

## Drought Management for Sustainable Development with Special Reference to Chhattisgarh

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**Abstract:** The biggest impact of drought on poor is on their livelihood. After all drought affects the economic and social business activities and ultimately affecting the lives of poor people. Rainfall plays a crucial role for sustainable development. One hundred two years (1901-2002) monthly mean rainfall data have been analyzed to find out intensity and frequency of meteorological drought occurrence at Chhattisgarh. The average annual rainfall of Chhattisgarh worked out to be 1418 mm. The observed frequency of drought was highest in Bilaspur district. The state experienced high number of mild droughts and few numbers of moderate droughts. However, no severe drought was experienced. Combating drought is necessary to achieving sustainable development goals, including the maintenance of ecosystem services, and improving the livelihood of millions of people living in drought-prone regions.

**Key Words:** Sustainable development, meteorological drought, rainfall analysis.

### Introduction:

Water is the nucleus of sustainable development and is vital for socio-economic development, healthy ecosystems and for human survival. It is crucial for reducing the global burden of disease and improving the health, welfare and productivity of populations. Water is also at the heart of adaptation to climate change, serving as the critical link between the climate system, human society and the environment.

Sustainable development was mainly popularized by the Brundtland Commission in the document "Our Common Future" where it was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (UN, 1987). The Brundtland Commission focused on three pillars of human well being: economic, socio-political and ecological/environmental conditions. The basic concept clearly shows the putting of strong measures to spur economic and social development, particularly for the developing countries, while ensuring that environmental unity is sustained for future generations.

Drought is among the most damaging, unpredictable and least understood of all "natural" hazards. Meteorological drought is the condition when a region receives less than half the amount of normal precipitation (IMD, 1971). The meteorological drought analysis is mostly done based on point rainfall data as reported by several researchers earlier. Bhalme and Mooley(1980) developed an objective numerical drought index and used for assessment of drought intensity. Bhelawe et al. (2015) assessed meteorological drought in Raipur district of Chhattisgarh. Ray et al. (1987) studied drought occurrence at Gopalpur station, Odisha. Das et al. (2009) analyzed the occurrence and severity of drought in Chhattisgarh. Tiwari et al. (2007) characterize the meteorological drought indices using the daily rainfall data of Hazaribagh station. Although some droughts may last a single season and affect only small areas, the climatic records shows that droughts have sometimes continued for a long time and have impacted large square kilometers area of Chhattisgarh. Therefore, issues related with droughts in the state have been analyzed and discussed in this paper.

## Study Area:

The state Chhattisgarh extends the area of 135,194.5 Sq. km. with total population of about 25,545,198. It is located between 17°50' to 24°08' N latitude and 80° 15' to 84° 13'E longitude. It is bounded on north by Uttar Pradesh, by Jharkhand on the north-east, by Odisha on the east, by Andhra Pradesh on the south and by Madhya Pradesh & Maharashtra on the west. Physical features, location and distance from sea have deep influence on the climate of state. Temperature is high in summer and it is very cold in winter. Average temperature in winter is around 18°C. Lowest temperature can be observed in the months of December and January. Average temperature in summer is around 30 - 32°C. May is the hottest month with maximum temperature touching 45°C.

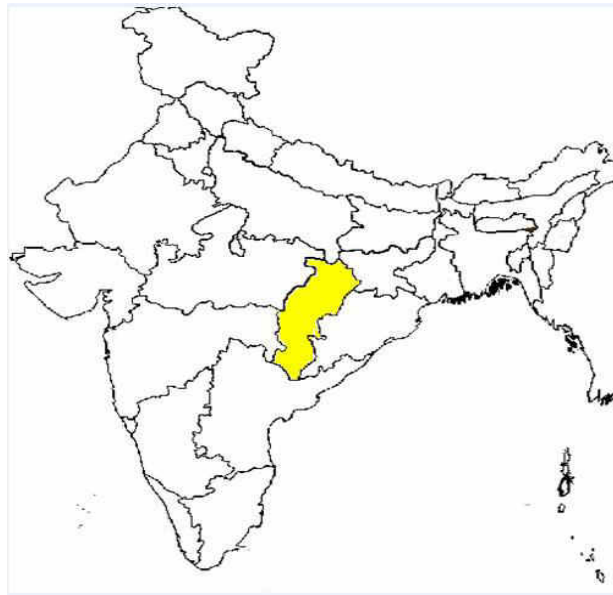


Figure-1: Location Map of the Study area (Chhattisgarh)

## Materials and Methods:

Average annual rainfall of Chhattisgarh state is 1418 mm. The basic rainfall data used is the monthly mean rainfall of 16 old districts of the state for period of 1901-2002 for which data were available. The data was obtained from India Water Portal ([www.indiawaterportal.org](http://www.indiawaterportal.org)). The monthly mean rainfall data was computed as the simple arithmetic average of the rainfall of the stations in the district. However, for some district the required data was not available. The mean monthly rainfall and yearly rainfall were analyzed. The variation of rainfall for each month and year from the mean was determined and the mean deviation for the seasons was calculated. Total numbers of drought years were determined using the standard procedure (IMD, 1971). A year is considered as drought year is the total amount of annual rainfall over an area is deficient by more than 25% of its normal value. The yearly intensity of drought was also determined using the criteria suggested by IMD (1971) which is based on the percentage deviation of rainfall from its long term mean and it is given by the following equation (IMD, 1971).

$$DI = \frac{P_i - \mu}{\mu} \times 100 \dots \dots \dots (1)$$

Where DI is the percentage deviation from the long-term mean,  $P_i$  is the annual rainfall, mm and  $\mu$  is the long term mean of the annual rainfall, mm. The DI values may be classified as no, mild, moderate and severe drought.

Using the rainfall data available, the Drought Index (IMD, 1971) was computed for 16 districts of Chhattisgarh. Drought codification as per IMD, 1971 is shown in Table-1.

Table-1: Drought Index Codification as per IMD, 1971

Intensity of Drought	Value of DI
No drought	0.0 or above
Mild drought	0.0 to -25.0
Moderate drought	-25.0 to -50.0
Severe drought	-50.0 or less

## Results and Discussion:

During 102 years of rainfall analysis, each district experienced mild drought and moderate drought in 102 years. Bilaspur district is the one that is mostly affected by moderate drought and Raipur district was least affected among all the other districts.. However, no districts were affected by severe drought, during the period of 102 years. Table-2 shows the Intensity and frequency of drought for the period of 102 years. Also Figure-2 shows variation in drought occurrence for different districts.

Table-2: Frequency and intensity of Drought during the Period of 102 Years

Sl. No.	District	As per IMD, 1971			
		No Drought	Mild Drought	Moderate Drought	Severe Drought
1.	Bastar	44	54	4	0
2.	Bilaspur	43	40	19	0
3.	Dantewada	46	52	4	0
4.	Damtari	48	47	7	0
5.	Durg	50	49	3	0
6.	Janjgir	49	49	4	0
7.	Jashpur	55	40	7	0
8.	Kanker	47	51	4	0
9.	Kawardha	60	41	1	0
10.	Korba	53	44	5	0
11.	Koriya	53	43	6	0
12.	Mahasamund	49	50	3	0
13.	Raigarh	56	41	5	0

14.	Raipur	49	52	1	0
15.	Rajnandgaon	50	48	4	0
16.	Sarguja	57	40	5	0

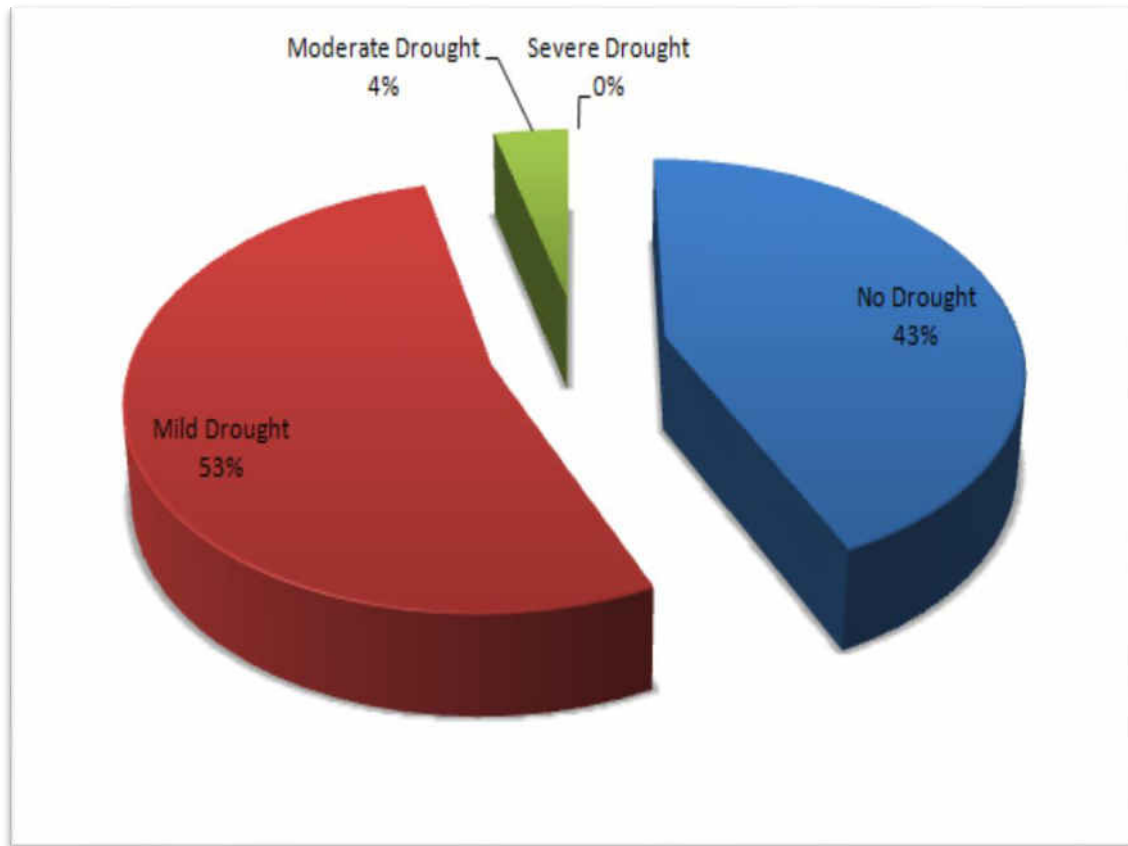


Figure 2: Occurrence of Drought in Chhattisgarh as per Drought Index for Period 1901-2002

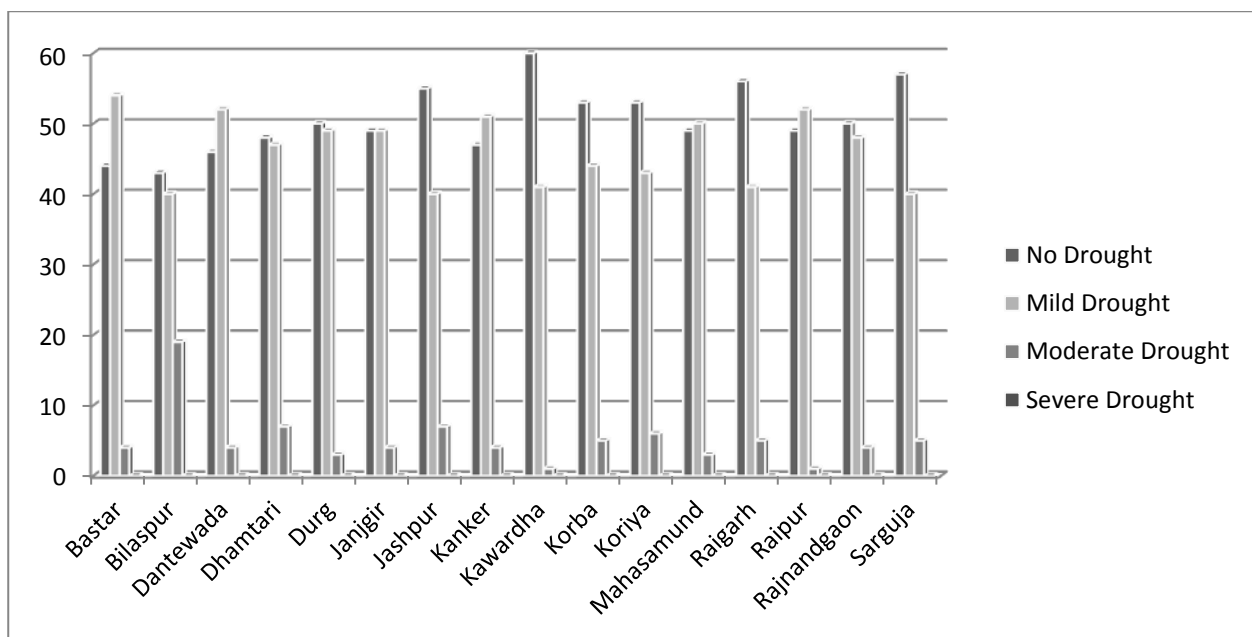


Figure-3: Variation in Drought Occurrence in Districts of Chhattisgarh (As per IMD, 1971)

## Conclusions:

Drought analysis based on 102 years of monthly mean rainfall record showed that Bilaspur district had experienced maximum frequency of drought. During 102 years of rainfall analysis, Bilaspur district was mostly affected by moderate drought. The state experienced high number of mild droughts and few numbers of moderate droughts. However, no severe drought was experienced. So, it can be concluded that Chhattisgarh is mildly affected by drought during the period of study.

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## Conflicts of Interest:

The authors hereby declare that they have no conflict of interest regarding this research paper.

## References:

1. Bhalme H.N. and Mooley D. A. : “Large-Scale Droughts/Floods and Monsoon Circulation”, Monthly Weather Review, pp 1197–1211. 1980.
2. Bhelawe. S. et al., Meteorological drought assessment in Raipur district of chhattisgarh state, India. Plant Archives, Vol. 15 No. 1, 2015 pp. 465-469.
3. Das D.C., Sarkar T.K. and Mukhopadhaya D. P. : “Drought in Chhattisgarh”, Journal of Soil and Water Conservation, Vol, 8, NO. 1, pp 25-32. 2009.
4. India Meteorological Department (IMD), : “Climate Diagnostic Bulletin” of India-June, July, August 1971; Rep. No 88, 89 and 90, National Climate Center, IMD, Pune. 1971.
5. Ray C. R., Senapati P.C. and Lal R. : “Investigation of drought from rainfall data at Gopalpur, Orissa”, Ind. J. soil Cons. 15 (1):15-19. 1987.
6. Tiwari, K. N., D. K. Paul and N. K. Gontia : Characterization of meteorological drought. J. of Hyd., 30(1-2) : 15-27, 2007.