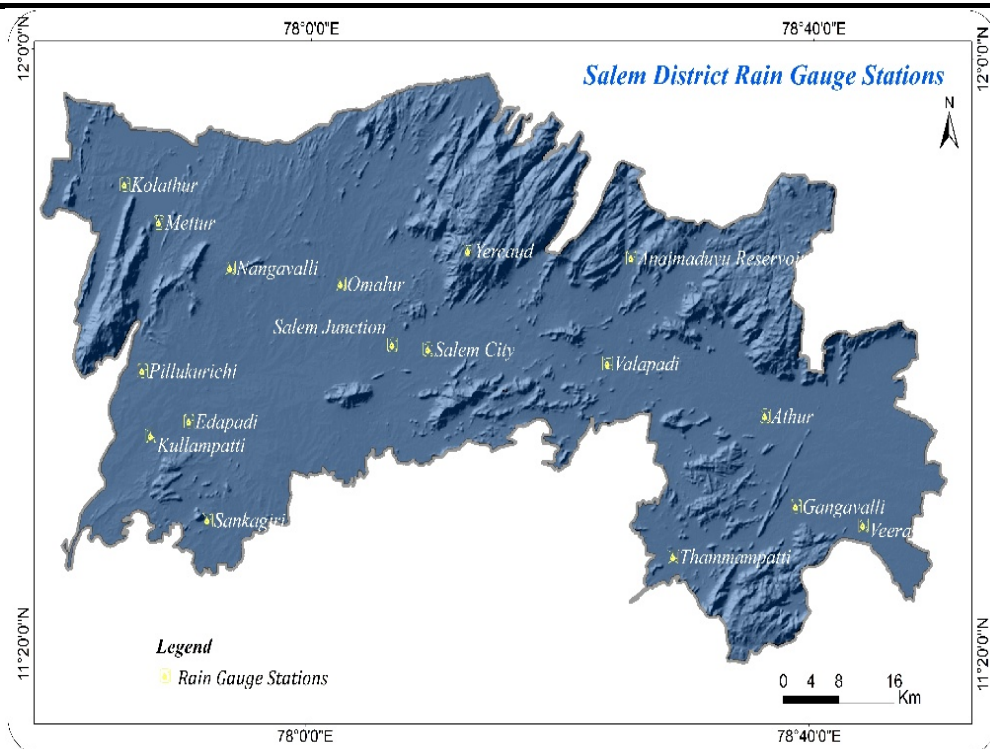


Fig. 3: Rain gauge stations of the study area

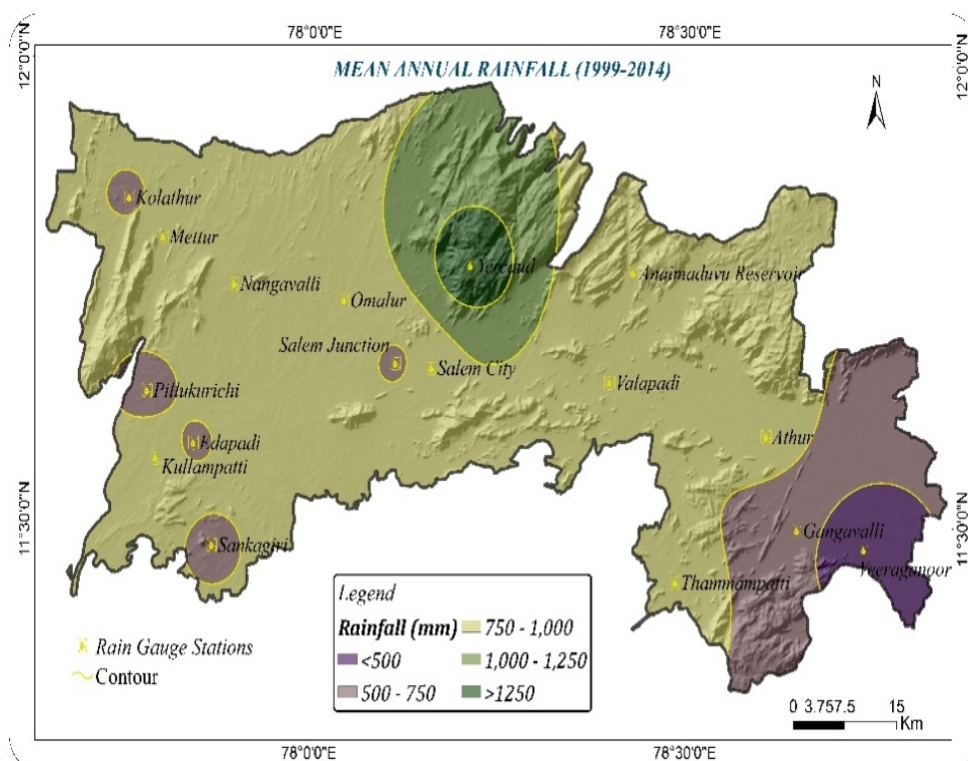


Fig.4: Spatial distribution of mean annual rainfall

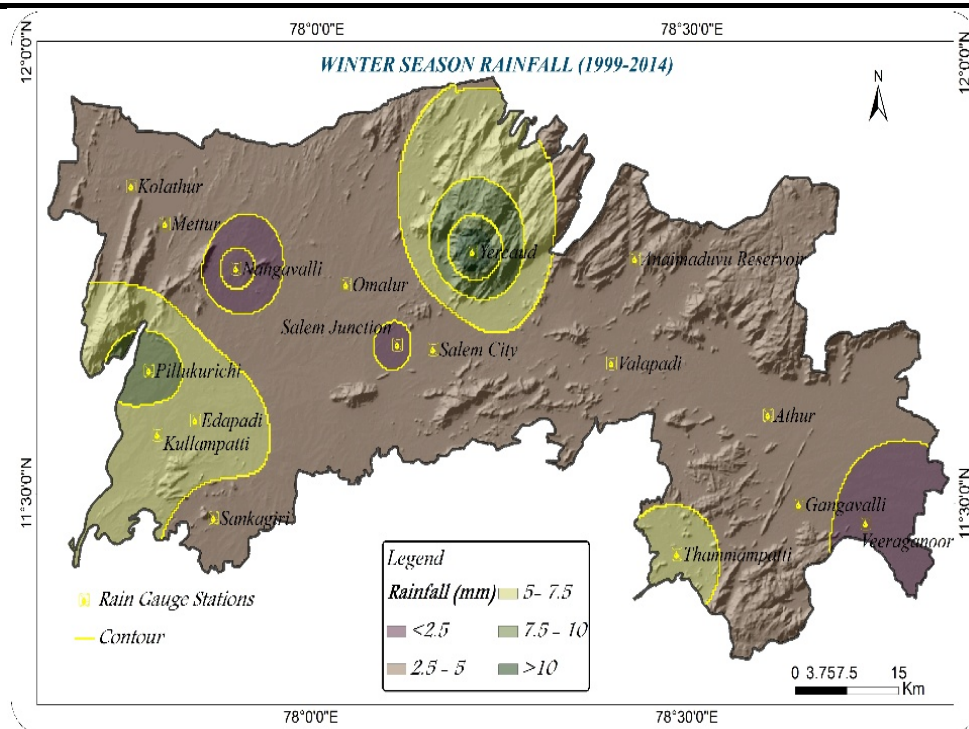


Fig.5:Spatial distribution of winter season rainfall

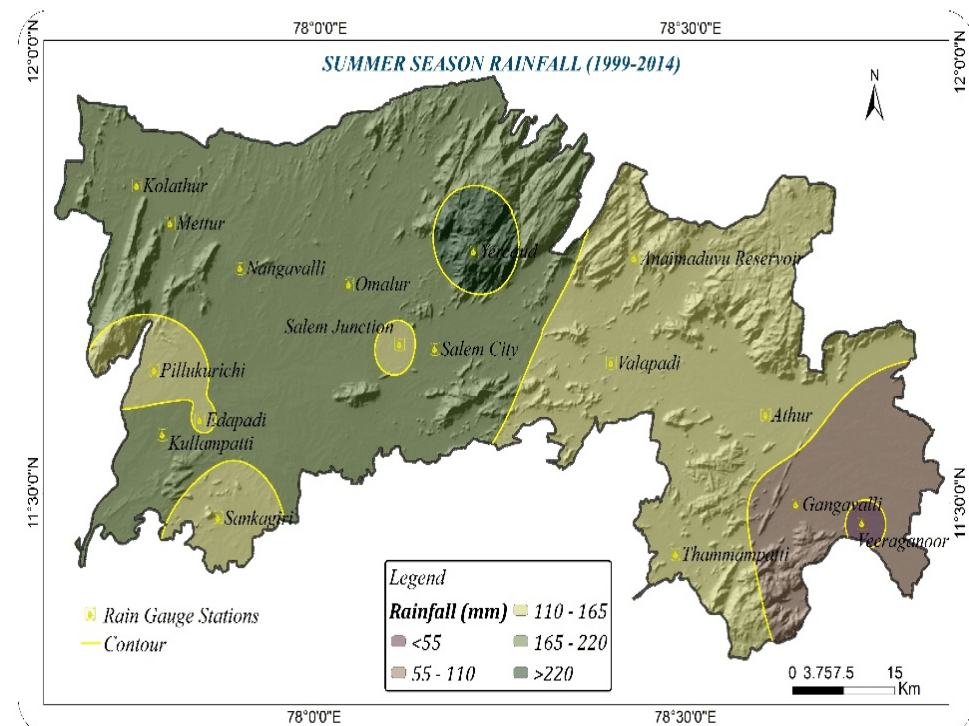


Fig.6:Spatial distribution of summer season rainfall

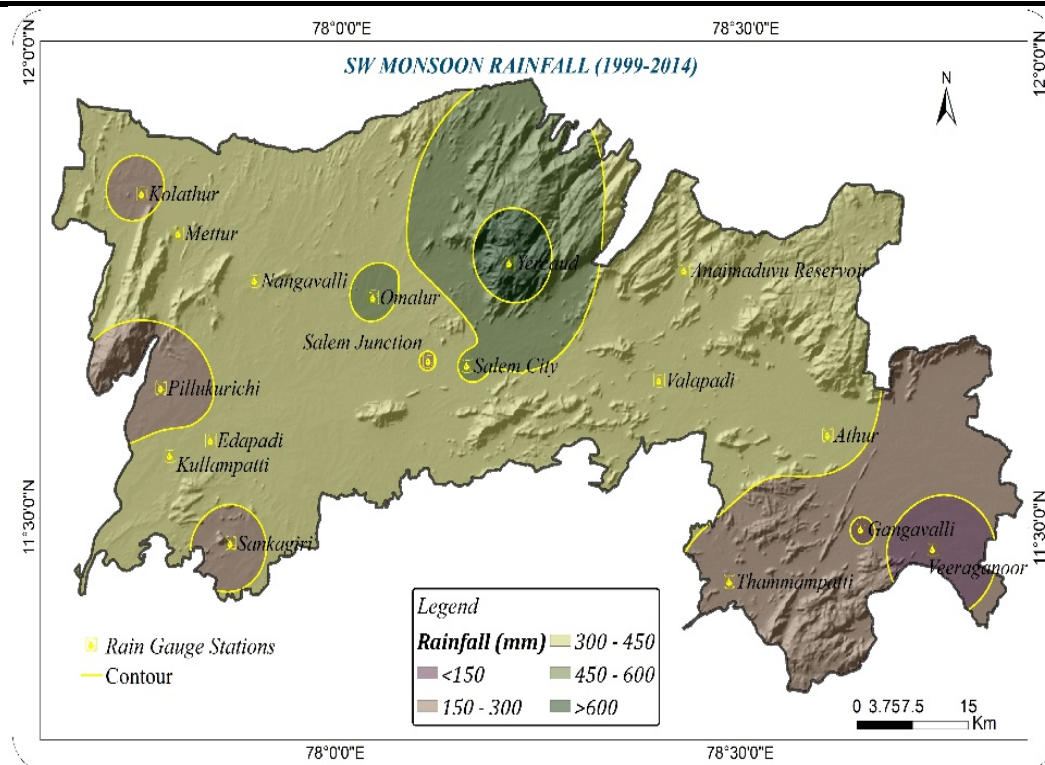


Fig.7: Spatial distribution of SW monsoon rainfall

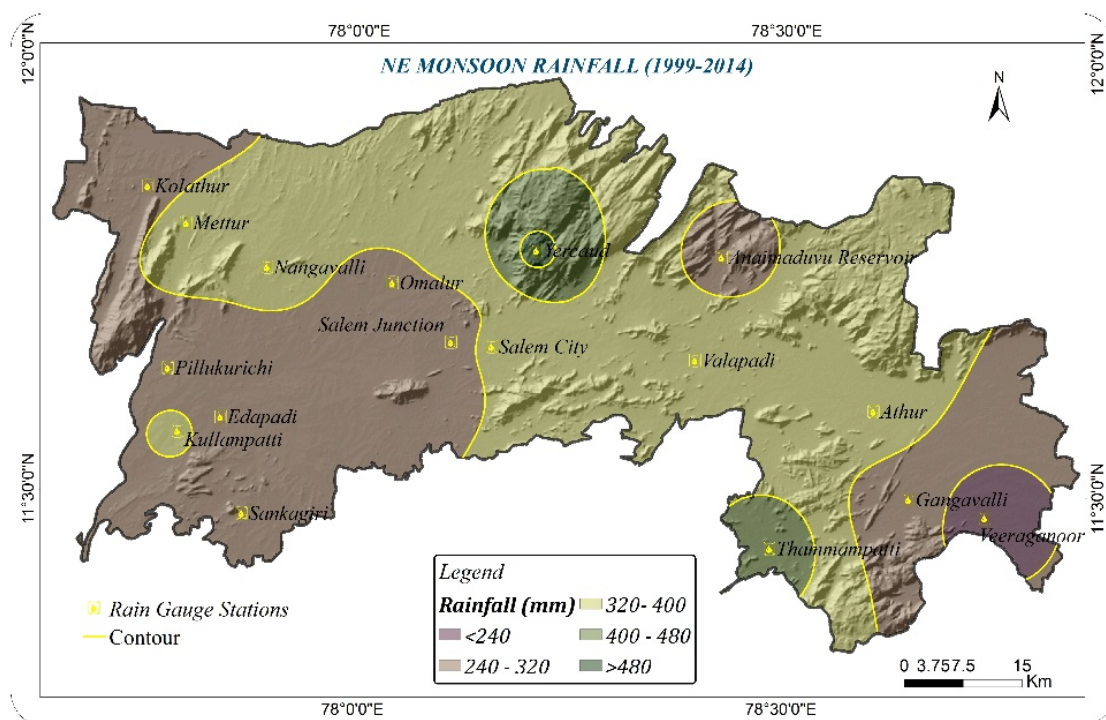


Fig.8: Spatial distribution of NE monsoon rainfall

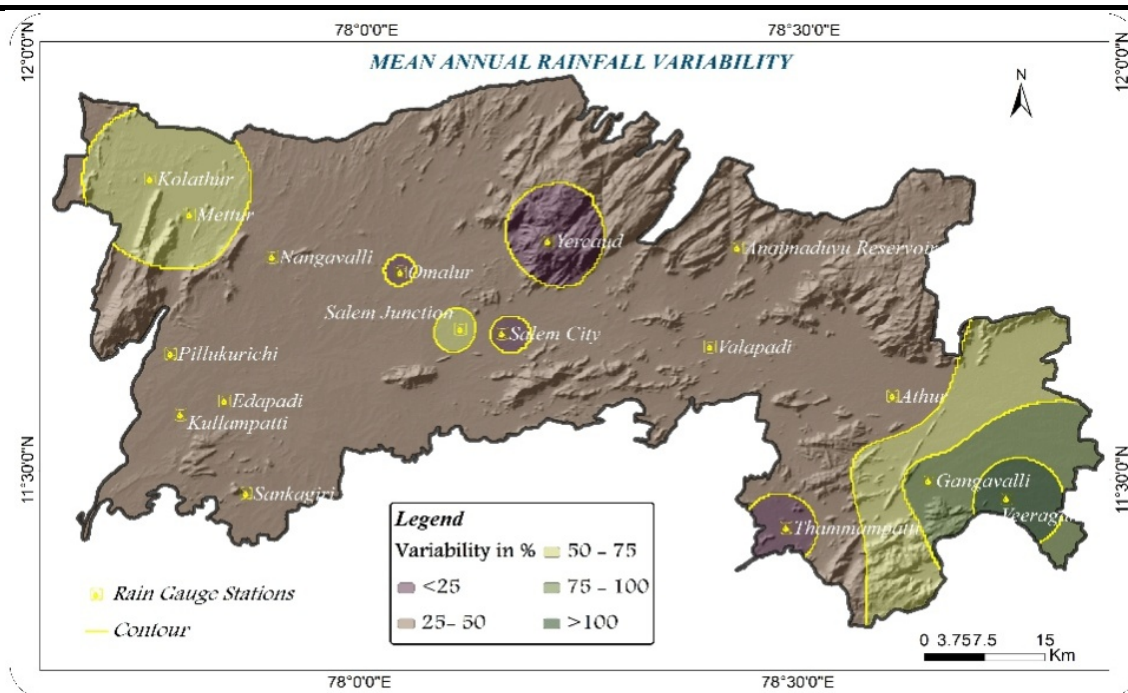


Fig.9: Spatial distribution of mean annual rainfall variability

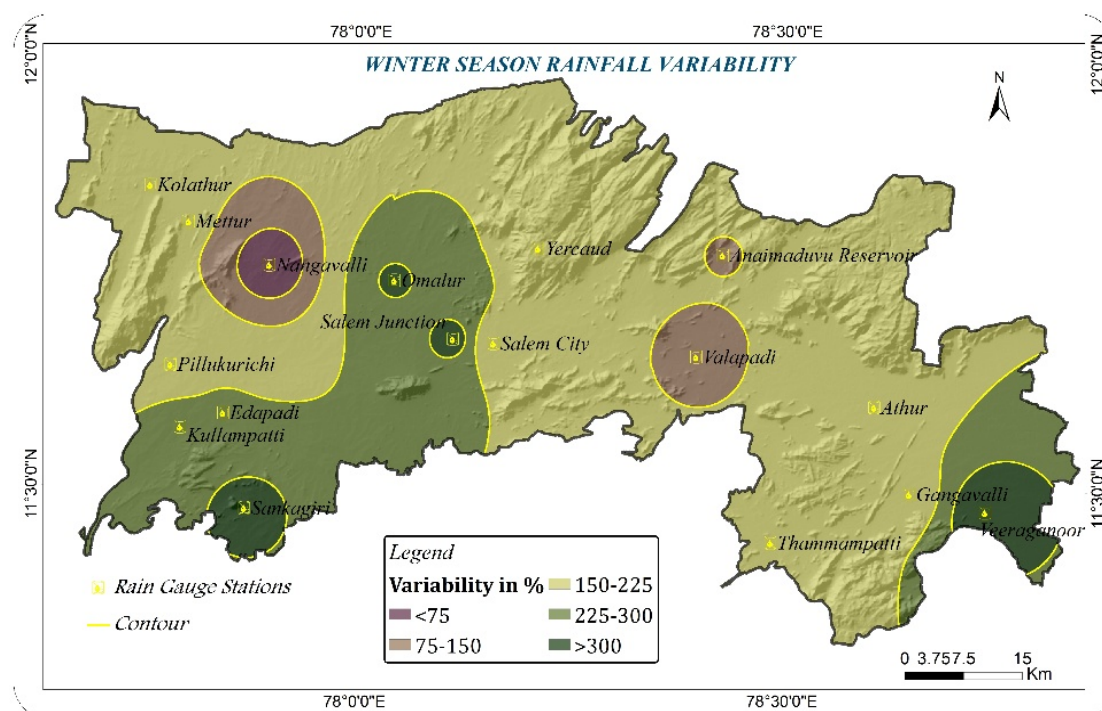


Fig.10: Spatial distribution of winter season rainfall variability

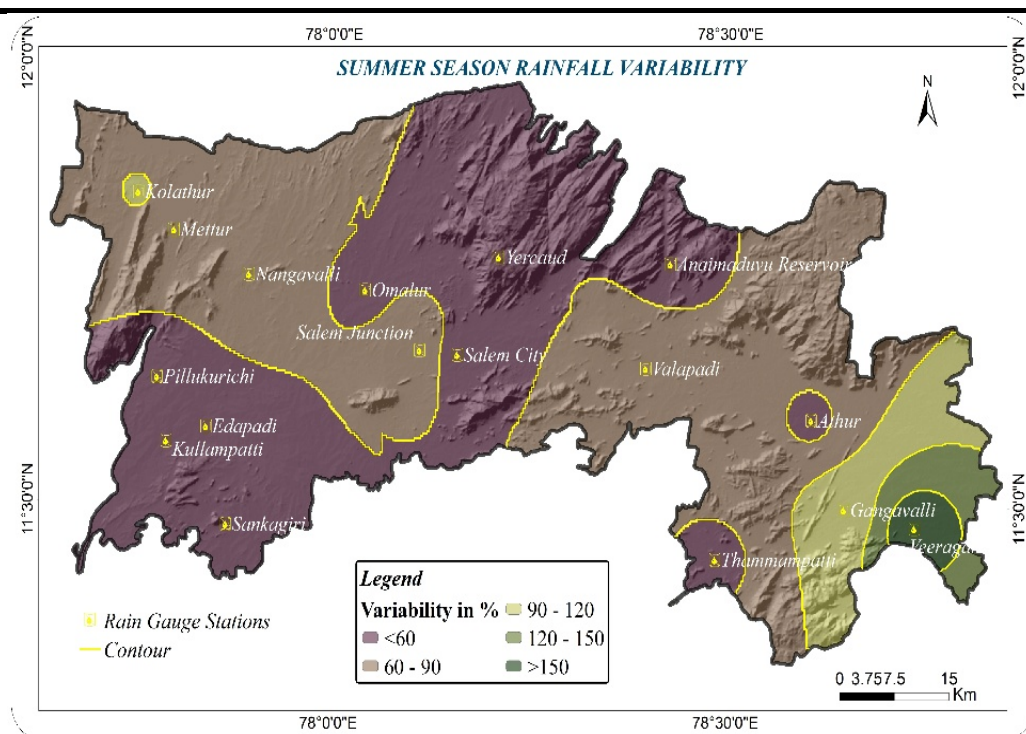


Fig.11: Spatial distribution of summer season rainfall variability

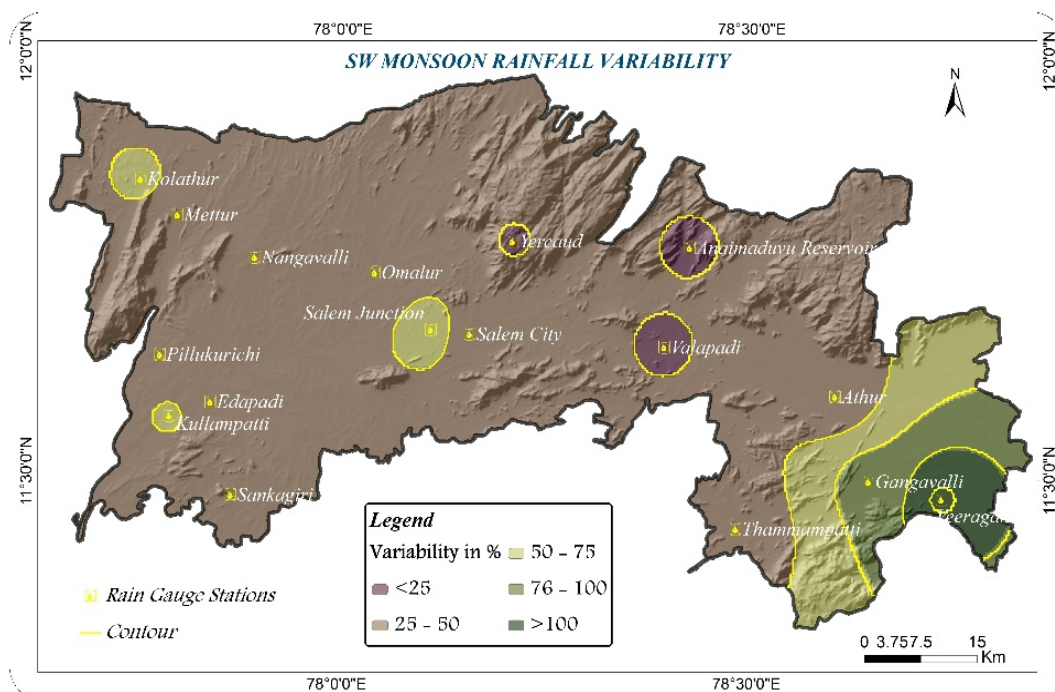


Fig.12: Spatial distribution of SW monsoon rainfall variability

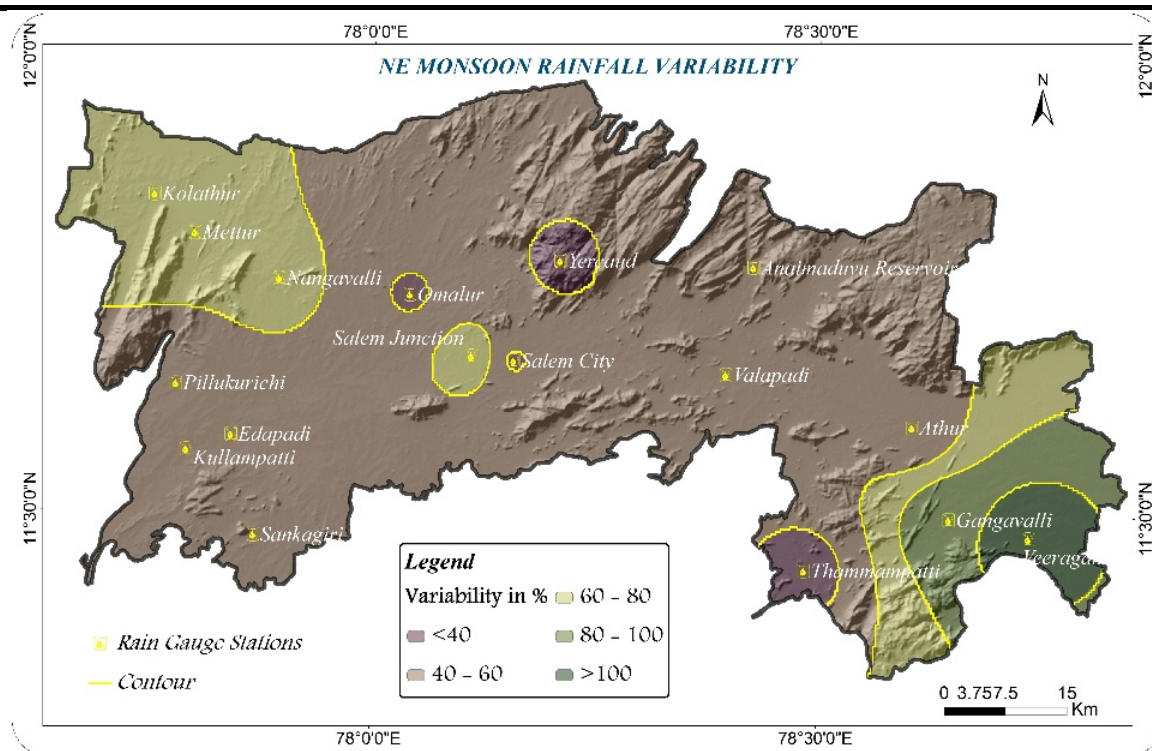


Fig.13: Spatial distribution of NE monsoon rainfall variability

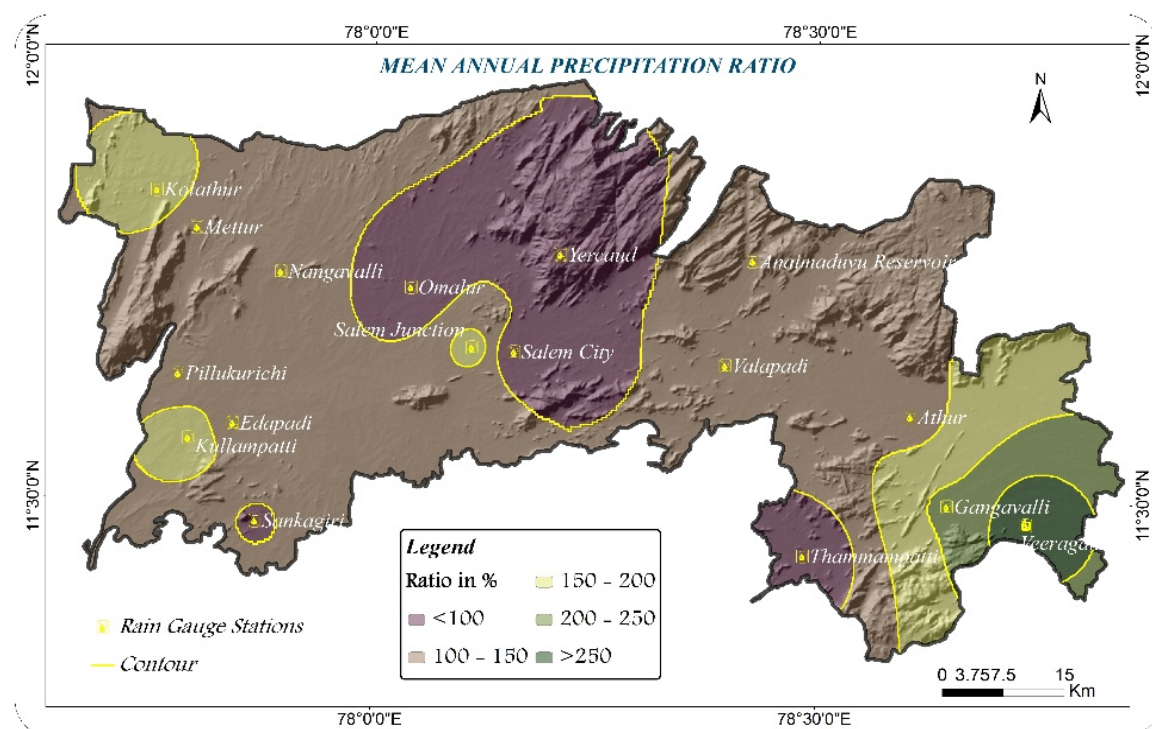


Fig.14: Spatial distribution of mean annual precipitation ratio

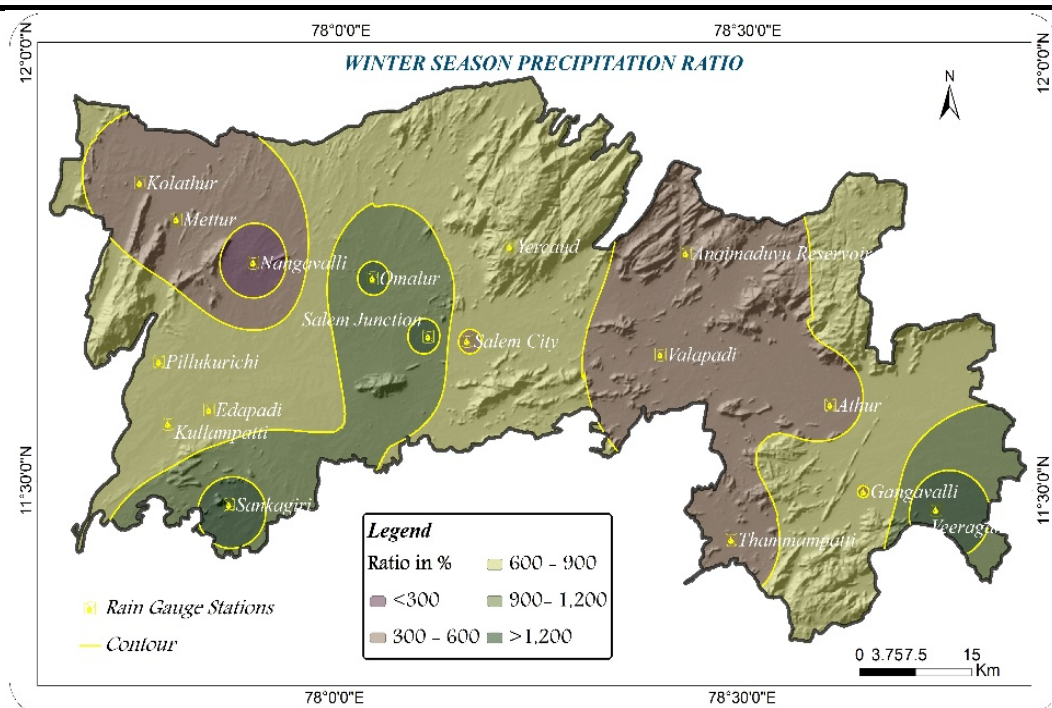


Fig.15: Spatial distribution of winter season precipitation ratio

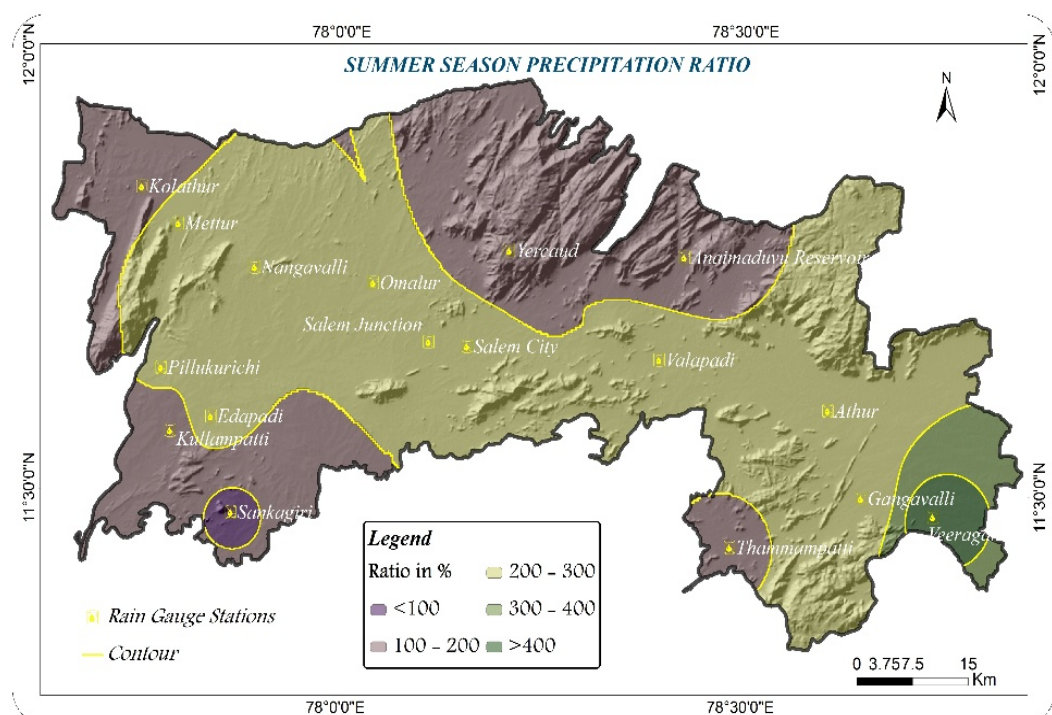


Fig. 16: Spatial distribution of summer season precipitation ratio

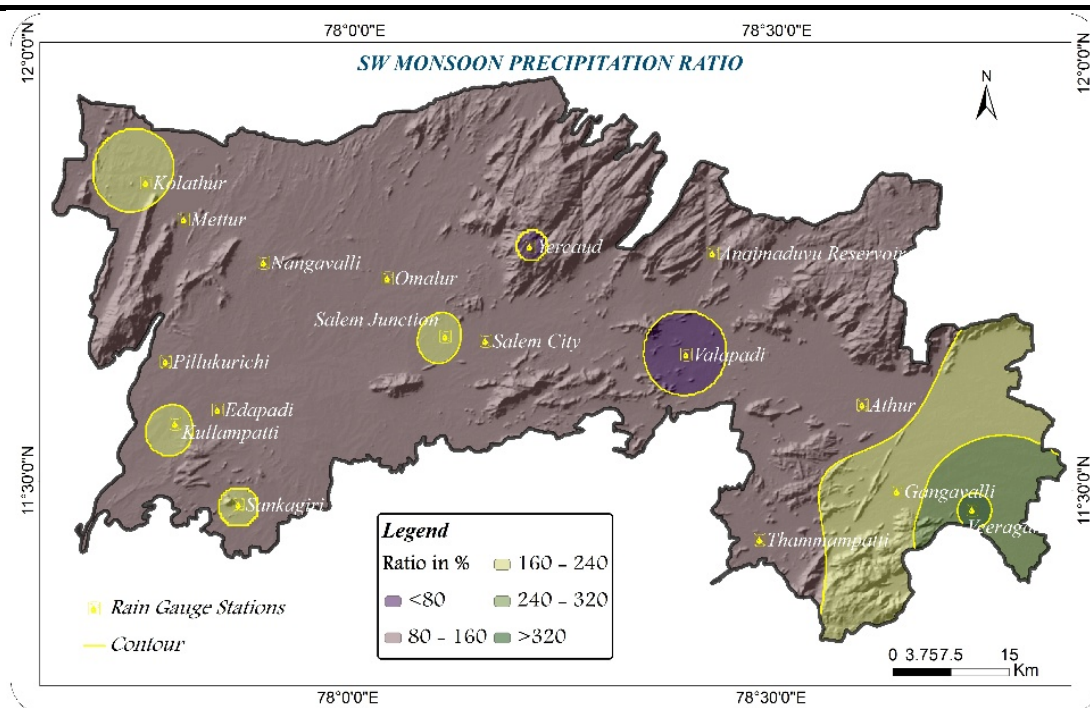


Fig.17: Spatial distribution of SW monsoon precipitation ratio

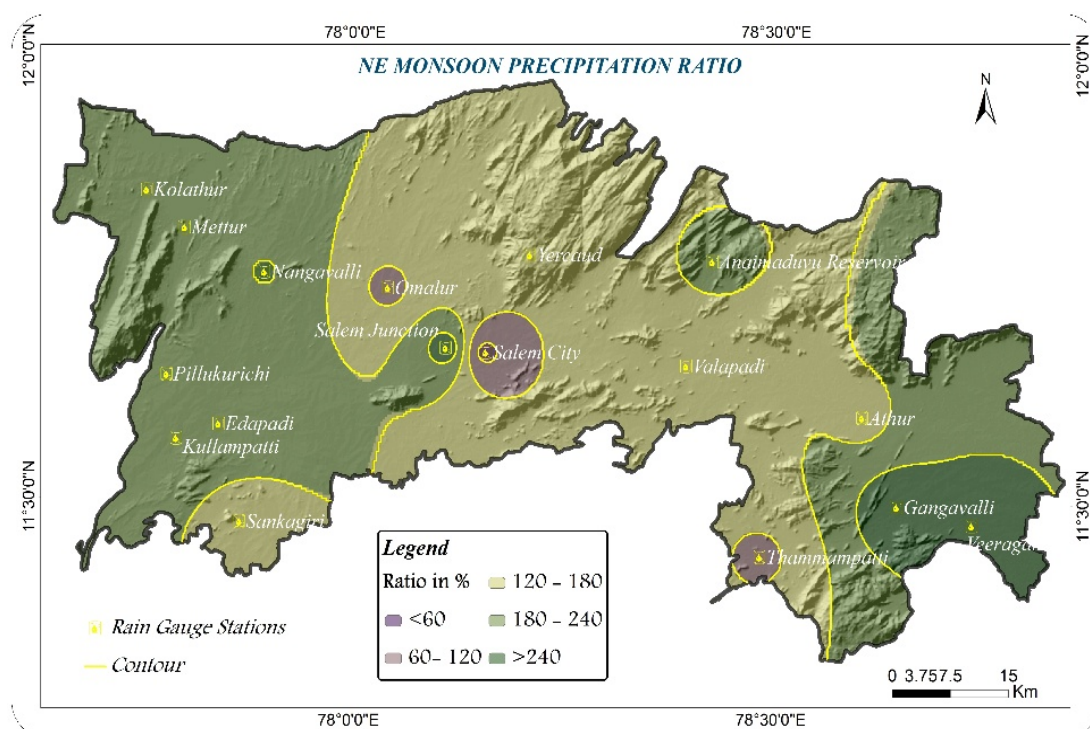


Fig. 18: Spatial distribution of NE monsoon precipitation ratio

Table.1: Annual and seasonal rainfall of the study area

Station	Winter (mm)	Summer (mm)	SW (mm)	NE (mm)	Mean Annual (mm)
Veeraganur	0.8	46.8	91.9	189.8	329.3
yercaud	12.5	264.2	718.9	496.0	1491.5
Thammampatti	6.5	132.3	288.2	448.6	875.6
Valapadi	2.7	119.2	358.5	355.3	835.8
Omalur	4.4	179.8	472.4	316.8	973.3
Pillukurichi	10.1	142.5	240.4	309.2	702.2
Salem	4.6	173.9	464.8	346.8	990.1
Athur	3.9	129.6	359.4	392.0	884.9
Gangavalli	4.9	97.4	144.6	254.9	501.8
Salem Rly	1.7	157.1	288.6	244.2	691.6
Edapadi	8.5	164.1	302.1	259.8	734.4
Kolathur	3.9	175.2	286.1	257.9	723.1
Anaimaduvu-RES.	3.3	160.4	350.5	300.4	814.6
Kullampatti	7.0	183.5	318.4	334.3	843.1
Mettur	5.8	203.9	333.1	366.9	909.7
Nangavalli	0.0	174.7	345.2	327.0	846.9
Sankagiri	4.9	155.9	287.7	282.6	731.2
Average	5.0	156.5	332.4	322.5	816.4
Percentage	1	19	41	39	

Table.2: Results of rainfall variability

Station	Winter %	Summer %	SW%	NE%	Mean annual
Veeraganur	374.2	174.3	128.4	120.4	119.0
yercaud	207.1	47.8	25.1	36.6	19.4
Thammampatti	160.1	52.6	32.3	32.4	19.2
Valapadi	125.6	81.6	22.7	44.0	30.3
Omalur	310.7	58.4	26.7	37.6	23.7
Pillukurichi	198.9	52.9	29.8	57.0	31.8
Salem	163.2	50.9	26.0	37.8	19.9
Athur	164.2	55.3	31.8	42.3	32.7
Gangavalli	180.6	105.7	84.1	100.0	79.7
Salem Rly	330.2	74.1	70.1	75.1	60.6
Edapadi	230.1	60.9	30.8	54.1	34.9
Kolathur	197.9	93.8	56.3	77.0	51.7
Anaimavu-RES	148.3	49.1	24.5	54.6	31.8
Kullampatti	242.5	45.1	53.6	54.9	39.2
Mettur	155.2	60.8	28.4	63.4	71.3
Nangavalli	0.0	71.0	41.8	68.2	40.5
Sankagiri	339.6	49.4	47.8	43.4	28.8
Average	207.6	69.6	44.7	58.8	42.6

Table.3: Results of precipitation ratio

Station	Winter %	Summer%	SW%	NE%	Mean annual%
Veeraganur	1437.5	486.4	330.7	269.9	301.4
yercaud	783.2	143.8	78.4	123.0	71.9
Thammampatti	521.1	180.5	118.6	112.3	54.9
Valapadi	336.4	246.6	62.9	134.7	102.7
Omalur	1250.0	205.5	112.1	107.8	53.7
Pillukurichi	765.9	207.0	102.0	224.3	129.7
Salem	535.6	232.1	101.2	48.1	70.8
Athur	548.7	209.5	99.2	169.9	139.0
Gangavalli	595.9	206.1	232.0	279.0	204.2
Salem Rly	1325.3	226.5	188.3	268.6	170.7
Edapadi	831.4	246.7	110.6	223.4	131.9
Kolathur	576.5	164.8	195.8	235.7	183.4
Anaimavu-RES	484.8	142.1	86.4	191.1	110.5
Kullampatti	828.6	159.2	183.3	240.1	181.3
Mettur	539.1	225.7	83.6	210.8	114.2
Nangavalli	0.0	227.5	100.5	243.1	124.3
Sankagiri	1359.0	70.9	164.0	139.6	96.5
Mean	748.2	210.7	138.2	189.5	131.8