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Short communication

Understanding and managing climatic variability in agriculture using agro-climatic characterisation

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Rainfall and temperature are two important weather elements that affect the phenological and morphological development of any living entity directly or indirectly. Favourable weather not only improves the growth and development of plants but also increases the pest and pathogen population associated with them. Alteration of these elements during different phenophases from their respective optimum affects the yield in terms of both quality and quantity. Therefore, present study aims to characterise agro-climatology of Sundergarh district which can be utilised while managing climatic variability and agricultural planning.

The present study was conducted with an aim to characterise the agro-climatology of Sundergarh district. North-western Plateau Agro-climatic zone of the Odisha (AEZ-7) extending from $21^0$35'N to $22^0$32' N latitudes and $83^0$32' E to $85^0$22' E longitude. The daily rainfall data over a period of 23 years (1995-2017) of 17 stations one in each administrative unit i.e., block and 33 years daily temperature data of the district were obtained from Department of Revenue and Disaster management, Special Relief Commissioner, Government of Odisha, India.

Statistical characteristics of rainfall was computed on weekly, monthly, seasonal and annual basis for all the seventeen blocks. To get an approximate value of the effective rainfall during different months, USDA Soil Conservation Service method was adopted which is widely used in India (AICRP on Water Management, 2009).

$P_e = P_t /125\ (125\text{-}0.2P_t)$ (when $P_t < 250$ mm) (Eq. 1)

$P_e = 125 + 0.1P_t$ (when $P_t > 250$ mm) (Eq. 2)

Where, P_e = monthly effective rainfall (mm) and P_t = total monthly rainfall (mm).

Block wise daily rainfall data were used to calculate the spatial and temporal rainfall variability. Standard deviation (SD) and coefficient of variation (CV) are the standard statistical measures to express variability in rainfall. The coefficient of variation (in percentage) is an indicative of dependability of rainfall. The threshold levels for CV is taken as <25 %, <50 %, <100 %, <150 % for annual, seasonal, monthly and weekly rainfall respectively during interpretation (Manorama *et al.,* 2007).

The rainfall trend analysis have been done on annual basis for different blocks using one of the most popular non-parametric test for monotonic trend detection in rainfall series called Mann-Kendall test. Probability distribution function, incomplete Gamma distribution has been used to compute the expected amount of rainfall at three different probability levels i.e. 50%, 75% and 90% by using block wise weekly rainfall data as input. The probability level of 60% is considered as dependable without risk; 50% is associated with 50% risk and 20% is very risk from the crop point of view (Kumar, 2009).

Markov chain probability model as described by Pandarinath (1991) has been used for estimation of initial, conditional and consecutive dry and wet spell analysis. In this method, a week receiving 20 mm or more rainfall is considered as wet week otherwise dry. We have also performed air temperature analysis for their normal and extremes; in case of extremes their frequency and the trend observed.

Rainfall analysis

The long term mean annual rainfall of the district is 1273 mm ± 325 mm with 26.1% coefficient of variation (Table 1). In the district the annual rainfall varied from 1077 mm in Rajgangpur to 1553 mm in Bonai. In genere the areas having high rainfall has low CV and Vice versa (Table 1). About 87 per cent of annual rainfall is received during June to September (monsoon season), 8 per cent in post monsoon and 5 per cent in pre monsoon sseason.

Based on the analysis it was reported that the mean monthly rainfall of July is 357 mm (Fig. 1), which is highest followed by August rainfall (345mm).

Total annual effective rainfall (ER) is 758.4 mm which is about 60% of the total annual rainfall and it clearly indicates about 40% of rainwater is lost as surface runoff which necessitates the kind attention for reducing the losses and strategies for conservation.

***Probability analysis*:** Expected rainfall at three different probability levels (50%, 75% and 90%) have been computed by fitting incomplete gamma distribution model (Table 2). Amount of rainfall expected at 75% and 90% probability level is considered as dependable and assured rainfall respectively. At 75% probability, four blocks namely Bonai, Hemgir,

Table 1: Statistical characteristics of annual rainfall block wise

S. No	Name of block	Rainfall (mm)	SD	CV (%)	No of rainy days
1	Balisankara	1242	264	20.8	58
2	Bargaon	1105	359	33.5	60
3	Bisra	1224	336	28.9	63
4	Bonai	1553	449	28.2	65
5	Gurundia	1343	287	21.8	60
6	Hemgir	1355	264	19.6	62
7	Koida	1323	321	25.0	70
8	Kuarmunda	1312	341	26.4	58
9	Kutra	1209	313	25.9	59
10	Lahunipara	1422	314	23.0	68
11	Lathikata	1425	317	23.7	65
12	Lephripara	1329	426	33.0	60
13	Nuagaon	1196	313	26.2	59
14	Rajgangpur	1077	348	33.6	55
15	Subdega	1151	283	24.9	58
16	Sundergarh	1280	262	19.4	65
17	Tangarpali	1118	331	29.4	59
	District average	**1273**	**325**	**26.1**	**61**

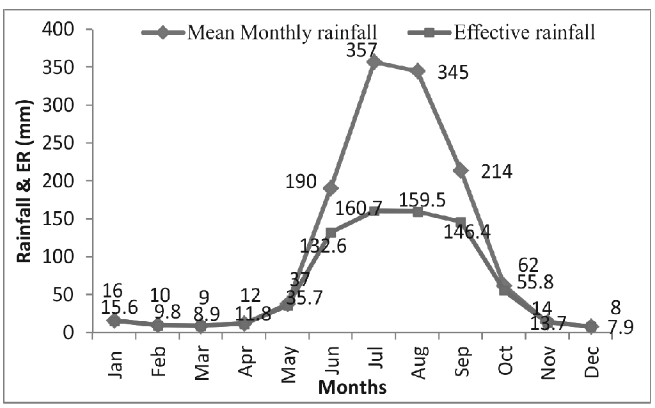

Fig. 1: Long-term average monthly rainfall and effective rainfall in Sundergarh

Table 2: Expected annual rainfall (mm) at 90%, 75% and 50% probability levels

S.No	Block	Expected rainfall (mm) at		
		90%	75%	50%
1	Balisankara	923.3	1059.6	1226.3
2	Bargaon	699.3	877.8	1109.2
3	Bisra	790.1	956.7	1168.1
4	Bonai	1048.3	1261.8	1531.7
5	Gurundia	977	1122.6	1300.8
6	Hemgir	1027.4	1165.9	1333.9
7	Koida	892.6	1068.0	1288.9
8	Kuarmunda	914.9	1081.4	1289.2
9	Kutra	826.3	980.5	1173.6
10	Lahunipara	1030.7	1194.2	1395.6
11	Lathikata	996.3	1169.3	1384.2
12	Lephripara	762.2	968.1	1238.1
13	Nuagaon	747.3	920.2	1142.2
14	Rajgangpur	541.5	719.1	959.3
15	Subdega	773.3	921.1	1106.5
16	Sundergarh	978.6	1114.5	1279.8
17	Tangarpali	666.4	838.7	1063.2
	District	**858.6**	**1024.7**	**1234.7**

Lahunipara and Lathikata receive rainfall above 1150 mm. However, rainfall was below 900 mm for the blocks, namely Bargaon, Rajgangpur and Tangarpali and in remaining blocks they receive rainfall between 900-1150 mm.

Extreme temperature frequency

The mean annual temperature of the district is 24.8°C which has increased and is well above the 25.4°C from 2008 onwards. Number of days with $T_{max} \geq 40^oC$ was zero during 1990, 1993, 2000, 2006 and 2007 in the district (Table 2). Between 1985 – 1989, the district experienced significant number of temperature extremes (≥40°C) which afterwards reduced to less than 5 during 1990-99 except in the year 1996 when 12 days were recorded having temperature greater than 40°C. In subsequent years the number of temperature extremes increased remarkably and in the year 2012, 67 such days were recorded with 46.8°C being the highest temperature during that year.

Despite of good amount of annual rainfall received by the district, cropping intensity is only 126.7%. This is because of the undulating hilly lands that creates heavy runoff i.e., around 45% during monsoon months which may cause flood and erosion of top fertile soil. But, if planned scientifically considering the local edaphic, topographic and relief features the same adversity can potentially be harvested to store the runoff and use it as life-saving irrigation for rainfed kharif as well rabi crops. In these areas artificial recharge techniques and rain water-harvesting methods; specifically In-farm Pond are required to be adopted based on site-specific conditions to take care of at least two crops without putting stress on any of them

Table 3: Temperature Extremes and their frequency (in days)

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Mean annual Temp (°C)	24.8	24.7	25.4	25	24.6	24.1	24.6	25.1	24.7	24.2	24.5
Highest temp (°C)	41.1	42.6	42.8	44.2	41.6	40.1	42.3	40.6	39.2	41.3	42.1
Lowest temp (°C)	9.1	6.3	6.8	9.5	6.7	8.7	7.3	5.5	9.6	7.6	5.6
No. of extremes (≥40°C)	10	12	23	11	10	0	2	2	0	3	5
No. of extremes (≤10°C)	13	13	18	2	18	7	12	20	5	11	17
Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Mean annual Temp (°C)	24.5	24.3	23.6	24.3	24.3	24	24.1	23.5	24.2	24.7	24.6
Highest temp (°C)	42.9	42.2	41.6	41.9	39.1	42.3	43.0	41.6	43.0	43.3	38.0
Lowest temp (°C)	8.3	7.6	6.8	7.4	8.3	7.2	7.2	7.8	6.4	8.4	9.7
No. of extremes (≥40°C)	12	3	3	5	0	5	5	4	9	19	0
No. of extremes (≤10°C)	13	17	18	25	11	15	10	18	17	21	2
Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Mean annual Temp (°C)	24.6	25.4	26.3	26.6	25.5	26.2	25.4	25.5	26	25.4	25.6
Highest temp (°C)	38.2	46.2	47.0	46.8	44.2	46.8	46.3	44.4	46.4	46	42.2
Lowest temp (°C)	9.3	6.8	9.4	7.0	5.3	5.9	4.4	5.6	5.9	5.5	5.8
No. of extremes (≥40°C)	0	40	51	56	28	67	43	42	41	58	46
No. of extremes (≤10°C)	3	16	2	23	28	19	33	37	26	22	28

REFERENCES

AICRP (2009). Annual Report of All India Coordinated Research Project on Water Management, 2008-09. Directorate of Water Management, ICAR, Bhubaneswar, India

Kumar, A. (2009). Assessment and management of Meteorological drought for crop planning in Tarai region of Uttarakhand. *Hydrol. J.*, 32 (1-2)

Manorama, K., Ravichandran, G., and Joseph, T. A. (2007). Rainfall analysis and crop planning for the Nilgiris. *J. Agrometeorol.*, 9: 209 215

Murari K.K., Ghosh S., Patwardhan A., Daly E., Salvi K. (2015). Intensification of future severe heat waves in India and their effect on heat stress and mortality. *Regional Environ. Change* 15(4): 569-579.

Pandarinath, N. (1991). Markov chain model probability of dry and wet weeks during monsoon periods over Andhra Pradesh. *Mausam*, 42(4): 393-400.

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