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Rainfall variation and frequency analysis study of Salem district Tamil Nadu

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Average rainfall and rainy days in Salem district during 32 years were calculated as 945.7mm and 52 days. Highest monthly rainfall 167.9mm occurred in September mostly during the south west monsoon and the highest rainy days were observed in October (8.44 days). Rainfall occurred in southwest monsoon, north east monsoon, winter and summer were 450.4, 324.2, 6.5, and 164.6 respectively. Rainfall frequency analysis revealed that the average annual rainfall of 890.80 mm can be expected to occur once in 2.5 years with a probability of 40%. Monthly dependable rainfall is expected to occur every year from August to October. Based on the results the soil and water conservation structures, crop planning and management can be designed.

[Keywords: Rainfall, rainfall variability, frequency analysis, Weibull distribution]

Introduction

Salem district receives the rain under the influence of both southwest and northeast monsoons. Southwest monsoon chiefly contributes to the rainfall in the district.

The rainfall frequency analysis of Salem district can be reasonably carried out using conventional methods where the data are available as compare to the desired return periods. For proper planning of water resources the knowledge of frequency of recurrence of extreme rainfall events are very important. The probability distributions were used to understand the rainfall distribution. Considering all these importance, a study on rainfall distribution and frequency of Salem district, Tamilnadu was conducted for proper design of soil and water conservation structures, crop planning and irrigation management.

Materials and Methods

Salem district is located between 11^{o}14' and 12 ^{o}53'N and 77 ^{o}44' and 78 ^{o}50'E. The total geographic area of the district is 5245 Km^{2}. Major agriculture in this district is paddy, groundnut, fodder, sugarcane etc. Salem district is drained by tributaries of Cauvery and velar rivers. The district receives rain under the influence of both southwest and northeast monsoons. Normal annual rainfall over the district varies from 800 to 1600 mm. Onset and withdrawal of southwest monsoon is from June to September and October to December.

Tamilnadu Water and Drainage Board (TWAD) is the principle organization which is responsible for all hydro meteorological data for Tamilnadu. Rainfall data for a period of 32 years (1982 to 2013) were collected from the TWAD board and was analyzed for annual, monthly and weekly rainfall.

Frequency analysis is used to predict how often certain values of a variable phenomenon may occur and to access the reliability of the prediction. Precipitation is most important and complex phenomena for rainfall frequency analysis over an area. Rainfall is a random hydrologic process and when arranged in a chronological order, it constitutes the time series of rainfall data. The studies have also been carried out to analyze rainfall data using Markov chain model for identifying appropriate cropping systems in different regions (Cosmo et al., 2011; Virmani et al., 1982; Khichar et al., 2000; Viswakharma et al., 2000; Dabral and Jhajharia, 2003) and eight two parameter distribution functions were studied for sub humid conditions (Sharda and Das, 2005).

The probability of each event is calculated by Weibull's method (Chow, 1964)

$$P = \frac{M}{N+1} \quad -----(1)$$

Where,

P - is the probability of each event in percent

M- is the order number of the each event when the data are arranged in decreasing order

N- is the total number of events in the data series

The return periods (recurrence interval) were calculated by using the formula

$$Return\ Period, T = \frac{1}{P} = \frac{N+1}{M} \quad -----(2)$$

Results and Discussion

Table 1 shows yearly rainfall for 32 years started from 1982 to 2013. Maximum and minimum rainfall occurs in 1992 (1632.8mm) and 1984 (276mm) with 41 and 17 rainy days. Average rainfall for the 32 years was found to be 945.7mm. 17 years (53mm) received rainfall above average were observed.

The average annual rainy days were 52 and the maximum and minimum rainy days observed were 71 days (1996) and 17 days (1984). No specific trend was observed, however the rainy days were above average during 18 years. Although a linear relationship occurs between the amount of rainfall and rainy days, however the maximum rainfall does not occur in the corresponding rainy days, due to heavy rain that occurred on a single day during monsoon season.

The maximum rainfall 167.9mm was occurred in the month of September during southwest monsoon season. Minimum rainfall of 2.08 was received in January during winter season Figure 1. Maximum rainfall 450.4mm occurred in the month of June to September during southwest monsoon and the minimum rainfall of 6.51mm were received by January and February during winter season. Annual monthly and mean monthly rainfall was 945.7mm and 78.8mm and the months January and February received below the mean. 6.5, 164.6, 324.97, 450.4mm rainfall were received during winter, summer, northeast and southwest monsoons respectively (Figure 2).

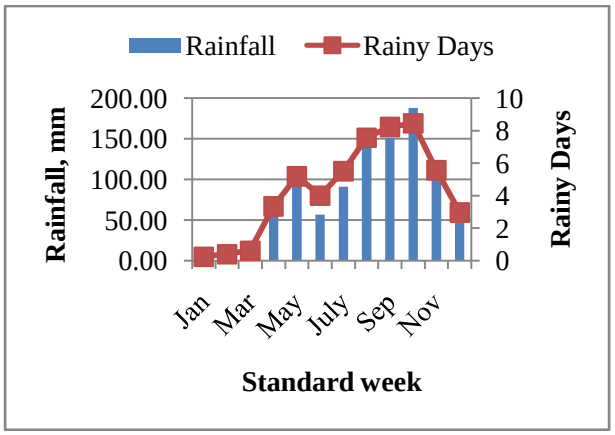

Figure 1. Mean monthly rainfall & rainy days for the period of 1982 to 2013

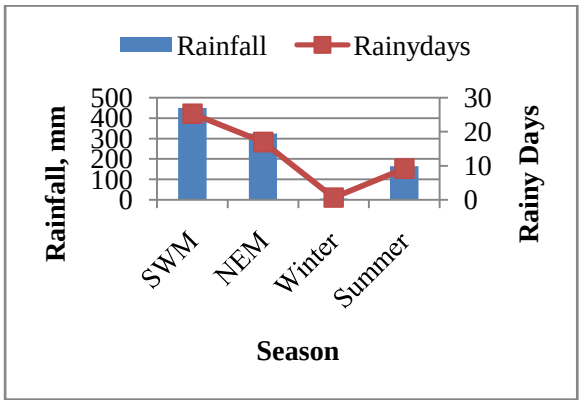

Figure 2 Seasonal distribution of rainfall and rainy days

It was observed that the variations in weekly rainfall showed reductions in rainfall up to 13th week. There after rainfall showed an increasing trend and gradually starts decreasing from the 45th week to 52nd week. Maximum weekly rainfall was recorded in the 38th week (44.2 mm) followed by 39th week (43.1 mm). No rainfall was received in the 4th week. More than 36 weeks (69 %) received rainfall higher than the average weekly rainfall 27.8 mm. It was observed that the weekly rainy days moves up and down and reaches the maximum in 38th week. The weekly rainfall was classified in to 6 classes and number of weeks under each classes are shown in Table 2. It can be observed that most of the weeks the rainfall is less than 20 mm (85 %) (Figure 3).

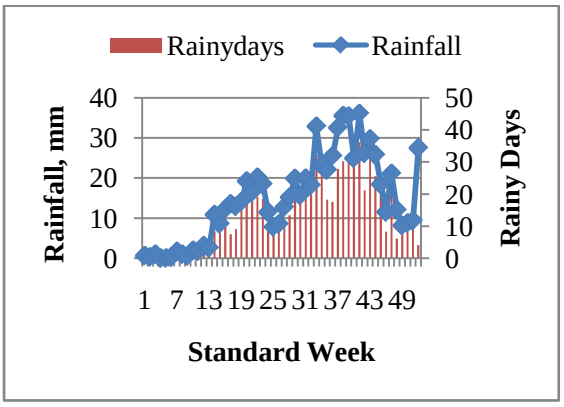

Figure 3 Mean weekly rainfall & rainy days for the period of 1982 to 2013

Weibull method was used to analyze the frequency analysis of the 32 years rainfall data. It is revealed that an annual rainfall of 890.8mm can be expected to occur once in 2.5 years at a probability of 40% Figure 4. The monthly dependable rainfall (with a probability >75 percent) is expected to occur in every year during the month of May with higher accumulation during August to October Table 3.

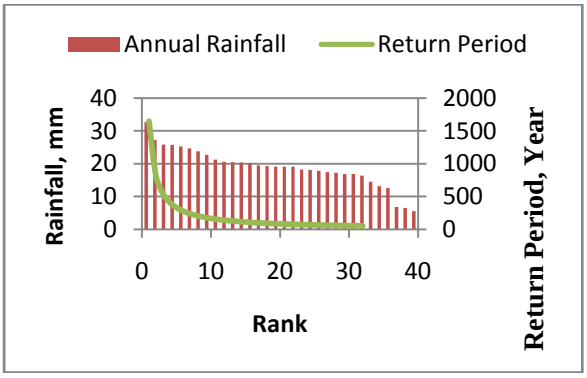

Figure 4 Probability analysis of annual rainfall for the period 1982 – 2013

Table 1 Annual rainfall and rainy days for the period of 1982-2013

Year	Annual Rainfall	Annual Rainydays	One day maximum rainfall
1982	909.8	61	58.6
1983	1261.4	60	91.4
1984	276.0	17	39.0
1985	1021.5	62	87.2
1986	818.2	59	53.2
1987	977.9	62	81.4
1988	1023.1	54	98.8
1989	627.5	39	63.0
1990	862.6	53	171.8
1991	728.5	32	78.0
1992	1632.8	41	90.0
1993	329.2	24	46.8
1994	908.7	51	61.8
1995	873.3	50	70.6
1996	1294.1	71	85.3
1997	968.0	65	82.2
1998	1136.7	60	119.3
1999	841.6	45	61.2
2000	1288.7	61	108.8
2001	1062.7	58	102.2
2002	659.3	42	49.2
2003	957.3	57	53.2
2004	1232.2	68	103.6
2005	1359.9	67	105.6
2006	1028.5	57	60.8
2007	893.2	52	72.7
2008	957.8	50	94.1
2009	842.2	52	80.5

2010	1190.2	67	97.6
2011	955.9	56	54.8
2012	1003.4	52	137.5
2013	340.7	21	49.3

Table 2 Number of Weeks under different amount of rainfall (mm)

Year	>=0	> 20	> 40	> 60	> 80	> 100
1982	37	7	3	2	2	1
1983	34	4	5	3	3	3
1984	44	5	3	0	0	0
1985	37	7	2	3	1	2
1986	35	11	2	3	1	0
1987	52	0	0	0	0	0
1988	38	6	3	1	3	1
1989	41	6	1	3	0	1
1990	40	5	3	2	1	1
1991	43	2	3	1	1	2
1992	41	4	3	2	0	2
1993	46	2	3	1	0	0
1994	37	4	5	4	1	1
1995	35	9	4	3	1	0
1996	34	7	1	3	3	4
1997	36	9	2	3	0	2
1998	36	6	3	1	4	2
1999	38	7	3	1	3	0
2000	33	10	2	1	3	3
2001	36	9	2	2	0	3
2002	42	5	2	2	0	1
2003	39	4	4	2	1	2
2004	33	6	6	3	2	2
2005	32	7	5	2	2	4
2006	38	7	2	1	0	4
2007	38	6	4	0	1	3
2008	40	4	3	2	0	3
2009	40	4	3	2	2	1
2010	34	6	5	3	1	3
2011	37	7	4	0	2	2
2012	39	6	1	3	1	2
2013	46	2	3	1	0	0
Total	**1231**	**184**	**95**	**60**	**39**	**55**
Mean	**38.46875**	**5.75**	**2.96875**	**1.875**	**1.21875**	**1.71875**

Table 3 Monthly Rainfall probability (P) and Return Period(T)

Rank	T	P	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	33	3	35.3	36.3	74.3	160	349	179	224	384	248	133	119	231
2	16.5	6.1	11.8	24.8	54.2	159	257	166	198	240	379	351	292	167
3	11	9.1	8	23	30.4	149	168	140	190	234	338	309	269	140
4	8.25	12.1	3.5	17.9	23.2	148	164	132	154	221	331	291	232	135
5	6.6	15.2	3.3	17	21.6	87	158	115	154	221	321	278	182	102
6	5.5	18.2	2.6	12.9	20.4	85.9	149	112	136	212	304	277	147	95.6
7	4.71	21.2	1.5	4.7	17.8	81	147	87.2	132	200	298	270	145	87.2
8	4.13	24.2	0.4	2.6	14.9	75.4	139	83.6	109	191	267	257	135	85.6
9	3.67	27.3	0.3	1.8	13.5	74	128	80.2	108	176	242	247	135	66.1
10	3.3	30.3	0	0.5	12.5	73.2	113	77.7	108	176	232	237	122	53
11	3	33.3	0	0	10.2	71.8	111	70.9	105	165	185	200	121	42.2
12	2.75	36.4	0	0	7.8	69.4	108	70	105	164	172	189	113	40.4
13	2.54	39.4	0	0	6.3	66.4	108	67.7	105	162	163	189	106	31.7
14	2.36	42.4	0	0	6	65.3	107	64	87.8	153	162	185	105	29.8
15	2.2	45.5	0	0	5.7	64	106	61.1	85.1	129	160	179	92.9	25.9
16	2.06	48.5	0	0	2.4	54.4	102	59.2	82	127	150	160	91.2	21.9
17	1.94	51.5	0	0	1.9	52.3	87.1	55.3	81.6	119	138	146	78.1	20.8
18	1.83	54.5	0	0	1.4	47.6	82	52	79.3	110	135	140	70.8	16.7
19	1.74	57.6	0	0	0.2	45.8	69	49.7	74.4	109	132	133	70.7	15.2
20	1.65	60.6	0	0	0	44.8	67.6	37.7	71.8	108	131	131	70	12.7
21	1.57	63.6	0	0	0	39.7	63.7	37.2	68.3	99	130	122	62.8	12
22	1.5	66.7	0	0	0	32.4	59.9	36.2	66.4	78.9	125	121	62.4	11
23	1.43	69.7	0	0	0	32.4	38.8	29.8	55.1	78.7	122	92.4	58.8	9.9
24	1.38	72.7	0	0	0	32.4	37.9	25.1	54	76	116	87.7	37	6.2
25	1.32	75.8	0	0	0	20.6	36.8	24.9	50.4	72.3	111	70.6	34.8	5.6
26	1.27	78.8	0	0	0	16.7	27.9	24.4	49.3	56.2	89	69.7	32.6	4.2
27	1.22	81.8	0	0	0	13.8	27.1	24.2	44.7	51	83.6	64.8	32	3.6
28	1.18	84.8	0	0	0	13.6	23.8	21.3	37.2	43.2	73.3	58.9	10.2	2.5
29	1.14	87.9	0	0	0	9.8	10	10.7	31	23.6	36	56.8	9.3	1.5
30	1.1	90.9	0	0	0	3	6	0	19.5	0	0	0	0	1.2
31	1.06	93.9	0	0	0	1.6	3.1	0	0	0	0	0	0	0.7
32	1.03	97	0	0	0	0	0	0	0	0	0	0	0	0

Conclusion

The characteristics of daily rainfall in Salem district have been studied for 32 years (1982 to 2013) to assess the weekly, monthly, seasonal and annual rainfall and its frequency. Probability and return periods were calculated for frequency analysis to design the water conservation structures, ground water recharge, water planning and management for proper crop planning during non rainfall periods.

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References

1. Arti Devi., Parthasarathy Choudhury. Extreme rainfall Frequency Analysis for Meteorological Sub –Division 4 of India using L-Moments. International Journal of Environmental, Ecological, Geological and Geophysical Engineering 2013., Vol7, No:12, 664 -669p.
2. Chow V.T. Handbook of applied hydrology, Mc Grew Hill Book Co., New York.
3. Cosmo S. Ngongondo, Chong-Yu Xu., Lena M. Tallaksen., Berhanu Alemaw and Tobias Chirwa. 2011. Regional frequency analysis of rainfall extremes in Southern Malawi using the index rainfall and L-moments approaches. Journal of Stoch Environ Research Risk Assess, 1964., 25: 939 – 955.
4. Dabral P. P. Meteorological drought analysis based on rainfall. Indian Journal of Soil Conservation, 1996., 24 (1): 37-40.
5. Gebre Hadgu., Kindie Tesfaye, Girma Mamo and Belay Kasssa. Trend and Variability of rainfall in Tigray, Northern Ethiopia: Analysis of Meteorological data and farmer's perception. Academia Journal of Agricultural Research 2013., 1(6):088-100.
6. Khichar M.L., Niwas R., and S. Pal. Markov chain model for use in analysis of south west monsoon rainfall of arid zone in Haryana. Journal of Applied Hydrology, 2000, XIII (3/4): 60-65.
7. Islam S. Banglapedia: National Encyclopedia of Bangladesh. Asiatic Society of Bangladesh2003.
8. Sharda V.N. and P. K. Das. Modelling weekly rainfall data for crop planning in a sub-humid climate of India. Agricultural Water Management, 2005, 76: 120-138.
9. Virmani S.M., Sivakumar M.V.K., and S. J. Reddy. Rainfall probability estimates for selected locations of semi-arid India. Research bulletin No. 1, seconded, enlarged, ICRISAT, Patancheru, Andhra Pradesh, 1982, 19p.
10. Vishwakarma S.K., Ranade D.H., Paradkar V.K., Jain L.K. and A. S. Tomar. Probability analysis of wet and dry spells for agricultural planning at Chhindwara. Indian Journal of Agricultural Science, 2000, 70 (10): 719-721.