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Research Paper

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Assesment of the Intensity Duration Frequency Curves for Storms in Upper Cauvery Karnataka Based on Pearson Type III Extreme Value

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***Abstract*-** Engineering infrastructures such as storm water drains and bridges are commonly designed using the concept of Intensity-Duration-Frequency (IDF) curves, which assume that the occurrence of precipitation patterns and distributions are spatially similar within the drainage area and remain unchanged throughout the lifespan of the infrastructures (stationary). Based on the premise that climate change will alter the spatial and temporal variability of precipitation patterns, inaccuracy in the estimation of IDF curves may occur. As such, prior to developing IDF curves, it is crucial to analyse trends of annual precipitation maxima. The objective of this study was to estimate the precipitation intensities and their uncertainties (lower and upper limits) for durations of 5min, 10min, 15min, 30min, 60min,120min, 720min and 1440min and return periods of 2, 5, 10, 25, 50, 75 and 100 years in the Upper Cauvery Karnataka India using Pearson type III Values . The annual precipitation maxima were extracted from long-term (1995–2017) precipitation data for Forty Three meteorological stations sourced from the Water resources Development Organization Karnataka. On average, the estimated extreme precipitation intensities for the Study area ranged from 5.1 mm/h for 24 h storm duration to 226.01 mm/h for 5min at 100 years return period. At 50 year return period, the intensity ranged from 5.2 mm/h for 24h duration to 225 mm/h for the duration of 5min.

***Keywords*:** Climate change, *Intensity Duration Frequency (IDF), Pearson Type III Distribution, Rainfall Duration.*

I. INTRODUCTION

Precipitation extremes are expected to increase in intensity and frequency over many regions in the world due to global warming. Municipal storm water management and the design of engineering infrastructures able to withstand floods and extreme precipitation events are often based on the concept of precipitation Intensity-Duration-Frequency (IDF) curves. 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, hunsur, kechamanna hosakote, naladi, shantebachahalli, belur, belagodu, javali, talakavery, shravanabelagola, siddapura, 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, srimangala, sukravarsanthe, krishnarajpet, virajpet and yelawala were considered as shown in Figure 2.

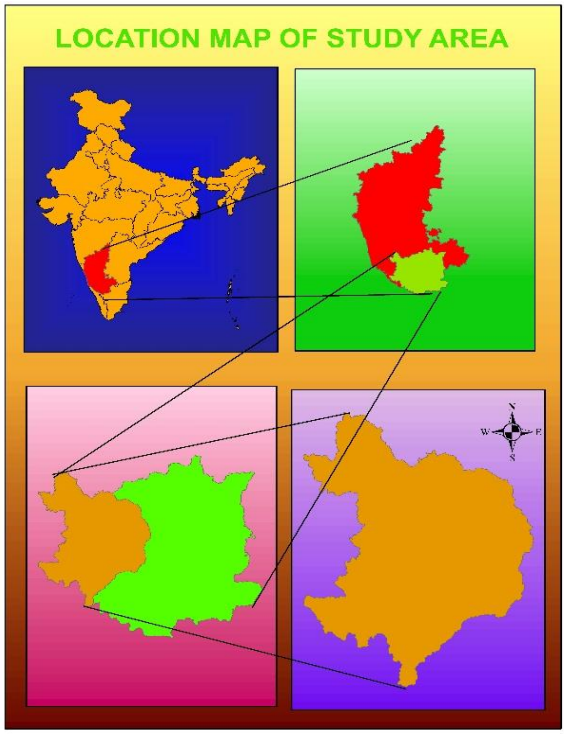

Figure 1 Location Map of Study Area

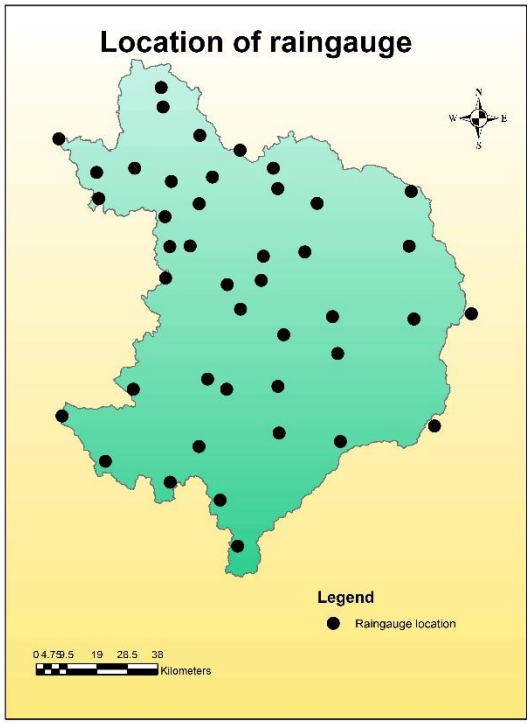

Figure 2 Location of raingauge stations

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[6].

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

(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 Arkalgud. Table 2 shows the tabulation of short duration rainfall of station Shantigrama. Table 3 shows the tabulation of short duration rainfall of station Javali. Similarly the short duration rainfall was tabulated for the remaining forty stations.

Pearson Type III 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 Arkalgud

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	54.400	8.238	10.379	11.881	14.969	18.859	23.761	43.177	54.400
1996	59.000	8.934	11.256	12.885	16.234	20.454	25.771	46.828	59.000
1997	76.000	11.508	14.500	16.598	20.912	26.348	33.196	60.321	76.000
1998	50.400	7.632	9.616	11.007	13.868	17.473	22.014	40.003	50.400
1999	50.300	7.617	9.597	10.985	13.841	17.438	21.971	39.923	50.300
2000	60.900	9.222	11.619	13.300	16.757	21.113	26.601	48.336	60.900
2001	70.400	10.660	13.431	15.375	19.371	24.406	30.750	55.877	70.400
2002	60.500	9.161	11.543	13.213	16.647	20.974	26.426	48.019	60.500
2003	60.500	9.161	11.543	13.213	16.647	20.974	26.426	48.019	60.500
2004	60.500	9.161	11.543	13.213	16.647	20.974	26.426	48.019	60.500
2005	100.600	15.234	19.193	21.971	27.681	34.876	43.941	79.846	100.600
2006	100.500	15.218	19.174	21.949	27.654	34.841	43.897	79.767	100.500
2007	100.900	15.279	19.250	22.036	27.764	34.980	44.072	80.084	100.900
2008	100.400	15.203	19.155	21.927	27.626	34.807	43.854	79.688	100.400
2009	60.200	9.116	11.485	13.147	16.565	20.870	26.295	47.781	60.200
2010	70.600	10.691	13.469	15.419	19.426	24.476	30.837	56.035	70.600
2011	100.800	15.264	19.231	22.014	27.736	34.945	44.028	80.005	100.800
2012	50.000	7.571	9.539	10.920	13.758	17.334	21.840	39.685	50.000
2013	70.700	10.706	13.489	15.441	19.454	24.510	30.881	56.115	70.700
2014	50.800	7.692	9.692	11.094	13.978	17.611	22.189	40.320	50.800
2015	40.800	6.178	7.784	8.911	11.227	14.145	17.821	32.383	40.800
2016	40.600	6.148	7.746	8.867	11.172	14.075	17.734	32.224	40.600
2017	30.900	4.679	5.895	6.748	8.502	10.712	13.497	24.525	30.900

Table 2 Short duration rainfall for Shantigrama

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	57.000	8.631	10.875	12.449	15.684	19.761	24.897	45.241	57.000
1996	67.000	10.146	12.783	14.632	18.436	23.228	29.265	53.178	67.000
1997	92.000	13.931	17.552	20.092	25.315	31.895	40.185	73.020	92.000
1998	95.000	14.386	18.125	20.748	26.140	32.935	41.495	75.402	95.000
1999	77.000	11.660	14.691	16.816	21.187	26.694	33.633	61.115	77.000
2000	60.000	9.086	11.447	13.104	16.510	20.801	26.207	47.622	60.000
2001	45.000	6.814	8.585	9.828	12.382	15.601	19.656	35.717	45.000
2002	60.000	9.086	11.447	13.104	16.510	20.801	26.207	47.622	60.000
2003	26.000	3.937	4.960	5.678	7.154	9.014	11.357	20.636	26.000
2004	66.500	10.070	12.687	14.523	18.298	23.054	29.047	52.781	66.500
2005	56.000	8.480	10.684	12.230	15.409	19.414	24.460	44.447	56.000
2006	46.000	6.966	8.776	10.046	12.657	15.947	20.092	36.510	46.000
2007	42.000	6.360	8.013	9.173	11.557	14.561	18.345	33.335	42.000
2008	39.100	5.921	7.460	8.539	10.759	13.555	17.078	31.034	39.100
2009	48.000	7.268	9.158	10.483	13.208	16.641	20.966	38.098	48.000
2010	88.500	13.401	16.885	19.328	24.352	30.681	38.656	70.242	88.500
2011	30.500	4.619	5.819	6.661	8.392	10.574	13.322	24.208	30.500
2012	56.000	8.480	10.684	12.230	15.409	19.414	24.460	44.447	56.000
2013	84.000	12.720	16.026	18.345	23.113	29.121	36.690	66.671	84.000
2014	60.000	9.086	11.447	13.104	16.510	20.801	26.207	47.622	60.000
2015	83.000	12.568	15.835	18.127	22.838	28.774	36.254	65.877	83.000
2016	33.300	5.043	6.353	7.273	9.163	11.544	14.545	26.430	33.300
2017	60.000	9.086	11.447	13.104	16.510	20.801	26.207	47.622	60.000

Table 3 Short duration rainfall for Javali

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	140.000	21.200	26.710	30.575	38.522	48.535	61.151	111.118	140.000

1996	87.000	13.174	16.598	19.000	23.939	30.161	38.001	69.052	87.000
1997	136.000	20.594	25.947	29.702	37.422	47.149	59.403	107.943	136.000
1998	124.000	18.777	23.657	27.081	34.120	42.988	54.162	98.419	124.000
1999	121.000	18.323	23.085	26.426	33.294	41.948	52.852	96.038	121.000
2000	156.600	23.713	29.877	34.201	43.090	54.290	68.401	124.294	156.600
2001	119.000	18.020	22.704	25.989	32.744	41.255	51.978	94.450	119.000
2002	131.000	19.837	24.993	28.610	36.046	45.415	57.220	103.975	131.000
2003	129.600	19.625	24.726	28.304	35.661	44.930	56.608	102.864	129.600
2004	170.000	25.743	32.434	37.127	46.777	58.936	74.254	134.929	170.000
2005	127.000	19.231	24.230	27.736	34.945	44.028	55.472	100.800	127.000
2006	146.400	22.169	27.931	31.973	40.284	50.754	63.946	116.198	146.400
2007	209.000	31.648	39.874	45.645	57.509	72.456	91.289	165.883	209.000
2008	158.000	23.925	30.144	34.506	43.475	54.776	69.013	125.405	158.000
2009	218.000	33.011	41.591	47.610	59.985	75.576	95.220	173.027	218.000
2010	112.500	17.035	21.463	24.569	30.956	39.002	49.139	89.291	112.500
2011	187.500	28.392	35.772	40.949	51.593	65.003	81.898	148.819	187.500
2012	149.300	22.608	28.484	32.606	41.081	51.759	65.213	118.499	149.300
2013	170.300	25.788	32.491	37.193	46.860	59.040	74.385	135.167	170.300
2014	210.000	31.800	40.065	45.863	57.784	72.803	91.726	166.677	210.000
2015	214.000	32.405	40.828	46.737	58.884	74.190	93.473	169.852	214.000
2016	112.500	17.035	21.463	24.569	30.956	39.002	49.139	89.291	112.500
2017	148.500	22.487	28.332	32.432	40.861	51.482	64.863	117.865	148.500

B. Pearson type III distribution

The Pearson type III distributions are commonly used to fit a sample of extreme hydrological data[9]. A closed-form expression for the CDF of the Pearson III distribution is not available. Tables or approximations must be used. Many tables provide frequency factors $K_p(\gamma)$ which are the p^{th}quantile of a standard Pearson III variate with skew γ, mean zero and variance 1. For any mean and standard deviation, p^{th} Pearson III quantile can be written as (MB Parvez et al, 2019)

$$x_p = \mu + \sigma k_p(\gamma) \qquad \text{(Equation B)}$$

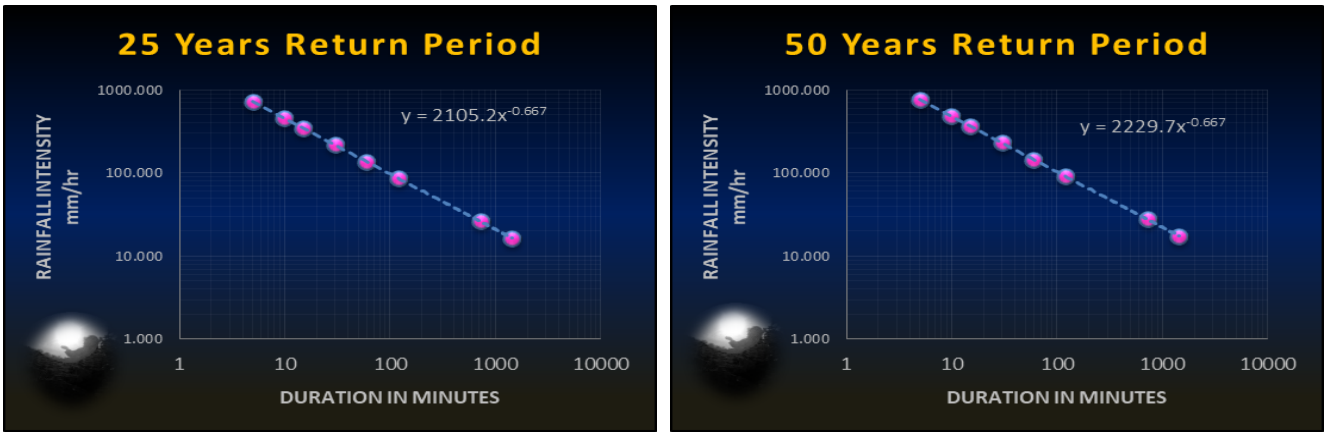

Figure 3.a IDF curves for Talakavery Station

Table 4 Estimation of maximum rainfall intensity for various return period For Talakavery 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	39.497	473.962	49.355	592.265	54.507	654.087	59.999	719.983	63.546	762.555	66.731	800.772	69.658	835.897
10	49.763	298.578	62.184	373.105	68.675	412.050	75.594	453.561	80.063	480.380	84.076	504.456	87.764	526.583
15	56.964	227.857	71.183	284.732	78.613	314.452	86.533	346.132	91.650	366.599	96.243	384.971	100.465	401.858
30	71.771	143.5	89.685	179.3	99.046	198.0	109.025	218.0	115.471	230.9	121.258	242.5	126.577	253.1

		41		70		93		49		43		17		55
60	90.425	90.425	112.996	112.996	124.791	124.791	137.363	137.363	145.485	145.485	152.776	152.776	159.478	159.478
120	113.929	56.964	142.366	71.183	157.226	78.613	173.066	86.533	183.299	91.650	192.486	96.243	200.929	100.465
720	207.022	17.252	258.696	21.558	285.699	23.808	314.482	26.207	333.077	27.756	349.770	29.147	365.112	30.426
1440	260.832	10.868	325.937	13.581	359.958	14.998	396.222	16.509	419.651	17.485	440.682	18.362	460.013	19.167

Table 5 Estimation of maximum rainfall intensity for various return period For Gorur 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	10.125	121.502	12.452	149.424	13.668	164.015	14.964	179.568	15.801	189.616	16.553	198.636	17.244	206.927
10	12.757	76.542	15.689	94.132	17.221	103.323	18.854	113.121	19.909	119.451	20.856	125.133	21.726	130.356
15	14.603	58.412	17.959	71.836	19.713	78.851	21.582	86.328	22.790	91.158	23.874	95.495	24.870	99.480
30	18.399	36.797	22.627	45.254	24.836	49.673	27.191	54.383	28.713	57.426	30.079	60.158	31.334	62.669
60	23.181	23.181	28.508	28.508	31.292	31.292	34.259	34.259	36.176	36.176	37.897	37.897	39.479	39.479
120	29.206	14.603	35.918	17.959	39.425	19.713	43.164	21.582	45.579	22.790	47.747	23.874	49.740	24.870
720	53.071	4.423	65.267	5.439	71.640	5.970	78.434	6.536	82.823	6.902	86.763	7.230	90.384	7.532
1440	66.865	2.786	82.231	3.426	90.261	3.761	98.820	4.118	104.350	4.348	109.314	4.555	113.876	4.745

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	9.522	114.258	11.948	143.373	13.216	158.587	14.567	174.804	15.440	185.281	16.224	194.687	16.944	203.331
10	11.996	71.978	15.053	90.320	16.651	99.904	18.353	110.120	19.453	116.720	20.441	122.645	21.348	128.091
15	13.732	54.930	17.232	68.927	19.060	76.241	21.009	84.037	22.269	89.074	23.399	93.596	24.438	97.752
30	17.302	34.604	21.711	43.421	24.014	48.029	26.470	52.940	28.057	56.113	29.481	58.962	30.790	61.580
60	21.799	21.799	27.354	27.354	30.256	30.256	33.350	33.350	35.349	35.349	37.143	37.143	38.793	38.793
120	27.465	13.732	34.463	17.232	38.120	19.060	42.019	21.009	44.537	22.269	46.798	23.399	48.876	24.438
720	49.907	4.159	62.624	5.219	69.269	5.772	76.353	6.363	80.929	6.744	85.037	7.086	88.813	7.401
1440	62.879	2.620	78.901	3.288	87.274	3.636	96.199	4.008	101.964	4.249	107.140	4.464	111.898	4.662

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/	Rainfall Depth(mm)	Rainfall Intensity (mm/	Rainfall Depth(mm)	Rainfall Intensity (mm/	Rainfall Depth(mm)	Rainfall Intensity (mm/	Rainfall Depth(mm)	Rainfall Intensity (mm/	Rainfall Depth(mm)	Rainfall Intensity (mm/	Rainfall Depth(mm)	Rainfall Intensity (mm/

		hr)		hr)		hr)		hr)		hr)		hr)		hr)
5	12.396	148.756	16.405	196.859	18.500	221.996	20.732	248.790	22.175	266.100	23.470	281.639	24.660	295.922
10	15.618	93.711	20.669	124.014	23.308	139.849	26.121	156.728	27.939	167.633	29.570	177.422	31.070	186.419
15	17.879	71.514	23.660	94.640	26.681	106.725	29.901	119.606	31.982	127.928	33.850	135.398	35.566	142.264
30	22.526	45.051	29.810	59.620	33.616	67.232	37.673	75.347	40.295	80.589	42.648	85.296	44.811	89.621
60	28.381	28.381	37.558	37.558	42.354	42.354	47.466	47.466	50.768	50.768	53.733	53.733	56.458	56.458
120	35.757	17.879	47.320	23.660	53.362	26.681	59.803	29.901	63.964	31.982	67.699	33.850	71.132	35.566
720	64.975	5.415	85.986	7.166	96.966	8.080	108.669	9.056	116.230	9.686	123.017	10.251	129.256	10.771
1440	81.864	3.411	108.336	4.514	122.169	5.090	136.914	5.705	146.441	6.102	154.992	6.458	162.852	6.786

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	10.012	120.143	12.728	152.739	14.148	169.772	15.661	187.928	16.638	199.658	17.516	210.188	18.322	219.866
10	12.614	75.686	16.037	96.220	17.825	106.950	19.731	118.388	20.963	125.777	22.068	132.410	23.085	138.507
15	14.440	57.759	18.357	73.429	20.405	81.618	22.587	90.347	23.996	95.986	25.262	101.048	26.425	105.701
30	18.193	36.386	23.129	46.258	25.708	51.416	28.457	56.915	30.234	60.467	31.828	63.656	33.294	66.587
60	22.922	22.922	29.140	29.140	32.390	32.390	35.854	35.854	38.092	38.092	40.101	40.101	41.947	41.947
120	28.879	14.440	36.715	18.357	40.809	20.405	45.173	22.587	47.993	23.996	50.524	25.262	52.850	26.425
720	52.477	4.373	66.715	5.560	74.155	6.180	82.085	6.840	87.209	7.267	91.808	7.651	96.036	8.003
1440	66.117	2.755	84.056	3.502	93.429	3.893	103.421	4.309	109.876	4.578	115.671	4.820	120.997	5.042

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	9.337	112.049	11.679	140.147	12.903	154.830	14.207	170.481	15.049	180.592	15.806	189.669	16.501	198.011
10	11.764	70.587	14.715	88.287	16.256	97.537	17.899	107.396	18.961	113.766	19.914	119.484	20.790	124.740
15	13.467	53.868	16.844	67.376	18.609	74.435	20.490	81.959	21.705	86.820	22.796	91.183	23.799	95.194
30	16.967	33.935	21.222	42.444	23.445	46.891	25.815	51.631	27.346	54.693	28.721	57.442	29.984	59.969
60	21.377	21.377	26.738	26.738	29.539	29.539	32.525	32.525	34.454	34.454	36.186	36.186	37.778	37.778
120	26.934	13.467	33.688	16.844	37.217	18.609	40.979	20.490	43.410	21.705	45.592	22.796	47.597	23.799
720	48.942	4.079	61.215	5.101	67.628	5.636	74.464	6.205	78.881	6.573	82.846	6.904	86.490	7.207
1440	61.663	2.569	77.126	3.214	85.206	3.550	93.819	3.909	99.384	4.141	104.379	4.349	108.970	4.540

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

Durati	**Return period 2**	**Return period 5**	**Return period 10**	**Return period 25**	**Return period 50**	**Return period 75**	**Return period**

on in minutes	yrs		yrs		yrs		yrs		yrs		yrs		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	24.776	297.312	33.388	400.652	37.888	454.654	42.685	512.215	45.784	549.402	48.565	582.785	51.122	613.468
10	31.216	187.295	42.066	252.395	47.736	286.415	53.779	322.676	57.684	346.103	61.189	367.133	64.410	386.462
15	35.733	142.933	48.153	192.614	54.644	218.575	61.562	246.248	66.031	264.126	70.044	280.174	73.731	294.925
30	45.021	90.042	60.669	121.339	68.847	137.694	77.563	155.126	83.194	166.389	88.249	176.499	92.896	185.791
60	56.723	56.723	76.439	76.439	86.742	86.742	97.723	97.723	104.818	104.818	111.187	111.187	117.041	117.041
120	71.466	35.733	96.307	48.153	109.288	54.644	123.124	61.562	132.063	66.031	140.087	70.044	147.463	73.731
720	129.863	10.822	175.001	14.583	198.589	16.549	223.731	18.644	239.974	19.998	254.555	21.213	267.957	22.330
1440	163.617	6.817	220.488	9.187	250.206	10.425	281.883	11.745	302.348	12.598	320.720	13.363	337.605	14.067

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	10.239	122.869	13.306	159.676	14.909	178.911	16.618	199.413	17.722	212.658	18.712	224.548	19.623	235.477
10	12.900	77.403	16.765	100.590	18.784	112.707	20.937	125.622	22.328	133.967	23.576	141.457	24.724	148.342
15	14.767	59.069	19.191	76.764	21.503	86.011	23.967	95.868	25.559	102.236	26.988	107.952	28.301	113.206
30	18.606	37.211	24.179	48.359	27.092	54.184	30.196	60.393	32.202	64.404	34.003	68.005	35.658	71.315
60	23.442	23.442	30.464	30.464	34.134	34.134	38.045	38.045	40.572	40.572	42.841	42.841	44.926	44.926
120	29.535	14.767	38.382	19.191	43.006	21.503	47.934	23.967	51.118	25.559	53.976	26.988	56.603	28.301
720	53.668	4.472	69.745	5.812	78.147	6.512	87.102	7.258	92.887	7.741	98.081	8.173	102.854	8.571
1440	67.617	2.817	87.873	3.661	98.458	4.102	109.741	4.573	117.030	4.876	123.574	5.149	129.588	5.400

Table 12 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	15.122	181.459	19.476	233.715	21.752	261.022	24.177	290.129	25.745	308.934	27.151	325.815	28.444	341.331
10	19.052	114.312	24.539	147.232	27.406	164.434	30.462	182.770	32.436	194.617	34.209	205.251	35.838	215.025
15	21.809	87.237	28.090	112.359	31.372	125.487	34.870	139.480	37.130	148.520	39.159	156.636	41.024	164.095
30	27.478	54.956	35.391	70.782	39.526	79.052	43.933	87.867	46.781	93.562	49.337	98.674	51.687	103.373
60	34.620	34.620	44.590	44.590	49.799	49.799	55.353	55.353	58.940	58.940	62.161	62.161	65.121	65.121
120	43.618	21.80	56.179	28.09	62.743	31.37	69.740	34.87	74.260	37.13	78.318	39.15	82.047	41.02

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720	79.260	6.605	102.085	8.507	114.012	9.501	126.726	10.560	134.940	11.245	142.313	11.859	149.090	12.424
1440	99.861	4.161	128.619	5.359	143.646	5.985	159.665	6.653	170.013	7.084	179.303	7.471	187.842	7.827

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	9.738	116.850	11.838	142.061	12.936	155.236	14.107	169.278	14.863	178.351	15.541	186.495	16.165	193.980
10	12.269	73.611	14.916	89.493	16.299	97.793	17.773	106.639	18.726	112.354	19.581	117.485	20.367	122.200
15	14.044	56.176	17.074	68.296	18.657	74.630	20.345	81.381	21.436	85.742	22.414	89.658	23.314	93.256
30	17.694	35.389	21.512	43.024	23.507	47.014	25.633	51.267	27.007	54.014	28.240	56.481	29.374	58.748
60	22.293	22.293	27.103	27.103	29.617	29.617	32.296	32.296	34.027	34.027	35.581	35.581	37.009	37.009
120	28.088	14.044	34.148	17.074	37.315	18.657	40.690	20.345	42.871	21.436	44.829	22.414	46.628	23.314
720	51.039	4.253	62.051	5.171	67.806	5.650	73.939	6.162	77.902	6.492	81.459	6.788	84.729	7.061
1440	64.305	2.679	78.179	3.257	85.430	3.560	93.158	3.882	98.150	4.090	102.632	4.276	106.752	4.448

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	21.546	258.557	30.516	366.190	35.203	422.436	40.199	482.389	43.427	521.121	46.324	555.891	48.987	587.849
10	27.147	162.881	38.448	230.686	44.353	266.119	50.648	303.886	54.714	328.287	58.365	350.190	61.720	370.322
15	31.075	124.301	44.012	176.046	50.772	203.086	57.977	231.909	62.632	250.529	66.811	267.245	70.652	282.609
30	39.152	78.305	55.451	110.902	63.968	127.936	73.047	146.093	78.912	157.824	84.177	168.354	89.016	178.032
60	49.329	49.329	69.864	69.864	80.595	80.595	92.033	92.033	99.423	99.423	106.056	106.056	112.153	112.153
120	62.151	31.075	88.023	44.012	101.543	50.772	115.954	57.977	125.265	62.632	133.623	66.811	141.304	70.652
720	112.935	9.411	159.949	13.329	184.516	15.376	210.703	17.559	227.621	18.968	242.808	20.234	256.767	21.397
1440	142.289	5.929	201.523	8.397	232.476	9.686	265.469	11.061	286.785	11.949	305.919	12.747	323.506	13.479

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	17.982	215.787	22.845	274.134	25.385	304.625	28.094	337.125	29.843	358.122	31.414	376.970	32.858	394.294
10	22.656	135.9	28.782	172.6	31.984	191.9	35.396	212.3	37.600	225.6	39.579	237.4	41.398	248.3

		37		94		02		76		03		77		90
15	25.935	103.740	32.948	131.790	36.612	146.449	40.518	162.073	43.042	172.167	45.307	181.229	47.389	189.557
30	32.676	65.352	41.511	83.023	46.128	92.257	51.050	102.100	54.229	108.459	57.083	114.167	59.707	119.414
60	41.169	41.169	52.301	52.301	58.118	58.118	64.319	64.319	68.325	68.325	71.921	71.921	75.226	75.226
120	51.870	25.935	65.895	32.948	73.224	36.612	81.036	40.518	86.084	43.042	90.614	45.307	94.779	47.389
720	94.254	7.854	119.739	9.978	133.057	11.088	147.253	12.271	156.424	13.035	164.657	13.721	172.224	14.352
1440	118.752	4.948	150.862	6.286	167.642	6.985	185.527	7.730	197.082	8.212	207.455	8.644	216.989	9.041

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	10.045	120.541	13.035	156.422	14.598	175.172	16.263	195.159	17.339	208.071	18.305	219.662	19.193	230.315
10	12.656	75.936	16.423	98.540	18.392	110.352	20.490	122.942	21.846	131.077	23.063	138.379	24.182	145.090
15	14.488	57.950	18.800	75.200	21.054	84.214	23.456	93.823	25.008	100.030	26.401	105.603	27.681	110.724
30	18.253	36.506	23.687	47.373	26.526	53.052	29.552	59.105	31.508	63.015	33.263	66.525	34.876	69.752
60	22.998	22.998	29.843	29.843	33.420	33.420	37.234	37.234	39.697	39.697	41.908	41.908	43.941	43.941
120	28.975	14.488	37.600	18.800	42.107	21.054	46.911	23.456	50.015	25.008	52.801	26.401	55.362	27.681
720	52.651	4.388	68.324	5.694	76.514	6.376	85.243	7.104	90.883	7.574	95.946	7.996	100.600	8.383
1440	66.336	2.764	86.083	3.587	96.401	4.017	107.400	4.475	114.506	4.771	120.885	5.037	126.748	5.281

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	9.032	108.387	11.560	138.725	12.882	154.578	14.290	171.476	15.199	182.394	16.016	192.194	16.767	201.202
10	11.380	68.280	14.565	87.391	16.230	97.378	18.004	108.024	19.150	114.901	20.179	121.075	21.125	126.749
15	13.027	52.107	16.673	66.692	18.578	74.314	20.609	82.437	21.921	87.686	23.099	92.397	24.182	96.728
30	16.413	32.825	21.007	42.013	23.407	46.815	25.966	51.932	27.619	55.239	29.103	58.207	30.467	60.935
60	20.679	20.679	26.467	26.467	29.491	29.491	32.715	32.715	34.798	34.798	36.668	36.668	38.386	38.386
120	26.054	13.027	33.346	16.673	37.157	18.578	41.219	20.609	43.843	21.921	46.199	23.099	48.364	24.182
720	47.343	3.945	60.594	5.049	67.518	5.627	74.899	6.242	79.668	6.639	83.949	6.996	87.883	7.324
1440	59.648	2.485	76.343	3.181	85.068	3.544	94.367	3.932	100.375	4.182	105.769	4.407	110.726	4.614

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 Intens	Rainfall Depth(mm)	Rainfall Intens	Rainfall Depth(mm)	Rainfall Intens	Rainfall Depth(mm)	Rainfall Intens	Rainfall Depth(mm)	Rainfall Intens	Rainfall Depth(mm)	Rainfall Intens	Rainfall Depth(mm)	Rainfall Intens

		ity (mm/ hr)		ity (mm/ hr)		ity (mm/ hr)		ity (mm/ hr)		ity (mm/ hr)		ity (mm/ hr)		ity (mm/ hr)
5	10.107	121.288	12.959	155.510	14.449	173.393	16.038	192.455	17.064	204.770	17.985	215.825	18.832	225.986
10	12.734	76.407	16.328	97.965	18.205	109.231	20.207	121.239	21.500	128.997	22.660	135.962	23.727	142.362
15	14.577	58.309	18.690	74.761	20.840	83.359	23.131	92.523	24.611	98.443	25.939	103.758	27.161	108.643
30	18.366	36.732	23.548	47.097	26.256	52.513	29.143	58.286	31.008	62.015	32.682	65.363	34.220	68.441
60	23.140	23.140	29.669	29.669	33.081	33.081	36.718	36.718	39.067	39.067	41.176	41.176	43.115	43.115
120	29.155	14.577	37.381	18.690	41.679	20.840	46.261	23.131	49.222	24.611	51.879	25.939	54.321	27.161
720	52.977	4.415	67.925	5.660	75.736	6.311	84.063	7.005	89.442	7.453	94.270	7.856	98.709	8.226
1440	66.747	2.781	85.580	3.566	95.422	3.976	105.912	4.413	112.689	4.695	118.773	4.949	124.365	5.182

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	9.392	112.700	11.349	136.184	12.371	148.456	13.461	161.537	14.166	169.987	14.798	177.574	15.379	184.546
10	11.833	70.996	14.298	85.791	15.587	93.521	16.960	101.762	17.848	107.086	18.644	111.865	19.376	116.257
15	13.545	54.180	16.368	65.470	17.843	71.370	19.415	77.659	20.430	81.722	21.342	85.369	22.180	88.721
30	17.066	34.132	20.622	41.244	22.480	44.960	24.461	48.922	25.741	51.481	26.889	53.779	27.945	55.891
60	21.501	21.501	25.982	25.982	28.323	28.323	30.819	30.819	32.431	32.431	33.879	33.879	35.209	35.209
120	27.090	13.545	32.735	16.368	35.685	17.843	38.829	19.415	40.861	20.430	42.684	21.342	44.360	22.180
720	49.226	4.102	59.484	4.957	64.844	5.404	70.558	5.880	74.249	6.187	77.563	6.464	80.608	6.717
1440	62.021	2.584	74.945	3.123	81.698	3.404	88.897	3.704	93.548	3.898	97.723	4.072	101.560	4.232

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	21.248	254.970	27.678	332.141	31.039	372.467	34.621	415.451	36.935	443.222	39.013	468.151	40.922	491.063
10	26.770	160.622	34.873	209.236	39.107	234.640	43.620	261.718	46.535	279.213	49.153	294.917	51.559	309.351
15	30.644	122.577	39.919	159.677	44.766	179.064	49.932	199.728	53.270	213.079	56.266	225.064	59.020	236.079
30	38.609	77.219	50.295	100.590	56.402	112.803	62.911	125.821	67.116	134.231	70.891	141.781	74.360	148.720
60	48.645	48.645	63.368	63.368	71.061	71.061	79.262	79.262	84.560	84.560	89.317	89.317	93.688	93.688
120	61.289	30.644	79.838	39.919	89.532	44.766	99.864	49.932	106.540	53.270	112.532	56.266	118.039	59.020
720	111.369	9.281	145.076	12.090	162.690	13.558	181.465	15.122	193.595	16.133	204.484	17.040	214.492	17.874
1440	140.316	5.846	182.784	7.616	204.977	8.541	228.632	9.526	243.915	10.163	257.634	10.735	270.243	11.260

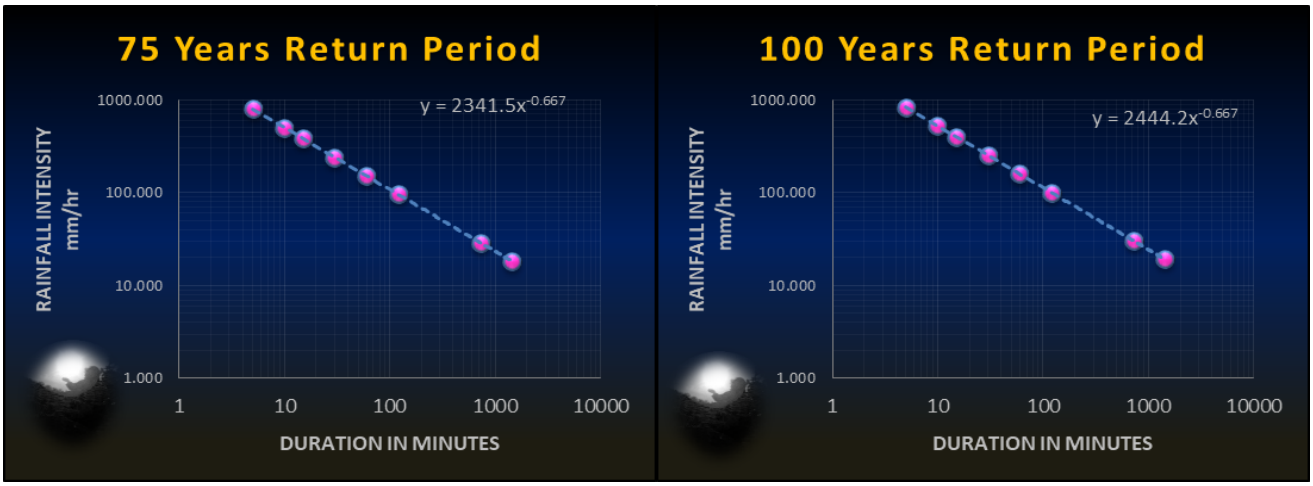
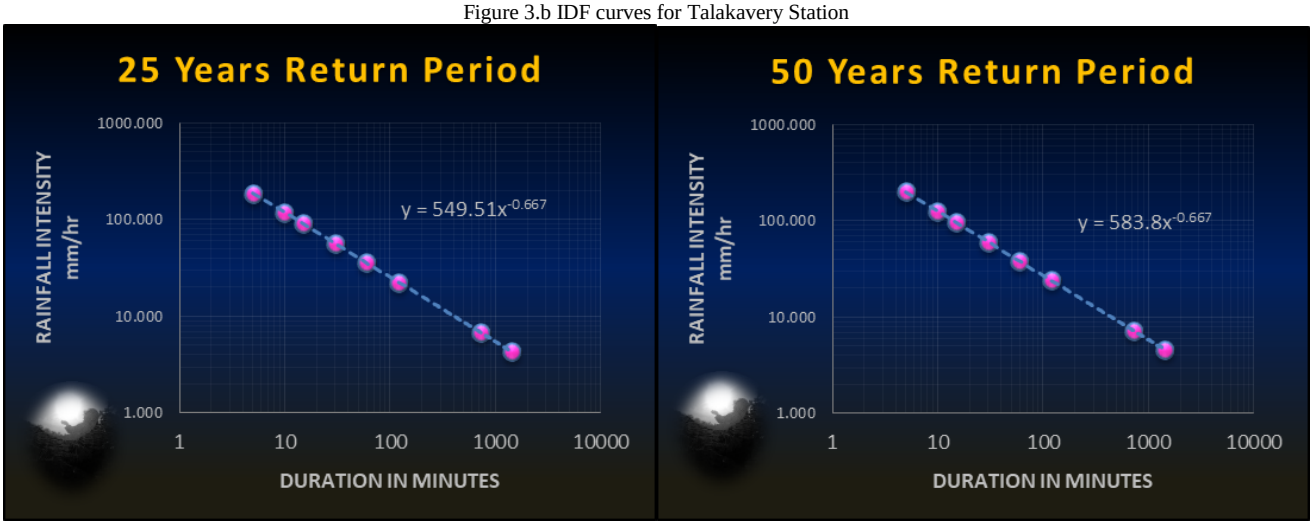


Figure 3.b IDF curves for Talakavery Station



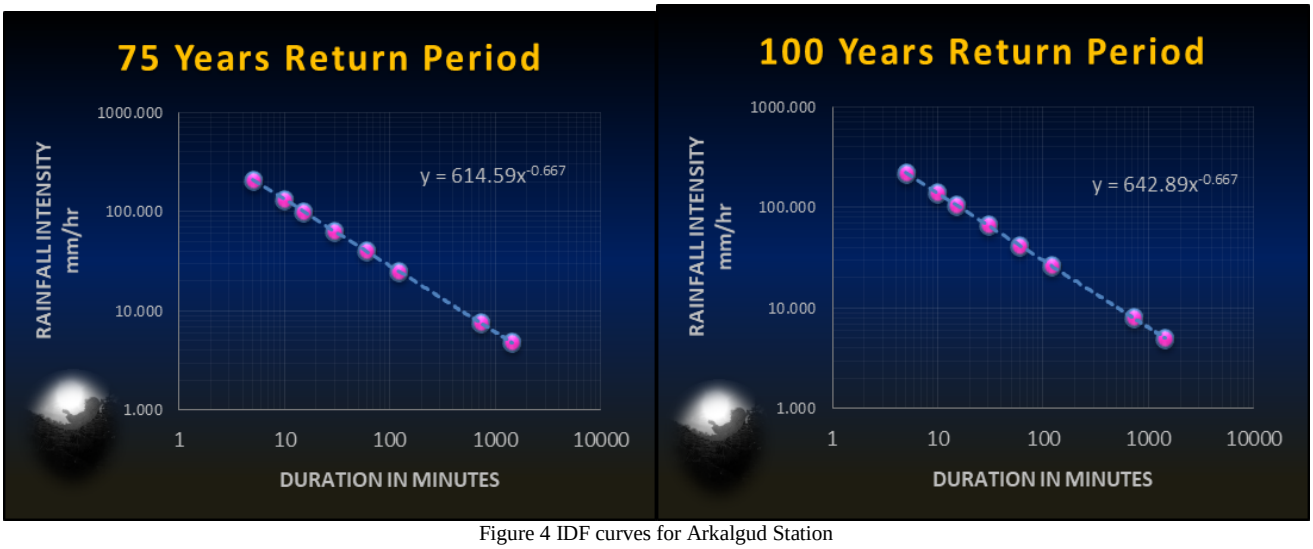
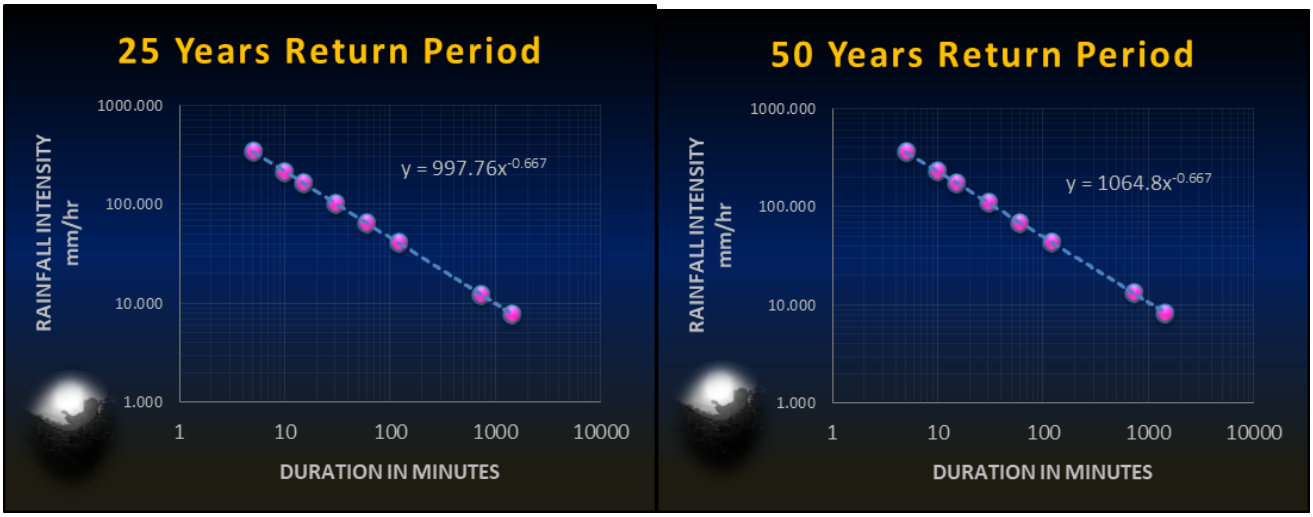


Figure 4 IDF curves for Arkalgud Station

Figure 5 IDF curves for Basavapatna Station



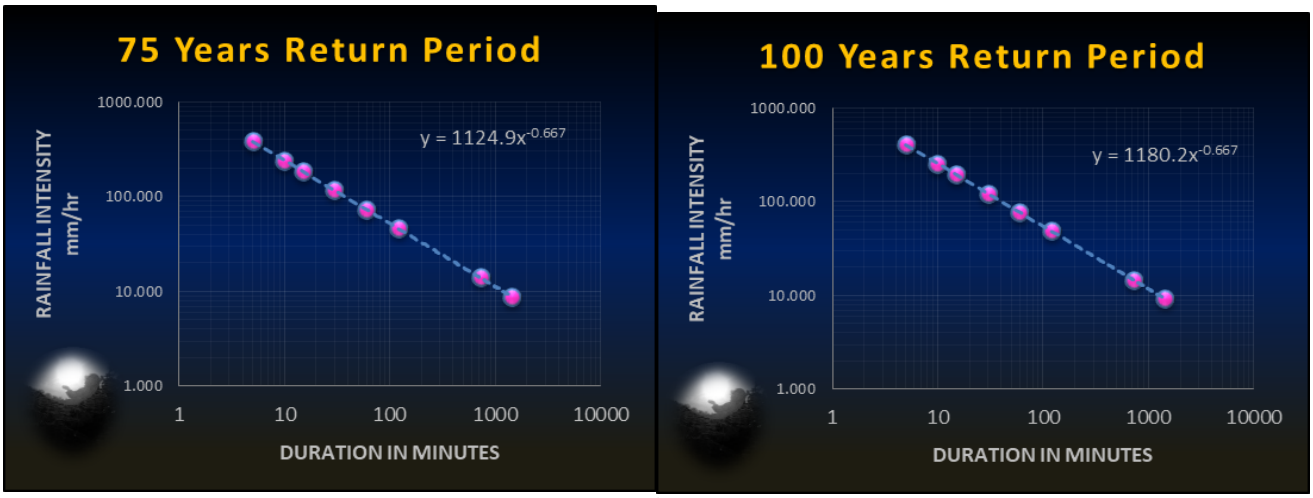


Figure 6 IDF curves for Gonibeedu Station

Figure 7 IDF curves for Hallimysore Station

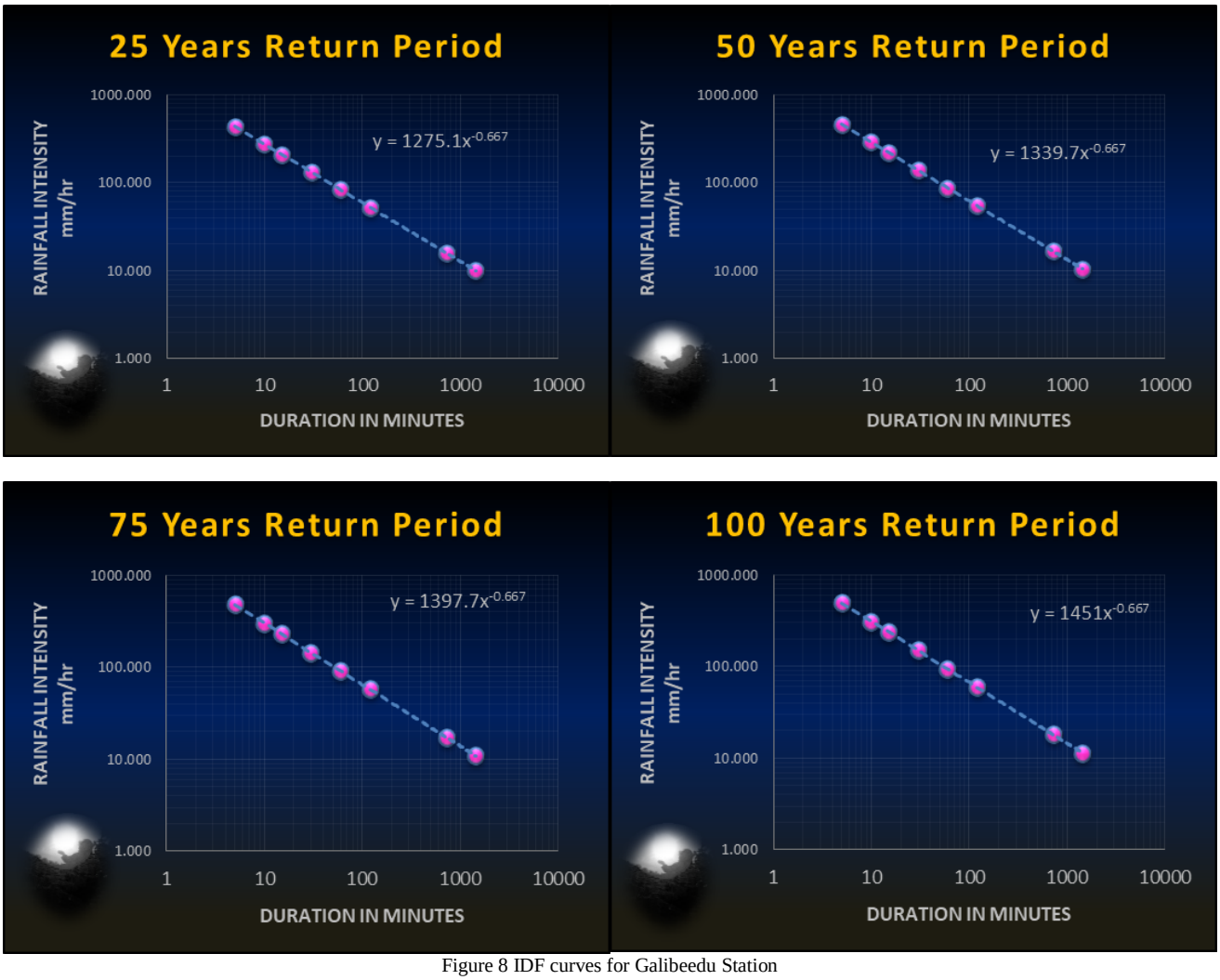
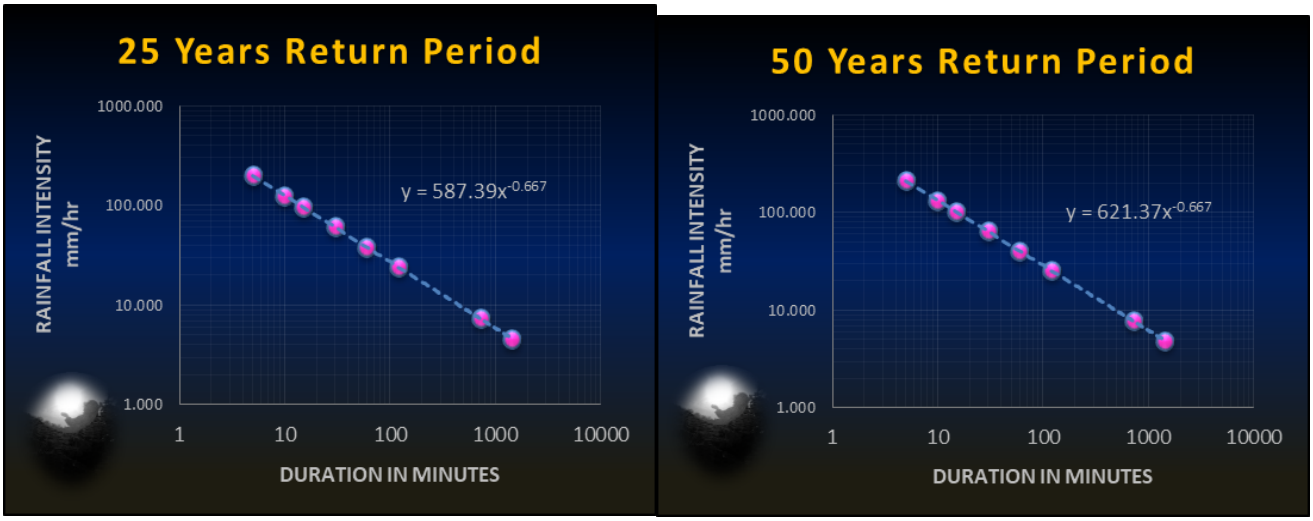


Figure 8 IDF curves for Galibeedu Station



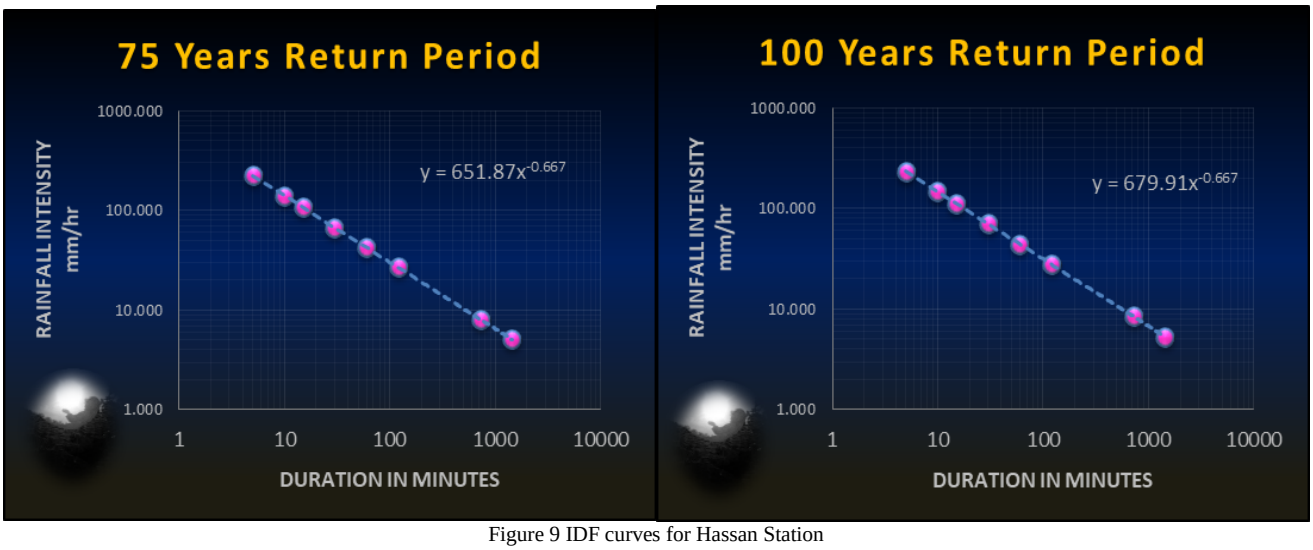


Figure 9 IDF curves for Hassan Station

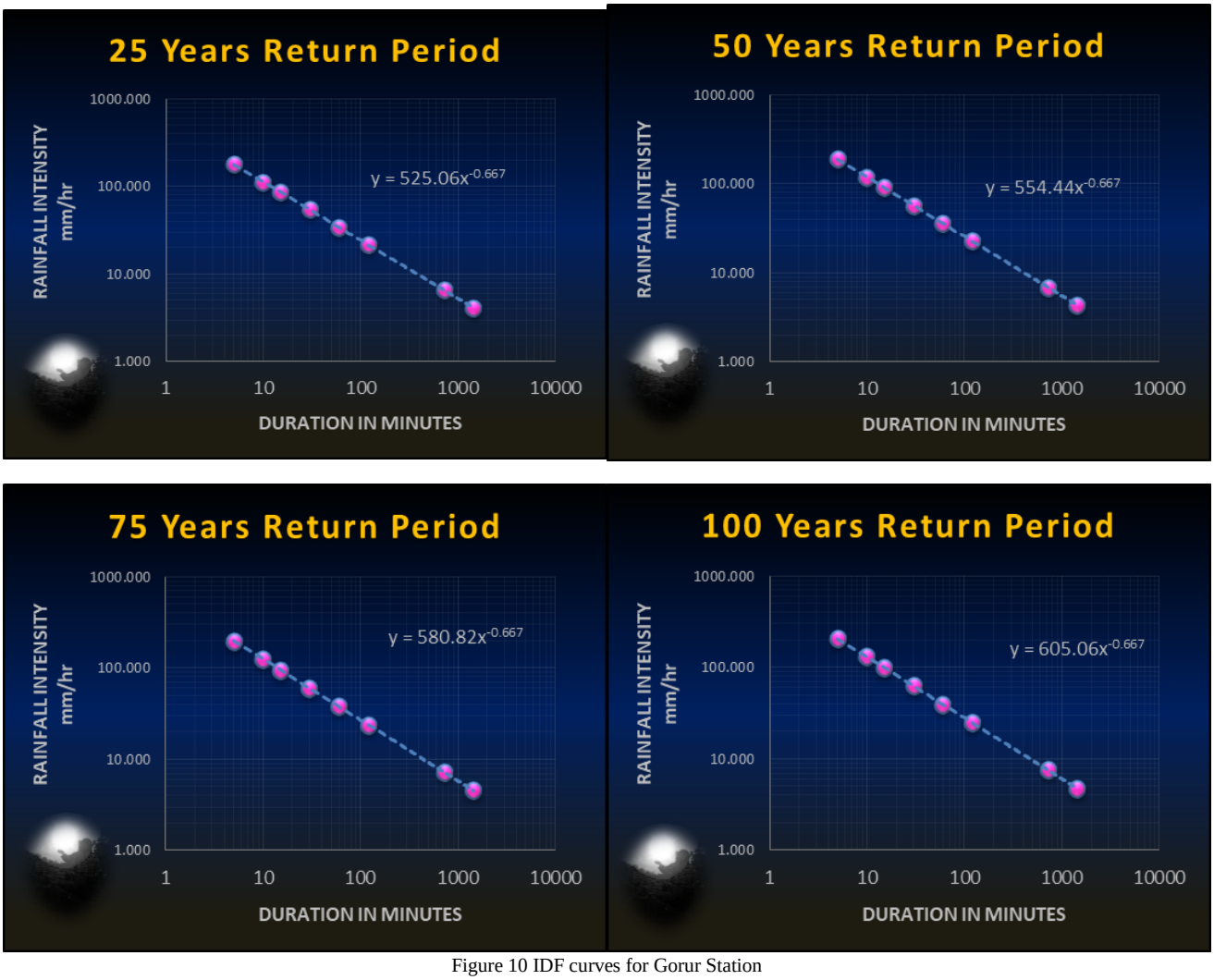
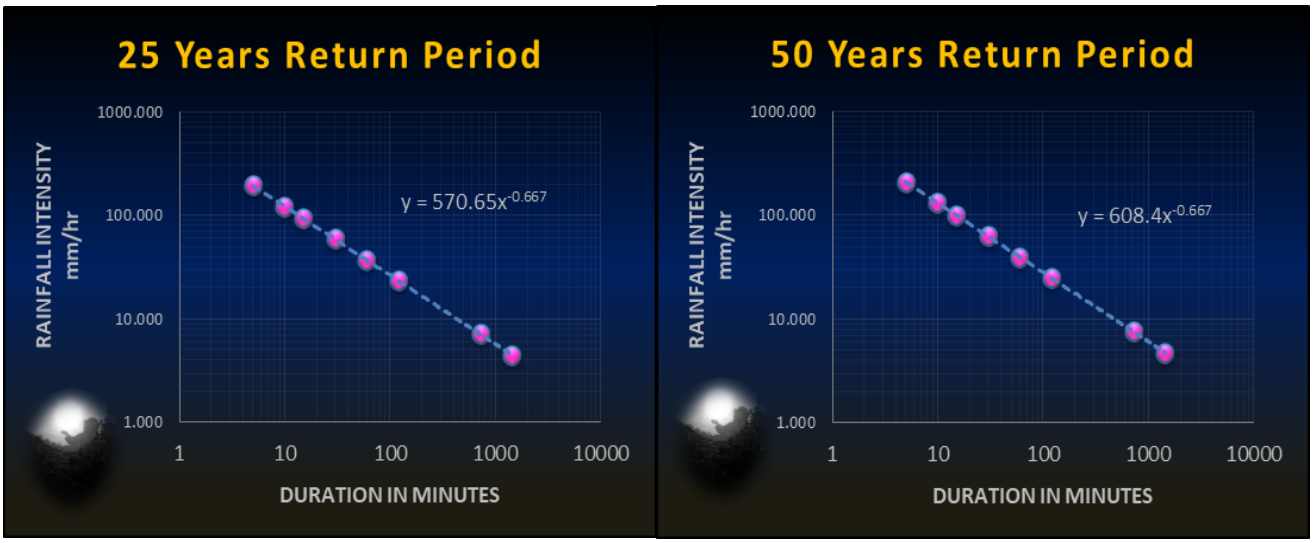


Figure 10 IDF curves for Gorur Station

Figure 11 IDF curves for Javali Station



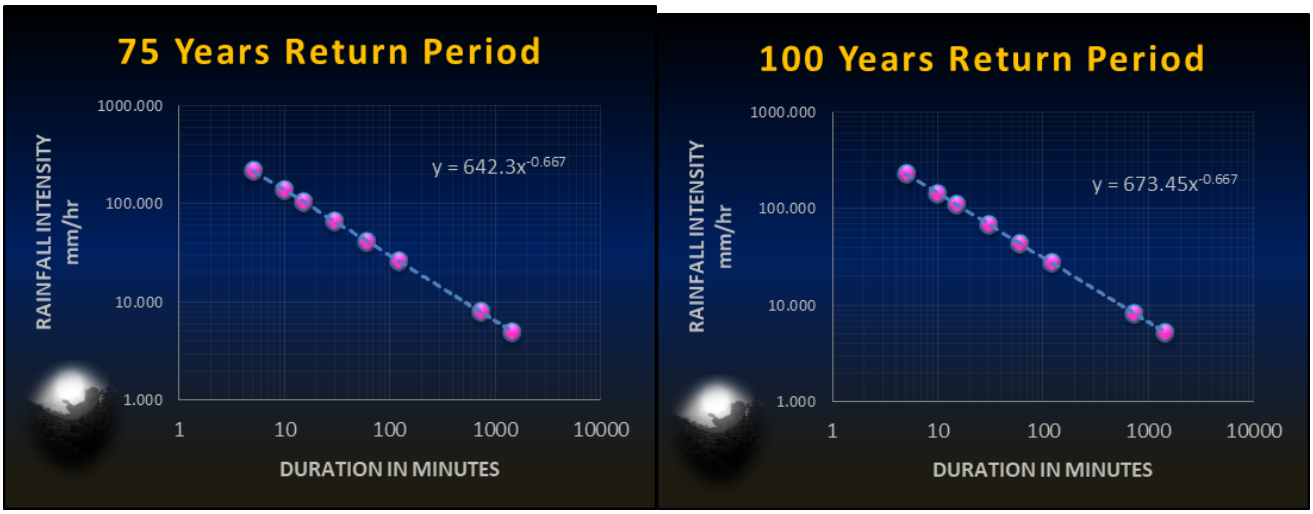


Figure 12 IDF curves for SalagameStation

Figure 13 IDF curves for Sakaleshpura Station

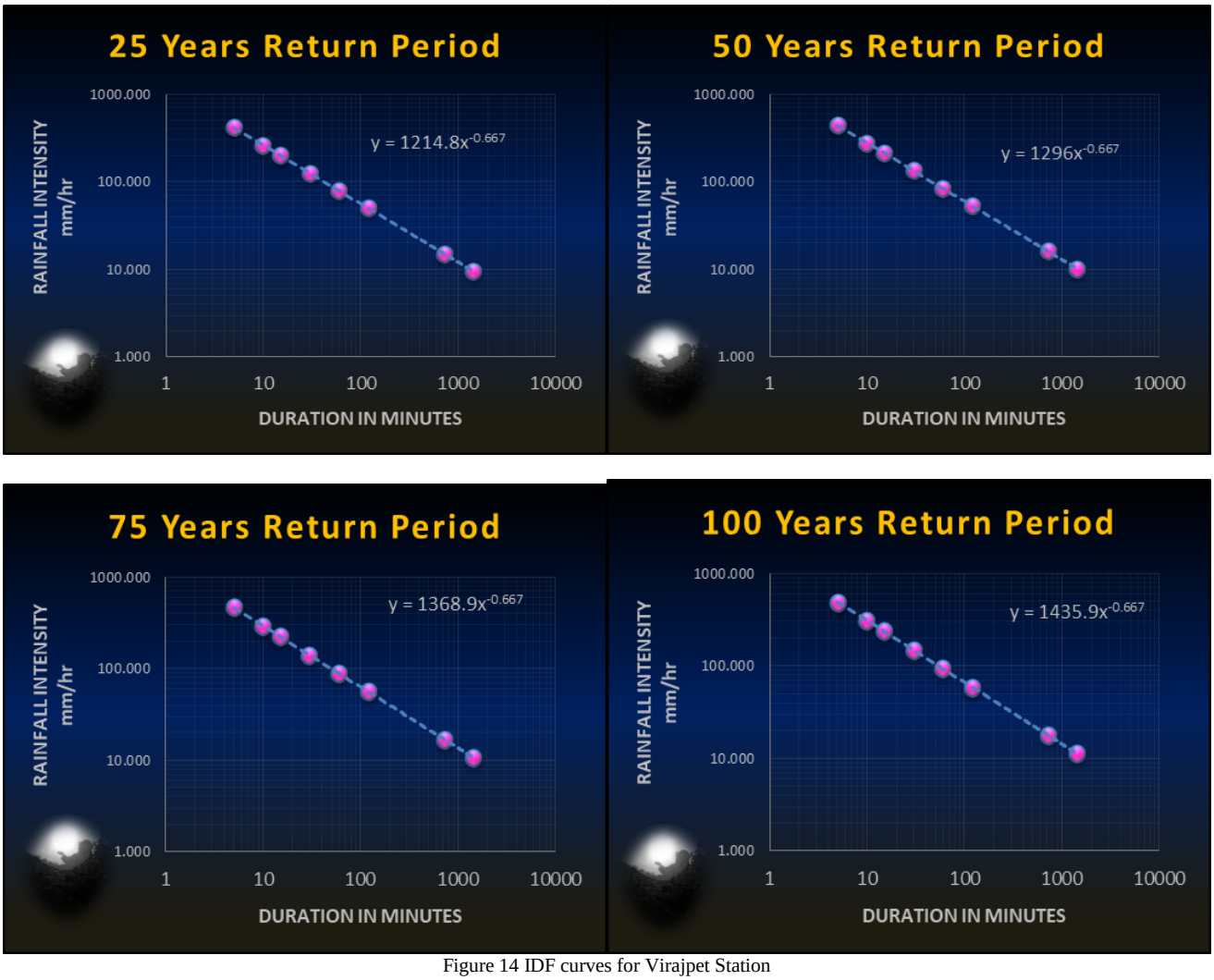
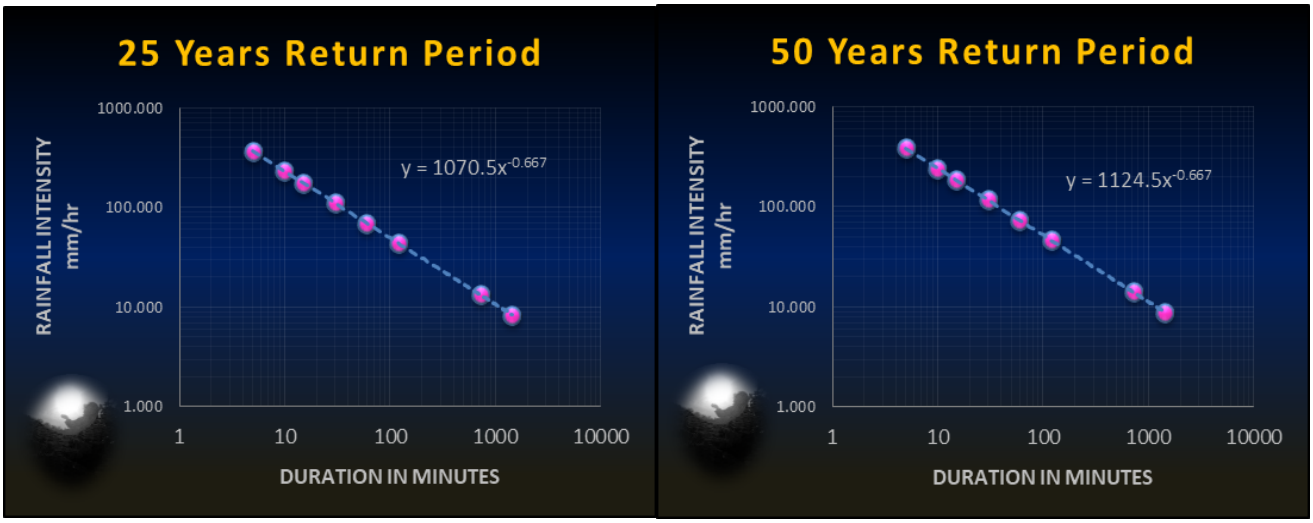


Figure 14 IDF curves for Virajpet Station



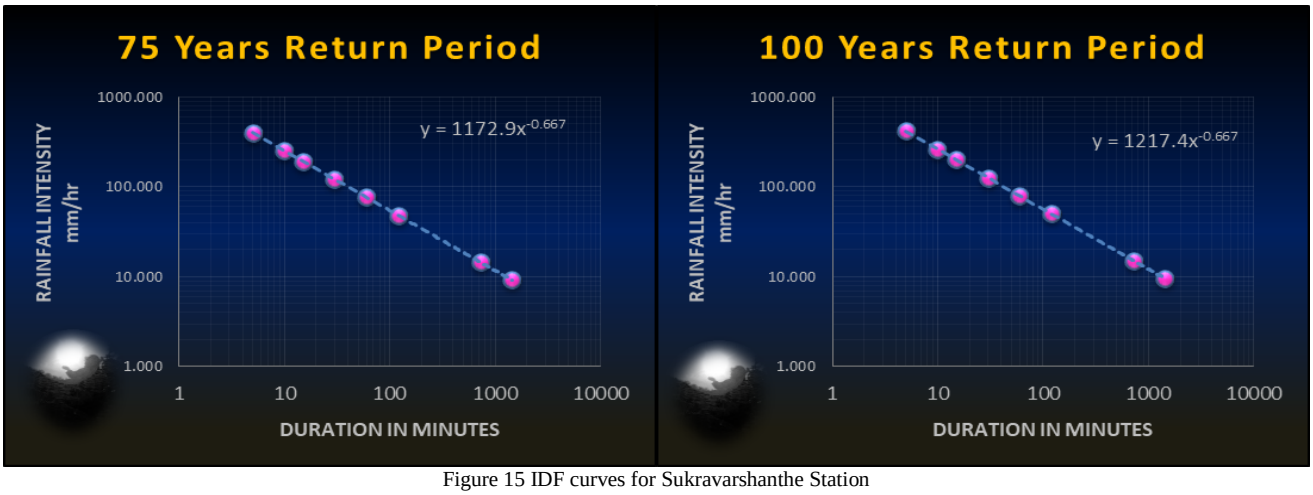


Figure 15 IDF curves for Sukravarshanthe Station

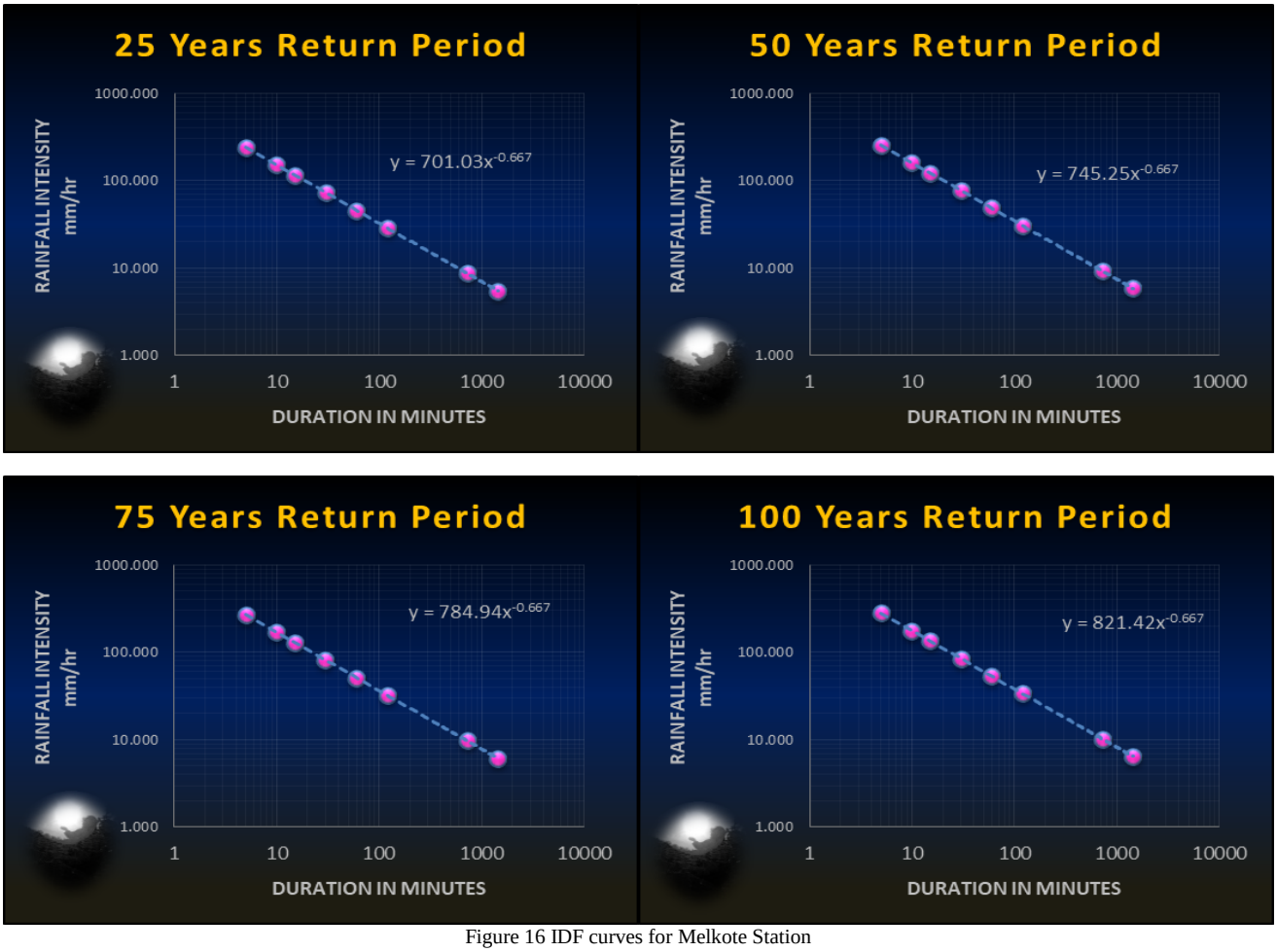


Figure 16 IDF curves for Melkote Station

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	530.6	683.4	763.2	848.3	940.3	952.7	998.1
Arkalgud	351.3	446.6	496.4	549.5	583.8	614.6	642.9
Basavapatna	334.1	419.2	463.7	511.1	541.8	569.3	594.5

Balagodu	435.0	575.6	649.6	727.5	778.1	823.5	865.8
Belur	390.5	508.9	570.7	636.7	679.3	717.6	752.7
Bettadapura	327.6	409.8	452.7	498.5	528.2	554.6	579.0
Bilur	869.3	1171.5	1329.4	1497.7	1606.5	1704.1	1793.8
Channenahally	359.3	466.9	523.1	583.1	621.8	656.6	688.5
Chikkamangalore	356.9	426.1	462.3	500.8	525.7	548.1	568.6
Doddabemmatti	270.6	324.6	352.9	382.0	402.5	419.9	436.0
Galibeedu	901.7	1081.3	1175.1	1275.1	1339.7	1397.7	1451.0
Gonibeedu	610.5	796.7	894.0	997.8	1064.8	1124.9	1180.2
Gorur	355.3	436.9	479.6	525.1	554.4	580.8	605.1
Hagare	343.6	433.8	480.9	531.2	563.6	592.8	619.6
Halekote	337.5	451.4	510.9	574.4	615.4	652.1	686.0
Hallibailu	814.9	978.0	1063.2	1154.1	1212.8	1265.4	1313.9
Hallimysore	345.5	408.1	440.8	475.6	498.1	518.3	536.9
Harangi	359.8	464.5	519.2	577.5	615.2	649.0	680.1
Hassan	391.0	485.4	534.8	587.4	621.4	651.9	679.9
Hosakere	1201.2	1445.5	1573.1	1709.2	1797.1	1876.0	1948.6
Hunsur	354.7	454.7	507.0	562.7	598.8	631.1	660.8
Javali	803.3	965.6	1050.5	1140.9	1199.3	1251.8	1300.0
Kenchammana hoskote	500.8	621.4	684.4	751.6	795.0	834.0	869.8
Krishnarajpet	373.4	447.7	486.6	528.0	554.8	578.8	600.9
Kushalnagar	329.5	398.2	434.1	472.3	497.1	519.2	539.6
Malalur	267.9	321.2	349.1	378.8	397.9	415.2	431.0
Mallipatna	370.8	434.1	467.2	520.5	525.2	545.7	564.5
Melkote	445.5	568.4	632.6	701.0	745.3	784.9	821.4
Naladi	1471.6	1887.5	2104.8	2336.5	2486.1	2620.4	2743.9
Nuggehalli	403.9	543.2	616.0	693.6	743.7	788.7	830.0
Periyapatna	341.7	415.2	453.9	495.0	521.5	545.3	567.2
Poonampet	756.0	1070.7	1235.2	1410.5	1523.8	1625.4	1718.9
Sakleshpura	631.0	801.6	890.7	985.8	1047.2	1102.3	1152.9
Salagame	352.5	457.4	512.2	570.7	608.4	642.3	673.5
Shantebachahalli	423.4	619.5	722.0	831.3	901.9	96525.0	1023.5
Shantigrama	316.9	405.6	451.9	501.4	533.3	562.0	588.3
Shravanabelagola	417.3	564.5	641.4	723.4	776.4	824.0	867.7
Siddapura	504.5	637.6	707.2	781.3	829.2	872.2	911.7
Srimangala	824.2	1062.2	1186.6	1319.3	1404.9	1481.8	1552.5
Sukravarashante	758.9	908.8	987.1	1070.5	1124.5	1172.5	1217.4
Talakavery	1385.9	1731.8	1912.6	2103.2	2229.7	2341.5	2444.2
Virajpet	745.5	971.2	1089.1	1214.8	1296.0	1368.9	1435.9
Yelawala	372.6	459.7	505.3	553.8	585.2	613.3	639.2

IV. CONCLUSIONS

The objective of the present study was to estimate the precipitation intensities and their uncertainties for durations of 5min, 10min, 15min, 30min, 60min,120min, 720min and 1440min and return periods of 2,5, 10, 25, 50, 75 and 100 years in the Upper Cauvery Karnataka India using Pearson type III Values . The conclusions drawn from this study were that; i) the extreme precipitation on the study area exhibited consistent trends, ii) the high intensity storms posing higher risk of damage to infrastructure and the environment are less frequent than low intensity storms. However, of critical concern is that their probability of over or under estimation (uncertainty) is higher. In the Upper Cauvery the development of IDF curves is crucial for storm water management and design of engineering infrastructures. Administrators and policy makers can use the IDF curves when planning development on the Upper Cauvery. Further studies should prioritize recording, storage and use of long-term precipitation data to develop IDF curves for other areas of the country, and at regional and continental levels. It is essential to understand and quantify the impacts of increased storm water and flooding on infrastructure and even on the environment. This is especially so under the context of climate change, where high intensity precipitation events are expected to increase in frequency and magnitude. Future work must also consider assessing the trends of urbanization, particularly removal of vegetation and infrastructure development, which make pervious surfaces to be impervious and changes the surface runoff characteristics of landscapes.

REFERENCE

[1]. Bell F. C., 1969, "Generalized rainfall-duration-frequency relationship", ASCE J. Hydraulic Eng., 95, 311–327.
[2]. Bernard, M. M., (1932), "Formulas for rainfall intensities of long durations". Trans. ASCE 6:592 - 624.
[3]. Bhaskar, N. R.; Parida, B. P.; Nayak, A. K. 1997. Flood Estimation for Ungauged Catchments Using the GIUH. *Journal of Water Resources Planning and Management., ASCE* 123(4): 228-238.
[4]. Chow V.T., D.R. Maidment and L.W.Mays, 1988, "Applied Hydrology", McGraw- Hill, Chapter 10 – Probability, Risk and Uncertainty Analysis for Hydrologic and Hydraulic Design: 361 – 398.
[5]. M. M. Rashid, 1 S. B. Faruque and 2 J. B. Alam 2012, "Modeling of Short Duration Rainfall Intensity Duration Frequency (SDRIDF) Equation for Sylhet City in Bangladesh.
[6]. Mohammed Badiuddin Parvez, M Inayathulla "Generation Of Intensity Duration Frequency Curves For Different Return Period Using Short Duration Rainfall For Manvi Taluk Raichur District Karnataka", International Research Journal of Engineering and Management Studies (IRJEMS), Volume: 03 Issue: 04 | April -2019.
[7]. Mohammed Badiuddin Parvez, M Inayathulla "Prioritization Of Subwatersheds of Cauvery Region Based on Morphometric Analysis Using GIS", International Journal for Research in Engineering Application & Management (IJREAM), Volume: 05 Issue: 01, April -2019. 4.
[8]. Mohammed Badiuddin Parvez, M Inayathulla "Modelling of Short Duration Isopluvial Map For Raichur District Karnataka", International Journal for Science and Advance Research in Technology (IJSART), Volume: 05 Issue: 4, April -2019.
[9]. Mohammed Badiuddin Parvez, M Inayathulla, "Rainfall Analysis for Modelling of IDF Curves for Bangalore Rural, Karnataka", International Journal of Scientific Research in Multidisciplinary Studies , Vol.5, Issue.8, pp.114-132, 2019
[10]. Mohammed Badiuddin Parvez, and M Inayathulla. "Generation of Short Duration Isohyetal Maps For Raichur District Karnataka" International Journal Of Advance Research And Innovative Ideas In Education Volume 5 Issue 2 2019 Page 3234-3242
[11]. Mohammed Badiuddin Parvez, and M Inayathulla. " Derivation Of Intensity Duration Frequency Curves Using Short Duration Rainfall For Yermarus Raingauge Station Raichur District Karnataka" International Journal of Innovative Research in Technology Volume 6 Issue 2 July 2019 Page 1-7
[12]. Mohammed Badiuddin Parvez, Chalapathi K and M Inayathulla. " Geomorphological Analysis of Two Mini-Watersheds in Raichur City Karnataka" International Research Journal of Engineering and Technology (IRJET) Volume 6 Issue 6 June 2019 Page 2896-2901

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