

Modelling of Short Duration Isopluvial Map For Raichur District Karnataka

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Abstract- Everyone acknowledges that it rains, runoff is generated for a design point of view we should know how much and how often it rains on our project location. Estimation of rainfall intensity is commonly required for the design of hydraulic and water resources engineering control structures. The present study aimed the Estimation of rainfall intensity in Raichur District using twenty five Rain gauge Station with 19 years of rainfall data (1998 to 2016). Log Normal Distribution, techniques are used to derived the rainfall intensity values of 2,5,10,15,30,60,120,720,1440 minutes of rainfall duration with different return period. The short duration IDF using daily rainfall data are presented, which is input for water resources projects. Isopluvial maps were developed for 25years, 50years, 75years and 100years return period

Keywords- Isopluvial Maps, Log Normal Distribution, Rainfall Duration, Return Period, Rainfall Intensity.

I. INTRODUCTION

Short-term, high-intensity rainfall that occurs in inland areas with poor drainage often produces urban flash floods. Densely populated areas have a high risk for flash floods. During periods of heavy rainfall, storm drains may become overwhelmed and flood roads and buildings. Low spots, such as underpasses, underground parking garages, and basements are especially vulnerable to flash floods. Rainfall is an important component in the hydrologic cycle. Quantification of rainfall is needed for planning and designing of various water resource projects. Quantification of rainfall is generally done using isopluvial maps and intensity-duration-frequency (IDF) curves (Chow et al., 1988).

IDF stands for Intensity-Duration Frequency. Rainfall intensity is defined as the ratio of the total amount of rain (rainfall depth) falling during a given period to the duration of the period It is expressed in depth units per unit time, usually as mm per hour . The number of times, during a specified period of years, that precipitation of a certain magnitude or greater occurs or will occur at a station is called frequency. (FAO, 2012).

The scope of this study was to predict rainfall intensity for the stations using the data of 1998 to 2016 spread in Raichur District by using Log Normal distribution and Develop Isopluvial Maps of different duration and return period.

II. MATERIALS AND METHODS

2.1 Study Area

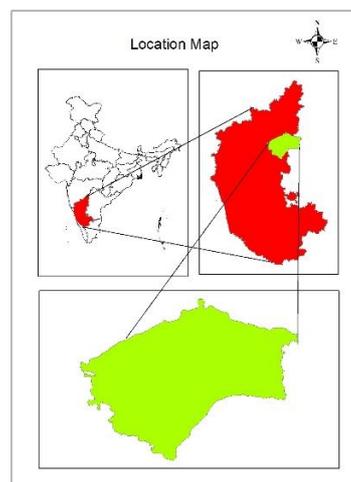


Fig 1 Location Map of Study Area

the Study area Raichur District, Karnataka is located between $76^{\circ}14'3.36''\text{E}$ to $77^{\circ}35'32.20''\text{E}$ and $15^{\circ}32'31.78''\text{N}$ to $16^{\circ}33'26.46''\text{N}$. Twenty five rainguage data station namely Chandrabanda, Maski, RaichurObsy, Raichur Railway, Yermarus, Sindnoor Pwd, Manvi, Lingsugur, Deodurga, Askihal, Gabbur, Hatti, Mudgal, Kurdi, Kallur, Kavatal, Sirwar, Deosugur, Yergera, Jagarkal, Kalmala, Salgunda, Turvihah, Jawalgere, Kunnatgi, And Maski has been taken From 1998 to 2016. The average mean daily temperature varies from 23 to 40°C respectively. The impact of climate change is likely to have serious influence on agriculture and water sector.

2.2 Methodology

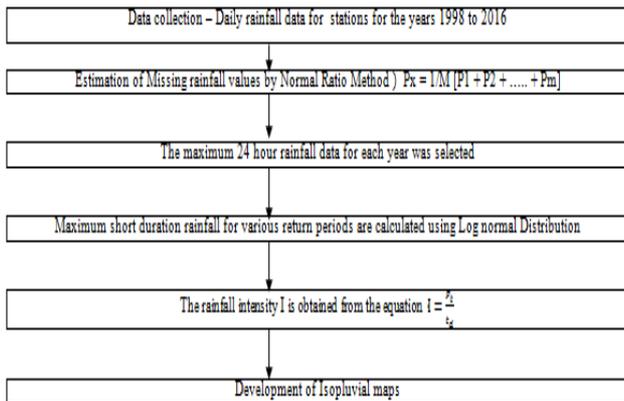


Fig 2 Methodology adopted for Isopluvial map

III. RESULTS AND DISCUSSIONS

3.1 Estimation of Short Duration Rainfall

Indian Meteorological Department (IMD) use an empirical reduction formula (Equation 3.1) for estimation of various duration like 1-hr, 2-hr, 3-hr, 5-hr, 8-hr rainfall values from annual maximum values. Chowdhury et al. (2007), used IMD empirical reduction formula to estimate the short duration rainfall from daily rainfall data in Sylhet city and found that this formula give the best estimation of short duration rainfall. (Rashid et al, 2012)

$$P_t = P_{24} \left(\frac{t}{24} \right)^{\frac{1}{3}} \tag{3.1}$$

Table1 Short duration rainfall for Gabbur

where, P_t is the required rainfall depth in mm at t-hr duration, P₂₄ is the daily rainfall in mm and t is the duration of rainfall for which the rainfall depth is required in hr.

Short duration rainfall by using IMD empirical formula for gabbur station is tabulated in Table 1.

Similarly short duration rainfall for remaining stations is calculated mean and standard deviation is determined.

3.2 Development of Isopluvial Maps

The IDF curve and IDF empirical equations helps in the determination of rainfall intensity for a point location. Analysis of rainfall data requires handling of large volumes of data and repeated computation of a number of statistical parameters for distribution fitting and estimation of expected rainfall at different return periods.

The isopluvial maps were generated for Raichur considering 25 stations with 19 years data, for various selected return periods such as 25, 50, 75 and 100 years based on design requirements. Considering lower return periods might not be appropriate considering the fact that, generally the life of a structure is more than 25 years. The short durations of 5, 10, 15, 30, 60, 120, 720 and 1440 minutes isopluvial maps were generated as the intensity decreases with the increase in duration.

3.3 LogNormal Distribution

Sl No	Raingauge Station	Time (t) in minutes								
		5	10	15	30	60	120	720	1440	
1	Chandrabanda	171.2379	107.8733	82.3227	51.8601	32.6698	20.5807	6.2329	3.9265	
2	Yergera	209.1197	131.7374	100.5344	63.3327	39.8971	25.1336	7.6118	4.7951	
3	Raichurrailway	198.3005	124.9217	95.3330	60.0561	37.8329	23.8333	7.2180	4.5470	
4	Asikhal	205.7955	129.6332	98.9286	62.3211	39.2598	24.7321	7.4902	4.7185	
5	Raichur	192.7816	121.4451	92.6799	58.3847	36.7800	23.1700	7.0171	4.4205	
6	Yermarus	214.6394	135.2146	103.1880	65.0044	40.9502	25.7970	7.8127	4.9217	
7	Jagerikal	153.2346	96.5320	73.6676	46.4077	29.2350	18.4169	5.5776	3.5137	
8	Deosugur	200.4065	126.2485	96.3455	60.6939	38.2348	24.0864	7.2946	4.5953	
9	Kalmala	191.4011	120.5754	92.0162	57.9666	36.5166	23.0040	6.9669	4.3888	
10	Gabbur	202.1789	127.3650	97.1976	61.2306	38.5729	24.2994	7.3592	4.6360	
11	Deodurg	210.8584	132.8327	101.3703	63.8593	40.2288	25.3426	7.6751	4.8350	
12	Kallur	146.0622	92.0136	70.2195	44.2355	27.8666	17.5549	5.3166	3.3492	
13	Kurdi	211.8934	133.4847	101.8679	64.1727	40.4263	25.4670	7.7128	4.8587	
14	Manvi	208.8703	131.5803	100.4145	63.2572	39.8495	25.1036	7.6027	4.7894	
15	Sirvar	188.5627	120.9818	93.3671	57.5774	35.9751	22.6629	6.8635	4.3238	
16	Kavatal	209.7886	132.1588	100.8560	63.5353	40.0247	25.2140	7.6361	4.8105	
17	Jawalagera	241.5353	152.1580	116.1182	73.1499	46.0815	29.0296	8.7917	5.5384	
18	Salgunda	179.0146	112.7723	86.0613	54.2153	34.1535	21.5153	6.5160	4.1048	
19	Sindanoorpwd	246.1590	155.0708	118.3411	74.5502	46.9637	29.5853	8.9600	5.6444	
20	Kunnatgi	211.5724	133.2825	101.7135	64.0755	40.3650	25.4284	7.7011	4.8514	
21	Turvihal	158.2410	99.6858	76.0744	47.9239	30.1902	19.0186	5.7598	3.6285	
22	Masiki	162.4464	102.3350	78.0962	49.1975	30.9925	19.5240	5.9129	3.7249	
23	Mudgal	176.0678	110.9160	84.6447	53.3228	33.5913	21.1612	6.4087	4.0372	
24	Hatti	235.6572	148.4551	113.2923	71.3697	44.9601	28.3231	8.5777	5.4036	
25	Lingasugur	168.2191	105.9716	80.8714	50.9458	32.0938	20.2178	6.1230	3.8573	

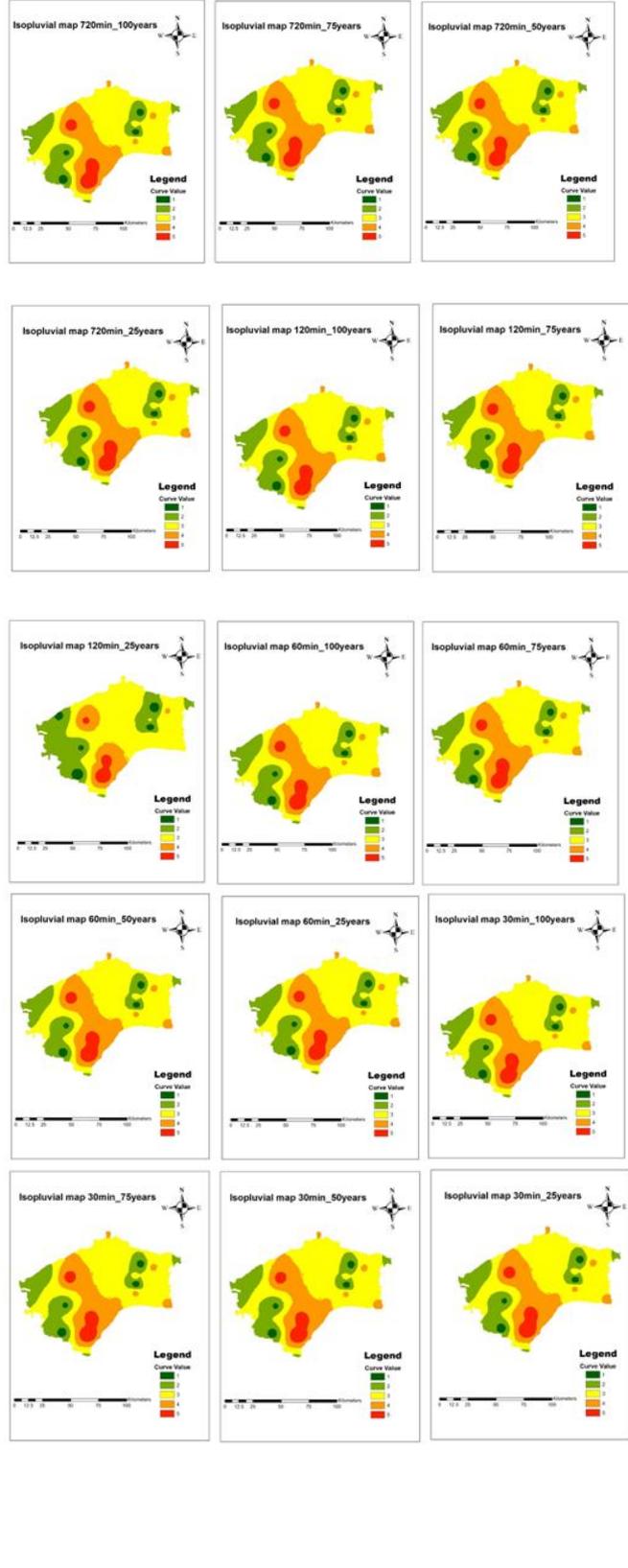
Sl No	Raingauge Station	Time (t) in minutes								
		5	10	15	30	60	120	720	1440	
1	Chandrabanda	171.7144	108.1735	82.5518	52.0044	32.7607	20.6379	6.2503	3.9374	
2	Yergera	209.6330	132.0608	100.7812	63.4882	39.9950	25.1953	7.6305	4.8069	
3	Raichur railway	198.8026	125.2380	95.5744	60.2081	37.9287	23.8936	7.2363	4.5586	
4	Asikhal	206.3599	129.9988	99.2076	62.4969	39.3706	24.8019	7.5113	4.7318	
5	Raichur	193.2349	121.7306	92.8978	58.5219	36.8665	23.2244	7.0336	4.4309	
6	Yermarus	215.1876	135.5599	103.4515	65.1704	41.0548	25.8629	7.8327	4.9343	
7	Jagerikal	153.6892	96.8183	73.8862	46.5454	29.3217	18.4715	5.5942	3.5241	
8	Deosugur	200.8669	126.5385	96.5669	60.8333	38.3226	24.1417	7.3114	4.6059	
9	Kalmala	191.9298	120.9084	92.2704	58.1267	36.6175	23.0676	6.9861	4.4010	
10	Gabbur	202.8452	127.7847	97.5179	61.4324	38.7000	24.3795	7.3834	4.6513	
11	Deodurg	211.2867	133.1025	101.5762	63.9890	40.3105	25.3940	7.6907	4.8448	
12	Kallur	146.3084	92.1687	70.3378	44.3101	27.9136	17.5845	5.3255	3.3549	
13	Kurdi	212.5711	133.9117	102.1937	64.3780	40.5556	25.5484	7.7374	4.8743	
14	Manvi	209.3803	131.9016	100.6597	63.4116	39.9468	25.1649	7.6213	4.8011	
15	Sirvar	189.0446	121.3295	93.6379	57.7323	36.0671	22.7208	6.8811	4.3348	
16	Kavatal	210.4711	132.5888	101.1841	63.7420	40.1549	25.2960	7.6610	4.8261	
17	Jawalagera	242.2394	152.6016	116.4567	73.3631	46.2159	29.1142	8.8173	5.5546	
18	Salgunda	179.4356	113.0376	86.2638	54.3428	34.2338	21.5659	6.5313	4.1145	
19	Sindanoorpwd	246.8901	155.5313	118.6925	74.7716	47.1032	29.6731	8.9866	5.6612	
20	Kunnatgi	212.1438	133.6425	101.9882	64.2486	40.4741	25.4971	7.7219	4.8645	
21	Turvihal	158.5438	99.8765	76.2200	48.0156	30.2479	19.0550	5.7709	3.6354	
22	Masiki	162.7945	102.5543	78.2635	49.3029	31.0589	19.5659	5.9256	3.7329	
23	Mudgal	176.4166	111.1357	84.8124	53.4285	33.6578	21.2031	6.4214	4.0452	
24	Hatti	236.1716	148.7791	113.5396	71.5255	45.0582	28.3849	8.5965	5.4154	
25	Lingasugur	168.5272	106.1657	81.0195	51.0391	32.1526	20.2549	6.1343	3.8643	

Table 4 Rainfall intensity in mm/hr for 75 years return period

Sl No	Raingauge Station	Time (t) in minutes							
		5	10	15	30	60	120	720	1440
1	Chandrabanda	171.8713	108.2723	82.6272	52.0519	32.7906	20.6568	6.2560	3.9410
2	Yargera	209.8020	132.1673	100.8624	63.5393	40.0273	25.2156	7.6366	4.8108
3	Raichur railway	198.9679	125.3422	95.6539	60.2582	37.9603	23.9135	7.2423	4.5623
4	Asikihal	206.5510	130.1192	99.2995	62.5548	39.4070	24.8249	7.5183	4.7362
5	Raichur	193.3841	121.8246	92.9695	58.5671	36.8950	23.2424	7.0390	4.4343
6	Yermarus	215.3680	135.6736	103.5383	65.2250	41.0892	25.8846	7.8392	4.9384
7	Jagerkal	153.8389	96.9127	73.9581	46.5907	29.3503	18.4895	5.5996	3.5275
8	Deosugur	201.0184	126.6339	96.6397	60.8792	38.3515	24.1599	7.3169	4.6094
9	Kalmala	192.1039	121.0181	92.3540	58.1794	36.6507	23.0885	6.9924	4.4050
10	Gabbur	203.0646	127.9230	97.6234	61.4989	38.7419	24.4059	7.3914	4.6563
11	Deodurg	211.4276	133.1913	101.6439	64.0317	40.3374	25.4110	7.6958	4.8481
12	Kallur	146.3894	92.2197	70.3768	44.3346	27.9290	17.5942	5.3285	3.3567
13	Kurdi	212.7943	134.0523	102.3010	64.4456	40.5982	25.5752	7.7456	4.8794
14	Manvi	209.5482	132.0073	100.7404	63.4625	39.9789	25.1851	7.6274	4.8050
15	Sirwar	189.2033	121.4439	93.7537	57.7832	36.0973	22.7399	6.8869	4.3384
16	Kavatal	210.6959	132.7304	101.2922	63.8101	40.1978	25.3230	7.6692	4.8313
17	Jawalagera	242.4713	152.7476	116.5682	73.4334	46.2601	29.1420	8.8258	5.5599
18	Salgunda	179.5742	113.1249	86.3304	54.3847	34.2602	21.5826	6.5364	4.1177
19	Sindanoorpwd	246.8901	155.5313	118.6925	74.7716	47.1032	29.6731	8.9866	5.6612
20	Kunnatgi	212.3319	133.7610	102.0787	64.3055	40.5099	25.5197	7.7287	4.8688
21	Turvihal	158.6435	99.9393	76.2679	48.0458	30.2670	19.0670	5.7745	3.6377
22	Maski	162.9090	102.6265	78.3186	49.3376	31.0808	19.5796	5.9298	3.7355
23	Mudgal	176.5315	111.2081	84.8676	53.4632	33.6797	21.2169	6.4256	4.0479
24	Hatti	236.3408	148.8857	113.6210	71.5767	45.0905	28.4052	8.6026	5.4193
25	Lingasugur	168.5272	106.1657	81.0195	51.0391	32.1526	20.2549	6.1343	3.8643

Table 5 Rainfall intensity in mm/hr for 100 years return period

Sl No	Raingauge Station	Time (t) in minutes							
		5	10	15	30	60	120	720	1440
1	Chandrabanda	171.9488	108.3212	82.6645	52.0754	32.8054	20.6661	6.2588	3.9428
2	Yargera	209.8855	132.2199	100.9026	63.5646	40.0432	25.2256	7.6397	4.8127
3	Raichur railway	199.0496	125.3936	95.6932	60.2829	37.9759	23.9233	7.2453	4.5642
4	Asikihal	206.6455	130.1787	99.3449	62.5834	39.4251	24.8362	7.5217	4.7384
5	Raichur	193.4578	121.8710	93.0049	58.5894	36.9090	23.2512	7.0417	4.4360
6	Yermarus	215.4572	135.7298	103.5812	65.2520	41.1062	25.8953	7.8425	4.9405
7	Jagerkal	153.9129	96.9593	73.9937	46.6131	29.3644	18.4984	5.6023	3.5292
8	Deosugur	201.0933	126.6811	96.6757	60.9019	38.3658	24.1689	7.3196	4.6111
9	Kalmala	192.1899	121.0723	92.3954	58.2055	36.6671	23.0989	6.9956	4.4069
10	Gabbur	203.1731	127.9913	97.6756	61.5318	38.7626	24.4189	7.3953	4.6588
11	Deodurg	211.4972	133.2352	101.6774	64.0528	40.3507	25.4194	7.6983	4.8496
12	Kallur	146.4294	92.2450	70.3960	44.3467	27.9367	17.5990	5.3299	3.3576
13	Kurdi	212.9046	134.1218	102.3540	64.4790	40.6192	25.5885	7.7496	4.8819
14	Manvi	209.6311	132.0596	100.7803	63.4876	39.9947	25.1951	7.6304	4.8069
15	Sirwar	189.2817	121.5005	93.8011	57.8084	36.1123	22.7493	6.8897	4.3402
16	Kavatal	210.8071	132.8004	101.3456	63.8437	40.2190	25.3364	7.6732	4.8338
17	Jawalagera	242.5859	152.8198	116.6233	73.4681	46.2820	29.1558	8.8299	5.5625
18	Salgunda	179.6427	113.1680	86.3633	54.4055	34.2733	21.5908	6.5389	4.1192
19	Sindanoor pwd	247.2498	155.7579	118.8655	74.8806	47.1718	29.7164	8.9997	5.6695
20	Kunnatgi	212.4249	133.8195	102.1234	64.3337	40.5277	25.5308	7.7321	4.8709
21	Turvihal	158.6927	99.9704	76.2916	48.0607	30.2763	19.0729	5.7763	3.6388
22	Maski	162.9656	102.6621	78.3458	49.3548	31.0916	19.5865	5.9318	3.7368
23	Mudgal	176.5882	111.2438	84.8949	53.4804	33.6905	21.2237	6.4277	4.0492
24	Hatti	236.4245	148.9384	113.6612	71.6021	45.1065	28.4155	8.6057	5.4212
25	Lingasugur	168.6787	106.2611	81.0924	51.0850	32.1815	20.2731	6.1398	3.8678



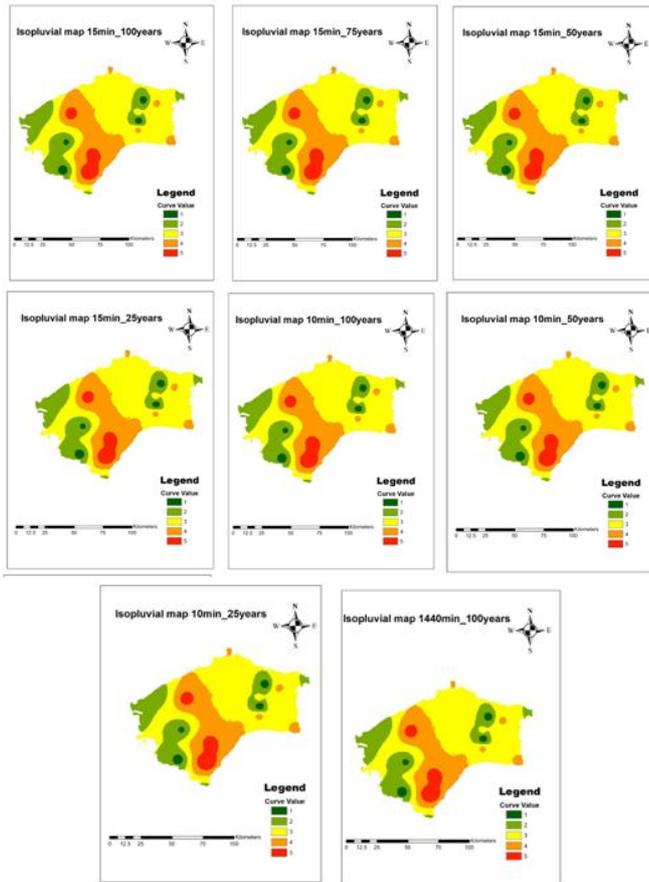


Figure 3 Isohyetal Maps for different duration and return period

Table 6 Rainfall intensity values in mm/hr for curve values given in figure 3

Curve Value	Duration T in minutes							
	5	10	15	30	60	120	720	1440
1	146-166	92-104	70-80	44-50	27-31	18-21	5.3-6	3.3-3.8
2	166.01-186	104.04-117	80.01-90	50.01-56	31.01-35	21.01-23	6-6.70	3.801-4.3
3	186.01-206	117.01-129	90.01-99	56.01-62	35.01-39	23.01-25	6.701-7.4	4.301-4.8
4	206.01-226	129.01-142	99.01-109	62.01-68	39.01-43	25.01-28	7.401-8.3	4.801-5.3
5	226.01-247	142.01-156	109.01-119	68.01-77	43.01-48	28.01-30	8.301-9	5.301-5.8

IV. CONCLUSIONS

Isopluvial maps were developed for the study area, considering the intensity calculated from log-normal probability distribution for various standard return periods for the 25 stations with 19 years rainfall data.

From the isopluvial maps, rainfall intensity for any location (longitude and latitude) in Raichur district may be estimated more easily and faster without having to go through the rigor of fitting probability distribution models all over again. These are very useful for design and planning purposes.

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