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Analysis the trend of wet spells and initial, conditional probability in Surguja district of northern hill zone of Chhattisgarh

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Abstract
In the present work on studies of rainfall and rainy days in Surguja district and its tehsils Ambikapur and Sitapur of northern hill zone of Chhattisgarh was carried out. For this study long term rainfall data (1975-2017) were collected from Department of Agrometeorology and crop data were collected from DES (Directorate of Economics and Statistics). Rainfall, rainy days and trend analysis was computed though weather cock software, trend, o- resource. The mean annual rainfall of 1225.3 mm was recorded in Surguja district with 15.3% coefficient of variation and 187.8 mm standard deviations are found. The mean annual rainy days of 74 days was recorded in that district with 13.9 % CV & 10.2 mm SD.

Keywords: trend, spells, initial, probability, Surguja, Chhattisgarh

Introduction
Among various production factor Rainfall is one of the single most important factor in crop production, particularly under rainfed condition which directly affect the production and productivity of any crop. The variation of monsoonal and annual rainfall in space and time are well known and this inter-annual variability of monsoonal rainfall has considerable impact on agricultural production

Changes in rainfall trend, variability, amount and its spatial and seasonal distribution critically modify the river runoff pattern and regimes (Gosain *et al*., 2006) [2], soil moisture, (Jain and Kumar, 2012) [3], ground water reservoirs, frequency of rainfall extremes, including floods and droughts, cropping pattern and agricultural productivity vegetation activity. The trends of extreme rainfall events have changed after 1950s in major parts of India. Major changes have occurred after 1975, which are correlated with indiscriminate exploitation of natural resources and rapid urbanization. The distribution of rainfall depends upon various factors. Rainfall climatology brings out the general pattern and characteristics of rainfall of a particular region. The local hydrological, agricultural and economic activities heavily depend on micro-level rainfall. Analysis of rainfall trends isimportant for water resources planning and management.

Amongst all natural resources, rainfall is regarded as the fundamental natural resource so far as progress of the society is concerned. Indian agriculture is mostly rainfed (around 60 % of arable land) and monsoon plays a major role not only in agriculture but also in allied day to day activities. India, 75 % (870 mm) of the annual rainfalls (1150 mm) is received during South-west monsoon period (June to September). Distribution of rainfall is important for crop planning especially for rainfed agriculture (Reddi and Reddy, 2004) [6].

Chhattisgarh state, situated in eastern India stretches between 80^0 15’ to 84^0 24’ E longitude and 17^0 46’ to 24^0 5’ N latitude. This state has three agro climatic zones viz., Chhattisgarh plains, Bastar plateau and northern hills region. Its climate is of dry sub-humid type. It covers total geographical area of about 13.5 million hectare. During kharif, growing of rice is a tradition and is widely accepted depending upon farmers socio-economic conditions. Rice is grown in 3.7 million hectares and rainfed rice production has always remained a challenged in this region. In *Rabi*, there are fewer options for the stakeholders to take profitable and suitable crops. Under these circumstances, they generally follow rice-wheat, rice-mustard and rice-winter vegetables under partially or assured irrigation and rice-fallow, rice-utera (Lathyrus, chickpea and linseed) under rain fed situation. Chhattisgarh state receives an average annual rainfall of 1200 mm with a variation of 1200 to 1600 mm which is considered to be quite enough amount for successful crop production.

Therefore, traditionally rice is grown throughout the state to feed the local population. Even with such ample availability of rainwater, the seasonal droughts especially during critical crop growth stages during September to October months are recurring phenomenon throughout the state under rainfed farming. It is necessary to manage the natural resources effectively in order to increase and stabilize the agricultural production to an optimum level to meet the demand of the population for their livelihood. Efficiently managing natural resources is a key factor for obtaining sustainable productivity in a watershed under rainfed farming (Thakur H., 2012) [4].

In view of the paramount importance of the rainfall from economic, societal and scientific points, extensive work has been carried out over the years on its various facets like trends, disaster events, spatiotemporal variability, seasonal contributions etc. (Awulachew *et al.*, 2010) [1].

Materials and methods

Description of study area, materials collected for the study, their sources and methodologies adopted for research work of "Analysis the trend of wet spells and initial, conditional probability in Surguja district of northern hill zone of Chhattisgarh" are briefly presented.

Data for the study

Rainfall Data

Daily rainfall data of Surgujsa districts of Chhattisgarh state and its two tehsils Ambikapur and Sitapur has been collected from the Department of Agrometeorology, IGKV Raipur. Selected area along with availability period were presented in Table 1.

Rainfall Analysis

Rainfall analysis was performed using Weather Cock software provided by CRIDA Hyderabad. The program gives the output as desired in terms of annual, seasonal, monthly or weekly with standard deviation and coefficient of variation values.

Crop data

Crop data with regard to area, production and productivity (yield) of different crops grown in Surguja districts of Chhattisgarh were obtained and used in the present study for strategic crop planning for such districts.

Weather Cock

Weather cock with version 15 is a software developed by V.U.M. Rao, A.V.M.S. Rao, G.G.S.N. Rao, T. Satyanaryana, N. Manikandan, B. Venkateswarlu and I. Ramamohan in 2011 under All India Co-ordinate Research Project CRIDA, Hyderabad. It contents various modules such as-Data Management, Data Quality, Daily Data Conversions, Rainfall Analysis, Dry Spell, Temperature Analysis, Length of Growing Period and Water Balance. Application under rainfall analysis have been found viz., agricultural drought, meteorological drought, high rainfall events incomplete gamma probability, initial and conditional probabilities, probability of dry and wet weeks and rainy days.

Results and discussions

The mean annual rainfall of 1225.3 mm was recorded in Surguja district with 15.3% coefficient of variation and 187.8 mm standard deviations are found. The mean annual rainy days of 74 days was recorded in thar district with 13.9 % CV & 10.2 mm SD.

The data pertaining to rainfall at Ambikapur is given in table 1 and the per cent departure from normal along with rainy days is depicted through figure 2. It can be seen that the highest rainfall of 1604.2 mm was received during the year 1986 followed by 1980 (1601.9mm). Whereas, the lowest rainfall was recorded during the year 1979 (813.3 mm). The highest rainy days was observed in the year 1990 (85 days) followed by 1977 (84) and 1975, 1997 and 1998 (81) days and the lowest rainy days was in the year 2015 (47) followed by 1979 (49). Further it is clear from the figure 4.6 that at Ambikapur out of 43 years 6 years *viz*. 1979, 2002, 2009, 2010, 2012 and 2013 are deficit rainfall years where the rainfall deficit was more than -19 percent. On the other hand 6 years *viz*. 1975, 1980, 1985, 1986, 1991 and 1997 were observed as excess rainfall years with greater than 20 per cent higher rainfall as compared to normal. Remaining 31 years had normal rainfall ranges between -19 to +19 per cent.

The rainfall shows decreasing trend from 1975 to 2017 at 5 per cent level of significance with R^2 value of 0.139 similarly the rainy days also showed significantly decreasing trend at 5 percent level with R^2 value of 0.092.

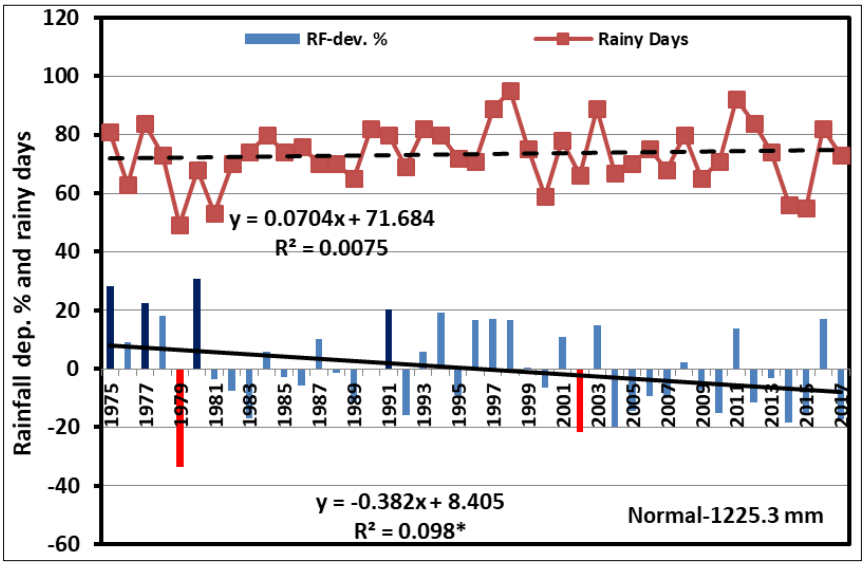

Fig 1: Pattern of per cent Rainfall departure and number of rainy days at Surguja

Table 1: Annual normal rainfall and rainy days with standard deviation (SD) and coefficient of variance (CV)

S. No.	District	Data Base	Rainfall (mm)	SD	CV	Rainy Days	SD	CV
1.	Surguja District	1975-2017	1225.3	187.8	15.3	74	10.2	13.9
2.	Ambikapur Tehsil	1975-2017	1307.9	210.1	16.1	68	10.0	14.8
3.	Sitapur Tehsil	1982-2017	1168.2	173.8	14.9	63	8.4	13.3

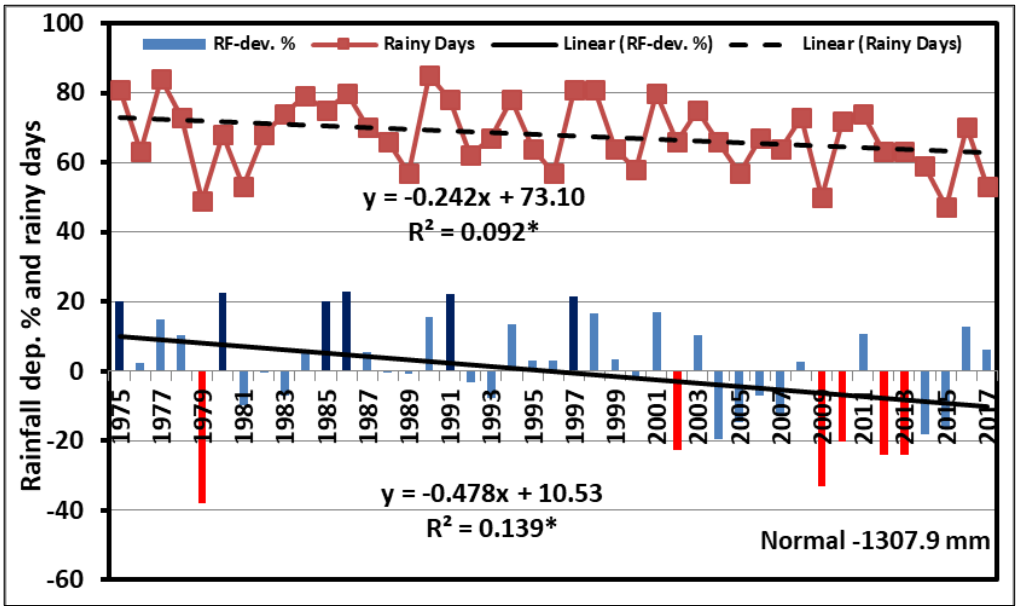

Fig 2: Pattern of percent rainfall departure and number of rainy days at Ambikapur

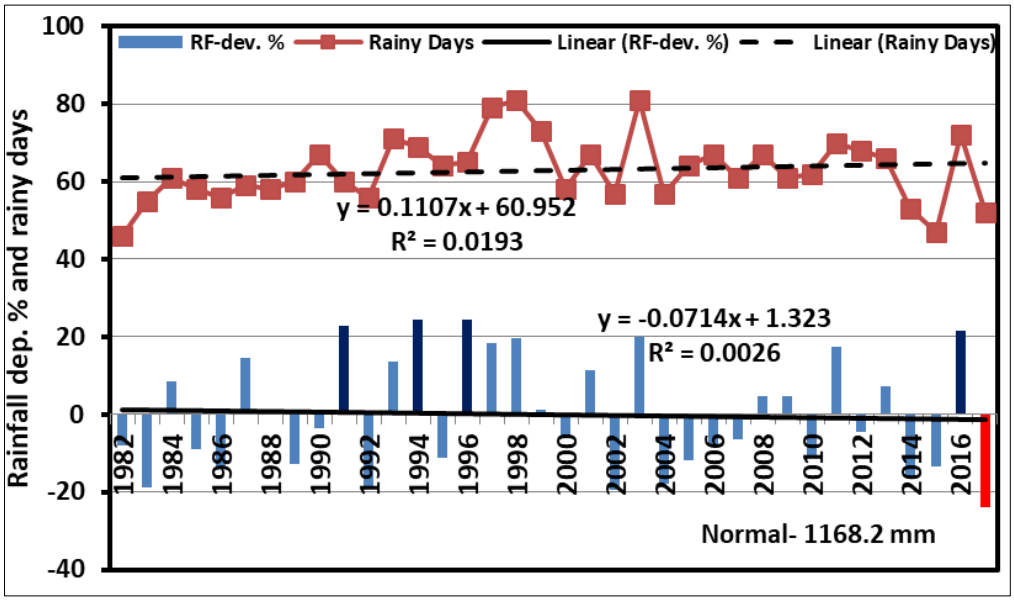

Fig 3: Pattern of per cent Rainfall departure and number of rainy days at Sitapur

In Sitapur the highest rainfall years were observed in figure 3 as 1996 (1453.1 mm) followed by 1994 (1452.6 mm) and the lowest are 2017 (890.2 mm) followed by 2002 (940.6 mm). The highest rainy days are 1998 (81), 2003 (81), 1997(79), 1999 (73), days. And the lowest rainy days are 1982 (46), 2015(47). The deficit year are 2017 range of – 23.8 % deviation from normal rainy days and the excess rainfall year are 1991, 1994, 1996, 2016 and had rainy day deviation ranges from 21.5 % to 24.4 %. And the remaining 38 years had normal average rainfall ranges between -19 to +19 % from mean rainfall deviation. The rainfall shows the decreasing trend from 1975 to 2017.

The rainfall shows decreasing trend from 1975 to 2017 at non significance with R^2 value of 0.002 whereas the the rainy days showed significantly increasing trend at with non significant R^2 value of 0.019.

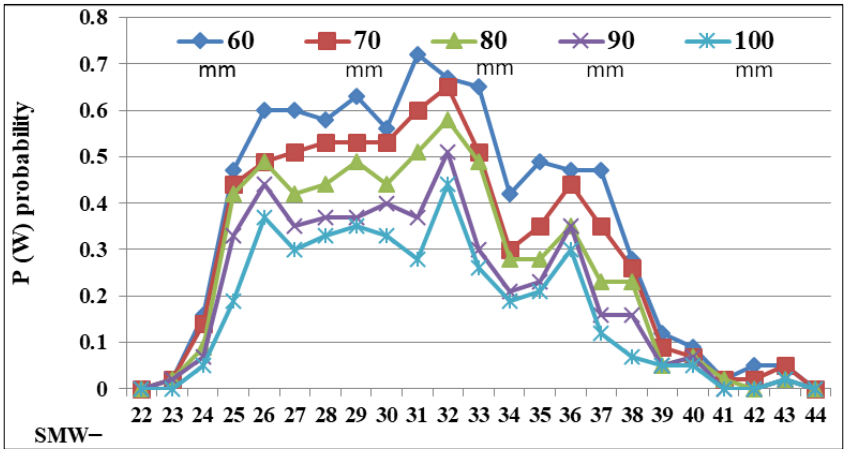

Fig 4: Initial probability P (W) of Sarguja district

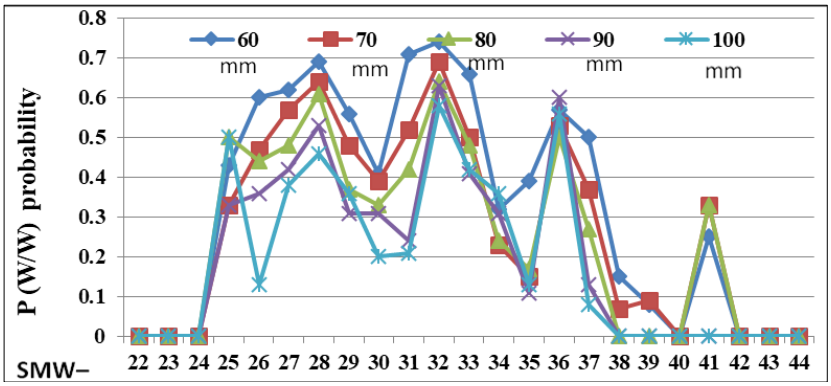

Fig 5: Conditional probability P (W/W) Sarguja district

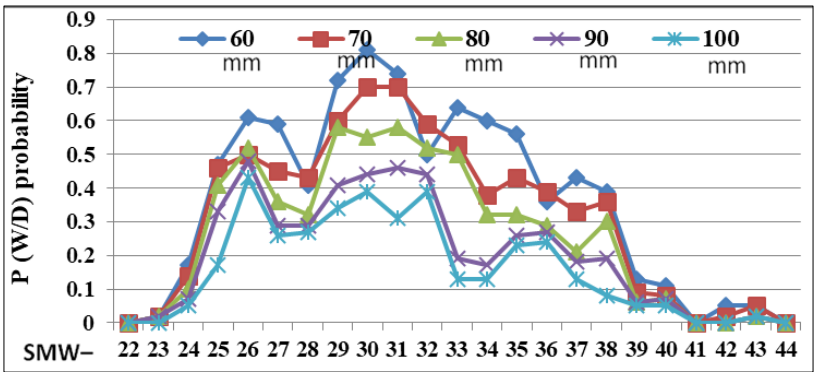

Fig 6: Conditional probability P (W/D) Sarguja district

It can be seen from the above graph that the initial probability of occurrence of wet spells was very high during SMW 28-29 ranging from 50-69, 45-62, 40-52, 36-43 and 31-38 % for 60, 70, 80, 90 and 100 mm rainfall limits, respectively, whereas from SMW 24-27, it was in ascending order ranging from 17-62, 10-50, 07-45, 07-38, and 07-33 % for the corresponding rainfall limits and again decreased thereafter ranging as 57-26, 50-17, 43-17, 38-14 and 31-14 for the corresponding rainfall limits during SMW 30 to 37, being nearly 0% for 35 weeks (SMW 41-52 & SMW 1-23). Thus, the chance of wet spell was more prominent on the weeks during monsoon period.

The conditional probability of wet spells followed by next wet spells was very high in the monsoon season (SMW 25-36); ranging from (40-75, 32- 75, 18-71, 13-67, 14-63) for rainfall limits of 60, 70, 80, 90, 100 mm respectively. On the other hand, the probability of occurrence of wet spells followed dry spells was high during monsoon season (SMW 25-34) ; ranging from (14-64, 21- 61, 21-48, 16-41 and 09-34 for rainfall limits of 60, 70, 80, 90 and 100 mm respectively and less during rest of the year.

Conclusion

In Surguja district and Sitapur tehsil the rainfall and rainy days both shows decreasing and increasing trend respectively, from 1975 to 2017 but in Ambikapur both shows decreasing trend. The length of rainy season is observed to be 16 weeks (112 days) during kharif in most of the year, so short duration crops of sorghum, soybean, maize, greengram, blackgram, horsegram, groundnut, and other low water required crops can be grown for getting high returns.

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