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INVESTIGATION OF DEPTH – AREA-DURATION CURVES FOR KOLAR TALUK REGION USING GEOSPATIAL APPROACH

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Abstract

Design rainfall values are generally expressed in the form of point rainfall values which is the rainfall depth at a location. In order to obtain areal average values for an area, hydrologists and engineers require techniques where by point rainfall amounts can be transformed to average rainfall amounts over a specified area. The study area chosen was Kolar Taluk Sub watersheds, Kolar District since it was found in the rocks and granite area of Karnataka state, India. The study area covers an area of 793.20 km2 and comprise of 24 sub watersheds. In the present study Daily rainfall data of Kolar Taluk was collected from statistical department M S Buildings, Bangalore. The isohyetal maps were developed by using the rainfall for a particular duration and return period by using spatial interpolation tool in software ArcGIS. The isohyetal map gives the spatial distribution of rainfall depth for Kolar Taluk Region. For the construction of DAD curves, the area between the contours were extracted from isohyetal maps from 5 stations with 25 years rainfall data using ArcGIS and the DAD curves were generated. Prepared curves will be used in designing structures for water resources to know the areal spread of rainfall within watershed and also to know the amount of high rainfall that may be expected over the catchment.

Keywords: Watershed, Rainfall, Isohyet Map, Depth – Area - Duration Curves

1. INTRODUCTION

Precipitation or rainfall is an important climatic parameter and the studies on rainfall are commonly hampered due to lack of continuous data in designing structures for water resources, one has to know the areal spread of rainfall within watershed. However, it is often required to know the amount of high rainfall that may be expected over the catchment. The rainfall depth is not proportional to the time duration of rainfall observation. Similarly, rainfall over a small area may be more or less uniform. But if the area is large, then due to the variation of rain falling in different parts, the average rainfall would be less than that recorded over a small portion below the high rain fall occurring within the area. Due to these facts, a Depth-Area-Duration

(DAD) analysis is carried out based on records of several storms on an area and, the maximum areal precipitation for different durations corresponding to different areal extents.

The purpose of preparing DAD curves is to determine maximum rainfall depth in part or all of drainage basin in different duration rainfall.

2. STUDY AREA DETAILS;

The study area chosen was Kolar Taluk Sub watersheds, Kolar District. The study area geographically lies between North latitude 12° 46' to 13° 58' and East Longitude 77° 21' to 78° 35'. The watershed area geographically covers an area of 793.20 Sq. km. The types of soils distributed range from red loamy soil to red sandy soil and lateritic soil. The topography of the district is undulating to plain. The central and eastern parts of the district forming the valley of Palar Basin, are well cultivated. The present study is intended to classify the land for its best suitability based on the various parameters which are derived from Survey of India (SOI) Toposheet 57 K/4, 57K/8, 57K/3,57G/15 and 57 G/16 on 1: 50,000 scale.

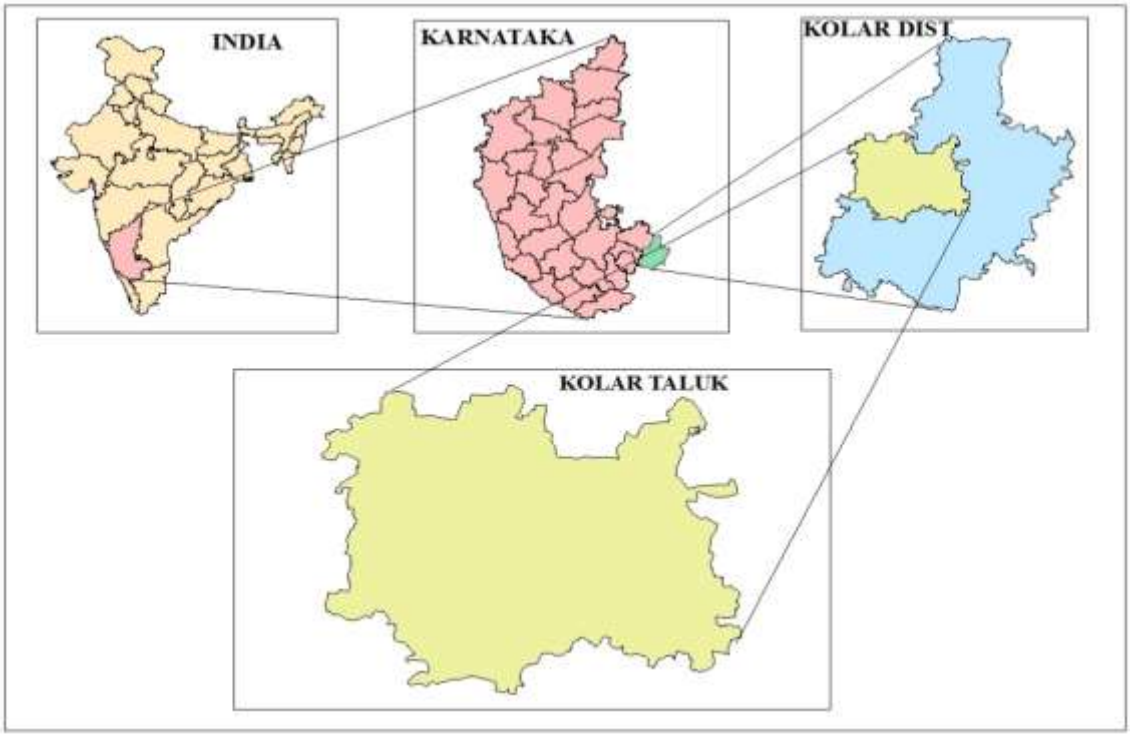


Fig.1 The Location of watershed in the study area

3. MATERIALS & METHODS

3.1 Delineation of Catchment

The catchment is delineated from Survey of India Toposheet bearing numbers 57 K/4, 57K/8, 57K/3,57G/15 and 57 G/16 on the scale of 1 : 50,000 by calculated by using using Arc GIS tool.
SOI Toposheets is collected from SOI Department, Koramangala, Bangalore.

3.2 Rainfall Data

Daily Rainfall data of Kolar Taluk was collected from Statistical Department MS Buildings, Bangalore for the construction of Depth –Area – Duration curves for Kolar Taluk.

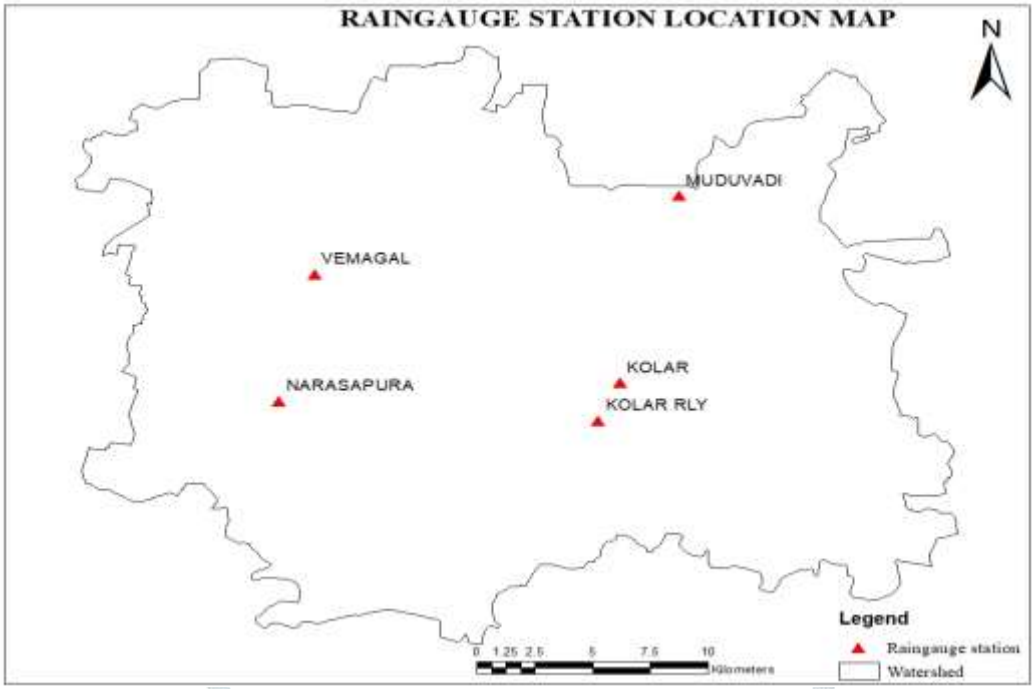


Fig. 2 Rain gauge stations map of the study area

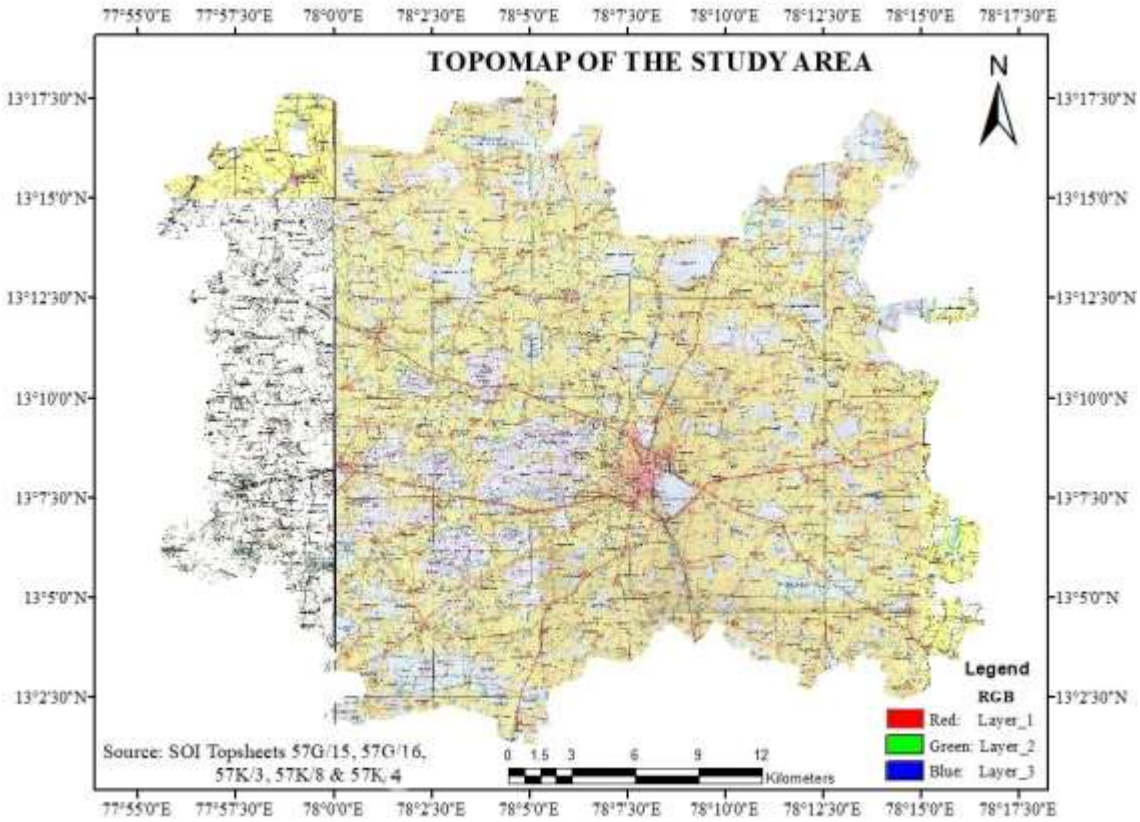


Fig. 3 SOI Topomap of the study area

3.3 Drawing of Isohyetal Maps

The rainfall depth for different short In this study isohyetal maps were constructed using software (ArcGIS 10.1). The isohyetal maps were generated for Kolar Taluk considering 5 stations with 25 years data, for various selected return periods such as 25,50,100 and 200 years based on design requirements. Considering lower return periods might not be appropriate considering the fact that, generally the life of a structure is more than 25 years. From the isohyetal maps, the rainfall depth for any location in Kolar may be estimated more easily and faster without having to go through the fitting probability distribution models all over again.
These are very useful for design and planning purposes. durations and return period can be predicted by using the different statistical distributions, which involves a time consuming procedure. And the procedure has to be repeated for different locations to get the spatial distribution of rainfall depths. This can be simplified by considering few stations and calculating the rainfall depths by using statistical procedures and generating the isohyetal maps. An isohyetal map gives the spatial distribution of rainfall depth in an area. These can be extensively used by hydrologist for planning purposes.

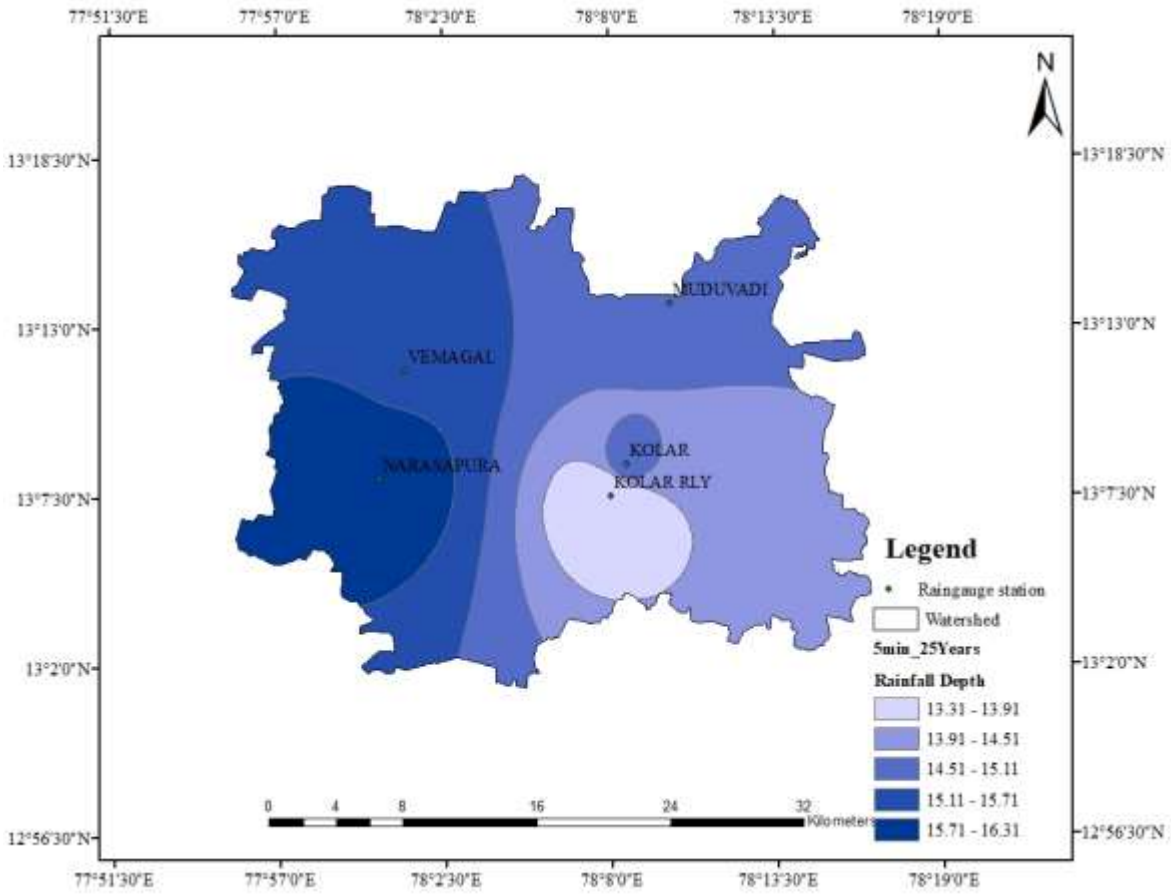


Fig.4 Isohyetal Map of Kolar Taluk for 5Mins_25Years Return

3.4 Depth – Area – Duration Curves

From the data of rainfall in different stations of the study area, the isohyetal map is prepared. Then the areas between the isohyets are extracted by using ArcGIS software (Version 10.1). Next the net incremental areas between two isohyets are calculated.

Then the average depth of rainfall between the two isohyets is the average of the two. The rainfall volume is then calculated by multiplying net incremental area by average rainfall. Thus the cumulative rainfall volume is determined. This cumulative volume is divided by the area enclosed between two isohyets to give the average rainfall in that area.

DAD curves are obtained by plotting the obtained average rainfall depth against areas.

Table1. Specimen Calculations for 5Mins_25 Years Return period.

Area (sq.km)	**Cu-Area (sq.km)**	**Rainfall Depth (mm)**	**Volume(Kmm^3)**	**Cu-Volume(Kmm^3)**	**Avg. Rainfall Depth (mm)**
55	55	13.61	742.3	742.3	13.50
116	171	16.01	1860.9	2603.2	15.20
198	370	14.21	2819.8	5423.0	14.95
207	576	14.81	3062.3	8485.3	14.72
217	794	15.41	3347.6	11832.9	14.91

Table2. Specimen Calculations for 5Mins_50 Years Return period.

Area (sq.km)	**Cu-Area (sq.km)**	**Rainfall Depth (mm)**	**Volume(Kmm^3)**	**Cu-Volume(Kmm^3)**	**Avg. Rainfall Depth (mm)**
57	57	13.6	775.1	775.1	13.60
114	171	16	1830.9	2606.0	15.20
202	373	14.8	2983.3	5589.3	14.98
204	577	14.2	2890.8	8480.1	14.71
217	793	15.4	3336.3	11816.4	14.90

Table3. Specimen Calculations for 5Mins_100 Years Return period.

Area (sq.km)	**Cu-Area (sq.km)**	**Rainfall Depth (mm)**	**Volume(Kmm^3)**	**Cu-Volume(Kmm^3)**	**Avg. Rainfall Depth (mm)**
58	58	13.6	782.7	782.7	13.49
114	172	16	1820.6	2603.3	15.15
200	372	14.8	2957.7	5560.9	14.96
206	577	14.2	2921.8	8482.7	14.69

216	794	15.4	3330.6	11813.4	14.88

Table4. Specimen Calculations for 5Mins_200 Years Return period.

Area (sq.km)	**Cu-Area (sq.km)**	**Rainfall Depth (mm)**	**Volume(Kmm^3)**	**Cu-Volume(Kmm^3)**	**Avg. Rainfall Depth (mm)**
55	55	13.6	748.0	748	13.60
115	170	16	1840.0	2588.0	15.22
200	370	14.8	2957.7	5545.7	14.99
207	577	14.2	2939.4	8485.1	14.71
216	793	15.4	3330.6	11815.7	14.90

Table5. Average rainfall depth calculations for 5mins duration & various return periods

Cu Area (sq.km)	**Average Rainfall Depth (mm)**			
	25Years	**50Years**	**100Years**	**200Years**
200	13.50	13.60	13.49	13.60
400	15.20	15.20	15.15	15.22
600	14.95	14.98	14.96	14.99
800	14.72	14.71	14.69	14.71
1000	14.91	14.90	14.88	14.90

Depth area duration curves were plotted for different duration and for various return periods by taking Area in sq.km along x – axis and average rainfall depth in mm along y – axis. The below figures shows the Depth - Area – Duration curves for various return periods.

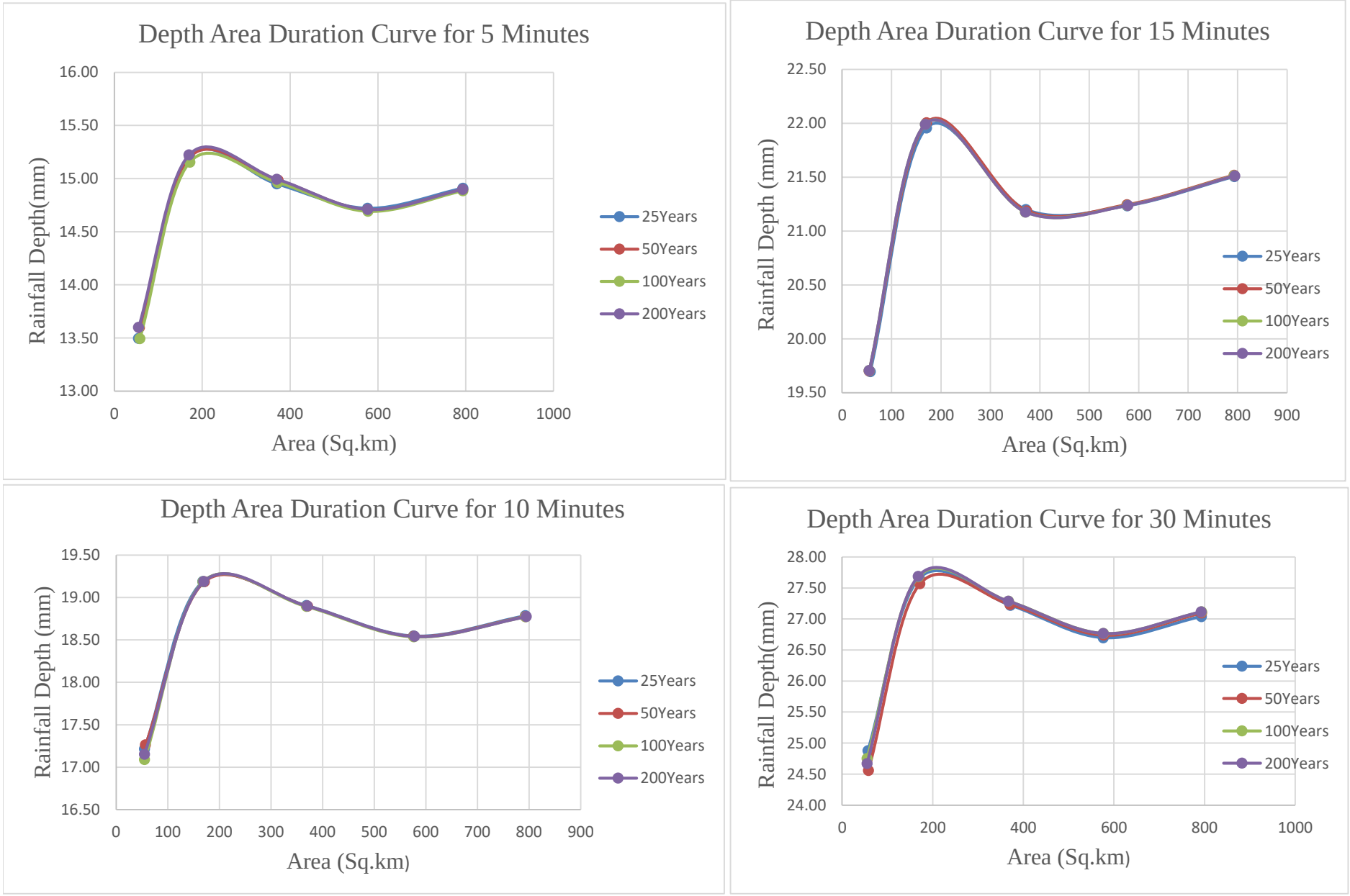
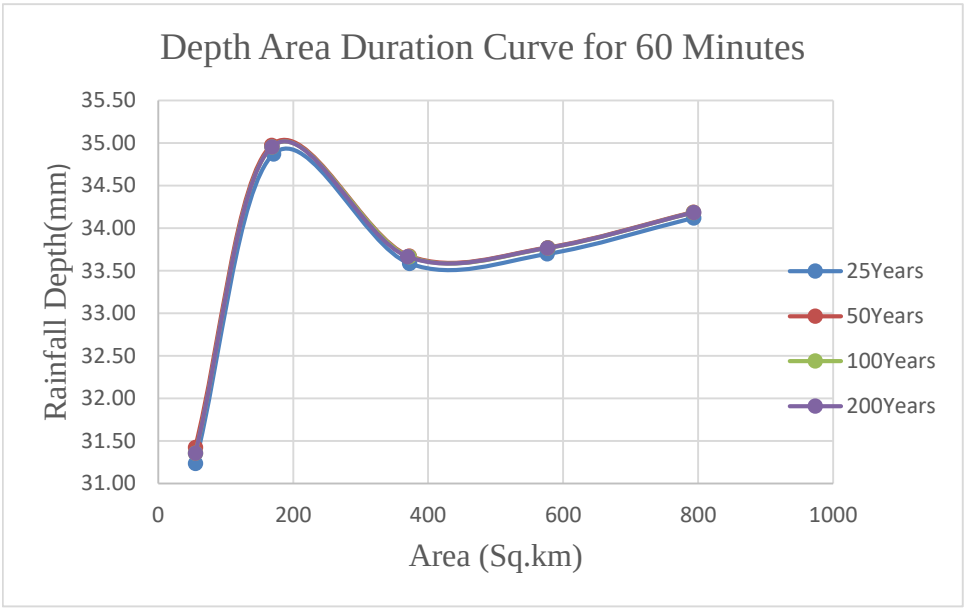
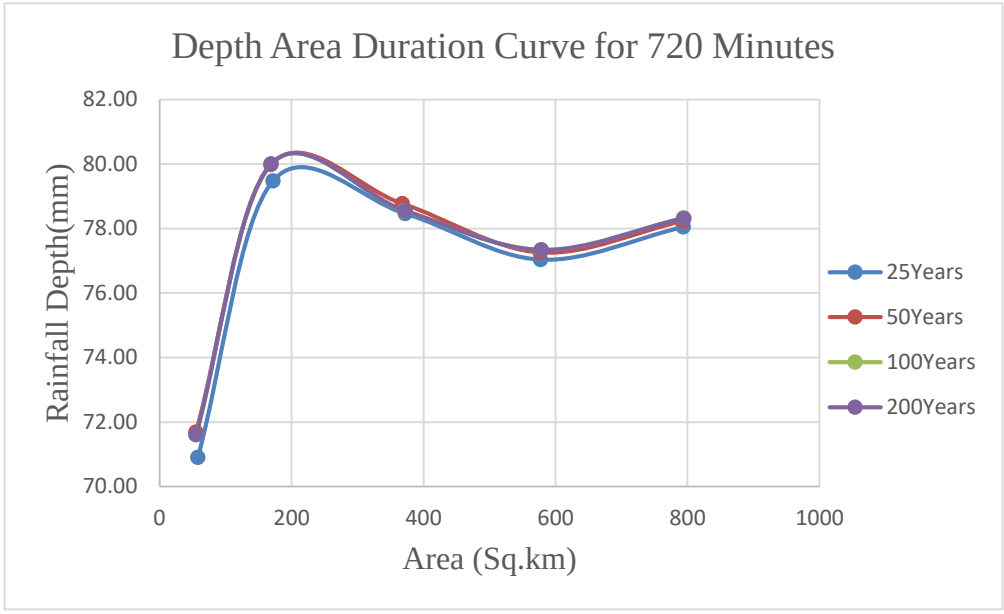
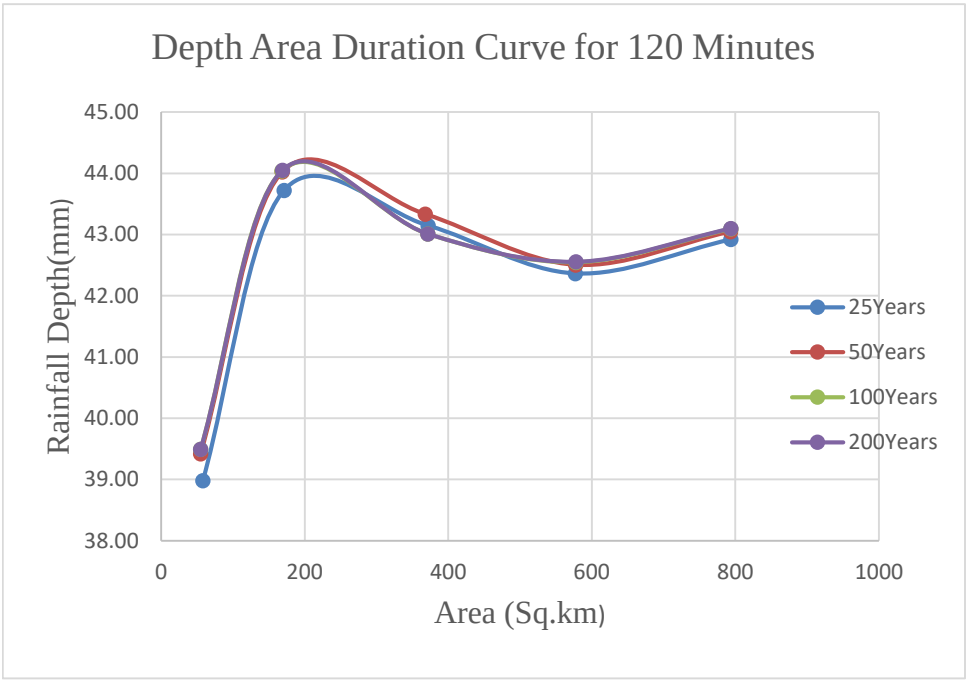


Fig. 5 DAD Curves for 5,10,15& 30 Minutes Duration







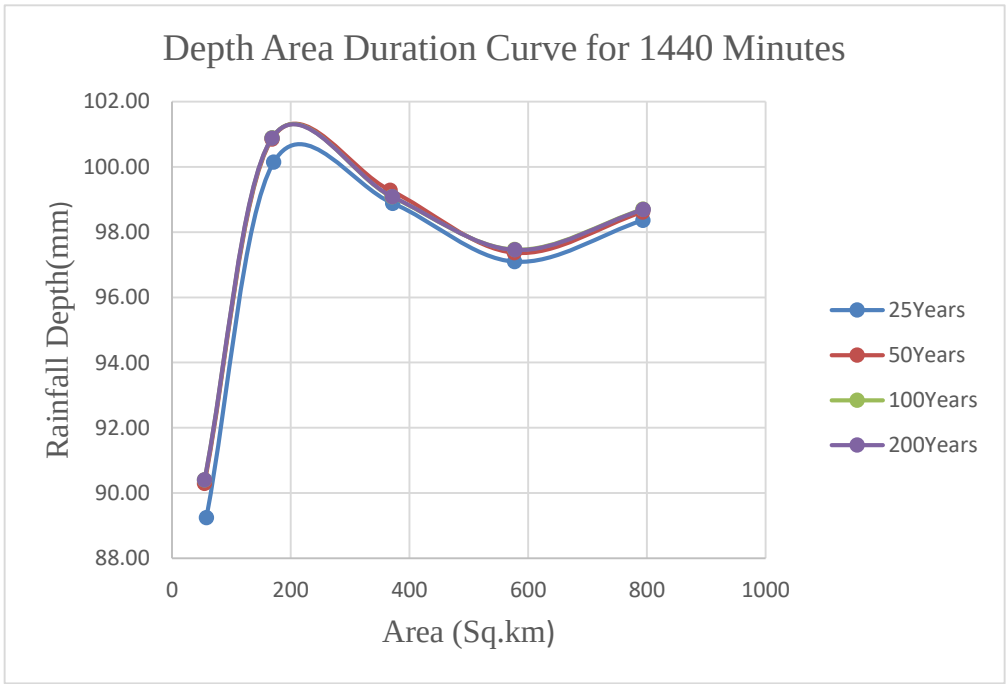


Fig.6 DAD Curves for 60,120,720& 1440 Minutes

4.0 Conclusion:

- The isohyetal maps help to estimation the rainfall depth at any location in the study area easily.
- DAD curves are plotted to understand the areal distribution of rainfall with respect to duration and to arrive the numerical values easily.
- This study helps in planning and design of any water resources project in study area specially the urban storm drainage management.

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