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INTENSITY OF DROUGHT AND SPATIAL VARIATION OF AGRICULTURAL DEVELOPMENT : A STUDY OF KALAHANDI DISTRICT IN ORISSA

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ABSTRACT : It is very much interesting to study the impact of the drought intensity on the levels of agricultural development on any part of droughty India. In the District of Kalahandi in Orissa drought is very frequent and all the community development blocks under the district come under the drought phenomena with varying intensity, in spite of a good amount of anual rainfall. The corresponding levels of agricultural development by Blocks are not concomitant to drought intensity; rather development is very much independent and the analysis presents a very peculiar picture It is very much contrasting as per the expectation. In this paper an attempt is made to assess the intensity of drought simultaneously measuring the levels of development and finally to establish the relationship between these two bringing out the facts behind them.

Introduction

The phenomenon of drought as a natural hazard is not new to Indian agriculture, especially in the areas of marginal rainfall. Droughts are usually defined as "periods of dryness due to lack of rain," though the concept of drought varies from place to place and time to time depending upon the normal climatic conditions, available water resources, land use, agricultural practices and various other economic activities of the region. Drought remains till now as a meteorological phenomena. This does not only occur depending on the annual rainfall, but also due to the erratic spatial distribu- of rainfall, seasonal concentration, availability of irrigation facilities, topography, socio-economic factors etc. An attempt is made here to study the contrasting drought characteristics of Kalahandi District in Orissa and secondly to study the spatial variation of agriculture development in relation to the intensity of drought.

As it is evidenced from historical records, the district was very frequently affected by drought conditions in spite of a good amount of annual rainfall which is just sufficient for a good return of kharif crops. For the last 35 years there was partial failure of Kharif crops during the years 1938-39, 1945-46, 1946-47, 1947-48, 1950-51, 1957-58, 1962-63, 1965-66, 1966-67, 1967-68, 1968-69, 1969-70, 1970-71, 1971-72, 1972-73, 1973-74. 1974-75 and very recently the year 1978-79 was also declared as a severe drought year.

There are various reasons together leading to drought in this district :

(a) There is a quick reduction of extensive forest land by unplanned exploitation com-

binig with shifting cultivation in the tribal tract (Thualmal- Rampur and Lanjigarh blocks).

(b) The topogrphy of the district is very much uneven. The slope analysis of the district shows that the areas having highest rainfall have got a steep slope exceeding 15°, The steep slope dose not allow the water either to remain there or to percolate underground, resulting in quik runoff.

(c) The anlaysis of areal coverage under different crops from 1974 to 1977 during kharif season shows that all the blocks except Bhawanipatna, Thualmal-Rampur and Lanjigarh blocks have got more than 50 per cent of area under paddy cultivation. In some of the blocks (Koksara, Jayapatna, Komna) the area under paddy exceeds 70 per cent. On an average for different blocks in the district, the area under paddy is 60 to 70 per cent. paddy requires 100 cm of rainfall with 10 cm of standing water for several varieties during kharif season, i. e. from June to November. The deviation from the requirement leads to drought.

(d) The average annual rainfall is 1355 mm in the district. As against this only 1253mm of rainfall is usually received in the majority of the blocks. Nowapara, Sub-division, consisting of Nowapara, Komna, Boden, Khariar, Sinapalli, Golamunda, Junagarh, Dharamgarh blocks remains always a drought-prone area and receives about 850 mm of rain on an average in a year. The average number of rainy days per year is 65. Nearly 85 per cent of the total annual rainfall is recorded during this period. August is the wettest month of the year records nearly 28 per cent of the total annual rainfall. The month-wise raintall for the district from 1951 to 1978, block-wise and month-wise rainfall from 1966 to 1978 and again block-wise rainfall during kharif season with weekly distribution of rainfall clearly indicated the regional fluctuations of the rainfall which is very much erratic in distribution. The rainfall figure of the drought years, i. e. 1974 shows that except Thualmal-Rampur and Kalampur all other blocks have got less than 100 cm of rainfall and in the month of November it is almost negligible. Some of the blocks (Boden, Kesinga) had got less than 35 to 50 cm of rainfall. The weekly distribution of rainfall of different blocks in 1974 during kharif season gave an idea of heavy rainfall (31 cm and above) in one week and 0.1 cm rainfall in another week. This indicates the wide variation of rainfall from week to week. The high amount of rainfall available in a particular week could not be useful as per the requirement and in contrast to this the dry spell in another week affects the crop.

Identification of the Drought-prone Area and Intensity of Drought

From the above discussion, it is understood that the drought of Kalahandi is not only a climatic phenomena but also agronomicas the cropping pattern is centred around kharif paddy. So the agro-climatic drou ght is defined in the following manner:

"The scarcity of water in raising the kharif paddy occurs generally in different stages of its growth. The first stage happens to coincide with the time of land preparation and sowing when the monsoon break is delayed. The second stage of water scarcity comes up at the time of puddling before transplanting or wet interculture of broadcast crop when at least 10 to 15 cm of standing water is essential to perform the operation efficiently due to discontinuation of the monsoon in the middle. The last stage occurs at the time of flowering when the requirement of water is maximum due to early closure of the monsoon."

In the district like Kalahandi irrigation networks are yet to be developed and the crops are practically grown under rainfed condition. Secondly the paddy being the major crop, the criteria for identifying drought-prone area and measnrement of the intensity of drought is centred around the kharif paddy on the basis of rainfall.

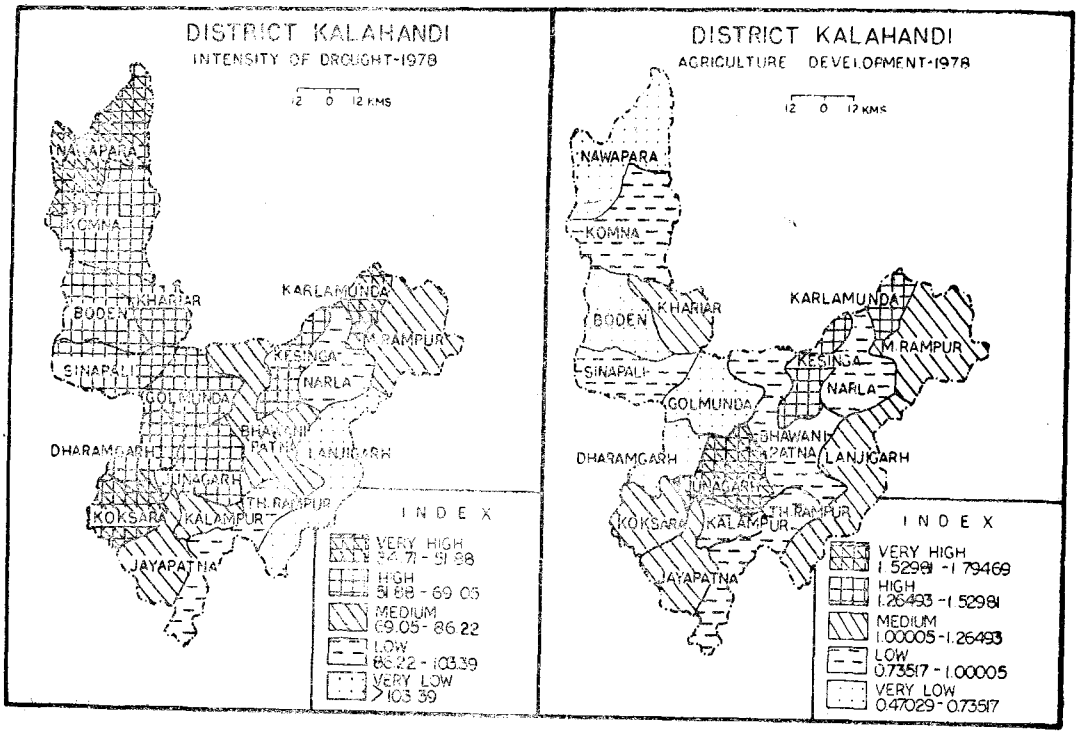

Fig. 1

Under these circumstances, an area is defined as drought-prone if the rainfall received is less than 50 cm in the year or the rainfall is less than 10-15 cm within the month of October and November.

Based on the above mentioned criteria from the average rainfall statistics during October and November (1966 to 1978) Table I) it is seen that all the blocks under the district are identified as drought-prone areas. The intensity of drought is measured by the standard deviation grouping technique. The followings are the different drought intensity groups.

1. Very High Intensity (Mean-2SD level to Mean-1SD level i. e. 34.71 mm to 51 88 mm) :	Nowapara, Koksara
2. High Intensity (Mean-1SD level to Mean level i. e. 51.88 mm to 69.05 mm) :	Karalamunda, Dharamgarh, Boden, Kesinga, Sinapalli, Golamunda, Khariar, Junagarh, Komna.
3. Medium Intensity Mean level to Mean + 1SD level i. e. 69.05 mm to 86.22 mm :	Bhawanipatna, Kalampur, M. Rampur, Jayapatna.
4. Low Intensity (Mean + 1SD level to Mean + 2 SD level i. e. 86.22 mm to 103.39 mm)	Narala, Th. Rampur.
5. Very Low Intensity (> Mean + 2SD level i. e. > 103.39 mm) :	Lanjigarh

Spatial Variation of Agriculture Development

For the study of the spatial variation of the agricultnre development at block level in this drought-prone district, four variables are selected as per the availability of data sources. The variables are as follows :

X_1 = Intensity of cropping,

X_2 = Percentage of area irrigated to net area sown,

X_3 = Area under High Yielding variety (HYV) as percentage to net area sown and

X_4 = Investment of agriculture loan per agricultural family (in Rupees).

For constructing composite index, the principal component technique of Kendall has been adopted. This gives objective mathematical weights for constructing a composite index by linear aggragation. The intercorrelation matrix along with eigen vectors and corresponding weights are presented below :

Inter Correlation Matrix

	X_1	X_2	X_3
X_1	1.0000	0.29216	.00086
X_2		1.00000	0.16024
X_3			1.00000
Mean	1.24000	9.97000	11.56000
SD	0.14000	11.85000	5.90000
Eigen Vector	0.87548	1.00000	0.48551
Weight	0.81233	0.08812	0.09964

The composite index (CI_1) is given in the equation (1) which is the first principal component of variables X_1, X_2, X_3,

$CI_1 = 0.81233\ X_1 + 0.08812\ X^3 + 0.9964\ X_3$ ..... (1). The total variation explained by this principal component is 44.45 per cent. The fourth variable X_4 is diffused with CI_1 by M. N. Pal's equal correlation coefficient method to derive final composite index (CI_2) which is the measure of agriculture development. The computed values of the composite index of agriculture development along with the value of the indicators for different blocks is given in table II. The standard deviation grouping technique is applied to derive different development classes such as very High, High, Medium, Low and very Low.

The different agriculture development groups are presented below :

1. Very Low Development (Mean-2SD to Mean-1 SD i. e. 0.47029 to 0.73517): Boden, Golamunda, Nowapara, Dharamagarh.

2. Low Development (Mean-1SD to Mean i. e. 0.73517 to 1.00005) : Komna, Kalampur, Sinapalli, Bhawanipatna, Narala, Th. Rampur.

3. Medium Development (Mean to Mean + 1SD i. e. 10005 to 1.26493) : Jayapatna, hariar. Lanjigarh, M. Rampur Koksara.

4. High Development (Mean+2SD i. e 1.26493 to 1.952981) : Kesinga, Karalamunda.

5. Very High Development (Mean + 3 SD i. e. 1.52981 to 1.79469); Junagarh.

Table I : Average Rainfall (in mm) from 1966 to 1978 During October and November

Sl. No.	Name of the block	October	November	Total
1.	Bhawanipatna	53.25	25.36	78.61
2.	Kesinga	49.84	4.75	54.49
3.	Narala	80.39	10.23	90.62
4.	M. Rampur	67.76	11.76	79.52
5.	Karalamunda	44.25	7.10	51.35
6.	Lanjigarh	89.38	17.27	106.65
7.	Th. Rampur	86.79	11.63	98.42
8.	Dharamgarh	44.33	8.02	52.35
9.	Junagarh	47.91	16.79	64.70
10.	Jayapatna	65.05	18.36	83.41
11.	Koksara	34.24	14.98	49.22
12.	Kalampur	63.87	14.92	78.79
13.	Golamunda	57.13	2.03	59.16
14.	Nowapara	45.07	3.18	48.25
15.	Komna	60.92	6.74	67.66
16.	Khariar	59.01	4.93	63.94
17.	Sinapalli	58.65	3.99	62.64
18.	Boden	39.82	13.36	53.18

Table II : Levels of Agriculture Development, 1978

Sl. No.	Name of the block	Intensity of cropping (X_1)	Percentage of irrigated area to net area sown (X_2)	Area under HYV crops as percentage of net area (X_3)	Investment of agricultural loan per agricultural family (X_4)	Composite index of ($X_1X_2X_3$)	Final Composite Index of ($X_1X_2X_3X_4$)
1.	Bhawanipatna	1.83	8.13	7.23	61.28	2,90713	0,90334
2.	Kesinga	1,47	16.38	8.44	106.81	3,47849	1.30063
3.	Narala	1.16	5.15	9.81	77.67	2.37358	0.91891
4.	M. Rampur	1.22	37.50	19.03	19.78	6.19169	1.19725
5.	Karlamunda	1.37	43.06	14.17	44.98	6.31111	1.38322
6.	Lanjigarh	1.05	1.02	14.49	109.65	2.38661	1.13103
7.	Th. Rampur	1.09	0.12	27.86	44.18	3,67198	0,92298
8.	Dharamgarh	1.10	1.23	11.03	50.74	2.10097	0.72150
9.	Junagarh	1,39	7.76	19.11	142.50	3,71707	1.57598
10.	Jayapatna	1.32	4.83	7.88	110.05	2,28305	1.11580
11.	Koksara	1,12	11.12	8.40	118.85	2.72666	1.25003
12.	Kalampur	1.17	2.25	6.78	80.11	1.82425	0.84022
13.	Golamunda	1.16	5.94	8.81	45.82	2.34356	0.70472
14.	Nawapara	1.20	7.87	6.30	47.36	2.29603	0.70663
15.	Komna	1.18	10.87	5.12	56.21	2.42657	0.78722
16.	Khariar	1.52	10.31	11.65	70.71	3.80226	1.11955
17.	Sinapalli	1.46	4.63	8.38	65.31	2.41898	0.84735
18.	Boden	1.24	1.46	8.64	35.11	1.99683	0·57466
	Mean	1.24	9.97	11.56	71·72	3.07037	1.00005
	S D	0.14	11.85	5.90	33.37	1.27025	0.26488

Observation

The spatial pattern of the drought intensity and the levels of agriculture development can be well visualised form Fig. 1. It is observed from the analysis that there is significantly low positive correlations (r= 0.05239) between two variabies. This explains that the level of agriculture development in the Kalahandi district is independent of the drought intensity. The assured supply of water only can play a very important role along with the cropping pattern in changing the picture and tending towards better development. As only 10 per cent of the cropped area is irrigated and paddy coverage is about 70 per cent, the role of these factors in promoting the present agriculture development is very much limited. The development is certainly due to some other extrnal factors which are not taken into consideration here for analysis. The blocks like Karalamunda and Koksara with very high intensity of drought are coming under high and medium order of development. The situation in Karalamunda is improved with the highest percentage of irrigated area (43.06 per cent) but in case of Koksara, the irrigation position is as low as 11.12 per cent. The M. Rampur block in both the cases occupies the medium order ladder which depicts the balanced situation. Though the intensity of drought is very low particularly in Lanjigarh and Th. Rampur blocks resepectively, the expected level of agriculture development is not achieved due to practice of shifting cultivation by tribal people. Thus the drought intensity phenomena in relation to agriculture development is very much contrasting. The impact of drought in loss of kharif crop can be further avoided by changing cropping pattern from paddy to dry farming suiting to the agro-climatic condition of the region along with the assured supply of irrigation both from surface and underground.

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