

Computation of average rainfall over a Basin:-

In order to compute the average rainfall over a basin or catchment area, the rainfall is measured at a number of rain-gauge stations suitably located in the area.

Number of rain gauge stations depend upon the area and distribution of rainfall.

If the basin or catchment area contains more than one rain gauge station, the computation of average rainfall may be done by the following methods:

- (1) Arithmetic Average Method.
- (2) Thiessen Polygon Method.
- (3) Isohytel Method.

(1) Arithmetic Average Method:-

- * Simplest method of estimating average rainfall.
- * Average rainfall is calculated by arithmetic average of recorded rainfall at various stations.
- * If $P_1, P_2, P_3, \dots, P_n$ are the rainfall values measured at n number of gauge stations

$$P_{av} = \frac{P_1 + P_2 + P_3 + \dots + P_n}{n} = \frac{\sum_{i=1}^n P_i}{n}$$

- * This method is suitable when the rainfall is uniform.

Problem:- Using Arithmetic Average Method, find average rainfall over a Catchment - The rain gauge data is 12.6, 18.8, 14.8, 10.4 and 16.2 mm

Solution:-

$$P_{av} = \frac{P_1 + P_2 + P_3 + \dots + P_n}{n}$$

$$P_{av} = \frac{12.6 + 18.8 + 14.8 + 10.4 + 16.2}{5}$$

$$P_{av} = \frac{72.8}{5}$$

$$P_{av} = 14.56 \text{ mm}$$

(2) Thiessen Polygon Method:-

Rainfall recorded at each station is given a weightage based on the area closed to the station -

Consider a catchment area with say, 3 rain gauge stations - Let there be 3 stations outside the catchment, but in its neighborhood -

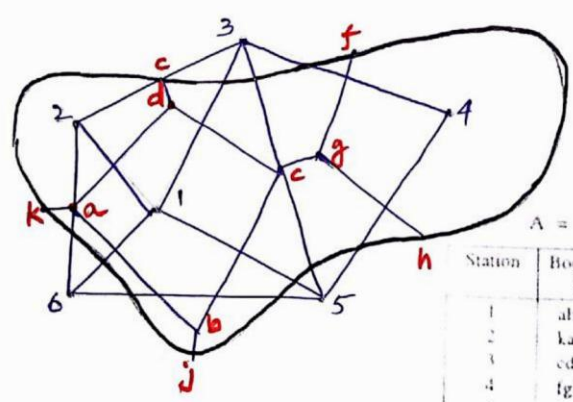
The catchment area is drawn to scale and the position of these 6 stations are plotted on it - These 6 stations are joined as to get a network of triangles -

Perpendicular bisectors are drawn to each of the sides of these triangles - These bisectors form a polygon around each station -

If the boundary of the catchment cuts the bisectors then the boundary is taken as the outer limit of the polygon -
 These bounding polygons are called Thiessen Polygons.
 The area of these polygons is measured with a planimeter -

Let suppose if there are n stations with rainfall values $P_1, P_2, P_3 \dots P_n$ and $A_1, A_2, A_3 \dots A_n$ are the areas of respective Thiessen polygons, the average rainfall over the catchment P is computed as:

$$P = \frac{P_1 A_1 + P_2 A_2 + P_3 A_3 \dots P_n A_n}{A_1 + A_2 + A_3 \dots A_n} = \sum_{i=1}^n \frac{P_i A_i}{A}$$



A = total catchment area

Station	Bounded by	Area	Weightage
1	abcd	A_1	A_1/A
2	kade	A_2	A_2/A
3	cdefg	A_3	A_3/A
4	igh	A_4	A_4/A
5	hgcbj	A_5	A_5/A
6	jbak	A_6	A_6/A

Figure: Thiessen Polygon

Problem:-

Using Thiessen Polygon Method, Find average rainfall over a Catchment. The data is

Rain gauge station	A	B	C	D	E
Polygon Area (km ²)	40	45	38	30	43
Precipitation (mm)	30.8	33.4	34.6	32.6	24.6

Solution:-

Rain gauge Station	Polygon Area (km ²) "A"	Precipitation P (mm)	A x P (km ² .mm)
A	40	30.8	1232
B	45	33.4	1503
C	38	34.6	1314.8
D	30	32.6	978
E	43	24.6	1057.8
Sum	193		6085.6

$$P_{av} = \frac{\sum (A \times P)}{\sum A} = \frac{6085.6}{193}$$

$$P_{av} = 31.53 \text{ mm} \quad \text{Ans.}$$

(3) Isohytel Method

Isohyet - It is a line joining points of equal rainfall magnitude.

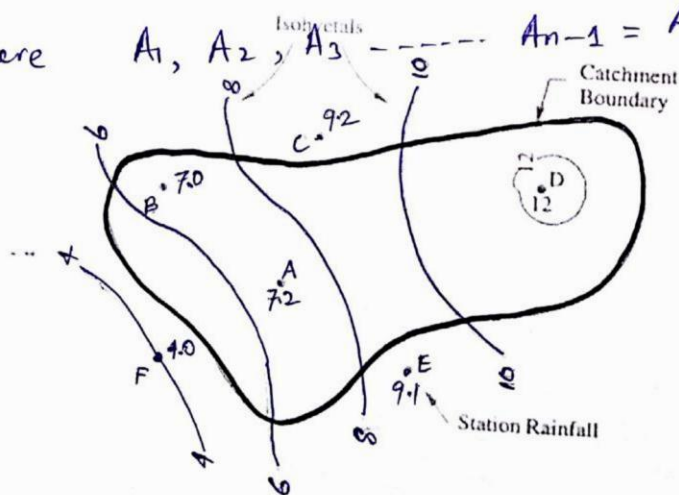
An isohyetal map is the map showing contours of equal rainfall presents a more accurate picture of the rainfall distribution -

The area between adjacent isohyets is measured using a planimeter.

If the rainfall values corresponding to the isohyets are $P_1, P_2, P_3, \dots, P_n$ and $A_1, A_2, A_3, \dots, A_{n-1}$ are the corresponding inter isohyetal areas, the average rainfall over the catchment is computed as -

$$P = \frac{A_1 \left(\frac{P_1 + P_2}{2} \right) + A_2 \left(\frac{P_2 + P_3}{2} \right) + \dots + A_{n-1} \left(\frac{P_{n-1} + P_n}{2} \right)}{A_1 + A_2 + A_3 + \dots + A_{n-1}}$$

Where $A_1, A_2, A_3, \dots, A_{n-1} = A$.



Problem:- Using Isohyetal Method, find average rainfall over a catchment. The data is

Isohyetes (cm)	12	13	14	15	16	17
Area b/w Isohyetes (km ²)	22	80	110	89	70	
Average precipitation (cm)	12.5	13.5	14.5	15.5	16.5	

Isohytes (cm)	Area b/w Isohyetes (km ²)	Average precipitation (P ₁ +P ₂)/2	Product A x $\frac{P_1+P_2}{2}$
12	22	12.5	275
13	80	13.5	1080
14	110	14.5	1595
15	89	15.5	1379.5
16	70	16.5	1155
17			
Sum	371		5484.6

$$P = \frac{\sum A \times \frac{P_1+P_2}{2}}{\sum A} = \frac{5484.6}{371}$$

$$P = 14.78 \text{ cm}$$