

Rainfall Analysis in Sri Kalahasti Mandal, Chittoor District, Andhra Pradesh, South India Using Statistical Technique

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ABSTRACT: The aim of the present study is statistical analysis of rainfall data of srikalahasti mandal, chittoor district and contains the rain gauge station with a normal rain fall 1084mm. The mandal receives rainfall from winter (19.8 mm.), summer (63.2 mm.) southwest monsoon (412.8 mm.) and the northeast monsoon (655.9 mm.). From the analysis of seasonal rainfall it is found that the mandal receives high rainfall in both southwest and northeast monsoon periods. In the eastern plains of the mandal the rainfall recorded is high in northeast monsoon period.

Keyword: Rainfall Analysis, Winter, Summer Seasons .Rain Fall Intensity Maps

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I. INTRODUCTION

The basic characteristic of drought is absence or severe deficiency of rainfall over a fairly long period. This creates an imbalance between the soil moisture and evapotranspiration needs of an area and causes damage to standing crops and reduction in crop yields. Although several factors are responsible for causing drought situation, the key role is played by rainfall, its distribution and its variation over an area. It is therefore, very necessary to analyse these characteristics of rainfall in order to appreciate the various causes responsible for drought situations as it is one of the drought stricken mandals in the district / state. Hence a study on rainfall pattern over the Chittoor District / Sri Kalahasti Mandal has been made in great detail and discussed in the following paragraph. The geographical features of India play a crucial role in influencing the climate, because they determine the direction of monsoon winds and their intensity. Rainfall in India is mainly dependent, in different degrees, on the southwest and northeast monsoons. Chittoor District and the study area i.e., Sri Kalahasti Mandal gets benefit to some extent both from southwest and northeast monsoons. A brief description of the onset of southwest and northeast monsoons and their influence over the study area is given below. In this season the Sri Kalahasti mandal receives the highest rainfall in the month of October under the influence of northeast monsoon high rainfall occurs along the eastern part in the mandal mainly based on the northeast monsoon. The total mean rainfall of the mandal in this season is 655.9 mm.

1.1 Existing Rain gauge Stations

The study area has a network of seven rain gauge stations for a geographical area of 78244.0 hectares or 80.70 Sq. Km. Thus the density works out to one for an area of 80.70 Sq. Km. Out of the seven raingauge stations, one rain gauge station is well maintained by the India Meteorological Department since the pre-independence period. The remaining eight rain gauge stations are maintained by various agencies like Public Works Department (P.W.D) and Revenue Department, the like. Some stations have continuous data for ten years. So, for the purpose of drawing the isohytes the rainfall data for the neighboring stations of the Mandal were also considered. The list and location of raingauge stations are shown in the Fig.1.1.

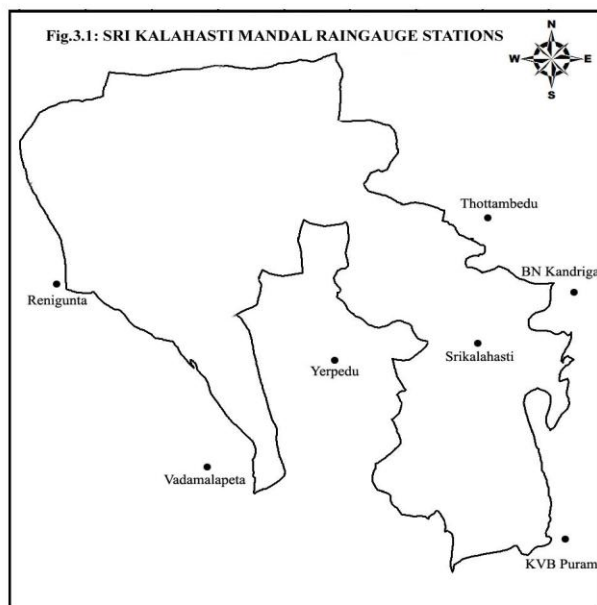


Figure 1.1 Showing Sri Kalahasti Mandal Rain Gauge Stations

II. STUDY AREA

Geographically the study area lies between $13^{\circ}39'7.2''$ N and $13^{\circ}55'26.4''$ N latitudes and $79^{\circ}26'2.4''$ E and $79^{\circ}42'50.4''$ E longitudes and covers a total area of about 407.36 sq.km. The area has a semi-arid climate, which is characterized by hot summer and cold winter. December is the coldest month of the year with the mean maximum and minimum temperature of 30.1°C and 19.9°C respectively. May is the hottest month with a mean maximum temperature of 34.8°C and minimum of 23.9°C . The average annual rainfall of mandal is about 959.6 mm and the mandal receives seasonal rainfall in both southwest and northeast monsoon periods. The eastern plain receives high rainfall during northeast monsoon period due to low pressure forming in the Bay of Bengal. Geologically rocks of Archaean, Proterozoic, tertiary and quaternary ages are exposed in the study area. The formations chiefly composed of a complex assemblage of gneissic variants, granitic rocks with dolerite intrusive, Nagari quartzite's, isolated laterite patches, Cuddapah formations such as Bairenkonda quartzites, Pullampeta shales, slates and recent alluvium deposits.

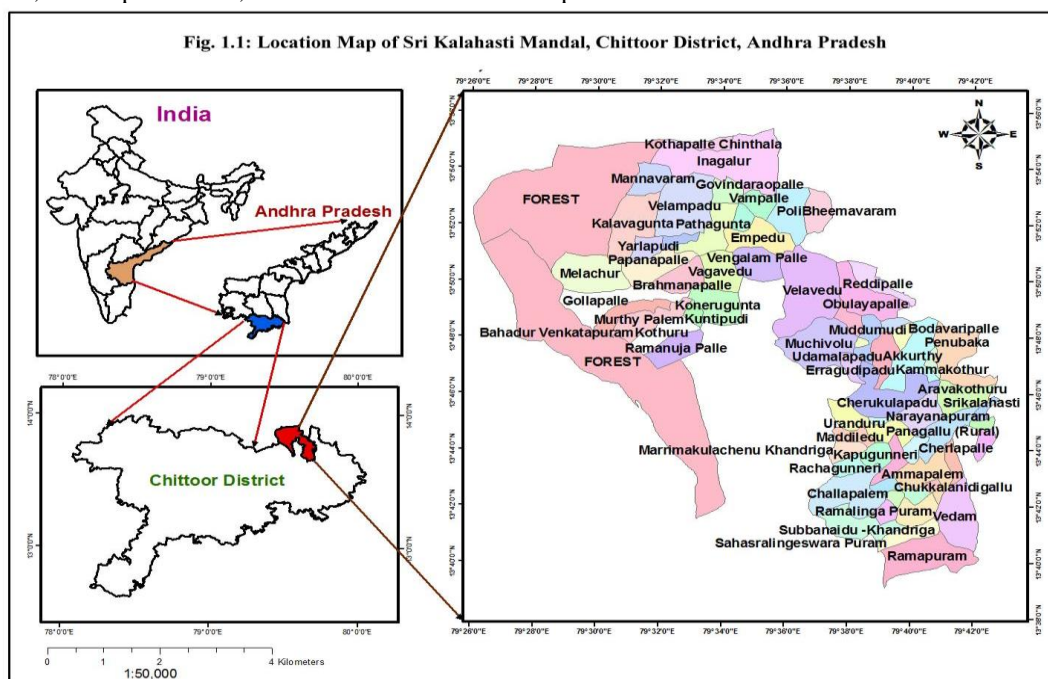


Figure1.2 Location Map Of The Study Area

III. RESULT AND DISCUSSION

3.1 Statistical Techniques Used For Rainfall Analysis:

Normal Rainfall / Mean Rainfall

The Normal rainfall of a station is generally defined as the simple arithmetic mean of rainfall figures for a sufficiently long and reasonable period. In meteorology if this number of individual figures equals to or more than 30 years the mean of these figures is known as "Normal". The formula is

$$\text{Normal Rainfall} = \frac{\sum X}{N}$$

Where X = Variates
 N = Number of variates

The mean rainfall is also defined as a single value that describes the characteristics of the entire mass of unwieldy data of rainfall. Such a value is of great significance because it depicts the characteristics of the whole group and gives a central value of data which is found out using the above formula.

ii) Rainfall Variability

Both standard deviation (S.D) and Co-efficient of Variation (C.V) are of the important statistical parameters used in the analysis of the study area. It was used in the sense to compare the variability of more than two series. That series for which the coefficient of variation is greater is said to be more variable and if it is less, is said to be less variable or more consistent, more uniform, more stable or more homogenous. Coefficient of variation is denoted by C.V and is obtained as follows : (Here after it is referred to as C.V)

$$\text{Co-efficient of Variation or C.V} = \frac{SD}{AM} \times 100$$

Where

SD = Standard Deviation
 AM = Arithmetic Mean

The Co-efficient of variation is always expressed in terms of percentage.

The rainfall variability in Sri Kalahasti Mandal has been the topic of much discussion but comparatively not much analytical work has been accomplished so far. Even though two places may have the same average rainfall, still they may have different crop growth conditions and agricultural potential if they have different variability in rainfall. In any rainfall study, averages should always be accompanied by a statistical parameter that describes its variability. Also in any analysis of variability of rainfall the time and the period considered is important. Expressions of annual, seasonal or even monthly mean and its variability do not give any indication of short period condition which is very important for successful crop production. The variability in weekly rainfall and fortnightly rainfall and monthly rainfall is very high and we cannot make generalizations based on it. In view of the above, seasonal rainfall was selected for the study of distribution of rainfall and its co-efficient of variation. It is known that variability decreases with the increase in precipitation. Also for the same series of years the variability of rainfall is generally lower on an annual basis than on monthly basis. The variability of seasonal rainfall is generally the intermediate between these two. The erratic nature of rainfall with reference to C.V. is generally identified on the basis of the following assumptions by the India Meteorological Department.

- (a) If C.V. is equal to or more than 50 per cent in monthly values and
- (b) If C.V. is equal to or more than 30 per cent in seasonal and annual values.
- (c)

iii) Intensity of Rainfall

Rainfall intensity is defined as the rate at which rainfall occurs expressed in depth units per unit time, usually millimeters (mm) per hour. As the seasonal rainfall data have been considered for the analysis the intensity of rainfall has been expressed in terms of mm per a rainy day.

The formula denotes :

$$\text{Intensity} = \frac{\text{Mean rainfall}}{\text{Average number of rainy days}}$$

iv) Rainfall Ratio

The rainfall ratio denotes the abnormalities in the occurrence of rainfall at any location. The rainfall ratio of a station can be analysed by the formula.

$$\text{Rainfall Ratio} = \frac{P_x - P_n}{P_m} \times 100$$

Where,

‘Px’ and ‘Pn’ represent maximum and minimum rainfall amounts over a series of years, ‘Pm’ is the average rainfall. Higher values of ratio indicate higher abnormalities and lower values denote greater stability of rainfall.

Table No - 3.1 Sri Kalahasti Manda Particulars of Rainfall in Winter Season

S. No.	Name of the Raingauge Station	Mean Seasonal Rainfall (mm)	Average No. of Rainy days	Rainfall Intensity (mm)	Rainfall Variability (%)	Rainfall Ratio (%)
1	B N Khandriga	30.8	1.73	17.8	55.7	164.7
2	K V B Puram	21.6	1.13	19.1	34.9	48.4
3	Renigunta	6.3	0.39	16.1	11.3	15
4	Srikalahasti	19.7	0.92	21.4	30.5	64
5	Thottambedu	21.7	1.02	21.3	33.9	65
6	Yerpedu	17.7	0.93	19.1	22.5	54
7	Vadamala Pet	20.9	1.27	16.4	33.3	88
	Srikalahasti Mandal	19.8	0.92	18.7	31.7	71.3

3.2 Description of Winter Rainfall

From the above table analysis of mean seasonal rainfall in the study area in winter it is evident that varies from minimum at 6.3 mm in Renigunta in the western part of the study area to a maximum at 30.8 mm In Bhuchinaidu Kandriga in eastern part of the study area. The normal rainfall being 19.8 (table.3.1), the spatial distribution of rainfall in the study area depicts that it is reducing from south east to north west. The average no. of rainy days ranges from a minimum of 0.92 in Sri Kalahasti to maximum of 1.73 mm in Bhuchinaidu Kandriga, the normal is 0.92, the intensity of rainfall I the study area reveals that it varies from a minimum of 16.1 mm, for a rainy days in Renigunta to a maximum of 21.4 mm per a rainy day in Sri Kalahasti, the normal intensity of the study area is 1807 mm per a rainy day. The spatial pattern of intensity in the study area shows that it is more southeastern part of the study area, then in the western part (Fig. 1

2). From the study and analysis of co-efficient of variability in the mandal, it is discernible that it ranges from a minimum of 11.3% in Renigunta to a maximum of 55.7% in Bhuchinaidu Kandriga, the normal variability of the study area is 31.72%, which shows the erratic nature of rainfall. The spatial pattern of variability in the study area shows that in the western part it is less variable than in the remaining part of the study area. The rainfall ratio or the abnormalities in the occurrence of rainfall in the study area is ranging from a minimum of 15% in Renigunta to a maximum of 164.7% in Bhuchinaidu Kandriga, the normal ratio in winter is 71.3%, the spatial distribution of rainfall ratio in this study area shows that the eastern part shows more abnormality than the remaining part of the study area.

Fig.3.2: SRI KALAHASTI MANDAL WINTER RAINFALL

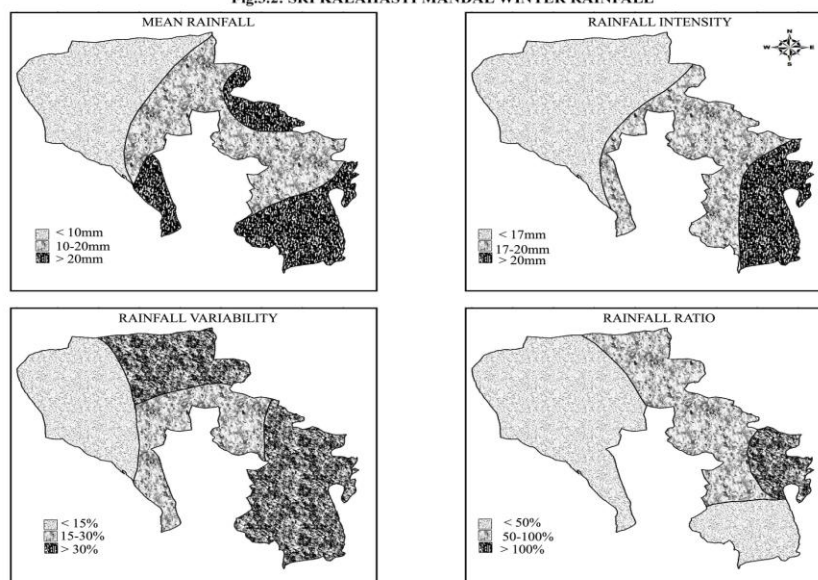


Table No – 3.2 Sri Kalahasti Mandal Particulars of Rainfall in Summer Season

S. No.	Name of the Raingauge Station	Mean Seasonal Rainfall (mm)	Average No. of Rainy days	Rainfall Intensity (mm)	Rainfall Variability (%)	Rainfall Ratio (%)
1.	B N Khandriga	63.1	2.5	25.6	66.4	165.7
2.	K V B Puram	70.0	2.6	26.9	49.1	107.7
3.	Renigunta	91.2	3.7	25.0	68.2	227.6
4.	Srikalahasti	58.9	2.8	20.8	47.4	131.8
5.	Thottambedu	57.1	2.5	22.5	56.1	168.4
6.	Yerpedu	77.3	3.0	25.8		252.1
7.	Vadamala Pet	94.9	4.1	23.3	73.4	161.7
	Srikalahasti Mandal	63.2	3.2	24.2	52.6	173.5

3.3 Description of Summer Rainfall

From the above table study of mean seasonal rainfall in summer it is found that the rainfall ranges from a minimum of 57.1 mm Thottambedu to a maximum of 94.9 mm in Vadamala Peta, the normal being 63.22 mm (table no.3.2). the spatial distribution shows that the rainfall is more in the western part of then in eastern part, the average number of rainy days in the study area ranges from a minimum of 2.5in Thottambedu to a maximum of 4.1in Vadamala Peta, the normal being 3.02. The rainfall intensity shows that it ranges from a minimum of 20.8 per a rainy days in Sri Kalahasti to a maximum of 26.9 per rainy days in K.V.B. Puram. The normal is 24.2 mm per a rainy days. Spatial pattern shows that in the southern part are more than in the remaining parts.

The rainfall variability shows that it varies from a minimum of 47.1% in the Sri Kalahasti to a maximum of 81.7% in Yerpedu, the study area average is 52.65% which shows the erratic of rainfall. The spatial distribution shows that in the western part are more and southern parts are less rainfall (Fig. 1.3), the rainfall ratio in the study area ranges from a minimum of 131.8% in Sri Kalahasti to a maximum of 227.6% in Renigunta, the normal being 173.5%. The spatial pattern shows that the abnormality in the occurrence of rainfall is increasing from south to northwest.

Fig.3.3: SRI KALAHASTI MANDAL SUMMER RAINFALL

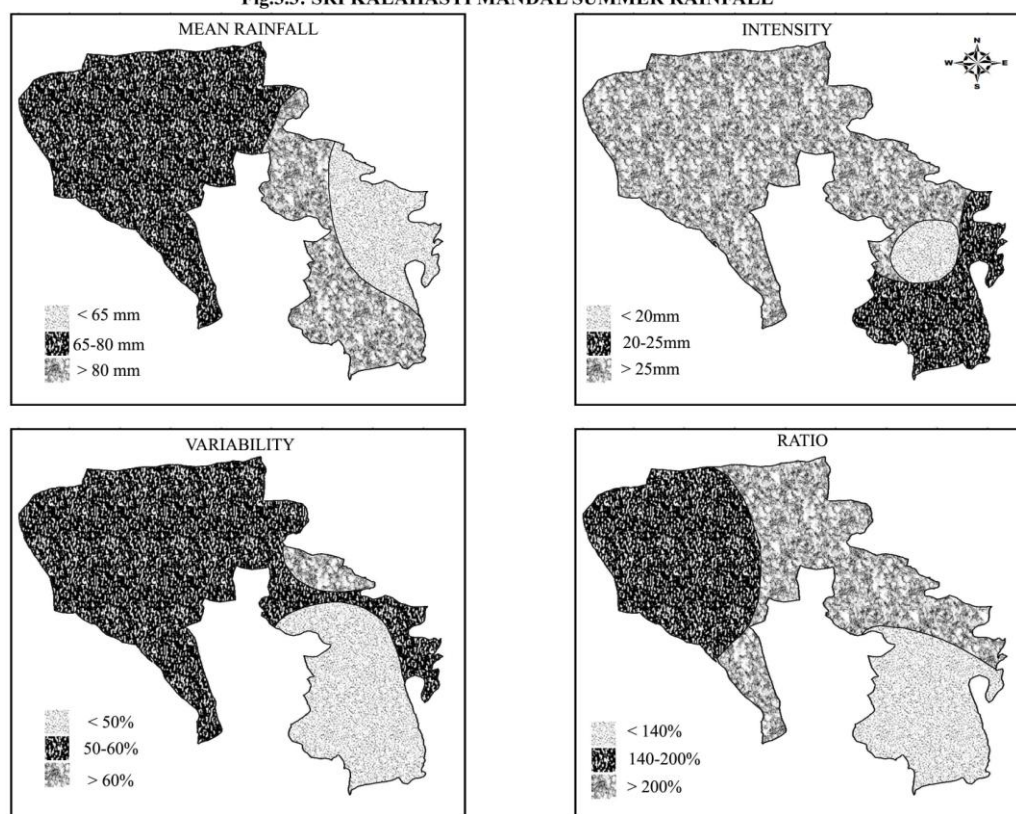


Table No - 3.3Sri Kalahasti Mandal Particulars of Rainfall in Southwest Monsoon Season

S. No.	Name of the Raingauge Station	Mean Seasonal Rainfall (mm)	Average No. of Rainy days	Rainfall Intensity (mm)	Rainfall Variability (%)	Rainfall Ratio (%)
1	B N Khandriga	345.0	15.0	23.0	113.6	515.2
2	K V B Puram	360.8	15.4	23.4	93.5	440.6
3	Renigunta	444.7	17.5	25.4	267.2	773.3
4	Srikalahasti	457.1	16.7	27.4	188.6	674.4
5	Thottambedu	441.1	16.3	27.1	207.3	715.8
6	Yerpedu	410.6	15.1	27.3	167.5	648.6
7	Vadamala Pet	430.6	14.7	29.3	171.5	698.5
	Srikalahasti Mandal	412.8	15.8	26.1	172.7	638.0

Source: Computed from the data collected.

3.4 Description of Rainfall in South west monsoon

The southwest monsoon and northeast monsoon seasons are the principal rainy seasons of the study area. As the study area lies very near from 45 km from the bay of bangle coast. The normal rainfall in this area is more consistent, more in increasing and less variable. From the study and analysis of rainfall in this season, it is experiential by that the normal rainfall ranges from a minimum of 345. Mm in Bhuchinaidu Kandriga to a maximum of 457.1 in Sri Kalahasti, the normal being 412.8 mm. the spatial of rainfall shows that it is high in central part of low rainfall in the southern part and medium in northern parts of the study area.

The average no. of rainy days in this study area ranges from a minimum of 14.7 in Vadamala Peta to a maximum of 17.5 in Renigunta, the normal being 15.8 (table 3.3). The rainfall intensity shows that it ranges from a minimum of 23.0 mm per a rainy day in Bhuchinaidu Kandriga to a maximum of 29.3mm per a rainy day in Vadamala Peta, the normal is 15.8mm per a rainy days. The spatial pattern shows that it central parts are more than remaining areas. The rainfall variability shows that it varies from a minimum of 93.5% in K V B Puram to a maximum of 267.2% in Renigunta, the normal being 26.1%. The spatial distribution shows that it is increasing from western and eastern part to remaining parts of the study area (Fig. 1.4).

The rainfall ratio in the study area ranges from a minimum of 440.6% in K. V.B. Puram to a maximum of 773.3% in Renigunta, the normal is 638.5%. The spatial pattern shows that the abnormality in the occurrence of rainfall is increasing from northwest to southern part of the study area.

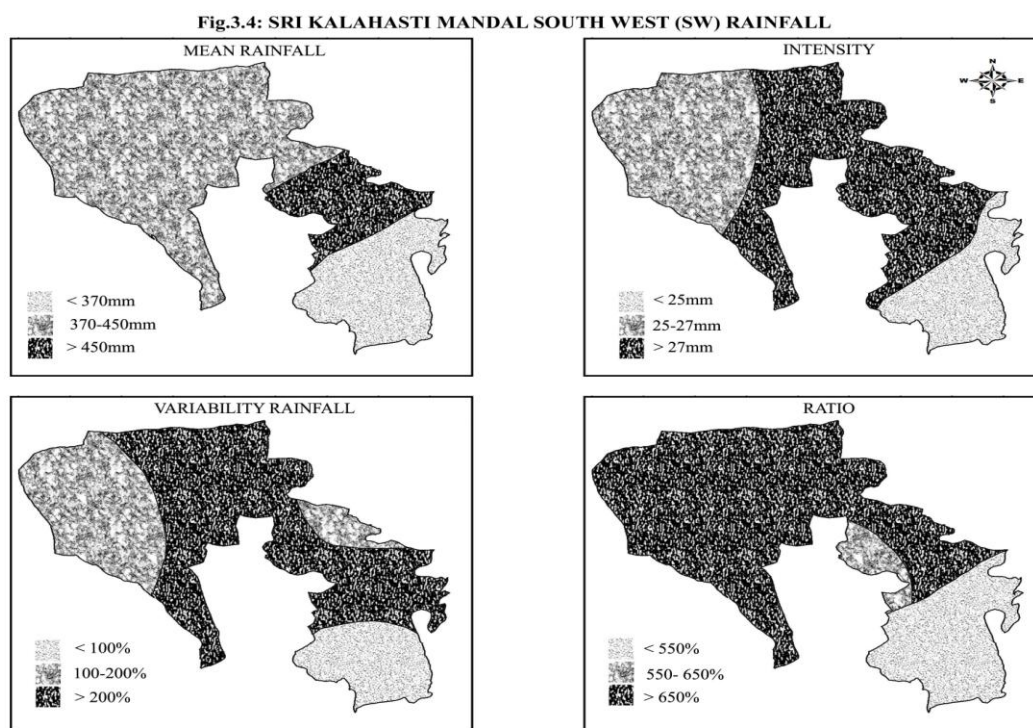


Table No -3. 4Sri Kalahasti Mandal Particulars of Rainfall in Northeast Monsoon Season

S. No.	Name of the Raingauge Station	Mean Seasonal Rainfall (mm)	Average No. of Rainy days	Rainfall Intensity (mm)	Rainfall Variability (%)	Rainfall Ratio (%)
1	B N Khandriga	715.7	19.3	37.1	380.4	1610.6
2	K V B Puram	540.0	16.5	32.8	315.7	1283.4
3	Renigunta	516.4	17.3	29.9	333.5	1205.4
4	Srikalahasti	791.4	20.6	38.4	341.8	1500.1
5	Thottambedu	782.0	21.3	36.7	331.5	1464.5
6	Yerpedu	687.1	20.8	33.1	315.1	1334.7
7	Vadamala Pet	630.7	18.8	33.5	356.0	1446.1
	Sri Kalahasti Mandal	655.9	19.2	34.5	291.7	1406.4

Source: Computed from the data collected.

3.5 Description of Rainfall in Northeast monsoon

From the study of analysis of mean seasonal rainfall in the northeast monsoon in the mandal. It is observed that it ranges from a minimum of 516.4mm in Renigunta to maximum of 791.4mm in Sri Kalahasti, the average being 655.9mm. The spatial pattern shows that it is more in eastern part than in the north western part at the study area. The average number at rainy days ranges from a minimum at 16.5 in KVB to a maximum at 20.8 in Yerpedu. The average is 19.2 (Table No.3.4).

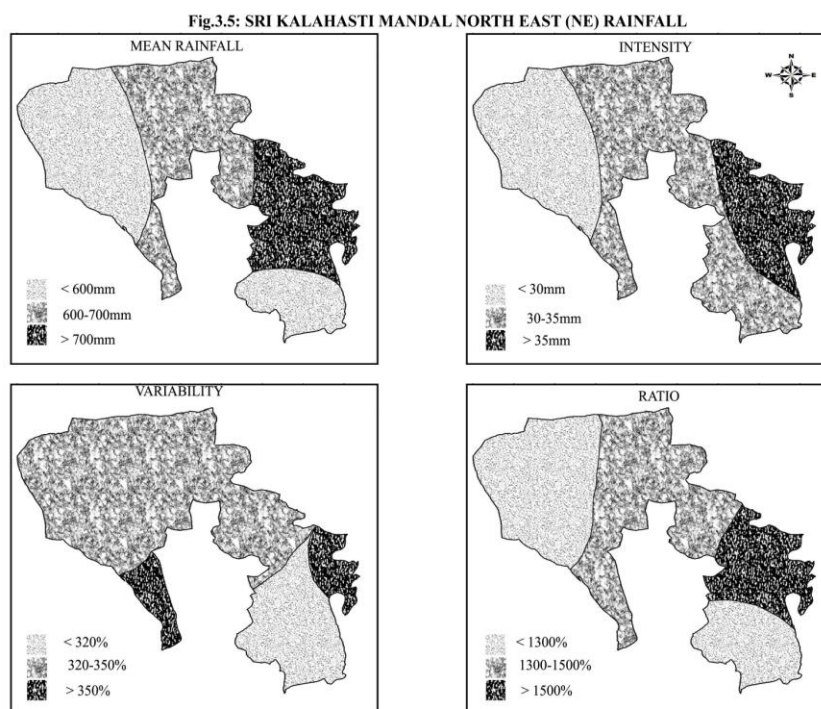
The rainfall intensity of the mandal ranges from a minimum of 29.9 mm for a rainy days in Renigunta to a maximum of 38.4 mm for a rainy days in Sri Kalahasti, the average being 34.5 mm for a rainy day. The spatial pattern shows that the intensity has been decreasing towards North West (Fig. 1.5).

The rain fall variability of the study area ranges from a minimum of 315.1% in Yerpedu to a maximum of 380.4% in the Bhuchinaidu Kandriga, the average being 291.78%. The spatial pattern shows that it is more in the parts of North western part than in the Southern part of the study area. The rain fall ratio ranges from a minimum of 1205.4% in Renigunta to a maximum of 1610.6% in Bhuchinaidu Kandriga, the average being 1406.4%. The spatial distribution shows that the abnormality in the distribution of rain fall is more in the Eastern part than in the North-Western and southern parts of the study area.

Table No 4Sri Kalahasti Mandal Particulars of Annual Rainfall

S. No.	Name of the Raingauge Station	Mean Seasonal Rainfall (mm)	Average No. of Rainy days	Rainfall Intensity (mm)	Rainfall Variability (%)	Rainfall Ratio (%)
1	B N Khandriga	939.3	38.1	24.6	365.1	122.5
2	K V B Puram	815.8	37.7	21.6	340.2	139.2
3	Renigunta	963	41.1	23.4	354.8	142
4	Srikalahasti	1080.1	45.3	23.8	410.3	119.4
5	Thottambedu	1068.3	45.9	23.2	392.9	114.4
6	Yerpedu	891	43.6	20.4	331.3	115.6
7	Vadamala Pet	960	47.2	20.3	432.0	137.1
	Sri Kalahasti Mandal	959.6	42.7	22.4	375.2	127.1

Source: Computed from the data collected.



IV. CONCLUSION

Climate is not so favorable for the development of land, water and agricultural resources. The mandal falls under the Semi-arid zone of South India due to its peculiar geographical location and diversified physical conditions. Temperature is as high as 34.1°C and the normal annual rainfall is 959.6 mm. The mandal receives rainfall from winter (19.8 mm.), summer (63.2 mm.) southwest monsoon (412.8 mm.) and the northeast monsoon (655.9 mm.). From the analysis of seasonal rainfall it is found that the mandal receives high rainfall in both southwest and northeast monsoon periods. In the eastern plains of the mandal the rainfall recorded is high in northeast monsoon period. It is presumed that owing to the formation of low pressure in Bay of Bengal during this monsoon, the rainfall received is high in this part of the mandal.

In winter, the rainfall recorded in the mandal is low i.e. 19.8 mm. However, in winter and summer, it varies from moderate to high instability. Hence, it is erratic in nature (Coefficient values varies from 31.7 per cent in winter to 52.6 per cent in summer). The value of rainfall ratio shows that in southwest monsoon and northeast monsoon periods there is greater stability in the rainfall distribution in the mandal. (Coefficient values ranges from 172.7 per cent in southwest monsoon to 291.7 per cent in northeast monsoon).

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