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Letters to the Editor

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THE ESTIMATION OF CATCHMENT RAINFALL USING POLYNOMIAL METHOD

The usual techniques of estimting areal rainfall such as polygon, isohyetal method is valued considerable degree of subjectivity. Moreover, due to preparation of charts and diagrams, these techniques may not provide rapid results required for catchment modelling.

The polynomial technique depends on the presumption that point rainfall can be expressed as a polynomial function of its location vector. This is obviously valid considering the spatial variation of point rainfall.

Consider that the rainfall (r) at point (x, y) is expressed as a second degree polynomial of x and y.

$$r = a_1 x + a_2 x^2 + a_3 xy + a_4 y + a_5 y^2 + a_6 \qquad (1)$$

consider a rectangular area O (0, 0), A (a, 0), B(a, b) and C (0, b), which represents the catchment satisfactorily.

Let, $P_1 = \int_0^a \int_0^b x\,dx\,dy$

$P_2 = \int_0^a \int_0^b x^2\,dx\,dy$

$P_3 = \int_0^a \int_0^b xy\,dx\,dy$

$P_4 = \int_0^a \int_0^b y\,dx\,dy$

$P_5 = \int_0^a \int_0^b y^2\,dx\,dy$

$P_6 = \int_0^a \int_0^b dx\,dy$

(0, b)	(a, b)
C	B
O	A
(0, 0)	(a, 0)

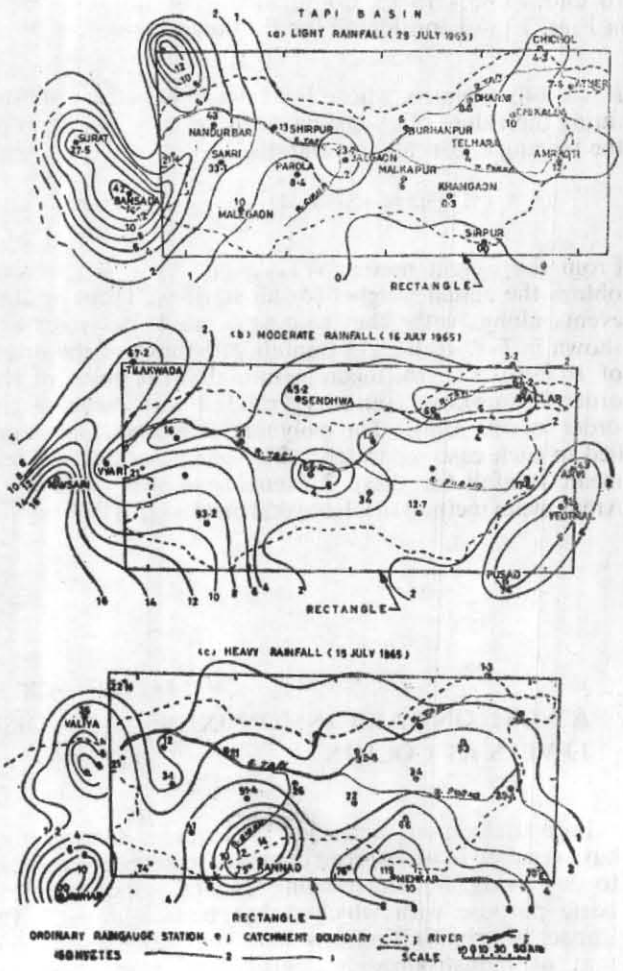
The volume of rainfall over the area will be

$V = a_1P_1 + a_2P_2 + \ldots\ldots\ldots\ldots + a_nP_n$ in matrix notations

$$V = P.A \qquad (2)$$

where, $A = (a_1\ a_2 \ldots\ldots\ldots a_n)$ and $P = (P_1, P_2 \ldots . P_n)$. The rainfall at n points gives a system of n equations of the form (1) which may be expressed as

$$R = FA \qquad (3)$$



Figs. (a-c). Isohyetal patterns of rainstorm (a) 29 July 1965 — A case of light rainfall, (b) 15 July 1965 — A case of moderate rainfall and (c) 15 July 1965 — A case of heavy rainfall

where, $R = (r_1, r_2 \ldots\ldots\ldots\ldots r_n$.

$$F = \begin{bmatrix} f_{11}, f_{12} \ldots\ldots\ldots\ldots f_{1n} \\ f_{21}, f_{22} \ldots\ldots\ldots\ldots f_{2n} \\ \ldots\ldots\ldots\ldots\ldots\ldots \\ \ldots\ldots\ldots\ldots\ldots\ldots \\ f_{n1}, f_{n2} \ldots\ldots\ldots\ldots f_{nn} \end{bmatrix}$$

From (3), $F'.FA = F'R \quad \therefore \quad A = (F'F)^{-1} F'R$

From (2), $V = P(F'F)^{-1} F'R$

The actual weights can be obtained by dividing the proportional values by their sum. In that case we get the mean catchment rainfall.

$$\overline{R} = W.R \qquad (4)$$

Tapi catchment (area 62272 km² between Lat. 20°5′-22° 10′ and. 73°45′- 75°15 ′Long). having 14 stations (shown in Figs. 1 (a-c) considered for the computations.

F is a 14×6 matrix whose rows are obtained by substituting the values of co-ordinates in respect of origin of the rectangle for all 14 stations in

$$F = (x, x^2, xy, y^2, y, 1) \quad .. \quad .. \quad 14 \times 6$$

From the weight matrix $WT = P(F'F)^{-1} F'$, we can obtain the actual weights for all stations. Three rainfall events along with the rectangles and isohyetes are shown in Fig. 1(a)(Light rainfall with mean of the order of 10 mm), Fig.1(b)(medium rainfall with mean of the order 25 mm),Fig. 1(c)(heavy rainfall with mean of the order of 40 mm). The polynomial method was applied to each case separately. The computations of areal mean rainfall for these 3 events have been made by (*i*) Areal mean method (*ii*), Isohyetal method (*iii*) Polynomial method. The results are provided in the following Table

	Light rainfall event	*Medium rainfall event*	*Heavy rainfall event*
Polynomial method	12.72	29.95	40.8
Arithmetic mean method	12.67	27.34	36.77
Isohyetal method	13.6	34.6	38.7

with the help of the computer, this method provides quick estimate of weights allotted to each station to be used for objective estimation of areal rainfall. These weights are the function of their location and net work density of the catchment. However, if used on operational basis, periodical verification of the results would be desirable by comparison with known standard methods.

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Reference

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