Eco. Env. & Cons. 28 (October Suppl. Issue) : 2022; pp. (S373-S377)

ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i06s.063

Assessment of Rainfall Erosivity Index using Lombardi Method for Amritsar, Punjab, India

Amarinder Singh Riar[1]*, Prashant Kumar[2], Bikramjit Singh[1], Sarabjeet Singh[2] and Rajanbir Singh[2]

[1]Department of Agriculture, Guru Nanak Dev University, Amritsar, Punjab, India
[2]Department of Agriculture, Khalsa College Amritsar, Punjab, India

(Received 4 March, 2022; Accepted 4 May, 2022)

ABSTRACT

The erosivity thing with inside the conventional soil loss equation (USLE) affords a powerful approach of comparing the erosive energy of rainfall. This study estimated the erosivity factor based on monthly and yearly periodic rush rainfall data of Amritsar, Punjab State covering a period of 45 year from 1971 to 2015 using Lombardi system (EI = 1.03 Vd1.51). It was found that early arrived rainfall led high erosive index. The data of seasonal distribution of precipitation illustrated that the most ferocious erosion imminence in the area can be anticipated in August, especially in the areas that aren't defended by foliage cover, which might be due to climatic change. The average periodic erosivity indicator for the megacity during the period of study was 744.6 MJ mm/ hr. The correlation between periodic erosivity indicator and average periodic rush was expressed as Y = 0.0002x + 0.8873. The R^2 of 0.79 shows that rush alone contributed 79 % of the corrosion threat within the study period. The knowledge of impact of rainfall on erosivity is essential in soil erosion threat assessment and for soil and water conservation planning. The information on effect of precipitation on erosivity is important in soil disintegration threat evaluation and for planning of water and soil conservation.

Key words : *Rainfall, USLE, Erosivity index, Lombardi models, Amritsar*

Introduction

Rainfall have a paramount place in the operation of soil erosion (ISSAC, 2016). Soil declination performing from disintegration by storm water is seen as one of the primary environment issues worldwide since it has huge natural and productive effects, particularly in agrarian regions (Arshad *et al.,* 2002). Main element in soil disintegration by water is the erosive possibility of drop sway. The precipitation erosivity factor (R) in the Universal Soil Loss Equation is best equation for vatic nation of the erosive possibility of drop sway (Loureiro *et al.,* 2001). Soil and water are the primary assets essential for farming creation everywhere. In any case, soil disintegration undermines their efficiency as decline land and water quality (Yusof and Ahmad, 2016). The greatest natural difficulty confronting by today's world is disintegration and quality of water. It is assessed that the world's surface soils might face extreme disintegration in the following 60 years (Horvath *et al.,* 2016). The proportion of precipitation's capacity to cause disintegration is called rainfall erosivity. Precipitation erosivity is a significant variable for soil disintegration, dregs creation and water quality demonstrating (Loureiro *et al.,* 2001). Exact and direct estimation of rainfall erosivity utilized in the well-known Universal Soil Loss Equation (Lee and Hoe, 2011). In many countries, especially developing countries, these data are not easy to obtain. These

[1, 2]Assistant Professor

countries have used this method to see rainfall erosivity under such situations. These methods link rainfall and erodibility.

The role of rainfall in loss of soil due to separation force of raindrops by hitting the soil surface and participation in conversion of rain water to runoff. This is applicable notably to erosion by land flow and rills, that intensity is mostly thought-about to be the foremost necessary downfall characteristic (Morgan, 1942). Soil degradation resulting from disintegration by storm water is seen together of the most environment related issues worldwide since its enormous natural and monetary effects, particularly in farming regions (Angulo and Begueria, 2009; Isikwue *et al*., 2015). One among the foremost necessary factors in eating away by water is that the erosive potential of driblet impact. Varied properties of raindrops, like intensity, velocity, size, and K.E., square measure among the foremost oft used parameters to develop erosivity indices.

The ArIm (rainfall volume × most intensity), EI30 (rainfall energy× most 30-min intensity), and Kinetic Energy > 1 are the main indicators of rainfall erosivity (Isikwue *et al*., 2015; Yu, 1998). A direct computation of rainfall erosivity elements requires long-term facts for every quantity and depth of rainfall. In such a circumstance, more noteworthy excepting issues available sorts of limits as month-to-month or yearly precipitation realities should be used to anticipate precipitation erosivity records. This makes it conceivable to attempt the appropriate procedures for soil protection. Factors influencing the cost of soil disintegration are precipitation, spill over, wind, inclination and the preservation measures of that place (Morgon, 1942). Precipitation erosivity is the feasible function of precipitation to create soil misfortune (Silva, 2004). The precipitation erosivity file addresses the close by environment affect water related soil disintegration (Isikwue *et al*., 2015).

This erosion prediction equation is:

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

Where,

A -Average annual soil loss (Mg $ha^{-1}yr^{-1}$)

R -rainfall erosivity index

K - soil erodibility

L -slope length

S -slope gradient

C -vegetation cover and

P - conservation protection.

Soil loss (Erosion) will be zero if any one factor will be zero, as it is multiplier equation.

According to Wichmeier and Smith, (1978).

KE (Kinetic Energy) = 11.87 + 8.73log10I

Wischmeier's index, EI30= KE x I30,

KE = kinetic energy of rainfall (metric tons × m/ha/cm of Rainfall).

I30= rainfall intensity (mm/hr) in 30 minutes

The intensity of rainfall is determined from the rainfall amount and duration using Eq. 3 below;

$$I = \frac{\textit{Rainfall Amount}}{\textit{Change in time}}$$

The objective of this study was to compute the rainfall erosivity index using Lombardi method of Amritsar, Punjab state.

Materials and Methods

Study area

This study considered the region of Amritsar, state of Punjab. Amritsar has total area of 139 km^2. Amritsar is located at latitude 31.63^o N and 74.87^o E with an average elevation of 234 meter (768 ft.). The average annual rainfall is 706 mm. A lot of rainy season fall in the month June, July, and Aug. on average July is the wettest month and November is driest month and wheat and paddy is the major crop of the district.

Data collection

For this study the data were obtained from IMD (Indian Meteorological Department) for last 45 years over the period of (1971 – 2015) of Amritsar station. Average annual erosivity index was calculated by using this equation:

$$\text{Average annual erosivity index} = \frac{\textbf{sum total of erosivity index for the rainy months}}{\textit{nubmber of rainy months}}$$

Lombardi

Is also related several USLE factor including rainfall erosivity and daily rainfall using Eq.

$EI = 1.03V\ d^{1.51}$

Where EI -the erosivity index (MJ.mm/hr).

V d - rainfall (mm).

Development of Regression Model

The time series were generated of rainfall and the calculated erosivities. Regression models for the estimates of R were calculated and graphed by using this shown equation on Microsoft Excel.

5E = 5N5C + 5O

In this equation: a is slope and b is interception.

Results and Discussion

Rainfall Erosivity Index

The calculation of rainfall erosivity index in this paper becomes based at the evaluation of rainfall size among the durations of 1971 to 2015. The rainfall erosivity index was estimated using Lombardi approach for all rain event the minimal length of 30 min. Figures 1 to 6 show the combined plot representations of the monthly erosivity index from 1971–2015.From figures 1 to 6, it is thrilling to notice that inside the period below consideration as could be seen from the month of August has the highest erosivity index. During this scenario, maximum erosivity index observed in decade of 1981-1990.The months with highest erosivity indices had been the months with highest kinetic energy which induced heavy erosion. Additionally, less value of erosivity index was obtained in the months which had less precipitation along with low kinetic energy. The months with low rainfall had low KE and low EI. It was illustrated from the all figures that pattern of rainfall led to same pattern of erosivity index of

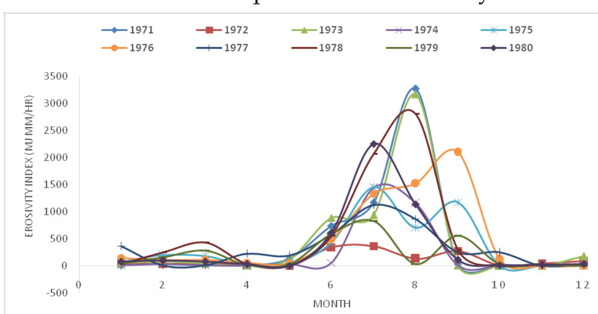

Fig. 1. Monthly Variation ofErosivity Index for 1971 – 1980

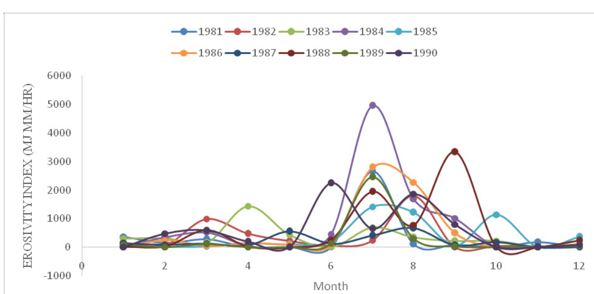

Fig. 2. Monthly Variation of Erosivity Index for 1981 – 1990

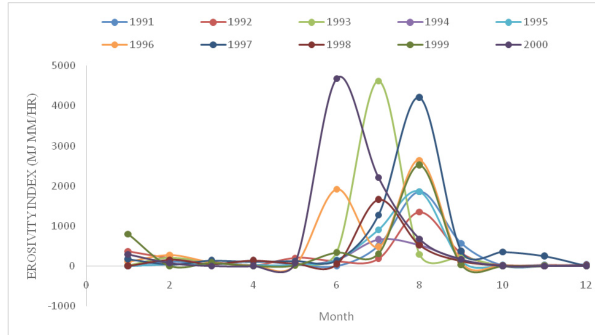

Fig. 3. Monthly Variation of Erosivity Index for 1991 – 2000

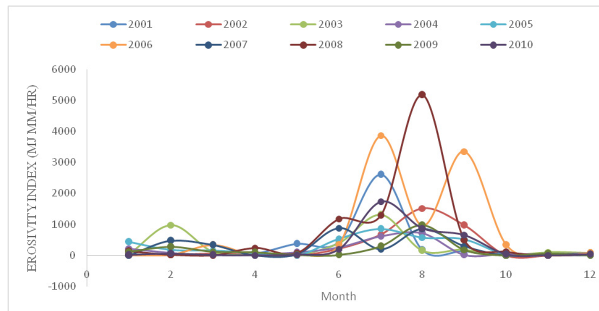

Fig. 4. Monthly Variation of Erosivity Index for 2001–2010

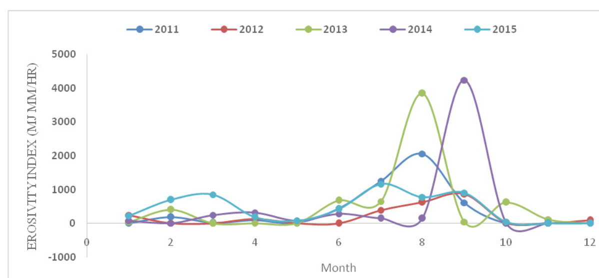

Fig. 5. Monthly Variation of Erosivity Index for 2011-2015

rainfall.

Rainfall

The analysis of yearly total rainfall data at Amritsar in Fig. 6 revealed that there was not a significant change. The Annual and *Kharif* total rainfall has decreasing trend at the rate of -0.039 mm/yr. and -0.223 mm/yr. but the total rainfall during *Rabi* has slightly increasing trend with 0.026 mm/yr.

Correlation

As the years pass by using, the connection between precipitation pattern and erosivity index becomes more said, i.e. better the precipitation, the better the erosivity index. That is showed with the aid of the finding of evaluate of rainfall erosivity in Brazil by way of (Oliveira *et al.*, 2002). That better erosivity values found inside the tropics are caused by the excessive amount of precipitation, intensity, and KE of rain. Additionally that dazes of precipitation erosivity esteems in tropical locales are similar and they're superior to the ones found in various mild environment regions. Further, affirmation by means of the correlation among annual erosivity index and average annual precipitation (Fig. 7). The correlation among annual erosivity index and common annual precipitation turned into expressed as Y = 0.0002X + 0.8873. The coefficient of determination R^2 of 0.79 is a sign that there are other key factors that decide the extent of soil erosion. It further suggests precipitation alone contributed 79 % of erosion risk throughout the duration of observe.

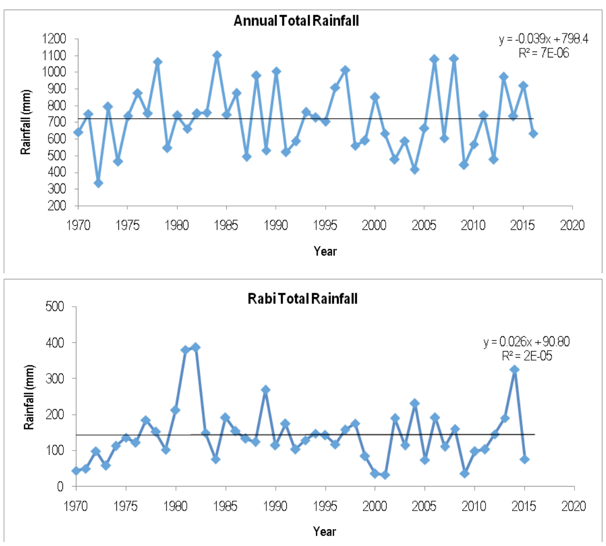

Fig. 6. Annual, *Kharif* and *Rabi* total yearly Rainfall at Amritsar

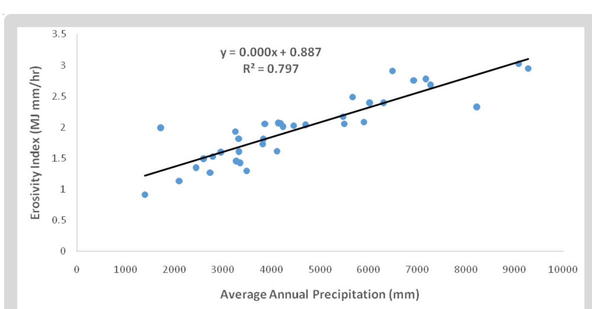

Fig. 7. Correlation between annual erosivity index and average annual precipitation

The closing percentage can be defined with the aid of using soil, conservation, manage and anthropogenic factors. The boom in precipitation may be due to climate change as mentioned (Arku, 2012) after rainfall information studies in Ghana that a few evidences of weather alternate embody boom in floor temperature, and exalter Nate in precipitation. The impact of those indices on agricultural manufacturing can't be overemphasized. (Wisner *et al.*, 2004) Pronounced that the vulnerability of agriculture isn't determined through the individual and value of environmental strain like weather change in keeping with se, however via the mixture of the societal functionality to cope with and or recover from environmental change. Climate exalter Nate is one of the maximum excessive environmental threats handling mankind international. It affects agriculture in numerous methods, including its direct impact on meals manufacturing. Climate alternate, this is because of the herbal climate cycle and anthropogenic activities, has adverse impact on productivity of agriculture (Ziervogel *et al.*, 2006).

Conclusion

From the analysis of rainfall seasonal distribution concluded that the most ferocious erosion imminence in the area can be anticipated in August, especially in the areas that aren't defended by foliage cover, which also depends on the climatic change. The average periodic rainfall erosivity indicator R for the Amritsar during the period of study was 744.6 MJ mm/ hr.

References

Angulo-Martínez, M. and Beguería, S. 2009. Estimating rainfall erosivity from daily precipitation records: a comparison among methods using data from the Ebro Basin (NE Spain). *Journal of Hydrology.* 379 : 111-121.

Arku, F.S. 2012. Rainfall Data as a case for Investigation into Climate Change in Ghana. *International Journal of Basic and Applied Sciences.* 1(4): 347-362.

Arshad, M.A. and Martin, S. 2002. Identifying Critical Limits for Soil Quality Indicators in Agro-Ecosystem. *Agric Ecosyst and Environ.* 88 : 153-160.

Horvath, C.S., Olga, K. and Rosian, G. 2016. Assessing Rainfall Erosivity from Monthly Precipitation Data. *Aerapa Conference, Babeº-Bolyai University, Cluj-Napoca, Romania.* 109-116.

Isaac, R.K. 2016. Development of Rainfall Erosivity Models for Allahabad (India). 1: 52–59.

Isikwue, M. O., Ocheme, E. and Aho, M. I. 2015. Evaluation of rainfall erosivity index for Abuja, Nigeria using Lombardi method. *Nigerian Journal of Technology (NIJOTECH)* 34(1): 56-63.

Lee, J.H. and Heo, J.H. 2011. Evaluation of estimation methods for rainfall erosivity based on annual precipitation in Korea. *Journal of Hydrology.* 409: 30–48. https://doi.org/10.1016/j.jhydrol.2011.07.031

Loureiro, N. and Coutinho, M. 2001. A New Procedure to Estimate the RUSLE EI30 Index Based on Monthly Rainfall Data and Applied to the Algarve Region, Portugal. *Journal of Hydrology.* 250: 12-18.

Morgan, C. 1979. *Field and Laboratory Examination of Soil Erosion as a Function of Erosivity and Erodibility for Selected Hillslope Soils from Southern Ontario.* PhD Thesis, University of Toronto. pp. 114

Morgan, R. P. C. 1942. *Soil Erosion and Conservation*. 3rd ed. Blackwell Publishing, 1942.

Oliveira, P.T., Wendland, E. and Nearing, M.A. 2002. Rainfall Erosivity in Brazil: A review. *Catena.* 100 : 139-147.

Silva, A.M. 2004. Rainfall Erosivity Map for Brazil. *Catena.* 57: 251-259.

Wichmeier, W.H. and Smith, D.D. 1978. Predicting Rainfall Losses—A Guide to Conservation Planning. *USDA, Science and Education Administration, Agricultural Research, Agriculture Handbook, Washington DC.* 537: 58

Wisner, B., Blaikie, P., Cannon, T. and Davis, I. *At Risk: Natural Hazards; People's Vulnerability and Disasters.* 2nd Edition. London: Routledge.

Yu, B. 1998. Rainfall Erosivity and its Estimation for Australia's Tropics. *Australian Journal of Soil Research.* 36: 143-65.

Yusof, K.W. and Ahmad, M.H. 2016. Evaluation of Rainfall Runoff Erosivity Factor for Cameron Highlands, Pahang, *Malaysia.* 17: 1–8. https://doi.org/10.12911/22998993/63338

Ziervogel G., Nyong, A., Osman, B., Conde, C., Cortes, S. and Dowing, T. 2006. Climate variability and change: Implications for Household Food Security.