Using the RUSLE and GIS Model to Predict Soil Degradation in Nguzu-Edda, Southeastern, Nigeria

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ABSTRACT

Evaluation of soil loss is among the leading challenges in natural resources and ecological planning. Automated model simulations are becoming more and more common in predicting soil loss for different land use and management practices. Present research combined the Revised Universal Soil Loss Equation (RUSLE) with a Geographic Information System (GIS) to evaluate soil loss and pinpoint the risk erosion zones in the Nguzu-Edda watershed.

The parameters used in the RUSLE were measured for the watershed using satellite and conventional data. It was ranked into four groups varying from low risk to severe erosion risk based on the measured degree of soil degradation. The soil degradation map was associated to land use, topography and slope maps to survey the correlation between soil degradation and ecological factors and pinpoint the zones of soil degradation risk. The results obtained can be utilized to counsel the concerned authorities in prioritizing the zones of urgent erosion abatement. The combined method permits for comparatively simple, fast, and cost-effective evaluation of spatially dispersed soil degradation. It therefore shows that RUSLE-GIS model is a convenient and effective tool for analyzing and delineating soil degradation risk at a vast watershed in South-eastern Nigeria.

(Keywords: RUSLE, Revised Universal Soil Loss Equation, Nguzu-Edda, GIS, Geographical Information System, soil degradation risk, gully erosion)

INTRODUCTION

Soil erosion impacts both agricultural production and natural resources globally (Bakker, et al., 2005; Pimentel, 1993; Prasannakumar, et al., 2011a). In mountain districts, soil erosion also causes serious dangers, like heavy rainfall, surface water streams on exposed terrains that add to the degradation of the land (Ristić et al., 2012; Ashiagbor et al., 2013; Tamene and Vlek, 2008). The soil erosion damage impacts on the richness of the soil and degradation of the soil resources quality, while pollution on water bodies and settling silt are an additional concern (Morgan, et al., 1984; Blaikie and Brookfield, 2015).

The problem of soil erosion is heavily concentrated in the ecologically fragile regions of south-eastern Nigeria, where population sizes and lowest land per capita ranks among the largest in rural Africa (Onu, 2006; Eboh and Lemchi, 1994; Prasannakumar, et al. 1995).The threat of soil degradation, particularly gully erosion, is without a doubt a significant environmental challenge confronting several Nigerian states, particularly Anambra, Imo, Ebonyi, Abia, and several other states in the tropical regions of southern Nigeria (Ume, et al., 2014). Since the soils of south-eastern Nigeria are highly erodible and structurally fragile (Idowu and Oluwatosin, 2008), erosion is a significant source of soil deterioration in the region.

Consequently, the soils in south-eastern Nigeria are predominantly ultisols and alfisols, they are inherently vulnerable to erosion owing to their delicate nature and ease of leaching (Oguike and Mbagwu, 2009). Physical, economic, and human impacts as well as inadequate farming production activities are presumed to have intensified and accelerated the elevated erodibility of the soils in the region.

Nguzu Edda, situated in the Afikpo South local government area of Ebnyi State southwestern Nigeria and about 65% of the total landmass of the area being underlain by loosed porous unconsolidated sand of Ajali Sandstone (Zhang, et al., 2001), suffers severe soil degradation rates due to over-logging and steep-slope agriculture. In the 1990s, the area of soil degradation was 2.5km^2; 3km^2 in the 2000s'; 5km^2 in the 2010s; and currently extending to 8.8km^2, about 30% of the entire landmass of the impacted region (Echiegu, 2011). As a result, greater and greater landmass are now almost bare due to topsoil loss, which is termed topsoil erosion [16] (Okonufua, et al., 2019).

Soil degradation has become a barrier to local sustainable growth, which has drawn greater attention from the Nigerian government and scholars [17,18,19,20] (Olufunmilayo, 2006; World Bank, 2013; Okorafor, et al., 2017; Obidimma and Olorunfemi, 2011). Regrettably, the Nguzu Edda region suffered from lack of economic resources to investigate, evaluate, and model soil degradation for large watershed. In an attempt to provide a scientific foundation for soil conservation plans, there is indeed a growing demand for forecasting mean annual soil erosion and degradation threat in vast areas in the Nguzu Edda region.

The Revised Universal Soil Loss Equation (RUSLE) is a mathematical soil degradation model developed on the Universal Soil Loss Equation (Angima, et al., 2003). It too can anticipate surface runoff of ungauged watersheds by using information of the hydrological processes and local temperature and rainfall factors (Dutta, et al., 2015), and also can portray the geographical variation of soil degradation. The RUSLE has always been the most regularly utilized empirical land degradation model globally due to its availability for application and integration with GIS.

Considering the Nguzu-Edda area the study area, present article used the GIS as well as RUSLE to predict erosion of the soil using derived RUSLE variables utilizing satellite and conventional data like ASTER-DEM, rainfall, soil as well as Lands at Enhanced Thematic Mapper plus (ETM+) for watershed. With these data, the risk of erosion evaluated in the region was determined. The present research findings provide the local authorities in the study area with valuable information in identifying the zones of urgent erosion prevention.

Study Area

The research was carried out in Nguzu-Edda (7°42′-7°54′E, 5°36′-5°48′N), situated in the southern part of Afikpo Region, Southeastern Nigeria (Figure 1). The study area is roughly 498 km^2 in landmark with a tropical climate and annual mean temperature 28°C. Mean annual rainfall roughly 1,800 mm, majority exists from April to October. From 31 to 273 m above the level of the sea, the elevation varies. Population density of the area is 157,072 according to 2006 census. The use of land in Nguzu-Edda includes vegetation, agriculture, built up land and agricultural activities. About 98% of the population are peasant farmers and their food crops include maize, yam, cassava, rice, and cocoyam as well as cash crops which include rubber, oil-palm, cocoa, banana, and different types of fruits.

MATERIALS AND METHODS

Model Framework

The mathematical expression of the RUSLE can be written as:

$$A = R \times K \times LS \times C \times P \quad \textbf{(1)}$$

Where A represents the mean of the soil per unit area as a result of erosion (t ha^{-1} year $^{-1}$), R represents erosive factor of rainfall (MJ mm ha^{-1} h^{-1} year $^{-1}$), K represents erodibility factor of soil (t ha h MJ^{-1}, ha^{-1}, mm^{-1}), L represents factor length of the slope (dimensionless), S represents factor of the steepness (dimensionless), C represents management and cover factor (dimensionless), P represents ecological practice support factor (dimensionless).

Data Sources

Using the RUSLE model to predict soil degradation in the study area, this was done by preparing and integrating different erosivity factors using GIS. Erosivity factors pertaining to rainfall, topography, slope, soil, and land use were prepared from satellite images acquired from Earth explorer (USGS government website) together with the rainfall data obtained from Nigerian Meteorological Agency (NIMET) stations and analogue soil map of eastern region of Nigeria collected from FAO/UNESCO/IS-RIC.

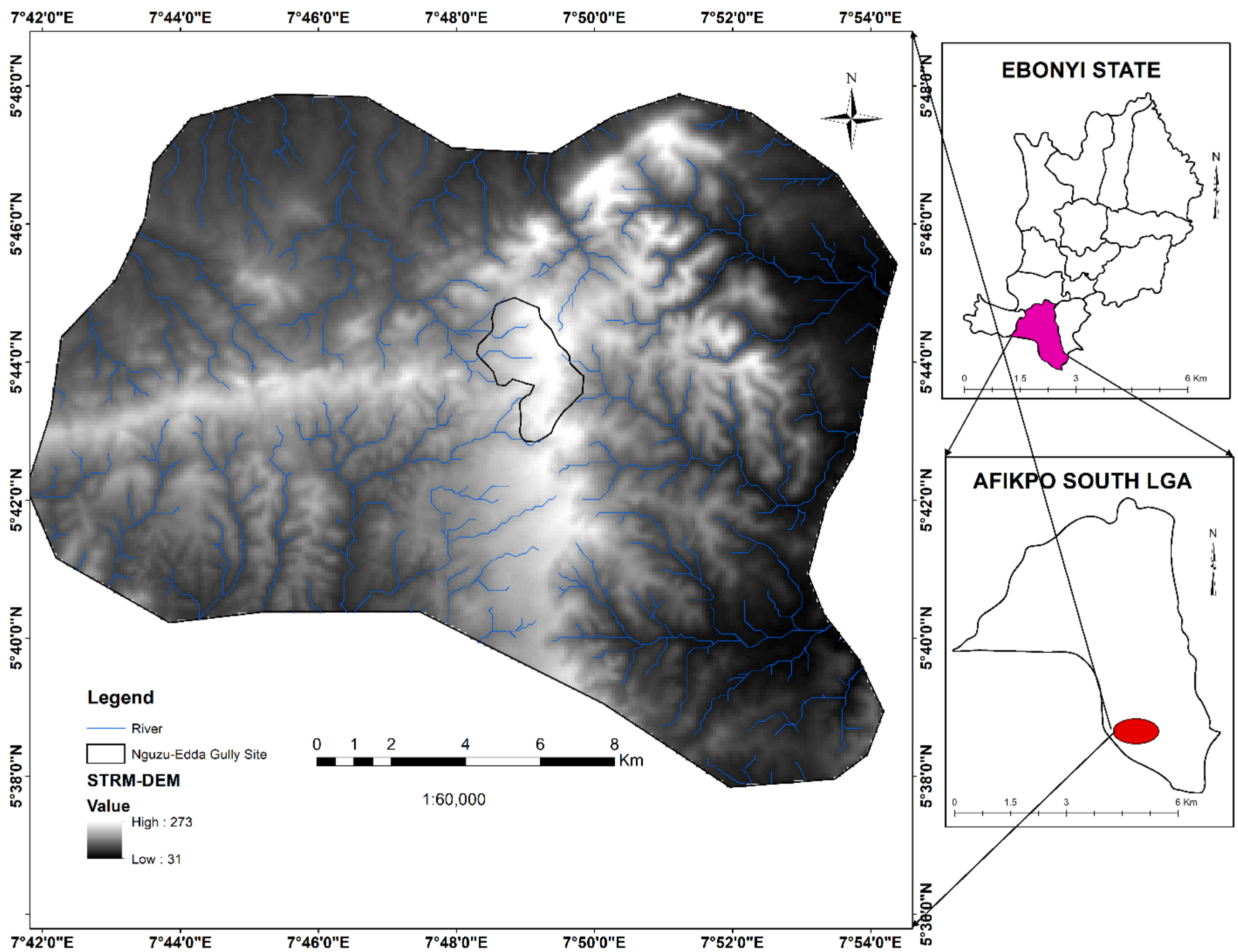

Figure 1: Location Map of the Study Area.

Computation of the Degree of the Soil Degradation

Erosivity Factor of Rainfall: Within RUSLE, rainfall erosivity (factor f R) is calculated utilizing EI30 calculations [23] (Yue-Qing, et al., 2008). The rainfall pattern of the area of study was obtained by the use of Thiessen polygon technique in the ArcGIS 10.5 software platform to process the data.

$$E_j = \alpha[1 + \eta\cos(2\pi f j + \omega)] \sum_{d=1}^{N} R_d^{\beta} R_d > R_0 \quad \textbf{(2)}$$

where E_j represents rainfall erosivity per month (MJ mm ha^{-1}h^{-1} year^{-1}), R_d represents day by day rainfall, R_0represents day by day rainfall threshold leading to erosion, in common, R_0 is12.7-millimetre, N is for days of rainfall in a month ≥12.7 mm. While *f* represents frequency, f is 1/12 and ω = 5π/6. α, β, η represents criteria of the model, the correlation among α and βis specified as Equation (3), where the yearly rainfall is over 1,500 mm.

The relationship amongst η and the yearly rainfall P is displayed in Equation (4). The value of β fluctuates from 1.2 to 1.8 and β is taken as 1.5 in current investigation.

Logα is equal to 2.11 - 1.57β **(3)**

η is 0.58 + 0.25*P*/1000 **(4)**

Erodibility Factor of the Soil

The K-factor value was computed in this research using the given formula [13]:

$$K = 7.954\{0.0034 + 0.0405 \exp [-1/2((\log D_g + 1.659)/0.7101)^2]\} \quad \textbf{(5)}$$

$$D_g = \exp (0.01\sum f_i \, In \, m_i) \quad \textbf{(6)}$$

And D_g represents geometric mean diameters of particles of soil, m_i = arithmetic mean of the particle size limits of class i, fi is the particle size part in percent of class i.

The erosivity for the precipitation was determined monthly by the equation above and also the data for the everyday rainfall representing the four weather stations ranging from year 1980 to year 2002, each month of the twelve months in each year was also averaged.

The yearly values of the different weather stations and the watershed research were obtained from values of 1980 to that of 2002. The parameter for the R-factor map was also obtained using inverse distance weighted (IDW) interpolation in the environment of the GIS. The association between altitude and precipitation in the central part of the area which accounts for impact of altitude on the erosivity of rainfall was used to determine the interpolation R-factor.

The obtained map of the R-factor was shown in Figure 2.

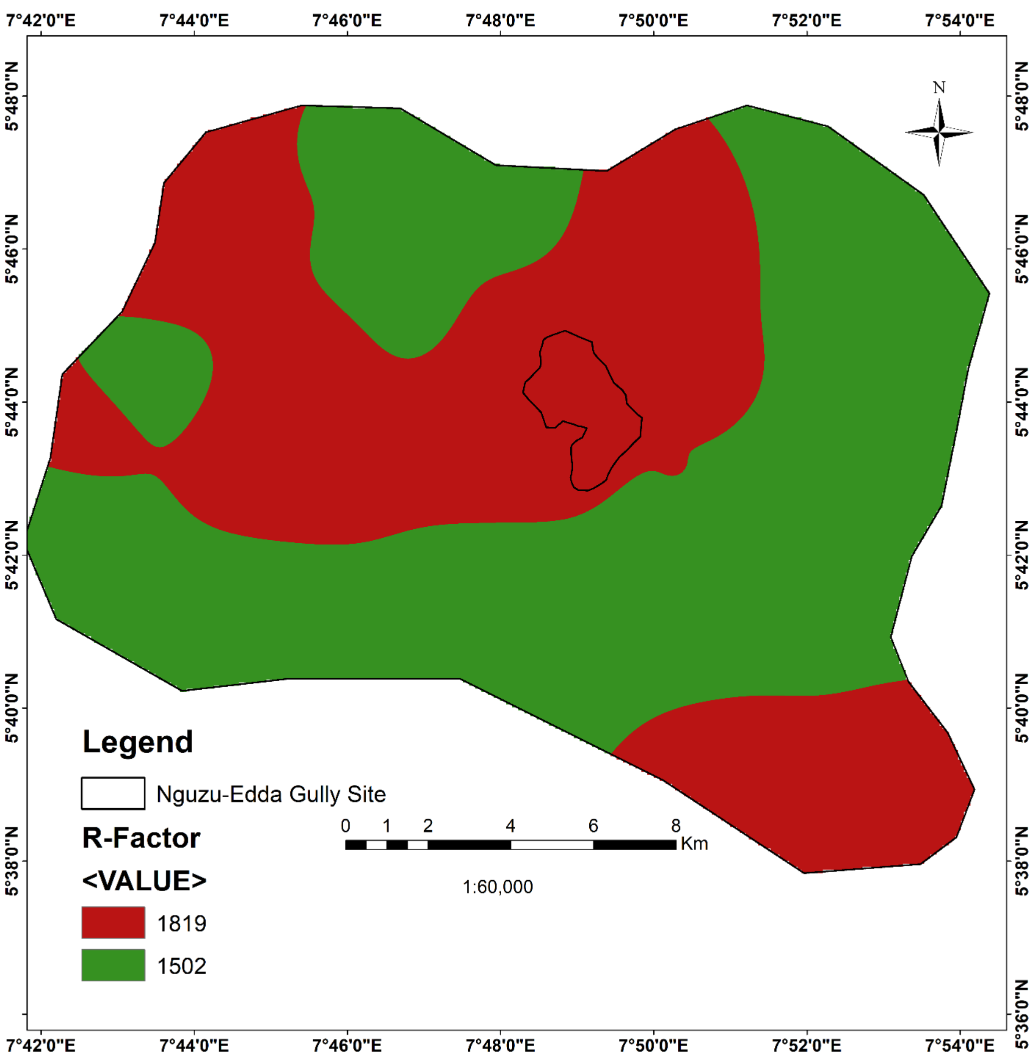

Figure 2: Spatial Dispersion Map of R-Factor in the Nguzu-Edda Watershed.

Soil Erodibility Factor

The above is represented by a constant k, which is the amount of soil lost per erosion index of rainfall as proved by a standard plot. This is always defined using the intrinsic characteristics of the soil [24] (Feng, et al., 2010). This K-factor is affected by the extent of the permeability of the organic matter, soil structure as well as other conditions. It is ultimately obtained from the conditions of the soil. The soil was obtained from the Nigeria soil Map which was acquired from the FAO/UNESCO/IS-RIC, having a scale of 1:250,000. This have been changed to that of digital format using scanning in Tiff method as well as geo-referenced to the Universal Transverse Mercator (UTM-Zone 32 N). Datum of WGS-1984 was used to generate the soil erosivity by the use of ArcGIS 10.5. The K-factor value was computed in this research using the given formulas 5 and 6.

And D_g represents geometric mean diameters of particles of soil, m_i = arithmetic mean of the particle size limits of class i, fi is the particle size part in percent of class i.

Data for soil was subjected to the database in the soil map. Finally, the K- factor (erodibility) were obtained to all the soil survey using Equation (5) and (6) in the environment of the GIS.

Figure 3 depicts the distribution of the erodibility factor spatially translated to digital form**.**

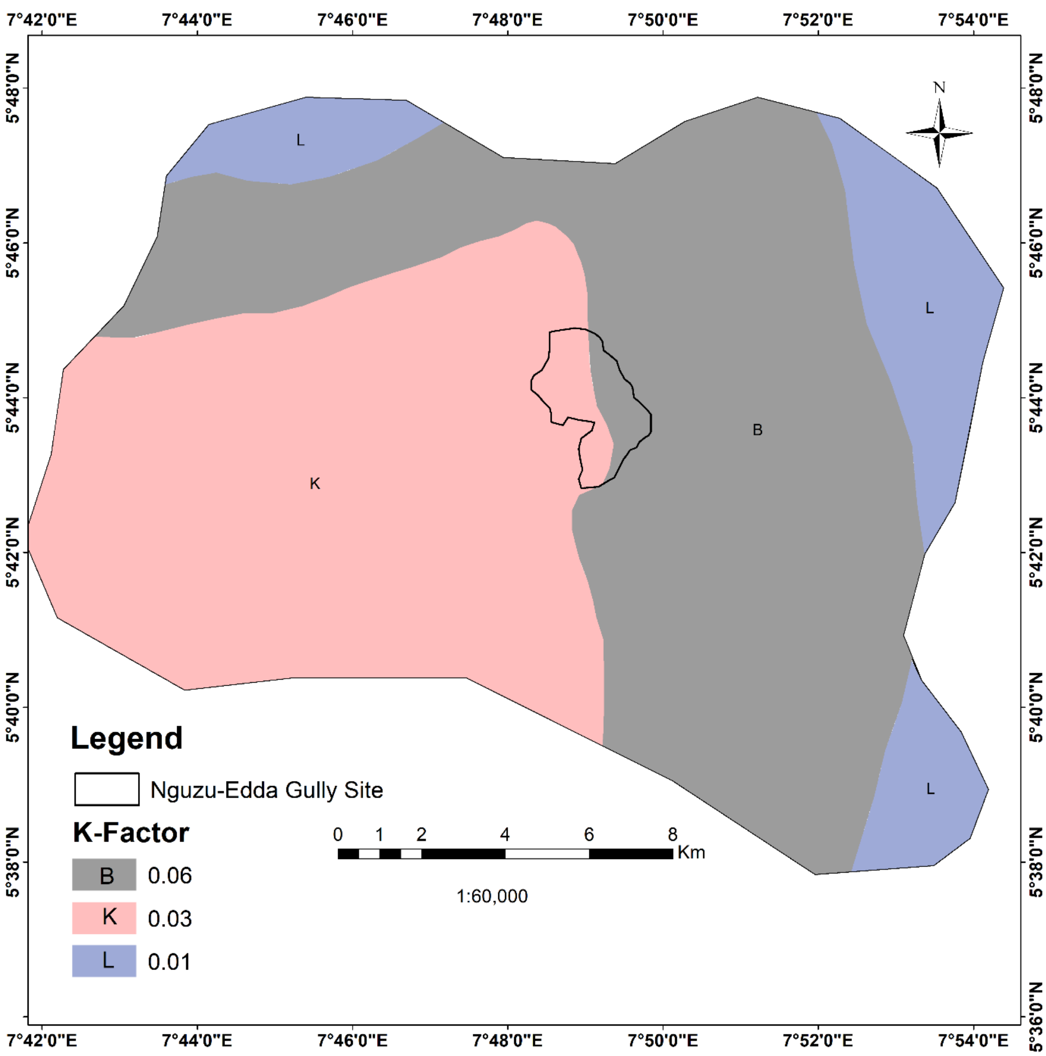

Figure 3: Spatial Dispersion Map of K-Factor in the Nguzu-Edda Watershed.

Topographic Factor

In RUSLE, the LS-factor shows the impact of topography on erosion, the slope length factor (L) depicts the influence of slope length on erosion, and the slope angle factor (S) indicates the effect of slope inclination on erosion [25] (Bocco, et al., 1990). The kind of slope with other topographic features can give an idea of soil degradation prospect of an area. Thus, ASTER-DEM of 2020 at 30 m pixel size were employed to produce the LS-factor map using assigned threshold values.

Cover and Management Practices Factor

The C-factor is used to show the effect of management and the farming practices on the level of soil erosion in ranch lands and the effect of vegetation covers on limiting the soil erosion in woody regions (Yue-Qing, et al., 2008), which changes with time and crop production system. In this investigation, the land use/land cover map was readily interpreted from Lands at Enhanced Thematic Mapper plus (ETM+) Image of the year 2020 by using visual interpretation and supervised classification methods using Arc GIS 10.5 software to determine the C-factor values.

The effects corresponding to the management can be contrasted through the variation in the C-factor which changes from absolutely zero (a very well conserved land cover) to that of the areas that are barren (Enyankwere, et al., 2015). The factor of C in the regional scale could be obtained in the scale of the plot. This possible when there is plenty of primary data used for plots or determined qualitatively when there is insufficient primary data (Fu, et al., 2005). Figure 5 shows the C-factor spatial distribution.

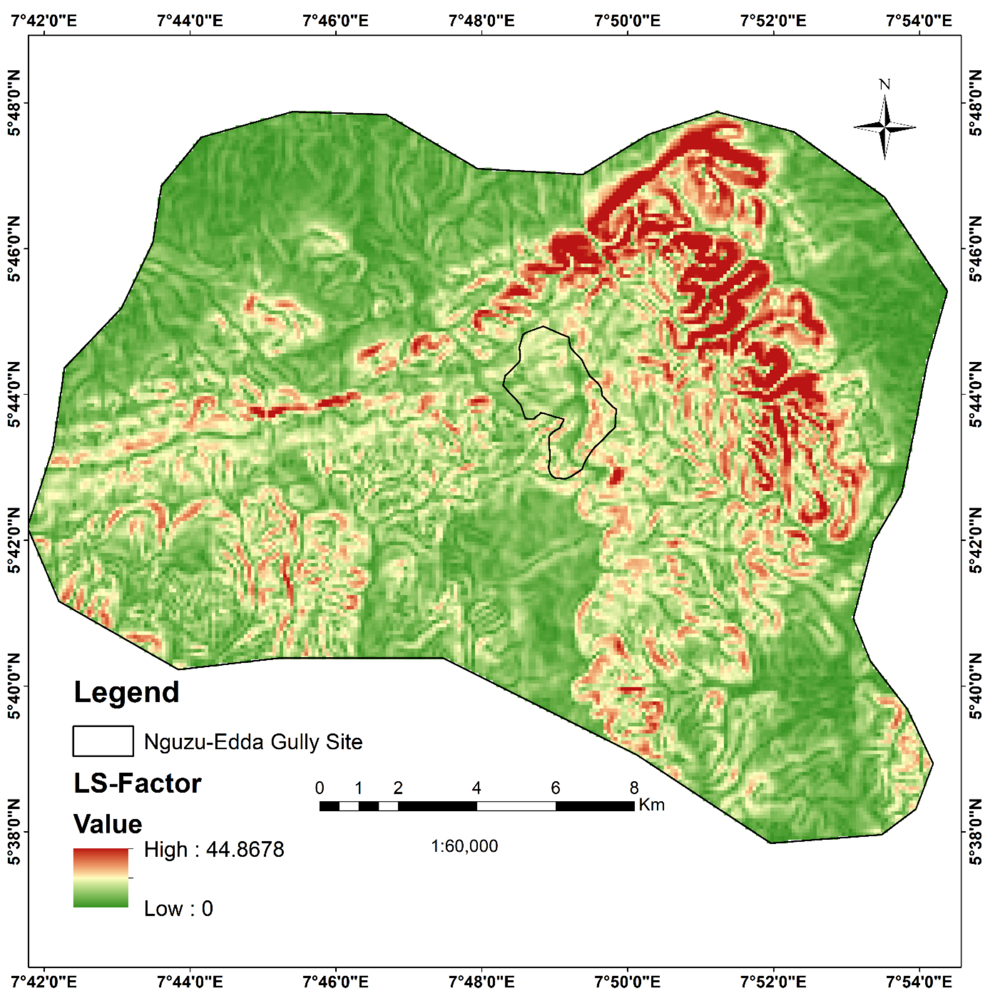

Figure 4: Spatial Dispersion Map of LS-Factor in the Nguzu-Edda Watershed.

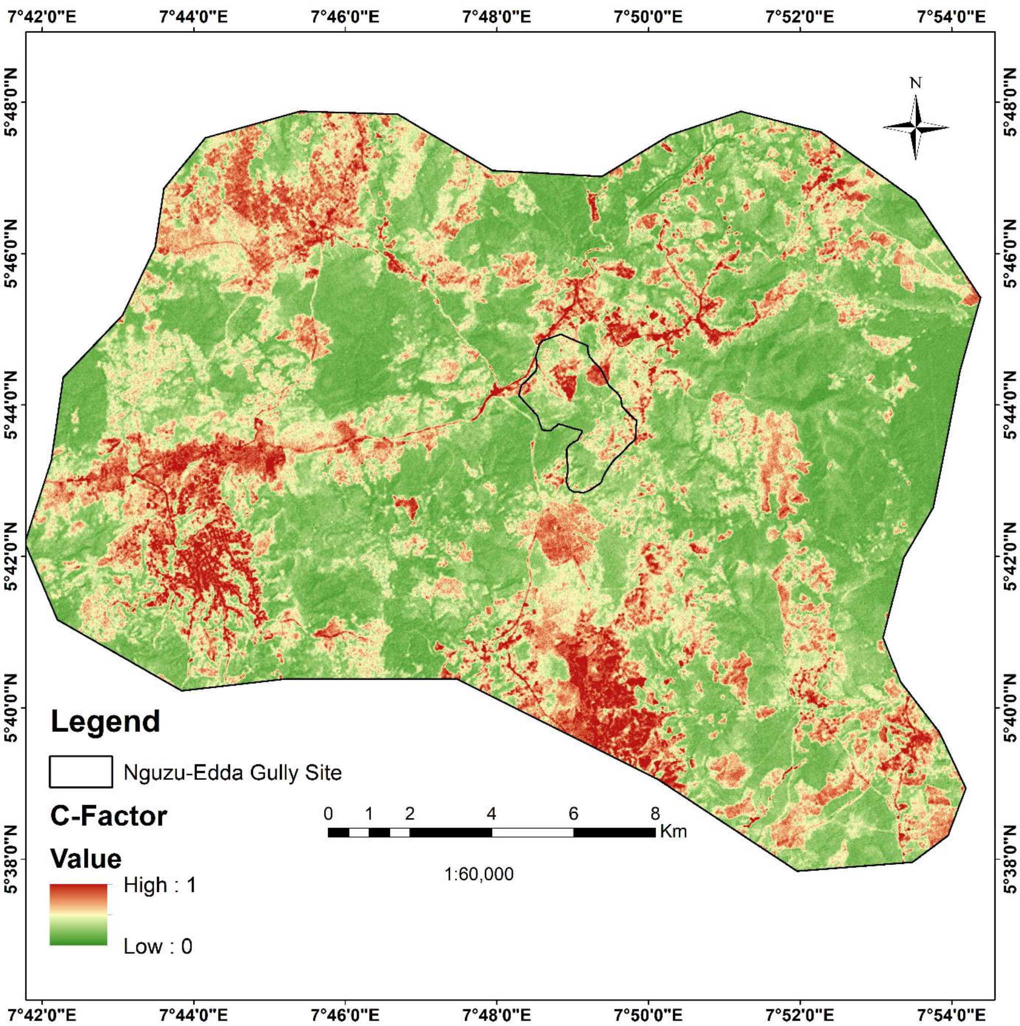

Figure 5: Spatial Dispersion Map of C-Factor in the Nguzu-Edda Watershed.

Support Practice Factor

The P factor is the proportion of soil loss with an explicit help practice to the general misfortune with steep incline and low-lying slant land (Amah, et al., 2020). The lesser the P value, the much efficient the preservation practice is considered to be at lowering soil erosion. As per field investigation and suitable data, the soil preservation techniques took on in the Nguzu-Edda watershed are terracing, contour field, and greater part of the dry lands are up and low land lacking conservation support practices.

In the recent research, very few assessments on the estimation of P factor for farmland in Nguzu-Edda and subjective data were utilized by not many of published articles (Yahya, et al., 2013; Nwakor, et al., 2015).

Development regions, meagerly vegetated, thickly vegetated and farmlands, without protection support rehearses, were credited to one. Thusly, the mean worth of P for each map layers was mastered organizing the conversation practices acquired from the field assessment. Figure 6 shows the spatial dispersion map factor of P.

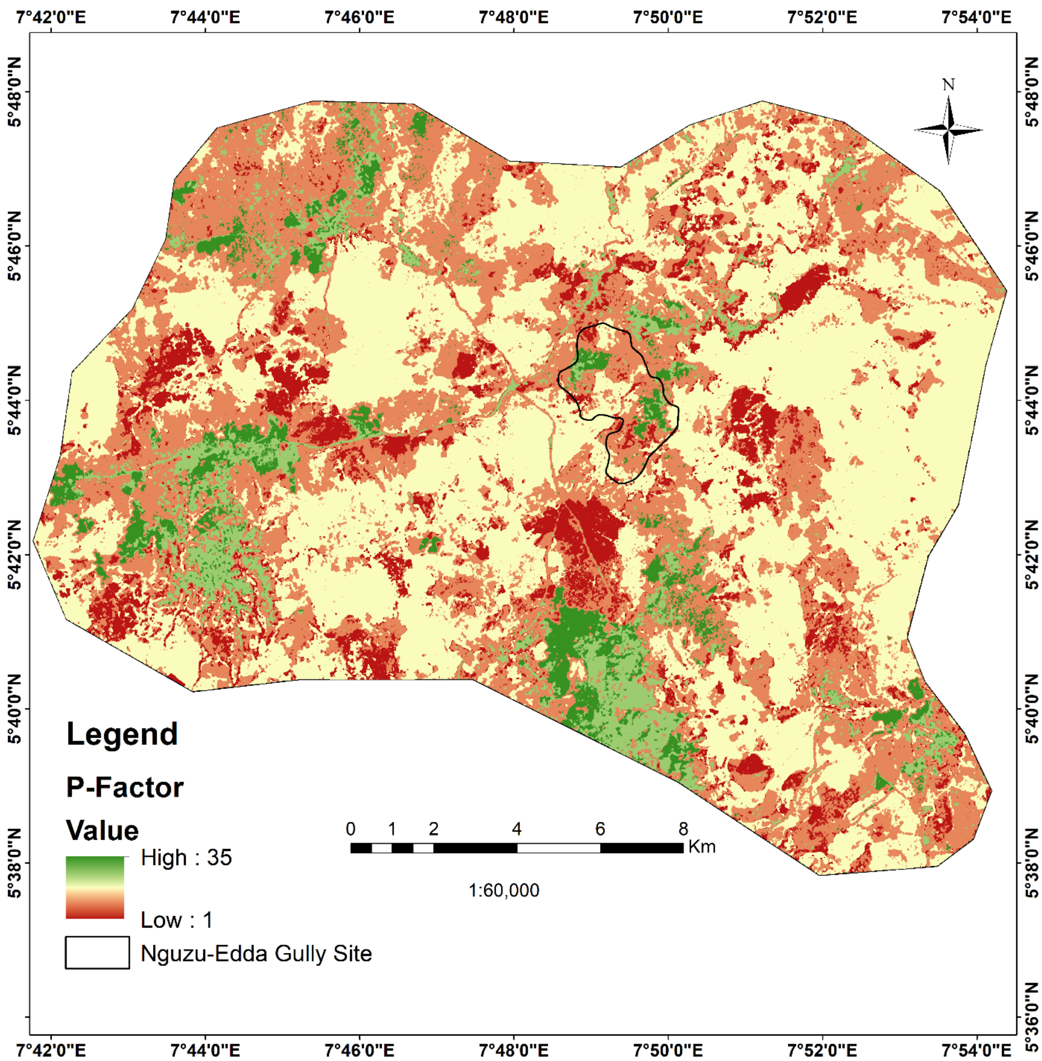

Figure 6: Spatial Dispersion Map of P-Factor in the Nguzu-Edda Watershed.

The five topical layers were changed over to grid plots with 25 m×25 m pixel size in a dependable organize framework. From there on, the GIS input information were increased, as described by the RUSLE, to ascertain yearly soil loss on a spatial goal premise, and the spatial resolution basis, and the spatial distribution of the soil erosion in the area of study (Figure 7).

Evaluation on Soil Erosion Hazard Region

Based on the Soil Erosion Rate Standard, Technological Standard of Soil and Water Conservation. The rate of the soil erosion was ranked into five count sections as demonstrated in Table 3. In order to examine the connectivity between soil erosion and ecological factors, the elevation and slope maps were generated, which were extracted from the ASTER-DEM, and the land use map was converted to raster with a pixel size of 25×25 m, which bears common reference style and resolution as the soil degradation map. Subsequently, the spatial dissemination map of soil loss was superimposed by land use, elevation, and slope maps, to evaluate the spatial dissemination of the soil degradation and distinguish the erosion danger zones in the watershed within GIS platform adopting the Spatial Analyst system.

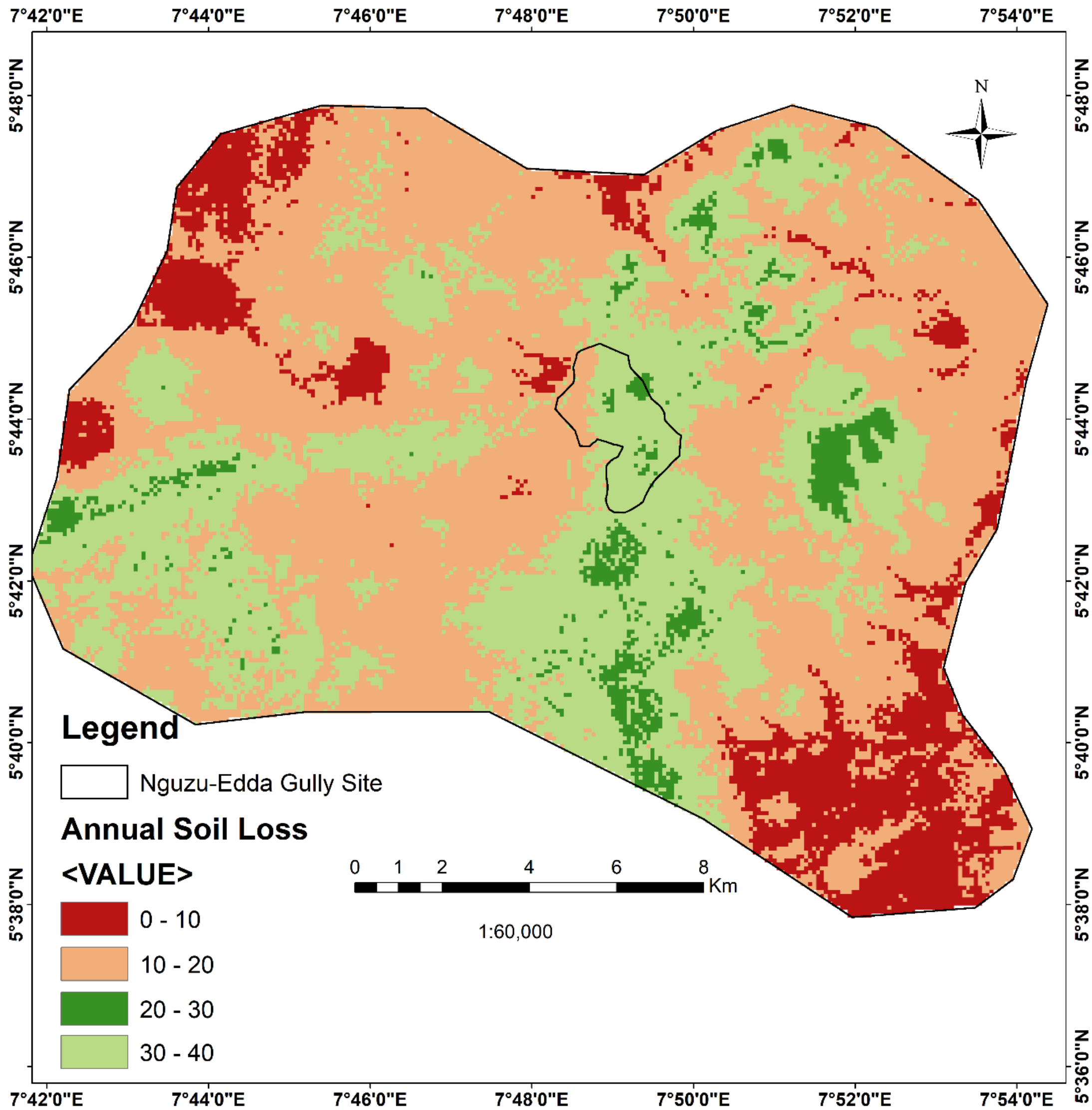

Figure 7: Spatial Distribution of Soil Loss in the Nguzu-Edda Watershed.

RESULTS AND DISCUSSIONS

The value of mean annual R factor varies from 1, 502 to 1,819 MJ mm ha^{-1} h^{-1} $year^{-1}$ and the mean value is 1,660.5 MJ mm ha^{-1} h^{-1} $year^{-1}$ as well as 224.2 being the standard deviation. There is much precipitation erosivity in the central and southern part of the watershed compared to the northern and eastern parts which has a close association with the declining trend of precipitation from the east-west to the northern section and heterogeneity of spatial dispensation of precipitation in the study area.

The K value in the Nguzu-Edda ranges from 0.01 to 0.05 and the average value is 0.03 t ha h $MJ^{-1}ha^{-1}$ mm^{-1}. The standard deviation is 0.025. As can be viewed from the soil erodibility map; K factor value is greater in the central compared to other areas, apart from few zones in the southern side of study area.

RUSLE-Factors

The value for R, K, LS, C, P factors are shown in Table 1.

Table 1: Values of R, K, LS, C and P.

Parameter	R factor	K factor	LS factor	C factor	P factor
Min	1502	0.01	0.00	0.00	1.00
Max	1819	0.06	44.87	1.0	35.00
Mean	1660.5	0.03	22.43	0.5	18.00
SD	224.2	0.025	25.89	0.57	24.04

The mean values of annual R factor are 1,502 - 1,819 MJ mm ha^{-1} h^{-1} $year^{-1}$, whereas 1,660.5 and 224.2 are the mean value in MJ mm ha^{-1} h^{-1} $year^{-1}$ and standard deviation, respectively. The southern and central part of the watershed has higher precipitation erosivity than that of eastern and northern parts. This is because, the later has a near association with the reducing trend of precipitation from there and the study area has different spatial dispensation of precipitation in the area of study.

The value of K value in the area of study, is from 0.01 to 0.05 with average value of 0.03 t ha h MJ^{-1} ha^{-1} mm^{-1} (Figure 4), while 0.025 is the standard deviation. As can be seen from the soil erodibility map, The value of K factor value is bigger in the central than those in the other areas, excluding those of little zones from the southern part of study area.

Nguzu-Edda watershed is described by declining topographic values from east to with, with a highest drop of 273 m. The north-eastern zone of the watershed possesses the maximum variability in topography, the steepest slopes and, as an effect, the highest LS values. It can be deduced from Figure 5 that the LS factor value in the research area ranges from 0 to 44.87 and the average value is 22.43, most of the research area possess LS values below 5. Few areas with steep slopes, such as in the north-eastern part of the watershed, possess LS values of above 20.

The C-factor value ranges from 0 to 1 and the average value is 0.5 (Figure 6). Due to the broad area of farmland situated in the higher topography, section of the down slope, the greater C-factor value occurs in that region as well.

The P factor value ranges from 1 to 35 and the mean value is 18 (Figure 7). Due to the vast area of densely vegetation is found in the eastern and central parts of the watershed, the greater P-factor value occurs in that region as well.

Annual Soil Loss

The mean annual soil loss in the Nguzu-Edda watershed was calculated by superimposing the five factor layers adopting RUSLE. As displayed in Figure 7, the mean annual soil loss in majority of the study region is between 10 and 40 t ha^{-1} $year^{-1}$ and the average value is 25 t $ha^{-1}year^{-1}$. Based on the spatial fluctuation, the central and south-eastern sections of the study area, few particular areas in excess of 150 t $ha^{-1}year^{-1}$, possess more erosion compared to the north-western section.

The justification for soil loss is closely associated with slope, land cover and rainfall erosivity. The computation results in agreement with the other researchers conducted in the study area (Amagu, et al., 2018; Okonufua. et al., 2019; Amah, et al., 2020), which indicated that it is a viable approach and technical method to use the GIS tools and RUSLE model to calculate the soil erosion loss in Nguzu-Edda.

Evaluation on Soil Degradation Risk Area

The extensive output of foreseen soil loss was separated into four distinct classes as indicated in Table 2. Major zones of the watershed are found in the moderate erosion class (45.03 %), which are mainly found in the eastern and western parts of the watershed. Roughly 20% of the watershed are surrounded between high to severe erosion risk, which are majorly identified in the central part of the watershed. Considering the overall rate of soil loss, approximately 76.34 % of the overall soil loss took place in the area of low to moderate erosion and roughly 23.66 % took place in the area of high to severe erosion. Therefore, management practices should be undertaken in the areas of high to severe risk erosion so as to minimize soil loss.

Table 2: Area and Amount of Soil Loss of Each Soil Erosion Risk Category.

Erosion categories	Numeric range (t $ha^{-1}year^{-1}$)	Area ($\times 10^4$ha)	Area percentage (%)	Soil loss ($\times 10^4$ t $year^{-1}$)	Soil loss percentage (%)
Low	0-10	8.91	31.31	100.10	7.24
Moderate	10-20	11.23	45.03	126.42	12.63
High	20-30	2.11	8.57	148.18	17.82
Severe	30-40	4.52	15.09	219.37	62.31

Table 3: Area of Soil Erosion Risk Categories on Elevation Zones.

Percentage of soil loss area amount (%)	Low	Moderate	High	Severe	Total
<200	0.10	0.06	0.02	0.08	0.26
200-220	0.15	0.16	0.12	0.24	0.67
220-240	0.74	0.38	0.25	0.41	1.78
240-260	15.6	14.43	6.19	5.34	41.56
260-280	10.64	9.62	4.47	5.87	30.6
280-300	8.93	7.21	3.54	4.11	23.79
300-320	0.52	0.19	0.10	0.53	1.34
Total	36.68	32.05	14.69	16.58	100.00

Table 4: Soil Loss Amount of Erosion Risk Categories on Elevation Zones.

Percentage of soil loss amount (%)	Low	Moderate	High	Severe	Total
<200	0.00	0.05	0.10	0.68	0.83
200-220	0.00	0.08	0.68	1.28	2.04
220-240	0.02	0.35	1.54	4.62	6.53
240-260	4.43	6.26	7.01	13.79	31.49
260-280	2.39	4.53	8.87	20.83	36.62
280-300	1.12	3.72	3.05	11.6	19.49
300-320	0.09	1.43	0.43	1.05	3.00
Total	8.05	16.42	21.68	53.85	100.00

The soil degradation related with distinct altitude areas are given in Tables 3 and 4. Roughly 72.16 % of the erosion zone and 68.11 % of the overall soil loss are located in the area between 240 and 280 m. Majority of the areas with low to severe risk erosion are situated in the zone between 240 and 280 m. This indicated the strong association with the topographical features of the Nguzu-Edda watershed, where above 72.16 % of the landmass possesses topography above 240 m. Hence, it is important to carry preservation practices in the area between 240 and 280 m to minimize soil loss.

As observed from soil degradation on distinct slope areas (Tables 5 and 6), approximately 71.75 % of the erosion zone and roughly 71.65 % of the overall soil loss take place in the area with slope below 6°. Specifically, greater values are viewed in the area with slope between 3 and 6°, showing roughly 49.27 % of the erosion zone and 45.83% of the overall loss, respectively. Majority of the zones depicting between low to moderate soil erosion are observed in the area with slope below 3°, and the high to severe risk erosion are majorly occur in the area with slope between 3 and 6°. Hence, the area with slope between 3 and 6° are considered as the main donor to soil loss, has grievous erosion issues, where soil preservation measures should be taken into account to mitigate the grievous soil loss.

The soil degradation map was superimposed with land use pattern and the distribution of the erosion risk classes on various land use pattern was examined (Tables 7 and 8). Results reveal that 63.03 % of the farmlands have low to moderate erosion risk, and 36.97% of the farmlands have a high to severe erosion risk.

Table 5: Area of Soil Erosion Risk Categories on Slope Areas.

Percentage of soil loss amount (%)	Low	Moderate	High	Severe	Total
<3°	8.29	4.93	4.63	5.56	23.41
3-6°	24.15	10.16	7.4	7.56	49.27
6-9°	10.72	4.4	3.4	3.96	22.48
>9°	1.74	1.48	0.89	0.73	4.84
Total	44.9	20.97	16.32	17.81	100.00

Table 6: Soil Loss Rate of Erosion Risk Categories on Slope Areas

Percentage of soil loss amount (%)	Low	Moderate	High	Severe	Total
<3°	3.09	2.58	2.24	17.91	25.82
3-6°	5.02	8.13	6.42	26.26	45.83
6-9°	4.23	5.79	7.41	4.09	21.52
>9°	0.51	1.09	2.22	3.01	6.83
Total	12.85	17.59	18.29	51.27	100.00

Table 7: Area of Soil Erosion Risk Categories on Land Use Types.

Land use types	Erosion categories	Area (ha)	In land use types (%)	In total watershed (%)
Farmland	Low	51,690.89	19.7	4.23
	Moderate	96,099.28	43.33	19.86
	High	40,025.91	14.73	1.91
	Severe	57,461.08	22.24	6.62
	Total	245,277.16	100	32.62
Built Up	Low	61,573.12	25.86	12.09
	Moderate	45,201.36	19.9	6.48
	High	33,659.07	15.29	3.11
	Severe	93,994.46	38.95	17.42
	Total	234,428.01	100	39.1
Dense Vegetation	Low	58,204.18	41.38	12.67
	Moderate	46,861.21	23.50	6.01
	High	40,124.31	18.92	5.45
	Severe	10,249.00	16.20	2.34
	Total	155,438.70	100	26.47
Sparse Vegetation	Low	48,391.38	38.80	7.09
	Moderate	39,335.41	20.87	4.18
	High	40,518.11	17.13	5.59
	Severe	63,764.09	23.20	14.21
	Total	192,008.99	100	31.07

Table 8: Soil Loss Amount of Erosion Risk Categories on Land Use Types.

Percentage of soil loss amount (%)	Low	Moderate	High	Severe	Total
Farmland	0.09	1.01	3.19	4.11	8.40
Build-up area	5.11	8.22	11.21	28.46	50
Dense Vegetation	4.80	1.61	0.25	0.0332	6.69
Light Vegetation	3.56	8.32	8.68	13.385	33.94

Majority of the buildup areas (84.71%) do not possess grievous issues. Densely vegetated zones have a considerable effect on soil erosion preservation, and 64.88 % of which possess a low to moderate erosion risk. Sparsely vegetated do possess grievous erosion issues, just 40.33 % of the sparsely vegetated are found within high to severe erosion risk.

As related to soil loss on land use patterns, majority of the overall loss happens in the farmland zones (8.4%) and sparsely vegetated zones (33.94%) and just 6.69% of the overall soil loss take place in the rest of land use patterns (Table 8).

CONCLUSIONS

Soil loss is a dangerous issue in south-eastern Nigeria and assessment soil loss and soil degradation risk are important for acceptable land use and extensive soil preservation management. Owing to the spatial and temporal instability of landscape and land use, high delivery expenses, and the period required to gather information, there are predicament in evaluating soil degradation over vast regions with conventional approaches. Moreover, these issues can be conquered by applying predictive models and modern approaches.

Using RUSLE and GIS, present investigation developed and used an unsophisticated approach to anticipate soil loss and soil degradation risk at a regional watershed scale. The RUSLE model and GIS and RS approaches were greatly useful in present research to evaluate soil loss and erosion risk. The approach and results delineated in present research are useful for understanding the association between soil degradation risk and ecological factors and are profitable for managing and planning land use that will avert soil erosion.

Availability of Data and Materials

The data and materials used in the course of the study are available from the corresponding author and on reasonable request.

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