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Analysis of the Pattern of Rainfall Erosivity in Suruli River Basin of Cumbam valley using Modified Fournier Index

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Abstract: **The current study on rainfall erosivity is based on 8 years rainfall data which is representing thirteen rainfall stations along the Suruli river basin of Cumbam valley as well as their adjacent area too. The research objective is to control rainfall Erosivity pattern of Suruli river basin of Cumbam valley, where using Modified Fournier Index. The linear regression model has been created which relates with the monthly EI30 index of Universal Soil Loss Equation (USLE) and modified Fournier Index has been used for assessing the monthly rainfall Erosivity values. The highest rainfall Erosivity recorded was 18670.5 MJ.MM/H/JR at Periyaru rainfall station. Whereas, the regression analysis was done with annual rainfall and annual rainfall Erosivity. The r2 value was found to be 0.117 which depicts the lesser correlation. Isoerodent map was prepared using the annual rainfall / annual rainfall Erosivity values and geographical locations of each rainfall stations around Suruli River Basin of Cumbam Valley. The according to FAO Erosivity class range shows that the southern part of study area is high erosive occurs.**

Keywords: **Rainfall Erosivity, Isoerodent, linear regression, FAO.**

1. INTRODUCTION

Soil erosion induced by water is a major environmental threat with concerns that changing patterns of rainfall related to global climate change will increase erosion risks, in interaction with land cover and land use (Ma et al., 2010). Assessment of this concern requires a detailed analysis of the existing data sets, as a basis for interpreting future climate change scenarios. Rainfall Erosivity, as presented by Hudson (1971), and Wischmeier and Smith (1978), describes an interaction between the kinetic energy of raindrops and the soil surface indicating the potential ability for rainfall to cause soil loss. Vegetation cover, soil infiltration, Erodability and rainfall Erosivity are the major factors impacting soil erosion. Rainfall Erosivity is particularly difficult to predict and control. Numerous studies have assessed the relationship between conventional rainfall characteristics and soil detachment (Arnoldus, 1977; Hudson, 1971; Wischmeier and Smith, 1978). The (Revised) Universal Soil Loss Equation (USLE/ RUSLE) R-factor is the most frequently used as a measure of soil Erosivity (Brown and Foster, 1987; Renard et al., 1997; Wischmeier and Smith, 1978). The RUSLE R-factor was first calculated by Wischmeier and Smith (1978), in which the R-factor was determined by calculating the average annual sum of the product of a storm's kinetic energy E and its maximum 30-min intensity I30, known as the EI30. Wang et al. (1995) recommended EI30 to calculate the rainfall Erosivity R-factor.

The soil loss estimation is a capital intensive and time consuming exercise by which conservation practices may be based on the quantification of the relevant nature of soil, land topography, vegetation and climatic factors and the relation of these factors to regional and temporal characteristics. Soil loss estimation started in first decades of the 20th century and has increased in number and variety using either the Universal Soil Loss Equation (ULSE) of Wishmeier and Smith (1978) or revised Universal Soil Equation, of Renard et al (1997). Both Universal Soil Loss Equation (USLE) and Revised Universal Soil Loss Equation (RULSE) have empirical Relationships, while USL quantifies Soil Erosion as the product of six factors representing rainfall and run -off erosivity (R) soil erodability (K) Slope Length (L), slope steepness (S) Cover and Management Practice (C) and supporting conversation Practice (P). The equation is *A*=R.K.L.S.C. P

Where, A is the computed spatial and temporal average soil loss per unit of area. RUSLE utilizes the same basic equation but in a computerized version.

Rainfall erosive factor (R) of the USLE and RUSLE in estimating soil Loss Depends on the availability of suitable quantifiable rainfall Erosivity parameters. These parameters must describe adequately the ability of rain detachment and down slope of Soil particles according to intensity of rain and amount of energy. Since the early stage of Soil Loss research, Kinetic E, of falling rain and its maximum 30-minute intensity I30, designated E30 has attained wide recognition as a causative factor in the erosion process and spatial distribution of mean annual rainfall energy for use in soil loss estimation model. However, the use of E30 alone is not sufficient to describe the relative rainfall Erosivity of any two locations with varying intensity of rainfall especially in developing countries (Cohen et al. 2005). Therefore, Index based on Kinetic and momentum of runoff can also be used to estimate the monthly and annual values of rainfall Erosivity with accurate record usually available for a long period. A Number of Indices which relate the Erosivity of kinetic energy and its associated run-off to soil loss estimation have been established. The most widely used index is the Fournier index (Fournier 1960). It has been found to have a food relationship with annual values of rainfall Erosivity. However, this Fournier index has short comings and subsequently modified into Modified Fournier Index (MFI) (Arnoldus 1980). This Modified Index is summed for a whole year and found to be linearly correlated with E30 index of the USLE.

2. STUDY AREA

Cumbum Valley is located in the Theni District of Tamil Nadu. It is near Kerala, geographically located between 9°30′N and 10°11′N, and between 77°E and 77°30′E. It is one of the fertile valley of south India. Soil, in this region is mostly red soil. Agriculture plays a very important role for its developmental activities. Crops like Paddy, Coconut, Groundnut and various types of fruits especially crepes and vegetables are having been cultivated in this area. It is situated at the bottom of Western Ghats. Based on Indian Meteorological Department (IMD) the Average maximum temperature is 41.6 °C and 31.6 °C respectively. Approximately the average annual rainfall is around 836 mm has been registered. When the rainfall during the Southwest Monsoon. The major source of water for drinking and agriculture comes from the Periyar River. Its gets diverted from the state of Kerala. Suruli Falls which is 10 km from Cumbum is surrounded by mountains the nearest airport is Madurai and Kochi International Airport (Kerala) which is 175 km by road. Thekkady (Periyar Wildlife Sanctuary Kerala) which is a tourist destination in Kerala state is 30 km from Cumbum, near Kumily which is a border town between the states of Tamil Nadu and Kerala. Cumbum is a valley, surrounded by hills. The eastern side of the hills constituting seven dams on the hills. In the South, the famous tourist attraction, "Thekkady" is situated Kerala. Cumbum is famous for its coconut & cardamom trading market.

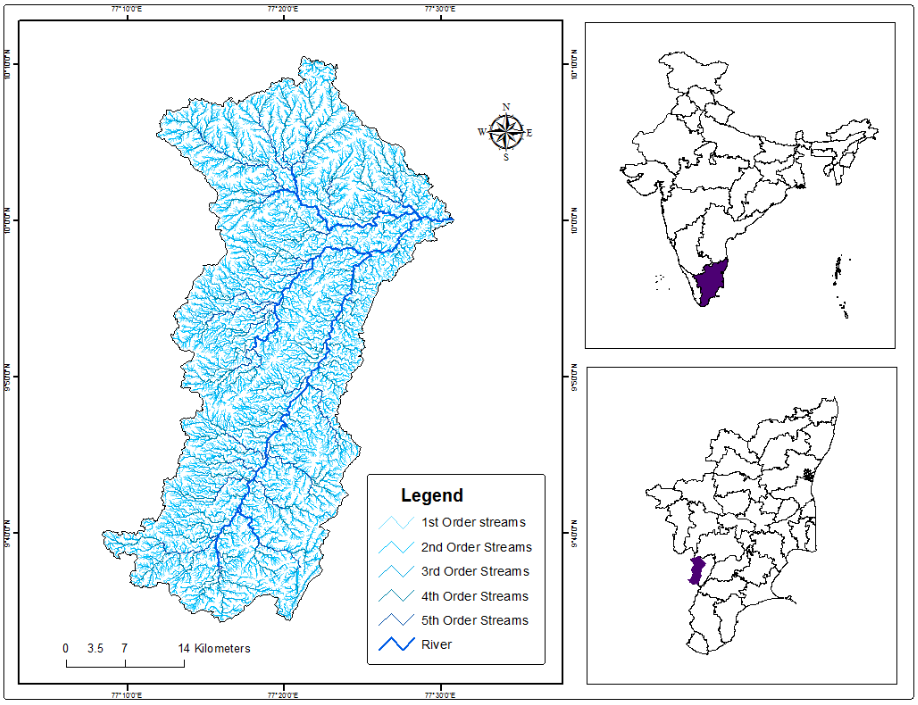

Figure 1: Study area in Suruli River Basin of Cumbam valley

3. METHODOLOGY

The present Study defines the rainfall erosive pattern of Suruli river basin area by using Modified Fournier Index (M.F.I) and Rainfall Data (Daily, Monthly and annual rainfall data) for fourteen stations. Scattered across Suruli river basin was used. These rainfall data, which at most stations distance a period of eight years (2002 to 2010) from the Indian Meteorological Department (IMD) was analyzed using the Modified Fournier Index (Arnoldus ,1977.1980) defined as

$$c = \frac{\sum p2}{p}$$

Where, C = Modified Fournier Index

P is the Monthly Rainfall of the wettest month

P is the annual rainfall

The index was summed for the whole year and linearly correlated with EI30(R), of the USLE as following

$R = b + a\,(C)$

Where, R + rainfall and Run –off erosive according to USLE and the constants (a and b) very widely among different climatic zone...

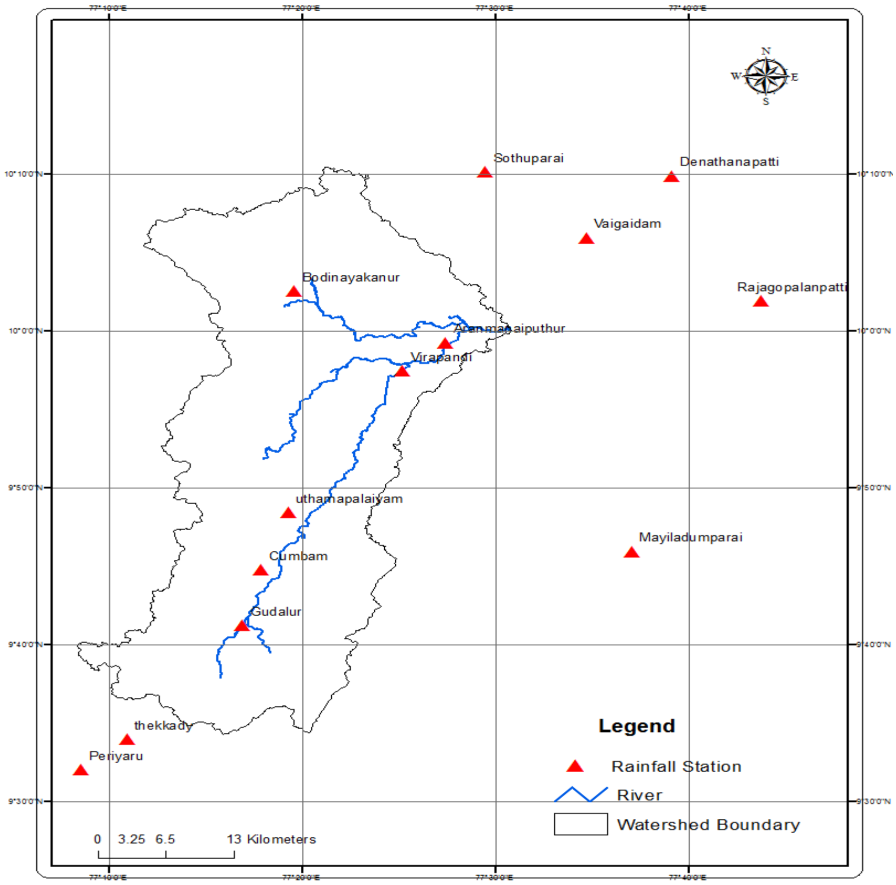

Figure 2: Suruli river basin of Cumbam Valley

The general approach used to estimate R – factor values for areas without data and resources required to calculate R can be summarized as the following four step process:

R- factor values were calculated by the prescribed method (Wischmeier and smith 1978; Renard et al.1993) for stations with recording rainfall. A relation is established between the calculated R-values and more readily available types of precipitation data for example monthly or annual totals. The Relation is extrapolated and R-values estimated for stations with the associated precipitation. Isolines are drawn between stations R-values for sites between isoerodent map estimated by linear interpolation. However, this approach has been used by so many authors to develop the R – value selection guide lines or provisional isoerodent maps for many parts of the world (Stoacking and Elwell, 1976; Roose, 1977: Arnoldus, 1977; Bollinne et al., 1980: Smithen and Schlze, 1982; Lo et al., 1985). Examples of guidelines derived relations used to estimate the R factor for location other that the continental. Suruli river basin below…

Table 1: FAO (1979) Rainfall Erosivity Ratings

Ratings (mm)	*Erosivity Class*
0-50	Slight
50-500	Moderate
500-1000	High
Above 1000	Very high

4. RESULT AND DISCUSSION

The results of the erosivity guides for the study showing the following table. The values of the both annual precipitation values (P) and average annual rainfall and runoff erosivity of R factor. The R values in the following table were calculated using the FAO Modification of Fournier. It was measured from the following table that the R. Value for Periyaru 18670.5 and Thekkady 12491.8 has acquired highest erosivity

Table 2: Rainfall Erosivity Index for Suruli river basin of Cumbam Valley

S_No	Station Name	P (mm)	R-Value (MJ.MM/H/JR)
1	Vaigaidam	617.5	5557.5
2	Devanathapatti	749.0	6704.0
3	Sothuparai	684.6	6161.2
4	Virapandi	683.8	6154.3
5	Rajagopalanpatti	767.5	6907.2
6	Aranmanaipudur	503.5	4531.6
7	Uthamapalaiyam	765.5	6889.2
8	Bodinaicknaur	673.0	6057.1
9	Gudalur	751.6	6764.4
10	Periyaru	2074.5	18670.5
11	Thekkadi	1388.0	12491.8
12	Cumbam	751.8	6766.1
13	Mayiladumparai	521.0	4688.9

P = Precipitation, R= Rainfall and run off Erosivity:

Where, suggested that rainfall intensity and its measure of erosivity that annual rainfall. From this table 2 the high R values has recorded in some rainfall station can be recognized heavy rains with more erosive belongings. Although, as per the data which highly recorded in months of July, August, September, November.

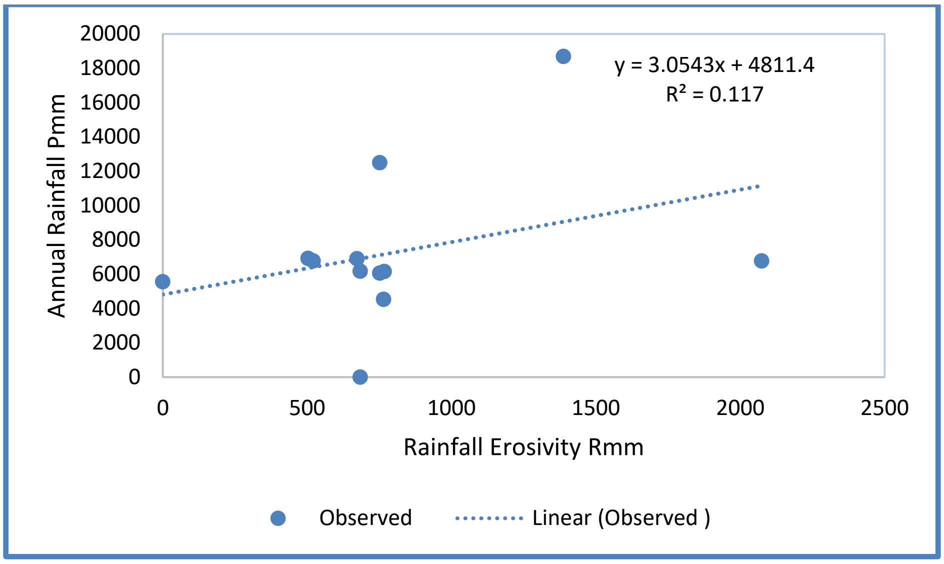

Figure 3: Relationship between Annual Rainfall Erosivity (R) and Annual Rainfall (P)

The correlation between annual precipitation values and annual rainfall erosivity is given an above the Isoerodent map given a figure.

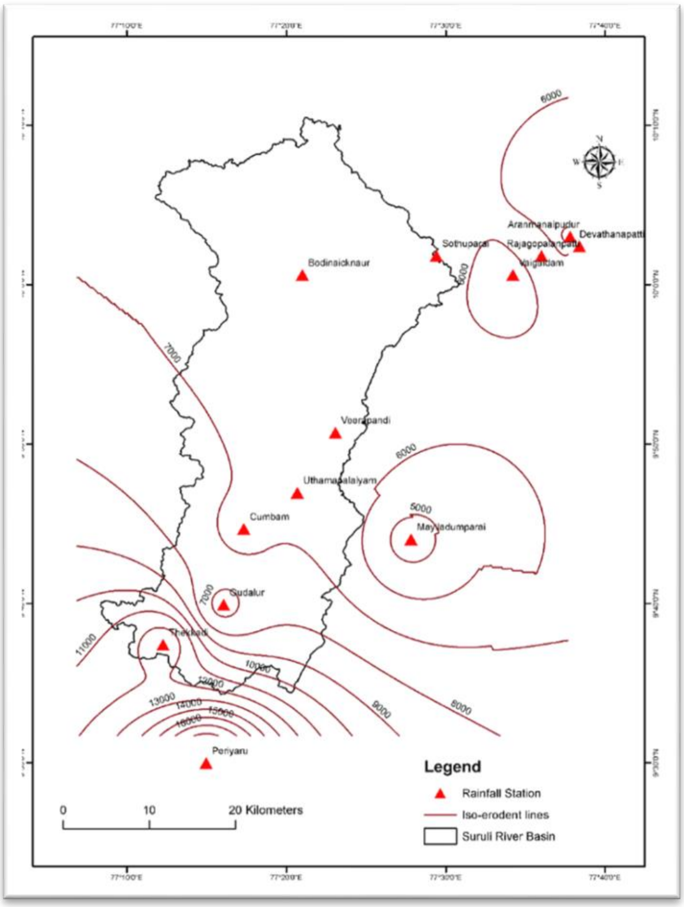

Figure 4: Isoerodent Map of Suruli River Basin in Cumbam Valley

Figure 4 shows that the estimated R- Values for each rainfall stations, which is based on eight years of data which is used to create the Isoerodent map by Arc GIS 10.2 software for the study area. The isoerodent map of Suruli in Cumbam valley has been interpreted, as per the FAO erosivity class range on table 1, the Suruli river basin of Cumbam valley areas have classified into high erosivity class, where the high erosive rainfall has been recorded at Periyaru rainfall station, as well as the highest erosive rainfall classified as this region with severe risk of erosion. Although, this trend might be as a consequence of south west monsoon and north east monsoon have been recorded as a high intensity of rainfall along the Suruli river basin in Cumbam valley, whereas this study area very close to Western Ghats. Therefore, this study results shows that along the Periyaru and Thekkadi rainfall station, this trend might be very close to Western Ghats therefore, during the south west monsoon where highest rainfall has been recorded.

Perhaps, the land degradation is due to high intensity rainfall encouraged the soil erosion. However, the high intensity rainfall and flooding period which soil management practices are insufficient. Where, rehabilitations of the degraded land along the Suruli river basin in Cumbam valley has very costly. Therefore, the data compress of this present study can be accepting the process of land degradation and proceeding the land development and their rehabilitation programs. This Isoerodent map results reveals the information the soil erosion risk of the entire Suruli river basin of Cumbam valley and this map will guide a planning land development and recovery programs. However, this map also agrees to better understanding of the process with spatial imprint and significant for soil erosion calculation. To conclude, the erosion assessment and prediction is not simply for the measuring erosion rate but outcome of erosion also assessment by utilizing it for policy formulation of maintaining the land conservation and environment too.

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