

Original Research Article

Assessment of Erosion Index through Rainfall Data for Hisar Region, Haryana

ABSTRACT

Soil erosion is the functional ability of rainfall to detach the soil particles and simultaneously the susceptibility of soil to resist against raindrop. The rainfall data of 16 years for Hisar region for selected duration of 15 to 60 minutes storm rainfall was analyzed to evaluate the erosion potential for the region. A highly significant linear correlation was observed between Erosion Index (EI) and Precipitation Index (PI) computed for the duration of 15, 30, 45 and 60 minutes. Precipitation index (PI₃₀) for 30 minutes duration also showed significant linear correlation with Precipitation Index PI₁₅, PI₄₅ and PI₆₀ minutes duration. The equations so developed could be used for the computation of Erosion Index (EI) values for Hisar region by substituting the corresponding values of Precipitation Index (PI) as independent variable and without going through the tedious process of computation of kinetic energy for the study area.

Keywords: Precipitation Index, Erosion Index, Runoff, Rainfall Intensity

1. INTRODUCTION

Runoff is generally caused by excessive storms in which the intensity of rainfall plays a role of paramount importance. Excessive rainfall generally caused the soil erosion and is a complicated issue.

An erosion model was designed to predict the long time average soil loss in runoff from specific fields under specific cropping and management system (Wischmeier and

Smith, 1978). This equation was named as Universal Soil Loss Equation (U.S.L.E.) and over the years it had proved its practicality for wide spread field use (ARS, USDA 1961). The erosivity of rainfall in (U.S.L.E.) is defined as by factor (R). It defines the energy of the raindrops that breaks soil aggregates and dislodge and transport the soil particles. The most reliable estimate of rainfall erosion potential (EI₃₀) is the one-hundredth fraction of the product of the rainstorm's kinetic energy and the 30-minute intensity (I₃₀) (Wischmeier, 1959). The erosion index (EI₃₀) is popularly known as rainfall factor (R) in U.S.L.E when it averaged annually. The erosion index (EI) is used for estimation of soil loss to categorize the rainstorm according to their potential and evaluating erodibility of different soils. The Precipitation index (PI) was introduced as new rainfall parameter and observed its high correlation with Erosion index (EI) (Erasmus et al. 1970). The application of PI values need to be critically examined at number of locations in spite of the simplicity and prospect of wide applicability (Das and Rambabu, 1978). Recording type rain gauge data of usually more than 20 years must be required for analyzing the EI values while in absence of long term data attempt could be made for computing EI values of lower frequencies of 2 year and 5 years (Gupta and Rambabu, 1967). The average annual erosion index and the relationship between average annual rainfall and average annual erosion index has also been worked out suggested to be useful for planning suitable soil and water conservation measures for different regions in the country (Ram Babu et al. 1978). In this study, an attempt was made to develop relationship between rainfall erosion index (EI), precipitation Index (PI) and also that of Precipitation index (PI₃₀) with precipitation Index PI₁₅, PI₄₅ and PI₆₀ individually, in order to arrive at an easy estimation of erosion index in Hisar region in Haryana state.

2. MATERIAL AND METHODS

The study was carried out for Hisar district of Haryana, India, The Hisar has the latitude of 29° 10' North and longitude of 75° 46' East and located in western zone of Haryana. Normal annual rainfall, received at Hisar is 400 mm and out of which about 80 percent received during monsoon period. The erosive rain storm data was collected from India Meteorological Department, New Delhi for Hisar region, for selected duration of 15 to 60 minutes storm rainfall, for the period of 16 years from 1982-1999. The recording rain gauge data for the year 1986 and 1987 were not available. Autographic rain gauge charts were analyzed for magnitude of rainfall and intensities. The erosion index values for all storms separated by more than six hours were considered as different storms, slope of rainfall line with corresponding time interval on autographic rain gauge charts were separated, tabulated and rainfall intensities for 15, 30, 45 and 60 minutes were worked out. Rainfall intensities of 25

mm/hr were taken as practical threshold level for separating erosive and non-erosive rain (Ellision, 1944).

The product of amount of rainfall and its intensity for the selected time interval was derived for each storm and termed as Precipitation index (Erasmus et al. 1970). The Precipitation index (PI) was analyzed by multiplying 6 hrs storm rainfall by maximum per hour rainfall intensity for the selected duration 15, 30, 45 and 60 minutes and designated as PI_{15} PI_{30} PI_{45} and PI_{60} respectively.

The erosion index (EI_x) for each erosive storm were computed. (Wischmeier, 1959),(Wischmeier and Mannering, 1969). The kinetic energy for these durations were computed in metric units using the below mentioned method.

$$KE = 210.3 + \log I \quad \text{-----}(1)$$

Where,

KE = Kinetic energy in metric tones / ha cm and

I = Rainfall intensity, cm/hr

$$EI_x = \frac{K.E. \times I_x}{100} \quad \text{-----}(1)$$

where,

EI_x =Erosion index for x (minutes) duration

KE = Kinetic energy of storm (metric tones/ha)

I_x = Maximum per hour rainfall intensity (cm/hr) for x (minute) duration

The erosion index (EI) for all selected duration i.e. 15, 30, 45 and 60 minutes wererecalculated and obtained the relationship between corresponding values of precipitation index.

3. RESULTS AND DISCUSSION

The linear relationship was found between erosion index (EI) values and corresponding precipitation index (PI) values for all selected durations 15, 30, 45, and 60 minutes. The corresponding equation has been shown in Table 1. The relationship between erosion index (EI) and precipitation index (PI) (the value of R varying from 0.97 to 0.99) were significantly correlated. Rainfall intensities of aforesaid duration are frequently encountered within the storm and can be easily computed on time axis of self-recording type rainuauge charts. The equations so developed (Table 1) can be utilized for the computation of erosion index values for required duration forHisar regionby substituting the corresponding values of precipitation index as independent variable and without going through the tedious process of computation of kinetic energy.

Table 1. Correlation between Erosion Index (EI) and Precipitation Index (PI)

Sr. No.	Duration (Minutes)	Equation	Correlation Coefficient (r)
1.	15	$EI_{15} = 2.78 PI_{15} - 0.66$	0.97
2.	30	$EI_{30} = 2.83 PI_{30} - 2.34$	0.98
3.	45	$EI_{45} = 2.73 PI_{45} - 3.29$	0.97
4.	60	$EI_{60} = 2.88 PI_{60} - 4.72$	0.99

As suggested the one hundredth fraction of the product of the kinetic energy of the storm and the 30 minutes duration intensity (I_{30}) was the most reliable single estimate of rainfall erosion potential (EI_{30}) to utilized as numerical substitute of rainfall factor in U.S.L.E. (Wischmeier,1959). Therefore to compute rainfall erosion potential (EI_{30}), the relationship of Precipitation index for 30 minutes (PI_{30}) with Precipitation indices (PI_{15} , PI_{45} and PI_{60}) were evaluated individually. Highly significant linear correlation was observed in each case (Table 2).

Table 2. Precipitation Index (PI_{30}) and Precipitation Indices (PI_{15} , PI_{45} and PI_{60})

Sr. No.	Duration (Minutes)	Equation	Correlation Coefficient (r)
1.	15	$PI_{30} = 0.91 PI_{15} - 1.63$	0.97
2.	45	$PI_{30} = 1.10 PI_{45} + 0.42$	0.97
3.	60	$PI_{30} = 1.12 PI_{60} + 4.25$	0.97

The erosivity index varied with the rainfall and various techniques and methods were used in past by many researchers for calculating erosivity index (Pandit and Isaac, 2015). Similar attempt was made and precipitation index values were correlated with corresponding erosion index values for 345 storm for Kota and observed highly significant (Parkash, et al. 1985).

4. CONCLUSION

Highly correlated linear correlation between erosion index and precipitation index for 15, 30, 45 and 60 minutes duration was observed. Precipitation Index for 30 minutes duration (PI_{30}) also has significant linear correlation with Precipitation Index 15, 45 and 60 minutes duration. The developed equation may be utilized for computing erosion index for Hisar region in Haryana. The equations so developed can be utilized for the computation of erosion indices value for Hisar region by substituting the corresponding values of precipitation indices as

independent variable and without going through the tedious process of computation of kinetic energy. The representation of erosion index by EI_{30} is most common Rainfall erosivity estimation method. Many researchers in absence of rainfall intensity data developed various methods using rainfall depth. Now a days Artificial Neural techniques and machine learning models are gaining popularity (Suhara et, al.2023).

COMPETING INTERESTS

Authors have declared that no competing interests exist

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