

International Journal of Scientific Research and Reviews

On The Spatial Variations of Rainfall In Kerala Durinf The Great Floods of The Year 1924

C. Sunilkumar Morais¹, T. E. Girish^{2*}, M. S. Baburaj³ and R G Abhilash Kumar⁴

¹Manonmanium Sundaranar University, Tirunelveli-627012, India.

^{2*}Department of Physics, University College, Trivandrum 695034, India

³Department of Physics, Christian College, Kattakada, Trivandrum, India.

⁴Department of Physics, Govt college for Women, Vazuthacaud, Trivandrum, India.

ABSTRACT

The total damage related to 2018 August floods in Kerala is more than thirty thousand crores of Indian rupees and casualties involved in this havoc is about 483. In this paper we have studied the spatial variations of rainfall during the great 1924 floods in Kerala. This flood on an average is found to be three times more than the intense than 2018 Kerala floods and is perhaps the largest of that kind during the past 180 years. Rainfall data of 74 stations in Kerala covering 14 districts is analyzed to find deviations from normals during the flood month (1924 July) and during the summer monsoon season for this year. In comparison with rainfall data in Kerala during 2018 floods it is found that Idukki district is the most flood prone district in Kerala followed by Malappuram, Ernakulam, Kottayam, Kollam and also possibly Wayanad. Very intense daily rainfall spells (more than 300 mm) is observed in Mananthody in Wayanad district and Nilambur in Malappuram district for the flood months of both 1924 and 2018 in Kerala. and The safety of important dams in Kerala like Mullaperiyar is matter of concern in this context.

KEYWORDS: 1924 floods, Kerala, rainfall, spatial variations, 2018 floods.

***Corresponding Author**

Dr T. E. Girish

Associate Professor and Head (Retd)

Department of Physics, University College

Trivandrum-695034, Kerala, India

E mail : tegirish5@yahoo.co.in Mobile : 9446967462

1 INTRODUCTION

Floods are natural calamities which can cause human casualties as well as severe damages with significant economic impacts. Increase in extreme rainfall events in India are now being associated with climate change effects.^{1,2} August 2018 floods in Kerala³ and 2015 floods in Chennai⁴ are recent examples of unpredicted severe flood occurrences. Meteorological origin of floods which occurred in different parts of India during 1908-1982 has been studied previously.⁵ In this paper we have studied spatial variations in the intensity of rainfall in 14 districts of Kerala during the great floods of 1924 using relevant rainfall data of 72 stations. Results of this study suggest that this flood is possibly the most intense of that kind in Kerala for the past 180 years. Idukki district is identified to be the most flood prone district in Kerala followed by Malappuram, Palakkad, Ernakulam, Kottayam, Kollam and possibly Wayanad. The present results are also compared with the same from 2018 floods in Kerala.

2 Spatial variations of rainfall in Kerala during the flood month and summer monsoon season of the year 1924

In Fig 1 we have plotted monthly rainfall for the Kerala meteorological subdivision during the year 1924.⁶ July rainfall in Kerala is observed to be the month of maximum rainfall during this year and can be understood as the flood month. The state of Kerala is now divided into 14 districts (in the order increasing geographic latitude) viz. Trivandrum, Kollam etc. We could collect monthly rainfall data for 74 stations in Kerala during the year 1924.⁷ Monthly and summer monsoon rainfall normals of different stations in Kerala are reported in previous studies.^{8,9} If any normal is missing for any station we have supplemented the same by calculating the same from published rainfall data for the years 1901-1950.⁴ We have studied the following rainfall related parameters of Kerala during the year 1924 in this paper :-

- i. July month rainfall for the given rainfall observing station in Kerala
- ii. Deviation (in %) of (i) from the respective normal values ($\delta R_f 1$) for July for this station
- iii. Summer monsoon (SM) total rainfall for the given rainfall station in Kerala
- iv. Deviation of SM rainfall (in %) of the station from the respective normal values ($\delta R_f 2$).
- v. The ratio of July to June rainfall for the rainfall station
- vi. The ratio of July rainfall of the station with SM rainfall (in %).

These parameters for different rainfall stations in different districts in Kerala is given in Tables 1-4. Since we have suspected some errors in published rainfall data for two stations in Wayanad district they are not included in this study.

Table1 : “Selected meteorological parameters related to rainfall variations in different stations in the Trivandrum, Kollam, Pathanamthitta and Kottayam districts during the summer monsoon season in Kerala for the flood year 1924”.

Name of station	1924 July RF (mm)	Deviation from normal (δR_{f1})%	1924 SM RF (mm)	Deviation from normal (δR_{f2}) %	July/June RF ratio	July/SM RF ratio
<u>Trivandrum</u>						
1 Attingal	525.02	89.13	2117.09	129.69	0.622	24.80
2 Nedumangad	585.47	157.24	2034.27	153.90	0.764	28.78
3 Neyyattinkara	579.94	209.80	1638.53	123.24	0.952	35.40
4 Parasala	525.78	267.68	1421.64	132.03	1.131	36.98
5 Trivandrum	542.54	143.29	1778.76	120.12	0.830	30.50
<u>Kollam</u>						
6 Karunagappally	683.51	75.44	2230.11	52.04	0.892	30.65
7 Punalur	1016.25	44.60	2675.39	2.39	1.175	37.99
8 Kottarakkara	914.65	112.56	2667.21	102.28	1.134	34.29
9 Aryankavu	1372.36	219.46	2907.01	25.53	1.819	47.21
10 Kollam	713.23	88.74	2110.74	61.95	0.948	33.79
11 Paravur	741.93	129.06	2084.31	108.37	1.111	35.60
<u>Pathanamthitta</u>						
12 Pathanamthitta	646.18	20.85	2288.01	28.90	0.862	28.2
13 Konni	1601.98	166.77	3701.80	18.51	2.131	43.2
14 Adoor	944.37	91.17	2589.78	84.32	1.159	36.4
15 Thiruvalla	962.15	68.80	2889.21	63.32	0.842	33.3
<u>Kottayam</u>						
16 Kottayam	1216.66	89.48	3159.76	65.16	1.145	38.50
17 Pala	1739.9	135.41	4395.47	90.95	1.325	39.58
18 Ettumanur	1343.41	94.56	3275.58	205.81	1.098	41.01
19 Kangairapally	1557.02	117.67	3511.51	52.93	1.712	44.34
20 Changanaserry	1013.21	79.30	2995.68	69.92	0.929	33.82

Table 2. “Selected meteorological parameters related to rainfall variations in different stations in the Alleppy, Idukki and Ernakulam districts during the summer monsoon season in Kerala for the flood year 1924”.

Name of station	1924 July RF (mm)	Deviation from normal ($\delta R_f 1$) %	1924 SM RF(mm)	Deviation from normal ($\delta R_f 2$) %	July/June RF ratio	July/SM RF ratio (%)
<u>Alleppy</u>						
21 Chenganur	1257.55	128.48	3016	56.33	1.2793	41.69
22 Harippad	777.24	53.30	2573	38.28	0.7439	30.20
23 Mavelikkara	837.18	45.65	2491	43.79	0.9075	33.60
24 Kayamkulam	736.85	52.24	2561	84.59	0.8018	28.77
25 Alleppy	898.14	46.64	2626	44.34	1.0103	34.20
26 Arukutty	1398.27	112.73	3489	64.88	1.2922	40.07
27 Cherthala	978.66	72.33	2847	57.36	0.8684	34.36
28 Ambalappuzha	718.57	46.74	2135	23.52	0.6908	33.65
<u>Idukki</u>						
29 Chinnar	309.37	274.77	630.9	272.41	3.8302	49.03
30 Marayur	1055.62	251.87	1530	175.39	5.3626	68.98
31 Munnar	2738.12	143.89	4619	56.52	2.7698	59.27
32 Devikulam	2147.57	181.76	3940	100.62	2.2613	54.51
33 Santhanpara	1158.75	314.73	1951	133.24	2.8873	59.36
34 Kumily	1565.91	370.24	2626	189.95	3.8173	59.62
35 Karikode	1830.32	131.25	4342	78.24	1.5270	42.15
36 Peerumedu	2666.73	148.62	5190	62.75	2.1112	51.38
<u>Ernakulam</u>						
37 Parur						
38 Perumbavur	1352.55	115.86	387	31.0	1.1272	34.94
39 Aluva	1542.29	94.12	420	113.2	1.0070	36.67
40 Muvattupuzha	1517.14	107.69	3968	173.7	1.0575	38.23
41 Vaikom	1531.87	102.71	4136	79.4	1.1364	37.03
42 Ernakulam	1165.35	83.81	3274	60.8	0.9939	35.59
43 Fortcochin	1324.86	109.23	3626	76.1	0.9864	36.53
	1258.06	104.83	332	58.7	1.1053	37.80

Table 3: “Selected meteorological parameters related to rainfall variations in different stations in the Thrissur, Palakkad and Malappuram districts during the summer monsoon season in Kerala for the flood year 1924”

Name of station	1924 July RF (mm)	Deviation from normal ($\delta R_f 1$) %	1924 SM RF (mm)	Deviation from normal ($\delta R_f 2$) %	July/June RF ratio	July/SM RF ratio (%)
<u>Thrissur</u>						
44 Chavakkadu	1317.24	80.07	3788.66	74.93	0.8640	34.77
45 Triprayar	1471.42	130.06	3762.25	101.66	1.07797	39.11
46 Kodungalur	1310.64	84.03	3712.21	23.84	0.9946	35.31
47 Mukunthapuram	1444.24	89.78	4241.04	35.38	0.9882	34.05
48 Trichur	1187.2	57.91	3243.58	43.08	1.1255	36.61
49 Thottappilly	1439.42	108.81	3924.05	95.40	0.9899	36.68
<u>Palakkad</u>						
50 Alathur	1419.86					
51 Palakkad	1367.79	130.24	2966.97	95.39	1.7502	47.86
52 Parli	1337.06	92.81	2564.64	68.47	2.1766	53.33
53 Ottappalam	1326.64	177.93	3002.28	28.07	1.6775	44.53
54 Cherpalasari	1595.12	93.22	3320.80	88.61	1.2152	39.95
55 Mannarkadu	2064.26	124.85	3819.91	116.82	1.4227	41.76
56 Chittur	1109.22	172.37	4125.47	47.15	1.8206	50.04
<u>Malappuram</u>						
57 Perunthalmanna		123.02	3808.48	36.61	1.5936	44.46
58 Ponnani	1693.16	70.47	3402.08	70.04	1.0911	35.87
59 Manjeri	1220.22	132.32	3915.92	82.81	1.9584	49.41
60 Nilambur	1934.97	167.56	3747.52	87.34	3.0385	61.52
	2305.30					

Table 4: “Selected meteorological parameters related to rainfall variations in different stations in the Kozhikode, Wayanad, Kannur and Kasaragod districts during the summer monsoon season in Kerala for the flood year 1924”

Name of station	1924 July RF (mm)	Deviation from normal ($\delta R_f 1$) %	1924 SM RF (mm)	Deviation from normal ($\delta R_f 2$) %	July/June RF ratio	July/SM RF ratio (%)
<u>Kozhikkode</u>						
61 Vadakara	1714.5	71.06	4018.79	55.75	1.41	42.66
62 Kuttiyadi	2385.06	86.61	5346.45	73.36	1.54	44.61
63 Quilandy	1664.72	75.29	3721.1	28.42	1.57	44.74
64 Thirurangady	1393.19	130.56	3314.95	55.74	1.39	42.03
65 Kozhikkode	1479.3	72.55	3483.86	51.78	1.48	42.46
<u>Wayanad</u>						
66 Vaithiri						
67 Mananthavady						
<u>Kannur</u>						
68 Irikkur						
69 Payyannur	2150.11	73.82	4438.65	62.71	1.99	48.44
70 Thalipparambu	1450.34	37.12	3761.23	41.83	1.11	38.56
71 Kannur	1683	50.35	3812.29	44.08	1.56	44.15
72 Thalaseri	1741.42	76.06	3953.76	44.25	1.27	44.04
<u>Kasaragod</u>						
73 Hosdurg	1304.8	21.90	3571.24	24.04	1.20	36.54
74 Kasaragod	1275.08	22.35	3462.02	16.91	1.14	36.83

Table 5: “District averages of rainfall (RF) deviations from normal during the July month and Summer monsoon (SM) season for the year 1924. District averages of SM season RF deviations for 2019 is also given for comparison”

District	Station with max RF in July 1924	RF dev Mean- July ($\delta R_f 1$ in %) 1924	RF dev Mean –SM ($\delta R_f 2$ in %) 1924	RF dev Mean SM ($\delta R_f 2$ in %) 2018
1 Trivandrum	Parassala	173.43	131.8	17.5
2 Kollam	Aryankavu	111.64	58.76	28.05
3 Pathanamthitta	Konni	86.89	48.76	26.72
4 Aleppy	Chengannur	69.78	51.64	
5 Kottayam	Pala	103.28	96.95	26.86
6 Idukki	Kumily	227.14	133.64	67.8
7 Ernakulam	North Parur	102.8	84.75	25.33
8 Thrissur	Trippayar	91.8	62.38	-2.6
9 Palakkad	Parli	130.8	71.94	51.28
10 Malappuram	Nilambur	123.34	69.2	32.12
11 Wayanad	Mananthody	.> 93.2		
12 Kozikode	Tirurangadi	87.21	53	14.7
13 Kannur	Thalassery	62.9	49.86	-1.15
14 Kasargod	Kasargod	22.12	20.5	-19.47

3. DISCUSSION

There are several studies on the rainfall variability in Kerala during different seasons.^{10,11} However there are no detailed studies previously on the spatial variations of rainfall in Kerala during the great floods of the year 1924. Intense rainfall spells in northern Kerala during July 1924 in association with the synoptic weather conditions has been discussed in a previous study.⁵ Rainfall observations of 74 stations in Kerala are available for this flood year. Published IMD Data for two stations in Wayanad district viz. Vythiri and Mananthody are suspected to be erroneous and hence they are not included in the present study. However intense daily rainfall data for 1924 July 12 to 25 is available for these stations from an independent report.⁵ This data is plotted in Fig 1 and Fig 2 respectively for Vythiri and Manthody. From the sum of the rainfall for these days we have

estimated deviation from July normal values for these stations . $\delta R_f 1$ for Vythiri is estimated to be > 71.4 % and for Mananthody is found to be >115 %.

From the daily rainfall data of Northern Kerala stations during occasions of intense spells for the month of July 1924⁵ we can find that maximum daily rainfall for this month occurred during July 17th and it is highest for stations in Wayanad (see Fig 1 and 2) followed by Nilambur (Malappuram district) registering more than 300 mm/day. During 2018 August also highest rainfall spells occurred in Nilambur (398 mm) followed by Mananthody in Wayanad district.¹² In Table 5 we have given the station for each district with maximum $\delta R_f 1$, district averages of $\delta R_f 1$ and $\delta R_f 2$. District averages of $\delta R_f 2$ published by IMD for the 2018 floods in Kerala¹³ is also included in this Table for comparison. Kerala state averages of some of these parameters separately for 1924 and 2018 floods are also given in this Table.

If we consider rainfall deviations for summer monsoon months from normals for Kerala state as a whole we can find the following results for the year 1924: June (+49 %), July (98 %), August (+55 %) and September (+15 %).The deviation of summer monsoon total rainfall in Kerala from the normals for 1924 is 62.4 %.If compare similar results for the 2018 floods in Kerala the deviation from normal for summer monsoon rainfall is only +23 %. From available data it can be inferred that 1924 floods is the most intense of that kind in Kerala during the past 180 years.¹⁴

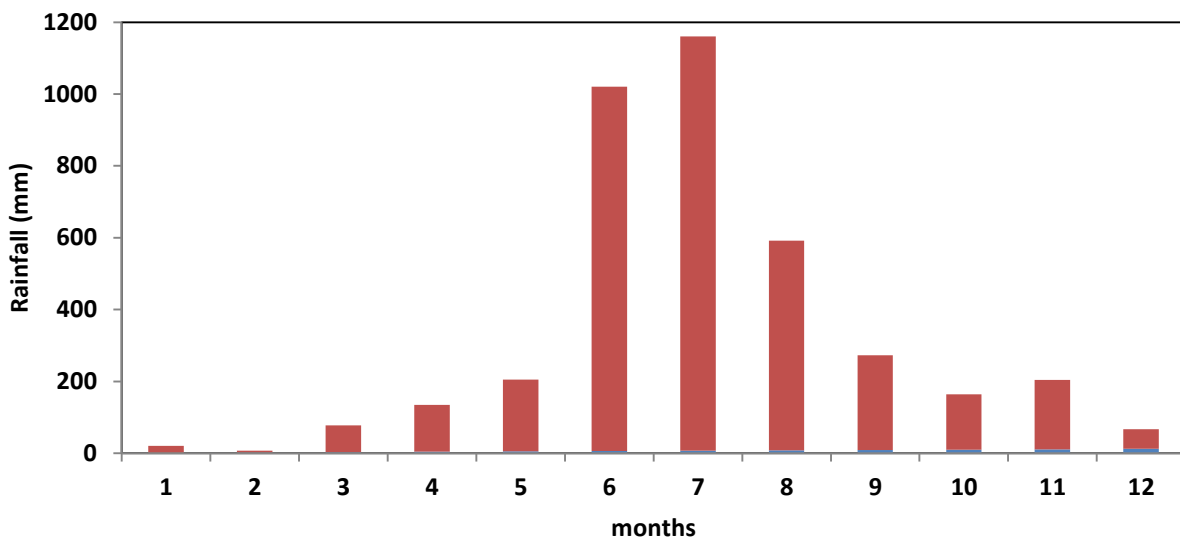


Figure 1: Monthly rainfall of Kerala state during the year 1924

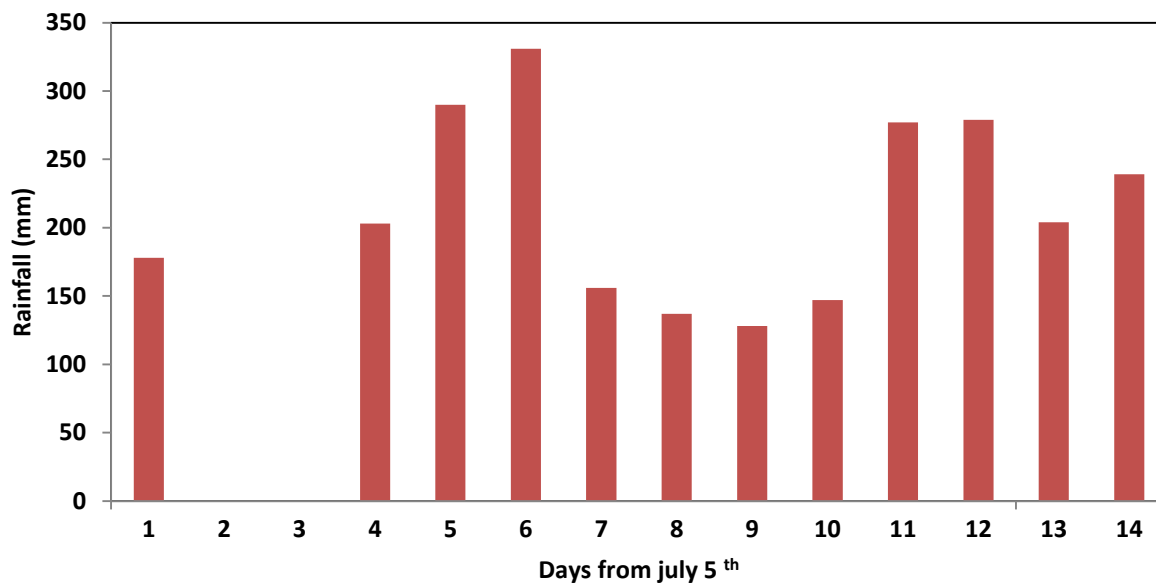


Figure 2: Daily rainfall of Mananthody (Wayanad district) during days with intense fall of rain for the month of July 1924

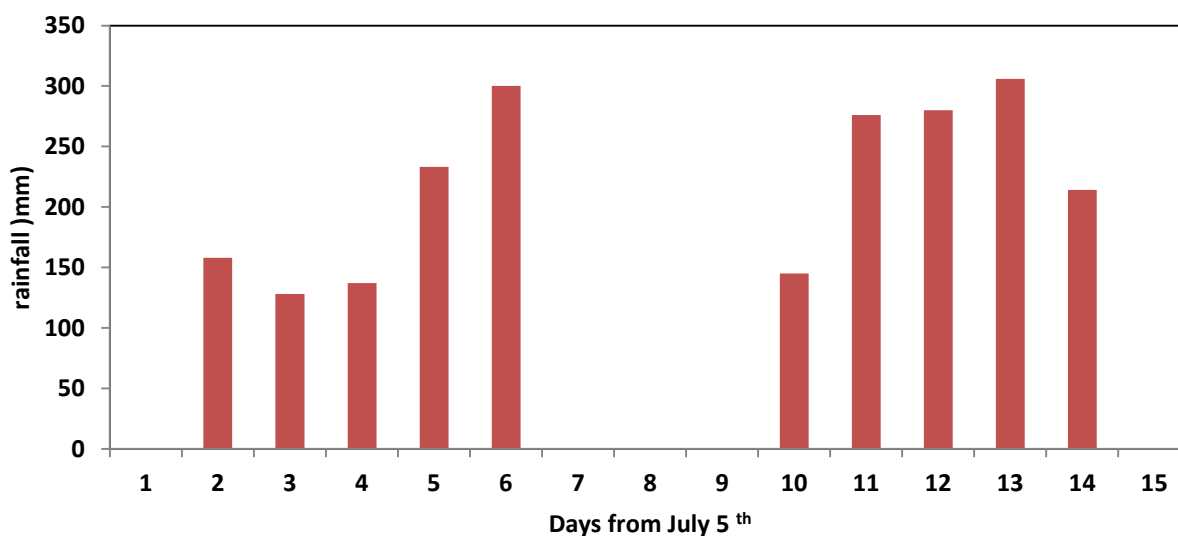


Figure 3: Daily rainfall of Vythiri (Wayanad district) during days with intense fall of rain for the month of July 1924

If we consider district averages of rainfall deviations from the normals ($\delta R_f 1$) given in Table 5, most intense spells of rainfall fell on the flood month of July in the districts of Tivandrum, Kollam, Kottayam, Idukki, Ernakulam, Palakkad and Malappuram. Considering also the summer season rainfall deviations from the normals ($\delta R_f 2$) given in this Table for different districts in Kerala, the above districts are also can be considered as the most flood affected districts during the year 1924. The summer monsoon rainfall deviations from normals for different districts during the recent floods of 2018 (given in Table 5) suggest that most flood affected during this year are

Kollam, Kottayam, Idukki, Ernakulam, Palakkad and Malappuram. The later six districts are also included in the list of most flood prone districts for the year 1924. Thus these districts can be considered as most flood prone districts in Kerala and also possibly Wayanad. Idukki ranks the top in the list for most flood affected districts in Kerala for both 1924 and 2018 from the rainfall parameters given in Table 5 (see district averages of $\delta R_f 1$ and $\delta R_f 2$). It is also interesting to find that the towns which are severely affected for both 1924 and 2018 floods in Kerala are Pala(Kottayam district), Chengannur (Aleppy district) and North Parur (Ernakulam district).

Since flood probability in Kerala is maximum in Idukki this will be matter of concern in two respects. At first Idukki is an important tourist destination. Secondly two important dams in Kerala is in Idukki district (Mullaperiyar and Idukki dams).Safety of these dams during future floods during summer monsoon season in Kerala needs more careful scientific and technical studies

AKNOWLEDGEMENTS

One of the authors (Sunil Kumar Morais) wish to thank the Head of the Department of Physics,University college,Trivandrum for providing necessary facilities for this research work. The authors also wish to thank Mrs.Thara N Sathyan for her assistance in preparing this paper.

REFERENCES

1. Guhathakurta P, Sreejith O P, and Menon P A, Impact of Climate change on Extreme rainfall events and flood risk in India, J. Earth Sys. Sci 2011;120:359-373.
2. Rajeevan M, Bhate J, Jaswal A K, Analysis of variability and trends of extreme rainfall over India using 104 years of gridded daily rainfall data, Geophys. Res. Lett. 2008 ;35:doi.org/10.1029/2008GL35143.
3. Mishra V and Shah H L, Hydrometeorological perspective of the Kerala flood of 2018 ,J. Geo.Soc.India 2018; 52:640-650.
4. Seenirajan M, Natarajan M, Thangaraj M, and Bhagyaraj M, Study and anysis of Chennai Flood 2015 using GSI and multicriteria technique, J. Geogr. In form. Sys. 2017; 9:126-140.
5. Ramaswamy.C, Review of floods in India during the past 75 years. Indian National Science Academy: New Delhi; 1985; 4-12.
6. Kothwale D R and Rajeevan M ,Monthly seasonal and annual rainfall time series for All-India homogeneous regions and Meteorological subdivisions: 1871 -2016,Research Report No RR-138, IITM:Pune, 2017.
7. IMD data, Monthly and Annual rainfall and number of rainy days period 1901-1950, Part V B, IMD Publication. New Delhi;1971; 971-1139.
8. Anu Simon and Mohankumar K ,Spatial variability and rainfall characteristics of Kerala, Proc. Ind. Acad .Sci.(Earth Planet. Sci.) 2004; 113:211-221.

9. Pradeepkumar P K, Physiographic features and changes in rainfall pattern of Kerala, PhD Thesis, CUSAT, Kerala;1994.
 10. Krishnakumar K N Prasad Rao G S L H V, and Gopkumar, C S, Rainfall trends in twentieth century over Kerala India, *Atmos. Env.* 2009; 43:1940-1944.
 11. Mini V K, Pushpa V L, and Manoj K B, Interannual and long term variations of rainfall in Kerala, *Vayumandal* 2016; 42: 30-42.
 12. Study report, Kerala Floods of August 2018 ,Central Water Commission, Govt. of India, available in [www. CWC.gov.in/main/downloads/Kerala Flood/Rev-0.pdf](http://www.CWC.gov.in/main/downloads/Kerala_Flood/Rev-0.pdf).2018.
 13. IMD Data, Cumulative rainfall of Kerala SW monsoon 2018 , available in www.imdvm.gov.in. 2018.
 14. Sunil kumar Morais C, Girish T E, Ambily S Sony K S and Eapen P E, A study of monthly distribution of rainfall in Trivandrum city during the period 1837-2010 AD in the climate change perspective, *IJBAR(Pragati Publication)* 2018; 8(11): 334-345.
-