INTENSIFICATION OF SEDIMENT LOSS ON LAND SURFACES IN CALABAR RIVER CATCHMENT, CROSS RIVER STATE, NIGERIA

ABUA, M.A.[1], ABALI, T.P[2], IGELLE, E. I[1].

Abstract: Intensification of sediment loss on land surfaces in calabar river catchment, cross river state, Nigeria. Soil loss is a direct consequence of soil erosion which is a function of rainfall amount, intensity and duration as well as surface configuration (relief/slope), nature of surface materials and vegetation. The study on the intensification of sediment loss on land surfaces in Calabar River Catchment, Cross River State, Nigeria was conducted, with the aim of examining intensification of sediment loss on land surfaces in Calabar. Sediment loss, rainfall amount, rainfall intensity, slope gradient, slope length, particles size and infiltration capacity were measured. Field measurement and Regression model were used in the study. The results revealed that sediment loss on the various land surfaces were 14.9477 kg/m^2 for urban land surface, bare surface 33.9138kg/m^2, farmland 28.7754kg/m^2, grassland 33.4992 kg/m^2 and forest surface 5.6646kg/m^2 respectively *(Table I).* Rainfall amount were 41.7385mm for urban land surface, bare surface 41.7385mm, farmland 41.7385mm, grassland 41.7385mm and forest land 41.7385mm respectively. Rainfall intensity were 89.4397mm/hr for urban land surface, bare surface 75.8882mm/hr, farmland 58.2398mm/hr, grassland 47.2512mm/hr and forest land 100.1724mm/hr. Slope gradient were 52.0000% 52.0000%, 52.0000%, 52.0000%, and 47.6292% for urban surface, bare surface, farmland, grassland, forest land respectively. Slope length were 5.2020m for urban land surface, bare surface 4.0180m, farmland 4.6177m, grassland 4.5746m and forest land 15.4364m. The particles sizes result for land surface sandy, silt and clay were 58.0%, 11.0% and 31.0% respectively. Bare surface sandy, silt and clay were 49.0%, 13.0% and 38.0% respectively. Farmland sandy, silt and clay were respectively 48.0%, 18.0% and 34.0%. Grassland sandy, silt and clay were 56.0%, 12.0% and 32.0%, and forestland sandy, silt and clay were 57.0%, 7.0% and 36.0% respectively. Vegetation cover were 4.2467m^2 for urban surface, bare surface 1.0263m^2, farmland surface 2.3462m^2 grassland surface 5.0917m^2 and forest surface 7.0705m^2. Infiltration capacity were 4.8200cm/hr for urban land surface, bare surface 5.9554cm/hr, farmland 4.7831cm/hr, grassland 4.5015cm/hr, and forest land 5.0723cm/hr respectively. Sediment loss was more intense on bare surface, grassland and farmland with their respective values of 33.9138kg, 33.4992kg and 28.7754kg. while forested land surface had the least

[1] Department of Geography and Environmental Science, University of Calabar, Calabar, Nigeria

[2] Department of Geography and Environmental Management University of Portharcourt, Portharcourt, Nigeria. Email: ask4mossabua@yahoo.com

sediment loss value of 5.6646kg with rainfall amount of 41.7385mm and rainfall intensity of 5.682mm/min. The regression results for the urban, bare, farmland and grassland surfaces indicated that slope gradient and slope length contributed much to sediment loss. Rainfall amount, rainfall intensity, particle size and infiltration capacity contributed little to sediment loss in urban, bare, farmland and grassland. The study recommended that sediment losses requires reforestation aim at increasing the vegetation cover and infiltration capacity of the soil.

Keywords: Intensification; Sediment Loss; Rainfall; Land uses; Calabar River Catchment.

1. INTRODUCTION

Sediments are materials of variable size of organic origin (Caribbean Environment Programme, 2015). The intensification of sediment loss is the level of soil material deposits loss in a particle land surfaces. Some of the factors that influences sediment loss are rainfall amount, rain intensity, erosion, infiltration, soil particle size, slope gradient and slope length. During rainy season, raindrops bombards the urban surface, bar surface, grassland surface, farmland surface and forest ground. This bombardment can cause losses of material deposits on land surfaces. The material deposits on land surfaces can migrate based on the nature of the slope gradient. Different land surfaces may have different level of sediment loss depended on the intensity of rainfall, surface runoff, infiltration rate and slope gradient. Sediment loss from land surfaces can be influence by rainfall intensity, slope gradient, slope length, particles size and infiltration capacity (Abali & Abua, 2016; Abua, 2017; Abua, Abali & Oka, 2018).

Palmer's (2012) study on agricultural fine sediment based on the sources, pathways and migration in the North East England, identified the distinctiveness of agricultural sediment loss processes in a slowly permeable tile-drain land. The field scale surface tile-drains appears to be the major sediment loss pathway due to their high permanent connectivity with surface runoff. Derpsch's (2001) study at the No-Till on the plains Winter Conference in Salina, Kansas, revealed that runoff and erosion start with raindrop impact on bar soil surface. The rain bombards the soil surface and scattered the soil particles in all direction. Tamene, Park, Dikau & Vlek (2006), study on assessment of the role of different catchment attributes in the siltation of reservoirs in the dry land of Northern Ethiopia, discovered that pronounced terrain steepness, easily detachable slope material, poor surface cover and gullies accelerate siltation in the reservoirs.

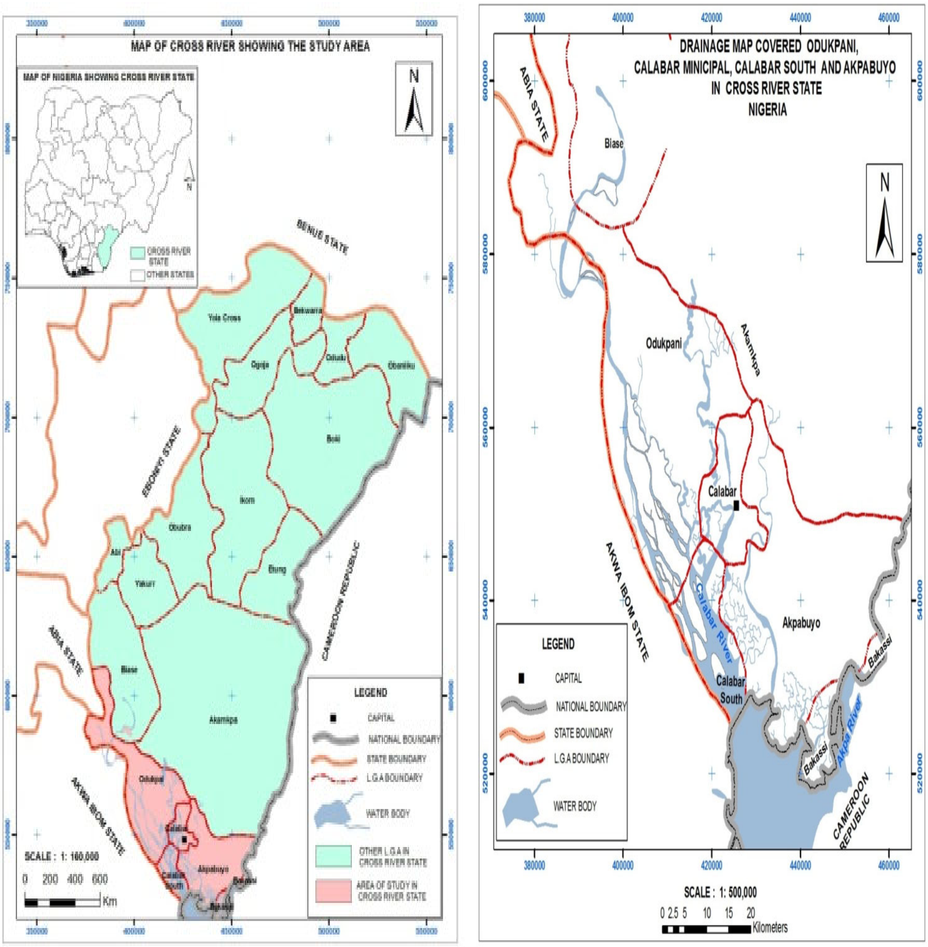
Pal (2009) study on soil loss shows that soil loss increases with increase in erosivity, and erosivity depends on both rainfall amount and rainfall intensity. Ho-Jun, Shin-chan, Sang-Ho, Sang-Soon, Seong-jun, Sang-Keon & Seung-Oh's (2010) study on the effect of soil physical properties, runoff and infiltration water on soil erosion characteristics under rainfall simulator conditions of the Jeju soil in Korea shows a relationship between soil erosion and runoff. Studies on land cover dynamics, soil loss and infiltration capacity of soil has been conducted in Porthartcourt and Calabar by (Akpan, 1995; Eze, Eni, & Oko, 2010; Abua & Digah, 2015; Oyegun, Umeuduji, Abali, & Abua, 2016; Abua, 2017; Abua, etal., 2018). There is dearth in literature on the intensification of sediment loss on land surfaces in Calabar River Catchment, Cross River State, Nigeria. It is against this limitation that form the thrust of the study with the aim of examining the intensification of sediment loss on land surfaces in Calabar River Catchment, Cross River State, Nigeria.

The study area lies between latitudes $4^{0}45^{1}$N and $5^{0}10^{1}$N and Longitude $8^{0}05^{1}$ and $8^{0}05^{1}$ E. The study area is within the Hydrological Boundary of the Calabar river system *(Figs. Ia &I.b)*. The lower Calabar river is a fourth-order river catchment. The river has an estimated area of 2,340 km^2. The catchment area coves the present Calabar South, Calabar Municipality and parts of Akpabuyo and Odukpani Areas of Cross River State (Abua, Kofi, Edide, Obiefuna & Ogar, 2017).

The Calabar river takes its source from the Oban hills in Akamkpa and flows Southwards through the tropical rainforest of South-Eastern part of Nigeria before discharging into the Cross River estuary (Akpan, 2002). It belongs to the lowland/swamplands of the South-eastern Nigeria (Petters, 1989; lloeje, 1991). Plains are the dominant features of the landscape of the area around Calabar (Ofomata, 1975). The Southern Cross River State which constitutes the present area of study is lowland underlain by the coastal plain sands which do not rise much above 68 meters, except at Oban hill with the height of 300 meters (Udofia & Inyang, 1987). The uniformity of the terrain is thus unique being most completely devoid of physiographic differentiations. However, vast interfluves being characterized by dry valleys which break the uniform terrain into undulating depressions and low hills in the middle and northern part of the area Abali, etal., 2016; Abua, 2017).

2. MATERIALS AND METHODS

Throughout the fieldwork exercise, 65 events were carried out for each land surface measuring sediment loss, rainfall amount, rainfall intensity, slope gradient, slope length, particle size, vegetation cover and infiltration capacity. Rainfall amount and intensity were measured using standard rain gauge mounted at a height devoid of vegetation obstruction. A 100mm plastic rain gauge cylinder with markings on the inner cylinder down to 0.25mm was used. Rainfall intensity was determined using Rainfall intensity (mm/min) equal to Rainfall amount (mm) allover Rainfall duration (min). Slope gradient and slope length were measured using (King, 1966) and (Young, 1964) method. Particle size was obtained using Robinsons pipette method. Infiltration capacity was measured using soil capillary method.



Figs. Ia. & Ib. Showing the map of the study area and drainage. Source Geography and Environmental Science GIS Laboratory.

Field work was conducted on sediment loss and 65 events were measured from various land surfaces. The measurement of five experimental plots of urban, farmland, grassland, bare surface and forest surface were carried out. A 2-inch pipe in the midway of the lower boundary of each plot land surface type at 5.4m^2 to a metal sediment box 31×23cm was used. This was arranged in a convex slope series on a foothill at 20% gradient slope oriented parallel to the topography. Sediments were removed from the sediment box and taken to the Laboratory for analyses. The samples were placed in a Gallekamp Hotbox oven dried between 105-110^{0}C and the weight scaled in (kg/m) with the aid of a measurement balance.

The regression model was used for the analysis, using IBM SPSS Software version 22. The variables are sediment loss, rainfall amount, rainfall intensity, slope gradient, slope length, particle size, vegetation cover and infiltration capacity.

3. RESULTS AND DISCUSSION

The results revealed that sediment loss on the various land surfaces were 14.9477 kg/m^2 for urban land surface, bare surface 33.9138kg/m^2, farmland 28.7754kg/m^2, grassland 33.4992 kg/m^2 and forest surface 5.6646kg/m^2 respectively *(Table I).*

Table I. Intensification of sediment loss on land uses

VARIABLES	LAND USES					
	Urban surface	Bare surface	Farm Land	Grass land	Forest ground	Total
Sediment loss (kg/m^2) (x)	14.9477	33.9138	28.7754	33.4992	5.6646	116.8007
Rainfall amount (mm) (x)	41.7385	41.7385	41.7385	41.7385	41.7385	208.6925
Rainfall intensity (mm/min -(x)	0.5682	0.5682	0.5682	0.5682	0.5682	2.841
Slope Gradient (%) (x)	52.0000	52.0000	52.0000	52.0000	47.6292	255.6292
Slope Length (m) (x)	5.2020	4.0180	4.6177	4.5746	15.4364	33.8488
Particle size (kg)	3.0000	3.0000	3.0000	3.0000	3.0000	15
Sand (%)	58.0	49.0	48.0	56.0	57.0	268.0
Silt (%)	11.0	13.0	18.0	12.0	7.0	61.0
Clay (%)	31.0	38.0	34.0	32.0	36.0	171.0
Total %	100	100	100	100	100	500
Vegetation cover (m^2)	4.2469	1.0263	2.3462	5.0917	7.0705	19.7816
Infiltration capacity (cm/hr)(x)	4.8200	5.9554	4.7831	4.5015	5.0723	25.1323

Source: Researchers' fieldwork, (2015).

Rainfall amount were 41.7385 mm for urban land surface, bare surface 41.7385 mm, farmland 41.7385 mm, grassland 41.7385 mm and forest land 41.7385 mm respectively. Rainfall intensity were 89.4397mm/hr for urban land surface, bare surface 75.8882 mm/hr, farmland 58.2398 mm/hr, grassland 47.2512mm/hr and forest land 100.1724 mm/hr. Slope gradient were 52.0000% 52.0000%, 52.0000%, 52.0000%, and 47.6292% for urban surface, bare surface, farmland, grassland, forest land respectively. Slope length were 5.2020 m for urban land surface, bare surface 4.0180 m, farmland 4.6177 m, grassland 4.5746 m and forest land 15.4364 m. The particles sizes result for land surface sandy, silt and clay were 58.0%, 11.0% and 31.0% respectively. Bare surface sandy, silt and clay were 49.0%, 13.0% and 38.0% respectively. Farmland sandy, silt and clay were respectively 48.0%, 18.0% and 34.0%. Grassland sandy, silt and clay were 56.0%, 12.0% and 32.0%, and forestland sandy, silt and clay were 57.0%, 7.0% and 36.0% respectively. Vegetation cover were 4.2467 m^2 for urban surface, bare surface 1.0263 m^2, farmland surface 2.3462 m^2 grassland surface 5.0917 m^2 and forest surface 7.0705 m^2. Infiltration capacity were 4.8200 cm/hr for urban land surface, bare surface 5.9554 cm/hr, farmland 4.7831 cm/hr, grassland 4.5015 cm/hr, and forest land 5.0723 cm/hr respectively.

Table II a. Measured attributes of 65 events for Urban surface

Variables	Mean	Std. Deviation	N
Sediment loss Y	14.9477	6.26488	65
Rainfall x_1	41.7385	32.70099	65
Rainfallintensity x_2	.5682	.86310	65
SlopeGradient x_3	52.0000	18.90767	65
SlopeLength x_4	5.2020	.18631	65
Particlesize x5	3.0000	1.42522	65
Vegetation Cover x_6	4.2469	.85387	65
InfiltrationCapacity x_7	4.8200	5.00379	65

Table II b. Summary of regression analysis for urban surface

Model	R	R Sq	Adj R Square	Std. Error of the Estimate	Change Statistics					Durbin Watson
					R square Change	F Change	df1	df2	Sig. F Chang	
1	.434[a]	.189	.176	5.68785	.189	14.644	1	63	.000	
2	.488[b]	.238	.144	5.79591	.049	.612	6	57	.720	1.962

a. Predictors: (Constant), x1: b. Predictors: (Constant), x_1, x_7, x_5, x_6, x_3, x_2, x_4: c. Dependent Variable: Y

Sediment loss was more intense on bare surface, grassland and farmland with their respective values of 33.9138kg, 33.4992kg and 28.7754kg. while forested land surface had the least value of 5.6646kg with rainfall amount and intensity of 41.74m and 5.682mm/hr.

The measured mean attributes for 65 events of urban surface are sediment loss 14.9477kg/m^2, rainfall amount 41.7385mm, rainfall intensity 0.5682mm/min, slope gradient 52.0000%, slope length 5.2020m, particle size 3.0000kg, vegetation cover 4.2469m^2 and infiltration capacity 4.8200cm/hr respectively. The model summaries are R=43.4%, R-square =18.9% and Adjusted R =17.6%. Even though the model fit looks low, the coefficients shows that there are two predictors in the model. There are several non-significant coefficients such as X_1(rainfall amount 0.128), X_2(rainfall intensity 0.209), X_5(particle size 0.020) X_6(vegetation cover 0.150) and X_7(infiltration capacity 0.271), indicating that these variables do not contribute much to the model. X_3(slope gradient 4.893) and X_4(slope length 4.666) contributes more to sediment loss. This indicates that in urban surface slope gradient and slope length contribute more to sediment loss.

Table III a. Measured attributes of 65 events for Bare surface

Variables	Mean	Std. Deviation	N
Sediment loss Y	33.9138	11.56854	65
Rainfallamount x_1	41.7385	32.70099	65
Rainfallintensity x_2	.5682	.86310	65
SlopeGradient x_3	52.0000	18.90767	65
SlopeLength x_4	4.0180	.19189	65
Particlesize x_5	3.0000	1.42522	65
Vegetation Cover x_6	1.0263	.42638	65
InfiltrationCapacity x_7	5.9554	7.81995	65

Table III b. Model Summary[c] of regression analysis for bare surface

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.505[a]	.255	.243	10.06568	.255	21.538	1	63	.000	
2	.689[b]	.475	.410	8.88618	.220	3.972	6	57	.002	2.452

a. Predictors: (Constant), x1: b. Predictors: (Constant), x_1, x_7, x_5, x_6, x_4, x_2, x_3: c. Dependent Variable: Y

The values of the partial and part correlations drop sharply from the zero-order correlation. This means that much of the variance in sediment loss that was explained by slope gradient and slope length is also explained by other variables (Table IIa & IIb).

The measured mean attributes for 65 events of bare surface are sediment loss 33.9138kg/m^2, rainfall amount 41.7385 mm, rainfall intensity 0.5682 mm/min, slope gradient 52.0000%, slope length 4.0180 m, particle size 3.0000kg, vegetation cover 1.0263 m^2 and infiltration capacity 5.9554 cm/hr respectively. The model summary was R 50.5%, R-square 25.5% and Adjusted R 24.3%. Even though the model fit looks small, the coefficients shows that there are two predictors in the model. There are several non-significant coefficients such as X_1(rainfall amount 0.965), X_2(rainfall intensity 0.445), X_5(particle size 0.012) X_6(vegetation cover 0.049) and X_7(infiltration capacity 0.231), indicating that these variables do not contribute much to the model. X_3(slope gradient 26.606) and X_4(slope length 26.356) contributes more to sediment loss. This indicates that in bare surface slope gradient and slope length contribute more to sediment loss.

The second section of the coefficients table shows that there might be a problem with multicollinearity. For most predictors, the values of the partial and part correlations drop sharply from the zero-order correlation. This implies that much of the variance in sediment loss that is explained by slope gradient and slope length is also explained by other variables (Table IIIa & IIIb.).

Table IV a. Descriptive Statistics of farmland surface

Variables	**Mean**	**Std. Deviation**	**N**
Sediment loss Y	28.7754	11.88435	65
Rainfallamount x_1	41.7385	32.70099	65
Rainfallintensity x_2	.5682	.86310	65
SlopeGradient x_3	52.0000	18.90767	65
SlopeLength x_4	4.6177	.18600	65
Particlesize x_5	3.0000	1.42522	65
Vegetation Cover x_6	2.3462	.82408	65
InfiltrationCapacity x_7	4.7831	5.40057	65

Table IV b. Model Summary of farmland surface

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Change Statistics**					**Durbin-Watson**
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.576[a]	.331	.321	9.79515	.331	31.212	1	63	.000	
2	.619[b]	.383	.308	9.88918	.052	.801	6	57	.573	1.804

a. Predictors: (Constant), x1: b. Predictors: (Constant), x_1, x_5, x_7, x_3, x_6, x_2, x_4: c. Dependent Variable: Y

The measured mean attributes for 65 events of farmland surface are sediment loss 28.7754kg/m^2, rainfall amount 41.7385mm, rainfall intensity 0.5682mm/min, slope gradient 52.0000%, slope length 4.6177m, particle size 3.0000kg, vegetation cover 2.342m^2 and infiltration capacity 4.7831cm/hr respectively. The model summary was R =57.6%, R-square =33.1% and Adjusted R =32.1%. Even though the model fit looks low, the coefficients shows that there are three predictors in the model. There are several non-significant coefficients such as X_1(rainfall amount 0.365), X_2(rainfall intensity 0.302), X_5(particle size 0.053) X_6(vegetation cover 0.312) and X_7(infiltration capacity 0.220), indicating that these variables do not contribute much to the model. X_3(slope gradient 8.451) and X_4(slope length 8.844) contributes more to sediment loss. This indicates that in farmland surface slope gradient and slope length contribute more to sediment loss. The values of the partial and part correlations drop sharply from the zero-order correlation. This implies that much of the variance in sediment loss that is explained by slope gradient and slope length is also explained by other variables (Table Iva & IVb).

Table V a. Descriptive Statistics of grassland surface

Variables	Mean	Std. Deviation	N
Sediment loss Y	33.4992	12.68172	65
Rainfallamount x_1	41.7385	32.70099	65
Rainfallintensity x_2	.5682	.86310	65
SlopeGradient x_3	52.0000	18.90767	65
SlopeLength x_4	4.5746	.92014	65
Particlesize x_5	3.0000	1.42522	65
Vegetation Cover x_6	5.0917	1.30598	65
InfiltrationCapacity x_7	4.5015	5.07098	65

Table V b. Model Summary[cc] of grassland surface

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Change Statistics**					**Durbin-Watson**
					R Square Change	**F Change**	**df1**	**df2**	**Sig. F Change**	
1	.400[a]	.160	.147	11.71297	.160	12.024	1	63	.001	
2	.468[b]	.219	.123	11.87368	.059	.718	6	57	.637	1.798

a. Predictors: (Constant), x1: b. Predictors: (Constant), x1, x5, x7, x6, x4, x2, x3: c. Dependent Variable: Y

The measured mean attributes for 65 events of urban surface are sediment loss 33.4992kg/m^2, rainfall amount 41.7385mm, rainfall intensity 0.5682mm/min, slope gradient 52.0000%, slope length 4.5746m, particle size 3.0000kg, vegetation cover 5.0917m^2 and infiltration capacity cm/hr 4.5015 respectively. The model summary was R =40.0%, R-square =16.0% and Adjusted R=14.7%. Even though the model fit looks poor, the coefficients indicate that there are three predictors in the model. There are several non-significant coefficients such as X_1(rainfall amount 0.592), X_2(rainfall intensity 0.102), X_5(particle size 0.025) X_6(vegetation cover 0.235) and X_7(infiltration capacity 0.143), indicating that these variables do not contribute much to the model. X_3(slope gradient 4.717) and X_4(slope length 4.783 contributes more to sediment loss. This indicates that in farmland surface slope gradient and slope length contribute more to sediment loss. The values of the partial and part correlations drop sharply from the zero-order correlation. This implies that much of the variance on sediment loss that is explained by slope gradient and slope length is also explained by other variables (Table Va &Vb).

Table VI a. Descriptive Statistics of Forestland surface

Variables	Mean	Std. Deviation	N
Sediment loss Y	5.6646	3.28726	65
Rainfallamount x_1	41.7385	32.70099	65
Rainfallintensity x_2	.5682	.86310	65
SlopeGradient x_3	47.6292	24.51358	65
SlopeLength x_4	15.4365	14.49487	65
Particlesize x_5	3.0000	1.42522	65
Vegetation Cover x_6	7.0705	.88711	65
InfiltrationCapacity x_7	5.0723	5.29013	65

Table VI b. Model Summary[c] of Forestland surface

Mo-del	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbi nWats on
					R Square Change	F Change	df1	df2	Sig. F Chang e	
1	.067[a]	.004	-.011	3.30580	.004	.284	1	63	.596	
2	.429[b]	.184	.084	3.14696	.179	2.087	6	57	.069	1.736

a. Predictors: (Constant), x1: b. Predictors: (Constant), x_1, x_7, x_5, x_4, x_3, x_6, x_2: c. Dependent Variable: Y

The measured mean attributes for 65 events of urban surface are sediment loss 5.6646kg/m^2, rainfall amount 41.7385mm, rainfall intensity 0.5682 mm/min, slope gradient 47.6292%, slope length 15.4365m, particle size 3.0000kg, vegetation cover 7.0705m^2 and infiltration capacity 5.0723 cm/hr respectively. The model summary was R=42.9%, R-square =18.4% and Adjusted R =8.4%. Even though the model fit looks poor, the coefficients indicate that there are three predictors in the model. There are several non-significant coefficients, indicating that these variables do not contribute much to the model. To determine the relative importance of the significant predictors, look at the standardized coefficients. X_1(rainfall amount 0.39), X_2(rainfall intensity 0.183), X_3(slope gradient 0.356), X_4(slope length 0.014), X_5(particle size 0.226), X_6(vegetation cover 0.237) and X_7(infiltration capacity 0.104) did not have significant effect on sediment loss. The quantity of sediment loss in forestland surface is insignificant (Table Via & VIb).

4. CONCLUSION

The study on the intensification of rainfall induced sediment loss on land surfaces in Calabar River Catchment, Cross River State, Nigeria was conducted. Sediment loss, rainfall amount, rainfall intensity, slope gradient, slope length, particles size and infiltration capacity were measured. The results revealed that sediment loss in urban surface are 14.9477kg/m^2, bare surface 33.9138kg/m^2, farmland 28.7754kg/m^2, grassland 33.4992kg/m^2 and forest land 5.6646kg/m^2 respectively. Rainfall amount were 41.7385mm, 41.7385mm, 41.7385mm, 41.7385mm and 41.7385mm respectively for urban, bare, farmland, grassland and forest surfaces. Rainfall intensity results were 0.5682mm/min for urban land surface, bare surface 0.5682mm/min, farmland 0.5682mm/min, grassland 0.5682mm/min and forest land 0.5682mm/min respectively. Slope gradient were 52.0000% for urban land surface, bare surface 52.0000%, farmland 52.0000%, grassland 52.0000%, and forest land 47.6292% respectively. Slope length were 5.2020m for urban land surface, bare surface 4.0180m, farmland 4.6177m, grassland 4.5746m and forest land 15.4364m respectively. The particles sizes for urban land surface sandy, silt and clay were 58.0%, 11.0% and 31.0%. Bare surface sandy, silt and clay were 49.0%, 13.0% and 38.0%. Farmland sandy, silt and clay were 48.0%, 18.0% and 34.0%. Grassland sandy, silt and clay were 56.0%, 12.0% and 32.0% and forestland sandy, silt and clay were 57.0%, 7.0% and 36.0% respectively. Vegetation cover were 4.2467m^2 for urban surface, bare surface 1.0263m^2, farmland surface 2.3462m^2 grassland surface 5.0917m^2 and forest surface 7.0705m^2. Infiltration capacity were 4.8200cm/hr for urban land surface, bare surface 5.9554cm/hr, farmland 4.7831cm/hr, grassland 4.5015cm/hr, and forest land 5.0723cm/hr respectively. The result implies that there was sediment loss on urban surface, bare surface, farmland and grassland surface. Though, the intensity of sediment loss was higher in urban, bare surface, farmland and grassland. The regression models indicated that slope gradient and slope length contributed much to sediment loss in urban surface, bare surface, farmland and grassland surface. Rainfall amount, rainfall intensity, slope gradient, slope length, particle size, vegetation covers and infiltration capacity did not have significant effect on sediment loss in forestland surface. The study recommended that sediment losses requires afforestation and reforestation aim at increasing the vegetation cover, and infiltration capacity of the soils.

REFERENCES

1. Abali, T.P. and Abua, M.A (2016), *Rainfall-Sediment Loss on Land Use Types in Clabar River Catchment, Cross River State, Nigeria*. International Journal of Innovative Environmental Studies. 4(3): 7-11. ISSN 2354-2918.
2. Abua, M.A (2017), *The Influence of Slope on Spatial Variability of Infiltration Capacity in Obudu Local Government Area of Cross River State, Nigeria.* International Journal of Innovative Environmental Studies. 5(1): 13-27.
3. Abua, M.A., Abali, T.P and Oka, P.O (2018), *Spatial Variability of Sediment Yield on Land Use Cover Types in Calabar River Basin Catchment, Cross River State, Nigeria.* Earth Science: An International Journal. (ESIJ), 1(1).
4. Abua, M.A., Kofi, B., Edide, J.I., Obiefuna, J.N and Ogar, B.I (2017), *Rainfall Erosivity Index in Response to Soil Loss Under Different Land Uses in Obudu Local Government Area of Cross River State, Nigeria.* International Journal of Innovative Environmental Studies. 4(3): 7-11.
5. Akpan, E. U. (1995), *Soil Loss Under Varying Land Use Types in Utu, Akwa Ibom State,* M.Sc. Thesis, University of PortHarcourt.
6. Akpan, E.R. (2002*). Heavy metals trends in Calabar River, Nigeria*: *Environ.,* 42, 47-51.
7. Caribbean Environment Programme 2015), *Sedimentation and Erosion.* http://www.cep.unep.org/publications-and-resources/marine-and-coastal-issues-links/sedimentation-and-erosion accessed on 26,2019
8. Eze, B.E, Eni, D.I. & Oko, C. (2010), *Evaluation of the Infiltration Capacity of Soils in Akpabuyo of Cross River.* Canadian Center of Science and Education, 189-199.
9. Ho-Jun, K. A.; Shin-chan, L. A.; Sang-Ho, Y. A.; Sang-Soon, L. A.; Seong-Jun, K. A.; Sang-Keon, H. A. and Seung-Oh, H. B. (2010). *Soil erosion characteristics under rainfall simulator conditions of the Jeju soil in Kore*a.*19th World Congress of Soil Science, Soil Solutions for a Changing World, 1 – 6 August 2010*, Brisbane, Australia.
10. Ileoje, N.P. (1991), *A New Geography of Nigeria.* Longman, Nigeria.
11. King, C.A. M. (1966), *Techniques in Geomorphology*. Edward Arnold, London.
12. Ofomata, G. E. K. (1975), *Nigeria in Maps. Benin City:* Ethiope Publishing House.
13. Oyegun, C.U., Umeuduji, J.E., Abali, T.P. and Abua, M.A. (2016), *Land Cover Dynamics in Calabar River Catchment, Cross River State, Nigeria*. Journal of Research in Environmental and Earth Science. 2(9), 11-18.
14. Young, A. (1964), *Slope Profile: A Symposium,* Geog. J., 130. 80-82.
15. Udofia, W. E. and Inyang, I. B. (1987), *Land and People of Cross River State*. Lagos University Press.
16. Young, A. (1964). *Slope profile*: A Symposium, Geog. J.,130, 80-82.
17. Pal, I. (2009). *Rainfall Trends in India and Their Impact on Soil Erosion and Land Managemen*t.Ph.D Thesis, Department of Engineering, University of Cambridge, UK.

18. Palmer, M. (2012). *Agricultural Fine Sediment*: Sources, Pathways and Mitigation.Ph.D Thesis, School of Civil Engineering and Geosciences, University of Newcastle, Upon Tyne.
19. Petters, S.W. (ed.) (1989). *A regional Hydrogeological study of rural water supply options for planning and implementation of phase II rural water programme in Cross River State* (Final Volume), DFFRI, Cross River State Unpublished Reports.
20. Abua M.A & Digah, O.N. (2015). *Assessment of Rainfall-Runoff Relationship on soil loss Using Runoff plots in Obudu, Nigeria.* International Journal of Contemporary Applied Sciences. 2(5) 108-120.
21. Derpsch, R. (2001). *Understanding the Process of Soil Erosion and Water Infiltration.*