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Analysis of rainfall trend in five districts of northern hill zone of Chhattisgarh state

Monika Mahilange and Gopi Krishna Das

Abstract
Long term rainfall data of 40 year from (1973-2015) at five districts *viz.* Balrampur, Jashpur, Koriya, Surajpur and Surguja districts of northern hill zone of Chhattisgarh has here analyzed to story the trend analysis. The rainfall data collected from department of agrometeorology, IGKV Raipur. This data series wite different datanese for different districts was analyzed by using weather cock and Mann Kandell software. Rainfall trend was also analyzed through linear regression line. The data revealed the average annual rainfall of 1146, 1396.6, 1235, 1215 and 1360.4 mm respectively for selected districts *viz.* Balrampur, Jashpur, Koriya, Surajpur and Surguja. When we compare the rainfall pattern of these five districts, a decreasing trend of annual rainfall was reported significant only in Balrampur and Koriya at 5% level of significance. Seasonal (south west monsoon) rainfall trend has been showing a significantly decreasing trend at Jashpur and Koriya at 5% level of significance.

Keywords: Annual and seasonal rainfall trend, data, analysis, northern hill zone

1. Introduction
Rainfall is one of the most important natural input resources to the crop production and its occurrence and distribution is erratic, temporal having spatial variation in nature. The knowledge of rainfall in any particular region is very helpful in sound crop planning (Singh and Sharma, 2003) [5] It is natural to imagine that total agricultural production depends, not only on the total rainfall in season, but also on its pattern of its occurrence. The amount and temporal distribution of rainfall are generally the most important determinate of inter-annual fluctuation in national crop production level. Dore, 2005 [1] and Kumar *et al.* 2010 [2], interpreted that rainfall is the most important but variable climatic parameter in the sub humid region and semiarid tropics. Trend and variability analysis of rainfall in Indian context require urgent and systematic attention due to significant possible implications on fresh water availability, agriculture, food security and primary economic activities, etc. Pandit, 2016 studied the trend in seasonal rainfall of four rainy months i.e. June July, August and September of Rahuri, Ahmednagar India. To determine the rainfall and rainfall analysis is important with respect to crop planning for any region. The trend analysis of rainfall will help in future climate scenarios in northern hill zone and to understand the climate change. In this regard, a detailed study of annual and seasonal rainfall for the study area was understand.

2. Materials and Methods
Chhattisgarh state is divided into three distinct agro climatic zone i.e. Chhattisgarh plains, Bastar plateau and Northern hills zone. Northern hill zone lies between $23^0 37' 25''$to $24^0 6' 17''$ north latitude and $81^0 34' 40''$ to $84^0 4' 40''$ east longitude and there is a lot of topographical variation in the zone as compared to plain zone. The analysis was carried out with five districts of northern hill zone. The districts and their co-ordinates that come under northern hill zone was shown below.

Table 2.1: Geographical locations of selected districts of northern hill zone.

Station	Latitude	Longitude	Altitude
Balrampur	$23^0 11' N$	$83^0 19E$	528 meters
Jashpur	$22° 53' N$	$84^0 12' E$	1200 meters
Koria	$23^0 38' N$	$82^0 38 E$	529 meters
Surajpur	$22^0 94' N$	$83^0 16' E$	528 meters
Surguja	23° 10' N	$83^0 15' E$	623 meters

Data base - Rainfall data base

S.NO.	Station	Database
1.	Balrampur	2003-2015
2.	Jashpur	1977-2015
3.	Koriya	1974-2015
4.	Surajpur	1973-2015
5.	Surguja	1991-2015

Mean rainfall

		Total rainfall
Mean annual Rainfall	=	----------
		Number of Years

Standard Deviation (SD)

Standard deviation	=	$SD\ (\sigma) = \sqrt{\frac{\sum(X - \bar{X})^2}{n-1}}$

- X = Rainfall frequency
- X = Mean rainfall
- n = Number of years

Coefficient of variation

		Standard deviation	
CV %	=	----------	X 100
		Mean	

Weather cock

Weather cock with version 15 is a software developed by Rao *et al*. (2014) under All India Co-ordinate and Research Project CRIDA, Hyderabad. It contents various modules such as contains data management, data quality, daily data conversions, rainfall analysis, 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, rainy days etc.

Trend analysis

A trend is a significant change over time exhibited by a random variable. In general, the magnitude of trend in a time series is determined either using regression analysis (parametric test) or Mann–Kendall's test (non-parametric method). Both these methods assume a linear trend in the time series. In this particular study, both the linear regression and Mann-Kendall' tests were employed.

3. Results and discussion

Trend analysis of five districts of Chhattisgarh has been done in the present study with long period of precipitation data. The result are discussed as below in table and the corresponding SD, CV trend and R^2 value has been shown.

Mean annual rainfall SD, CV of rainfall with the trend equation has been shown in table (3.1). The average annual rainfall was recorded maximum in case of Jashpur (1396.5) mm followed by Surguja (1360.4) mm and Koriya (1234.9) mm while it was recorded minimum in case for Balrampur 1146 mm followed by Surajpur (1215) mm. Similarly variation of the rainfall was found maximum in case of Surajpur (CV 28.7%) followed by Koriya (27.0) and Surguja (26.1%) respectively while it was least in case of Jashpur 18.2%. In case of seasonal rainfall it was observed very well from the table that the maximum amount of rainfall was recorded during south-west monsoon season. The seasonal rainfall was recorded maximum at Jashpur 1238 mm followed by Surguja (1178.7) mm and Koriya (1117.9) mm while it was recorded minimum at Balrampur (1067.2) mm followed by Surajpur (1111.2) mm. Linear trend analysis was also done to find the particular districts wise long term rainfall trend .The annual rainfall trend was found in decreasing way at all the districts but significant decreasing pattern found only at Balrampur and Surajpur at 5% level of significance. Where as in case of south west season rainfall trend it was also found in decreasing way but significantly decreases at Balrampur, Jashpur and Surguja at 5% level of significance.

Table 3.1: Annual and seasonal rainfall, SD CV and trend equation with regression and correlation at five districts of northern hill zone.

	Rainfall			Rainfall Trend		
Balrampur	**Mean**	**SD**	**CV**	**Equation**	**R^2**	**Correlation**
South West	1067.2	275.9	25.9	y = -39.62x + 1344.	0.312	0.558*
North East	62.7	49.7	79.2	y = -4.206x + 92.12	0.108	0.328
Summer	7.74	15.2	197.3	y = -1.556x + 18.63	0.157	0.396
Winter	8.3	17.0	202.9	y = -0.577x + 12.41	0.017	0.130
Annual	1146.0	308.1	26.9	y = -45.96x + 1467.	0.337	0.580*
Jashpur						
South West	1238.0	225.7	18.2	y= -7.132x+1380	0.129	0.359*
North East	78.3	64.1	81.8	y= 1.128x+55.75	0.040	0.200
Summer	48.6	37.6	77.4	y= -0.466x+57.87	0.02	0.141
Winter	31.7	39.8	125.6	y= -0.300x+37.66	0.007	0.083
Annual	1396.5	254.2	18.2	y= -6.771x+1531.	0.092	0.303
Korea						
South West	1117.9	275.0	24.7	y= -1.930X+1159	0.007	0.083
North East	69.0	72.0	104.4	y= 0.777x+52.32	0.017	0.130
Summer	21.2	43.5	205.1	y -0.091x+32.16	0.000	0.000
Winter	27.0	41.2	153.2	y= 0.66x+12.72	0.038	0.194
Annual	1234.9	333.8	27.0	y= -0.584x+1247.	0.000	0.000
Surajpur						
South West	1111.2	354.4	31.9	y= -4.180x+1203	0.021	0.144
North East	49.4	47.8	96.4	y=0.127x+46.66	0.001	0.031
Summer	33.6	68.6	204.3	y= -0.294x+40.06	0.002	0.044
Winter	20.7	32.2	155.8	y= -0.524x+32.24	0.041	0.202
Annual	1215.0	347.7	28.7	y= -15.82x+1566.	0.107	0.327*
Surguja						
South West	1178.7	322.4	27.3	y= -18.11x+1414	0.171	0.413*
North E.	91.0	72.9	80.0	y= 1.441x+72.24	0.021	0.144
Summer	50.8	54.3	107.0	y= 1.111x+36.32	0.022	0.148
Winter	40.0	38.2	95.3	y= -0.256x+43.38	0.002	0.044
Annual	1360.4	355.2	26.1	y= -4.872x+1322.	0.031	0.176

Note – (**) at 1% level of significant and (*) at 5% level of significant

Table 3.2: Mann Kendall test of significance for annual and seasonal rainfall trend of five District of northern hill zone

	Balrampur	Jashpur	Koriya	Surajpur	Surguja
Seasonal					
South West	-1.769**	-2.637**	-0.77	-0.8	-1.57
North East	-1.28*	1.04	1.13	0	0.56
Summer	0.24	-0.75	1.44	-0.05	0
Winter	0.67	-1.38	1.832***	-1.27	0.14
Annual	-1.769**	-2.226*	-0.48	-1.25	-1

(Note – (**) significant at 1 %, (*) significant at 5% and (***) significant at 10 %)

The value comes out by Mann Kendall test for the annual and seasonal rainfall (Table-2). Result showed annual and seasonal rainfall trend for five districts *viz.* Balrampur, Jashpur, Koriya, Surajpur and Surguja of Chhattisgarh state .It can be very well observed from the table that annual rainfall trend was significantly decreasing at Balrampur and Jashpur at 1% and 5% level of significance respectively both the districts was also showed significantly down trend at 1% level of significance during south-west monsoon season. While only Winter season was showed significantly increasing trend at 10% level of significance for Koriya district

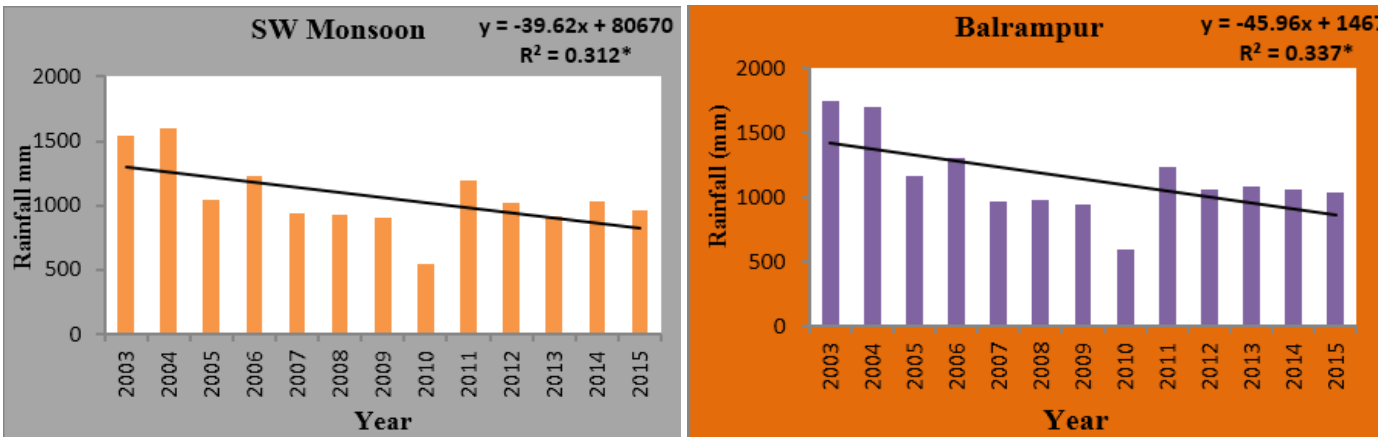

Fig 3.1: Seasonal and annual rainfall trend at Balrampur district

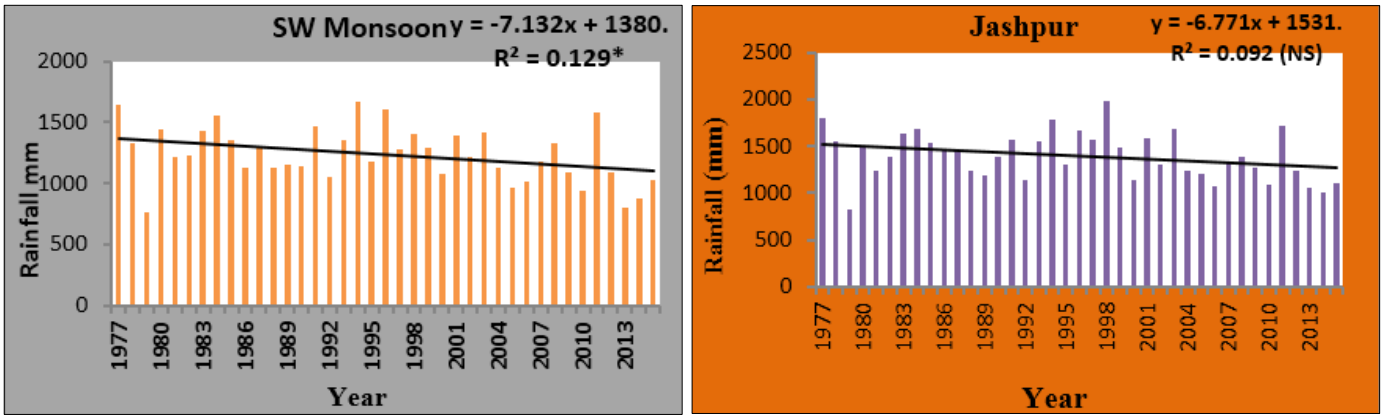

Fig 3.2: Seasonal and annual rainfall trend at Jashpur district

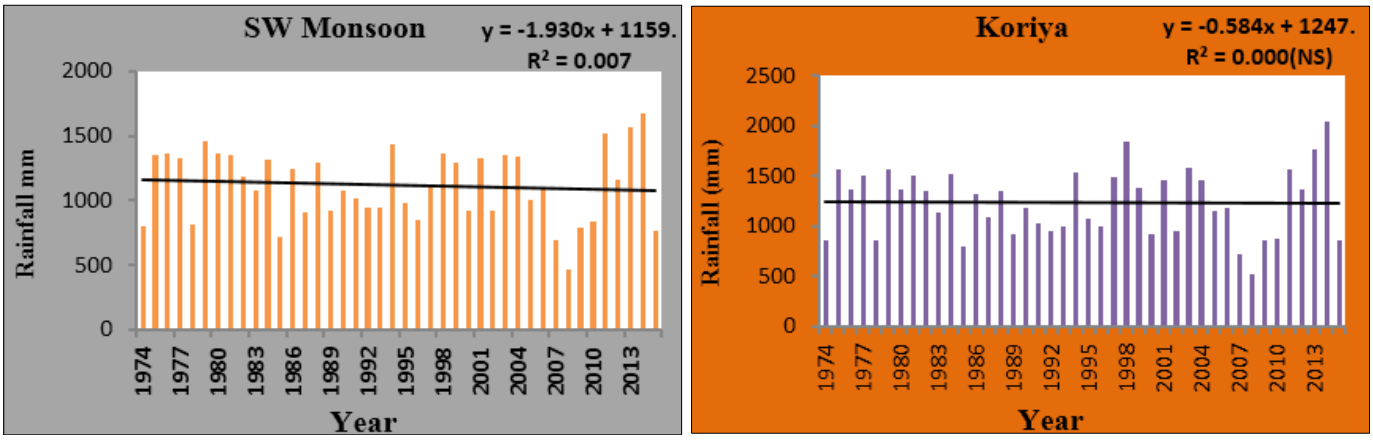

Fig 3.3: Seasonal and annual rainfall trend at Koriya district

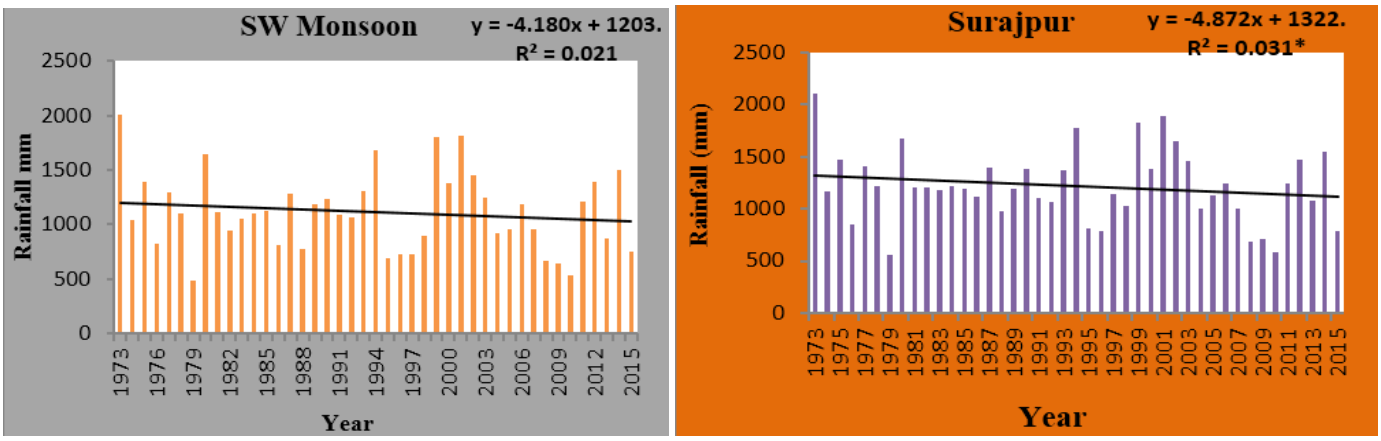

Fig 3.4: Seasonal and annual rainfall trend at Surajpur district

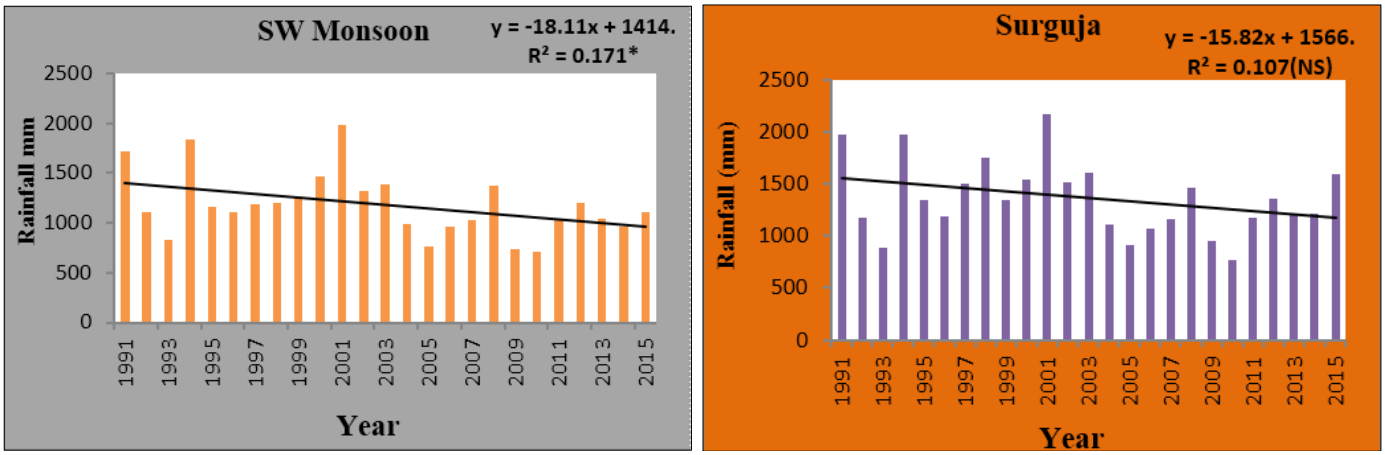

Fig 3.5: Seasonal and annual rainfall trend at Surguja district

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