Original Research Article

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

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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 (PI_{30}) for 30 minutes duration also showed significant linear correlation with Precipitation Index PI_{15}, PI_{45} and PI_{60} 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~~index, Erosion ~~Index~~index, Runoff, Rainfall ~~Intensity~~intensity

1. INTRODUCTION

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

An erosion model was designed to predict ~~the~~ long ~~time~~ term average soil loss in runoff from specific fields under specific cropping and management ~~system~~systems (Wischmeier and Smith,1978). This equation was named ~~as~~the Universal Soil Loss Equation (U.S.L.E.) ~~and over~~Over the years ~~it had proved~~, its practicality for ~~wide spread~~widespread field use has been proven (ARS, USDA 1961). The erosivity of rainfall in ~~(~~U.S.L.E.~~)~~ is defined as ~~by~~a factor (R). It defines the energy of the raindrops that ~~breaks~~break soil aggregates and then dislodge and transport the soil particles. The most reliable estimate of the 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 the rainfall factor (R) in the U.S.L.E. when it is averaged annually. The erosion index (EI) is used ~~for estimation of~~to estimate soil loss to categorize ~~the rainstorm~~rainstorms according to their potential and ~~evaluating~~evaluate the erodibility of different soils. The ~~Precipitation~~precipitation index (PI) was introduced as a new rainfall parameter, and ~~observed~~ its high correlation with ~~Erosion~~the erosion index (EI) was observed (Erasmus et al. 1970). The application of PI values ~~need~~needs to be critically examined at a number of locations ~~in spite of~~despite the simplicity and prospect of wide applicability (Das and Rambabu, 1978). Recording ~~type~~types of raingauge data of usually more than 20 years ~~must be~~are required for analyzing the EI values ~~while~~, whereas in the absence of long-term data ~~attempt~~, attempts could be made ~~for computing~~to compute the EI values of lower frequencies of 2 ~~year~~years and 5 years (Gupta and Rambabu,1967). The average annual erosion index and the relationship between the average annual rainfall and average annual erosion index ~~has~~have 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 a relationship between the rainfall erosion index (EI) ~~,~~and precipitation ~~Index~~index (PI) and ~~also that of Precipitation~~between the precipitation index (PI_{30}) ~~with~~and the precipitation ~~Index~~indices PI_{15}, PI_{45} and PI_{60} individually ~~, in order~~ to arrive at an easy estimation of the erosion index in the Hisar region in Haryana state.

2. ~~MATERIAL~~MATERIALS AND METHODS

The study was carried out ~~for~~in the Hisar district of Haryana, India ~~.~~. ~~The~~ Hisar has ~~the~~a latitude of 29^0 10' North and a longitude of 75^0 46' East and is located in the western zone of Haryana. ~~Normal~~The normal annual rainfall ~~,~~ received at Hisar is 400 mm ~~and out~~, approximately 80% of which ~~about 80 percent~~was received during the monsoon period. The erosive rain storm data ~~was~~were collected from the India Meteorological Department, New

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Delhi, for the Hisar region, for a selected duration of 15 to 60 minutes of storm rainfall, for thea period of 16 years from 1982-1999. The recording raingaugerecorded rain gauge data for the yearyears 1986 and 1987 were not available. Autographic rainguageraingaugery charts were analyzed for the magnitude of rainfall and intensitiesand intensity of rainfall. The erosion index values for all storms separated by more than six hours were considered as different storms, slopethe slopes of the rainfall linelines with corresponding time intervalintervals on the autographic rainguageraingaugery charts were separated, and tabulated, and the rainfall intensities for 15, 30, 45 and 60 minutes were worked outdetermined. Rainfall intensities of 25 mm/hr were taken as practical threshold levellevels for separating erosive and non erosivenonerosive rain (Ellision, 1944).

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

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

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

Where,where

KE = Kinetic energy in metric tones / tons/ha cm and

I = Rainfall intensity, cm/hr

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

where,

EI_x =Erosion index for duration x (minutes) duration

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

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

The erosion index (EIindices (EIs) for all selected durationdurations,i.e., 15, 30, 45 and 60 minutes, were calculated, and obtained the relationshipthe relationships between the corresponding values of the precipitation indexindices were obtained.

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3. ~~RESULTS~~RESULTS AND DISCUSSION

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

Table 1. Correlation between ~~Erosion Index~~the erosion index (EI) and ~~Precipitation Index~~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~~-minute duration intensity (I_{30}) was the most reliable single estimate of the rainfall erosion potential (EI_{30}) to be utilized as a numerical substitute ~~of~~for the rainfall factor in the U.S.L.E. (Wischmeier,1959).Therefore, to compute the rainfall erosion potential (EI_{30}), the ~~relationship of Precipitation~~relationships of the precipitation index for 30 minutes (PI_{30}) with ~~Precipitation~~the precipitationindices (PI_{15}, PI_{45} and PI_{60}) were evaluated individually. ~~Highly~~A 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

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

4. CONCLUSION

~~Highly~~A highly correlated linear correlation between the erosion index and the precipitation index for durations of 15, 30, 45 and 60 minutes ~~duration~~ was observed. ~~Precipitation Index for 30 minutes~~The precipitation index for the 30-minute duration (PI_{30}) also has a significant linear correlation with ~~Precipitation Index 15, 45 and 60 minutes duration~~the precipitation indices for the 15-, 45- and 60-minute durations. The developed equation may be utilized for computing the erosion index for the Hisar region in Haryana. The equations ~~so~~ developed here can be utilized for the computation of erosion ~~indices value~~index values for the Hisar region by substituting the corresponding values of precipitation indices as independent ~~variable and~~variables without ~~going through~~ the tedious process of ~~computation of~~computing kinetic energy. The representation of the erosion index by the EI_{30} is the most common ~~Rainfall~~rainfall erosivity estimation method. Many researchers, in the absence of rainfall intensity data, have developed various methods using rainfall depth~~. Now a days Artificial Neural~~ data. Currently, artificial neural techniques and machine learning models are gaining popularity (Suhara et~~,~~ al.2023).

COMPETING INTERESTS

~~Authors have declared~~The authors declare that no competing interests exist.

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