

# Generation of Short Duration Isohyetal Maps For Raichur District Karnataka

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## ABSTRACT

Estimation of rainfall intensity is often needed for the planning of hydraulic and water resources engineering management structures. Everyone knows that it rains, runoff is generated for a design purpose we should know how much depth often it rains on our project location. In raichur district log normal distribution is used to estimate the rainfall depth using 25 raingauge stations with nineteen years of rainfall data and isohyetal maps were generated for duration of 5,10,15,30,60,120,720 and 1440 minutes of different return period.

**Key words:** Isohyetal Maps, Log Normal Distribution, Rainfall Duration, Return Period, Rainfall Depth

## INTRODUCTION

The rainfall IDF relationship in one of the most basic and important tools in water resource engineering to assess the risk and vulnerability of water resource structure as well as for planning, design and operation. Short-duration rainfall intensity statistics is often used for sizing and design of hydrological structures to structurally accommodate and carry water runoff from small catchments. Building roof rain loads and drainage systems, road culverts, and municipal storm sewer systems are examples where rainfall intensity is important.

The isohyetal maps are helpful in estimating the rainfall depth for any location in the study area considered 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.

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

## 2 MATERIALS AND METHODS

### 2.1 Study Area

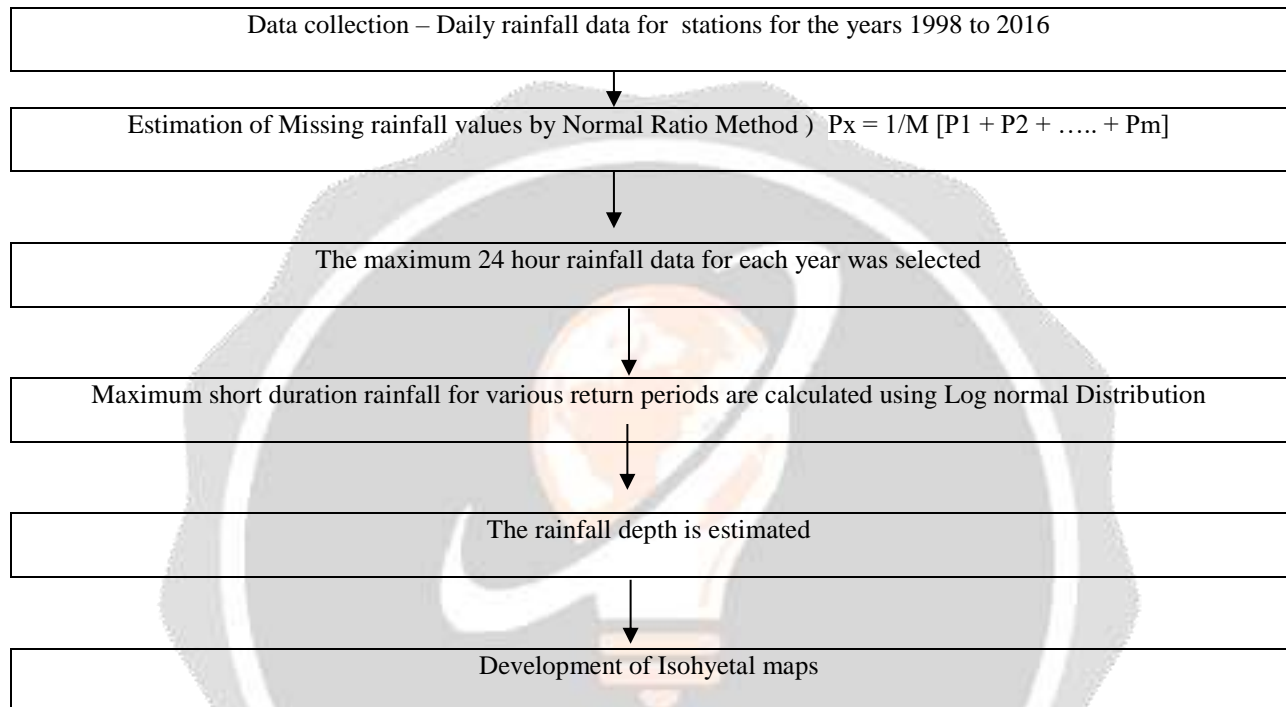


Fig 1 Location Map of Study Area

The Study area Raichur District, Karnataka is located between 76°14'3.36"E to 77°35'32.20"E and 15°32'31.78"N to 16°33'26.46"N. Twenty five rainguage station namely Chandrabanda, Maski, Raichur Obsy, Raichur Railway, Lingasugur, Deodurga, Askihal, Gabbur, Hatti, Mudgal, Kurdi, Kallur, Kavatal, Sirwar, Yermarus, Sindnoor Pwd, Manvi, , Deosugur, Yergera, Jagarkal, Kalmala, Salgunda, Turvihhal, Jawalgere, Kunnatgi, And Maski has been taken From 1998 to 2016. It is located at north western part of Karnataka.

## 2.2 Methodology

**Fig 2 Methodology adopted for Isohyetal maps**



## 3 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.

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

where,  $P_t$  is the required rainfall depth in mm at t-hr duration,

$P_{24}$  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 Mudgal station is tabulated in Table 1.

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

Year	Rainfall (mm)	$P_t = P_{24} \left(\frac{t}{24}\right)^{\frac{1}{3}}$ in mm where, time t is in hours							
Duration in Minutes		5	10	15	30	60	120	720	1440
1998	60.0000	9.0856	11.4472	13.1037	16.5096	20.8008	26.2074	47.6220	60.0000
1999	100.0000	15.1427	19.0786	21.8395	27.5161	34.6681	43.6790	79.3701	100.0000
2000	112.0000	16.9598	21.3680	24.4603	30.8180	38.8282	48.9205	88.8945	112.0000
2001	73.4000	11.1147	14.0037	16.0302	20.1968	25.4464	32.0604	58.2576	73.4000
2002	51.0000	7.7228	9.7301	11.1382	14.0332	17.6807	22.2763	40.4787	51.0000
2003	110.0000	16.6569	20.9864	24.0235	30.2677	38.1349	48.0469	87.3071	110.0000
2004	65.0000	9.8427	12.4011	14.1957	17.8854	22.5342	28.3914	51.5905	65.0000
2005	155.0000	23.4711	29.5718	33.8512	42.6499	53.7355	67.7025	123.0236	155.0000
2006	66.0000	9.9941	12.5919	14.4141	18.1606	22.8809	28.8282	52.3842	66.0000
2007	90.0000	13.6284	17.1707	19.6556	24.7645	31.2013	39.3111	71.4330	90.0000
2008	55.0000	8.3285	10.4932	12.0117	15.1338	19.0674	24.0235	43.6535	55.0000
2009	220.0000	33.3138	41.9729	48.0469	60.5353	76.2697	96.0939	174.6141	220.0000
2010	130.0000	19.6854	24.8022	28.3914	35.7709	45.0685	56.7827	103.1811	130.0000
2011	35.0000	5.2999	6.6775	7.6438	9.6306	12.1338	15.2877	27.7795	35.0000
2012	73.0000	11.0541	13.9274	15.9428	20.0867	25.3077	31.8857	57.9401	73.0000
2013	67.0000	10.1456	12.7827	14.6325	18.4358	23.2276	29.2649	53.1779	67.0000
2014	46.5000	7.0413	8.8715	10.1554	12.7950	16.1206	20.3107	36.9071	46.5000
2015	82.6000	12.5078	15.7589	18.0394	22.7283	28.6358	36.0789	65.5597	82.6000
2016	47.7000	7.2230	9.1005	10.4174	13.1252	16.5367	20.8349	37.8595	47.7000

Table1 Short duration rainfall for Mudgal

### 3.2 Development of Isohyetal Maps

The Isohyetal 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 isohyetal maps were generated as the intensity decreases with the increase in duration.

### 3.3 Log Normal Distribution

Table 2 Rainfall depth in mm for 25 years return period									
Sl No	Raingauge Station	Time (t) in minutes							
		5	10	15	30	60	120	720	1440
1	Chandrabanda	14.2698	17.9789	20.5807	25.9300	32.6698	41.1614	74.7951	94.2360
2	Yergera	17.4266	21.9562	25.1336	31.6663	39.8971	50.2672	91.3416	115.0832
3	Raichur railway	16.5250	20.8203	23.8333	30.0280	37.8329	47.6665	86.6158	109.1291

4	Askihal	17.1483	21.6055	24.7321	31.1606	39.2598	49.4643	89.8826	113.2450
5	Raichur	16.0651	20.2408	23.1700	29.1923	36.7800	46.3399	84.2052	106.0920
6	Yermarus	17.8866	22.5358	25.7970	32.5022	40.9502	51.5940	93.7525	118.1208
7	Jagerkal	12.7696	16.0887	18.4169	23.2038	29.2350	36.8338	66.9315	84.3284
8	Deosugur	16.7005	21.0414	24.0864	30.3469	38.2348	48.1728	87.5357	110.2881
9	Kalmala	15.9501	20.0959	23.0040	28.9833	36.5166	46.0081	83.6022	105.3322
10	Gabbur	16.8482	21.2275	24.2994	30.6153	38.5729	48.5988	88.3099	111.2635
11	Deodurg	17.5715	22.1388	25.3426	31.9296	40.2288	50.6851	92.1010	116.0400
12	Kallur	12.1718	15.3356	17.5549	22.1177	27.8666	35.1097	63.7986	80.3812
13	Kurdi	17.6578	22.2475	25.4670	32.0864	40.4263	50.9339	92.5531	116.6096
14	Manvi	17.4059	21.9300	25.1036	31.6286	39.8495	50.2072	91.2326	114.9459
15	Sirwar	15.7136	20.1636	23.3418	28.7887	35.9751	45.3258	82.3625	103.7702
16	Kavatal	17.4824	22.0265	25.2140	31.7676	40.0247	50.4280	91.6337	115.4513
17	Jawalagera	20.1279	25.3597	29.0296	36.5749	46.0815	58.0591	105.5004	132.9222
18	Salgunda	14.9179	18.7954	21.5153	27.1076	34.1535	43.0307	78.1919	98.5157
19	Sindanoor pwd	20.5132	25.8451	29.5853	37.2751	46.9637	59.1705	107.5200	135.4667
20	Kunnatgi	17.6310	22.2138	25.4284	32.0378	40.3650	50.8568	92.4129	116.4329
21	Turvihal	13.1867	16.6143	19.0186	23.9619	30.1902	38.0372	69.1182	87.0835
22	Maski	13.5372	17.0558	19.5240	24.5988	30.9925	39.0481	70.9551	89.3978
23	Mudgal	14.6723	18.4860	21.1612	26.6614	33.5913	42.3223	76.9048	96.8940
24	Hatti	19.6381	24.7425	28.3231	35.6848	44.9601	56.6462	102.9329	129.6873
25	Lingasugur	14.0183	17.6619	20.2178	25.4729	32.0938	40.4357	73.4765	92.5746

Table 3 Rainfall depth in mm for 50 years return period

Sl No	Raingauge Station	Time (t) in minutes							
		5	10	15	30	60	120	720	1440
1	Chandrabanda	14.3095	18.0289	20.6379	26.0022	32.7607	41.2759	75.0033	94.4982
2	Yergera	17.4694	22.0101	25.1953	31.7441	39.9950	50.3906	91.5658	115.3657
3	Raichur railway	16.5669	20.8730	23.8936	30.1041	37.9287	47.7872	86.8351	109.4054
4	Askihal	17.1967	21.6665	24.8019	31.2484	39.3706	49.6038	90.1361	113.5644
5	Raichur	16.1029	20.2884	23.2244	29.2610	36.8665	46.4489	84.4032	106.3414
6	Yermarus	17.9323	22.5933	25.8629	32.5852	41.0548	51.7258	93.9920	118.4224
7	Jagerkal	12.8074	16.1364	18.4715	23.2727	29.3217	36.9431	67.1300	84.5786
8	Deosugur	16.7389	21.0897	24.1417	30.4167	38.3226	48.2834	87.7368	110.5415
9	Kalmala	15.9942	20.1514	23.0676	29.0633	36.6175	46.1352	83.8332	105.6232
10	Gabbur	16.9038	21.2975	24.3795	30.7162	38.7000	48.7590	88.6009	111.6302
11	Deodurg	17.6072	22.1838	25.3940	31.9945	40.3105	50.7881	92.2881	116.2757
12	Kallur	12.1924	15.3615	17.5845	22.1550	27.9136	35.1689	63.9062	80.5167
13	Kurdi	17.7143	22.3186	25.5484	32.1890	40.5556	51.0968	92.8491	116.9825
14	Manvi	17.4484	21.9836	25.1649	31.7058	39.9468	50.3298	91.4554	115.2266
15	Sirwar	15.7537	20.2216	23.4145	28.8661	36.0671	45.4416	82.5730	104.0354

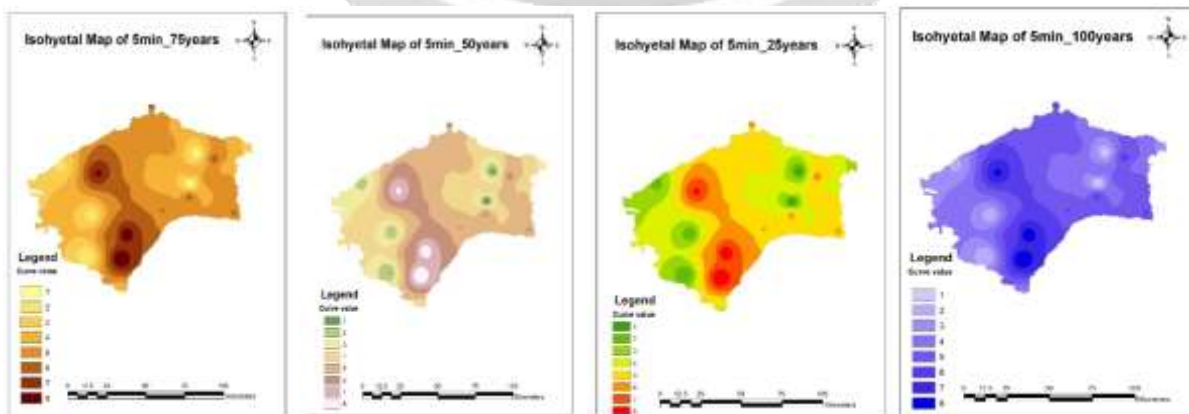
16	Kavatal	17.5393	22.0981	25.2960	31.8710	40.1549	50.5920	91.9319	115.8269
17	Jawalagera	20.1866	25.4336	29.1142	36.6816	46.2159	58.2284	105.8079	133.3097
18	Salgunda	14.9530	18.8396	21.5659	27.1714	34.2338	43.1319	78.3758	98.7473
19	Sindanoor pwd	20.5742	25.9219	29.6731	37.3858	47.1032	59.3463	107.8393	135.8690
20	Kunnatgi	17.6786	22.2737	25.4971	32.1243	40.4741	50.9941	92.6624	116.7474
21	Turvihal	13.2120	16.6461	19.0550	24.0078	30.2479	38.1100	69.2505	87.2501
22	Maski	13.5662	17.0924	19.5659	24.6515	31.0589	39.1318	71.1071	89.5894
23	Mudgal	14.7014	18.5226	21.2031	26.7142	33.6578	42.4062	77.0572	97.0860
24	Hatti	19.6810	24.7965	28.3849	35.7627	45.0582	56.7698	103.1576	129.9704
25	Lingasugur	14.0439	17.6943	20.2549	25.5196	32.1526	40.5098	73.6111	92.7442

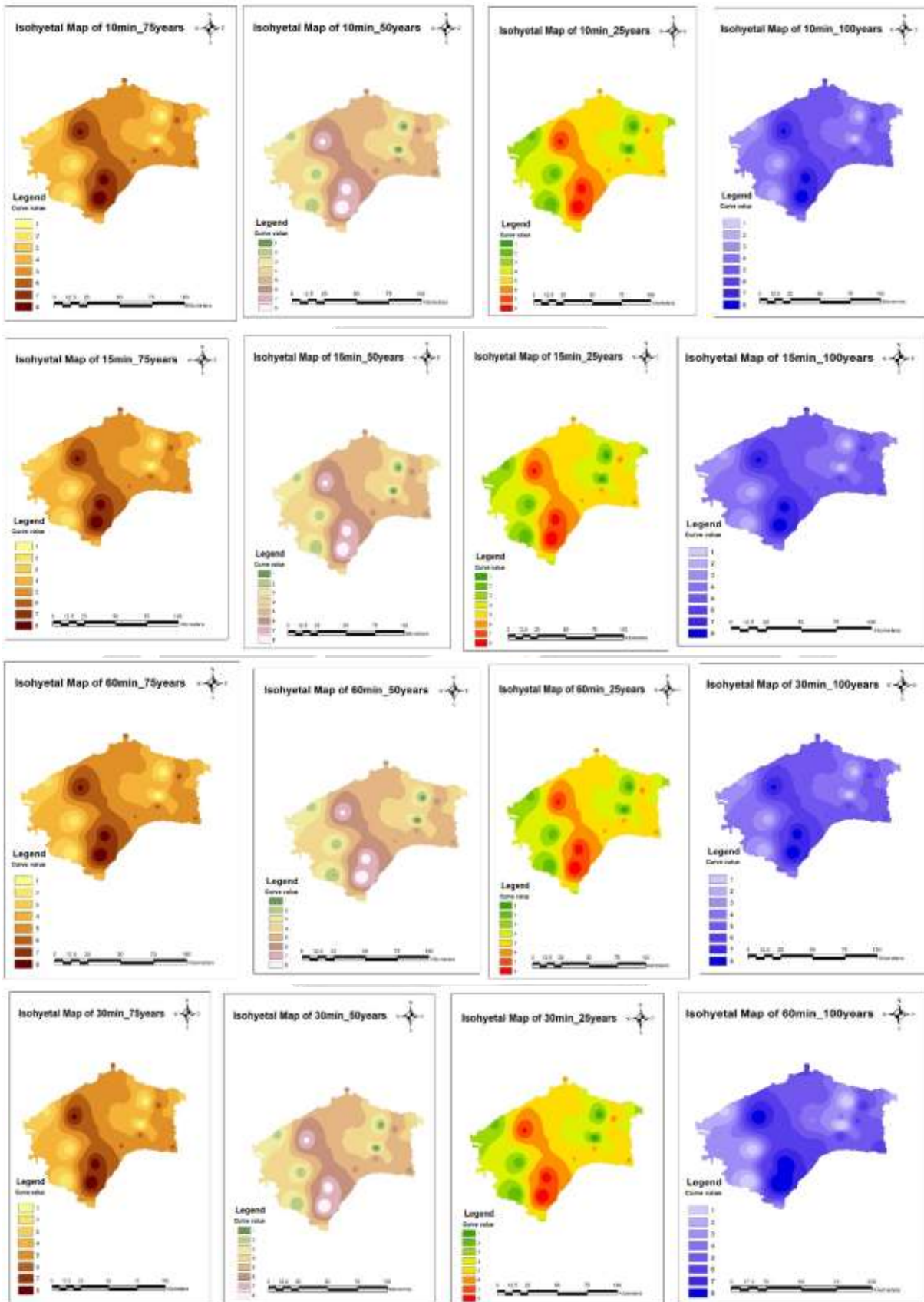
**Table 4 Rainfall depth in mm for 75 years return period**

Sl No	Raingauge Station	Time (t) in minutes							
		5	10	15	30	60	120	720	1440
1	Chandrabanda	14.3226	18.0454	20.6568	26.0259	32.7906	41.3136	75.0718	94.5845
2	Yergera	17.4835	22.0279	25.2156	31.7697	40.0273	50.4312	91.6396	115.4587
3	Raichur railway	16.5807	20.8904	23.9135	30.1291	37.9603	47.8270	86.9073	109.4964
4	Askihal	17.2126	21.6865	24.8249	31.2774	39.4070	49.6497	90.2196	113.6695
5	Raichur	16.1153	20.3041	23.2424	29.2836	36.8950	46.4848	84.4684	106.4235
6	Yermarus	17.9473	22.6123	25.8846	32.6125	41.0892	51.7691	94.0708	118.5218
7	Jagerkal	12.8199	16.1521	18.4895	23.2954	29.3503	36.9791	67.1954	84.6609
8	Deosugur	16.7515	21.1057	24.1599	30.4396	38.3515	48.3199	87.8030	110.6249
9	Kalmala	16.0087	20.1697	23.0885	29.0897	36.6507	46.1770	83.9092	105.7190
10	Gabbur	16.9221	21.3205	24.4059	30.7495	38.7419	48.8117	88.6968	111.7509
11	Deodurg	17.6190	22.1986	25.4110	32.0158	40.3374	50.8220	92.3496	116.3532
12	Kallur	12.1991	15.3700	17.5942	22.1673	27.9290	35.1884	63.9416	80.5613
13	Kurdi	17.7329	22.3420	25.5752	32.2228	40.5982	51.1505	92.9466	117.1054
14	Manvi	17.4623	22.0012	25.1851	31.7312	39.9789	50.3702	91.5287	115.3190
15	Sirwar	15.7669	20.2407	23.4384	28.8916	36.0973	45.4798	82.6423	104.1227
16	Kavatal	17.5580	22.1217	25.3230	31.9050	40.1978	50.6461	92.0300	115.9506
17	Jawalagera	20.2059	25.4579	29.1420	36.7167	46.2601	58.2841	105.9092	133.4373
18	Salgunda	14.9645	18.8541	21.5826	27.1924	34.2602	43.1652	78.4364	98.8236
19	Sindanoor pwd	20.5942	25.9472	29.7021	37.4223	47.1491	59.4041	107.9445	136.0015
20	Kunnatgi	17.6943	22.2935	25.5197	32.1528	40.5099	51.0393	92.7446	116.8509
21	Turvihal	13.2203	16.6566	19.0670	24.0229	30.2670	38.1340	69.2940	87.3050
22	Maski	13.5758	17.1044	19.5796	24.6688	31.0808	39.1593	71.1572	89.6524
23	Mudgal	14.7110	18.5347	21.2169	26.7316	33.6797	42.4338	77.1073	97.1491
24	Hatti	19.6951	24.8143	28.4052	35.7884	45.0905	56.8105	103.2315	130.0636
25	Lingasugur	14.0524	17.7049	20.2671	25.5349	32.1720	40.5341	73.6554	92.8000

**Table 5 Rainfall depth in mm for 100 years return period**

Sl No	Raingauge Station	Time (t) in minutes							
		5	10	15	30	60	120	720	1440
1	Chandrabanda	14.3291	18.0535	20.6661	26.0377	32.8054	41.3322	75.1057	94.6272
2	Yergera	17.4905	22.0366	25.2256	31.7823	40.0432	50.4513	91.6761	115.5046
3	Raichur railway	16.5875	20.8989	23.9233	30.1415	37.9759	47.8466	86.9430	109.5413
4	Askihal	17.2205	21.6965	24.8362	31.2917	39.4251	49.6725	90.2608	113.7215
5	Raichur	16.1215	20.3118	23.2512	29.2947	36.9090	46.5025	84.5006	106.4641
6	Yermarus	17.9548	22.6216	25.8953	32.6260	41.1062	51.7906	94.1097	118.5708
7	Jagerkal	12.8261	16.1599	18.4984	23.3066	29.3644	36.9969	67.2278	84.7017
8	Deosugur	16.7578	21.1135	24.1689	30.4509	38.3658	48.3379	87.8357	110.6661
9	Kalmala	16.0158	20.1787	23.0989	29.1027	36.6671	46.1977	83.9468	105.7663
10	Gabbur	16.9311	21.3319	24.4189	30.7659	38.7626	48.8378	88.7442	111.8106
11	Deodurg	17.6248	22.2059	25.4194	32.0264	40.3507	50.8387	92.3801	116.3916
12	Kallur	12.2025	15.3742	17.5990	22.1734	27.9367	35.1980	63.9590	80.5833
13	Kurdi	17.7421	22.3536	25.5885	32.2395	40.6192	51.1770	92.9948	117.1661
14	Manvi	17.4693	22.0099	25.1951	31.7438	39.9947	50.3901	91.5650	115.3646
15	Sirwar	15.7735	20.2501	23.4503	28.9042	36.1123	45.4986	82.6765	104.1659
16	Kavatal	17.5673	22.1334	25.3364	31.9219	40.2190	50.6728	92.0786	116.0117
17	Jawalagera	20.2155	25.4700	29.1558	36.7340	46.2820	58.3116	105.9593	133.5003
18	Salgunda	14.9702	18.8613	21.5908	27.2027	34.2733	43.1817	78.4663	98.8613
19	Sindanoor pwd	20.6042	25.9597	29.7164	37.4403	47.1718	59.4327	107.9965	136.0670
20	Kunnatgi	17.7021	22.3033	25.5308	32.1668	40.5277	51.0617	92.7852	116.9021
21	Turvihal	13.2244	16.6617	19.0729	24.0304	30.2763	38.1458	69.3155	87.3321
22	Maski	13.5805	17.1104	19.5865	24.6774	31.0916	39.1729	71.1819	89.6836
23	Mudgal	14.7157	18.5406	21.2237	26.7402	33.6905	42.4474	77.1321	97.1804
24	Hatti	19.7020	24.8231	28.4153	35.8010	45.1065	56.8306	103.2681	130.1096
25	Lingasugur	14.0566	17.7102	20.2731	25.5425	32.1815	40.5462	73.6773	92.8276





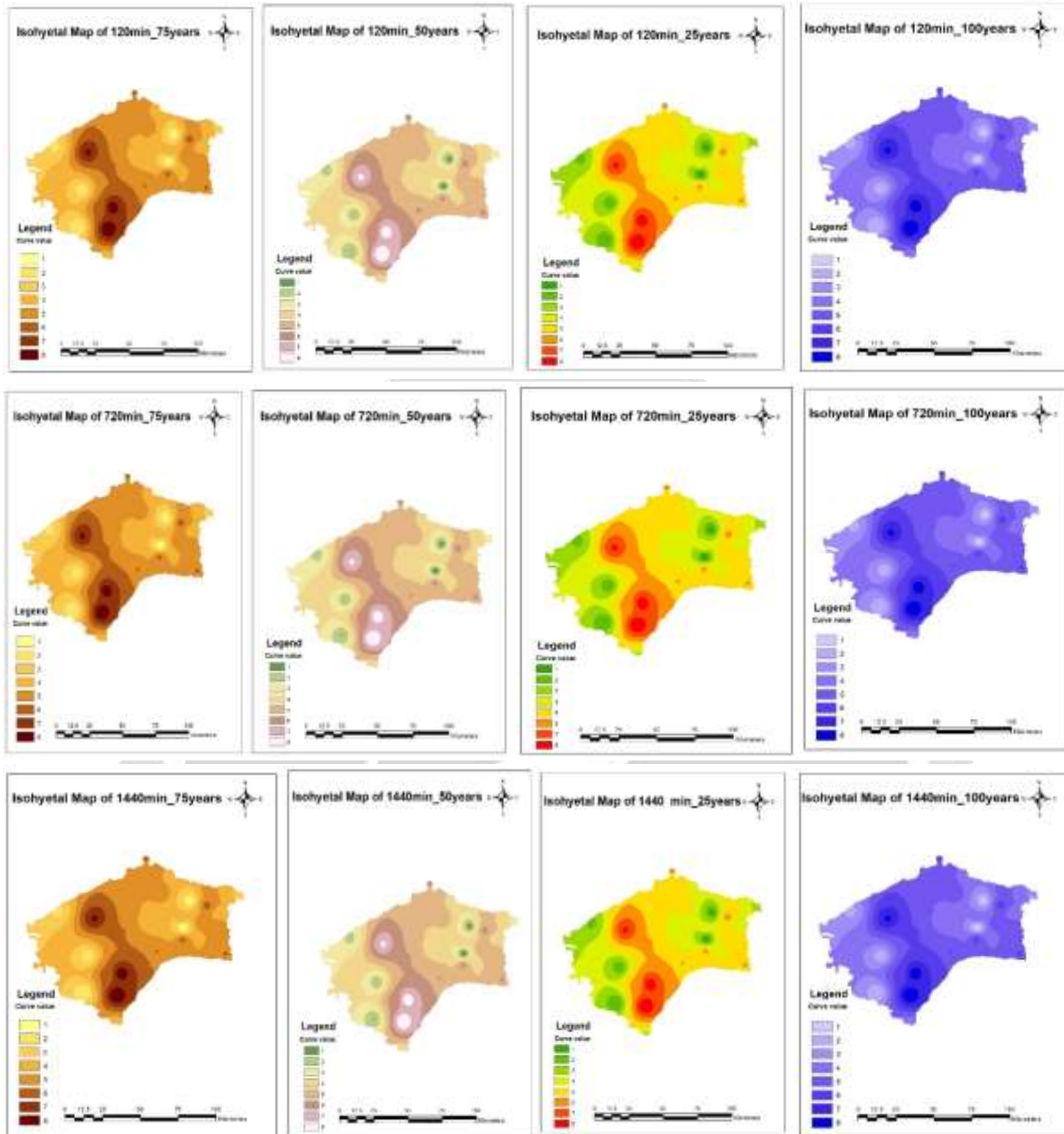


Figure 3 Isohyetal Maps for different duration and return period

Table 6 Rainfall depth values for curve values given in figure 3								
Curve Value	Duration 't' in minutes							
	5	10	15	30	60	120	720	1440
1	12.17- 13.22	15.53- 16.65	17.55- 19.05	22.11- 24.01	27.86- 30.25	35.11- 38.11	63.80- 69.26	80.38- 87.27
2	13.22- 14.26	16.65- 17.96	19.05- 20.56	24.01- 25.90	30.25- 32.64	38.11- 41.12	69.26- 74.73	87.27- 94.15
3	14.26- 14.26	17.96- 17.96	20.56- 22.06	25.90- 27.80	32.64- 35.02	41.12- 44.13	74.73- 80.19	94.15- 101.03



	15.3	19.27						
4	15.3- 13.64	19.27- 20.59	22.06- 23.56	27.80- 29.69	35.02- 37.41	44.13- 47.13	80.19- 85.65	101.03- 107.92
5	16.34- 17.38	20.59- 21.90	23.56- 25.07	29.69- 31.59	37.41- 39.80	47.13- 50.14	85.65- 91.12	107.92- 114.80
6	17.38- 18.43	21.90- 23.21	25.07- 26.57	31.59- 33.48	39.80- 42.18	50.14- 53.15	91.12- 96.58	114.80- 121.68
7	18.43- 19.47	23.21- 24.52	26.57- 28.07	33.48- 35.37	42.18- 44.57	53.15- 56.15	96.58- 102.01	121.68- 128.57
8	19.47-21	24.52- 26.0	28.07- 30	35.37- 37.50	44.57- 47.5	56.15- 59.50	102.04- 108.00	128.57- 135.80

## CONCLUSIONS

Isohyetal maps were developed for the Raichur district, considering the depth calculated from log-normal probability distribution for various standard return periods for the 25 stations with 19 years rainfall data. From the Isohyetal maps, rainfall depth 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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