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Drought analysis for Ootacamund

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Abstract : The daily rainfall data for the years 1967-1996 (30 years) of Ootacamund station, recorded by India Meteorological Department was collected from the Directorate of Statistics, Chennai. Drought analysis was done and the expected monthly, seasonal and annual rainfall at different probability levels were found out. The extent of normal, abnormal and drought years were 60.5 per cent 9.4 per cent and 30 per cent of the total months in 30 years of study. *(**Key Words** : Rainfall, Normality, Abnormality, Drought).*

Drought has no universal definition but all the definitions envisage that a departure from the normal is involved (Hofman Walter and Rantz 1968). A distinction is made between hydrological and agricultural droughts. As the biological life in a region is adapted to the prevailing pattern of a place, it has been assumed that the rainfall deficits exceeding the average, should be included an evaluation of drought (Herbest *et al.* 1966). Ootacamund taluk in Nilgiris covers an area of 1195 km^2. On its south, east and north are the Elk-hill (2427m), Dodabetta (2592 m) and club hill (2409 m). The influence of these physical features upon climatic condition is significant.

Materials and Methods

The following definitions have been described on drought by Sharma *et al.* (1979) and were used.

Drought month : Any month receiving precipitation less than 50 per cent of the average monthly rainfall.

Abnormal month : Any month receiving the precipitation more than twice the average monthly rainfall.

Normal month : Any month receiving the precipitation in between 50 per cent and 200 per cent of the average monthly rainfall.

Droung year : Any year receiving rainfall less than or equal to $\bar{X}+\sigma$

Abnormal year : Any year receiving rainfall more than or equal to $\bar{X}+\sigma$

Normal year : Any year receiving rainfall in between the limit $\bar{X}+\sigma$, where $\bar{X}$ is the mean yearly rainfall and σ is the standard deviation.

Thus the percentage of months and years coming under normal, abnormal and drought categories were determined. The probability of normal, abnormal and drought months were determined using California method. In which case the months were ranked in the descending order and probability calculated using the formula

$$P = \frac{m}{n} \times 100$$ Where m is the rank no. and n is the no. of years

Results and Discussion

Drought analysis

The number of normal, abnormal and drought months in each year were worked out (Table 1). The rainfall values for normal (N), abnormal (A) and drought (D) with average values for each month, were estimated (Table 2).

Normal month

About 60.5 per cent of the total number of months over 30 years of recorded were normal months (Table 1), of which 58.06 per cent fell during the months from June to October. The probability distribution of normal months obtained in an year and the percentage of total years having a given number of normal months were calculated (Table 3).

Abnormal month

The computed number of abnormal months in an year, their probability distribution and percentage of total years having the given number of abnormal months are given in Table 3. About 9.4 per cent of the total months were abnormal, 82.87 per cent of which fell in the months of October to May and the rest 17.14 per cent during June to September of the year.

Drought month

It was found that 30 per cent of the total months in 30 years cycle were drought months. The month wise distribution of drought pattern indicates

Table 1. The number of months in a year classified as normal, abnormal and drought and their ranks

Year	Normal	Rank	Abnormal	Rank	Drought	Rank
1967	7	10(2.5)	1	4(2)	4	6(2)
1968	8	10(2.5)	1	4(2)	3	6(2)
1969	10	10(2.5)	0	4(2)	2	6(2)
1970	8	10(2.5)	1	3(4)	3	5(6.5)
1971	6	9(6)	4	2(7.5)	2	5(6.5)
1972	8	9(6)	1	2(7.5)	3	5(6.5)
1973	5	9(6)	2	2(7.5)	5	5(6.5)
1974	7	8(11.5)	0	2(7.5)	5	5(6.5)
1975	9	8(11.5)	0	2(7.5)	3	5(6.5)
1976	6	8(11.5)	1	2(7.5)	5	4(12.5)
1977	6	8(11.5)	4	1(14)	2	4(12.5)
1978	9	8(11.5)	2	1(14)	1	4(12.5)
1979	8	8(11.5)	2	1(14)	2	4(12.5)
1980	10	8(11.5)	0	1(14)	2	4(12.5)
1981	10	8(11.5)	0	1(14)	2	4(12.5)
1982	6	7(16.5)	0	1(14)	6	3(19)
1983	8	7(16.5)	0	1(14)	4	3(19)
1984	5	6(21.5)	4	0(24)	3	3(19)
1985	8	6(21.5)	0	0(24)	4	3(19)
1986	5	6(21.5)	2	0(24)	5	3(19)
1987	10	6(21.5)	0	0(24)	2	3(19)
1988	5	6(21.5)	2	0(24)	5	3(19)
1989	6	6(21.5)	0	0(24)	6	2(26)
1990	5	6(21.5)	1	0(24)	6	2(26)
1991	8	6(21.5)	0	0(24)	4	2(26)
1992	6	5(28)	2	0(24)	4	2(26)
1993	9	5(28)	0	0(24)	3	2(26)
1994	6	5(28)	1	0(24)	5	2(26)
1995	8	5(28)	0	0(24)	4	2(26)
1996	6	5(28)	3	0(24)	3	1(30)

Figures in paranthesis indicate in average of the ranks alloted

Table 2. The rainfall for a month to be normal, abnormal or drought and the Average rainfall

Sl.	Month	Average rainfall mm	Normal (in between) mm	aAbnormal (in between) mm	Drought (less than) mm
1.	Jan	8.61	4.30-17.22	17.22	4.30
2.	Feb.	8.84	4.42-17.68	17.68	4.42
3.	March	21.37	10.68-42.73	42.73	10.68
4.	April	66.03	33.01-132.06	132.06	33.01
5.	May	143.03	71.51-286.06	286.06	71.51
6.	June	135.73	67.86-271.45	271.45	67.86
7.	July	182.49	91.24-364.98	364.98	91.24
8.	Aug.	103.23	51.62-206.46	206.46	51.62
9.	Sept.	152.51	76.25-305.02	305.02	76.25
10.	Oct.	175.98	87.99-351.96	351.96	87.99
11.	Nov.	157.61	78.8-315.22	315.22	78.8
12.	Dec.	55.98	27.99-111.96	111.96	27.99

Table 3. Probability distribution of normal, abnormal and drought months in a year and percentage of total years having the given number of months as normal, abnormal and drought

Number of months arranged in descending order as			Probability (m/N)			Percentage of total years having the given numbers of months as		
N	A	D	N	A	D	N	A	D
10	4	6	0.083	0.067	0.07	13.33	10.0	10.0
9	3	5	0.2	0.01	0.217	10.00	3.3	20.0
8	2	4	0.3833	0.25	0.417	26.7	20.0	20.0
7	1	3	0.55	0.467	0.63	6.67	23.00	23.3
6	0	2	0.716	0.8	0.87	26.6	43.33	23.3
5		1	0.933		1.0	16.66		3.3

Table 4. Expected rainfall at Ootacamund with different per cent chance in mm

Month	1%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%
Jan.	79	36	25	16	11	9	7	Nil	Nil	Nil	Nil
Feb.	158	50	29	14	8	5	Nil	Nil	Nil	Nil	Nil
Mar.	190	87	58	35	25	18	14	10	5	Nil	Nil
April	363	200	151	100	83	69	55	48	38	30	21
May	630	398	302	229	182	144	120	107	87	69	50
June	398	275	229	182	138	131	120	104	95	79	63
July	457	331	275	229	199	174	158	138	120	100	83
Aug.	331	229	181	144	120	104	87	79	69	55	44
Sept.	398	288	251	199	173	144	125	114	100	87	69
Oct.	457	331	288	229	199	178	158	138	126	110	87
Nov.	954	501	347	218	158	120	83	69	52	38	25
Dec.	338	251	158	79	50	32	20	16	10	9.5	8.9
Annual	2089	1737	1584	1380	1258	1148	1096	1047	977	891	794
Kharif	1318	1000	870	724	631	575	524	478	436.5	380	316
Rabi	1047	759	630	501	436	398	363	301	263	218	186
Summer	725	501	417	339	275	251	208	190	165	138	110

that during October to February, 60.18 per cent of total months were drought months. In such a pattern of drought occurrence there is about 50 per cent chance of failure of crop during this season under rainfed condition. The percentage distribution of drought months during this season are 6.14 per cent, 16.93, 24.60 per cent, 24.60 per cent and 27.7 per cent respectively for October, November, December, January and February.

Normal, abnormal and drought years

From the yearly distribution of normality, abnormality and drought it was found that the percentage of drought year is about 13.3 per cent of the total 30 years. The worst affected year was 1982 in which the annual rainfall was only 714.2 mm. The abnormal years were 16.7 per cent of the total years. The year 1977 recorded the highest abnormal event was 2273.6mm.

Out of the 30 years analysed, 21 years were normal which arrived to 70 per cent of the total years of rainfall studied.

Expected monthly rainfall

The monthly expected rainfall values were determined at different probability levels by graphical method. For the different probabilities the expected rainfall for each month as well as seasons is shown in Table 4. At 90 per cent probability level the annual rainfall expected is only 794 mm which may cause drought (< 870 mm). For the months of November, December, January and February the expected amount of rainfall at 60 per cent, 70 per cent, 80 per cent probability levels is in the drought scale.

Since the distribution of rainfall during *rabi* season is highly erratic, rainfed cultivation would lead to crop failure. Thus, from the study on investigation of drought, it was found that the normal, abnormal and drought months were in the range of 60.5 per cent, 9.4 per cent and 30 per cent of the total months in the 30 years. During the *rabi* season (October-February) 60.18 per cent of the total were drought. Similarly the extent of normal, abnormal and drought years were 70 per cent, 16.7 and 13.3 per cent of the total years. The years 1982, 1983, 1985 and 1995 were the drought affected years as per the analysis. At 90 per cent probability level, the expected annual rainfall obtained is in the drought range and during *rabi* season there is erratic distribution of rainfall. The farmers must have irrigation facilities for taking *rabi* crops.

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Prediction of maximum daily rainfall at Ootacamund

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Abstract : The maximum daily rainfall data for 30 years (1967-1996) of Ootacamund, Nilgiris, recorded by India Meteorological Department were collected from the Directorate of Statistics, Chennai. Two programs were developed in BASIC for Lognormal and Gumbel distributions. The theroetical values so obtained were in close agreement with the observed data except at the highest rainfall for both the distributions. *(Key Words : Rainfall, Probability distribution).*

Design engineers and hydrologists require maximum daily rainfall under different return periods for economic planning and design of small and medium hydraulic structures (small dams, bridges, culverts). Probability analysis is required to gather information on hydrological events that are governed by unknown physical law. Thus, lognormal distribution and Gumbel distribution were used to predict the maximum daily rainfall for Ootacamund.

Materials and Methods

Most hydrologic variables are assumed to come from a continuous random process and the historical sequence thereof is fitted with some common continuous distribution. Many probability distributions can be transformed by replacing the variate with its logarithmic value (Agarwal, M.C., Katiyar, V.S. and Rambabu, 1988). In the present