COMPUTATION OF EROSIVITY FACTOR WITH DAILY RAINFALL DATA IN SHIGA PREFECTURE

A. Nasir and K. Uchida.

1. INTRODUCTION

It is commonly believed that erosion patterns change in regions under going a climate change. Erosion is generally low if the soil is covered with natural vegetation, namely the forest. This study was conducted under natural rainfall condition from 1993 to 1998 in the Kawamukai and Jakujo watershed. Daily rainfall data from these two sites in Shiga Prefecture were used to evaluate daily erosivity and to estimate the erosivity factor (R) and its monthly distribution. Results indicated that runoff, rainfall erosion and soil loss in these watersheds mainly occurred by storms in June to September. Land slope had a major effect on runoff and sediment loss; this effect was very small when the rainfall intensity was less than 3mm/h. Mean annual rainfall for Kawamukai and Jakujo ranged from 1630 to 1673 mm, and erosivity factor from 196.63 to 190.75 MJ mm/ha/hr/yr respectively. There was a positive correlation between rainfall with runoff and erosion index, which was highly significant for both sites. The runoff amount and sediment losses were both closely related to rainfall and the maximum rainfall intensity (I_{30}). Significant correlations (R^2 = 0.80-0.99) were observed between daily, monthly, annual EI_{30} and daily, monthly, annual rainfall of the storm with > 12.5mm. Mean monthly rainfall erosivity values were computed for both watersheds in six years.

2. METHODOLOGY

Table 1. Summary statistics for two sites in Shiga prefecture.

	Kawamukai	Jakujo
Latitude	34º 56' 41.4" N	34º 55' 30.5" N
Longitude	135º 57' 41.5" E	135º 58' 26.4" E
Elevation above M.S.L. (m)	203	242
Catchment area (ha)	2.66	2.88
Maximum % of rainfall	July (23%)	July (24%)
Seasonality Index#	0.39 (1966-98)	0.36 (1977-98)
R-factor (MJ mm/ha/hr/yr)*	196.63	190.75

*Determined using daily rainfall data from 1993-1998.

Both index values >0.13 would indicate the presence of a marked wet season.

$$EI_{30} = \frac{\sum KE \times I_{30}}{100}$$

EI_{30} = EI (MJ mm/ha/hr/storm)

ΣKE = KE of storm (MJ/ha)

I_{30} = Maximum rainfall intensity of storm (mm/hr)

$$KE = (E \times I)$$

KE = KE of unit rainfall (MJ/ha)

Measurement Techniques

For this study, rainfall data from January 1993 until December 1998 was used with the different rainfall parameters. The erosion index EI_{30} value is the sum of kinetic energy (KE) values occurring during one storm. The EI_{30} is the product of the KE and the maximum 30 min rainfall intensity I_{30}. For each erosive storm, the EI_{30} values were computed according to the RUSLE handbook instructions (Wischmeier[3]) in SI units (Foster[1]). Three models are applied to evaluate kinetic energy of rain in this study. The monthly R-value was computed by summation of EI_{30} for each erosive storm that occurred during the month.

Models

$$E = 0.119 + 0.0873 \log I \qquad (1)$$

$$E = 0.29\left[1 - 0.72\exp(-0.05 + I)\right] \qquad (2)$$

$$E = \frac{0.015 \times 3.87 + 0.28(I)^{1.47}}{3.87 + (I)^{1.47}} \qquad (3)$$

E = Energy per unit of rainfall (MJ/ha/mm)

I = Unit rainfall per unit time of storm (mm)

Equation (2) has proposed by Brown[2]

Department of Agricultural & Environmental Engineering, Kobe University.

3. RESULTS AND DISCUSSION

Analysis of the rainfall and runoff data clearly shows that land use condition and vegetation cover influence runoff generation. There was a significant difference between runoff, due to vegetation. In the Kawamukai watershed the runoff amount was less than Jakujo for every rainfall event. High runoff rates are an indication that processes of soil removal and deposition are active. The results indicate that improving canopy cover is the best way of decreasing runoff on the slopes of the study areas. The annual values are shown in Fig.1. In both watersheds the rainfall intensity is directly related to the amount of runoff produced by specified storm. The energy of a given storm depends upon the intensities at which the rain occurred and the amount of precipitation that is associated with each particular intensity value. The comparison of unit rainfall of storm and KE of rain by using three models are show in Fig.2. From the determination of EI_{30}, it observed that a short duration with high rainfall intensity creates a high erosion index. The erosivity factor is the average of all computed EI_{30} values for a one-year period. The monthly erosion index is then expressed as a summation of monthly distribution.

Of the six factors considered in the RUSLE, the rainfall erosivity factor is the most readily computable. Both watersheds have the same soil texture, topography, and no cultivated areas. We concluded that only the rainfall factor and canopy of forest trees are important which influence the soil erosion per year. The annual erosivity values for both watersheds are shown in Fig.3.

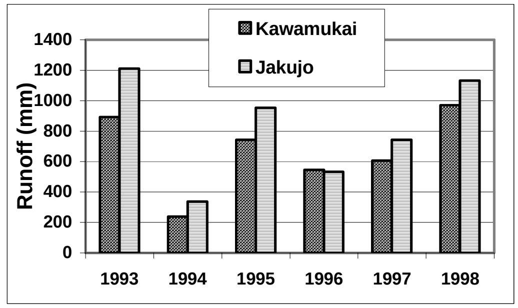

Fig.1. Annual runoff in two watersheds.

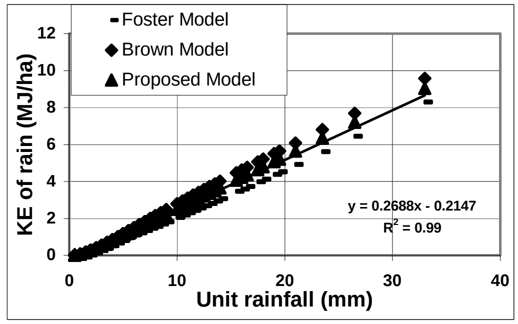

Fig.2. Relationship of I and KE for storms (1998)

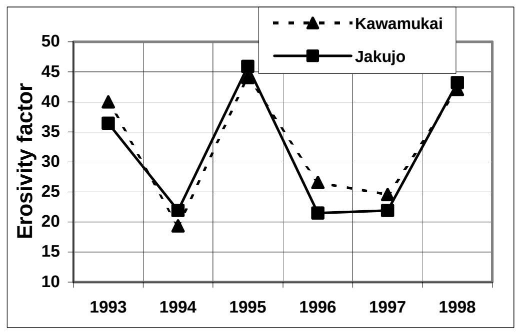

Fig.3. Comparison of erosivity factor

4. CONCLUSIONS

The rainfall erosivity indexes can be summed for any time period to provide a numerical measure for the erosivity of the rainfall during that period. If this procedure used for long-term rainfall data can provide average annual values of the rainfall erosivity index (EI_{30}) or rainfall factor (R). These values for a large area can be presented as curves of equal erosivity on a map of the area of interest. The use of proposed model allows any user with a data set of large area to fit this model to their data and come to a reasonable determination of erosivity factor.

REFERENCES

1) Foster, G.R., D.K. McCool, K.G. Renard, and W.C. Moldenhauer. 1981. Conservation of the Universal Soil Loss Equation to SI metric units. Journal of Soil Water Conservation 36 (5): pp 355-359.

2) Brown, L.C., and G.R. Foster. 1987. Storm erosivity using idealized intensity distribution. Trans. ASAE 30: pp 379-386.

3) Wischmeier WH., and D.D. Smith. 1978. Predicting rainfall-erosion losses: A guide to conservation planning. USDA. Agriculture Handbook # 537**:** pp 58.