

ESTIMATING RAINFALL INTENSITY*

PENAKSIRAN INTENSITAS CURAH HUJAN

Tohari**

INTISARI

Penelitian ini dilaksanakan untuk mengembangkan tiga model intensitas curah-hujan yang secara berurutan berdasarkan asumsi bahwa (1) intensitas curah-hujan berbanding langsung dengan curah-hujan total per hari dan berbanding terbalik dengan keseragaman lama hujan per hari untuk tiap bulan dalam setahun, (2) intensitas curah-hujan berhubungan secara linier terhadap curah-hujan total per hari, dan (3) intensitas curah-hujan berhubungan secara asimtotik terhadap curah-hujan total per hari. Di samping itu, penelitian juga bertujuan untuk menguji kemampuan tiga model intensitas curah-hujan yang dikembangkan untuk menaksir intensitas curah-hujan di tiga lokasi, yang hanya tersedia data curah-hujan total harian.

Hasil penelitian menunjukkan bahwa intensitas curah-hujan dihitung menggunakan model $r_{iA} = (10/t)(RR_i)$ dan model $r_{iC} = 1,9975 (1,0 - \exp (-0,0860 RR_i))$ tidak berbeda secara nyata dan lebih tinggi daripada intensitas curah-hujan dihitung menggunakan model $r_{iB} = 0,0299 RR_i$. Persamaan intensitas curah-hujan model $r_{iA} = (10/t) (RR_i)$ dan model $r_{iC} = 1,9975 (1,0 - \exp (-0,0860 RR_i))$ mempunyai kemampuan setara untuk menaksir intensitas curah-hujan.

Kata kunci : model intensitas curah-hujan

ABSTRACT

The experiment was conducted to develop three models of rainfall intensity based on the respective assumption that (1) there is similarity in daily rainfall duration for each month of the year, (2) there is a linear relationship between rainfall intensity and total rainfall per day, and (3) there is an asymptotic relationship between rainfall intensity and total rainfall per day. The ability of three developed models in estimating rainfall intensity were tested in three locations where amount of rainfall per day data are available.

The results showed that estimate of rainfall intensity computed using model $r_{iA} = (10/t)(RR_i)$ and $r_{iC} = 1.9975 (1,0 - \exp (-0.0860 RR_i))$ did not differ significantly and these were higher than that of rainfall intensity computed using model $r_{iB} = 0.0299 RR_i$. Model $r_{iA} = (10/t) (RR_i)$ and model $r_{iC} = 1.9975 (1,0 - \exp (-0.0860 RR_i))$ had the same ability in estimating rainfall intensity.

Key words : rainfall intensity modelling

INTRODUCTION

The intensity of rainfall affects surface run-off, physical properties of soil, and modifies the final pattern of soil water recharge (Baver, 1972). Run-off occurs whenever the rate of rainfall exceeds the rate of infiltration (Hillel, 1980; Raghunath, 1985). In consequence, run-off varies with amount and intensity of rainfall (and frequently with rainfall duration, since infiltration rate, initially high, tends to decrease with time) and with surface conformation (Slatyer, 1967).

The rate of rainfall per day is usually not available at the farm sites. The most available rainfall data is the amount of rainfall per day only, even at the Agrometeorological Station. Although the rainfall data are available, either the amount and duration of rainfall per rainfall even or total rainfall and rainfall duration per day, but these data can not be directly used when the daily rainfall intensity is required in the short period of time. It is, then, reasonable to develop a mathematical model of rainfall intensity in relation to total rainfall per day which can be

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used to estimate the rainfall intensity when the amount of rainfall per day is available

MATERIALS AND METHODS

Three models of estimating rainfall intensity were used. These models described below.

1. Model A. On the assumption that there is similarity in daily rainfall duration for each month of the year, then rainfall intensity at each site was computed by dividing total rainfall per day at the site with average rainfall duration per day computed by month from the nearest weather station data, as presented in equation (1). For this study the data from Los Banos, Laguna (IRRI dryland weather station) was used.

$$r_{iA} = \frac{RR_i}{t} \times 10 \quad (1)$$

where :

r_{iA} = rainfall intensity on day i computed using model A in mm/10 minutes
 RR_i = total rainfall on day i in mm
 t = average rainfall duration per day in minutes

2. Model B. On the assumption that there is a linear relationship between rainfall intensity and total rainfall per day, then the rainfall intensity Model B was computed as follows :

$$r_{iB} = b \times RR_i \quad (2)$$

where :

r_{iB} = rainfall intensity on day i computed using model B in mm/10 minutes
 b = regression coefficient
 RR_i = total rainfall on day i in mm

Equation (2) was computed using the average rainfall intensity and total rainfall per day data obtained from the nearest weather station. For this study the data from Los banos, Laguna (IRRI dryland weather station) was used.

3. Model C. On the assumption that there is an asymptotic relationship between rainfall intensity and total rainfall per day,

then the rainfall intensity Model C was computed as follows :

$$r_{iC} = b_0(1.0 - \exp(-b_1.RR_i)) \quad (3)$$

where :

r_{iC} = rainfall intensity on day i computed using model C in mm/10 minutes
 RR_i = total rainfall on day i in mm
 b_0, b_1 = regression parameters

Equation (3) was computed using the average rainfall intensity and total rainfall per day data obtained from the nearest weather station. For this study the data from Los Banos, Laguna (IRRI dryland weather station) was used.

Three estimated models of rainfall intensity were, therefore, used to compute the intensity of rainfall at three sites where total rainfall per day data are available. These three sites were (1) Balite, Victoria, Laguna, (2) Banlic, Calamba, Laguna, and (3) Central Experimental Station of the University of the Philippines at Los Banos, College, Laguna. The estimated values of rainfall intensity were, then, analyzed using a completely randomized design to detect whether there was a significant effect of model used at 5% level of significance. Duncan's Multiple Range Test was used to decide which model significantly differed to the others (Gomez and Gomez, 1984).

RESULT AND DISCUSSIONS

Rainfall intensity model A. Based on the rainfall duration per day from IRRI dryland weather station which their range and mean rainfall characters are given in Table 1, the average rainfall duration per day for given month was computed. The results are presented in Table 2. It is clear that there was a significant difference in the average of rainfall duration per day for each month. Using the average rainfall duration derived from IRRI data, the computed rainfall intensity were then used as estimate of rainfall intensity in the three locations.

Table 1. Monthly minimum, maximum, and mean total rainfall per day (mm), rainfall duration per day (minutes) and rainfall intensity per day[#] (mm/10 minutes) and correlation coefficient (r) between total rainfall per day and other rainfall characters at IIRRI dryland weather station Los Banos, Laguna

Months	Rainfall Characters	Minimum	Maximum	Mean	r [@]
July	Number of rainy day			17	
	Total rainfall per day	0.6	166.9	19.4	
	Rainfall duration	20.0	750.0	134.4	0.92329**
	Rainfall intensity	0.01667	4.23333	1.25497	0.30864ns
August	Number of rainy day			10	
	Total rainfall per day	0.6	32.3	6.7	
	Rainfall duration	20	120	58.5	0.62325*
	Rainfall intensity	0.07500	2.86667	1.00370	0.71743**
September	Number of rainy day			20	
	Total rainfall per day	0.4	114.7	11.9	
	Rainfall duration	10.0	520.0	150.5	0.47993*
	Rainfall intensity	0.07619	3.47576	0.93611	0.67752**
October	Number of rainy day			20	
	Total rainfall per day	0.3	90.0	15.4	
	Rainfall duration	10.0	1010.0	278.5	0.75232**
	Rainfall intensity	0.08667	3.80000	0.91256	0.16373ns
November	Number of rainy day			14	
	Total rainfall per day	0.6	20.7	6.4	
	Rainfall duration	20.0	480.0	143.2	0.14488ns
	Rainfall intensity	0.13333	4.14000	0.85550	0.77146**
December	Number of rainy day			12	
	Total rainfall per day	0.5	22.6	8.8	
	Rainfall duration	10.0	650.0	169.2	0.65842*
	Rainfall intensity	0.10000	2.13333	0.60596	0.55398*
January	Number of rainy day			4	
	Total rainfall per day	0.4	1.8	1.2	
	Rainfall duration	30.0	110.0	57.5	0.23936ns
	Rainfall intensity	0.11818	0.45000	0.24538	0.73338ns

[@]** - significant at 1% level of significance; * - significant at 5% level of significance; ns - not significant; [#] - computed only for rainy day

Table 2. Average rainfall duration per day (minutes) during the months of July, August, September, October, November, December 1985 and January 1986 at IIRRI dryland weather station, Los Banos, Laguna

Months	Number of Rainy Day	Average Rainfall Duration [@]
July	17	134.4 ab
August	10	58.5 b
September	20	150.5 ab
October	20	278.5 a
November	14	143.2 ab
December	12	169.2 ab
January	4	57.5 b

[@]In a column, means followed by a common letter are not significantly different at 5% level by DMRT

Rainfall intensity model B and C. Based on rainfall data from IIRRI which their range and mean rainfall characters are given in Table 1, the linear and non-linear regression between rainfall intensity and total rainfall per day was computed. The results are as follows :

$$r_{IB} = 0.0299 RR_i \quad (r = 0.57^{**})$$

$$r_{IC} = 1.9975 (1.0 - \exp(-0.0860 RR_i)) \quad (r = 0.50^{**})$$

These above-mentioned equations indicate that a significant portion of the variability in rainfall intensity can be explained by total rainfall per day. Using regression equation derived from IIRRI data, the intensity of rainfall for the three test sites were computed. These computed rainfall intensity were then used as

estimate of rainfall intensity in the three locations.

The intensity of rainfall computed using three models: $r_{iA} = (10/t)(RR_i)$, $r_{iB} = 0.0299 RR_i$ and $r_{iC} = 1.9975 (1.0 - \exp(-0.0860 RR_i))$ for the three locations are given in Table 3. It should be noted that rainfall intensity computed using model A and C did not differ significantly in the

three sites. These estimates were significantly higher than that of rainfall intensity computed using model B (Table 4). This indicates that model $r_{iA} = (10/t)(RR_i)$ and $r_{iC} = 1.9975 (1.0 - \exp(-0.0860 RR_i))$ had the same ability in estimating rainfall intensity and differed significantly as compared to model $r_{iB} = 0.0299 RR_i$.

Table 3. Average rainfall intensity[#] (mm/10 minutes) computed using three estimation models of rainfall intensity in three location during the course of study

Location	Months	Rainfall	Intensity	Model
		r_{iA}	r_{iB}	r_{iC}
Balite, Victoria, Laguna	August	1.11	0.20	0.85
	September	0.98	0.44	1.34
	October	0.69	0.57	1.20
	November	0.67	0.29	0.98
	December	0.65	0.33	1.02
Banlic, Calamba, Laguna	July	1.17	0.47	1.01
	August	1.05	0.18	0.64
	September	0.85	0.38	1.00
	October	0.46	0.38	0.90
	November	0.37	0.16	0.64
	December	0.54	0.27	1.00
Central Experimental Station, Los Banos, Laguna	January	0.38	0.19	0.85
	July	1.53	0.62	0.94
	August	0.82	0.15	0.58
	September	0.75	0.34	0.66
	October	0.63	0.52	1.05
	November	0.57	0.22	0.78
	December	0.48	0.24	0.85
	January	0.14	0.03	0.13

[#] - computed only for rainy day

Table 4. Predicted rainfall intensity[#] (mm/10 minutes) computed using three estimation models of rainfall intensity in three location during the course of study

Location	Rainfall	Intensity	Model [@]
	r_{iA}	r_{iB}	r_{iC}
Balite, Victoria, Laguna	0.82 a	0.37 b	1.08 a
Banlic, Calamba, Laguna	0.69 a	0.29 b	0.86 a
CES, Los Banos, Laguna	0.70 a	0.30 b	0.72 a

[@] In row, means followed by a common letter are not significantly different at 5% level by DMRT

[#] - computed only for rainy day

CONCLUSION

The results showed that :

1. The estimate of rainfall intensity computed using $r_{iA} = (10/t)(RR_i)$ and $r_{iC} = 1.9975 (1.0 - \exp(-0.0860 RR_i))$ did not differ significantly and these were higher than that of rainfall intensity computed using model $r_{iB} = 0.0299 RR_i$; and
2. Model $r_{iA} = (10/t)(RR_i)$ and $r_{iC} = 1.9975 (1.0 - \exp(-0.0860 RR_i))$ had the same ability in estimating rainfall intensity.

It should be noted, however, that this model was only developed in the vicinity of the University of the Philippines at Los Banos. It is, therefore, recommended that a follow-up study be instituted in other locations with different environmental conditions.

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