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Modelling of Intensity-Duration Frequency curves for Upper Cauvery Karnataka through Normal Distribution

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ABSTRACT: ***The IDF Curves accessible are for the most part done by fitting arrangement of yearly greatest precipitation force to parametric dispersions. Intensity-duration-frequency (IDF) curves represent the relationship between storm intensity, storm duration and return period. Environmental change is relied upon to intensify the boundaries in the atmosphere factors. 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 approach 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 necessity 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 lies in Karnataka India. The sub-daily IDF curves for current and future climate for the region were constructed from 1 to 24 h based on the Normal Distribution approach. Rainfall data of 23 (Twenty three) hydrological years of all stations were used. Maximum rainfall frequency analysis was made by Normal Distribution method. Finally Equations were developed for different return periods.***

Key words: ***Climate change, Intensity Duration Frequency (IDF), Normal Distribution, Rainfall Duration.***

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I. INTRODUCTION

Precipitation extremes are expected to increase in intensity and frequency over many regions in the world due to global warming. In urban areas, which are typically characterized by significantly higher population density, climate change is likely to exacerbate and compound existing vulnerabilities, especially for the urban poor.

Therefore, there is a need to know the extent of increasing extreme rainfall for combating climate change impacts and for strategic planning. This study is one of the few to assess climate change impacts on short-duration maximum rainfall over urbanized areas in a developing country.

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.

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 kushalnagar, malalur, mallipatna, nuggehalli, periyapatna, ponnampet, sakaleshpur, salagame, shantigrama, arehalli, arkalgud, basavapatna, bettadapura, bilur, channenahally, chikkamagalur, doddabemmatti, galibidu, gonibeedu, gorur, hagare,halllibailu, hallimysore, harangi, hassan, hosakere, hunsur, kechamanna hosakote, naladi, shantebachahalli, belur, belagodu, javali, talakavery, shravanabelagola, siddapura, srimangala, sukravarsanthe, krishnarajpet, virajpet and yelawala were considered as shown in Figure 2.

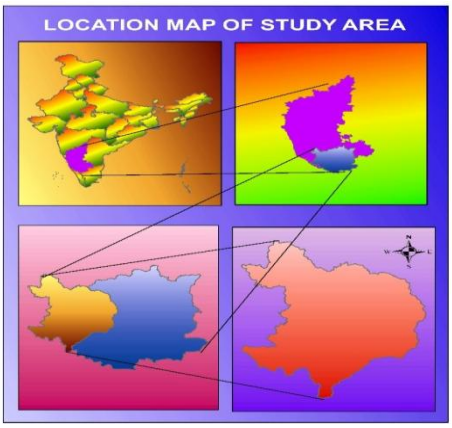


Figure 1 Location Map of Study Area

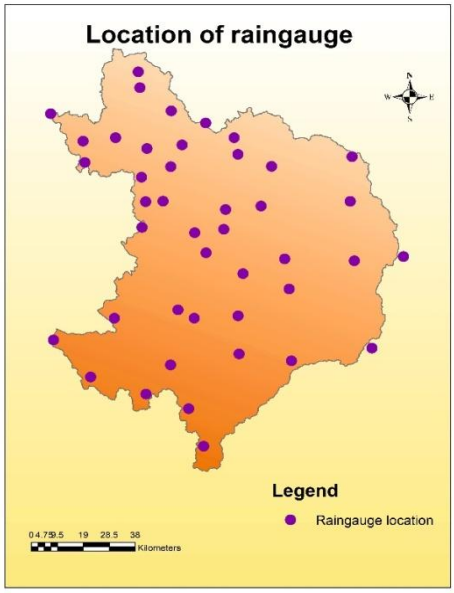


Figure 2 Location of raingauge stations

B. Methodology

Equation A 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[4].

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

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 Gonibeedu. Table 2 shows the tabulation of short duration rainfall of station Hagare. Table 3 shows the tabulation of short duration rainfall of station Nuggehalli. Similarly the short duration rainfall was tabulated for the remaining forty stations.

Normal 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 [9]. Using this values IDF equation for various durations and return period was generated for all the stations and is tabulated in the Table 21.

C. Normal distribution

Normal probability distribution, also called Gaussian distribution refers to a family of distributions that are bell shaped. The PDF for a normal random variable x is

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}}\exp\left[-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right](\sigma > 0)$$

(Equation B)

Where exp is the exponential function with base e = 2.718. μ is the mean and σ the standard deviation. 1/ (σ√ (2π)) is a constant factor that makes the area under the curve of $f(x)$ from -∞ to ∞ equal to 1.

The curve of f(x) is symmetric with respect to x = μ because the exponent is quadratic. Hence for μ = 0 it is symmetric with respect to the y-axis x = 0.

The frequency factor for normal distribution is given by $k_T = \frac{x_T-\mu}{\sigma}$. This is same as the standard normal variate z i.e., frequency factor k_T = z(Kreyszig, 2006

III. RESULTS AND DISCUSSIONS

A. Estimation of Short Duration Rainfall

Table 1 Short duration rainfall for Gonibeedu

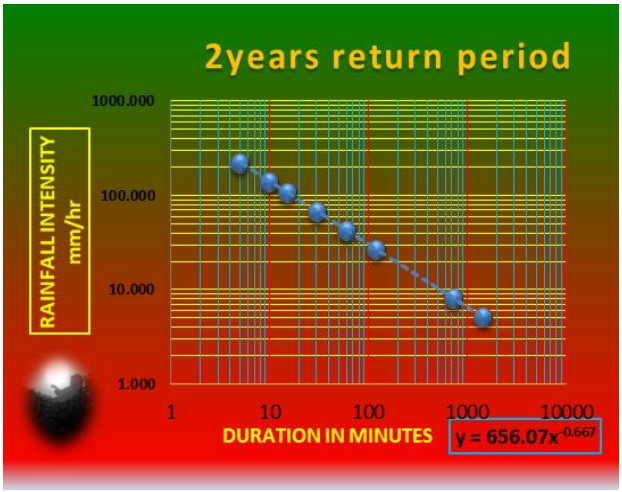
Year	Rainfall (mm)	$P_t = P_{24}\left(\frac{t}{24}\right)^{\frac{1}{3}}$ in mm where, time t is in hours							
Duration in minutes		5	10	15	30	60	120	720	1440
1995	89.00	13.477	16.980	19.437	24.489	30.855	38.874	70.639	89.000
1996	134.00	20.291	25.565	29.265	36.872	46.455	58.530	106.356	134.000
1997	130.00	19.685	24.802	28.391	35.771	45.068	56.783	103.181	130.000
1998	100.00	15.143	19.079	21.840	27.516	34.668	43.679	79.370	100.000
1999	106.00	16.051	20.223	23.150	29.167	36.748	46.300	84.132	106.000
2000	165.00	24.985	31.480	36.035	45.401	57.202	72.070	130.961	165.000
2001	91.00	13.780	17.362	19.874	25.040	31.548	39.748	72.227	91.000
2002	78.20	11.842	14.919	17.078	21.518	27.110	34.157	62.067	78.200
2003	64.30	9.737	12.268	14.043	17.693	22.292	28.086	51.035	64.300
2004	116.30	17.611	22.188	25.399	32.001	40.319	50.799	92.307	116.300
2005	119.00	18.020	22.704	25.989	32.744	41.255	51.978	94.450	119.000
2006	113.80	17.232	21.711	24.853	31.313	39.452	49.707	90.323	113.800
2007	253.00	38.311	48.269	55.254	69.616	87.710	110.508	200.806	253.000
2008	146.00	22.108	27.855	31.886	40.173	50.615	63.771	115.880	146.000
2009	161.00	24.380	30.717	35.162	44.301	55.816	70.323	127.786	161.000
2010	102.00	15.446	19.460	22.276	28.066	35.361	44.553	80.957	102.000
2011	136.00	20.594	25.947	29.702	37.422	47.149	59.403	107.943	136.000
2012	64.00	9.691	12.210	13.977	17.610	22.188	27.955	50.797	64.000
2013	130.00	19.685	24.802	28.391	35.771	45.068	56.783	103.181	130.000
2014	87.00	13.174	16.598	19.000	23.939	30.161	38.001	69.052	87.000
2015	106.00	16.051	20.223	23.150	29.167	36.748	46.300	84.132	106.000
2016	76.00	11.508	14.500	16.598	20.912	26.348	33.196	60.321	76.000
2017	75.20	11.387	14.347	16.423	20.692	26.070	32.847	59.686	75.200

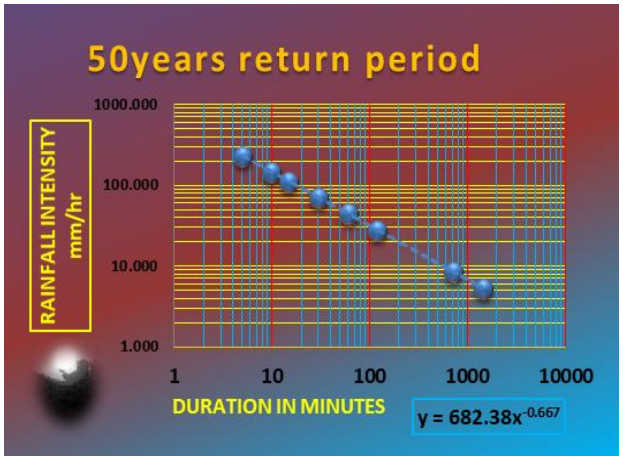
Table 2 Short duration rainfall for Hagare

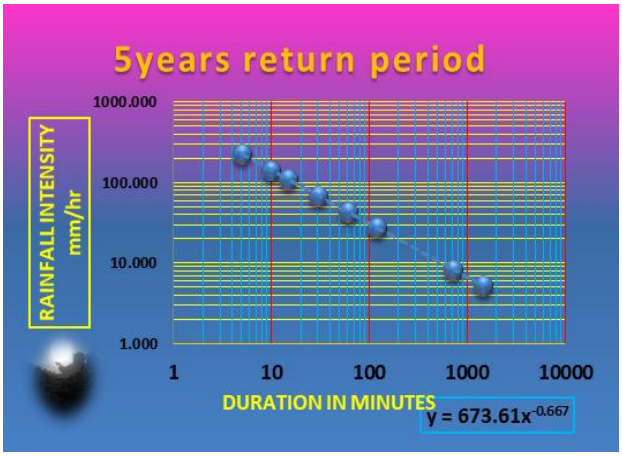
Year	Rainfall (mm)	$P_t = P_{24}\left(\frac{t}{24}\right)^{\frac{1}{3}}$ in mm where, time t is in hours							
Duration in minutes		5	10	15	30	60	120	720	1440
1995	34.00	5.149	6.487	7.425	9.355	11.787	14.851	26.986	34.000
1996	60.00	9.086	11.447	13.104	16.510	20.801	26.207	47.622	60.000
1997	61.00	9.237	11.638	13.322	16.785	21.148	26.644	48.416	61.000
1998	95.00	14.386	18.125	20.748	26.140	32.935	41.495	75.402	95.000
1999	89.00	13.477	16.980	19.437	24.489	30.855	38.874	70.639	89.000
2000	67.80	10.267	12.935	14.807	18.656	23.505	29.614	53.813	67.800
2001	56.10	8.495	10.703	12.252	15.437	19.449	24.504	44.527	56.100
2002	67.00	10.146	12.783	14.632	18.436	23.228	29.265	53.178	67.000
2003	78.00	11.811	14.881	17.035	21.463	27.041	34.070	61.909	78.000
2004	44.00	6.663	8.395	9.609	12.107	15.254	19.219	34.923	44.000
2005	42.20	6.390	8.051	9.216	11.612	14.630	18.433	33.494	42.200
2006	54.80	8.298	10.455	11.968	15.079	18.998	23.936	43.495	54.800
2007	51.10	7.738	9.749	11.160	14.061	17.715	22.320	40.558	51.100
2008	110.40	16.717	21.063	24.111	30.378	38.274	48.222	87.625	110.400
2009	72.40	10.963	13.813	15.812	19.922	25.100	31.624	57.464	72.400
2010	103.00	15.597	19.651	22.495	28.342	35.708	44.989	81.751	103.000
2011	56.20	8.510	10.722	12.274	15.464	19.483	24.548	44.606	56.200
2012	60.80	9.207	11.600	13.278	16.730	21.078	26.557	48.257	60.800
2013	44.20	6.693	8.433	9.653	12.162	15.323	19.306	35.082	44.200
2014	62.00	9.388	11.829	13.540	17.060	21.494	27.081	49.209	62.000
2015	59.40	8.995	11.333	12.973	16.345	20.593	25.945	47.146	59.400
2016	40.00	6.057	7.631	8.736	11.006	13.867	17.472	31.748	40.000
2017	79.00	11.963	15.072	17.253	21.738	27.388	34.506	62.702	79.000

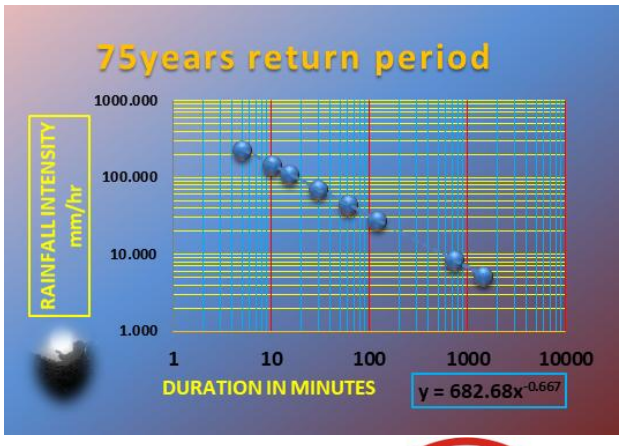
Table 3 Short duration rainfall for Nuggehalli

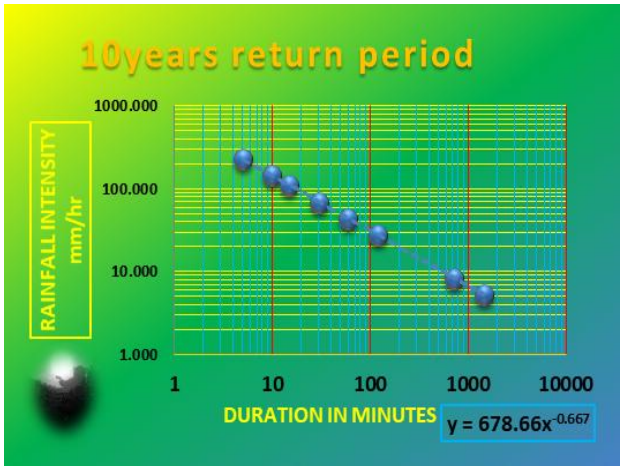
Year	Rainfall (mm)	$P_t = P_{24}\left(\frac{t}{24}\right)^{\frac{1}{3}}$ in mm where, time t is in hours							
Duration in minutes		5	10	15	30	60	120	720	1440
1995	62.40	9.449	11.905	13.628	17.170	21.633	27.256	49.527	62.400
1996	98.40	14.900	18.773	21.490	27.076	34.113	42.980	78.100	98.400
1997	118.40	17.929	22.589	25.858	32.579	41.047	51.716	93.974	118.400
1998	43.80	6.632	8.356	9.566	12.052	15.185	19.131	34.764	43.800
1999	62.40	9.449	11.905	13.628	17.170	21.633	27.256	49.527	62.400
2000	66.80	10.115	12.744	14.589	18.381	23.158	29.178	53.019	66.800
2001	56.40	8.540	10.760	12.317	15.519	19.553	24.635	44.765	56.400
2002	60.80	9.207	11.600	13.278	16.730	21.078	26.557	48.257	60.800
2003	65.40	9.903	12.477	14.283	17.996	22.673	28.566	51.908	65.400
2004	56.40	8.540	10.760	12.317	15.519	19.553	24.635	44.765	56.400
2005	100.70	15.249	19.212	21.992	27.709	34.911	43.985	79.926	100.700
2006	57.80	8.752	11.027	12.623	15.904	20.038	25.246	45.876	57.800
2007	62.20	9.419	11.867	13.584	17.115	21.564	27.168	49.368	62.200
2008	55.40	8.389	10.570	12.099	15.244	19.206	24.198	43.971	55.400
2009	54.60	8.268	10.417	11.924	15.024	18.929	23.849	43.336	54.600
2010	124.80	18.898	23.810	27.256	34.340	43.266	54.511	99.054	124.800
2011	73.20	11.084	13.966	15.987	20.142	25.377	31.973	58.099	73.200
2012	48.60	7.359	9.272	10.614	13.373	16.849	21.228	38.574	48.600
2013	61.20	9.267	11.676	13.366	16.840	21.217	26.732	48.574	61.200
2014	60.60	9.176	11.562	13.235	16.675	21.009	26.469	48.098	60.600
2015	146.80	22.229	28.007	32.060	40.394	50.893	64.121	116.515	146.800
2016	60.80	9.207	11.600	13.278	16.730	21.078	26.557	48.257	60.800
2017	150.60	22.805	28.732	32.890	41.439	52.210	65.781	119.531	150.600

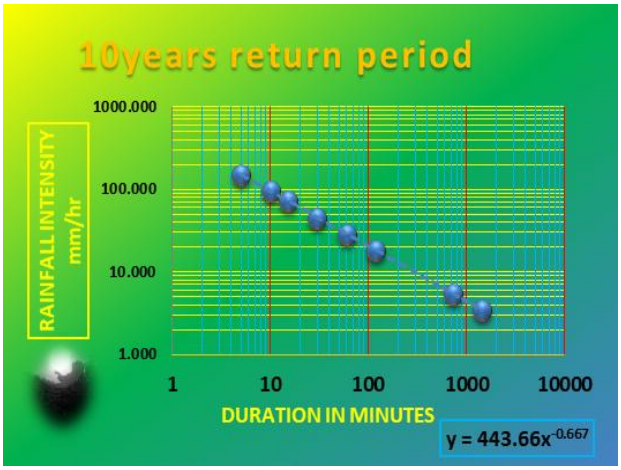


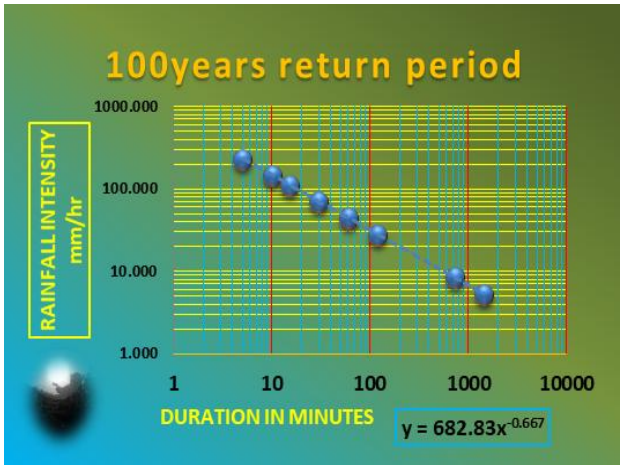












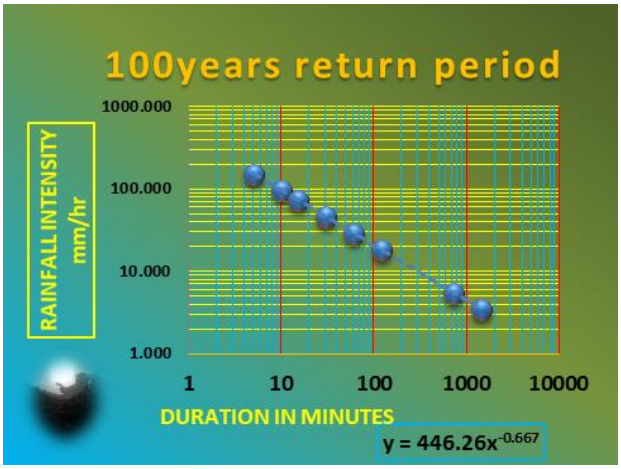
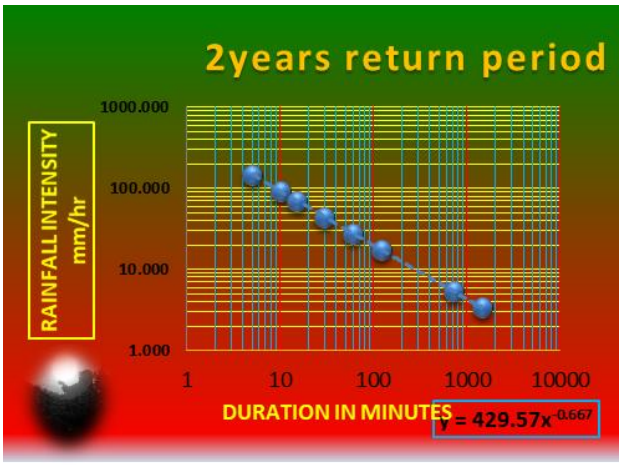


Figure 3 IDF curves for Arehalli Station



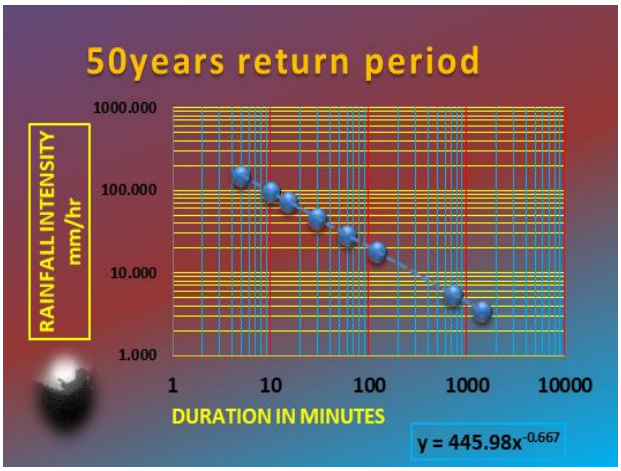


Figure 4 IDF curves for Arkalgud Station

Table 4 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	11.904	142.844	12.199	146.386	12.284	147.405	12.331	147.974	12.346	148.157	12.351	148.217	12.354	148.246
10	14.998	89.986	15.370	92.218	15.477	92.859	15.536	93.218	15.555	93.333	15.562	93.371	15.565	93.389
15	17.168	68.672	17.594	70.375	17.716	70.865	17.785	71.138	17.807	71.226	17.814	71.255	17.817	71.269
30	21.630	43.261	22.167	44.334	22.321	44.642	22.407	44.814	22.435	44.870	22.444	44.888	22.448	44.897
60	27.253	27.253	27.928	27.928	28.123	28.123	28.231	28.231	28.266	28.266	28.278	28.278	28.283	28.283
120	34.336	17.168	35.188	17.594	35.432	17.716	35.569	17.785	35.613	17.807	35.628	17.814	35.635	17.817
720	62.393	5.199	63.940	5.328	64.385	5.365	64.634	5.386	64.713	5.393	64.740	5.395	64.753	5.396
1440	78.610	3.275	80.560	3.357	81.120	3.380	81.433	3.393	81.534	3.397	81.567	3.399	81.583	3.399

Table 5 Estimation of maximum rainfall intensity for various return period For Nuggehalli 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	14.771	177.256	15.227	182.725	15.358	184.298	15.431	185.176	15.455	185.459	15.463	185.552	15.466	185.597
10	18.611	111.665	19.185	115.110	19.350	116.101	19.442	116.654	19.472	116.832	19.482	116.890	19.487	116.919
15	21.304	85.216	21.961	87.845	22.150	88.601	22.256	89.024	22.290	89.159	22.301	89.204	22.307	89.226
30	26.841	53.683	27.670	55.339	27.908	55.815	28.041	56.081	28.083	56.167	28.097	56.195	28.104	56.209
60	33.818	33.818	34.861	34.861	35.161	35.161	35.329	35.329	35.383	35.383	35.401	35.401	35.409	35.409
120	42.608	21.304	43.923	21.961	44.301	22.150	44.512	22.256	44.580	22.290	44.602	22.301	44.613	22.307
720	77.424	6.452	79.813	6.651	80.500	6.708	80.883	6.740	81.007	6.751	81.047	6.754	81.067	6.756
1440	97.548	4.064	100.558	4.190	101.423	4.226	101.907	4.246	102.062	4.253	102.113	4.255	102.138	4.256

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	11.514	138.168	11.793	141.511	11.873	142.472	11.917	143.009	11.932	143.181	11.937	143.238	11.939	143.266
10	14.507	87.040	14.858	89.146	14.959	89.752	15.015	90.090	15.033	90.199	15.039	90.235	15.042	90.252
15	16.606	66.424	17.008	68.031	17.123	68.493	17.188	68.752	17.209	68.835	17.215	68.862	17.219	68.875
30	20.922	41.845	21.429	42.857	21.574	43.148	21.655	43.311	21.682	43.363	21.690	43.380	21.694	43.389
60	26.360	26.360	26.998	26.998	27.182	27.182	27.284	27.284	27.317	27.317	27.328	27.328	27.333	27.333
120	33.212	16.606	34.016	17.008	34.247	17.123	34.376	17.188	34.417	17.209	34.431	17.215	34.438	17.219
720	60.350	5.029	61.811	5.151	62.230	5.186	62.465	5.205	62.540	5.212	62.565	5.214	62.577	5.215
1440	76.037	3.168	77.876	3.245	78.405	3.267	78.701	3.279	78.796	3.283	78.827	3.284	78.843	3.285

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	15.688	188.259	16.149	193.782	16.281	195.370	16.355	196.257	16.379	196.543	16.386	196.636	16.390	196.682
10	19.766	118.596	20.346	122.075	20.513	123.076	20.606	123.635	20.636	123.814	20.646	123.873	20.650	123.902
15	22.626	90.505	23.290	93.161	23.481	93.924	23.588	94.351	23.622	94.488	23.633	94.533	23.639	94.555
30	28.507	57.015	29.344	58.688	29.584	59.169	29.719	59.437	29.762	59.524	29.776	59.552	29.783	59.566
60	35.917	35.917	36.971	36.971	37.274	37.274	37.443	37.443	37.498	37.498	37.515	37.515	37.524	37.524
120	45.253	22.626	46.580	23.290	46.962	23.481	47.175	23.588	47.244	23.622	47.266	23.633	47.278	23.639
720	82.230	6.852	84.642	7.054	85.336	7.111	85.723	7.144	85.848	7.154	85.889	7.157	85.909	7.159
1440	103.603	4.317	106.642	4.443	107.517	4.480	108.005	4.500	108.162	4.507	108.213	4.509	108.239	4.510

Table 8 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	12.243	146.911	12.554	150.654	12.644	151.730	12.694	152.331	12.710	152.524	12.716	152.588	12.718	152.619
10	15.425	92.548	15.818	94.906	15.931	95.584	15.994	95.963	16.014	96.085	16.021	96.125	16.024	96.144

15	17.657	70.628	18.107	72.427	18.236	72.944	18.308	73.233	18.332	73.326	18.339	73.357	18.343	73.372
30	22.246	44.493	22.813	45.626	22.976	45.952	23.067	46.134	23.096	46.193	23.106	46.212	23.111	46.221
60	28.029	28.029	28.743	28.743	28.948	28.948	29.063	29.063	29.100	29.100	29.112	29.112	29.118	29.118
120	35.314	17.657	36.213	18.107	36.472	18.236	36.617	18.308	36.663	18.332	36.678	18.339	36.686	18.343
720	64.169	5.347	65.804	5.484	66.274	5.523	66.537	5.545	66.621	5.552	66.649	5.554	66.663	5.555
1440	80.848	3.369	82.908	3.455	83.500	3.479	83.831	3.493	83.938	3.497	83.972	3.499	83.990	3.500

Table 9 Estimation of maximum rainfall intensity for various return period For Bettadapura 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	11.260	135.124	11.529	138.350	11.606	139.277	11.650	139.796	11.664	139.962	11.668	140.017	11.670	140.044
10	14.187	85.123	14.526	87.155	14.623	87.739	14.678	88.066	14.695	88.171	14.701	88.205	14.704	88.222
15	16.240	64.961	16.628	66.512	16.739	66.958	16.802	67.207	16.822	67.287	16.828	67.313	16.832	67.326
30	20.461	40.923	20.950	41.900	21.090	42.181	21.169	42.338	21.194	42.388	21.202	42.405	21.206	42.413
60	25.780	25.780	26.395	26.395	26.572	26.572	26.671	26.671	26.703	26.703	26.713	26.713	26.718	26.718
120	32.480	16.240	33.256	16.628	33.479	16.739	33.603	16.802	33.643	16.822	33.657	16.828	33.663	16.832
720	59.021	4.918	60.430	5.036	60.835	5.070	61.061	5.088	61.134	5.095	61.158	5.097	61.170	5.097
1440	74.361	3.098	76.137	3.172	76.647	3.194	76.933	3.206	77.024	3.209	77.054	3.211	77.069	3.211

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	31.848	382.176	32.837	394.042	33.121	397.454	33.280	399.360	33.331	399.972	33.348	400.173	33.356	400.273
10	40.126	240.756	41.372	248.231	41.730	250.381	41.930	251.581	41.995	251.967	42.016	252.094	42.026	252.157
15	45.933	183.731	47.359	189.436	47.769	191.076	47.998	191.992	48.072	192.287	48.096	192.384	48.108	192.431
30	57.872	115.743	59.669	119.337	60.185	120.370	60.474	120.948	60.567	121.133	60.597	121.194	60.612	121.224
60	72.914	72.914	75.178	75.178	75.829	75.829	76.192	76.192	76.309	76.309	76.347	76.347	76.366	76.366
120	91.866	45.933	94.718	47.359	95.538	47.769	95.996	47.998	96.143	48.072	96.192	48.096	96.216	48.108
720	166.931	13.911	172.114	14.343	173.604	14.467	174.437	14.536	174.704	14.559	174.792	14.566	174.835	14.570
1440	210.320	8.763	216.850	9.035	218.727	9.114	219.776	9.157	220.113	9.171	220.224	9.176	220.279	9.178

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	12.758	153.096	13.110	157.322	13.211	158.537	13.268	159.216	13.286	159.434	13.292	159.506	13.295	159.541
10	16.074	96.444	16.518	99.107	16.645	99.872	16.717	100.300	16.740	100.437	16.747	100.483	16.751	100.505
15	18.400	73.601	18.908	75.633	19.054	76.217	19.136	76.543	19.162	76.648	19.171	76.683	19.175	76.700
30	23.183	46.366	23.823	47.646	24.007	48.014	24.110	48.219	24.143	48.285	24.153	48.307	24.159	48.318
60	29.208	29.208	30.015	30.015	30.247	30.247	30.376	30.376	30.418	30.418	30.431	30.431	30.438	30.438
120	36.800	18.400	37.816	18.908	38.108	19.054	38.272	19.136	38.324	19.162	38.341	19.171	38.350	19.175
720	66.871	5.573	68.717	5.726	69.248	5.771	69.544	5.795	69.639	5.803	69.671	5.806	69.686	5.807
1440	84.252	3.510	86.578	3.607	87.246	3.635	87.620	3.651	87.740	3.656	87.780	3.657	87.799	3.658

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	11.791	141.493	12.018	144.211	12.083	144.993	12.119	145.429	12.131	145.570	12.135	145.616	12.137	145.638
10	14.856	89.135	15.141	90.848	15.223	91.340	15.269	91.615	15.284	91.703	15.289	91.732	15.291	91.747
15	17.006	68.023	17.332	69.330	17.426	69.705	17.479	69.915	17.496	69.983	17.501	70.005	17.504	70.016
30	21.426	42.852	21.837	43.675	21.956	43.912	22.022	44.044	22.043	44.086	22.050	44.100	22.054	44.107
60	26.995	26.995	27.513	27.513	27.663	27.663	27.746	27.746	27.773	27.773	27.781	27.781	27.786	27.786
120	34.011	17.006	34.665	17.332	34.853	17.426	34.958	17.479	34.991	17.496	35.002	17.501	35.008	17.504
720	61.803	5.150	62.990	5.249	63.331	5.278	63.522	5.294	63.583	5.299	63.604	5.300	63.614	5.301
1440	77.867	3.244	79.363	3.307	79.793	3.325	80.033	3.335	80.110	3.338	80.136	3.339	80.148	3.340

Table 13 Estimation of maximum rainfall intensity for various return period For Periyapatna 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	11.463	137.554	11.704	140.449	11.773	141.281	11.812	141.746	11.825	141.895	11.829	141.945	11.831	141.969
10	14.442	86.654	14.746	88.477	14.834	89.002	14.882	89.295	14.898	89.389	14.903	89.420	14.906	89.435

15	16.532	66.129	16.880	67.521	16.980	67.921	17.036	68.144	17.054	68.216	17.060	68.240	17.063	68.252
30	20.829	41.659	21.268	42.535	21.394	42.787	21.464	42.928	21.487	42.974	21.494	42.988	21.498	42.996
60	26.243	26.243	26.796	26.796	26.954	26.954	27.043	27.043	27.072	27.072	27.081	27.081	27.086	27.086
120	33.065	16.532	33.760	16.880	33.960	16.980	34.072	17.036	34.108	17.054	34.120	17.060	34.126	17.063
720	60.082	5.007	61.347	5.112	61.710	5.143	61.913	5.159	61.979	5.165	62.000	5.167	62.011	5.168
1440	75.699	3.154	77.292	3.220	77.750	3.240	78.006	3.250	78.088	3.254	78.115	3.255	78.129	3.255

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

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	28.912	346.947	29.942	359.305	30.238	362.859	30.404	364.844	30.457	365.482	30.474	365.692	30.483	365.795
10	36.427	218.563	37.725	226.349	38.098	228.587	38.306	229.838	38.373	230.240	38.395	230.372	38.406	230.437
15	41.699	166.795	43.184	172.736	43.611	174.445	43.850	175.399	43.926	175.706	43.952	175.807	43.964	175.856
30	52.537	105.074	54.409	108.817	54.947	109.893	55.247	110.494	55.344	110.688	55.376	110.751	55.391	110.783
60	66.193	66.193	68.550	68.550	69.228	69.228	69.607	69.607	69.729	69.729	69.769	69.769	69.789	69.789
120	83.397	41.699	86.368	43.184	87.222	43.611	87.700	43.850	87.853	43.926	87.903	43.952	87.928	43.964
720	151.543	12.629	156.941	13.078	158.494	13.208	159.361	13.280	159.639	13.303	159.731	13.311	159.776	13.315
1440	190.932	7.956	197.734	8.239	199.689	8.320	200.782	8.366	201.133	8.381	201.248	8.385	201.305	8.388

Table 15 Estimation of maximum rainfall intensity for various return period For Sakaleshpura 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	21.975	263.702	22.534	270.402	22.694	272.328	22.784	273.405	22.813	273.750	22.822	273.864	22.827	273.920
10	27.687	166.122	28.390	170.343	28.593	171.557	28.706	172.234	28.742	172.452	28.754	172.524	28.760	172.559
15	31.694	126.775	32.499	129.996	32.731	130.922	32.860	131.439	32.901	131.606	32.915	131.660	32.922	131.687
30	39.932	79.863	40.946	81.892	41.238	82.476	41.401	82.802	41.453	82.906	41.470	82.941	41.479	82.958
60	50.311	50.311	51.589	51.589	51.956	51.956	52.162	52.162	52.228	52.228	52.249	52.249	52.260	52.260
120	63.388	31.694	64.998	32.499	65.461	32.731	65.720	32.860	65.803	32.901	65.830	32.915	65.844	32.922
720	115.183	9.599	118.109	9.842	118.951	9.913	119.421	9.952	119.572	9.964	119.621	9.968	119.646	9.970
1440	145.121	6.047	148.808	6.200	149.868	6.245	150.461	6.269	150.651	6.277	150.713	6.280	150.744	6.281

Table 16 Estimation of maximum rainfall intensity for various return period For Salagame 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	12.501	150.007	12.844	154.127	12.943	155.312	12.998	155.973	13.016	156.186	13.021	156.256	13.024	156.291
10	15.750	94.499	16.182	97.094	16.307	97.840	16.376	98.257	16.399	98.391	16.406	98.435	16.410	98.457
15	18.029	72.116	18.524	74.097	18.667	74.666	18.746	74.984	18.772	75.087	18.780	75.120	18.784	75.137
30	22.715	45.430	23.339	46.678	23.518	47.037	23.619	47.237	23.651	47.302	23.661	47.323	23.667	47.333
60	28.619	28.619	29.405	29.405	29.631	29.631	29.758	29.758	29.798	29.798	29.811	29.811	29.818	29.818
120	36.058	18.029	37.048	18.524	37.333	18.667	37.492	18.746	37.543	18.772	37.560	18.780	37.568	18.784
720	65.522	5.460	67.321	5.610	67.839	5.653	68.128	5.677	68.221	5.685	68.251	5.688	68.266	5.689
1440	82.552	3.440	84.819	3.534	85.471	3.561	85.836	3.576	85.953	3.581	85.991	3.583	86.010	3.584

Table 17 Estimation of maximum rainfall intensity for various return period For Shantigrama 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	11.108	133.301	11.399	136.784	11.482	137.786	11.529	138.345	11.544	138.525	11.549	138.584	11.551	138.613
10	13.996	83.974	14.361	86.169	14.467	86.800	14.525	87.152	14.544	87.266	14.550	87.303	14.554	87.321
15	16.021	64.084	16.440	65.759	16.560	66.241	16.627	66.510	16.649	66.596	16.656	66.624	16.660	66.638
30	20.185	40.371	20.713	41.426	20.864	41.729	20.949	41.898	20.976	41.953	20.985	41.971	20.990	41.980
60	25.432	25.432	26.097	26.097	26.288	26.288	26.394	26.394	26.429	26.429	26.440	26.440	26.446	26.446
120	32.042	16.021	32.880	16.440	33.120	16.560	33.255	16.627	33.298	16.649	33.312	16.656	33.319	16.660
720	58.225	4.852	59.746	4.979	60.184	5.015	60.428	5.036	60.507	5.042	60.532	5.044	60.545	5.045
1440	73.358	3.057	75.275	3.136	75.827	3.159	76.135	3.172	76.233	3.176	76.266	3.178	76.282	3.178

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	12.449	149.391	12.777	153.321	12.871	154.451	12.923	155.082	12.940	155.285	12.946	155.351	12.949	155.384
10	15.685	94.111	16.098	96.586	16.216	97.298	16.283	97.696	16.304	97.823	16.311	97.865	16.314	97.886
15	17.955	71.820	18.427	73.709	18.563	74.252	18.639	74.556	18.663	74.653	18.671	74.685	18.675	74.701

30	22.622	45.244	23.217	46.434	23.388	46.776	23.484	46.967	23.514	47.029	23.524	47.049	23.529	47.059
60	28.502	28.502	29.251	29.251	29.467	29.467	29.587	29.587	29.626	29.626	29.639	29.639	29.645	29.645
120	35.910	17.955	36.855	18.427	37.126	18.563	37.278	18.639	37.327	18.663	37.343	18.671	37.351	18.675
720	65.253	5.438	66.969	5.581	67.463	5.622	67.738	5.645	67.827	5.652	67.856	5.655	67.870	5.656
1440	82.213	3.426	84.376	3.516	84.998	3.542	85.345	3.556	85.457	3.561	85.493	3.562	85.511	3.563

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	10.999	131.985	11.223	134.681	11.288	135.457	11.324	135.890	11.336	136.029	11.340	136.075	11.341	136.098
10	13.858	83.146	14.141	84.844	14.222	85.333	14.268	85.606	14.282	85.693	14.287	85.722	14.289	85.736
15	15.863	63.452	16.187	64.748	16.280	65.121	16.332	65.329	16.349	65.396	16.355	65.418	16.357	65.429
30	19.986	39.972	20.394	40.789	20.512	41.024	20.577	41.155	20.598	41.197	20.605	41.211	20.609	41.218
60	25.181	25.181	25.695	25.695	25.843	25.843	25.926	25.926	25.952	25.952	25.961	25.961	25.965	25.965
120	31.726	15.863	32.374	16.187	32.560	16.280	32.665	16.332	32.698	16.349	32.709	16.355	32.714	16.357
720	57.650	4.804	58.828	4.902	59.166	4.931	59.356	4.946	59.416	4.951	59.436	4.953	59.446	4.954
1440	72.634	3.026	74.118	3.088	74.545	3.106	74.783	3.116	74.860	3.119	74.885	3.120	74.897	3.121

Table 20 Estimation of maximum rainfall intensity for various return period For Virajpet 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	26.529	318.343	27.267	327.204	27.479	329.752	27.598	331.175	27.636	331.633	27.649	331.783	27.655	331.857
10	33.424	200.544	34.354	206.126	34.622	207.731	34.771	208.628	34.819	208.916	34.835	209.011	34.843	209.057
15	38.261	153.044	39.326	157.304	39.632	158.528	39.803	159.213	39.858	159.433	39.876	159.505	39.885	159.541
30	48.206	96.412	49.548	99.095	49.933	99.867	50.149	100.298	50.218	100.436	50.241	100.482	50.252	100.504
60	60.735	60.735	62.426	62.426	62.912	62.912	63.184	63.184	63.271	63.271	63.300	63.300	63.314	63.314
120	76.522	38.261	78.652	39.326	79.264	39.632	79.606	39.803	79.716	39.858	79.752	39.876	79.770	39.885
720	139.049	11.587	142.920	11.910	144.033	12.003	144.654	12.055	144.854	12.071	144.920	12.077	144.952	12.079
1440	175.191	7.300	180.068	7.503	181.470	7.561	182.253	7.594	182.505	7.604	182.588	7.608	182.628	7.610

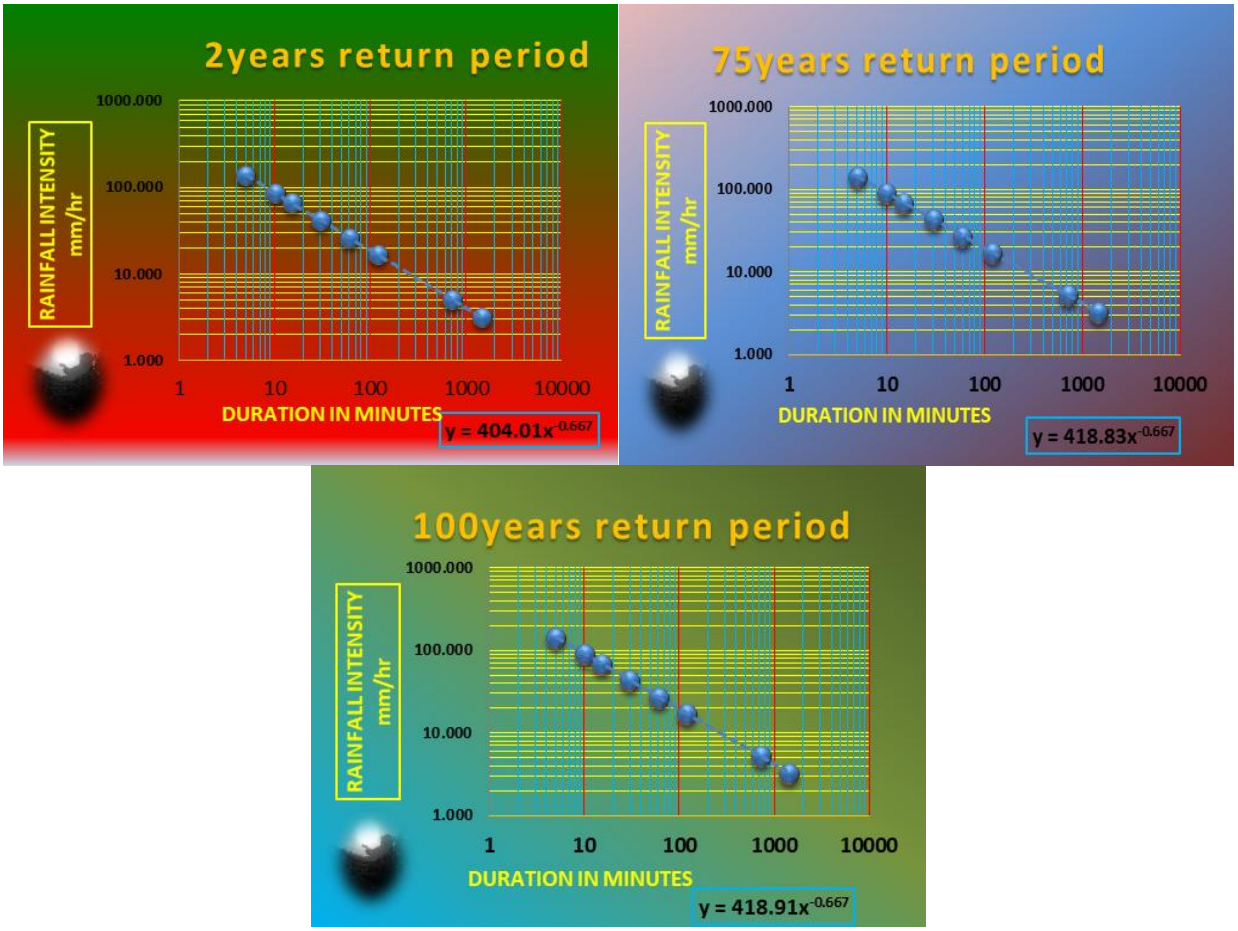
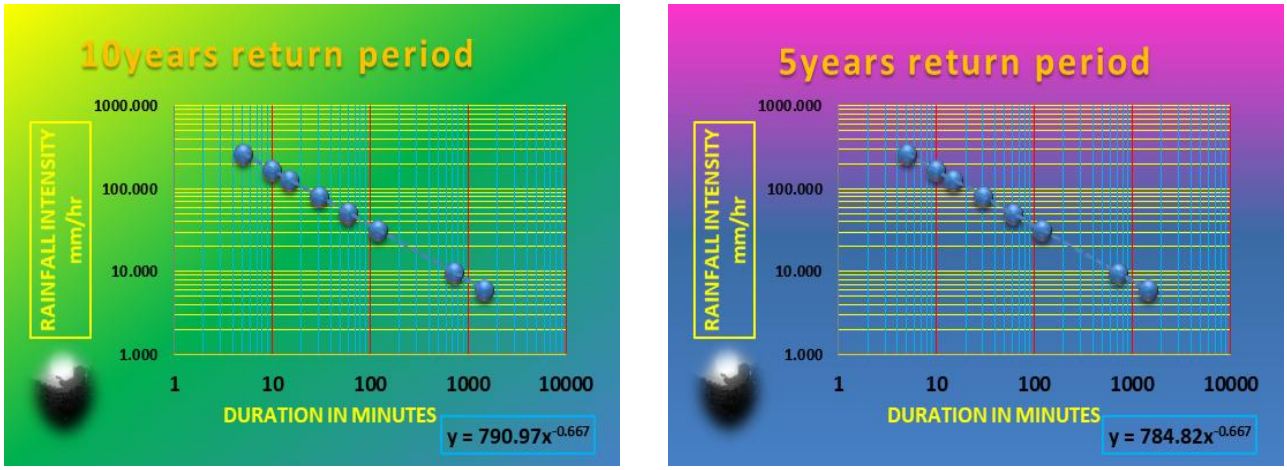


Figure 5 IDF curves for Basavapatna Station

Figure 6 IDF curves for Gonibeedu Station



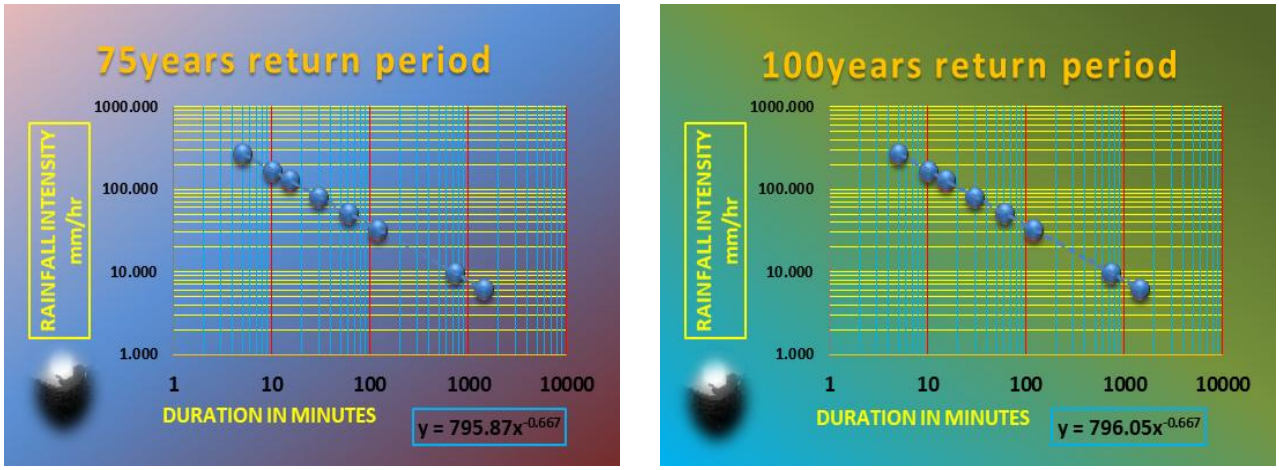


Figure 7 IDF curves for Hallimysore Station

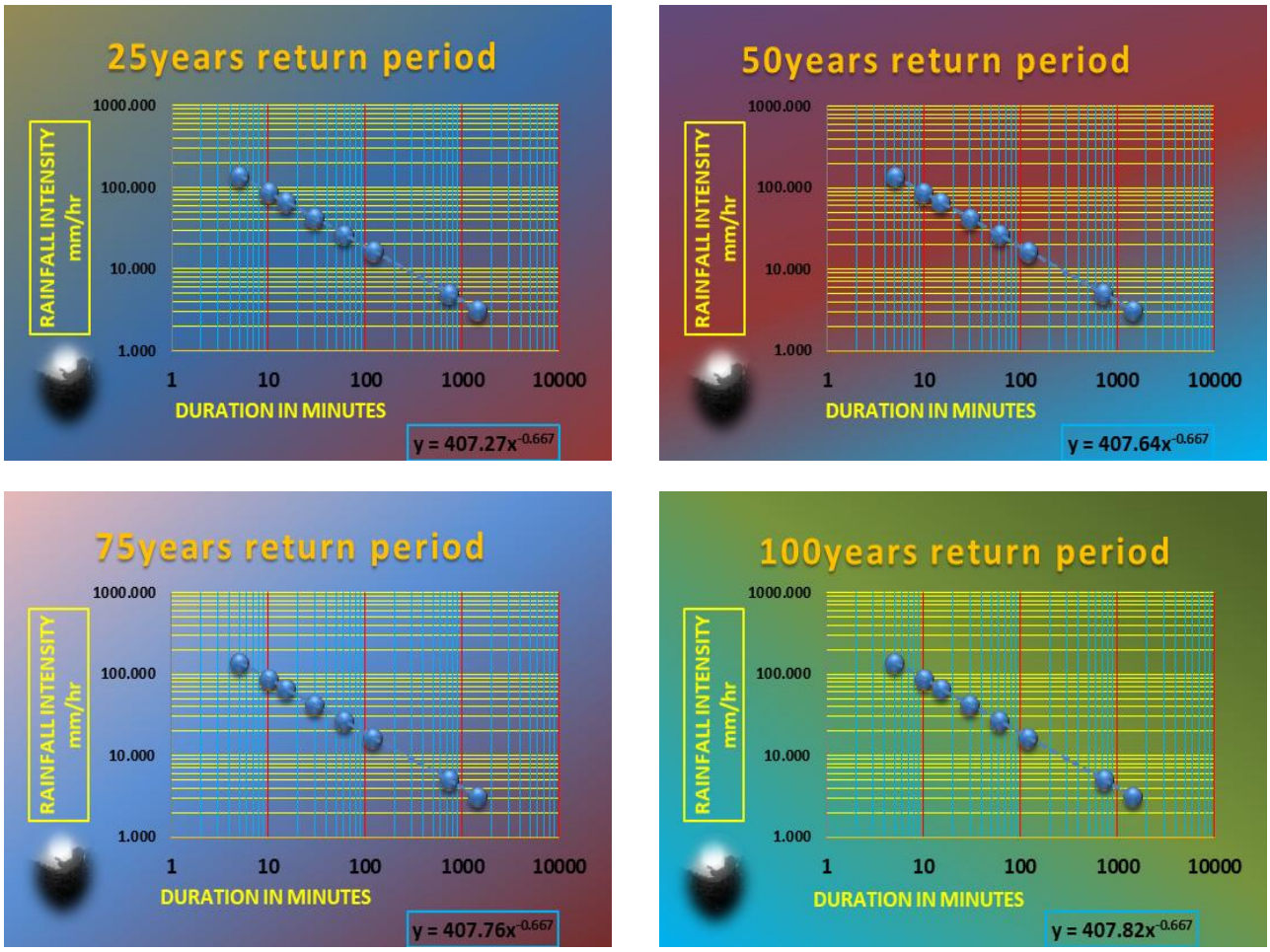


Figure 8 IDF curves for Galibeedu Station

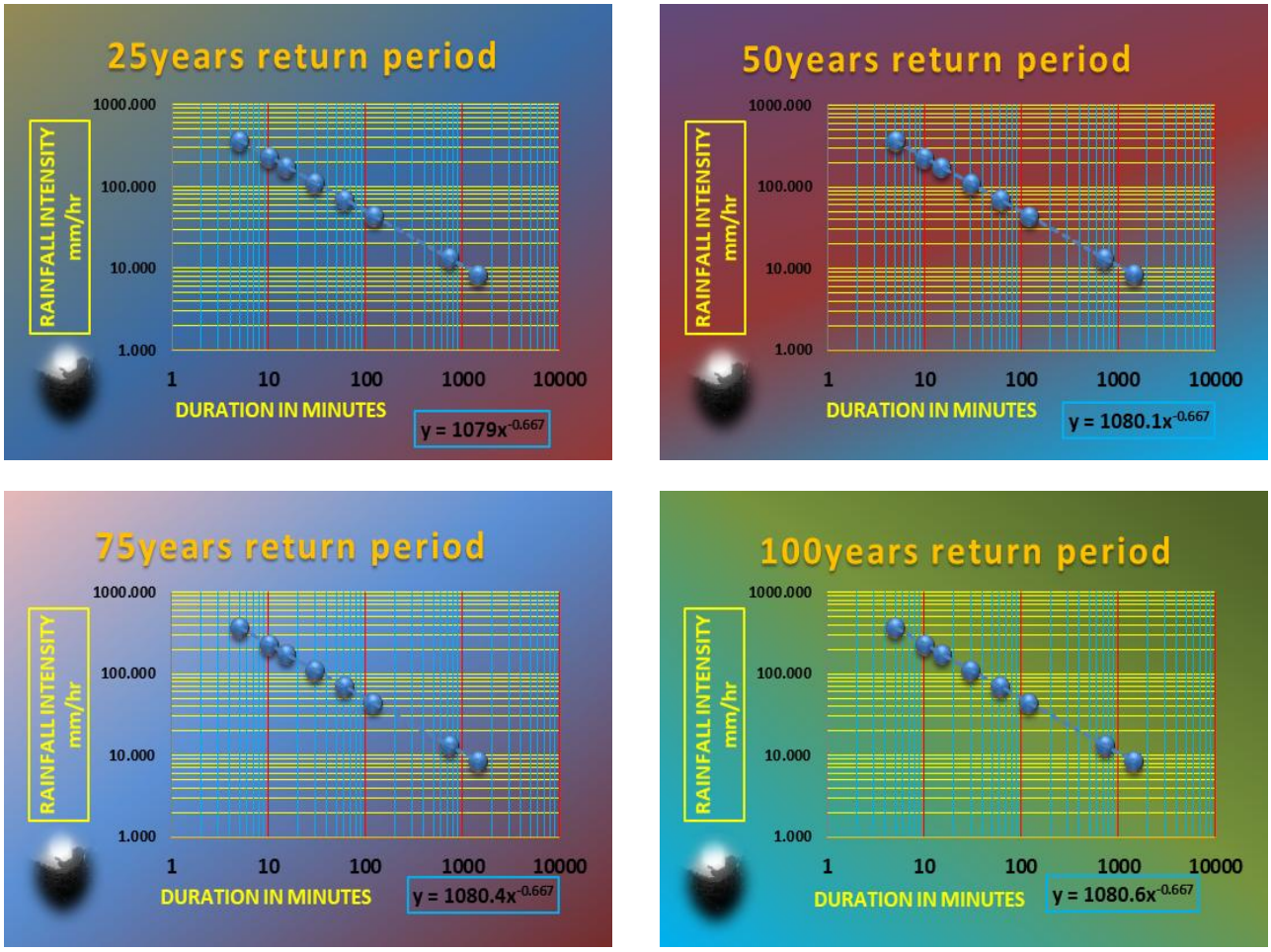
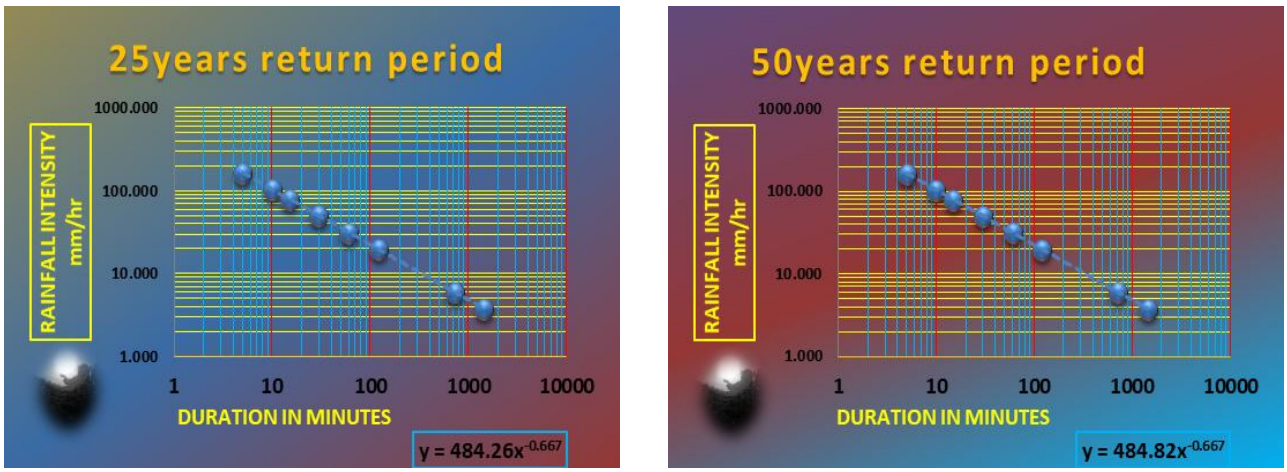
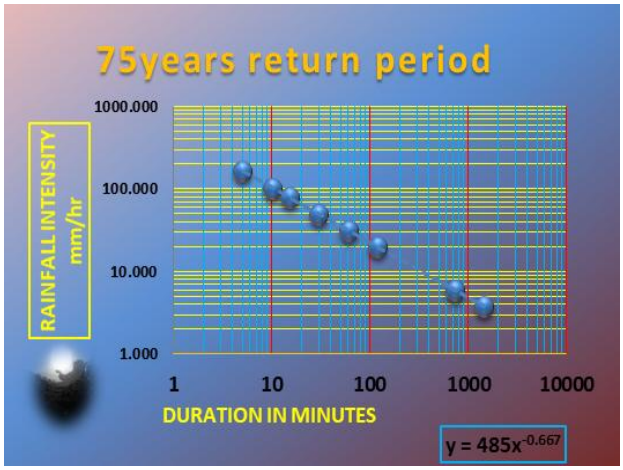


Figure 9 IDF curves for Hassan Station





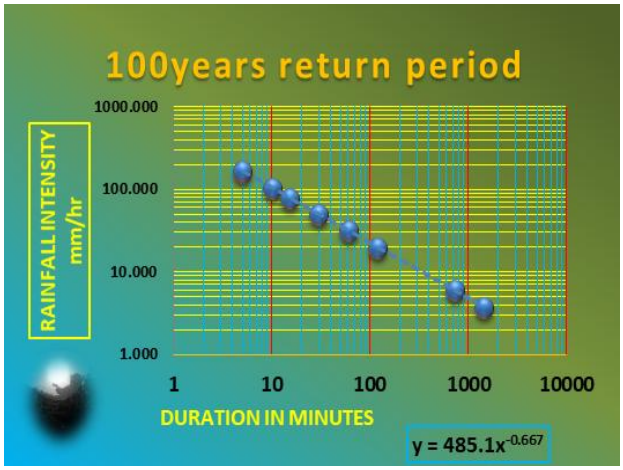
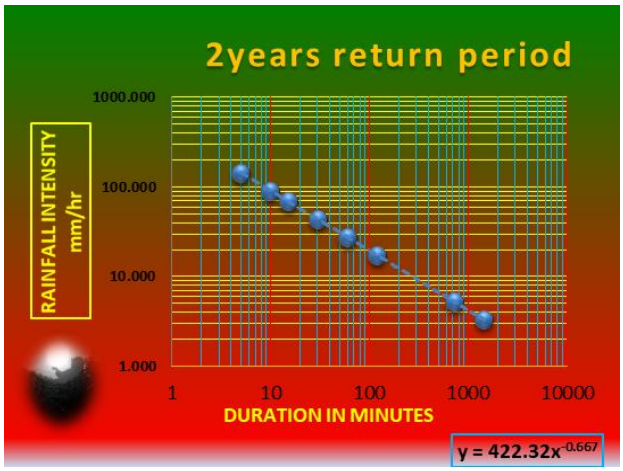
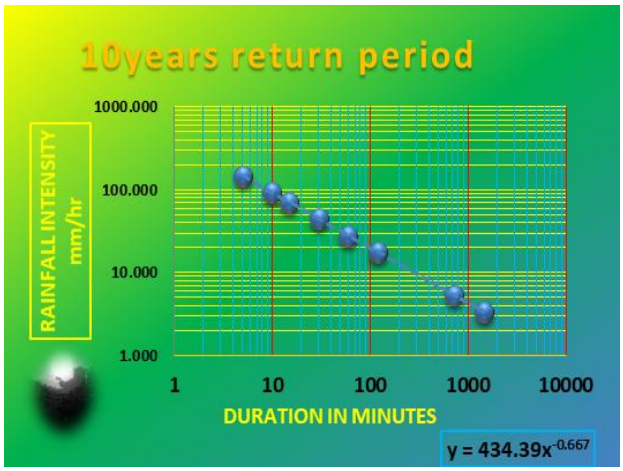
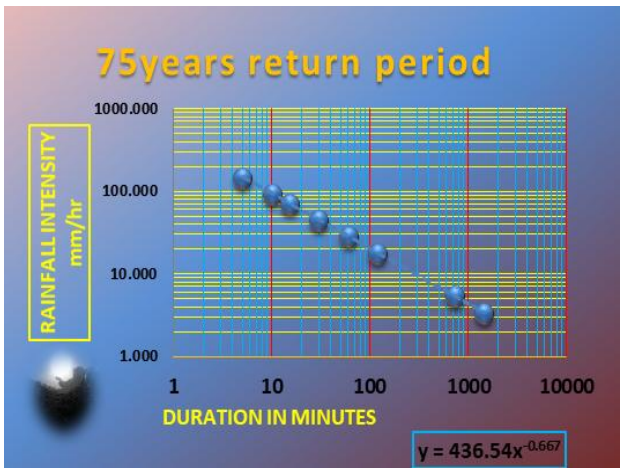


Figure 10 IDF curves for Gorur Station







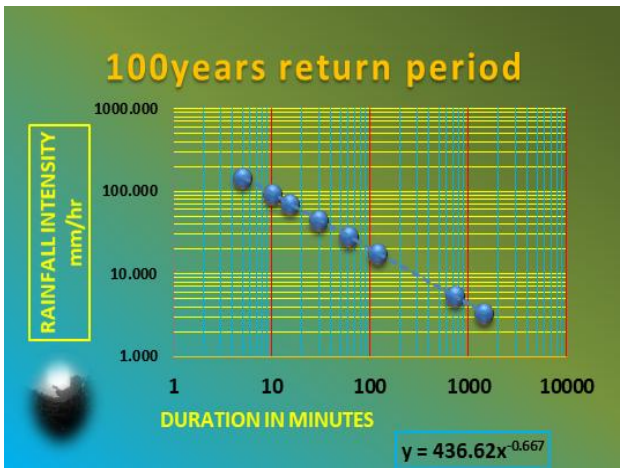


Figure 11 IDF curves for Javali Station

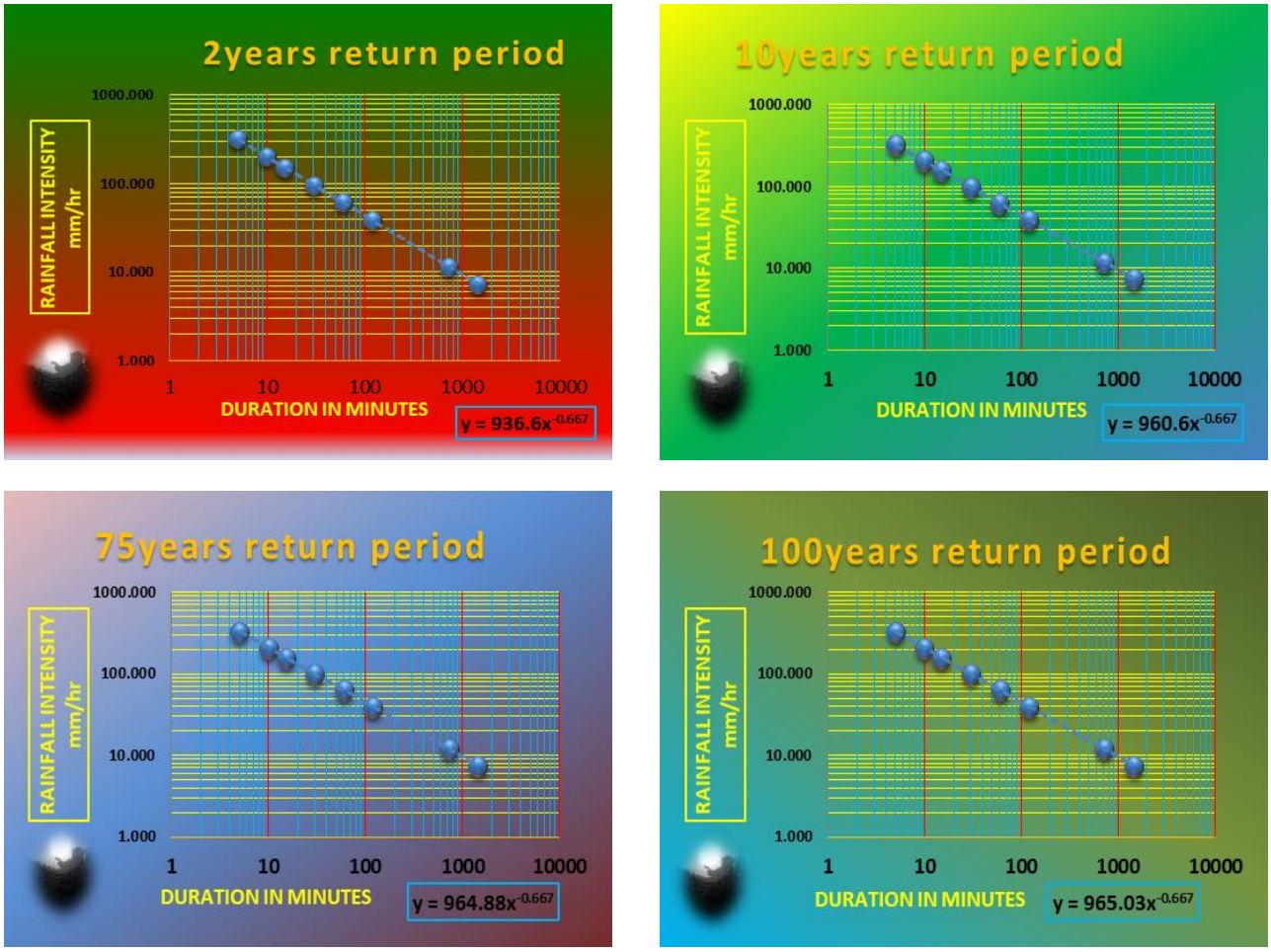
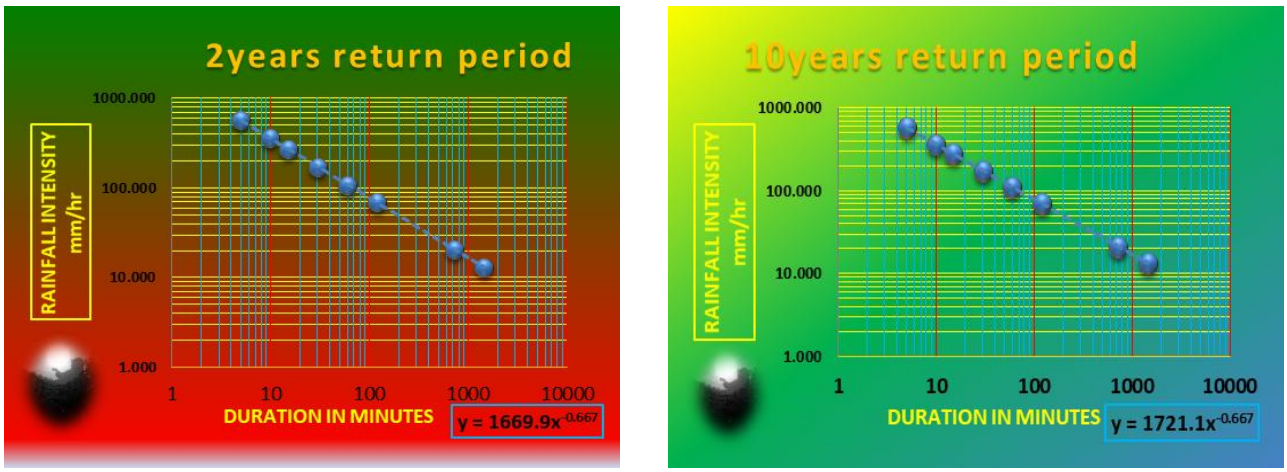


Figure 12 IDF curves for Talakavery Station



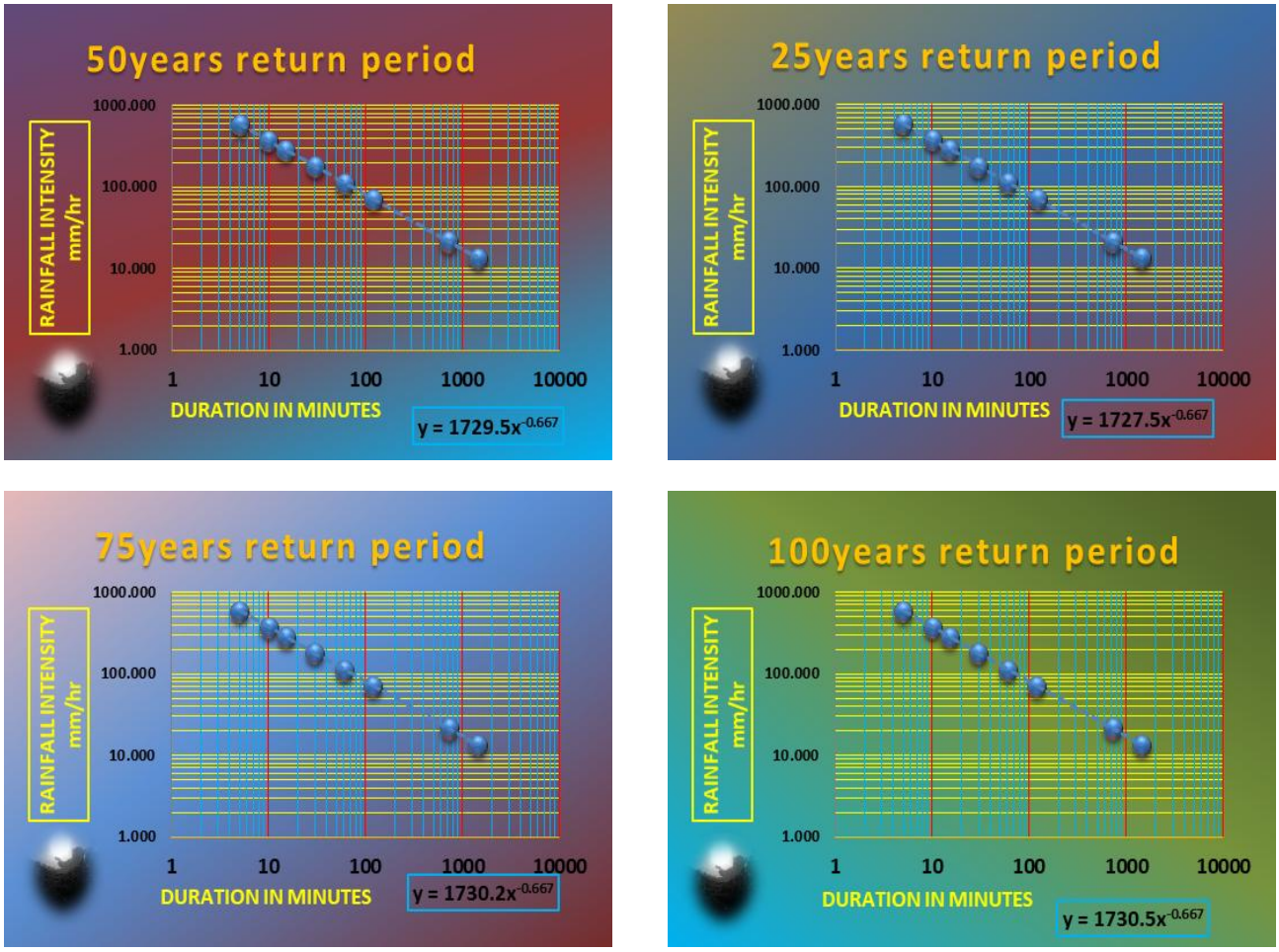
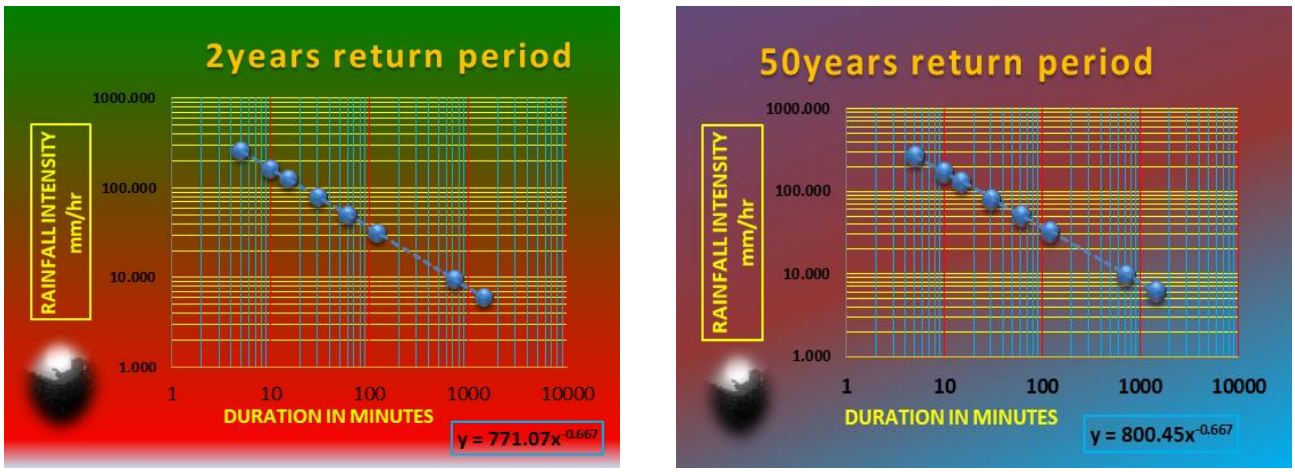
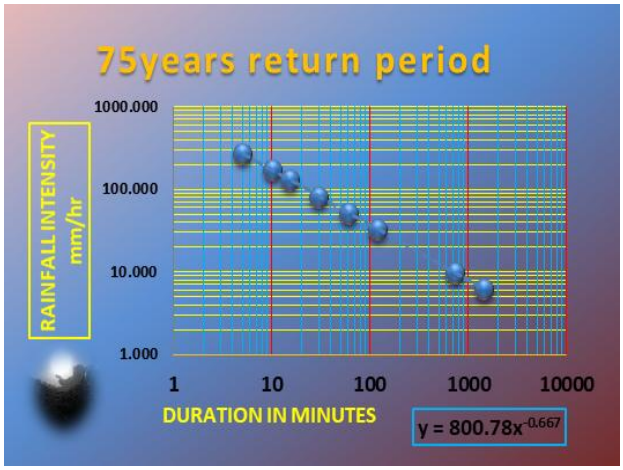


Figure 13 IDF curves for Sakaleshpura Station





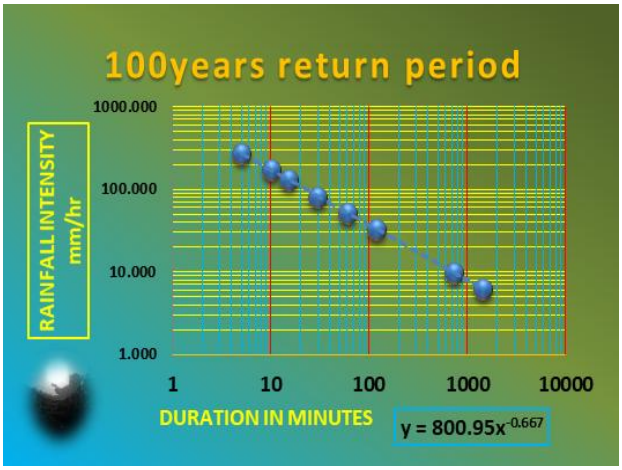
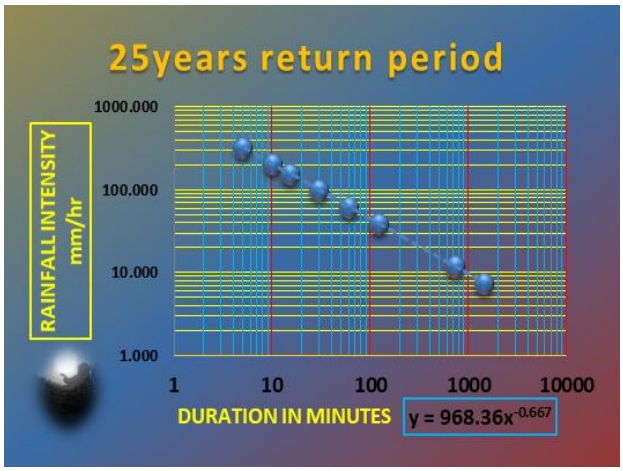
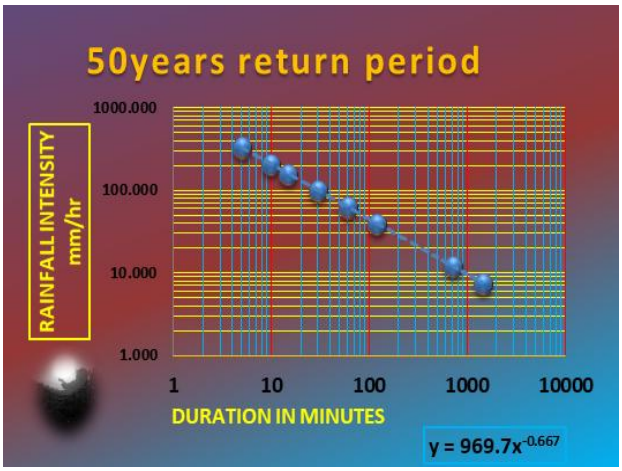
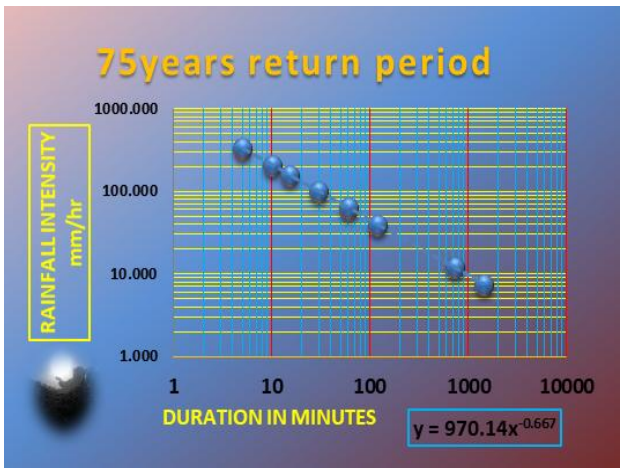


Figure 14 IDF curves for Virajpet Station







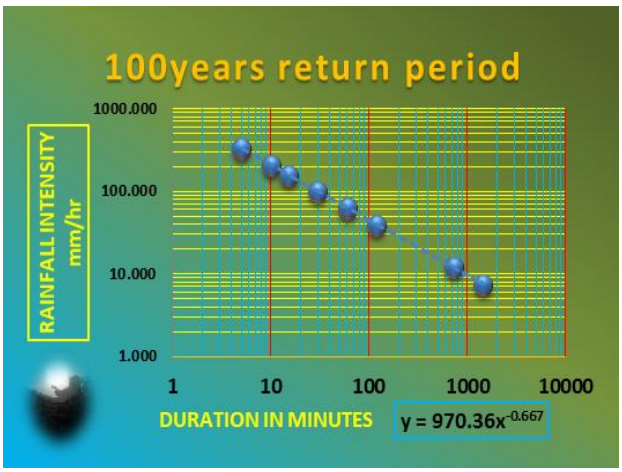


Figure 15 IDF curves for Sukravarshanthe Station

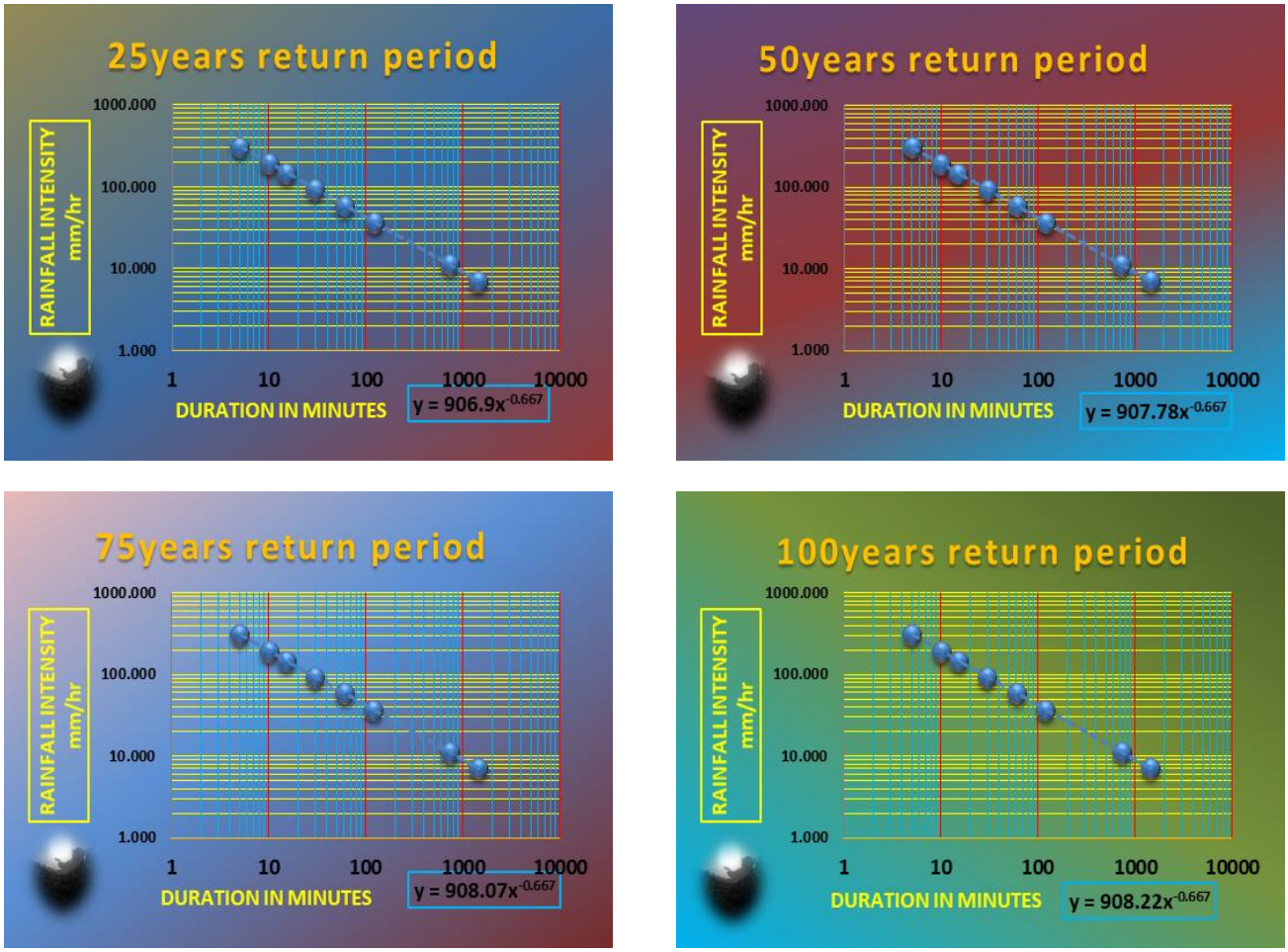
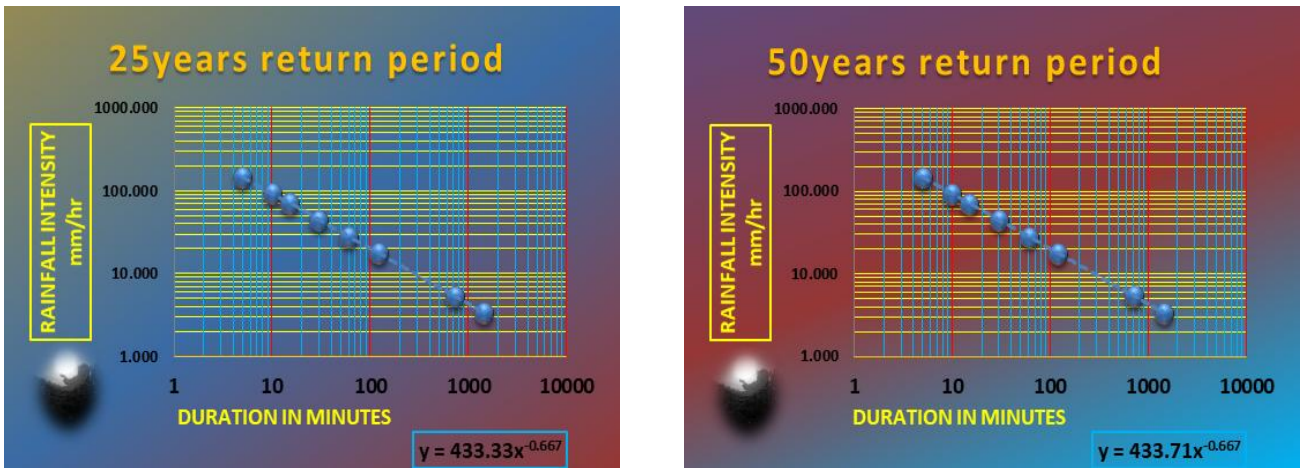
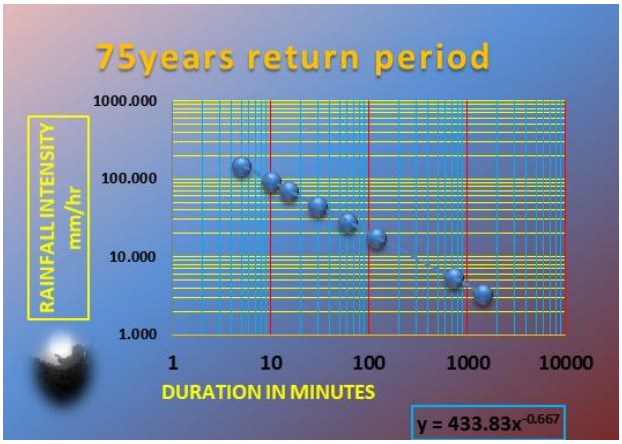


Figure 16 IDF curves for Mallipatna Station





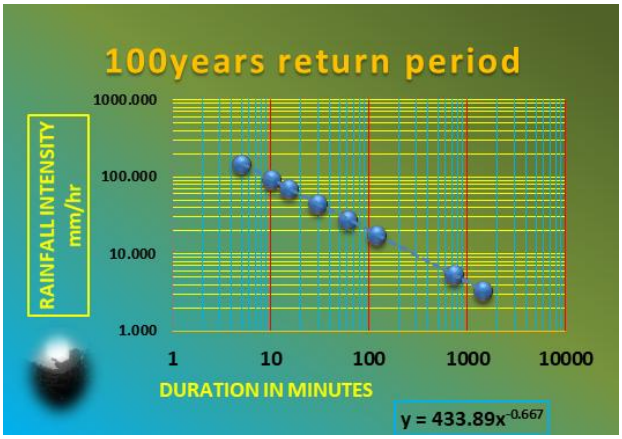


Table 21; IDF equations for all the raingauge stations in the study

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	656.1	673.7	678.7	681.5	682.4	682.9	682.8
Arkalgud	429.6	440.5	443.7	445.5	446.0	446.2	446.3
Basavapatna	404.0	413.8	416.6	418.2	418.7	418.8	418.9
Balagodu	550.5	566.6	571.3	573.9	574.6	575.0	575.1
Belur	487.8	501.4	505.3	507.5	508.2	508.4	508.5
Bettadapura	392.1	404.5	407.3	408.8	409.3	409.4	409.5
Bilur	1147.5	1152.2	1162.2	1167.7	1169.5	1176.1	1170.4
Channenahally	447.7	460.0	463.5	465.6	466.2	466.4	446.5
Chikkamangalore	413.7	421.7	424.0	425.2	425.7	425.8	425.8
Doddabemmatti	315.0	321.2	324.0	324.0	324.8	324.4	324.4
Galibeedu	1049.0	1069.8	1075.7	1076.0	1080.1	1080.4	1080.6
Gonibeedu	763.4	784.8	791.0	794.4	795.5	795.9	796.1
Gorur	422.3	431.7	434.4	435.9	436.4	436.5	436.4
Hagare	417.7	428.0	431.0	432.7	433.2	433.4	433.5
Halekote	431.0	444.1	447.9	450.0	450.6	450.9	451.0
Hallibailu	948.9	967.6	973.0	976.0	977.0	977.3	977.4
Hallimysore	396.9	404.1	406.1	407.3	407.6	407.8	407.8
Harangi	445.8	457.8	461.2	463.2	463.8	464.0	464.1
Hassan	468.6	479.4	482.5	484.3	484.8	485.0	485.1
Hosakere	1401.8	1429.8	1437.9	1442.4	1443.8	1444.3	1444.6
Hunsur	436.8	448.3	451.6	453.5	454.1	454.3	454.4
Javali	936.6	955.2	960.6	963.6	964.6	964.9	965.0
Kenchammana hoskote	599.9	613.7	617.7	619.9	620.6	620.9	621.0
Krishnarajpet	434.4	442.9	445.2	446.8	447.2	447.4	447.5
Kushalnagar	385.9	393.8	396.1	397.4	397.8	397.9	398.0
Malalur	311.7	317.8	319.6	320.5	320.9	321.0	321.0
Mallipatna	422.8	430.1	432.2	433.3	433.7	433.8	433.9
Melkote	546.4	560.5	564.6	566.9	567.6	567.8	567.9
Naladi	1813.2	1880.9	1874.6	1882.3	1884.8	1885.6	1886.0
Nuggehalli	518.3	534.3	538.9	541.5	542.3	542.6	542.7
Periyapatna	402.2	410.7	413.1	414.5	414.9	415.1	415.1
Poonampet	1014.5	1050.6	1061.0	1066.8	1068.7	1069.3	1069.6
Sakleshpura	771.1	790.7	796.3	799.4	800.5	800.8	801.0
Salagame	438.6	450.7	454.1	456.1	456.7	456.9	457.0
Shantebachahalli	584.5	607.0	613.5	617.1	618.3	618.6	618.8
Shantigrama	389.8	400.0	402.9	404.5	405.1	405.2	405.3
Shravanabelagola	538.2	555.1	559.9	562.7	563.5	563.8	564.0
Siddapura	613.8	629.1	633.5	636.0	636.8	637.0	637.1
Srimangala	1019.7	1047.0	1054.9	1059.3	1060.7	1061.7	1061.4

Sukravarashante	882.0	899.2	904.1	906.9	907.8	908.1	908.2
Talakavery	1169.9	1709.7	1721.1	1727.5	1729.5	1730.2	1730.5
Virajpet	930.8	956.8	964.2	968.4	969.7	970.1	970.4
Yelawala	444.2	454.2	457.0	458.6	459.2	459.3	459.4

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, Normal 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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