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Assessment of Meteorological Drought in Satna District, M.P., India

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Abstract:
Rainfall data of 60 years of Satna were analyzed for drought year interpretation which can be used long term hydrological activity system planning in the area. Meteorological records of Satna district shows that maximum rain 1359.1 mm is in1971 and minimum rainfall is 326.5 mm in 1979. Annual average rainfall is 870.78 mm. The district witness almost two drought year and one heavy rainfall year in one decade. To reduce the problem of water scarcity in drought years, proper rain water harvesting must be done.

Keywords: Meteorological Drought, Rainfall and Satna.

1.0 Introduction:
Rainfall is the most important natural hydrologic event and is a unique phenomenon varying both in space and time, the rainfall distribution is very uneven and varies considerably from place to place and also fluctuates from year to year. The rainfall is one of the most important and governing factor in the planning and operation strategies of any agricultural programme for any area. As such, proper and specific information about the rainfall distribution pattern over a period for a particular place is essential for proper and optimal hydrological planning for requisite irrigation system and cropping pattern. Indian subcontinent gets around 75% of the annual rainfall during monsoon period, which falls from June to September i.e. four months. The major share of conjunctive water-need of the country during entire calendar year is met by the rainfall, which occurs in the monsoon period. In our country swallowing floods and thirstily droughts are the results of spectacular extremities of the rainfall distribution.

As such no general method is available which can be applied for the drought prediction *(Salas, 1986)*. Meteorological drought is the condition when a region receives less than half the amount of normal precipitation (IMD, 1971). In spite of having good potential of rain water, Satna faces the problem of

water scarcity during the maximum part of year *(*Kumar and Rajput, 2013). Shrivastava et al. (2008) assessed meteorological drought in north Lakhimpur district of Assam and Lala I P Ray et al. in Barapani of Meghalaya. Kumar and Kumar (1989), Dabral (1996)analysed weekly, monthly, seasonally andyearly rainfall data for drought situation at Pantnagar and Ranchi station respectively.

Satna city is the district place of Madhya Pradesh and is situated in north eastern part of Madhya Pradesh (80°49'59"E, 24°35'10"N, **Fig 1**). Important places of the district are Satna, Nagod, Maihar, Majhgaon, Amarpatan, Birsimpur, Chitrakoot etc. District covers an area of about 7424.32 square km. Important river of district are Tons, Simarwal, Paisuni, Bihari and Son rivers.in satna district, chitrakoot and maihar are very important pilgrim place and million of people visit this area annually. In recent times, there has been rapid growth in industrialization, population and agricultural activities that has lead to tremendous increase in demand of fresh water (Raju N. Janardhana, 2006). Chitrakoot holds its its importance because in india according to Ramayan lord Ram along with his wife Sita and brother Laxman lived here for 12 years exile period. Many rishi & munies lived here in ashrams. These ashram in past were known as centre of knowledge. Chitrakoot is also known for its natural sanic beauty. Maiher is also a pilgrim place known

for place of godess of power & knowledge. In satna district there are many industries mainly cement industry because of huge deposite of lime stone.

Rainfall of the area variesnormally from326.5 to 1359.1 mm and average annual rainfall of Satna district in last six decades is 870.78 mm(IMD, 1971). Yearly in different season approximate rainfall is winter 3.7%, summer 2.6%, monsoon 88.6% and post-monsoon 5.1%; (Ashwini A Ranadeet. al.,2007)Which falls in sub humid category (O. Berkatand M. Tazi. 2006)**.**Maximum temperature of Satnadistrict rises up to 48^{0} C and minimum temperature goes up to 3^{0} C.

Topographically northern part and western part is hilly while eastern, southern and central part is plain. Rocks exposed are mainly of sedimentary origin belonging to vindhyan group. In maximum part of the district water scarcity is the major problem during maximum part of year (Khan Seraj, 2009, Kumar A and Rajput PS, 2013). Present study aims to analyses the trend of annual rainfall of vital important in all activities which is the only resources of renewable water resource and analyze the cause of scarcity of water.

2.0 Materials and Methods:
In the study to analyze the cause of water scarcity (Map), yearly precipitation values of Satna have been obtained from State Metrological Service for meteorological drought analysis. Record intervals of precipitation values are listed in T**able 2**.

Drought year: the annual rainfall is deficient by 20-60 % of average yearly rainfall and if the deficient is more than 60 % of average yearly rainfall is known as scanty drought year *(Dhar et. al., 1979).* Yearly intensity of drought was also determined using the criteria suggested by IMD (1971) which is based on percentage deviation of rainfall from its long term mean and it is given by (Eq.)

$$Di = \left(\frac{Pi - \mu}{\mu}\right) \times 100$$

Where *Di* is the percentage deviation from the long term mean,
Pi is the annual rainfall, mm and
μ is the long term mean of annual rainfall, mm

Drought codification based on percentage departure of rainfall from normal is presented in **Table- 1.** The percentage of deviation (Di) is then used to categories the drought.

On the basis of percentage depature drought conditions are dividing into five categories as No drought (M_0), Mild drought (M_1), moderate drought (M_2), severe drought (M_3) and extreme drought (M_4).

Table 1: Category of Drought codification based on percentage deviation of rainfall from normal value (IMD, 1971)

Percentage departure of rainfall from normal	Category Intensity of Drought	Code
0.0 or above	No drought	M_0
0.0 to -25.0	Mild drought	M_1
-25.0 to - 50.0	Moderate drought	M_2
-50.0 to -75.0	Severe drought	M_3
-75.0 to less	Extreme drought	M_4

3.0 Result and Discussion:
Year wise, rainfall, long term mean, percent deviation and drought category is shown in **table 2. Table 3** shows number of years of different categories in 60 years. The yearly drought analysis of Satna is presented in table 2 and fig 2.In 60 years, no drought/ normal rain years are 30, mild drought years are 26, moderate 3, severe 2 and extreme is nil **(Fig 4)**.Meteorological records of Satna district shows that maximum rain 1359.1 mm is in 1971 and minimum rainfall is 326.5 mm in 1979. Rainfall of 60 years has been studied and percentage deviation of rainfall is calculated and categorized as No Drought, Mild Drought, Moderate Drought, Severer Drought and Extreme Drought as respectively M_0, M_1, M_2, M_3 and M_4.

Table- 2 Yearly intensity of drought for Satna (*Source.AshwiniA et. al. 2007*)

Y	R	LTM	PD	C	ID
1950	986.9	856.5	15.22	M_0	ND
51	863.2	856.5	0.78	M_0	ND
52	794.5	856.5	-7.24	M_1	Mi D
53	1048.5	856.5	22.41	M_0	ND
54	661.2	856.5	-22.80	M_1	Mi D
55	1041.6	856.5	21.61	M_0	ND
56	1299.7	856.5	51.74	M_0	ND
57	546.4	856.5	-36.21	M_2	Mo D
58	792.7	856.5	-7.45	M_1	Mi D
59	840.5	856.5	-1.87	M_1	Mi D
60	920.2	856.5	7.44	M_0	ND
61	880.7	856.5	2.82	M_0	ND
62	941.3	856.5	9.90	M_0	ND
63	831.7	856.5	-2.90	M_1	Mi D
64	825.2	856.5	-3.66	M_1	Mi D
65	405	856.5	-52.72	M_2	SD
66	510	856.5	-40.46	M_2	Mo D
67	1018.5	856.5	18.91	M_0	ND
68	412.9	856.5	-51.79	M_3	SD
69	815.1	856.5	-4.84	M_1	Mi D
70	963.8	856.5	12.53	M_0	ND
71	1359.1	856.5	58.68	M_0	ND
72	788.5	856.5	-7.94	M_1	Mi D
73	907.2	856.5	5.92	M_0	ND
74	660.4	856.5	-22.90	M_1	Mi D
75	972.5	856.5	13.54	M_0	ND
76	781.6	856.5	-8.75	M_1	Mi D
77	909.6	856.5	6.20	M_0	ND
78	927.2	856.5	8.25	M_0	ND
79	326.5	856.5	-61.88	M_3	SD
80	1270.4	856.5	48.32	M_0	ND
81	847.4	856.5	-1.06	M_1	Mi D
82	923.4	856.5	7.81	M_0	ND
83	804.5	856.5	-6.07	M_1	Mi D
84	837.1	856.5	-2.27	M_1	Mi D
85	864.8	856.5	0.97	M_0	ND
86	765.7	856.5	-10.60	M_1	Mi D
87	799.3	856.5	-6.68	M_1	Mi D
88	753	856.5	-12.09	M_1	Mi D
89	677	856.5	-20.96	M_1	Mi D
90	1091.6	856.5	27.45	M_0	ND
91	920.9	856.5	7.52	M_0	ND
92	794.4	856.5	-7.25	M_1	Mi D
93	666.4	856.5	-22.20	M_1	Mi D
94	936.9	856.5	9.39	M_0	ND
95	791.9	856.5	-7.54	M_1	Mi D
96	894	856.5	4.38	M_0	ND
97	968.8	856.5	13.11	M_0	ND
98	956.7	856.5	11.70	M_0	ND
99	1093.3	856.5	27.65	M_0	ND
2000	867.5	856.5	1.28	M_0	ND
01	1070.6	856.5	25.00	M_0	ND
02	798.1	856.5	-6.82	M_1	Mi D
03	1162.7	856.5	35.75	M_0	ND
04	657.2	856.5	-23.27	M_1	Mi D
05	825.3	856.5	-3.64	M_1	Mi D
06	N A				
07	740	856.5	-13.60	M_1	Mi D
08	854	856.5	-0.29	M_1	Mi D
09	891.8	856.5	4.12	M_0	ND
10	663.4	856.5	-22.55	M_1	Mi D
11	1027	856.5	19.90	M_0	ND

Y. Years
R. Rainfall
L.TM Long Term Mean
PD. Percentage Deviation
C. Category
ID. Intensity of Drought

Table. 3 Drought codification based on percentage deviation of rainfall

Category Intensity of Drought	Code	No of years (1950 to 2011)	%
No drought	M_0	30	49.18
Mild drought	M_1	26	42.62
Moderate drought	M_2	3	4.91
Severe drought	M_3	2	3.27
Extreme drought	M_4	Nil	Nil

Obtained data clearly shows that out of 60 years, number of drought years of different drought intensity is shown in Table-1 and represented in **Figure -3.** No drought (M_0) years which are above the normal average rainfall are 49.18 %. No of years of different intensities of drought are M_1 42.62%, M_2 4.91 %, M_3 3.27 % and M_4 Nil (Table 1). Within 10 years (every decade) 3 to 4 years face good rain (no drought) & 4 to 5 years are faces normal / near normal rain (Mild drought) and 1 to 2 year face Severe to extreme drought **(Table 4).**
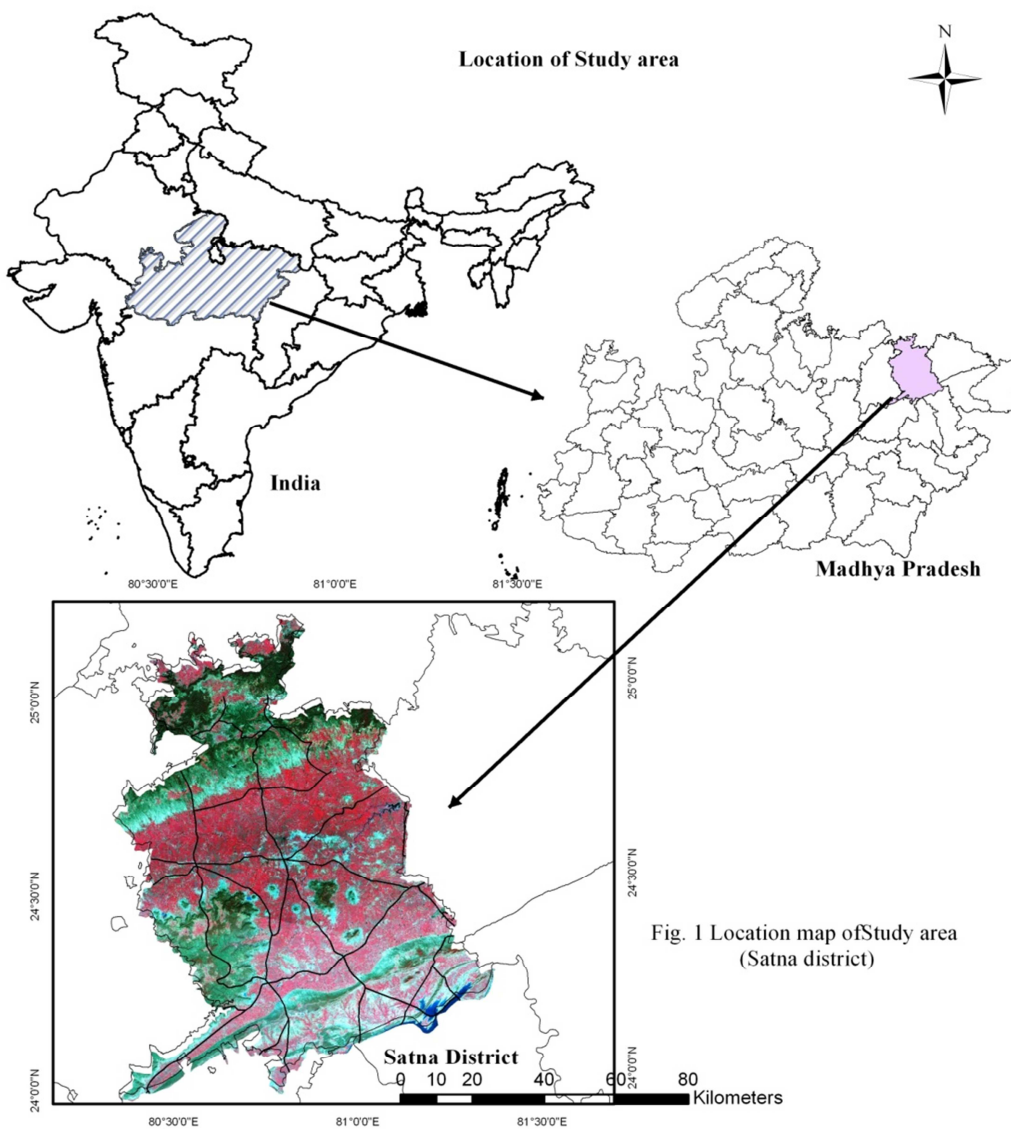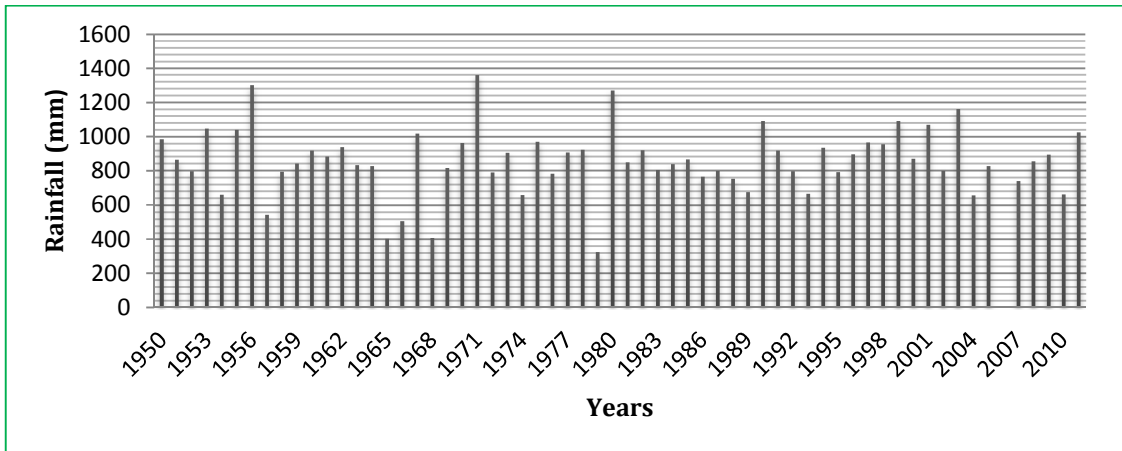

Fig. 1 Location map ofStudy area (Satna district)

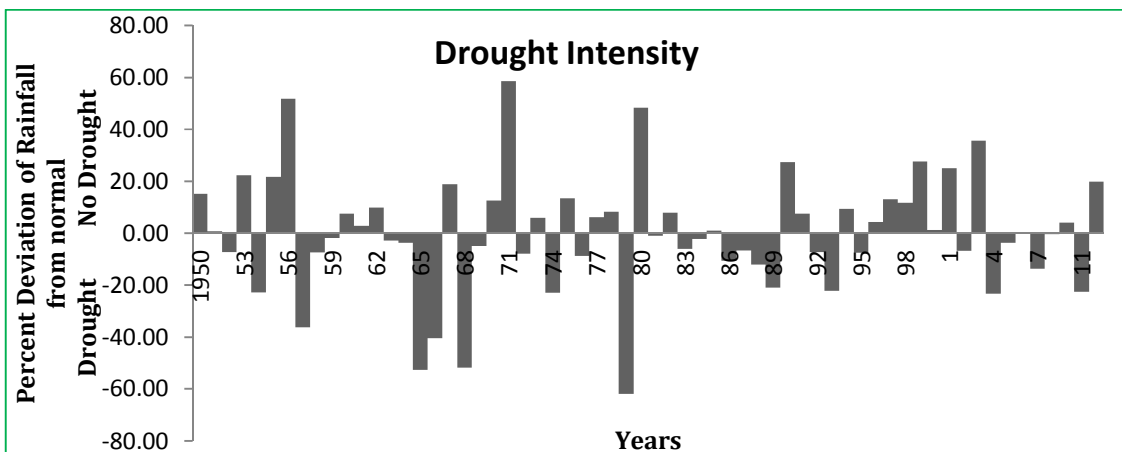**Fig 2:** Yearly rainfall Trend for Satna, M. P.
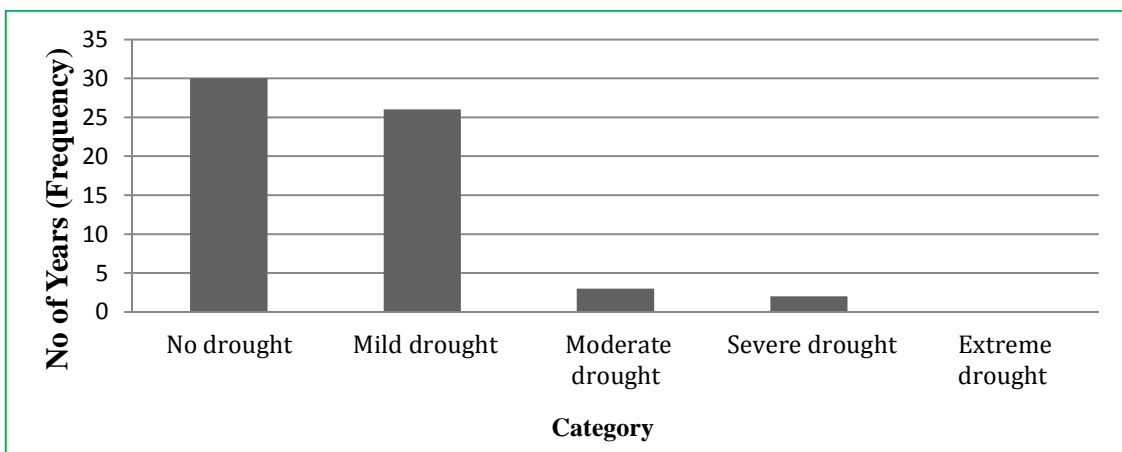

Fig 3 - Drought analysis for Satna, M. P.

Fig 4 - Drought frequencies for Satna, M. P.

4.0 Conclusion:

In Satna district annual rainfall equally deviates ±25 % from normal average yearly rainfall. The yearly rainfall is good but scarcity of water during maximum part of the year and flood situation during monsoon needs proper management of water resources.

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