Statical Analysis of Rainfall for Modelling of IDF curves for Upper Cauvery Karnataka by Gumbel's Distribution

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Abstract- Intensity-duration-frequency (IDF) curves represent the relationship between storm intensity, storm duration and return period. The IDF curves available are mostly done by fitting series of annual maximum rainfall intensity to parametric distributions. Climate change is expected to exacerbate the extremes in the climate variables. Being prone to harsh climate impacts, it is very crucial to study extreme rainfall-induced flooding for short durations over regions that are rapidly growing. One way to study the extremes is by the application of the Intensity-Duration-Frequency (IDF) curves. The annual maximum rainfall intensity (AMRI) characteristics are often used to construct these IDF curves that are being used in several infrastructure designs for urban areas. Thus, there is a need to obtain high temporal and spatial resolution rainfall information. Many urban areas of developing countries lack long records of short-duration rainfall. The shortest duration obtained is normally at a daily scale/24 h. Thus, it is very crucial to find a methodology to construct IDF curves for short-duration rainfall (sub-daily) for these urban areas. The fast extension of urban area that does not have adequate preparedness to cope with climate change is certainly a big risk to life and economy. The study region is Upper Cauvery which lies in Karnataka India. The sub-daily IDF curves for current and future climate for Upper Cauvery were constructed from 1 to 24 h based on the Gumbel's Distribution approach. Rainfall data of 23 (Twenty three) hydrological years of all stations were used. Maximum rainfall frequency analysis was made by Gumbel's Distribution method. Finally Equations were developed for different return periods.

Key words: *Climate change, Gumbel Distribution, Intensity Duration Frequency (IDF), Log Normal Distribution, Normal Distribution, Pearson Type III Distribution, Log Pearson Type III Distribution Rainfall Duration.*

I. INTRODUCTION

Rainfall intensities of different frequencies and durations are the fundamental inputs in hydrologic risk analyses and design. These data are normally used when designing urban infrastructures such as culverts and storm water drainage systems. Finding suitable distributions, regardless of parametric or nonparametric distributions, to fit rainfall data has long been a subject of interest in various fields of study including hydrology, meteorology, economy and agriculture. Several studies have been conducted to find the best-fit distribution for rainfall data using various parameter estimation methods such as maximum likelihood estimation (MLE) and L-moments. However, determining the best-fit distribution is usually tedious, complex and subjective. This is due to the different rankings provided by different goodness-of-fit indices being used in the study. Therefore, there is a need to know the extent of increasing extreme rainfall for combating climate change impacts and for strategic planning.

Degradation of water quality, property damage and potential loss of life due to flooding is caused by extreme rainfall events. Historic rainfall event statistics (in terms of intensity, duration, and return period) are used to design flood protection structures, and many other civil engineering structures involving hydrologic flows. Since rainfall characteristics are often used to design water structures, reviewing and updating rainfall characteristics (i.e., Intensity–Duration–Frequency (IDF) curves) for future climate scenarios is necessary.

The relation between rainfall and runoff is influenced by various storm and basin characteristics. Because of these complexities and the frequent paucity of adequate runoff data, many approximate formulae have been developed to relate rainfall and runoff. The earliest of these formulae were usually empirical statements.

II. MATERIALS AND METHODS

A Study Area

The study area geographically lies between 75^0 29' 19" E and 76^0 37' 40" E longitude and 11^0 55' 54" N and 13^0 23' 12.8" N latitude, as shown in Figure 1, the study area has an area of 10874.65 Sq km. The maximum length and width of the study area is approximately equal to 143.73 km and 96.75 km respectively. The maximum and minimum elevation of the basin is 1867 m and 714 m above MSL, respectively. Fourthy three raingauge stations namely arehalli, arkalgud, basavapatna, bettadapura, bilur, channenahally, chikkamagalur, doddabemmatti, galibidu, gonibeedu, gorur, hagare,halllibailu, hallimysore, harangi, hassan, hosakere, hunsur, kechamanna hosakote, kushalnagar, malalur, mallipatna, nuggehalli, periyapatna, ponnampet, sakaleshpur, salagame, shantigrama, naladi, shantebachahalli, belur, belagodu, javali, talakavery, shravanabelagola, siddapura, srimangala, sukravarsanthe, krishnarajpet, virajpet and yelawala were considered as shown in Figure 2.
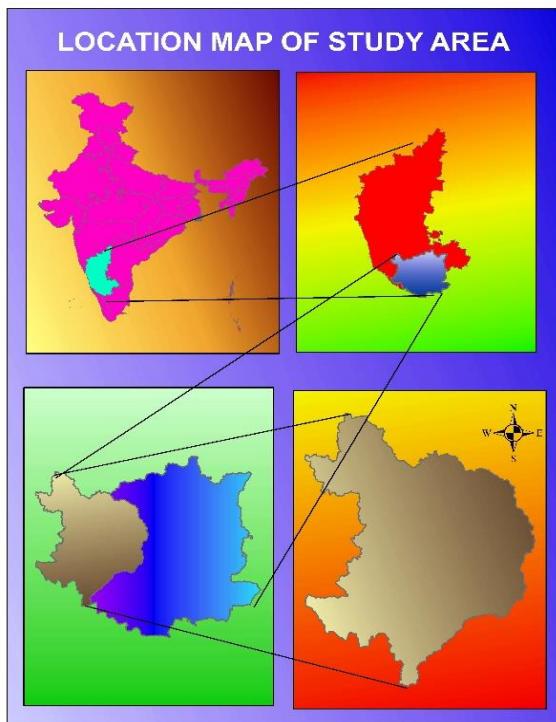

Figure 1 Location Map of Study Area   **Figure 2 Location of raingauge stations**
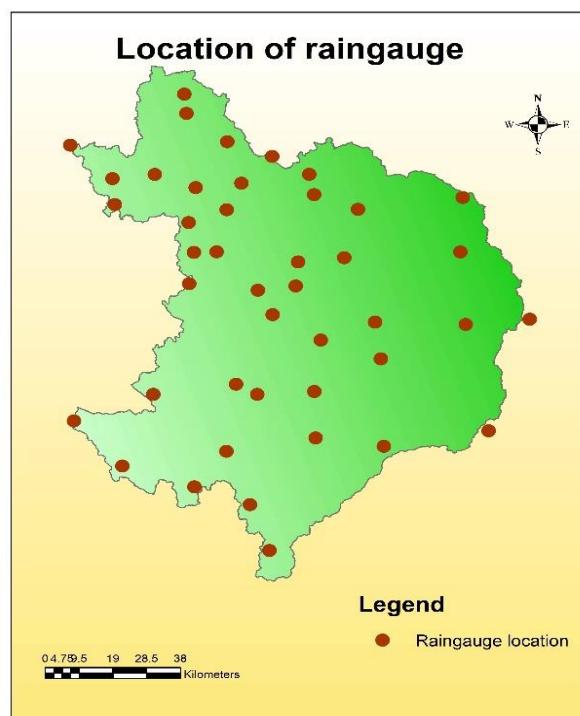
B Methodology

Equation 1 was used for the estimation of various duration like 5minutes, 10minutes, 15minutes, 30minutes,1-hr, 2-hr, 6-hr, 12-hr rainfall values from annual maximum values.

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

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.

Twenty three years (1995-2017) rainfall data was used for the estimation of Short duration rainfall by using above equation for various stations as tabulated in Table 1 to Table 3. Table 1 shows the tabulation of short duration rainfall of station Arehalli. Table 2 shows the tabulation of short duration rainfall of station Gorur. Table 3 shows the tabulation of short duration rainfall of station Chikkamangalore. Similarly the short duration rainfall was tabulated for the remaining fourty stations.

Gumble's Distribution was applied for the above estimated short duration rainfall to obtain the maximum depth and maximum intensity for various durations of all the stations and a graph of maximum intensity against the duration was plotted for different return periods. Using this values IDF equation for various durations and return period was generated for all the stations and is tabulated in the table 21.

III. RESULTS AND DISCUSSIONS

A Estimation of Short Duration Rainfall

Table 1 Short duration rainfall for Arehalli

Year	Rainfall (mm)	$P_t = P_{24}\left(\dfrac{t}{24}\right)^{\frac{1}{3}}$ in mm where, time t is in hours							
Duration in Minutes		**5**	**10**	**15**	**30**	**60**	**120**	**720**	**1440**
1995	59.00	8.934	11.256	12.885	16.234	20.454	25.771	46.828	59.000
1996	108.00	16.354	20.605	23.587	29.717	37.442	47.173	85.720	108.000
1997	98.60	14.931	18.811	21.534	27.131	34.183	43.068	78.259	98.600
1998	60.20	9.116	11.485	13.147	16.565	20.870	26.295	47.781	60.200
1999	83.00	12.568	15.835	18.127	22.838	28.774	36.254	65.877	83.000
2000	102.60	15.536	19.575	22.407	28.231	35.569	44.815	81.434	102.600
2001	112.40	17.020	21.444	24.548	30.928	38.967	49.095	89.212	112.400
2002	97.60	14.779	18.621	21.315	26.856	33.836	42.631	77.465	97.600
2003	56.80	8.601	10.837	12.405	15.629	19.691	24.810	45.082	56.800
2004	156.00	23.623	29.763	34.070	42.925	54.082	68.139	123.817	156.000
2005	165.60	25.076	31.594	36.166	45.567	57.410	72.332	131.437	165.600
2006	94.80	14.355	18.086	20.704	26.085	32.865	41.408	75.243	94.800
2007	175.60	26.590	33.502	38.350	48.318	60.877	76.700	139.374	175.600
2008	122.80	18.595	23.429	26.819	33.790	42.572	53.638	97.466	122.800
2009	107.60	16.293	20.529	23.499	29.607	37.303	46.999	85.402	107.600
2010	68.80	10.418	13.126	15.026	18.931	23.852	30.051	54.607	68.800
2011	94.20	14.264	17.972	20.573	25.920	32.657	41.146	74.767	94.200
2012	78.40	11.872	14.958	17.122	21.573	27.180	34.244	62.226	78.400
2013	116.60	17.656	22.246	25.465	32.084	40.423	50.930	92.545	116.600
2014	72.40	10.963	13.813	15.812	19.922	25.100	31.624	57.464	72.400
2015	134.60	20.382	25.680	29.396	37.037	46.663	58.792	106.832	134.600
2016	75.00	11.357	14.309	16.380	20.637	26.001	32.759	59.528	75.000
2017	56.20	8.510	10.722	12.274	15.464	19.483	24.548	44.606	56.200

Table 2 Short duration rainfall for Gorur

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
1995	60.00	9.086	11.447	13.104	16.510	20.801	26.207	47.622	60.000
1996	65.00	9.843	12.401	14.196	17.885	22.534	28.391	51.591	65.000
1997	80.00	12.114	15.263	17.472	22.013	27.734	34.943	63.496	80.000
1998	33.00	4.997	6.296	7.207	9.080	11.440	14.414	26.192	33.000
1999	66.20	10.024	12.630	14.458	18.216	22.950	28.916	52.543	66.200
2000	68.30	10.342	13.031	14.916	18.793	23.678	29.833	54.210	68.300
2001	44.00	6.663	8.395	9.609	12.107	15.254	19.219	34.923	44.000
2002	82.00	12.417	15.644	17.908	22.563	28.428	35.817	65.083	82.000
2003	62.00	9.388	11.829	13.540	17.060	21.494	27.081	49.209	62.000
2004	43.00	6.511	8.204	9.391	11.832	14.907	18.782	34.129	43.000
2005	95.00	14.386	18.125	20.748	26.140	32.935	41.495	75.402	95.000
2006	50.30	7.617	9.597	10.985	13.841	17.438	21.971	39.923	50.300
2007	95.50	14.461	18.220	20.857	26.278	33.108	41.713	75.798	95.500
2008	62.00	9.388	11.829	13.540	17.060	21.494	27.081	49.209	62.000
2009	80.00	12.114	15.263	17.472	22.013	27.734	34.943	63.496	80.000
2010	82.50	12.493	15.740	18.018	22.701	28.601	36.035	65.480	82.500
2011	56.00	8.480	10.684	12.230	15.409	19.414	24.460	44.447	56.000
2012	48.00	7.268	9.158	10.483	13.208	16.641	20.966	38.098	48.000
2013	91.10	13.795	17.381	19.896	25.067	31.583	39.792	72.306	91.100
2014	51.00	7.723	9.730	11.138	14.033	17.681	22.276	40.479	51.000
2015	67.00	10.146	12.783	14.632	18.436	23.228	29.265	53.178	67.000
2016	59.00	8.934	11.256	12.885	16.234	20.454	25.771	46.828	59.000
2017	97.00	14.688	18.506	21.184	26.691	33.628	42.369	76.989	97.000

Table 3 Short duration rainfall for Chikkamangalore

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
1995	57.60	8.722	10.989	12.580	15.849	19.969	25.159	45.717	57.600
1996	66.00	9.994	12.592	14.414	18.161	22.881	28.828	52.384	66.000

Year									
1997	64.60	9.782	12.325	14.108	17.775	22.396	28.217	51.273	64.600
1998	87.80	13.295	16.751	19.175	24.159	30.439	38.350	69.687	87.800
1999	88.20	13.356	16.827	19.262	24.269	30.577	38.525	70.004	88.200
2000	98.60	14.931	18.811	21.534	27.131	34.183	43.068	78.259	98.600
2001	49.80	7.541	9.501	10.876	13.703	17.265	21.752	39.526	49.800
2002	63.60	9.631	12.134	13.890	17.500	22.049	27.780	50.479	63.600
2003	82.40	12.478	15.721	17.996	22.673	28.566	35.992	65.401	82.400
2004	71.10	10.766	13.565	15.528	19.564	24.649	31.056	56.432	71.100
2005	65.20	9.873	12.439	14.239	17.940	22.604	28.479	51.749	65.200
2006	45.30	6.860	8.643	9.893	12.465	15.705	19.787	35.955	45.300
2007	65.40	9.903	12.477	14.283	17.996	22.673	28.566	51.908	65.400
2008	64.00	9.691	12.210	13.977	17.610	22.188	27.955	50.797	64.000
2009	88.00	13.326	16.789	19.219	24.214	30.508	38.438	69.846	88.000
2010	88.00	13.326	16.789	19.219	24.214	30.508	38.438	69.846	88.000
2011	48.00	7.268	9.158	10.483	13.208	16.641	20.966	38.098	48.000
2012	47.80	7.238	9.120	10.439	13.153	16.571	20.879	37.939	47.800
2013	64.00	9.691	12.210	13.977	17.610	22.188	27.955	50.797	64.000
2014	67.20	10.176	12.821	14.676	18.491	23.297	29.352	53.337	67.200
2015	65.00	9.843	12.401	14.196	17.885	22.534	28.391	51.591	65.000
2016	65.10	9.858	12.420	14.218	17.913	22.569	28.435	51.670	65.100
2017	42.20	6.390	8.051	9.216	11.612	14.630	18.433	33.494	42.200

B Gumble's Distribution

Gumbel distribution is a statistical method often used for predicting extreme hydrological event such as floods. The equation for fitting the Gumbel distribution to observed series of flood flow at different return periods T is

$$x_T = \bar{x} + k\sigma_x \qquad (2)$$

Where x_T denotes the magnitude of the T-year flood event, K is the frequency factor, $\bar{x}$= mean and σ_x= standard deviation of the variate X.

The frequency factor K for Gumbel distribution is expressed as

$$K = -\left[\frac{\sqrt{6}\left(0.5772 + \text{In}\text{In}\ (T/(T-1))\right)}{\pi}\right] \qquad (3)$$

Table 4 Estimation of maximum rainfall intensity for various return period For Arehalli Station

Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	14.272	171.259	18.865	226.375	21.872	262.464	25.697	308.368	28.535	342.423	30.185	362.217	31.352	376.226
10	17.981	107.886	23.768	142.607	27.557	165.342	32.377	194.260	35.952	215.713	38.030	228.183	39.501	237.008
15	20.583	82.333	27.207	108.830	31.545	126.180	37.062	148.248	41.155	164.620	43.534	174.136	45.218	180.871
30	25.933	51.866	34.279	68.558	39.744	79.488	46.695	93.391	51.852	103.704	54.849	109.699	56.971	113.942
60	32.674	32.674	43.189	43.189	50.074	50.074	58.832	58.832	65.330	65.330	69.106	69.106	71.779	71.779
120	41.166	20.583	54.415	27.207	63.090	31.545	74.124	37.062	82.310	41.155	87.068	43.534	90.435	45.218
720	74.804	6.234	98.878	8.240	114.642	9.553	134.692	11.224	149.567	12.464	158.213	13.184	164.332	13.694
1440	94.247	3.927	124.579	5.191	144.440	6.018	169.702	7.071	188.443	7.852	199.336	8.306	207.046	8.627

Table 5 Estimation of maximum rainfall intensity for various return period For Arkalgud Station

Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	9.482	113.781	12.347	148.160	14.223	170.671	16.609	199.305	18.379	220.548	19.408	232.894	20.136	241.633
10	11.946	71.677	15.556	93.335	17.919	107.516	20.926	125.555	23.156	138.937	24.452	146.715	25.370	152.220
15	13.675	54.700	17.807	71.228	20.513	82.050	23.954	95.816	26.507	106.028	27.991	111.964	29.041	116.165
30	17.229	34.459	22.435	44.871	25.844	51.689	30.180	60.360	33.397	66.794	35.266	70.533	36.590	73.179
60	21.708	21.708	28.267	28.267	32.562	32.562	38.025	38.025	42.077	42.077	44.433	44.433	46.100	46.100
120	27.350	13.675	35.614	17.807	41.025	20.513	47.908	23.954	53.014	26.507	55.982	27.991	58.083	29.041
720	49.698	4.142	64.715	5.393	74.548	6.212	87.055	7.255	96.333	8.028	101.726	8.477	105.543	8.795
1440	62.616	2.609	81.536	3.397	93.924	3.914	109.682	4.570	121.372	5.057	128.167	5.340	132.976	5.541

Table 6 Estimation of maximum rainfall intensity for various return period For Basavapatna Station

Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	9.048	108.575	11.607	139.283	13.283	159.390	15.414	184.966	16.995	203.940	17.914	214.968	18.564	222.773
10	11.400	68.398	14.624	87.743	16.735	100.410	19.420	116.522	21.412	128.474	22.570	135.422	23.390	140.339
15	13.049	52.198	16.740	66.961	19.157	76.627	22.231	88.923	24.511	98.044	25.836	103.346	26.775	107.098
30	16.441	32.882	21.091	42.182	24.136	48.272	28.009	56.018	30.882	61.764	32.552	65.104	33.734	67.468
60	20.715	20.715	26.573	26.573	30.409	30.409	35.289	35.289	38.909	38.909	41.013	41.013	42.502	42.502
120	26.099	13.049	33.480	16.740	38.314	19.157	44.461	22.231	49.022	24.511	51.673	25.836	53.549	26.775
720	47.425	3.952	60.838	5.070	69.620	5.802	80.792	6.733	89.079	7.423	93.896	7.825	97.305	8.109
1440	59.751	2.490	76.651	3.194	87.716	3.655	101.791	4.241	112.233	4.676	118.302	4.929	122.597	5.108

Table 7 Estimation of maximum rainfall intensity for various return period For Belagodu Station														
Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	11.614	139.366	15.842	190.102	18.610	223.323	22.132	265.579	24.744	296.927	26.262	315.148	27.337	328.044
10	14.633	87.795	19.959	119.757	23.447	140.685	27.884	167.305	31.175	187.053	33.089	198.531	34.443	206.655
15	16.750	67.000	22.848	91.392	26.841	107.363	31.919	127.677	35.687	142.748	37.877	151.508	39.427	157.707
30	21.104	42.208	28.787	57.573	33.817	67.634	40.216	80.432	44.963	89.926	47.722	95.444	49.675	99.349
60	26.589	26.589	36.269	36.269	42.607	42.607	50.669	50.669	56.650	56.650	60.126	60.126	62.586	62.586
120	33.500	16.750	45.696	22.848	53.681	26.841	63.839	31.919	71.374	35.687	75.754	37.877	78.854	39.427
720	60.874	5.073	83.035	6.920	97.545	8.129	116.003	9.667	129.695	10.808	137.654	11.471	143.287	11.941
1440	76.696	3.196	104.617	4.359	122.899	5.121	146.154	6.090	163.406	6.809	173.433	7.226	180.530	7.522

Table 8 Estimation of maximum rainfall intensity for various return period For Belur Station														
Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	10.472	125.665	14.030	168.365	16.360	196.323	19.324	231.886	21.522	258.269	22.800	273.604	23.705	284.457
10	13.194	79.164	17.677	106.063	20.613	123.676	24.347	146.080	27.117	162.700	28.727	172.360	29.866	179.197
15	15.103	60.414	20.235	80.941	23.596	94.383	27.870	111.480	31.041	124.163	32.884	131.535	34.188	136.753
30	19.029	38.058	25.495	50.990	29.729	59.457	35.114	70.228	39.109	78.218	41.431	82.862	43.074	86.149
60	23.975	23.975	32.122	32.122	37.456	37.456	44.241	44.241	49.274	49.274	52.200	52.200	54.270	54.270
120	30.207	15.103	40.471	20.235	47.191	23.596	55.740	27.870	62.082	31.041	65.768	32.884	68.376	34.188
720	54.890	4.574	73.540	6.128	85.752	7.146	101.286	8.440	112.810	9.401	119.508	9.959	124.248	10.354
1440	69.156	2.882	92.655	3.861	108.041	4.502	127.612	5.317	142.131	5.922	150.570	6.274	156.543	6.523

Table 9 Estimation of maximum rainfall intensity for various return period For Birhalgere Station														
Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	8.880	106.565	11.350	136.200	12.967	155.605	15.024	180.288	16.550	198.599	17.437	209.242	18.065	216.775
10	11.189	67.132	14.300	85.801	16.338	98.025	18.929	113.574	20.852	125.110	21.969	131.814	22.760	136.560
15	12.808	51.231	16.370	65.478	18.702	74.807	21.668	86.673	23.869	95.476	25.148	100.593	26.054	104.215
30	16.137	32.274	20.624	41.249	23.563	47.126	27.300	54.601	30.073	60.146	31.685	63.370	32.826	65.651
60	20.331	20.331	25.985	25.985	29.687	29.687	34.396	34.396	37.890	37.890	39.920	39.920	41.358	41.358
120	25.616	12.808	32.739	16.370	37.404	18.702	43.337	21.668	47.738	23.869	50.297	25.148	52.107	26.054
720	46.546	3.879	59.491	4.958	67.967	5.664	78.748	6.562	86.746	7.229	91.395	7.616	94.685	7.890
1440	58.645	2.444	74.954	3.123	85.633	3.568	99.216	4.134	109.293	4.554	115.150	4.798	119.296	4.971

Table 10 Estimation of maximum rainfall intensity for various return period For Bilur Station

Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	23.095	277.141	32.178	386.136	38.125	457.504	45.690	548.283	51.302	615.629	54.564	654.772	56.873	682.477
10	29.098	174.588	40.542	243.251	48.035	288.210	57.566	345.398	64.637	387.823	68.747	412.482	71.656	429.934
15	33.309	133.235	46.409	185.635	54.986	219.945	65.897	263.588	73.991	295.964	78.696	314.782	82.025	328.101
30	41.967	83.933	58.471	116.943	69.278	138.557	83.025	166.050	93.223	186.446	99.150	198.300	103.345	206.691
60	52.875	52.875	73.669	73.669	87.285	87.285	104.605	104.605	117.453	117.453	124.921	124.921	130.207	130.207
120	66.618	33.309	92.817	46.409	109.973	54.986	131.794	65.897	147.982	73.991	157.391	78.696	164.050	82.025
720	121.052	10.088	168.661	14.055	199.834	16.653	239.485	19.957	268.901	22.408	285.999	23.833	298.100	24.842
1440	152.517	6.355	212.499	8.854	251.775	10.491	301.732	12.572	338.794	14.116	360.336	15.014	375.582	15.649

Table 11 Estimation of maximum rainfall intensity for various return period For Channenahally Station

Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	9.640	115.684	12.875	154.506	14.994	179.926	17.688	212.260	19.687	236.247	20.849	250.189	21.671	260.056
10	12.146	72.877	16.222	97.333	18.891	113.346	22.286	133.715	24.804	148.826	26.268	157.609	27.304	163.826
15	13.904	55.615	18.570	74.279	21.625	86.499	25.511	102.044	28.394	113.576	30.070	120.278	31.256	125.022
30	17.518	35.035	23.396	46.793	27.246	54.491	32.142	64.284	35.774	71.548	37.885	75.771	39.380	78.759
60	22.071	22.071	29.478	29.478	34.327	34.327	40.496	40.496	45.073	45.073	47.732	47.732	49.615	49.615
120	27.808	13.904	37.139	18.570	43.250	21.625	51.022	25.511	56.788	28.394	60.139	30.070	62.511	31.256
720	50.530	4.211	67.487	5.624	78.590	6.549	92.713	7.726	103.190	8.599	109.280	9.107	113.590	9.466
1440	63.663	2.653	85.028	3.543	99.017	4.126	116.811	4.867	130.012	5.417	137.684	5.737	143.115	5.963

Table 12 Estimation of maximum rainfall intensity for various return period For Chikkamangalore Station

Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	9.786	117.435	11.867	142.400	13.229	158.747	14.962	179.541	16.247	194.966	16.994	203.932	17.523	210.278
10	12.330	73.979	14.951	89.707	16.667	100.005	18.851	113.104	20.470	122.821	21.412	128.470	22.078	132.467
15	14.114	56.457	17.115	68.459	19.079	76.318	21.579	86.314	23.433	93.730	24.510	98.041	25.273	101.091
30	17.783	35.566	21.563	43.126	24.039	48.077	27.187	54.375	29.523	59.046	30.881	61.762	31.842	63.684
60	22.405	22.405	27.168	27.168	30.287	30.287	34.254	34.254	37.197	37.197	38.907	38.907	40.118	40.118
120	28.228	14.114	34.230	17.115	38.159	19.079	43.157	21.579	46.865	23.433	49.020	24.510	50.546	25.273
720	51.294	4.275	62.199	5.183	69.339	5.778	78.422	6.535	85.159	7.097	89.076	7.423	91.848	7.654
1440	64.627	2.693	78.366	3.265	87.362	3.640	98.805	4.117	107.294	4.471	112.228	4.676	115.721	4.822

Table 13 Estimation of maximum rainfall intensity for various return period For Galibeedu Station

Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	24.700	296.399	30.097	361.161	33.631	403.567	38.126	457.507	41.460	497.522	43.398	520.780	44.770	537.242
10	31.120	186.720	37.920	227.518	42.372	254.232	48.035	288.212	52.237	313.420	54.679	328.072	56.407	338.442
15	35.623	142.494	43.407	173.629	48.504	194.015	54.987	219.947	59.796	239.184	62.591	250.365	64.570	258.279
30	44.883	89.765	54.690	109.379	61.111	122.222	69.279	138.558	75.338	150.676	78.860	157.720	81.353	162.706
60	56.549	56.549	68.905	68.905	76.995	76.995	87.286	87.286	94.920	94.920	99.358	99.358	102.498	102.498
120	71.247	35.623	86.814	43.407	97.008	48.504	109.973	54.987	119.592	59.796	125.183	62.591	129.140	64.570
720	129.464	10.789	157.752	13.146	176.274	14.690	199.835	16.653	217.313	18.109	227.472	18.956	234.662	19.555
1440	163.115	6.796	198.755	8.281	222.092	9.254	251.776	10.491	273.797	11.408	286.597	11.942	295.656	12.319

Table 14 Estimation of maximum rainfall intensity for various return period For Gonibeedu Station

Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	16.364	196.364	21.961	263.533	25.626	307.514	30.288	363.458	33.747	404.960	35.757	429.082	37.180	446.155
10	20.617	123.702	27.669	166.016	32.287	193.722	38.161	228.965	42.518	255.109	45.051	270.305	46.843	281.061
15	23.601	94.402	31.673	126.694	36.959	147.838	43.683	174.733	48.671	194.685	51.570	206.282	53.622	214.489
30	29.735	59.470	39.906	79.812	46.566	93.132	55.037	110.075	61.322	122.644	64.975	129.949	67.560	135.120
60	37.463	37.463	50.278	50.278	58.669	58.669	69.343	69.343	77.261	77.261	81.863	81.863	85.120	85.120
120	47.201	23.601	63.347	31.673	73.919	36.959	87.366	43.683	97.342	48.671	103.141	51.570	107.245	53.622
720	85.770	7.147	115.109	9.592	134.319	11.193	158.755	13.230	176.883	14.740	187.419	15.618	194.877	16.240
1440	108.063	4.503	145.028	6.043	169.232	7.051	200.019	8.334	222.858	9.286	236.133	9.839	245.529	10.230

Table 15 Estimation of maximum rainfall intensity for various return period For Hagare Station

Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	9.291	111.491	12.002	144.026	13.778	165.330	16.036	192.428	17.711	212.531	18.685	224.215	19.374	232.485
10	11.706	70.235	15.122	90.731	17.359	104.152	20.204	121.222	22.314	133.886	23.541	141.247	24.409	146.457
15	13.400	53.599	17.310	69.241	19.871	79.483	23.127	92.510	25.544	102.174	26.948	107.792	27.942	111.767
30	16.883	33.765	21.809	43.619	25.035	50.071	29.139	58.278	32.183	64.366	33.952	67.904	35.204	70.409
60	21.271	21.271	27.478	27.478	31.543	31.543	36.713	36.713	40.548	40.548	42.777	42.777	44.355	44.355
120	26.800	13.400	34.620	17.310	39.741	19.871	46.255	23.127	51.087	25.544	53.896	26.948	55.884	27.942
720	48.698	4.058	62.909	5.242	72.215	6.018	84.051	7.004	92.831	7.736	97.935	8.161	101.547	8.462
1440	61.356	2.556	79.261	3.303	90.985	3.791	105.897	4.412	116.960	4.873	123.391	5.141	127.942	5.331

Table 16 Estimation of maximum rainfall intensity for various return period For Halimysore Station													
Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	9.498	113.975	11.379	136.546	12.610	151.325	14.177	170.124	15.339	184.070	16.015	192.176	16.493	197.913
10	11.967	71.800	14.336	86.019	15.888	95.329	17.862	107.172	19.326	115.957	20.177	121.064	20.780	124.678
15	13.698	54.794	16.411	65.645	18.187	72.750	20.447	81.787	22.123	88.492	23.097	92.389	23.787	95.147
30	17.259	34.518	20.677	41.353	22.915	45.829	25.761	51.523	27.873	55.746	29.101	58.201	29.969	59.939
60	21.745	21.745	26.051	26.051	28.871	28.871	32.457	32.457	35.118	35.118	36.665	36.665	37.759	37.759
120	27.397	13.698	32.822	16.411	36.375	18.187	40.894	20.447	44.246	22.123	46.194	23.097	47.573	23.787
720	49.783	4.149	59.642	4.970	66.097	5.508	74.309	6.192	80.400	6.700	83.941	6.995	86.447	7.204
1440	62.723	2.613	75.144	3.131	83.278	3.470	93.623	3.901	101.298	4.221	105.759	4.407	108.916	4.538

Table 17 Estimation of maximum rainfall intensity for various return period For Hassan Station													
Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	10.618	127.420	13.457	161.482	15.315	183.785	17.680	212.155	19.433	233.201	20.453	245.433	21.174	254.091
10	13.378	80.270	16.955	101.728	19.296	115.778	22.275	133.649	24.485	146.908	25.769	154.614	26.678	160.068
15	15.314	61.257	19.408	77.633	22.089	88.355	25.498	101.994	28.028	112.111	29.498	117.992	30.539	122.155
30	19.295	38.590	24.453	48.906	27.830	55.660	32.126	64.252	35.313	70.626	37.165	74.330	38.476	76.953
60	24.310	24.310	30.809	30.809	35.064	35.064	40.476	40.476	44.491	44.491	46.825	46.825	48.477	48.477
120	30.629	15.314	38.816	19.408	44.177	22.089	50.997	25.498	56.056	28.028	58.996	29.498	61.077	30.539
720	55.656	4.638	70.534	5.878	80.276	6.690	92.667	7.722	101.860	8.488	107.203	8.934	110.985	9.249
1440	70.122	2.922	88.867	3.703	101.141	4.214	116.753	4.865	128.335	5.347	135.067	5.628	139.832	5.826

Table 18 Estimation of maximum rainfall intensity for various return period For Hunsur Station													
Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	9.551	114.608	12.559	150.703	14.528	174.337	17.033	204.399	18.892	226.701	19.972	239.664	20.737	248.839
10	12.033	72.199	15.823	94.937	18.304	109.826	21.461	128.764	23.802	142.813	25.163	150.979	26.126	156.759
15	13.774	55.098	18.113	72.450	20.953	83.813	24.566	98.265	27.247	108.987	28.805	115.219	29.907	119.629
30	17.355	34.709	22.820	45.641	26.399	52.799	30.952	61.903	34.329	68.657	36.292	72.583	37.681	75.362
60	21.866	21.866	28.752	28.752	33.261	33.261	38.997	38.997	43.251	43.251	45.725	45.725	47.475	47.475
120	27.549	13.774	36.225	18.113	41.906	20.953	49.133	24.566	54.493	27.247	57.609	28.805	59.815	29.907
720	50.060	4.172	65.826	5.485	76.149	6.346	89.280	7.440	99.021	8.252	104.683	8.724	108.690	9.058
1440	63.071	2.628	82.935	3.456	95.941	3.998	112.485	4.687	124.759	5.198	131.892	5.496	136.941	5.706

Table 19 Estimation of maximum rainfall intensity for various return period For Kushalnagar Station

Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	9.010	108.116	11.074	132.885	12.425	149.103	14.144	169.733	15.420	185.037	16.161	193.933	16.686	200.229
10	11.351	68.109	13.952	83.712	15.655	93.929	17.821	106.925	19.428	116.567	20.362	122.170	21.023	126.136
15	12.994	51.977	15.971	63.884	17.920	71.682	20.400	81.599	22.239	88.957	23.308	93.233	24.065	96.260
30	16.372	32.743	20.122	40.245	22.578	45.157	25.702	51.404	28.020	56.039	29.367	58.733	30.320	60.640
60	20.627	20.627	25.353	25.353	28.447	28.447	32.383	32.383	35.303	35.303	37.000	37.000	38.201	38.201
120	25.988	12.994	31.942	15.971	35.841	17.920	40.800	20.400	44.478	22.239	46.617	23.308	48.130	24.065
720	47.224	3.935	58.043	4.837	65.127	5.427	74.138	6.178	80.823	6.735	84.708	7.059	87.458	7.288
1440	59.498	2.479	73.129	3.047	82.055	3.419	93.408	3.892	101.830	4.243	106.726	4.447	110.190	4.591

Table 20 Estimation of maximum rainfall intensity for various return period For Naladi Station

Duration in minutes	Return period 2 yrs		Return period 5 yrs		Return period 10 yrs		Return period 25 yrs		Return period 50 yrs		Return period 75 yrs		Return period 100 yrs	
	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)	Rainfall Depth(mm)	Rainfall Intensity (mm/hr)
5	39.628	475.533	52.128	625.538	60.313	723.760	70.725	848.696	78.448	941.381	82.938	995.253	86.115	1033.381
10	49.928	299.567	65.678	394.065	75.990	455.941	89.108	534.646	98.839	593.034	104.495	626.971	108.498	650.991
15	57.153	228.613	75.182	300.728	86.987	347.948	102.003	408.011	113.142	452.569	119.617	478.468	124.200	496.799
30	72.008	144.017	94.723	189.447	109.597	219.194	128.515	257.031	142.550	285.101	150.708	301.416	156.482	312.963
60	90.725	90.725	119.344	119.344	138.083	138.083	161.919	161.919	179.602	179.602	189.880	189.880	197.155	197.155
120	114.306	57.153	150.364	75.182	173.974	86.987	204.006	102.003	226.285	113.142	239.234	119.617	248.399	124.200
720	207.708	17.309	273.229	22.769	316.132	26.344	370.703	30.892	411.187	34.266	434.717	36.226	451.371	37.614
1440	261.696	10.904	344.247	14.344	398.301	16.596	467.056	19.461	518.063	21.586	547.709	22.821	568.692	23.696
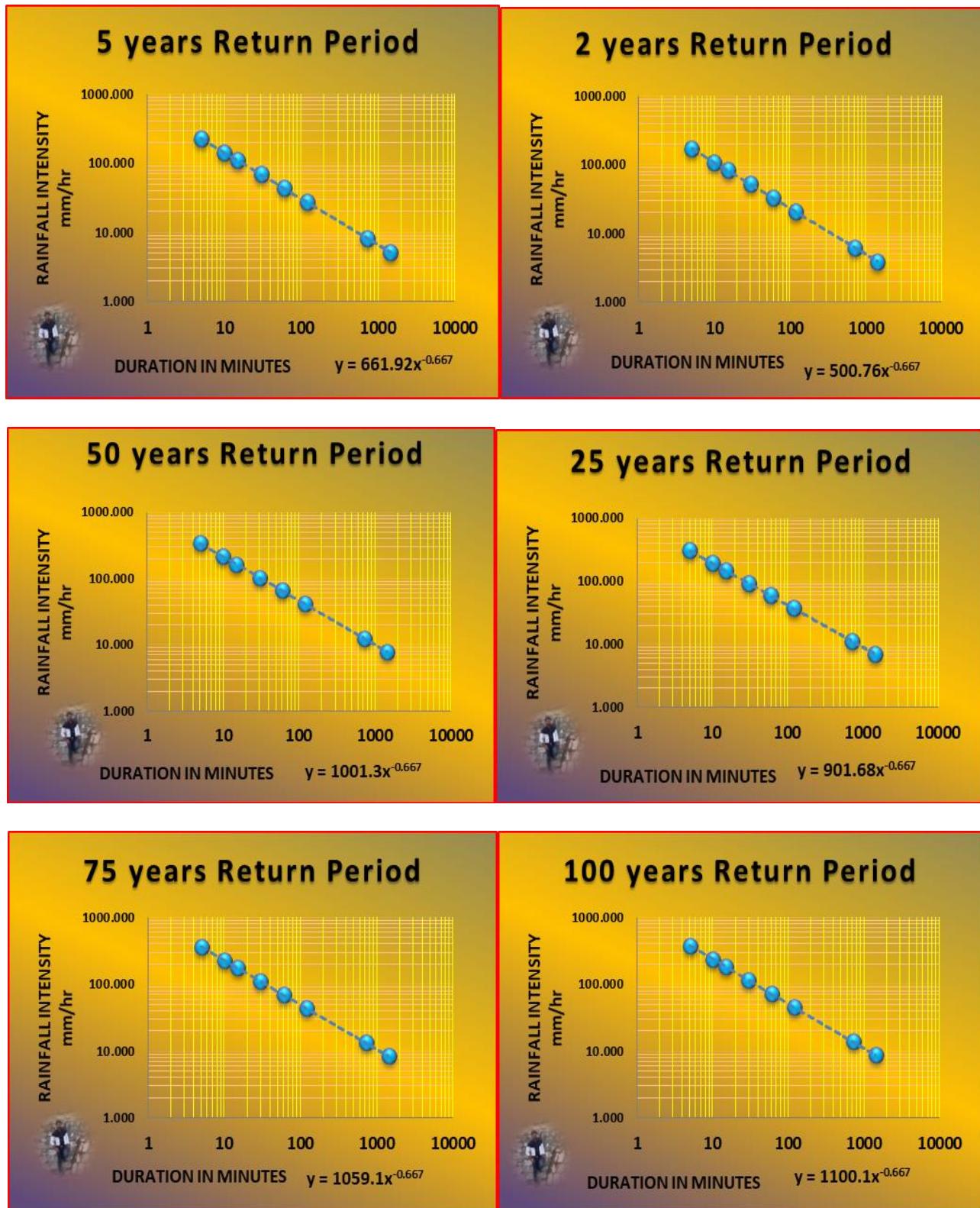
Figure 3 IDF curves for Arehalli Station

Figure 4 IDF curves for Arkalgud Station
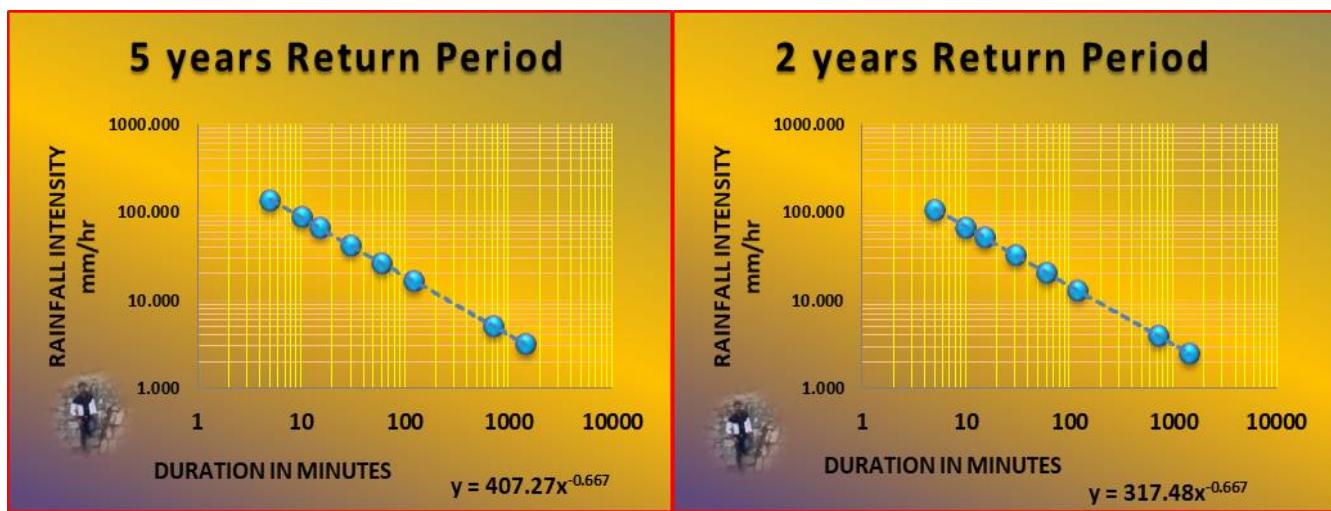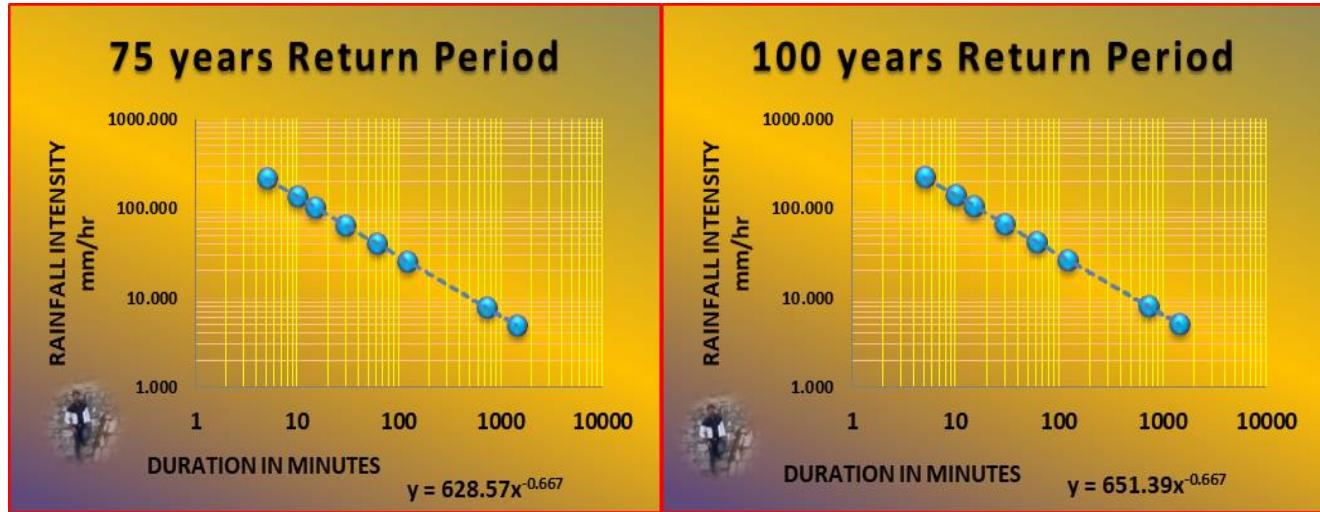
Figure 5 IDF curves for Basavapatna Station
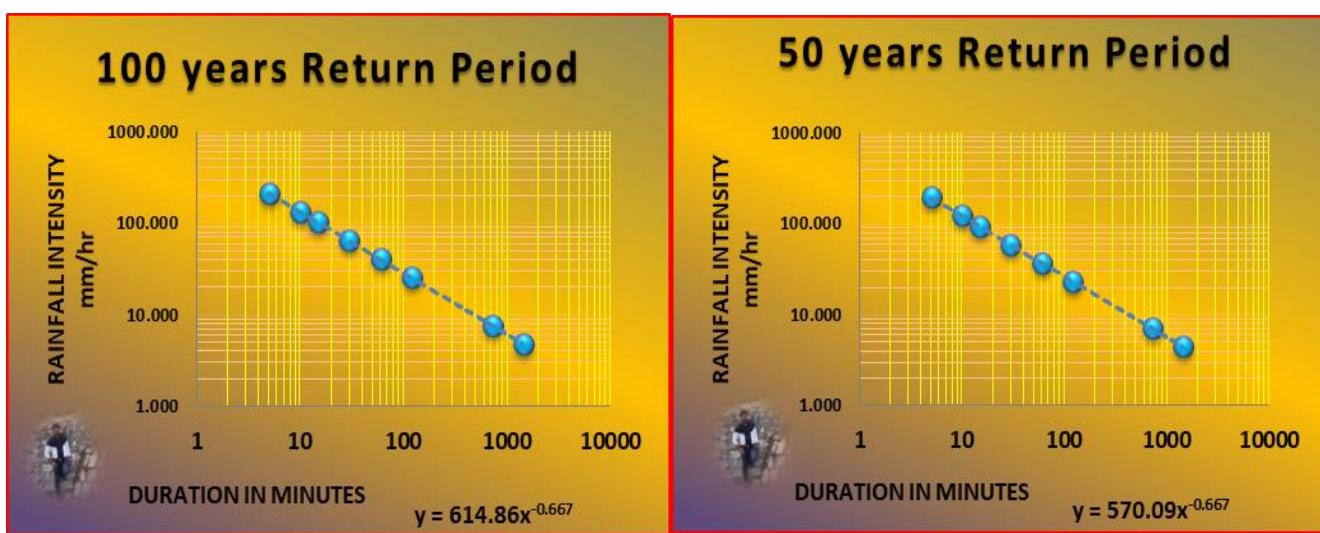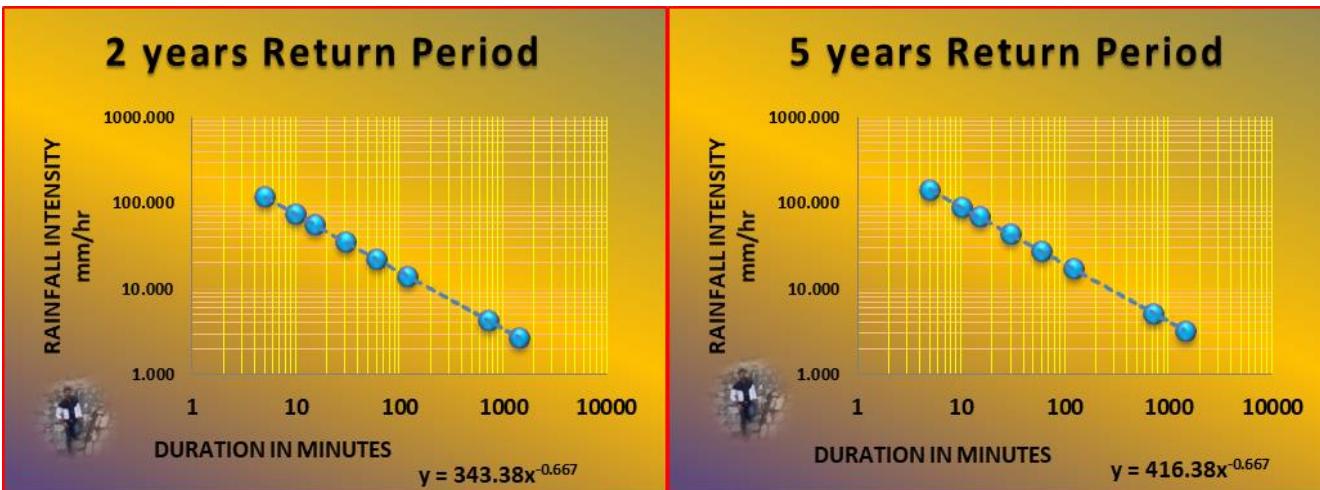
Figure 6 IDF curves for Chikkamangalore Station
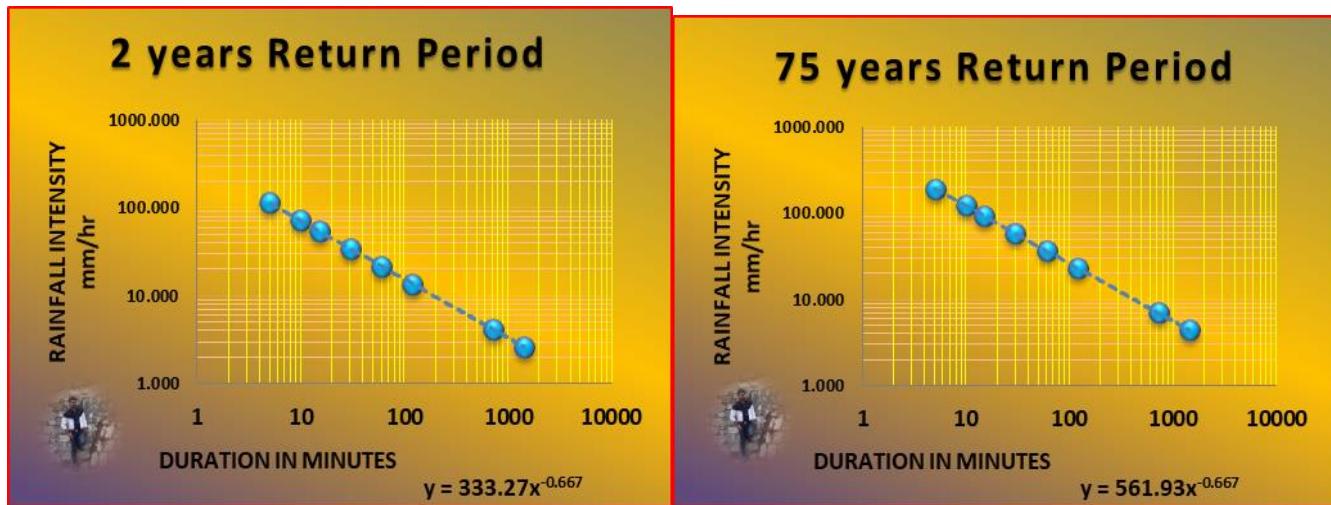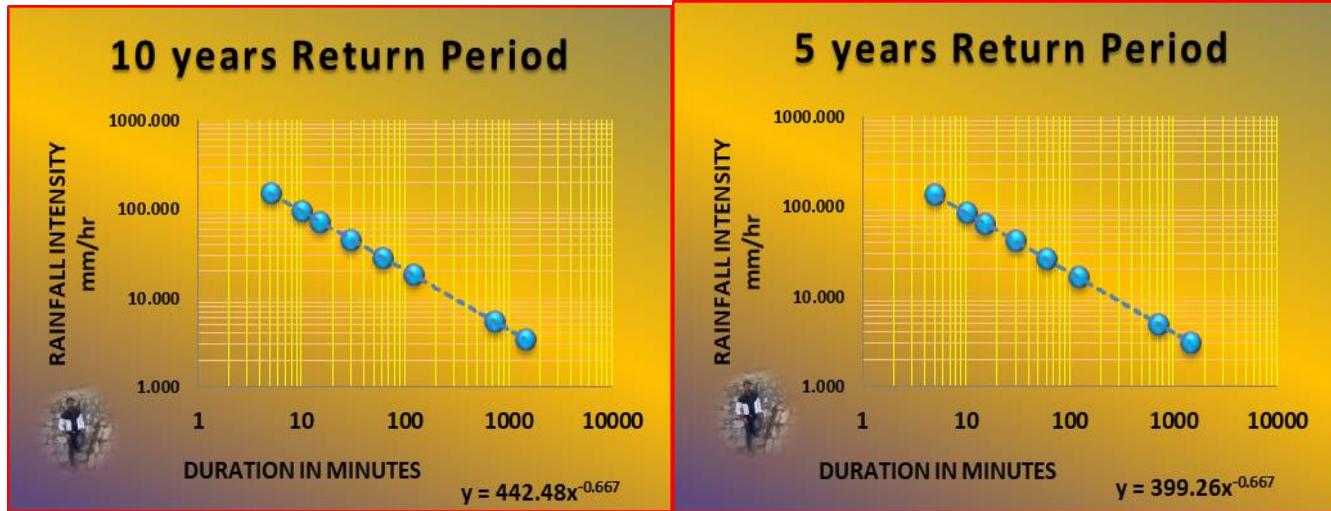
Figure 7 IDF curves for Hallimysore Station
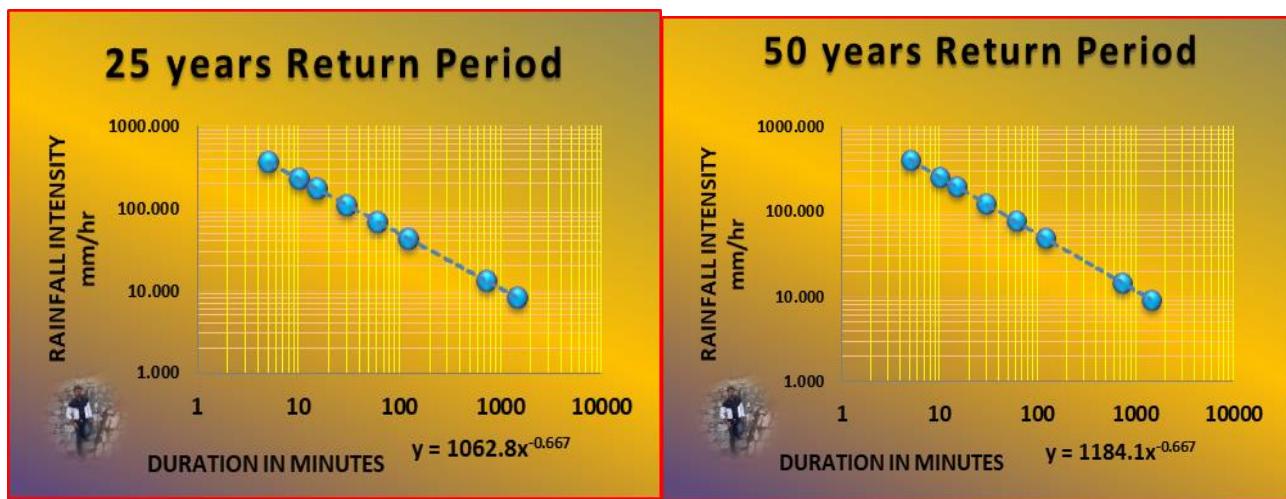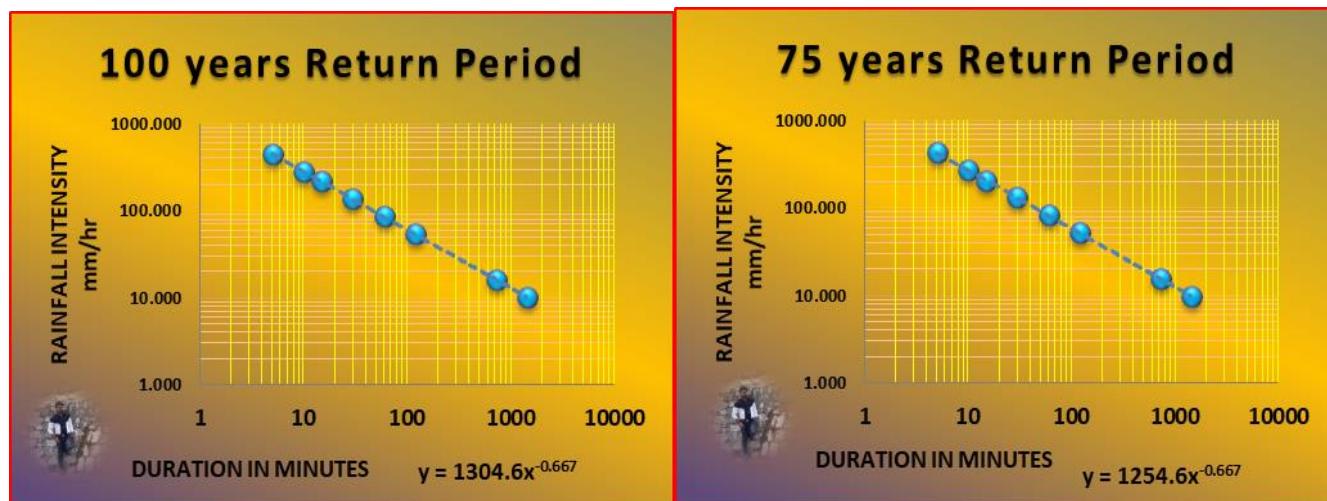
Figure 8 IDF curves for Gonibeedu Station
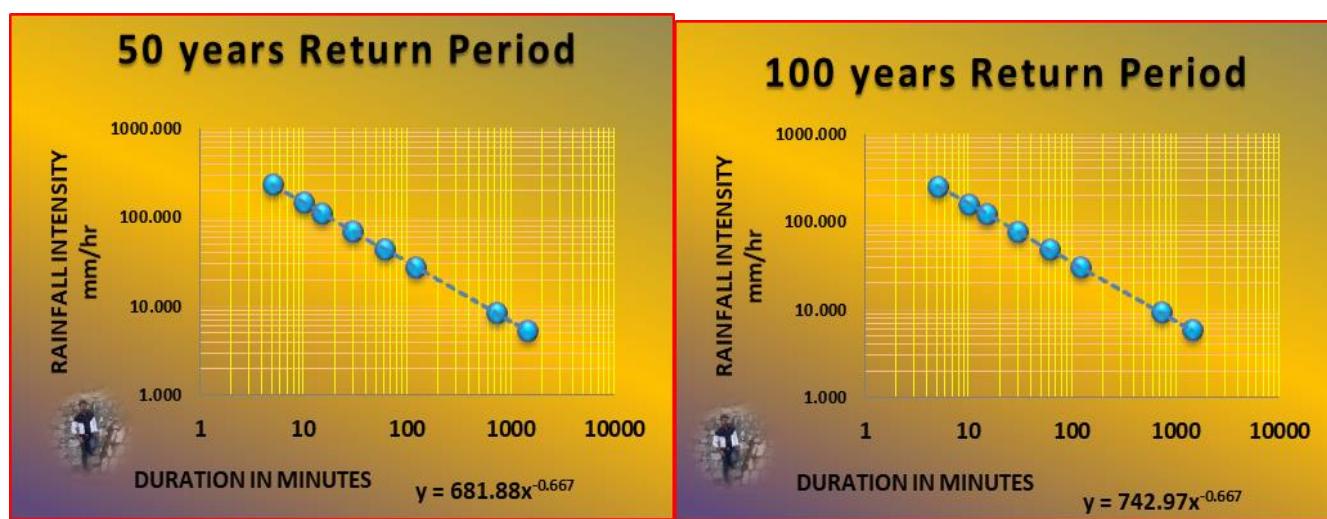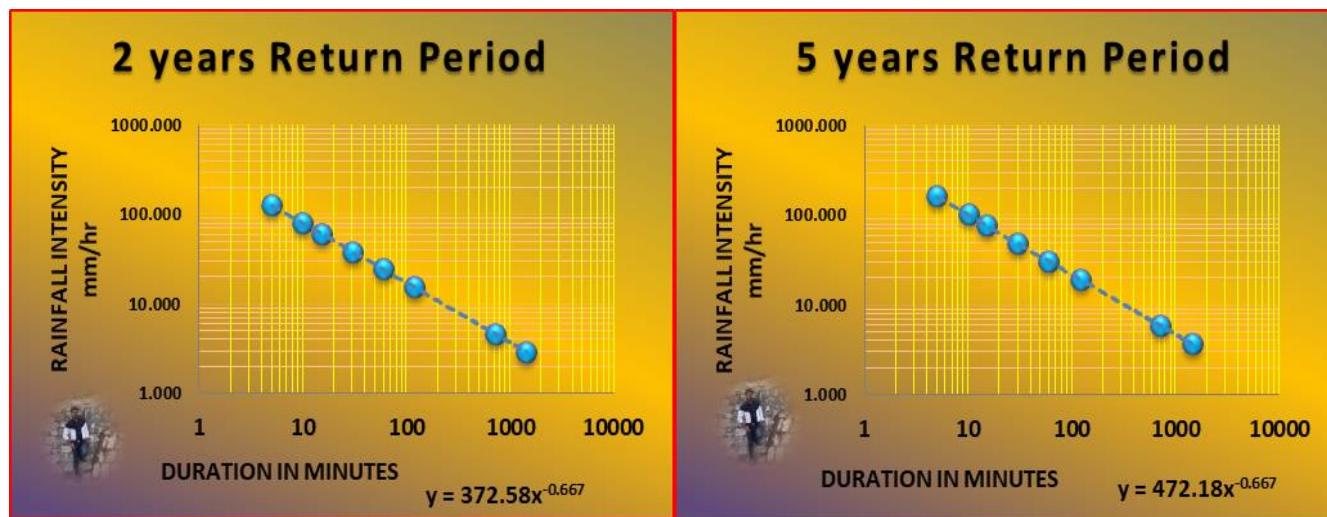
Figure 9 IDF curves for Hassan Station
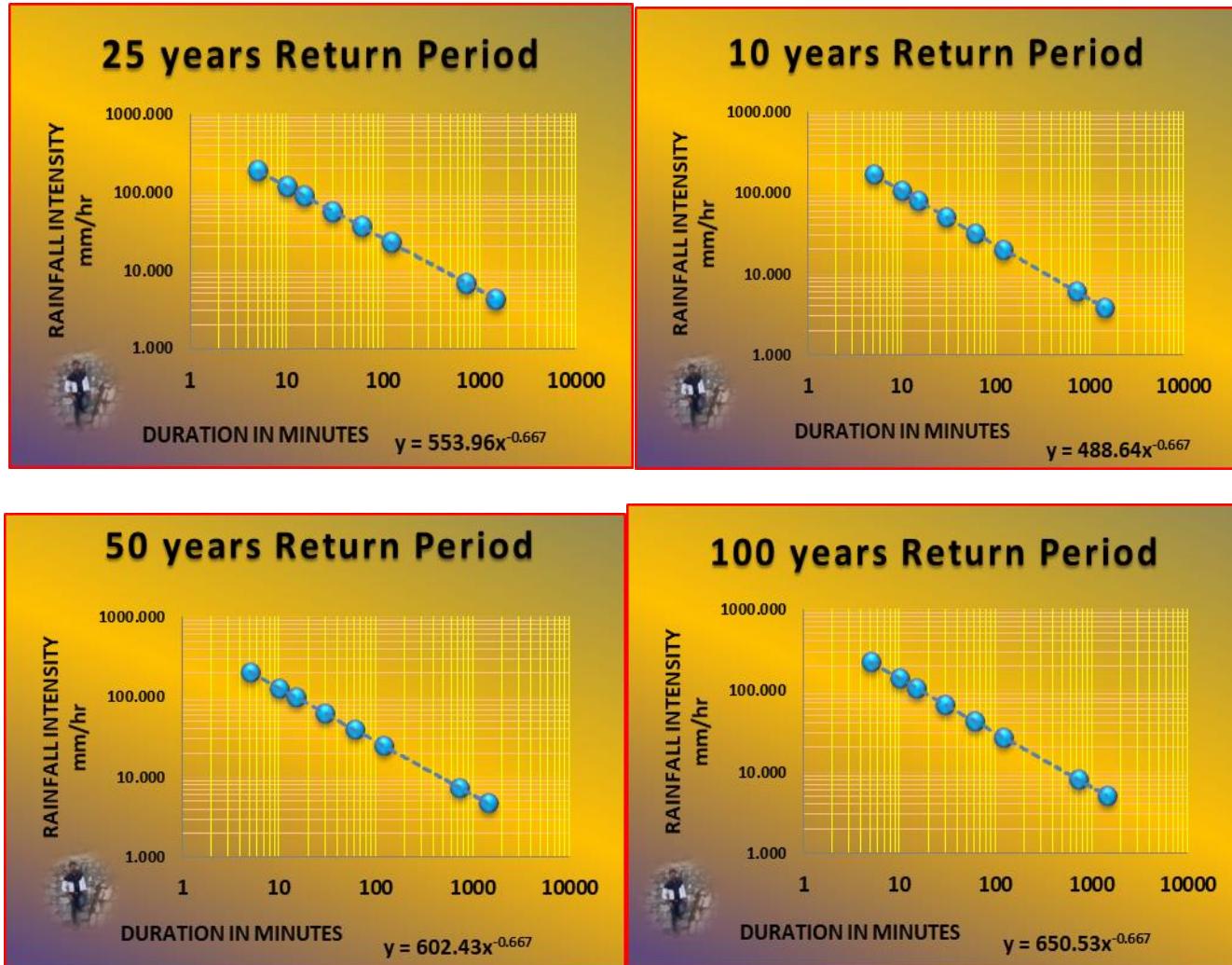
Figure 10 IDF curves for Krishnarajpet Station
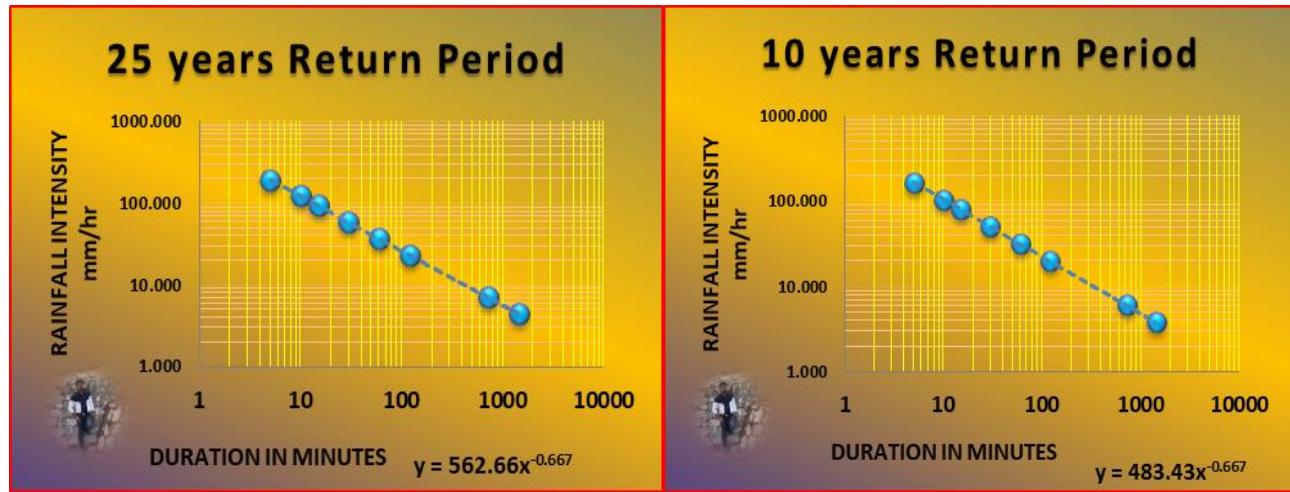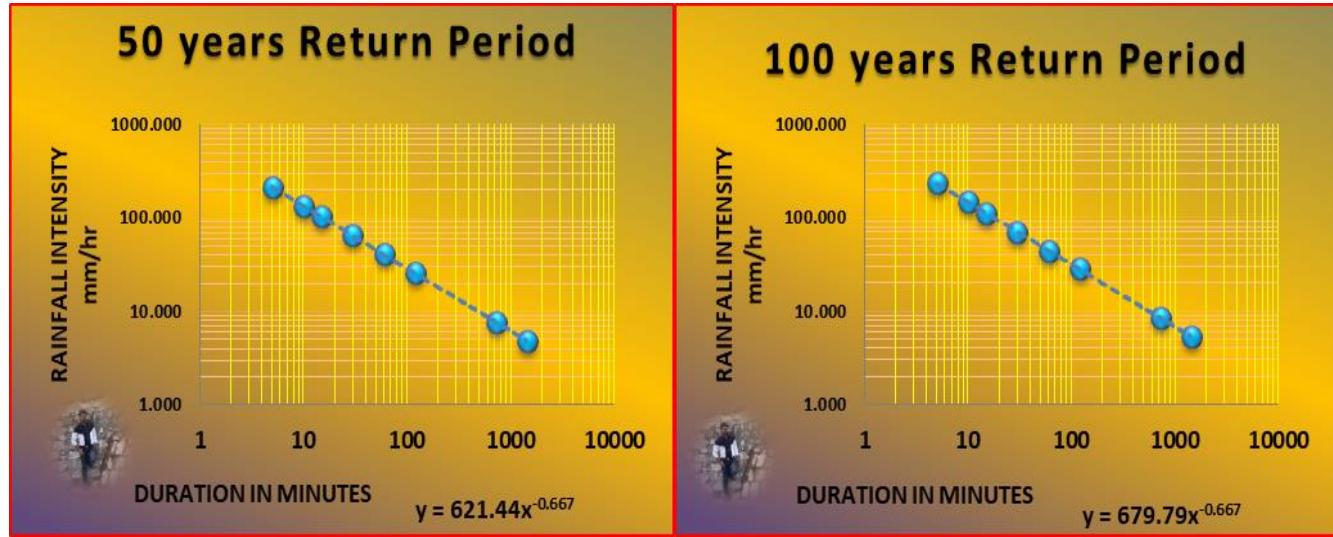
Figure 11 IDF curves for Halibailu Station
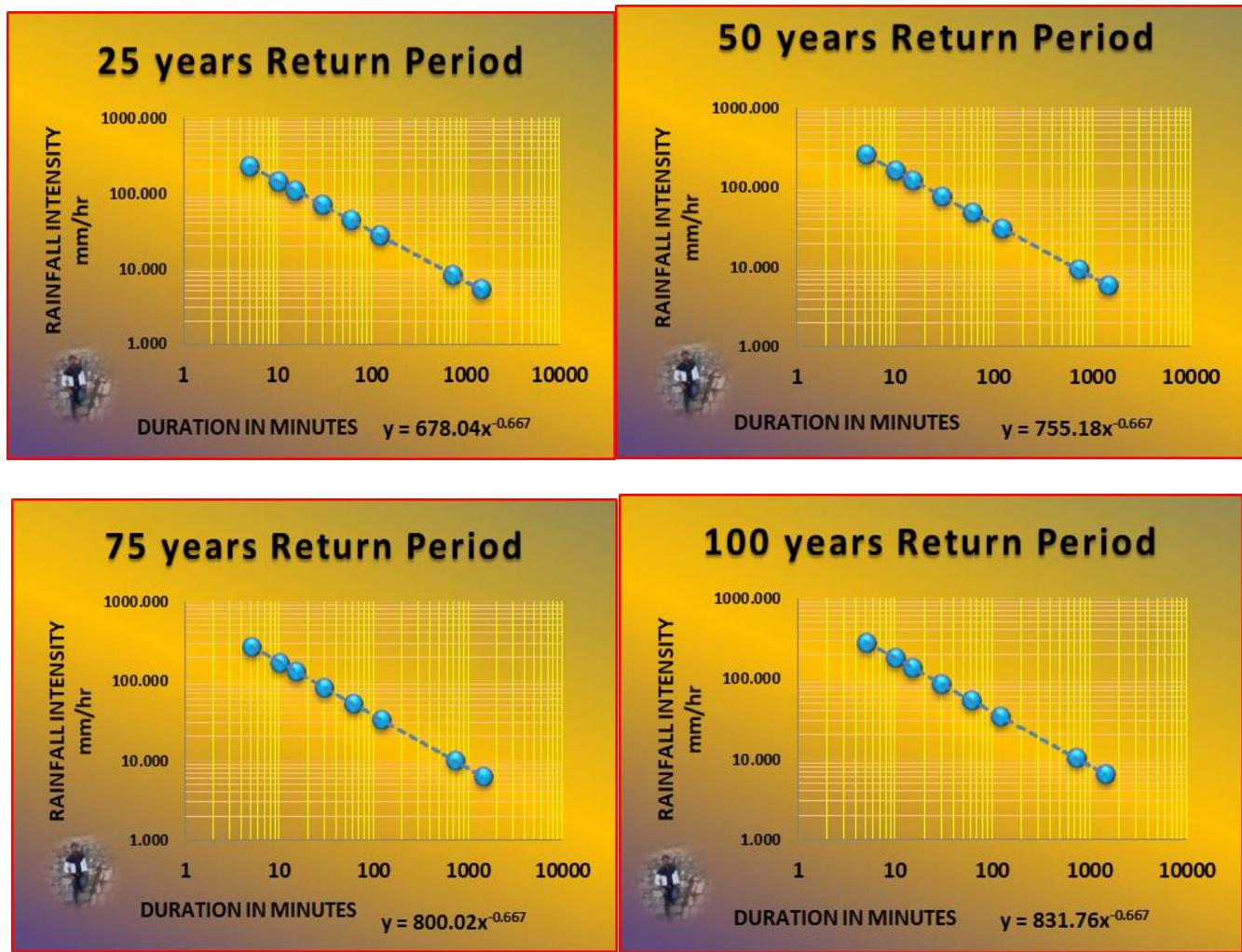

Figure 12 IDF curves for Hagare Station
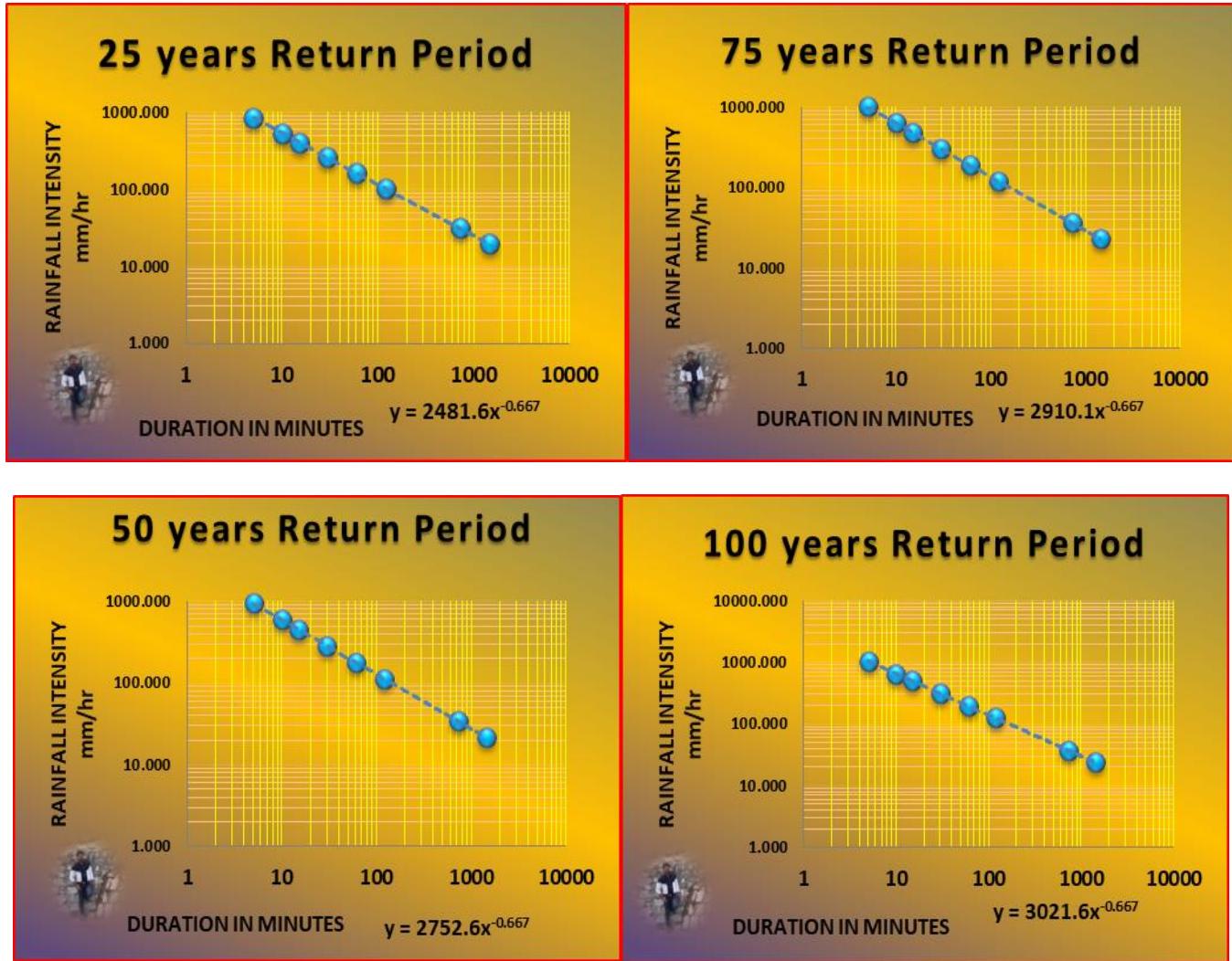
Figure 13 IDF curves for Naladi Station
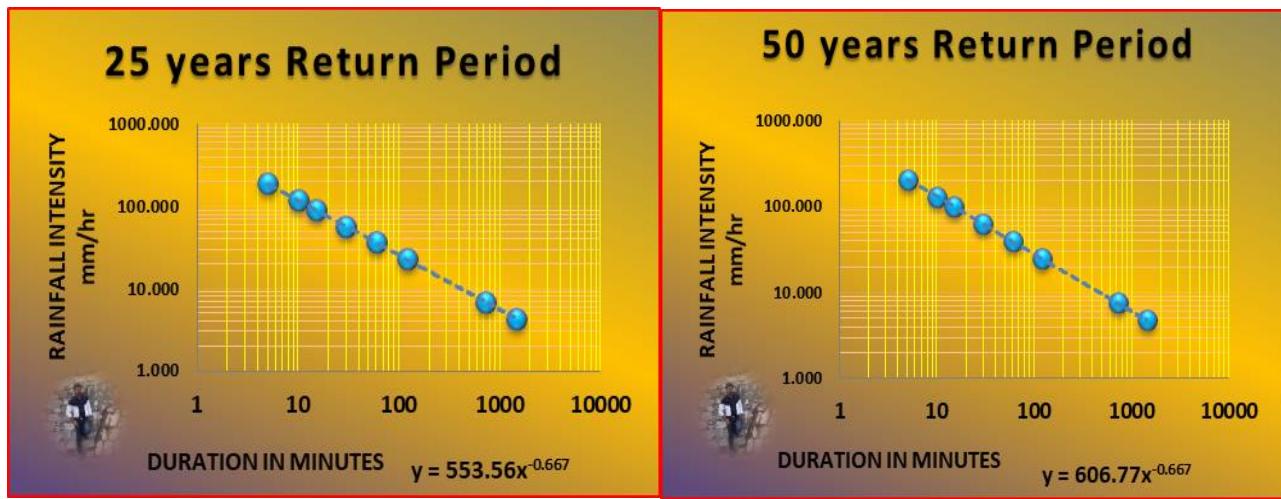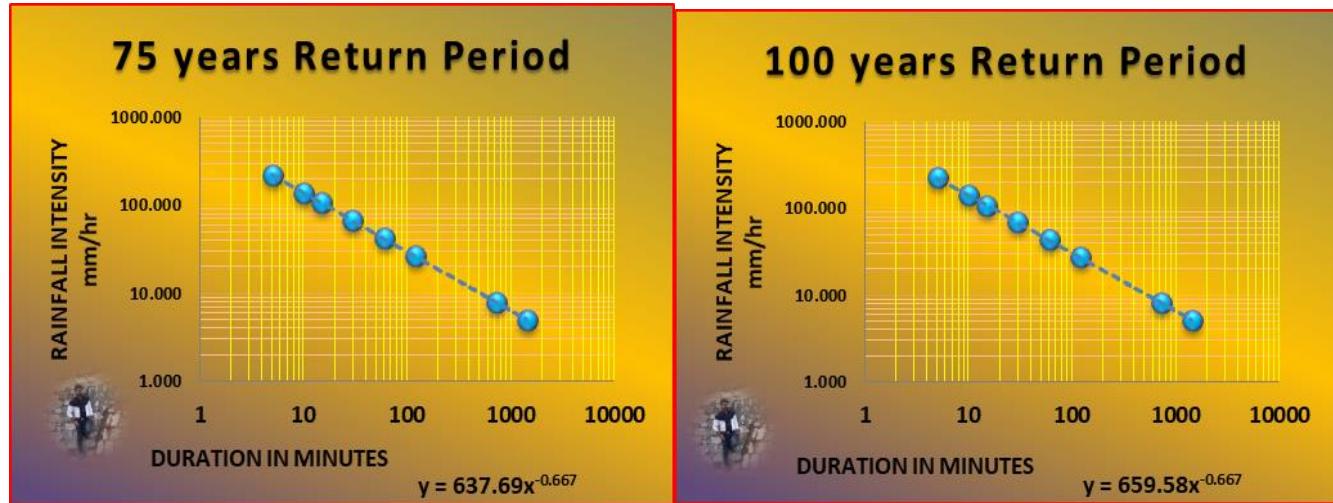
Figure 14 IDF curves for Gorur Station
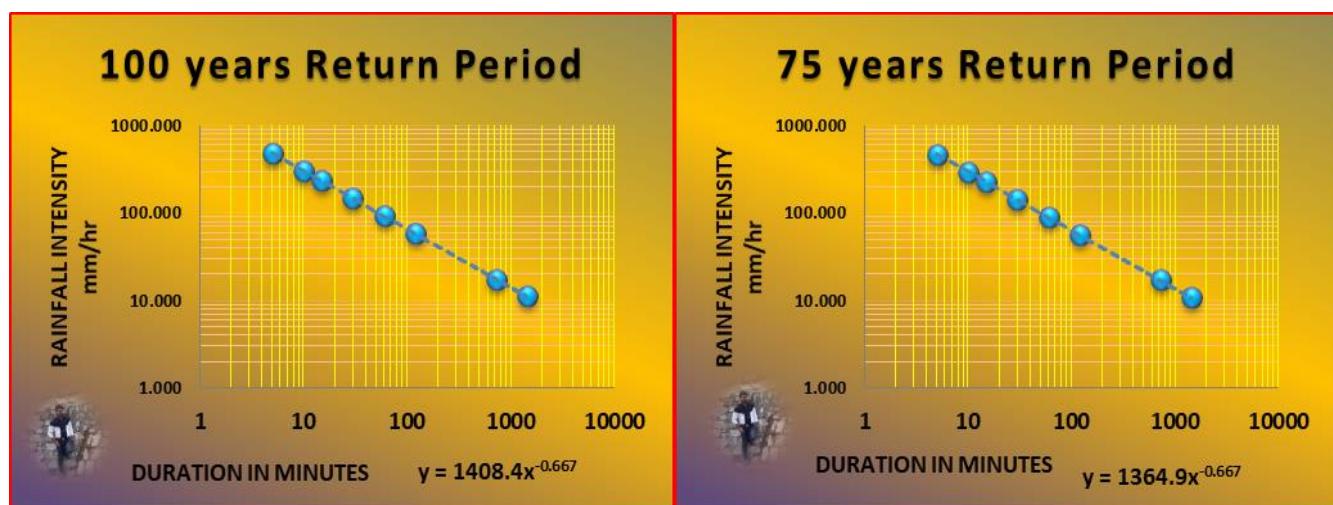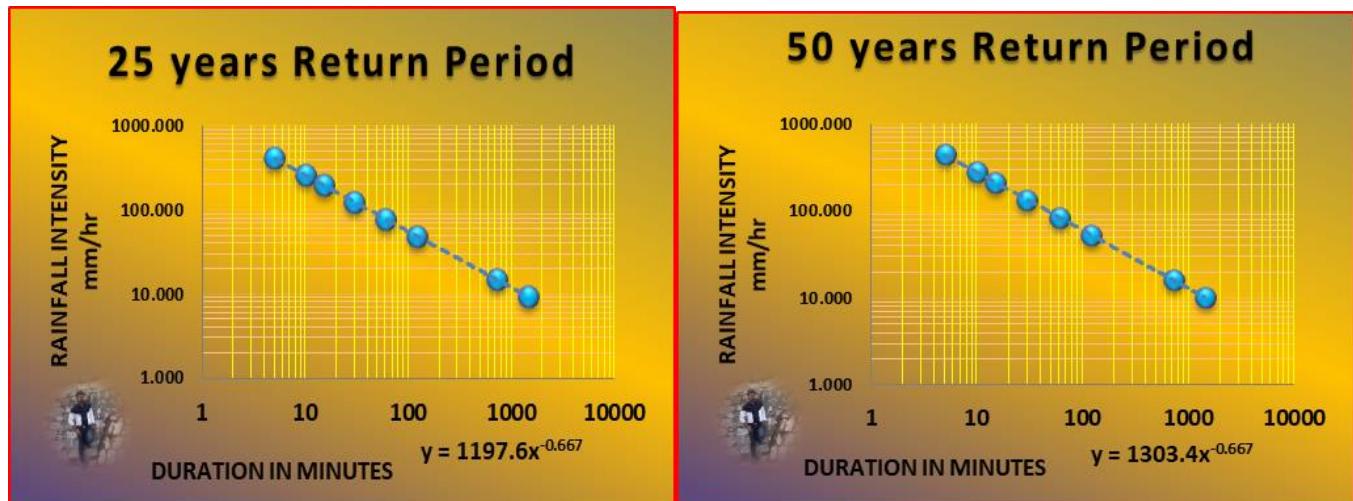
Figure 15 IDF curves for Javali Station
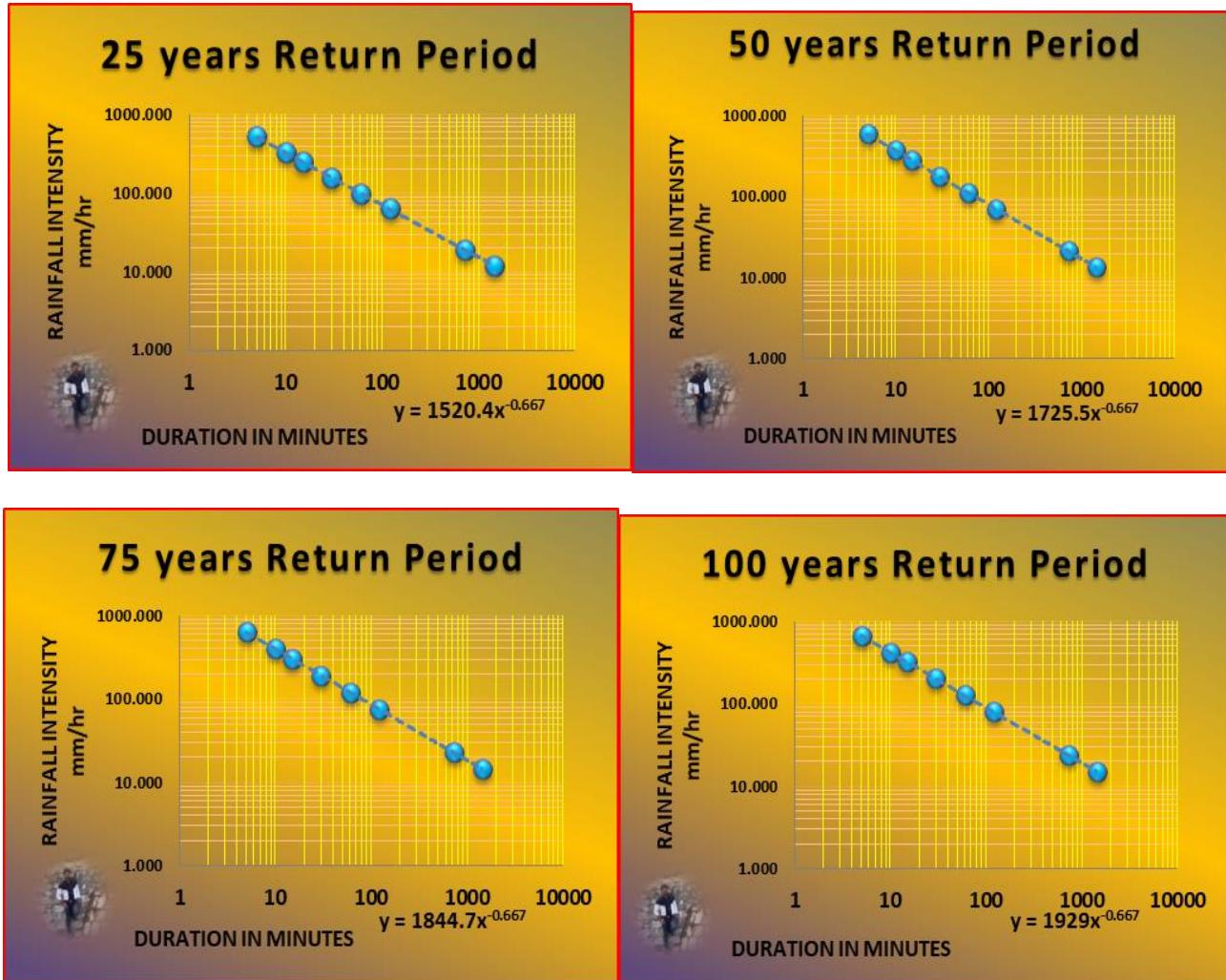
Figure 16 IDF curves for Poonampet Station
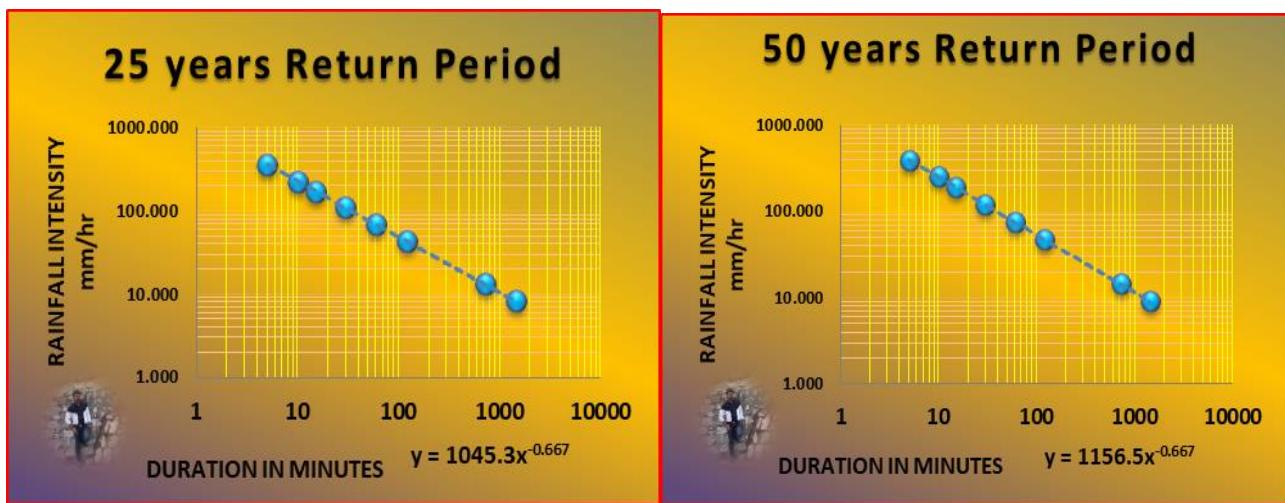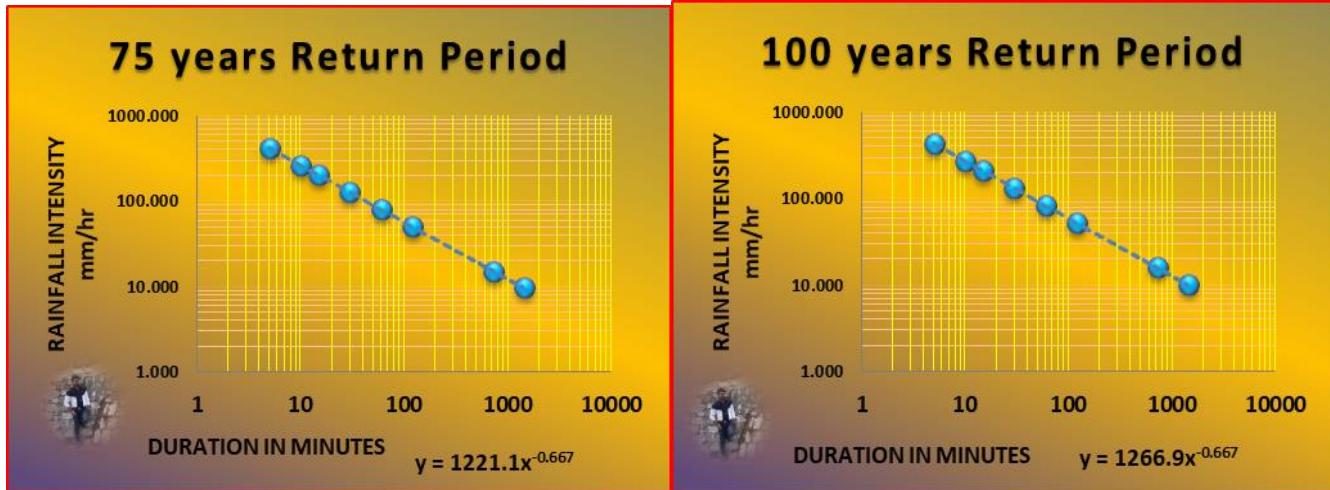
Figure 17 IDF curves for Sakaleshpura Station
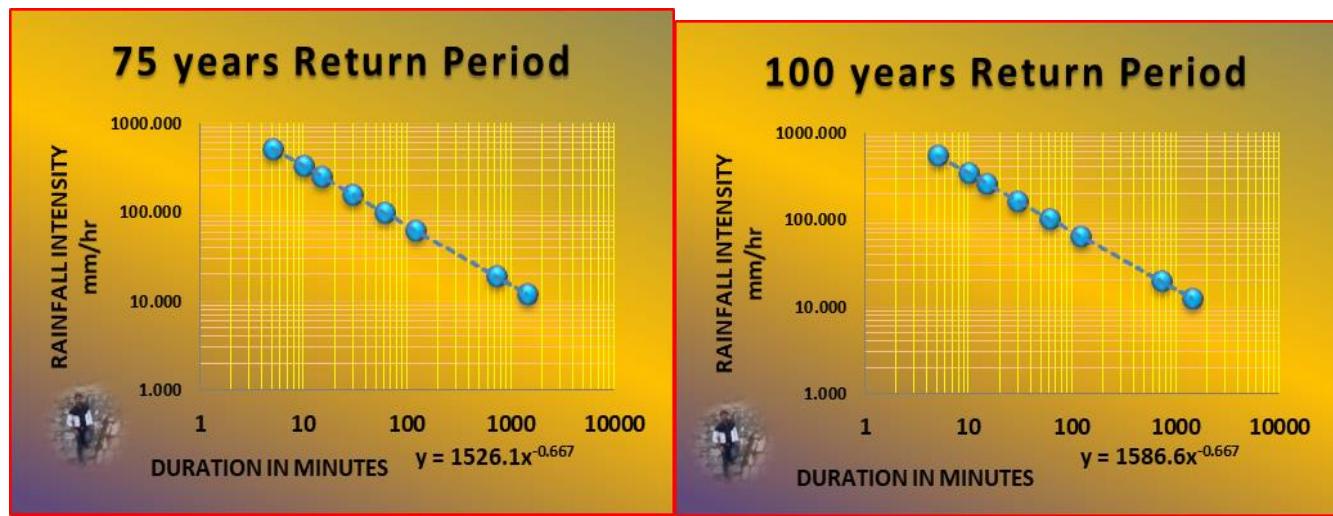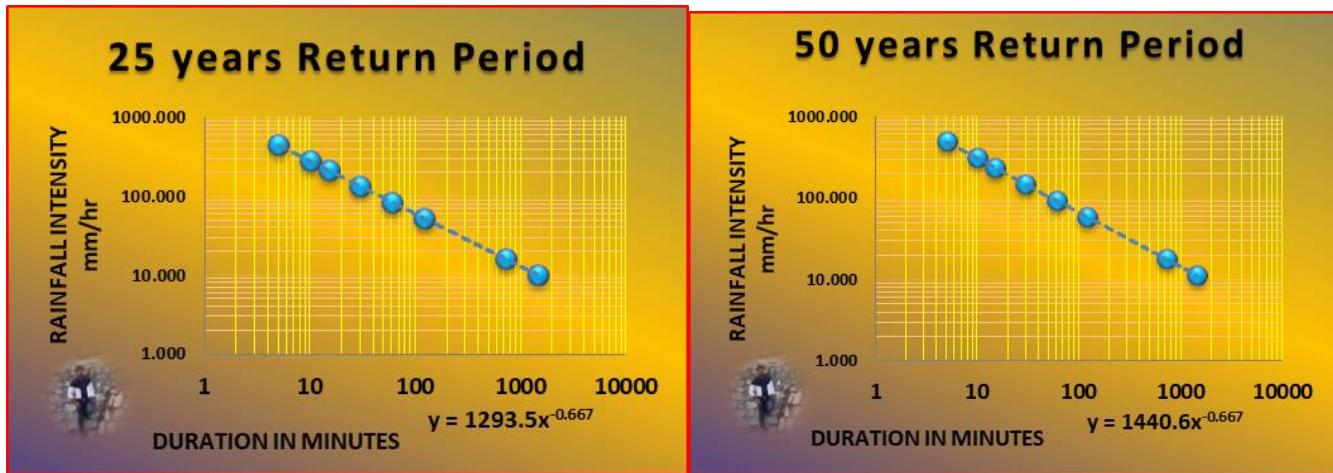
Figure 18 IDF curves for Virajpet Station

Table 21: IDF equations for all the raingauge stations in the study

IDF Equation $Y=aX^{-0.667}$ where Y is intensity of rainfall, X is the time interval and a is constant						
Station Name	**Value of constant 'a' for different a return period**					
	2years	**5years**	**10years**	**25years**	**50years**	**75years**	**100years**
Arehalli	500.8	661.9	767.5	901.7	1001.3	1059.1	1100.1
Arkalgud	332.7	433.2	499.1	582.8	644.9	681.0	706.5
Basavapatna	317.5	407.3	466.1	540.8	596.3	628.5	651.4
Balagodu	407.5	555.9	653.0	776.5	868.2	921.5	959.2
Belur	367.5	492.3	574.1	678.0	755.2	800.0	831.8
Bettadapura	311.6	398.3	455.0	527.2	580.7	611.8	633.9
Bilur	810.4	1129.1	1337.8	1603.2	1800.1	1914.6	1995.6
Channenahally	338.3	451.8	526.1	620.7	690.8	731.6	760.4
Chikkamangalore	343.4	416.4	464.2	525.0	570.1	596.3	614.9
Doddabemmatti	260.0	317.0	354.4	401.9	437.1	457.6	472.1
Galibeedu	866.7	1056.0	1180.0	1337.8	1454.8	1522.8	1570.9
Gonibeedu	574.2	770.6	899.2	1062.8	1184.4	1254.6	1304.6
Gorur	339.3	425.5	481.8	553.6	606.8	637.7	659.6
Hagare	326.0	421.1	483.4	562.6	621.6	655.6	679.8
Halekote	315.2	435.4	514.1	614.1	688.4	731.5	762.0
Hallibailu	783.1	955.1	1067.7	1211.0	1317.3	1379.0	1422.8
Hallimysore	333.3	399.3	442.5	497.5	528.2	561.9	578.7
Harangi	339.4	499.8	522.1	614.0	682.2	721.9	750.0
Hassan	372.6	472.2	537.4	620.3	681.9	717.7	743.0
Hosakere	1153.5	1411.1	1580.0	1794.6	1953.7	2046.2	2111.7
Hunsur	335.1	440.7	509.8	597.7	662.9	700.8	727.6
Javali	771.6	942.8	1054.9	1197.6	1303.4	1364.9	1408.4
Kenchammana hoskote	477.3	604.5	687.8	793.7	872.3	918.0	950.3
Krishnarajpet	358.8	437.3	488.6	554.0	602.4	630.6	650.5
Kushalnagar	316.1	388.6	436.0	496.3	541.1	567.1	585.5
Malalur	257.5	313.7	350.5	397.4	432.1	452.3	466.6
Mallipatna	358.8	425.2	469.0	524.6	565.8	589.8	606.8
Melkote	421.5	551.1	636.0	743.9	824.0	870.5	903.5
Naladi	1390.5	1829.1	2116.3	2481.0	2752.0	2910.0	3021.6
Nuggehalli	376.7	523.6	619.8	742.2	832.9	885.7	923.0
Periyapatna	327.3	405.0	456.0	520.7	568.7	596.7	616.4
Poonampet	694.6	1026.5	1243.9	1520.4	1725.5	1844.7	1929.0
Sakleshpura	597.7	777.6	895.4	1045.3	1156.5	1221.1	1266.9
Salagame	312.0	442.6	515.1	607.3	675.6	715.4	743.5
Shantebachahalli	385.1	592.0	727.5	899.7	1027.6	1101.9	1154.5
Shantigrama	299.6	393.2	454.4	532.4	590.2	623.8	647.6
Shravanabelagola	388.5	543.8	645.9	774.8	870.8	926.6	966.0
Siddapura	478.6	618.9	710.8	827.7	914.5	964.9	1000.6
Srimangala	777.7	1028.8	1193.2	1402.3	1557.5	1647.7	1711.5
Sukravarashante	729.7	887.7	991.2	1122.8	1220.5	1277.3	1317.4
Talakavery	1318.4	1683.2	1922.1	2226.0	2451.4	2582.4	2675.2
Virajpet	701.5	939.5	1095.3	1293.5	1440.6	1526.1	1586.6
Yelawala	355.6	447.5	507.7	584.2	641.0	674.0	697.4

IV. CONCLUSIONS

The present work shows a methodology for the evaluation of the IDF curves from daily rainfall data. In particular, to obtain durations shorter than 24 hours, Gumbel's distribution model of disaggregation was applied to the historical data available for forty three raingauge stations present in the study area. Table 21 shows the equations that can be applied to different raingauge station for different return period . There is always a shortage of short-duration rainfall data as it requires automatic rain gauges to record such data. On the contrary, daily rainfall values are generally available due to the use of cheap manual instruments. These IDF equations will help to estimate the rainfall intensity for any specific return period in a short time and more easily.

The results computed can be utilized for developing surface drain network for recharging ground water. These equations are also useful for the estimation of runoff. The floods with higher return period were considered to be severe when compared to that of lower return period.

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