International Journal of Computational Engineering Research||Vol, 03||Issue, 6||

Construction of Theissen Polygons for Rain Gauge Stations in Anantapuram District

Dr. R. Bhavani,

Assistant Professor in Civil Engineering, JNTUA College of Engineering, Anantapuram

ABSTRACT

Anantapuram district is one of the drought affected districts in Andhra Pradesh and has semi arid type of climate. The spatial and temporal variability of rainfall in the district is high. It is necessary to adopt a suitable method to evaluate the applicable precipitation for water resources management. Computation of weighted precipitation considering all the influencing rain gauge stations of the catchment area is one of the suitable methods. Theissen polygon method can be used for finding the influencing zones of the rain gauge stations. In the present study an attempt has been made to construct Theissen polygons for all the existing 63 rain gauge stations in Anantapuram district so that the area influenced by each rain gauge station can be determined. It provides facility to estimate the weighted area for the proposals where ever necessary with in Anantapuram district.

KEY WORDS :*Influencing area, Isohyet, Perpendicular bisectors, Precipitation, Rain gauge station, Theisssen polygon and Weighted area.*

I. INTRODUCTION

The definition of precipitation is, any form of water, liquid or solid falling from the sky. It includes rain, sleet, snow, hail and drizzle plus a few less common occurrences such as ice pellets, diamond dust and freezing rain. In cold air way up in the sky, rain clouds will often form. Rising warm air carries water vapor high into the sky where it cools, forming water droplets around tiny bits of dust in the air. Some vapor freezes into tiny ice crystals which attract cooled water drops. The drops freeze to the ice crystals, forming larger crystals we call snowflakes. When the snowflakes become heavy, they fall. When the snowflakes meet warmer air on the way down, they melt into raindrops**.**Hanefi Bayraktar et.al., used the percentage weighting polygon (PWP) method to estimate average areal rainfall in Southeastern Anatolia Region of Turkey for the first time by considering 10 meteorological stations. In a paper entitled “A comparative analysis of techniques for spatial interpolation of precipitation” by Guillermo Q. Tabios III et.al., various proposed interpolation techniques for estimating annual precipitation at selected sites were compared and It has been concluded that the inverse distance interpolation and the Thiessen polygon gave fairly satisfactory results when compared to the polynomial interpolation technique. Precipitation will be measured at different rain gauge stations by ordinary rain gauges or self recording rain gauges. In order to find the applicable precipitation over an area consisting of more number of rain gauge stations, some methods like arithmetic mean method, Theissen polygon method and Isohyetal methods are available.

1.1 Arithmetic mean method

In this method the rainfall values at different rain gauge stations that are existing in a particular area are to be added and divided by the total number of rain gauge stations to get the average value of rainfall for that particular area.

1.2 Theissen polygon method

An accurate estimation of the spatial distribution of rainfall can be done by using Theissen polygon method which is one of the interpolation methods. This method assigns weight at each gauge station in proportion to the catchment area that is closest to that gauge station.

The polygons can be constructed as follows:

[1] First the rain gauge stations are to be located.
[2] Lines are to be drawn to connect the adjacent stations.
[3] Perpendicular bisectors are to be drawn for all the lines joining the rain gauge stations.

[4] The bisectors are to be extended to form the polygon around each gauge station.
[5] The area of each polygon must be multiplied by the rainfall value of the station that is existing inside the polygon.

The values obtained from step 5 are to be added and divided by total catchment area to get the weighted precipitation.

1.3 Isohyetal method :

An isohyet is a line joining points of equal rainfall magnitude. The isohyets of various rainfall values are to be drawn. The area between two adjacent isohyets are to be determined and if the isohyets go out of the catchment the catchment boundary is to be taken as the bounding line. For every pair of isohyets the average rainfall value is to be determined and it should be multiplied with the area that is surrounded by these two isohyets. And a set of such values are to be determined. All these values are to be added and divided by the total area to get the average value of rainfall.

1.4 An overview of the above methods :

An overview of the advantages and limitations of the above techniques of assessing applicable precipitation for water resources projects are.

a) Arithmetic mean method gives equal importance to all the rain gauge stations irrespective of their location and magnitude of precipitation. In general, the rain gauge stations may not be evenly positioned and the magnitude of precipitation may vary from place to place. Hence Arithmetic mean method may not be suitable.
b) In case of Isohyetal method, the Isohyets are to be drawn for every situation as the magnitude of precipitation varies from time to time and hence it can not be standardized.
c) Theissen polygon method provides the influencing areas of the existing rain gauge stations and hence a polygon for a particular region can be standardized.

II. CASE STUDY :

Anantapuram district is lying between 76° 45′ East longitude to 78° 30′ East longitude and between 13° 40′ North latitude to 15° 15 ′ North latitude. The geographical area of the district is 19134.772 sq. km. The total number of rain gauge stations existing in the district, are 63. The locations of all the 63 rain gauge stations are identified on plan and lines are drawn to connect the adjacent stations. Perpendicular bisectors are drawn for all the lines joining the rain gauge stations and are extended to form the polygon around each gauge station. A map showing the locations of rain gauge stations and the construction lines for Theissen polygon is given in figure 1.

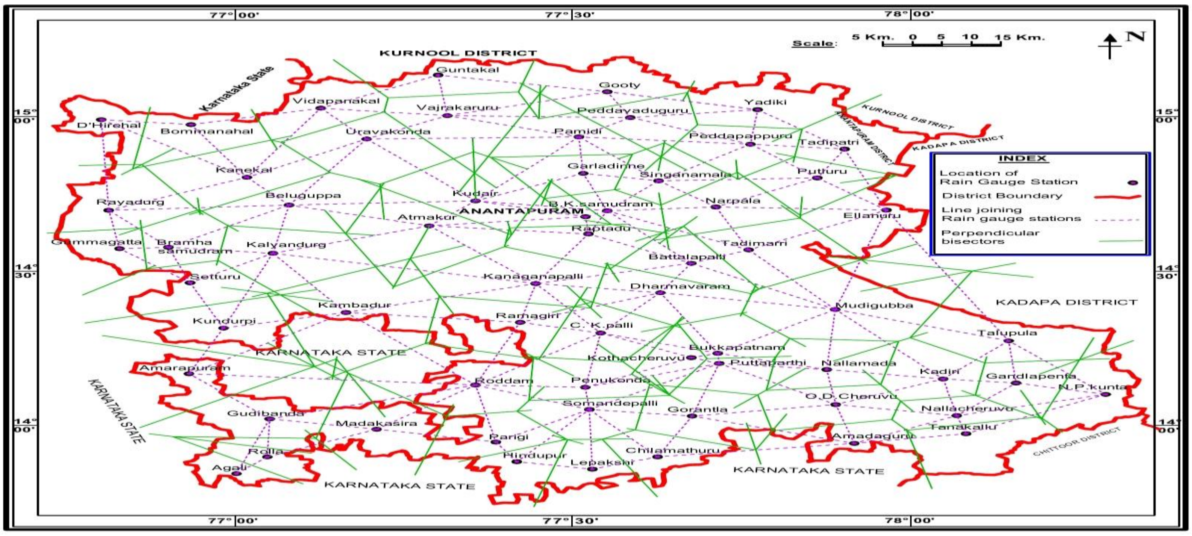

Figure 1 : Map showing the locations of rain gauge stations and construction lines for Theissen polygons in Anantapuram district

By adopting the above procedure, Theissen polygons for all the rain gauge stations in the district are constructed and are shown in figure 2.

Table 1. Influencing areas of rain gauge stations in Anantapuram district

S No.	Name of the rain gauge station	Influencing area (Sq. km)	% area Influence in total area	S No.	Name of the rain gauge station	Influencing area (Sq. km)	% area Influence in total area	S No.	Name of the rain gauge station	Influencing area (Sq. km)	% area Influence in the total area
1	Anantapuram	125.700	0.657	23	Battalapalli	268.604	1.404	45	Amarapuram	172.445	0.901
2	Rapthadu	288.124	1.506	24	C.K. Palli	315.747	1.650	46	Gudibanda	268.711	1.404
3	Garladinne	269.714	1.410	25	Kanaganapalli	473.935	2.477	47	Rolla	182.689	0.955
4	Atmakur	543.614	2.841	26	Ramagiri	296.005	1.547	48	Agali	111.072	0.580
5	Kuderu	436.075	2.279	27	Kalyanadurgam	448.836	2.346	49	Hindupuram	198.528	1.037
6	Singanamala	260.242	1.360	28	Beluguppa	420.425	2.197	50	Parigi	223.631	1.169
7	B.K. Samudram	151.677	0.793	29	Kambadur	456.794	2.387	51	Lepakshi	187.635	0.981
8	Narpala	327.036	1.709	30	Kundurpi	305.604	1.597	52	Chilamattur	228.893	1.196
9	Tadipatri	319.787	1.671	31	Brahmasamudram	240.500	1.257	53	Gorantla	352.803	1.844
10	Yadiki	384.016	2.007	32	Setturu	265.056	1.385	54	Kadiri	299.213	1.564
11	Peddapappur	297.976	1.557	33	Rayadurgam	373.267	1.951	55	Mudigubba	627.216	3.278
12	Putluru	289.083	1.511	34	D. Hirehal	190.147	0.994	56	Nallamada	353.508	1.847
13	Yellanur	293.657	1.535	35	Gummagatta	170.671	0.892	57	N.P. Kunta	303.598	1.587
14	Guntakal	264.337	1.381	36	Kanekal	452.563	2.365	58	Talupula	437.34	2.286
15	Gooty	385.665	2.015	37	Bommanahal	304.873	1.593	59	Nallacheruvu	202.087	1.056
16	Pamidi	316.199	1.652	38	Penukonda	286.960	1.500	60	O.D. Cheruvu	318.332	1.664
17	Peddavadaguru	257.057	1.343	39	Somandepalli	263.930	1.379	61	Tanakal	355.378	1.857
18	Uravakonda	439.918	2.299	40	Roddam	301.033	1.573	62	Amadaguru	179.425	0.938
19	Vajrakarur	416.702	2.178	41	Puttaparthi	173.695	0.908	63	Gandlapenta	255.802	1.337
20	Vidapanakal	310.796	1.624	42	Kothacheruvu	192.082	1.004		**Total**	**19134.772**	**100**
21	Dharmavaram	375.196	1.961	43	Bukkapatnam	219.602	1.148				
22	Tadimarri	394.660	2.062	44	Madakasira	308.906	1.614				

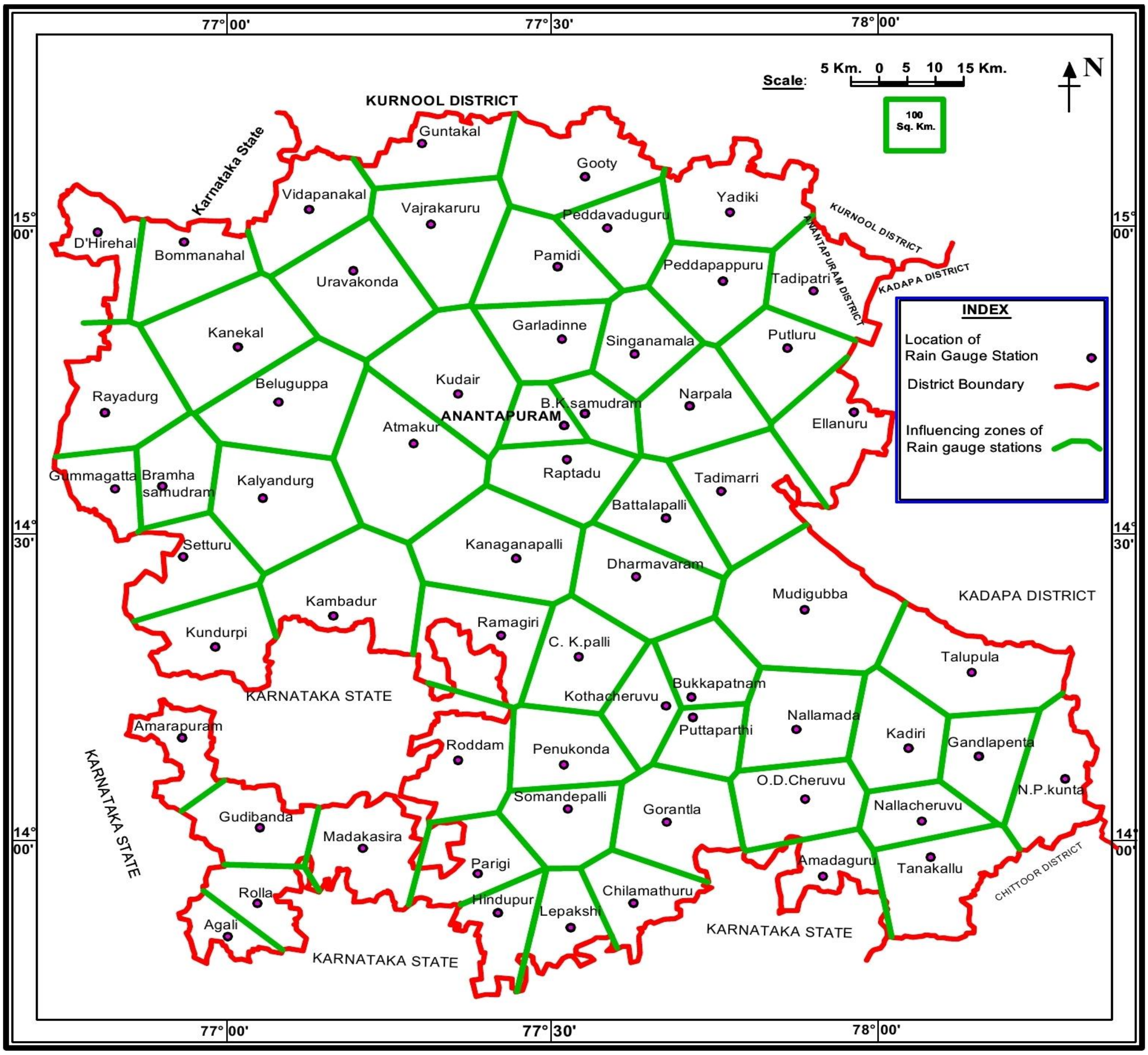

Figure 2 : Map showing Theissen polygons of rain gauge stations in Anantapuram district.

III. RESULTS :

From figure 2, the influencing area of each rain gauge station is obtained and the corresponding percentage area in the total geographical area of the district is computed. These details are presented in table 1.

Conclusions Figure 2 and Table 1 can be readily used for computation of weighted precipitation as long as the number and locations of rain gauge stations are not changed.

1. The weighted precipitation can be computed for a specified location and for the entire district for a specified period.

REFERENCES:

[1] Guillermo Q. Tabios III, Jose D. Salas, A comparative analysis of techniques for spatial interpolation of precipitation, jawra Journal of the American Water Resources Association, Volume 21, Issue 3, pages 365–380, June 1985.

[2] Hanefi Bayraktar, F. Sezer Turalioglu, Zekai Şen, The estimation of average areal rainfall by percentage weighting polygon method in Southeastern Anatolia Region, Turkey, Volume 73, pp 149-160, issues1-2, Jan 2005.

[3] Jaya Rami Reddy. P, A textbook of Hydrology, 2nd edition, Laxmi publications (P) LTD, New Delhi.

[4] K.Subramanya, Engineering Hydrology, 3rd edition, The McGraw-Hill Publishing Company Ltd, New Delhi.

[5] Warren Viessman, Jr. Gary L. Lewis, A text book of Introduction to Hydrology, 5th edition, Prentice-Hall of India Private Limited, New Delhi, 2008.