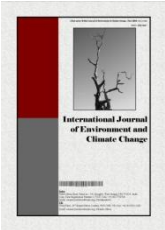

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Analysis of Rainfall Probabilities and Crop Planning for Different Districts of Chhattisgarh

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Rainfall data of 17 districts in Chhattisgarh state has been used to determine the quantity of rainfall at different probability levels through incomplete gamma distribution. Bastar has the highest total annual rainfall, with 1090.0 mm, 1247.5 mm, and 1440.0 mm, respectively, at 90 percent, 75 percent, and 50 percent likelihood levels. Sukma district has the highest total annual rainfall with 1696.6 mm and 1955.3 mm at the 25% and 10% probability levels, respectively. At 90 percent and 75 percent probability levels, Bilaspur district has the lowest total annual rainfall of 300.8 mm and 542.8 mm, respectively. Kabirdham district has the lowest total annual rainfall at 50%, 25%, and 10% likelihood levels, with 983.1 mm, 1126.4 mm, and 1267.0 mm, respectively. Sukma district has the most rainfall (1466.6 mm) while Kabirdham district has the least (996.1 mm). Crop planning strategies have been designed in several districts of C.G. based on probability analysis. Potential crops are found by examining the appropriate agro-ecosystem, and suitable recommended types for production in various places are indicated. Only the inclusion of maize and sugarcane crops in cropping systems is being criticized.

Keywords: Probability; rainfall; incomplete gamma distribution; crop planning.

1. INTRODUCTION

Rain-fed, disaster-prone, and climate-vulnerable agriculture accounts for over 60% of Indian agriculture. Climate variability, especially rainfall, is the most important factor influencing agricultural productivity and sustainability in the tropics. Droughts and heavy rainfall events are

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becoming increasingly common around the world, posing a danger to ecosystems and, in particular, agricultural production and productivity. Rainwater management and usage is a primary focus of current research for the long-term viability of drenched agriculture. A good study of rainfall distribution can help determine the ideal periods for various agricultural operations and crop planning, which can help solve the problem. Crop type, climate, soil quality, geography, and socioeconomic status are all elements that influence crop planning in a specific area. However, in rainfed locations, it is primarily determined by the amount and distribution of rainfall over time and place. The rainfall pattern influences the cultivation of crops, their types, and the adoption of cultural activities. Water harvesting structures for agricultural activities, field preparation, seeding, irrigation, fertiliser application, and crop planning in general require information about a region's yearly and seasonal rainfall. As a result, the annual and seasonal rainfall trends, as well as weekly rainfall probability, are helpful for crop planning in a specific place.

The weather and its variability are well known to the farming community and have great impact on crop production and have a great impact on crop production. Rainfall is an important climatic indicator in crop planning, particularly in rainfed agriculture regions [1]. Analysis of rainfall probabilities for strategic crop planning in Raipur district of Chhattisgarh state for the recent forty-three years (1971-2013) through incomplete gamma probability [2]. Probability analysis for prediction of annual maximum rainfall of one to seven consecutive days for Ambedkarnagar Uttar Pradesh. 20 years (1993-2012) data were used. Wei-formula bull's was used to find the observed values. Proposed projected models Gumbel, Log Pearson Type III Log Normal, and Gamma were used to estimate the maximum rainfall values [3]. Rainfall probability analysis allows for a better prediction of the minimum assured rainfall, which helps crop planning in rainfed areas. Based on 12 years of data (2001-2012) from Bilaspur, Chhattisgarh, an attempt was made to examine rainfall distribution patterns, such as weekly, seasonal, and yearly rainfall [4]. Probability analysis of rainfall at Kohima (Nagaland) for crop planning. Study the daily rainfall data for the period 1997 to 2004 was collected for Kohima (Nagaland) and converted into weekly, monthly, seasonal and annual series [5]. The probability analysis of rainfall for Udhagamandalam.To establish the rainfall distribution pattern, annual, seasonal and monthly rainfall data from Udhagamandalam were used for annual, seasonal and monthly analysis at different probability levels over a 43-year period (1960-2002). The rainfall available in the first (May to August) and second (September to November) seasons is more than the water demand of the crops grown in this region by an 80 percent chance. Without irrigation, rainfall availability in the third season (December to April) is insufficient to support any crop [6]. The rainfall pattern, weekly rainfall probability and moisture availability in distinct agro-climatic areas of Bihar state in this research [7]. Rainfall probability analysis for crop planning in Bargarh district of Odisha, India. The average rainfall at Bargarh district is around 1337.5 mm, though it receives high amount rainfall but most of the rainfall occurred during kharif. Therefore, most of the crops get low yield due to improper crop planning. Annual, seasonal and monthly rainfall data from the Bargarh district were subjected to a probability analysis. Rainfall data was acquired from OUAT's Agril Meteorology Department and evaluated monthly, seasonal, and annual rainfall from 2001 to 2017 (17 years). Equations were fitted to several distributions and the best fitted equations were tested using probability analysis. The probability rainfall distribution in Bargarh district in different months, years and seasons is shown in a monthly, annual, and seasonal probability analysis of rainfall data. Rainfall is slightly less than 1000 mm from June to September, and cropping patterns such as paddy (110 days) or mustard (110 days) are ideal for this region. Annual rainfall of Bargarh district was found to be 1337.5 mm at 50% probability level [8]. Fitting probability distributions for rainfall analysis of Karnataka, India. The secondary data of Rainfall for a period of 34 years (1980-2013) was received from AICRP on Agro-Meteorology, UAS Bangalore [9]. Rainfall variability and probability pattern for crop planning of Roorkee region (Uttrakhand) of India. Daily rainfall data of 30 years 1979-2008 were used [10].

2. MATERIALS AND METHODS

The data required for the rainfall analysis was collected from the Department of Agrometeorology IGKV Raipur.

2.1 Weather Cock

Weather cock with version 15 developed by Rao et al. [11] under All India Co-ordinated Research

Project CRIDA, Hyderabad were used. It contains various modules such as-data management, data quality, daily data conversions, rainfall analysis, temperature analysis, length of growing period and water balance. Application under rainfall analysis has been found viz., agricultural drought, meteorological drought, high rainfall events, incomplete gamma probability, initial and conditional probabilities, probability of dry and wet weeks, rainy days etc.

2.2 Rainfall probability

The probability of rainfall enables us to determine the expected rainfall at various chances. Rainfall data of Balrampur, Bastar, Bemetara, Bilaspur, Dantewada, Gariyaband, Jashpur, Kabirdham, Kanker, Kondagaon, Korba, Koriya, Mungeli, Rajnadgaon, Sukma, Surajpur and Surguja districts of Chhattisgarh were used to find weekly rainfall probability. It is estimated for each district separately using WEATHER COCK software which is developed by CRIDA, Hyderabad for weather data analysis.

1. Never rename the Weather Cock folder.
2. All data files should be either created in Notepad or as csv files (comma separated values) of excel.
3. Kindly examine the data file structure in the 'Sample Data' folder for any analysis before creating the new data file.
4. While analyzing data with csv file, if any error occurs then open the. CSV file in Notepad and delete all the last commas in every data line.
5. Data for every day Date structure-mm/dd/yyyy.
6. The possible errors in data are like 13.8.0 or 13..8 or 13.8.instead of 13.8. Data may be typed as a non-numeric symbols (space, _, +).

Correct data file
Bastar
Year, Week, RF (MM)
2019, 1, 0
2019, 2, 0
Incorrect data file
Bastar
Year, week, RF (MM),,,,
2019, 1, 0,,,,

The outline deals with research method and procedures are as follow.

Table 1. Geographical location of selected 17 districts and long term data of rainfall availability

S.NO.	Districts	Stations	Latitude	Longitude	Database Period
1	Balrampur	Wadrafnagar	$23^0$11'N	$83^0$19'E	2003 - 2019
2	Bastar	Jagdalpur	$19^0$05'N	$82^0$02'E	1980 – 2019
3	Bemetara	Bemetara	$21^0$70'N	81^0 53'E	1960 – 2019
4	Bilaspur	Bilaspur,Kota, Pendra, Pendraroad	$22^0$05'N	$82^0$08'E	1972 – 2019
5	Dantewada	Dantewada	$18^0$53'N	$81^0$21'E	1973 – 2019
6	Gariyaband	Rajim,Deobhog, Gariyaband	$20^0$63'N	$82^0$06'E	1972 – 2019
7	Jashpur	Bagicha, Jaspurnagar, Kunkari	$22^0$83'N	$84^0$14'E	1972 -2019
8	Kabirdham	Kabirdham, Bodla	$22^0$01'N	$81^0$15'E	1963 – 2019
9	Kanker	Kanker	$20^0$16'N	81^0 30'E	1981 – 2019
10	Kondagaon	Kondagaon	$23^0$21'N	$82^0$21'E	1999 – 2019
11	Koriya	Manendragarh	$23^0$15'N	$82^0$34'E	1974 – 2019
12	Korba	Kanki, Korba	$22^0$00'N	$82^0$42'E	1960 – 2019
13	Mungeli	Mungeli	$22^0$05'N	$81^0$68'E	1972 – 2019
14	Rajnandgaon	Ambagarhchowki, Gandai, Khairagarh, Mohala, Rajnandgaon	$21^0$05'N	81^0 02'E	1962 – 2019
15	Sukma	Sukma	$18^0$40'N	$81^0$67'E	1972 – 2019
16	Surajpur	Pratappur	$23^0$22'N	$82^0$85'E	1973 - 2019
17	Surguja	Ambikapur	$23^0$07 'N	$83^0$12'E	1973 – 2019

Table 2. Annual rainfall quantum through incomplete gamma distribution at different probability levels for different districts of Chhattisgarh

District	90%	75%	50%	25%	10%	Mean (mm)
Balrampur	780.0	920.3	1095.3	1291.1	1486	1117.2
Bastar	1090.0	1247.5	1440.0	1651.0	1857.7	1459.5
Bemetara	812.0	945.8	1111.1	1294.5	1475.9	1130.1
Bilaspur	300.8	542.8	990.0	1673.7	2520.8	1189.6
Dantewada	990.1	1154.7	1358.3	1584.6	1808.3	1382.2
Gariyaband	901.0	1021.8	1168.3	1328.2	1484.0	1182.0
Jashpur	1052.4	1181.4	1336.8	1505.3	1668.5	1350.2
Kabirdham	745.6	852.6	983.1	1126.4	1267.0	996.1
Kanker	835.5	974.9	1147.5	1339.4	1529.1	1167.7
Kondagaon	940.7	1064.4	1214.2	1377.5	1536.0	1228.0
Korba	868.7	1003.9	1170.1	1353.7	1534.4	1188.2
Koriya	848.0	1005.5	1202.4	1423.6	1644.0	1228.0
Mungeli	793.8	894.4	1015.8	1147.8	1275.9	1026.4
Rajnandgaon	856.0	965.4	1097.6	1241.4	1381.0	1109.3
Surguja	844.8	1037.4	1284.1	1567.4	1854.9	1323.1
Sukma	1019.4	1205.1	1436.8	1696.6	1955.3	1466.6
Surajpur	966.6	1101.6	1266.0	1446.0	1621.8	1282.2

2.3 Analysis of Weekly Rainfall Probability

Weekly rainfall probability was calculated through the model named as “Incomplete Gamma Distribution”. Districts wise weekly rainfall data were used to calculate districts wise weekly rainfall quantum at a level of 90%, 75%, 50%, 25% and 10% for a year. By fitting an Incomplete Gamma Distribution model to each standard week, the amount of rainfall at five probability levels was calculated.

3. RESULTS AND DISCUSSION

Among all the districts Bastar has the highest total annual rainfall through incomplete gamma distribution at 90%, 75% and 50% probability levels amounting 1090.0 mm, 1247.5 mm and 1440.0 mm respectively(Table 2). Sukma district has the highest total annual rainfall at 25% and 10% probability levels amounting 1696.6 mm and 1955.3 mm respectively. Bilaspur district has lowest total annual rainfall at different probability levels 90% and 75% i.e. 300.8 mm and 542.8 mm respectively. At 50%, 25% and 10% probability levels Kabirdham district has lowest total annual rainfall i.e. 983.1 mm, 1126.4 mm and 1267.0 mm respectively. Mean rainfall is highest in Sukma district 1466.6 mm and lowest in Kabirdham district 996.1mm.

4. CONCLUSION

On the basis of the study district wise crop planning of three agro-climatic zones are given below. Cropping sequence is proposed in such a way so as to include maize and sugarcane crops in the cropping sequences.

1. Chhattisgarh plain:- Gariyaband, Bemetara, Rajnandgaon, Kabirdham, Bilaspur, Mungeli, Korba and Kanker districts are comes in this zone.

   Maize – Mustard/ safflower, Maize – chickpea, Maize- vegetable, Sugarcane + Urd/Moong/leafy vegetables

2. Bastar plateau:- Kondagaon, Dantewada, Batar and Sukma districts are comes in this zone.

   Maize – Green gram/ Black Gram, Maize – Vegetable, Millets / Niger – Leafy vegetables, Sugarcane + Urd/Moong/leafy vegetables, Rice- maize

3. Northern hills:- Surajpur, surguja, Balrampur, Koriya and Jashpur districts are comes in this zone.

   Maize - Mustard, Rice – Wheat / Mustard, Sugarcane, Pigeon pea – Vegetable

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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