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Trend analysis of wet spell in different districts of Bastar plateau in Chhattisgarh

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Abstract
The study of trend wet spell in different districts of Bastar plateau in Chhattisgarh. For this study, long term rainfall data of 11 stations were collected from the Department of Agrometeorology, IGKV Raipur and Water Recourse Department Raipur. Wet spell length and trend analysis were computed though O-resource and trend software. The result revealed that Bijapur district showed significantly increasing trend in all criteria for longest spell, total spell, and total days in less than critical value and Dantewada district recorded significantly decreasing trend of wet spell.

Keywords: Wet spell, trend analysis, Bastar plateau, Chhattisgarh

1. Introduction
It is an established fact that the crop development will be affected if the dry spells coincide with the sensitive phonological stage of the crop. On the other hand, dry periods at the ripening stage of the crop are sometimes beneficial. Hence, for the purpose of crop planning and to carry out the agricultural practices, it is important to know the sequence of dry and wet periods. Design of earthen dams and other soil conservation structures also necessitates the probability analysis of occurrence of wet and dry spells. The Markov chain model is based on the transitional probability describing a situation that changes between two stages. The first stage occurs at time t-1 and the second stage takes place at time t. In other words, the current probability of certain state depends on the probability of the immediate preceding state only. The Markov chain model has been extensively used to study spell distribution and other properties of rainfall occurrence, long term frequency behaviour of wet and dry weather as well as for computation of probability of occurrence of daily precipitation. Pandarinath used the Markov chain model to study the probability of dry and wet spells in terms of the shortest period like week (Dabral *et al.* 2014) [2].

Chhattisgarh state, situated in eastern India stretches between 80˚15′ to 84˚24′ E longitude & 17˚46′ to 24˚ 5′ N latitude. It covers a total geographical area of about 13.5 million hectares. This state has three agro-climatic zones viz., Chhattisgarh plains, Bastar plateau and Northern hills region. Its climate is dry sub-humid type. In Chhattisgarh south-west monsoon receiving 90% rainfall during the month of June-September. The analysis of wet spell would be helpful to prepare a strategies plan in changing climatic scenario. The onset of monsoon is around 15th June in southern parts of Bastar and later on extend over the entire state. (Bhelawe *et al*. 2014) [1].

Considering the above facts the present investigation entitled “trend analysis of wet spells in different districts and tehsils of Bastar plateau in Chhattisgarh” was carriedout in Department of Agrometeorology.

2 Material and methods
2.1 Description of the Study Area
The present study is confined to Bastar plateau zone of Chhattisgarh. It is considered as Bastar plateau zone of Chhattisgarh situated between Latitude ranging from 17˚ 44′ to 20˚ 30′ N latitudes and longitude 82˚ 15′ to 82˚ 20′ E longitudes. It is surrounded by Andhra Pradesh, Orissa and Maharashtra. It is forest and mineral rich zone with a rich cultural heritage. It has spread over 39,117 km^2 and it is divided into six administratic districts i.e. Bastar, Kondagaon, Sukma, Bijapur, Narayanpur and Dantewada.

2.2 Data for the study

2.2.1 Rainfall Data

Daily rainfall data of 11 stations which come under 6 Districts of Bastar plateau zone of with period of 1985 to 2017, geographic information were collected from the Department of Agrometeorology, IGKV Raipur and Water Recourse Department Raipur.

2.2.2 Wet Spell analysis

Wet spell analysis were worked out using O Resources Software developed by CRIDA Hydrabad (Rao *et al*. 2011) Estimation of extreme rainfall events was done using "Spell Estimator" a FORTRAN Based software and OS which was used to analyze the extreme event. The criteria used for analysis of wet Spell.

The criteria used for analysis of wet Spell.

S. No.	Event Wet Spell	Criteria
1	Wet spell	More than 10 mm for 7 days More than 25 mm for 3 days More than 50 mm for 2 days Extreme RF 100 mm for 1 day

3. Mann-Kendall tests for trend analysis

Mann Kendal has been used to analyze the trend of software. The Mann-Kendall test is a non-parametric test for identifying trends in time series data. The test was suggested by Mann (1945). The test compares the relative magnitudes of sample data rather than the data values. One benefit of this test is that the data need not confirm to any particular distribution.

The Mann- Kendall test assumes that a value can always be declared less than, greater than or equal to another value; that data are independent; and that the distributions of data remain constant in either the original units or transformed units (Helsel and Hirrsch, 1992) [3].

To perform a Mann-Kendall test, the difference between the later-measured value and all earlier-measured values, (xj-xk) were computed, where j>k, and assign the integer value of 1, 0 or -1 to positive differences, no differences and negative differences, respectively.

Let X_1, X_2……. Xn represents n data points where Xj represents the data point at time j. Then the Mann-Kendall statistic (S) is given by

$$S=\Sigma\ \Sigma sign\ (Xj- Xk),\ j=2, 3….n;\ k=1, 2…..j-1$$

Where: sign (Xj-Xk) = 1 if Xj-Xk>0, = 0 if Xj-Xk =0, = -1 if Xj-Xk<0

A very high positive value of S is an indicator of an increasing trend, and a very low negative value indicates a decreasing trend. However, it is necessary to compute the probability associated with S and the sample size, n, to statistically quantify the significance of the trend. For a sample size >10, a normal approximations to the Mann-Kendall test may be used. For this, variance of S is obtained as,

$$V(S) = [n\ (n-1)\ (2n+5) – \Sigma tp\ (tp-1)\ (2tp+5)]\ /18,\ p=1,2…..q$$

Where,

tp is the number of ties for the pth value and q is the number of tied values.

Then standardized statistical test is computed by:

$$Z=S-1/\sqrt{V(S)}\ if\ S>0, =0\ if\ S=0, =S+1/\sqrt{V(S)}\ if\ S<0$$

Presence of a statistically significant trend is evaluated using the Z value and here the statistics Z has a normal distribution. Significance level α is used for testing either an upward or downward monotone trend (a two-tailed test). If Z appears greater than Zα/2 where α depicts the significance level, then the trend is considered as significant. The value for Zα/2 is obtained from the standard normal cumulative distribution tables for the significance levels (α) 0.001, 0.01, 0.05 and 0.1.

4. Results and Discussion

For trend analysis of wet spell carried out on the basis of 4 criteria viz. 10, 25, 50 and 100 mm of different districts under two categories i.e. less than critical value and more than critical value, Mann-Kendall test has applied to understand the trend of wet spell of different districts.

4.1 District wise wet spell analysis

4.1.1 Criteria of less than and more than critical value (10 mm for 7 days)

Bastar, Dantewada, Kondagaon, Narayanpur, and Sukma districts shows non significant increasing trend of wet spell for longest spells, whereas Bijapur district shows non significant decreasing trend. Analysis of wet spell for total spells indicates that there was non significant decreasing trend observed in Bastar, Dantewada, Kondagaon, Narayanpur, and Sukma districts while it was non significant increasing trend in Bijapur. For total days, Bastar, Dantewada and Kondagaon, districts recorded the non significant increasing trend, while Narayanpur and Sukma districts showed the non significant decreasing trend. It was Bijapur district showed significantly decreasing trend of total days.

Five districts observed non significantly decreasing trend of longest spell, while Kondagaon showed non significantly increasing trend Dantewada district showed non significantly increasing trend for total spell. Other five districts recorded non significant decreasing trend. Based on the outcome of total days, Bijapur district recorded significantly increasing trend while other districts showed non significant decreasing trend.

4.1.2 Criteria of less than and more than critical value (25 mm for 3 days)

It can be concluded that Bijapur Dantewada, Kondagaon, Narayanpur, and Sukma districts recorded non significant increasing trend, while only one district, i.e. Bastar showed significantly increasing trend of longest spell. Outcome of analysis of total spell indicates that only Dantewada recorded significantly decreasing trend of wet spell while Bastar, Bijapur, Kondagaon, and Narayanpur, showed the non significant decreasing trend, and only Sukma district showed non significant increasing trend. Analysis for total days indicates that Bijapur and Dantewada showed significantly increasing trend, While Bastar, Kondagaon and Sukma districts showed the non significant increasing trend, and Narayanpur district recorded non significant decreasing trend.

Sukma district indicates the significantly decreasing trend for longest spell, while Bastar, Dantewada and Kondagaon districts recorded non significant increasing trend, Bijapur and Narayanpur district observed that non significant decreasing trend of wet spell. Outcome of the total spells indicates that Bijapur and Sukma districts showed significantly decreasing trend, while other two districts i.e. Bastar and Dantewada recorded non significant increasing trend and district Kondagaon and narayanpur observed non significant decreasing trend, total days indicates that non significant

increasing trend recorded in Kondagaon and Narayanpur district, whereas one district Dantewada, observed significantly decreasing trend, While Bastar Bijapur and Sukma district recorded non significant decreasing trend of wet spell.

4.1.3 Criteria of less than and more than critical value (50 mm for 2 days)

It was observed that Bijapur, Kondagaon and Narayanpur districts shows significantly increasing trend, whereas Bastar and Sukma shows non significant decreasing trend for longest spells, only one district Dantewada recorded non significant increasing trend of wet spell. For total spells, Bastar and Bijapur districts indicates significantly increasing trend, while Dantewada and Kondagaon showed significantly decreasing trend, Narayanpur and Sukma districts recorded non significant increasing trend. Bastar, Dantewada and Narayanpur district, recorded non significant increasing trend, while remaining two districts i.e. Bijapur and Kondagaon observed the significantly increasing trend, only one district Sukma showed non significant decreasing trend of total days.

Non significant increasing trend were observed in Bastar, Dantewada and Narayanpur districts while non significant decreasing trend were showed by Bijapur, Kondagaon and Sukma districts for longest spell. Only one district i.e. Dantewada recorded significantly decreasing trend, While Bastar, and Bijapur districts showed the non significant increasing trend, Kondagaon, Narayanpur and Sukma districts recorded non significant decreasing trend of total spell. Analysis of total days indicates that Bastar, Sukma and Dantewada districts recorded non significant increasing trend, whereas Narayanpur was recorded non significant decreasing trend, while Bijapur district observed significantly increasing trend, only Kondagaon district recorded significantly decreasing trend for total days.

4.1.4 Criteria of less than and more than critical value (100 mm for 1 day)

Bastar, Dantewada and Sukma districts showed non significant decreasing trend while Bijapur, Kondagaon and Narayanpur showed non significant increasing trend for longest spell.For total spells, Bastar Bijapur, Narayanpur and Dantrewada observed significantly increasing trend, whereas Kondagaon and Sukma showed non significant increasing trend. Districts of Bastar, Dantewada and Sukma recorded non significant decreasing trend while Bijapur, Kondagaon and Narayanpur showed non significant increasing trend of total days.

Five district viz. Bastar, Bijapur, Dantewada, Narayanpur, and Sukma recorded non significant increasing trends of longest spell, while only Kondagaon district indicates decreasing trend that too was non significant. Bastar, Dantewada, Narayanpur and Sukma recorded non significant increasing trend while Bijapur and Kondagaon districts showed non significant decreasing trend total spells. For total days, non significant increasing trend of rainfall recorded in Bastar, Dantewada, Narayanpur and Sukma district, while remaining two districts i.e. Bijapur and Kondagaon observed the non significant decreasing trend was observed.

Table 1: Trend analysis of wet spell in 10 mm for 7 days

SN	Districts Name	RF mm/ day	Longest Spells (< Critical Value)	Total Spells (<Critical Value)	Total Days (< Critical Value)	longest Spells (>=Critical Value)	Total Spells (>=Critical Value)	Total Days (>=Critical Value)
1	Bastar	10mm/7days	Inc.(NS)	Dec.(NS)	Inc.(NS)	Dec.(NS)	Dec.(NS)	Dec.(NS)
2	Bijapur		Dec.(NS)	Inc.(NS)	Dec.*	Dec.(NS)	Dec(NS)	Inc.*
3	Dantewada		Inc.(NS)	Dec.(NS)	Inc.(NS)	Dec.(NS)	Inc.(NS)	Dec.(NS)
4	Kondagaon		Inc.(NS)	Dec.(NS)	Inc.(NS)	Inc.(NS)	Dec.(NS)	Inc.(NS)
5	Narayanpur		Inc.(NS)	Dec.(NS)	Dec.(NS)	Dec.(NS)	Dec.(NS)	Inc(NS)
6	Sukma		Inc.(NS)	Dec.(NS)	Dec.(NS)	Dec.(NS)	Dec.(NS)	Inc. (NS)

Table 2: Trend analysis of wet spell in 25 mm for 3 days

SN	Districts Name	RF mm/ day	Longest Spells (< Critical Value)	Total Spells (<Critical Value)	Total Days (< Critical Value)	Longest Spells (>=Critical Value)	Total Spells (>=Critical Value)	Total Days (>=Critical Value)
1	Bastar	25mm/3days	Inc. **	Dec.(NS)	Inc.(NS)	Inc.(NS)	Inc.(NS)	Dec.(NS)
2	Bijapur		Inc.(NS)	Dec.(NS)	Inc.***	Dec.(NS)	Dec.***	Dec.(NS)
3	Dantewada		Inc.(NS)	Dec. **	Inc. **	Inc.(NS)	Inc.(NS)	Dec. **
4	Kondagaon		Inc.(NS)	Dec.(NS)	Inc.(NS)	Inc.(NS)	Dec.(NS)	Inc.(NS)
5	Narayanpur		Inc.(NS)	Dec.(NS)	Dec. NS)	Dec.(NS)	Dec.(NS)	Inc.(NS)
6	Sukma		Inc.(NS)	Inc.(NS)	Inc.(NS)	Dec.**	Dec.*	Dec.(NS)

Table 3: Trend analysis of wet spell in 50 mm for 2 days

SN	Districts Name	RF mm/ day	Longest Spells (< Critical Value)	Total Spells (<Critical Value)	Total Days (< Critical Value)	longest Spells (>=Critical Value)	Total Spells (>=Critical Value)	Total Days (>=Critical Value)
1	Bastar	50mm/2days	Dec.(NS)	Inc.* *	Inc.(NS)	Inc.(NS)	Inc.(NS)	Inc.(NS)
2	Bijapur		Inc.* *	Inc.***	Inc.* *	Dec.(NS)	Inc.(NS)	Inc.* *
3	Dantewada		Inc.(NS)	Dec.*	Inc.(NS)	Inc.(NS)	Dec.*	Inc.(NS)
4	Kondagaon		Inc.* *	Dec.*	Inc.*	Dec.(NS)	Dec.(NS)	Dec.*
5	Narayanpur		Inc.*	Inc.(NS)	Inc.(NS)	Inc.(NS)	Dec.(NS)	Dec.(NS)
6	Sukma		Dec.(NS)	Inc.(NS)	Dec.(NS)	Dec.(NS)	Dec.(NS)	Inc.(NS)

Table 4: Trend analysis of wet spell in 100 mm for 1 day

SN	Districts Name	RF mm/ day	Longest Spells (<Critical Value)	Total Spells (<Critical Value)	Total Days (< Critical Value)	longest Spells (>=Critical Value)	Total Spells (>=Critical Value)	Total Days (>=Critical Value)
1	Bastar	100mm/1 days	Dec.(NS)	Inc.*	Dec.(NS)	Inc.(NS)	Inc.(NS)	Inc.(NS)
2	Bijapur		Inc.(NS)	Inc.***	Inc.(NS)	Inc.(NS)	Dec.(NS)	Dec.(NS)
3	Dantewada		Dec.(NS)	Inc.*	Dec.(NS)	Inc.(NS)	Inc.(NS)	Inc.(NS)
4	Kondagaon		Inc.(NS)	Inc.(NS)	Inc.(NS)	Dec.(NS)	Dec.(NS)	Dec.(NS)
5	Narayanpur		Inc.(NS)	Inc*	Inc.(NS)	Inc.(NS)	Inc.(NS)	Inc.(NS)
6	Sukma		Dec.(NS)	Inc.(NS)	Dec.(NS)	Inc.(NS)	Inc.(NS)	Inc.(NS)

5. Conclusion

It was concluded that from the study, Bijapur showed significantly increasing trend in all of criteria for longest spell, total spell, and total days in less than critical value and Dantewada Destrict recorded significantly decreasing trend of wet spell.

6. References

1. Bhelawe S, Chaudhary JL, Nain AS, Singh R, Khavse R, Chandrawanshi SK. Rainfall Variability in Chhattisgarh State Using GIS. Int. Rese Journal of Environmental Science. 2014; 9(2):519-524.
2. Dabral PP, Purkayastha K, Aram M. Dry and wet spell probability by Markov chain model- a case study of North Lakhimpur (Assam), India. Int. Journal Agric & Bio Eng. 2014; 7(6):1-6.
3. Helsel DR, Hirsch RM. Statistical Methods in Water Resources as Studies in Environmental Science, Elsevier Science Publishers, Netherlands, 1992. ISBN 0-444-88528-5.
4. Lacombe G, Matthew MC. Uncovering consistencies in Indian rainfall trends observed over the last half century Climatic Change. 2014; 123(2):287-299.
5. Manikandan M, Thiyagrajan G, Bhuvanesheswari J, Prabhakaran NK. Wet and Dry spell analysis for agricultural crop planning using Markov Chain probability model at Bhavanisagar. Int. Journal of Math and Comp Applications Research. 2017; 7(1):11-22.
6. Mane MS, Jedhe SH, Kadam US, Patil ST. Probability of dry/wet spell and rainwater availability at Dapoli for rice crop planning. Journal of Agrometeorology. 2016; 18(1):165-167.