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Estimation of rainfall risk index of different districts of odisha: A new approach

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Abstract
The rainfall data of Odisha from 1993 to 2016 were analyzed for evaluation of Rainfall Risk Index. The district Jharsuguda had maximum rainfall risk index where as dist. Puri had the lowest risk index. On an average the state is under moderately risk prone (28%) and hence facilities for 100% irrigation has to be developed to reduce risk along with appropriate contingency plans.

Keywords: Climate change, risk analysis, rainfall, rainfall risk index

Introduction
The stat of Odisha is present near the sea coast of Bay of Bengal with its maximum rainfall received from S.W Monsoon. Uneven distribution of rainfall the state frequently suffers from natural calamities like droughts, floods, unseasonal rain and cyclones which substantially affect production and productivity of agriculture. Agriculture is the main source of livelihood of 61.8% of total workers (2011-census) excluding the workers engaged in agriculture based industries and business sector. The state has irrigation potentiality of 35% to meet the weather aberrations. As there is no perennial river in the State, Agriculture in the state depends upon rainfall and is most vulnerable to vagaries of monsoon

ISO 31000920090/ISO Guide 73:2002 definition of risk is the effect of uncertainty on objective. In the said definition Uncertainty includes events (which may or may not happen) and uncertainties caused by ambiguity or lack of information. It also includes both negative and positive impacts on objectives. Many definition exist in common usage, however this definition was developed by an international committee representing over 30 countries and is based on the inputs of several experts. Mishra and Mishra, 2016 has evaluated the risk in agriculture by use of formula as Agricultural Risk Index – [1- (Xmean/Xmaximum)] x 100 where X stands for area/yield rate /production during 5 consecutive years.

Materials and Methods
The rainfall data from the Statistical data of Odisha (1993-2013) were analyzed for estimation of risk of rainfall in Odisha as per the formula developed by Mishra and Mishra (2016) [1-3] taking the mean rainfall data of last (1993 to 2016) 24 years and maximum rainfall received during the period along with standard deviation and rainfall risk index have been presented in Table-2 and classification of districts based on rainfall risk index in table-3. The risk estimated by using 5 years standard was taken but for analyzing risk of rainfall or temperature as factor of climate, data of more years is required to have an overall effect. Hence, the data of 24 years was analysed to identify the risk in different districts using the formula developed by Mishra and Mishra, 2016 [1-3].

Results and Discussion
The data on rainfall 1993 to 2016 of different districts of Odisha has been presented in Table - 2 along with minimum, maximum, mean rainfall. Out of the 30 districts, the district Boudh, Jharsuguda, Nuapada, Bolangir, and Sonepur recorded the lowest rainfall of ranging from 584.9 to 670.0 mm. The said districts are present in North western parts of Odisha which is the distal part of Odisha for monsoon which might have resulted in reduction of rainfall.

The maximum rainfall was received in Kandhamal, Jharsuguda, Mayurbhanj, Balaswar Ranging from 2232.3to 2369.9mm. The district Baleswar recorded the mean maximum rainfall followed by Nowrangur and Kandhamal. The districts Kalahandi, Sonepur, Sambalpur Kandhamal, Jharsuguda and Baleswar recorded the higher values of Standard Deviation of rainfall. The risk as a factor of uncertainty calculated are present in table 1are presented below.

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Table 1: Rainfall and Rainfall Risk index of different districts of Odisha

Districts	M Maximum rainfall (mm) 1993 to 2016	Mean Rainfall (mm) 1993 to 2016	Standard deviation	Rainfall Risk Index (RRI) (%)
Angul	1794.2	1323.5	259.1	26.2
Balasore	2232.3	1724.9	336.7	22.7
Bargarh	1728.8	1254.7	259.9	27.4
Bhadrak	2052.6	1470.9	289.5	28.3
Bolangir	1785.2	1269.3	315.7	28.9
Boudh	1848.0	1312.1	298.9	29.0
Cuttack	2011.3	1544.4	315.6	23.2
Deogarh	1786.9	1296.3	269.4	27.5
Dhenkanal	1746.0	1394.4	245.5	20.1
Gajapati	1987.5	1356.3	282.4	31.8
Ganjam	1972.3	1272.4	269.9	35.5
Jagatsinghpur	1898.6	1443.9	303.2	24.0
Jajpur	2079.0	1567.6	304.5	24.6
Jharsuguda	2338.1	1337.7	338.8	42.8
Kalahandi	2133.3	1579.6	387.6	33.3
Kandhamal	2369.9	1605.9	339.2	32.2
Kendrapara	2072.1	1491.2	341.5	28.0
Keonjhar	1910.1	1360.3	270.0	28.8
Khordha	1872.8	1404.0	276.0	25.0
Koraput	1952.6	1452.5	235.2	25.6
Malkanagiri	2130.0	1508.2	305.3	29.2
Mayurbhanj	2246.2	1501.3	295.9	33.2
Nawarangpur	2293.6	1624.7	329.8	29.2
Nayagarh	2055.4	1395.7	305.3	32.1
Nuapara	1604.2	1117.0	254.2	30.4
Puri	2099.2	1449.2	336.2	17.2
Rayagada	1977.2	1265.3	256.2	36.0
Sambalpur	2057.1	1452.9	339.4	29.4
Sonepur	2082.1	1355.9	352.8	34.9
Sundargarh	1945.0	1310.1	243.8	32.6
State mean		1414.7	213.3	28.9

Table 2: Classification of different districts of Odisha basing on RRI

S. No	Name of the District	Rainfall Risk Index	Districts in Risk Category
1	Normal	0-10%	**Nil**
2	Low	10-20%	Puri
3	Moderate	20-30%	Angul, Balasore, Bargarh, Bhadrak, Bolangir, Boudh, Cuttack, Deogarh, Dhenkanal, Jagatsinghpur, Jajpur Kendrapara, Keonjar, Khorda, Koraput, Malkanagiri, Nabrangpur, and Sambalpur
4	Moderately high	30-40%	Gajapati, Ganjam, Kalahandi, Kandhamal, Mayurbhanja, Nuapada, Nayagarh, Sonepur, Sundergarh,
5	High	40-50%	Jharsuguda
6	Severe	50-60%	Nil
7	Very severe	60-70%	Nil
8	Extremely severe	More than 70%	Nil

Results and Discussion

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Normal Risk: None of the district is coming under normal risk with 0-10% RRI indicating the nature of monsoon is erratic throughout the State of Odisha.

Low Risk: The data revealed that the RRI of Puri was the lowest amongst the districts. It is under low risk area. Since, Puri is situated in coastal tract might have recorded lowest risk.

Moderate Risk

Angul, Balasore, Bargarh, Bhadrak, Bolangir, Boudh, Cuttack, Deogarh, Dhenkanal, Jagatsinghpur, Jajpur, Kendrapara, Keonjar, Khorda, Koraput, Malkanagiri, Nabrangpur, and Sambalpur have recorded the moderate RRI. The districts Jagatsinghpur Kendrapara, Bhadrak and Baleswar although situated in coastal line of the state have recorded moderate risk probably uncertainty of monsoon.

Moderately high Risk-
The districts like Gajapati, Ganjam, Kalahandi, Kandhamal, Mayurbhanja, Nuapada, Nayagarh, Sonepur, Sundergarh have recorded moderately high RRI varying from 31-40% due to their presence in inlands of the state.

High Risk: The data revealed that the districts Jharsuguda recorded highest risk 41-50% uncertainty of rainfall being situated in the farthest place from seacoast to be touched by monsoon i.e North West of the state.

Conclusion: The Rainfall risk index increases with the distance from sea. Crop diversification, use of appropriate duration rice variety according to land type, efficient use of water and appropriate technology and availability of irrigation etc. will reduce the risk of rainfall.

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