

## Rainfall Erosion Index of Anand and Computational Models for Rainfall Erosivity

G.S. Sutaria<sup>1</sup>, N.K. Patel, K.N. Akbari and C.L. Patel

B.A. College of Agriculture, Gujarat Agriculture University, Anand 388 110, India

**Abstract:** The rainfall erosion index (EI<sub>30</sub>) is a measure of the erosivity of rain, which is useful in prediction of soil loss. The average annual EI<sub>30</sub> at Anand comes to 772.59. Nearly 98% of annual erosion index is concentrated during June to September. July has been found to be the most erosive month. Prediction models have been developed and tested. These models have been found to be very useful in quick determination of kinetic energy and erosion index of storms.

**Key words:** Rainfall erosion index, computational model.

Erosion losses from agriculture fields are governed by climatic factors, basic nature of the soils, topography of the field and the vegetation cover growing over it. Wischemier and Smith (1965) developed an equation popularly known as Universal Soil Loss Equation (USLE), taking the above factors into account:

$$A = R.K.L.S.C.P$$

where,

A= computed soil loss per unit area (t ha<sup>-1</sup>),

R= rainfall factor (number of erosion index units: a measure of erosive force of specific rainfall),

K= soil erodibility factor (the erosion rate in tones per unit of erosion index for a specific soil type in cultivated fallow),

L= slope length factor (ratio of soil loss from field slope length to

that from a 72.6 feet length on the same soil type and gradient),

S= slope gradient factor (ratio of soil loss from the field gradient to that from a 9% slope),

C= crop management factor (ratio of soil loss from a field with specified cropping and management to that from the fallow condition on which the factor K is evaluated), and

P= erosion control practice factor (ratio of soil loss with contouring, strip cropping or terracing to that with straight row farming up and down slope).

The 'R' factor in the equation is the average annual rainfall erosion index and is a measure of the erosivity of rain. As described by Wischemier (1959), the storm erosion index (EI) is one hundredth of the product of kinetic energy of rainstorm and its maximum 30 minutes intensity. But, the computation of stormwise kinetic energy and erosion index by this method required

<sup>1</sup> Dry Farming Research Station, Gujarat Agricultural University, Targhadia (Rajkot) - 360 003, India.

lengthy calculations. To simplify these calculations Chandra *et al.* (1979) have shown the usefulness of statistical models, which can help in rapid computation of the kinetic energy of rain from rainfall amount. This also eliminates the need for the rainfall charts from the self-recording rain gauges. The present investigation has been made to establish an average rainfall erosion index and to find out computational models for rainfall erosivity under Anand conditions.

### Materials and Methods

The rainfall charts from self-recording rain gauge located at the Meteorology Observatory, Gujarat Agricultural University, Anand, have been used for computation of kinetic energy and erosion index. The data for a period of four years (1990-93) have been evaluated. Rainfall storms of more than 12.5 mm have been considered for the calculation of kinetic energy of rainfall. The rainfall intensity ( $\text{cm hr}^{-1}$ ) has been used for computation of kinetic energy (KE) equation for individual rainstorms, as suggested by Hudson (1971):

$$\text{KE} = 210.3 + 89 \log I$$

where,

KE is the kinetic energy (metric tones  $\text{ha}^{-1} \text{cm}^{-1}$ ) of rain, and

I is the rainfall intensity ( $\text{cm hr}^{-1}$ ).

Erosion index ( $\text{EI}_{30}$ ) values were then computed as suggested by Wischmeier (1959):

$$\text{EI}_{30} = (\text{KE} \times I_{30})/100$$

where,

$\text{EI}_{30}$  is the erosion index,

KE is the kinetic energy (metric tones  $\text{ha}^{-1} \text{cm}^{-1}$ ), and

$I_{30}$  is the maximum 30 minute rainfall intensity ( $\text{cm hr}^{-1}$ )

To find out the degree and nature of relationship the regression equations between daily amount with daily kinetic energy and erosion index values were developed as suggested by Chandra *et al.* (1979).

### Results and Discussion

Annual erosion index varied from 405.1 to 1124.0. The average annual rainfall erosion index was worked out to be 772.5 under Anand conditions (Table 1). Nearly 98% of the annual erosion index is concentrated during four rainy months (June to September). The erosion index distri-

Table 1. Monthly and annual rainfall erosion index (R) for Anand ( $\text{EI}_{30}$ )

Year	June	July	Aug.	Sept.	Oct.	Annual
1990	11.59	61.50	786.04	265.07	—	1124.20
1991	4.26	351.05	28.46	21.35	—	405.12
1992	154.74	28.93	142.57	293.77	—	620.01
1993	31.47	714.68	117.80	10.56	66.54	994.05
Total	202.06	1156.16	1074.87	590.75	66.54	3090.38
Average monthly	50.51	289.04	268.72	147.69	16.63	772.59
Monthly cumulative	50.51	339.55	608.27	755.96	772.59	—
Percentage cumulative	6.54	43.95	78.73	97.85	100.00	—

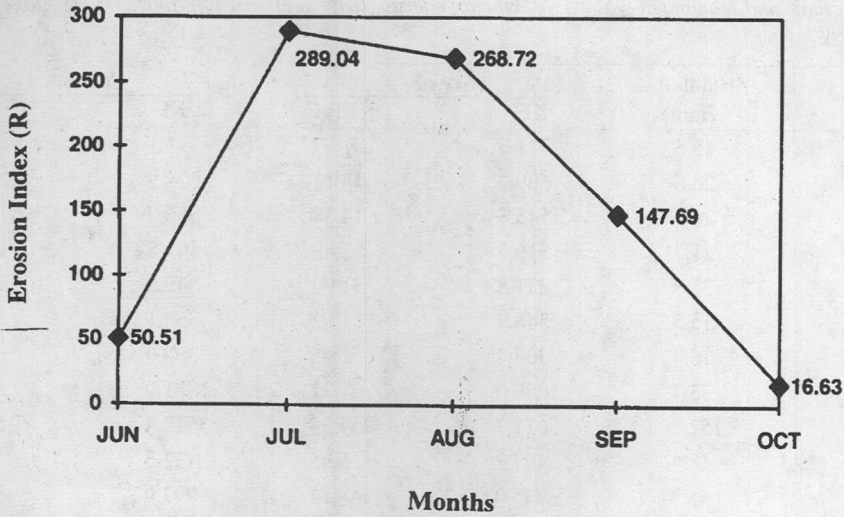


Fig. 1. Average monthly rainfall erosion index for Anand.

tribution curve (Fig. 1) showed that July is the most erosive month with EI<sub>30</sub> of 289.04, whereas June is the least erosive month with EI<sub>30</sub> of 50.51. July and August months contribute 72.30% of annual EI<sub>30</sub>.

It is observed that the relationship between these parameters is of the nature of  $Y = a+bx$ , and the coefficient of the correlations is very high. The general equations thus developed are:

$$KE = -8.192 + 23.95 RN \quad (r = 0.983)$$

$$EI_{30} = -28.186 + 1.88 Rn \quad (r=0.957)$$

where,

KE = kinetic energy (metric tones  $ha^{-1} cm^{-1}$ ),

EI<sub>30</sub> = erosion index, and

Rn= rainfall (mm).

These statistical models are useful for rapid computation of the kinetic energy

of rain from daily, monthly or yearly rainfall amounts, and also eliminates the need for the rainfall charts.

In order to test the validity of these models, the year was selected at random, which came out to be 1990, and KE and EI<sub>30</sub> values for the rainstorms during this year were computed using these models. The actual (as per rainfall charts) and computed values for the storms for the year 1990 are given in Table 2. These two values appeared to be quite comparable to each other. However, a chi-square test was also made to test the computability of these values. The calculated chi-square values are 14.44 and 5.81 for kinetic energy and erosion index, respectively, which are much smaller than chi-square value at 5% level (28.87).

### Conclusions

July and August months are most critical for soil erosion under Anand conditions.

Table 2. Actual and computed values of kinetic energy (KE) and erosion index (EI<sub>30</sub>) for rainfall of 1990

Date	Rainfall (mm)	Actual		Computed	
		KE	EI <sub>30</sub>	KE	EI <sub>30</sub>
14/6	15.5	371.5	1.97	363.1	0.95
4/7	26.6	609.2	19.11	628.9	21.82
5/7	24.0	545.7	14.38	566.7	16.93
7/7	21.3	516.9	12.49	501.8	11.86
18/7	35.8	871.8	31.04	849.3	39.12
27/7	15.5	348.0	1.92	363.1	0.95
26/7	16.4	368.4	2.45	384.0	2.64
6/8	43.4	1059.0	47.21	1031.0	53.40
17/8	152.2	3671.3	254.33	3637.4	257.95
18/8	18.4	407.3	5.95	432.5	6.40
19/8	41.8	965.0	48.11	993.0	50.40
21/8	33.7	807.2	33.95	799.0	35.17
24/8	252.5	5864.2	434.62	6039.9	446.50
25/8	26.4	626.4	19.23	624.1	21.44
26/8	20.4	476.2	8.81	480.4	10.16
27/8	28.4	690.1	28.41	672.0	25.20
7/9	110.5	2702.3	193.67	2638.6	179.55
8/9	20.5	488.9	12.37	482.8	10.35

Calculated chi-square value.

For, KE = 14.44, EI<sub>30</sub> = 5.81.

Chi-square table value at 5% level = 28.87.

Normally, during this period, fields have little crop canopy. Therefore, it is necessary to take precautionary measures such as green manuring or short duration pulse crops during these two months to minimize the soil loss. The kinetic energy and rainfall erosion index values, computed either by using models or by actual determination, makes no difference so far as validity of the parameter is concerned. Thus, it is concluded, that if the rainfall data are available, the kinetic energy and rainfall erosion indices can be estimated using these equations.

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