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Rainfall analysis over Kalyana Karnataka districts for resource planning in agriculture

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ABSTRACT

The study has been made to analyze the rainfall of six districts of Kalyana Karnataka by utilizing the past 50 years (1971-2020) rainfall data. The rainfall data was critically examined and analyzed statistically for annual and seasonal values followed by computation of trend analysis of annual rainfall. The results revealed that, the highest mean annual rainfall was recorded at Bidar (917.8 mm) followed by Yadgir (877.8 mm) and the lowest at Ballari (559.8 mm). The CV varied between 24.0% (Bidar) to 32.6% (Yadgir). From the skewness analysis it was observed that, skewness varied from 0.3 (Bidar and Koppal) to 0.7 (Yadgir and Raichur). The Yadgir district showed zero Kurtosis and the remaining districts were found to be negatively Kurtosis and it varied from -0.1 to -0.6. The Raichur district showed 0.6 positively Kurtosis. From regression analysis, it was found that, the slopes of regression line of annual rainfall are positive at Bidar, Raichur and Koppal. This shows that these districts have increasing annual rainfall trend. However, since the correlation coefficient value (R^2) is too low, the increasing trend is not significant. The remaining stations (Kalaburgi, Yadgir and Ballari) showed negative slope of regression line. This indicates these stations have decreasing trend of annual rainfall. The mean monsoon season rainfall varied between 315.3 mm (Ballari) to 705.8 mm (Bidar) and the CV was found to be more than 30% in all the districts which indicate highly erratic rainfall and the rainfall is not much dependable around the mean rainfall. The skewness analysis revealed that, all the stations showed positive skewness and it varied between 0.3 (Raichur and Koppal) to 0.9 (Yadgir).

Key words : *Rainfall trend, Skewness, Kurtosis, Seasonal rainfall*

Introduction

Study of rainfall over a long period reveals general pattern of rainfall of a particular place and helps in understanding the amount, intensity, distribution and other rainfall characteristics. Efficient cropping systems can be evolved by understanding the rainfall pattern besides taking decision on time of sowing, scheduling of irrigation and time of harvesting. Rainfall analysis is necessary for designing farm ponds, tanks or irrigation projects also. Analysis of long-term rainfall data over different locations of India indicated that monsoon rainfall is trendless. The Indian monsoon rainfall shows an inter-annual variability. There is a need to quantify regional climate variability to assess its effect on crop productivity (Panda and Sahu, 2019).

The pattern and amount of the rainfall are among the most vital factors that affect agricultural production and to India's economy and livelihood of its people (Gajbhiye *et al.*, 2016). The southwest (SW) monsoon brings about 80% of the total precipitation over the country. Changes in the pattern, frequency and variability of SW monsoon (Seo and Ummenhofer, 2017) would have a significant impact on agricultural production, water resources management and overall economy of the country. In view of the above, a number of studies have attempted to investigate the trend of climatic variables for the country.

Kundu *et al.* (2015) has carried out analysis of spatial and temporal variation in rainfall trend of Madhya Pradesh India from 1901-2011. Pal *et al.* (2017) studied the trend analysis of rainfall, temperature and runoff data for rangoon watershed in Nepal. Dugal *et al.* (2018) assessed crop planning based rainfall probability for Bhadrak district of Odisha. Meshram *et al.* (2018) studied statistical evaluation of rainfall time series in concurrence with agriculture and water resources of Ken River basin, Central India from 1901–2010. Deoli and Rana (2019) examined seasonal trend in rainfall and temperature for Udaipur district of Rajasthan. Jaydip *et al.* (2021) has made an attempt to analyze rainfall characteristics and moisture availability index for crop planning in semi arid region of north Gujarat by utilizing thirty years (1990-2019) of rainfall data. Rainfall analysis for crop planning was carried out in different regions of the country as reported by Sevak, *et al.* (2018), Panda and Sahu, 2019, and Abebe, 2020. A similar attempt was made to analyze rainfall over Kalyana Karnataka districts for resource planning in agriculture.

Materials and Methods

Study area

Kalyana Karnataka is a region located in north-eastern part of Karnataka. The region comprises 6 districts namely Bidar, Kalaburagi, Yadgir, Raichur, Koppal and Ballari. The rainfall and temperature analysis was carried out for all districts of Kalyana Karnataka except Yadgir district. The districts selected for the study purpose is presented in Fig. 1. and the geographical locations of the districts are presented in Table 1.

Data used

For the proposed study, the rainfall data of 50 years

Table 1. Details of geographical location of Kalyana Karnataka districts

Sl. No.	Districts	Latitude (°N)	Longitude (°E)
1	Bidar	17° 53' 60.00"	77° 32' 60.00"
2	Kalaburgi	17° 20' 08.99"	76° 50' 15.25"
3	Yadgir	16°46'20.42"	77° 08'25.03"
4	Raichur	16° 11' 60.00"	77° 22' 12.00"
5	Koppal	15° 20' 60.00"	76° 09' 00.00"
6	Ballari	15° 09' 00.00"	76° 55' 48.00"

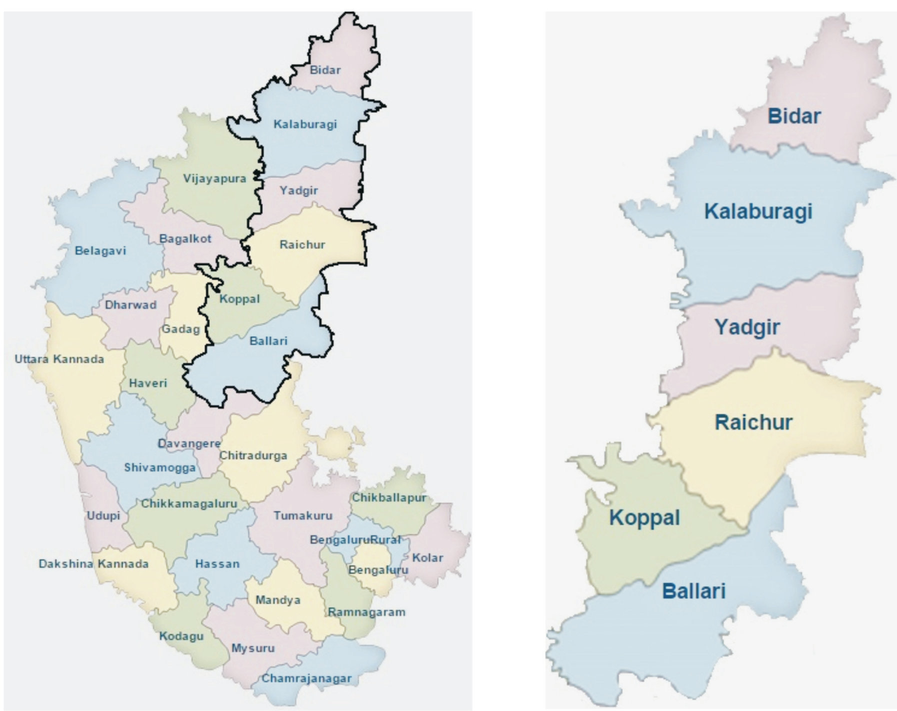

Fig. 1. Location of different districts of Kalyana Karnataka

(1971-2020) was collected from Karnataka State Natural Disaster Monitoring Centre (KSNDMC) Bengaluru.

Statistical analysis of rainfall

The statistical behavior of any hydrological series can be described on the basis of certain parameters. Generally mean, standard deviation, coefficient of variation and skewness coefficient are taken as measures of variability of any hydrologic series. All these parameters have been used to describe the variability of rainfall in the present study. The coefficient of variability (CV) indicates the dependability or reliability of rainfall for any period. Lower values of CV indicate better reliability (Singh *et al.* 2021). The rainfall data was critically examined and analyzed statistically for annual and seasonal values (Ghosh *et al.*, 2021).

Trend analysis

Trend is defined as the general movement of a series over an extended period of time or it is the long-term change in the dependent variable over a long period of time. The statistical method such as regression analysis and coefficient of determination R^2 are used for the significance of trend of rainfall (Arpita and Netrananda, 2019).

Computation of trend values provides with a tool to ascertain, if a locality is getting drier or wetter. In case the rainfall series show a positive trend, the area would be considered to be getting wetter year–by–year or month–by–month. If it is negative, they would imply possible approach of drier conditions (Sridhara and Gopakkali, 2021).

The regression equations were developed and the slopes of the regression lines were compared to know the increasing or decreasing trend of the rainfall. The correlation coefficient values (R^2) of the developed regression equations were critically analyzed to know the significant increasing or decreasing trends at the critical limit value of 0.1 (10%).

Results and Discussion

Statistical analysis of annual rainfall

Annual rainfall data of five districts of Kalyana Karnataka were analyzed statistically and statistical parameters like mean, maximum, minimum, standard deviation, coefficient of variance and skewness and Kurtosis are presented in Table 2. The results revealed that, the highest mean annual rainfall was received at Bidar (917.8 mm) followed by Yadgir (877.8 mm). The lowest mean annual rainfall was received at Ballari (559.8 mm). The difference of 219.5 mm rainfall was observed between highest and lowest mean annual rainfall within the five Kalyana Karnataka districts.

The maximum annual rainfall recorded during study period was highest at Yadgir (1618.6 mm) followed by Bidar (1445.6 mm). Similarly, the lowest minimum annual rainfall recorded during study period was observed at Koppal (314.4 mm) followed by Yadgir (424.3 mm). The standard deviation (SD) varied from 149.0 mm (Ballari) to 286.4 mm (Yadgir). The CV varied between 24.0% (Bidar) to 32.6% (Yadgir). From the skewness analysis it was observed that, skewness varied from 0.3 (Bidar and Koppal) to 0.7 (Yadgir and Raichur). The Yadgir district showed zero Kurtosis and the remaining districts were found to be negatively Kurtosis and it varied from -0.1 to -0.6. The Raichur district showed 0.6 positively Kurtosis.

Trend analysis of annual rainfall

The trend analysis for annual rainfall was carried out to know the significant increasing or decreasing trend of annual rainfall over five districts of Kalyana Karnataka are presented in Fig. 2-6. The significant increase or decrease was considered at R^2 value of 0.1 (10 % reliability). The positive slopes and negative slopes of regression lines indicate increasing and decreasing trends respectively.

From regression analysis, it was found that, the

Table 2. Annual rainfall parameters over Kalyana Karnataka districts

Station	Mean (mm)	Lowest (mm)	Highest (mm)	SD (mm)	CV (%)	Skewness	Kurtosis
Bidar	917.8	396.6	1445.6	220.0	24.0	0.3	-0.1
Kalaburgi	773.5	358.7	1295.1	223.1	28.8	0.5	-0.1
Yadgir	877.8	424.3	1618.6	286.4	32.6	0.7	0.0
Raichur	684.4	342.2	1320.8	204.3	29.9	0.7	0.6
Koppal	590.3	314.4	906.2	149.4	25.3	0.3	-0.6
Ballari	559.8	340.5	957.9	149.0	26.6	0.6	-0.1

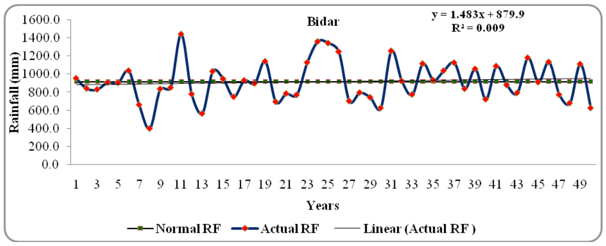

Fig. 2. Annual variability and trend of rainfall of Bidar

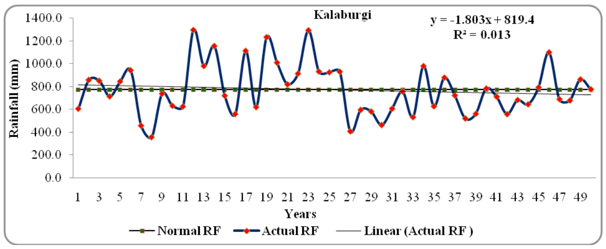

Fig. 3. Annual variability and trend of rainfall of Kalaburgi

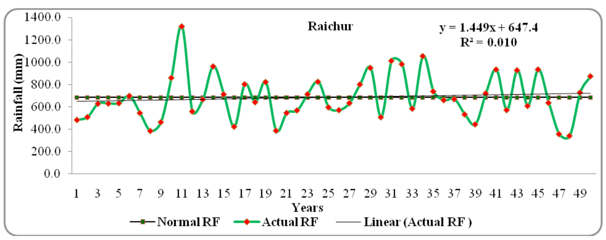

Fig. 4. Annual variability and trend of rainfall of Raichur

slopes of regression line of annual rainfall are positive at Bidar, Raichur and Koppal. This shows that these districts have increasing annual rainfall trend. However, since the correlation coefficient value (R^2) is too low, the increasing trend is not significant. The remaining districts (Kalaburgi, Yadgir and Ballari) showed negative slope of regression line. This indicates these districts have decreasing trend of annual rainfall.

Analysis of seasonal rainfall

Season rainfall analysis was carried out for five districts of Kalyana Karnataka region to know the contribution of seasonal rainfall towards the mean annual rainfall which is a key factor for dryland crop production. The average seasonal rainfall and its variability during the seasons winter (January- February), summer (March- May), monsoon (June - September) and post monsoon (October- December) are presented in Table 3, it is revealed that the mean monsoon season rainfall varied between 315.3 mm (Ballari) to 705.8 mm (Bidar). The CV of monsoon season rainfall varied from 29.2% (Bidar) to 39.3% (Yadgir). For monsoon season, Bidar district showed moderate degree of variability of CV 29.2 % within the threshold limit (20 < CV < 30%). The CV was found to be more than 30% in all the districts which indicate highly erratic rainfall and the rainfall is not much dependable around the mean rainfall. The skewness analysis revealed that, all the stations showed positive skewness and it varied between 0.3 (Raichur and Koppal) to 0.9 (Yadgir).

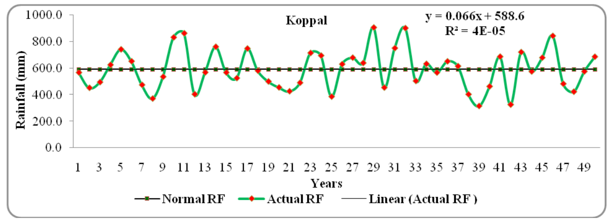

Fig. 5. Annual variability and trend of rainfall of Koppal

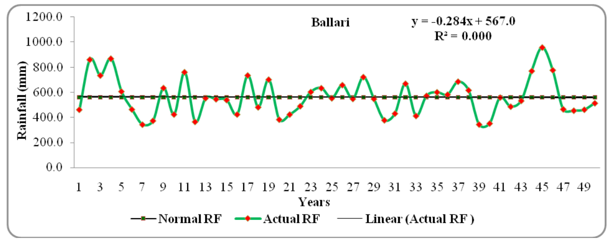

Fig. 6. Annual variability and trend of rainfall of Ballari

The mean, maximum, minimum, SD, CV and skewness analysis of post monsoon revealed that the mean post monsoon season rainfall varied between 120.5 mm (Kalaburgi) to 152.9 mm (Ballari). The mean *rabi* season rainfall was found to be greater than 120 mm except Ballari. The CV of post monsoon season rainfall varied from 54.6% (Ballari) to 95.8% (Raichur). For post monsoon season also, none of the districts showed CV within the threshold limit (< 50 %) which indicates highly erratic rainfall and the rainfall is not much dependable around the mean. The skewness analysis revealed that all the stations showed positive skewness and it varied between 0.7 at Ballari to 2.4 at Raichur.

The statistical parameters of mean summer season rainfall varied between 63.4 mm (Kalaburgi) to 84.3 mm (Ballari). The mean summer season rainfall was found to be greater than 60 mm. The CV of summer season rainfall varied from 63.5 % (Ballari) to 75.6 % (Raichur). It was also observed that, the CV of Ballari (63.5 %) is much lesser than the thresh-

Table 3. Characteristics of seasonal rainfall of Kalyana Karnataka districts

Seasons	Districts	Mean (mm)	Lowest (mm)	Highest (mm)	SD (mm)	CV (%)	% of annual RF	Skewness	Kurtosis
Winter	Bidar	14.2	0.0	93.7	23.5	164.7	1.6	1.9	2.8
	Kalburgi	9.5	0.0	74.7	16.3	172.5	1.2	2.3	6.1
	Yadgir	9.0	0.0	91.4	20.0	222.0	1.0	2.6	6.6
	Raichur	4.2	0.0	40.4	9.7	232.6	0.6	2.7	6.7
	Koppal	1.9	0.0	30.9	5.8	297.9	0.3	3.7	15.0
	Ballari	7.3	0.0	73.0	16.5	225.7	1.3	2.8	7.8
Summer	Bidar	71.2	5.8	297.4	51.0	71.7	7.8	2.0	6.9
	Kalburgi	63.4	0.0	238.4	45.1	71.1	8.2	1.4	3.4
	Yadgir	68.0	0.0	260.1	50.8	74.7	7.8	1.6	3.5
	Raichur	67.6	4.0	205.6	51.1	75.6	9.9	1.1	0.6
	Koppal	75.8	4.4	202.8	50.1	66.1	12.8	0.7	0.0
	Ballari	84.3	14.0	227.9	53.5	63.5	15.1	1.0	0.5
Monsoon	Bidar	705.8	252.1	1254.3	206.0	29.2	76.9	0.4	0.6
	Kalburgi	580.1	195.0	1108.3	202.0	34.8	75.0	0.5	0.2
	Yadgir	666.7	216.2	1483.3	262.3	39.3	76.0	0.9	0.9
	Raichur	484.2	165.0	813.7	151.3	31.2	70.7	0.3	-0.3
	Koppal	374.8	169.0	698.1	116.8	31.2	63.5	0.3	0.1
	Ballari	315.3	124.1	582.8	97.4	30.9	56.3	0.4	0.3
Post monsoon	Bidar	126.6	6.8	353.3	99.4	78.5	13.8	0.8	-0.2
	Kalburgi	120.5	10.0	428.9	77.5	64.4	15.6	1.4	3.6
	Yadgir	134.1	5.0	418.0	97.6	72.8	15.3	1.2	1.4
	Raichur	128.5	5.0	680.4	123.1	95.8	18.8	2.4	7.7
	Koppal	137.8	13.8	447.1	86.4	62.7	23.3	1.2	2.0
	Ballari	152.9	29.0	401.1	83.5	54.6	27.3	0.7	0.2

old limits which imply the mean summer season rainfall of Ballari is highly dependable. However all the other stations showed CV above the threshold limits which indicates, highly erratic rainfall and the rainfall is not much dependable. The skewness analysis revealed that all the stations showed positive skewness and it varied between 0.7 at Koppal to 2.0 in Bidar.

Similarly, Alam, *et al.* (2015) reported weekly rainfall analysis for crop planning in rainfed Shiwalik Himalayas of India. Panda and Sahu (2019) reported trend analysis of seasonal rainfall and temperature pattern in Kalahandi, Bolangir and Koraput districts of Odisha, India. Asfaw *et al.* (2018) reported variability and time series trend analysis of rainfall and temperature in north central Ethiopia, a case study which was conducted in Wolek a sub-basin. Sinha *et al.* (2020) reported extreme rainfall trends over Chhattisgarh state of India.

Conclusion

The following conclusions can be made based on the analysis. The results revealed that 56-76 % of the total annual rainfall is received during SW monsoon months (June–September) in all districts of Kalayan Karntaka . Post monsoon post monsoon (October-December) account 13-27 % while pre monsoon or summer month (March- May) accounts 7-15 % of total yearly rainfall. The *kharif* season crops and their varieties may be chosen with short and medium duration growing period to avoid moisture stress as well as *In–situ* moisture conservation practices like mulching, use of anti–transpirants, control of weeds, adequate plant stands should be adopted and to mitigate the effect of dry spell during critical crop growth stages provide live saving or supplemental irrigation through use of sprinkler or drip system.

The major part of the Kalayan Karnataka is dominated by black cotton soils. The important crops like Bt. cotton, maize, chilli, groundnut, jowar, bajra and rabi sorghum can be successfully grown under rainfed conditions. Mid season correction crop like sunflower is recommended as a contingent crop under late onset of monsoon (July and early August). *Rabi* crops like winter sorghum, safflower and chickpea are recommended for this period which can be grown on residual soil moisture. The millets like finger, little and kodo millets can be grown as a contingent crops during delayed rains.

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Conflict of Interest Statement: The author(s) declare(s) that there is no conflict of interest.

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References

Abebe, T.H. 2020. Time series analysis of monthly average air temperature and rainfall using seasonal arima model in case of ambo area, Ethiopia. *International Journal of Theoretical Applied Maths.* 6(5) : 76-87.

Alam, N.M., Jana, C., Panwar, P., Kumar, G., Mishra, P.K., Sharma, N.K. and Tiwari, A.K. 2015. Weekly rainfall analysis for crop planning in rainfed Shiwalik Himalayas of India. *Journal of Agrometeorology*. 17(2): 234-240.

Pal, A. B., Khare, D., Mishra, P.K. and Singh, L. 2017. Trend analysis of rainfall, temperature and runoff data: A case study of rangoon watershed in Nepal. *International Journal of Students' Research in Technology & Management.* 5 (3) : 21-38.

Asfaw, A., Simane, B., Hassen, A. and Bantider, A. 2018. Variability and time series trend analysis of rainfall and temperature in northcentral Ethiopia: A case study in Woleka sub-basin. *Weather and Climate Extremes.* 19 : 29-41.

Deoli, V. and Rana, S. 2019. Seasonal Trend Analysis in Rainfall and Temperature for Udaipur District of Rajasthan. *Current World Environment*. 14 (2) : 312-319.

Dugal, D., Mohapatra, A.K.B., Pasupalak, S., Rath, B.S., Baliarsingh, A., Khuntia, A. and Panigrahi, A.N.G. 2018. Crop planning based on rainfall probability for Bhadrak district of Odisha. *Pharma Innovation.* 7(11): 162-167.

Gajbhiye, S., Meshram, C., Singh, S.K., Srivastava, P.K. and Islam, T. 2016. Precipitation trend analysis of Sindh River basin, India, from 102-year record (1901-2002). *Atmospheric Science Letters*. 17 : 71–77.

Jaydip J.M., Deora, B.S., Patel, C.K., Parmar, B.S. and Saini, A.K. 2021. Analysis of rainfall characteristics and moisture availability index for crop planning in semi arid region of north Gujarat. *Journal of Agrometeorology.* 23 (4) : 409-415.

Meshram, S.G., Singh, S.K., Meshram, C., Deo, R.C. and Ambade, B. 2018. Statistical evaluation of rainfall time series in concurrence with agriculture and water resources of Ken River basin, Central India (1901–2010). *Theoretical and Applied Climatology.* 134: 1231–1243. https://doi.org/10.1007/s00704-017-2335-y.

Panda, A. and Sahu, N. 2019. Trend analysis of seasonal rainfall and temperature pattern in Kalahandi, Bolangir and Koraput districts of Odisha, India. *Atmospheric Science Letters*. 20 : 932-936.

Kundu, S., Khare, D., Mondal, A. and Mishra, P.K. 2015. Analysis of spatial and temporal variation in rainfall trend of Madhya Pradesh India (1901-2011). *Environmental Earth Sciences*. 73(12) : 8197-8216. https://doi.org/10.1007/s12665-014-3978-y.

Seo, H. and Ummenhofer, C. 2017. Intra-seasonal rainfall variability in the Bay of Bengal during the summer monsoon: coupling with the ocean and modulation by the Indian Ocean dipole. *Atmospheric Science Letters*. 18 : 88–95. https://doi.org/10.1002/asl.729.

Sevak, D., Patel, P.H., Chaudhary, M.G. and Desai, A.I. 2018. Variability and trend analysis of rainfall for crop planning and management. *International Journal of Agricultural Sciences.* 10(6) : 5554-5557.

Sinha, H.K., Manikandan, N., Chaudhary J.L. and Nag S. 2020. Extreme rainfall trends over Chhattisgarh state of India. *Journal of Agrometeorology.* 22 (2) : 215-219.

Singh, R.N., Sonam, S., Gaurav, C., Bappa, D. and Pathak, H. 2021. Innovative trend analysis of rainfall in relation to soybean productivity over western Maharashtra. *J. Agrometeorol.* 23 (2) : 228-235.

Ghosh, A., Nanda, M.K., Sarkar, D., Sarkar, S., Brahmachari, K. and Ray, K. 2021. Assessing the agroclimatic potentiality in Indian Sundarbans for crop planning by analyzing rainfall time series data. *Journal of Agrometeorology.* 23 (1) : 113-121.

Sridhara, S. and Pradeep Gopakkali, 2021. Trend and change point detection of seasonal rainfall for effective crop planning over southern transition zone of Karnataka, India. *Journal of Agrometeorology.* 23 (3) : 316-323.

Panda, A. and Sahu, N. 2019. Trend analysis of seasonal rainfall and temperature pattern in Kalahandi, Bolangir and Koraput districts of Odisha, India. *Atmopheric Science Letters.* 20 : e932.