IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 4, Issue 4 (Jul. - Aug. 2013), PP 10-16
www.iosrjournals.org

Evaluation of potential erodibility of basin wetland using soil particles distribution

O. E. Essien
Department of Agricultural and Food Engineering University of Uyo, Uyo, P. O. Box 4309, Uniuyo Post Office, Uyo, Nigeria. Postal Code: 520003

Abstract: *The objective of this study was to predict soil erodibility using soil properties of upper and lower tributary river (Enyong Creek and Ikpa river) basins wetland, comprising different soil groups or series. Mathematical formulation used for the nomograph of Wischmeier et al was used for the evaluation. Investigated soil properties included soil organic matter (SOM); granulometry of silt and clay; soil structure and permeability. The predicted K-factors, hence soil erodibility potentials, were high and significantly different (p<.05) from each catchment soil, and ranged between 0.0073 and 0.0827 for Ikpa River wetland, and between 0.0827 and 0.121 for Enyong Creek wetland. Percentage SOM was significantly different (P<0.01) between the wetlands, with Ikpa river wetland registering higher values. Percentage clay in Ikpa was generally higher than its values in Enyong Creek; other properties were not significantly different. Significant correlation was observed between silt percentage and erodibility factor. Further investigation is required between K-factor and influence of saturated hydraulic conductivity. However, the study provided baseline information on wetland erodibility for the reduction of soil susceptibility to erosion when considering any appropriate wetland development projects.*

Keywords: *Soil erodibility, K-factor, river basin development, granulometry, wetland erosion.*

I. Introduction

Soil erosion is the vagaries from environmental agents (rainfall, runoff, streams, and wind) solely or coupled with anthropogenic factors. While nature builds the land, its agencies along with human and animal factors, destroy the land surface by erosion and, in many cases, destroy down the soil sublayer by gully and tunnel erosion. The need for environmental sustainability of land for agricultural resource productivity informed the formulation of the program of soil conservation such as composed by Revised Universal Soil Loss Equation, RUSLE [1, 2] in which conservation practices evaluated the K- factor, called erodibility factor, to assess the potential of soil being vulnerable to the vagaries of erosion so as to plan against its incipience or progress. Soil erosion, generally is a three-step process of soil particles detachment, particles transportation or displacement and finally deposition ata different or new location [3]. Soil itself is a material with greater or lesser degree of cohesion and therefore is vulnerable. The susceptibility of each soil surface to the vagaries of erosion defines soil's erodibility, which is soil's intrinsic property defined by the soil's resistance to two impactful energy sources: the impact of raindrops on soil surface, and the shearing action of surface runoff over soil surface as sheet erosion or between clods in grooves or rills (as in rill erosion) etc. [1,4].

Soil physical properties, namely, particle size distribution (soil texture), structure, organic matter and permeability govern erodibility [1, 2, 3, and 5]. Texture is the mix proportion of sand, silt and clay. Erodibility is low for clay-rich soils with a low-shrink-swell capacity because these clay particles aggregates resist detachment and transport, while sandy soils with large amount of fine, medium, or coarse sand particles (0.10 - 2.0mm diameter) are found to have low erodibility [6,3]. Structure is the aggregation of individual soil particles (sand, silt, clay) into larger aggregates of identifiable shape, and good aggregation enables the soil to resist the detachment forces of water and rainfall impact by holding particles together. Soil organic matter (SOM), being highly decomposed organic material in soils, is highly available in topsoil and act as a glue to bind soil particles together into stickier aggregates, thereby offering resistance to erosion if its SOM is high [3].Permeability is the measure of rate at which water percolates through the soil under a head of water in soil and is a function of soil texture, structure and bulk density, hence a function of soil particles. For instance, sandy soils with large amounts of fine, medium, or coarse sand particles (0.10 – 2.0mm) also have low erodibility [3, 7]. Therefore, in general, all these factors depend on soil particles size (sand, silt, clay) and SOM; hence edibility can be defined by the soil particle size distribution [1, 2, 3, 8].

Researchers have used different methods to relate soil erosion potential (soil erodibility) to topsoil condition or soil particles distribution. Example is the SCS county soil-survey report [9]. Nomographs have been formulated but were limited to where mineral disturbance at the site was anticipated as site analysis was unavailable [8, 9]. Bouyoucos related erodibility to the percentages of sand, silt and clay [1, 8].However, the method of K-factor (soil erodibility factor) as evaluated by [9], which is a mathematical representation of [9,10] is preferred as it integrates many factors of the soil ecosystem, thereby simulating the real soil ecosystem in the erosion process.

Particle size distribution is very important in soil conservation, engineering, and management as such inherent properties of the soil can influence its erodibility, and hence could be managed to reduce soil erosion potential in a geographic extent [3]. However, soil particles cannot be known off-hand as they are soil properties at specific field locations [4]. Hence, they must be investigated before applying the mathematical tools to the established particles. This is necessary for Enyong Creek and Ikpa river watersheds which are largely in undisturbed state, with annual rainfall as high as 2000 – 3000mm and daily or N-day rainfall of 200 – 300mm [12] which offer great potentials for soil erosion.

Therefore, the objectives of the study were to evaluate soil properties in the soil groups of the study area landforms and apply them in a mathematical formulation to determine K-factor and evaluate the soil erosion potential (or risk) on the catchment wetland.

II. Materials And Methods

2.1Study Area

The study area covered the wetlands of Itu/Igwu and Enyong subcatchments in northern Akwa Ibom State. The field survey was carried out in collaboration with Akwa Ibom Agricultural Development Project in 1999, and had the grid of 1000m x 1000m for XYZ and 100m x 100m for Z information respectively. Field survey (1:20,000 scale) showed the swamp or wetland profile to be generally flat with slopes ranging from 0.5 – 3% except at the gentle undulation of river terraces which formed small islands of dry land having elevation from 5-45m above mean sea level [12].

2.2 Site description

The area covered the whole of Enyong Creek and Ikpa river catchments which drainage river (Enyong Creek and Ikpa) are upper and lower tributaries to Cross River, hence making their respective catchments the upper and lower tributary catchments in Cross River basin. Enyong Creek and Ikpa river catchmens have area coverage of 1400km^2,and 450km^2 respectively. Soil samples were taken by arguring from 50 sites and examined by 3 profile pits in Enyong and Ikpa basins (the upper and lower tributary swamps to Cross River).

Soil properties were investigated by arguring to 100cm except at sites where soil proved impenetrable at shallow depth. Texture was examined by land-held lenses. Composite topsoil samples consisting of 5 sub-samples were taken from 0 -10 and 10 – 20cm depths. Soil samples for laboratory analysis were taken with the auger from all soil horizons distinguished in the profile pits. Where necessary, soil samples below the water table were also taken with the auger. The samples were properly labeled in plastic bags and conveyed to the laboratory where they were air-dried at room temperature; after which the dried samples were ground in mortars to pass through a 2-mm sieve, prior to physical (and chemical) analysis. For the determination of organic matter, total N, P, K and micro nutrients, the samples were ground again to pass through 100-mesh sieve.

The particle size analysis of the soil samples used the hydrometer method with calgon or hexametaphosphate solution as the dispersing agent [13, 14, 15]. The sand fraction was separated into coarse and fine by sieving. pH used a pH meter in water and KCl solution in 1:2 soil-to-suspension ratio. Organic carbon content was obtained by the dichromate-oxidation method of [16].

2.3 Soil parameters

Textural class of the soil was identified using USDA texture tangible. For soil structure,
the exposed soil surface in the profile pit was carefully studied with the aid of a hand lens. The arrangement of the soil aggregates was examined and described using Ahn's (1971) specification as very fine granular, fine granular, coarse granular, and blocky (or platty or massive) and assigned codes 1,2,3,4 respectively according to [10,17]. For permeability, using the previously cut transects and grid spacing of 1000m intervals along the transects, auger hole method was used to measure the soil saturated hydraulic conductivity at 0 – 25cm profile depth at locations within the relevant major and minor soil series on the wetland and upland areas. Infiltration rate and hydraulic conductivity measuring location was spatially distributed about 200m along the lateral pre-cut transects and 1000m along the longitudinal pre-cut transects. The auger-hole method followed the approach described in [7].

2.4 Statistical analysis

Data were statistically analyzed using the SPSS system version 17 Word.

2.5 Mathematical equation of soil factor, K_{fact} [9,10,11].

$$K_{fact} = 1.292\left[2.1 \times 10^{-6}\int_{p}^{1.14} \times (12 - P_{0m}) + 0.0325(S_{stru} - 2) + 0.025(f_{perm} - 3)\right] \quad (1)$$

where:

f_p = P_{silt} (100 – P_{clay})
f_p = the particles size parameter
P_{om} = is the percent of organic matter
P_{struct} is the soil structure index
f_{perm} is the profile permeability class factor
P_{silt} is the percent silt, and
P_{clay} is the percent clay.

And, where 1.292 converts English unit used in [9,10] to metric unit [11]. S_{struc} is equal to: 1 for very fine granular soil; 2 for fine granular soil; 3 for medium or coarse granular soil; 4 is for blocky, platy or massive soil; where f_{perm} is equal to: 1 for very slow infiltration; 2 for slow infiltration; 3 for slow to moderate infiltration; 4 for moderate infiltration; 5 for moderate to rapid infiltration; 6 for rapid infiltration [11].

III. Results

3.1 Specific characteristics of the site of the representative soil series in the wetland are summarized in Table 1. Soil series encoded EN 31, 33, 51, 52, 53 are shown with their categories of soil type, soil structure and permeability and examples.

3.2Predicting Erodibility Factor, K-factor

The values of P_{om}, S_{struc}, f_{perm}, P_{silt} and P_{clay} in equation (1) were evaluated based on the site characteristics. The data on P_{silt}, P_{clay} and P_{om} were retrieved from Akwa Ibom Agricultural Development Project (AKADEP) data bank for Northern Akwa Ibom Swamps Resources study [12].

Using the values of P_{silt}, P_{clay}, P_{om}, P_{struc}, f_{perm} and f_p into (1), the erodibility factor (K-factor) was computed for each set of data on the different soil series. The results of computed K-factor based on soil properties of Ikpa river catchments soils are shown in Table 2, while those on Enyong Creek basin wetland soils are summarized in Table 3.

K_{fact} Was interpreted into erodibility class [18] as:

K_{fact}	<0.020	is erodibility class:	Negligible
"	0.020 – 0.039	" " " "	Low
"	0.039 – 0.053	" " " "	Moderate
"	0.053 – 0.066	" " " "	High
"	>0.066	is erodibility class:	Very high

TABLE 1: Site description and characteristics of soil series sites in Enyong Creek and Ikpa River catchments

Soil series	Texture/drainage class	Soil structure (S_{stonet})	Permeability	Vegetation	Swamps/ Examples of soil series
EN 31	The main imperfectly drained fine texture soil	Profile: 15m, sandy clay, 10cm, strongly developed medium blocky subangular structure (S_{struc}=4)	Moderate ≥ 20cm; rapid < 20cm K_{sat} 3.1/day	Vegetative cover: mainly dry land crops + associated fallow, or cocoa but some area are under forest.	Nkari(A) west, NK 10/1200 Itu South (B) MB 1/100 use west (J) US 7B/400
EN 31	The main imperfectly drained fine texture soil				
EN 33	Imperfectly drained soils with coarse over fine texture profiles	Profile 10cm: weakly developed medium subangular block structure (S_{struc} =4		Farm land/rice field (EkoiMbatfam)	Igwu(E) IG 2B/200
Dysticfluvisol	Imperfectly drained soils with coarse over fine texture profiles				
EN 51 Eutricgleyicfluvisol	Poor drained clay	Weak medium subangular blocky structure (S_{struc}=4)	Moderately rapid at ≥20cm (5)	Diverse vegetation or land use. Swamp grassland, swamp forest, cocoa farm.	Mbiabet (H) MB 5/1000

EN 51 Eutricglevicfluvisol	Poor drained	Strong fine subangular blocky (S_{struc}=4)			Nkari (A) NK 8A/00
EN 51 Eutricgleyicfluvisol	Poor drained (0 – 2% slope)	Moderately medium subangular block (S_{struc}=4)		Fellow Swamp grass	Use (J) US 7/500
EN 51 Eutricgleyicfluvisol	Very poor drained (flood plain)	Weak medium subangular blocky (S_{struc}=4)		Swamp grass/rice farm	Mbiabet (H) MB 5A/200
EN 53 Eutricgleyicfluvisol	Poor drain flat 0-2%	Moderate mediumsubangular blocky (4)	Rapid 5	Main under fallow rice field	Use (1) us 3/600
En 53	Poorly drained flatland 0-2%	Profile 10cm: weak, medium subangularblecky (4)	Rapid @ ≤20cm (form 6) at >20cm, 5	Fallow/grassland Iqwu swamp E	IG 3A/600
EN 52 Eutrcgleyicfluvisol	Very poorly drained flood plain	Medium to coarse grain	Moderately rapid (5) > 4cm	Rice field (Mbiabet rice project swamp H)	(H) MRF/1

Table 2. Input parameters for computation of K_{fact} and wetland erodibility class for soil series on Ikpa River

Series	Depth	pH	P_{silt} %	P_{clay} %	P_{om} %	S_{struc}	f_{perm}	K_{fact}	Erodibility class [18]
EN 71 0-13cm									
MB 1/500	0-10	4.48	41.6	38.4	6.99	2	5	0.0569	Low
MB 1/1000	0-10	4.56	5.0	85.6	14.35	4	3	0.0651	,,
MB1/2000	0.10	4.55	10.2	22.6	6.34	3	5	0.0840	High
US 5A/800	0-10	4.86	4.0	30.2	6.55	4	3	0.0409	Low
IK 1/400	0-10	4.97	41.4	29.4	8.67	2	3	0.0073	Negligible
IK 10/1000	0-19	4.40	14.8	34.8	0.69	3	5	0.0851	High
IK 11/400	0-15	4.59	19.4	34.4	10.59	3	5	0.0859	,,
IK 11/800	0-10	4.83	14.6	57.4	13.62	4	3	0.0668	Low
IK 15/550	0-10	4.91	11.8	26.0	13.62	3	5	0.0848	High
Ik 20/2500	0-18	4.93	15.2	84.8	8.67	4	3	0.0656	Low
IK 3/600	0-15	4.42	8.0	40.8	7.12	3	5	0.0837	High
Ik 20/1500	0-20	4.92	28.9	71.1	10.84	3	2	0.0098	Negligible
Ik 21/2000	0-10	4.93	48.0	42.0	11.18	2	5	0.0576	Low
EN 72	0-15	5.67	16.0	36.0	4.75	3	4	0.0603	Low
EN 73		4.55	32.2	27.8	13.67	2	5	0.0560	Low
Ik 3/800	0-10								
IK 9/100	0-10	5.21	24.6	34.4	13.64	2	5	0.05434	Low
IK 10A/400	0-10	4.53	0.80	4.8	15.26	3	5	0.0827	High
EN 61	0-5	5.43	0.0	5.4	0.89	3	6	0.1080	High
IK 20/900	0-20	4.78	38.7	31.3	11.51	2	5	0.0572	Low
IK 16/600	0-10	5.15	52.3	36.3	12.25	2	2	0.0090	Negligible
IK 01/400	1-10	4.80	28.4	15.2			3		
IK 12/400	0-10	4.82	21.7	62.3	13.67	3	5	0.0847	High
IK 13/200	0-10	4.94	24.8	26.6	13.31	3	5	0.0874	High
IK 12/400	0-10	4.82	21.7	62.3	18.67	3	3	0.0347	Low
IK 12/200	0-15	5.53	52.4	26.6	11.23	3	3	0.0429	Low
US 6/1400	0-15	5.67	16.0	36.0	4.75	3	4	0.0603	Low
US 2B/900	0-15	5.03	14.0	26.2	3.70	3	4	0.0603	Low
NA 5/00	0-15	4.80	18.0	31.4	2.90	3	4	0.0609	Low
IK 2/100	0-10	4.88	42.2	27.8	6.65	3	5	0.0908	High
IK 2/200	0-15	4.62	46.8	8.4	11.82	3	5	0.0941	High

Table 3. Physio-chemical properties and erodibility factor and class for different soil groups in Enyong creek wetland

Series and samples	P_{silt}	P_{clay}	P_{om}	S_{struc}	f_{perm}	K_{fact}	Erodibility class [18]
EN 31 US 7/400 0-14cm	14.0	22.0	4.56	4	4	0.093	High
EN 33 192 B/200 0-10	29.8	12.6	3.86	4	5	0.122	High
EN 51 MB 5/1000 0-12cm	14.8	41.2	4.11	4	5	0.117	High
EN 51 NK 8A/00 0-19cm	32.0	35.4	2.87	4	5	0.121	High
US 7A,/500 0-18cm	18.0	39.8	8.28	4	5	0.118	High
MB 5/200 0-10cm	24.0	38.8	6.63	4	5	0.119	High
EN 53, US/600 0-15cm	34.6	31.4	2.54	4	5	0.121	High
19 2A/400 0-12cm	14.2	10.6	2.61	4	5	0.118	High
1G 3A/600 0-10cm	9.8	22.6	4.28	4	5	0.117	High
EN 52 MRF 11 0-10cm	25.1	12.7	4.45	3	5	0.0895	High
MB 3/400	14.3	23.2	1.71	4	6	0.110	High
MB 17 0-10cm	13.4	42	4.51	4	5	0.085	High
MB 25	11.4	12.8	3.27	4	5	0.085	High

IV. Discussion

4.1 Effect of site characteristics

Soil series composing the two tributary wetlands varied; however EN 51, covered up to 50% of the Enyong Creek wetland [12]. Their classes defined the drainage profile of the wetland. The blocky, weak to strong subangular structure of top soil (0-20cm) and subsoil composed all the poor, imperfect and duplex soil series of EN 31, EN 33, EN 51 and even EN 52 (Tables 1 and 2). These affected the drainage (hydraulic conductivity) of the soil. Apart from seasonal flooding of the swamps to varying depth of inundation during the rains, standing water was usually observed on the floodplains after the rainy season up to the threshold of the dry season or November (the transition period); while in the deeper depressions, polluted and muddy ponds, may subsist till the end of November [19]. Thus, soil structure affected the hydraulic conductivity, hence drainage in the off-rainy period up to the threshold of the dry season. This resulted in the delays on commencement of dry or late season farming on the wetland where the landforms were relatively flat bottom.

4.1.1 Structural parameter

The soil structure parameter was high, for its blocky, platty or massive soil, which means that it tended

Table 4. Summary of average erodibility factors, erodibility classes for soil series In wetland soil of soil creek catchment.

Soil series	Average K_{factor}	Erodibility class	K_{sat} m/day
EN 51	0.119	high	6.1
EN 52	0.086	low	7.3
EN 53	0.119	High	9.6
EN 31	0.093	High	3.1
EN 71	0.072	Very low	8.5
EN 73	0.064	very low	7.9
EN 75	0.575	Very High	12.0
EN 81	0.575	Very High	3.1

N/B. See Table 1 for soil type or soil series. The average K_{factor} shows on the average soil erodibility vary between very low and very high under the varied soil groups. This is higher than the values 0.02 – 0.06 (Wischmeieret al, 1971). K_{sat} – saturated hydraulic conductivity

to be structureless down the profile [12]. As such, the structure was not well defined as granular forms. In that case, it could not promote a network of cracks and large pores that could accommodate infiltrating water that would result in reduced erosion due to decreased runoff [3]. It could be stated that the pondage on the swamps provided a cushion to impactive rain drops on the wetland soil otherwise the level of erosion could have been severe. High P_{silt} and P_{clay} for some soil series marked the wetland cross-section such as EN 33, 51, 52 in Enyong Creek wetland in Table 3.

The above observations were in contrast with the structural parameter values for Ikpa river catchment (Table 2).The $S_{struc}$was lower than those for Enyong Creek wetland although the values also varied (Table 2). Average value of S_{struc} for Enyong Creek wetland was 4 (Table 3) while S_{struc} for Ikpa wetland varied between 2 and 3 with average value of 3 (Table 2). The structure of Ikpa wetland was more developed granular or fine to medium granular soils. Hence, the observed high values of clay (P_{clay}) show that clay behaved as the binder to the granular particles such that large pores in the soil accommodated infiltrating water.

4.1.2 Organic matter parameter, P_{om}

Soil organic matter (SOM) is a binding agent that agglomerates smaller and individual soil particles into larger aggregates of identifiable shapes [3]. The SOM in Ikpa swamp floor was comparatively higher than P_{om} of Enyong Creek wetland except the 0.69% for IK 10/1000 site in Ikpa swamp. Thus, resistance to erosion water velocity on Ikpa swamp is higher than that on Enyong wetland, because soils that are higher in SOM are more resistant to erosion, hence were precursors to low erodibility[3]. The physical reality is that there was a significant difference at R<.05 in P_{om} between Enyong Creek and Ikpa River wetlands.

4.1.3 Texture class

Erodibility is governed by four major soil properties, one of which is texture (particle size distribution [3]. Very few soil series in the area were sandy or clayey soils. They were generally loamy soils having not more than 40% of clay or not more than 55% of sand, for clayey and sandy soils should have more than 40% and 55% clay or sand respectively [2,20,21]. Only four cases in Ikpa wetland had soil series with clayey soil; for EN 71 soil series, these were MB 20/1000 (85.6% clay), IK 11/800 (57.4% clay) and IK 20/2500 (84.8 clay) and IK 12/400 (62.3% clay) (Table 2). In Enyong wetland, these were (MB 17/ (42%) and MB 5/1000 (41.2% clay) Table 3.Erodibility is low for clay-riched soils.The difference in P_{silt} between Enyong Creek and Ikpa river wetland was not significant at P = .05; but significant (P= .05) was the difference in P_{clay} between the two wetland soils.

4.1.4 Erodibility factor, K_{fact}

The computed values of soil erodibilityfactor (K_{fact}) of the wetland soils of Ikpa river and Enyong Creek catchments are given in Tables 2 and 3 respectively. Significant difference (P<0.01) was observed in K_{fact} between EnyongCreek and Ikpa river wetland. The vaues of K_{fact} for Ikpa river wetland were single degree lower than those for Enyong Creek wetland, signifying that erodibility or susceptibility to water erosion was lower in Ikpa river wetland than Enyong Creek swamp, other parameters being equal. Using the erodibility factor ranges of K- factor in equation (1), the erodibility classes for the various K-factors of the soil series were indicated (Tables 2 and 3),varying from very low especially in Ikpa river wetland(Table 2) to low especially in Enyong Creek wetland (Table 3).

The K_{fact} varied with soil series. The EN 51 series or poorly drained clays had average of 0.1187; the EN 52 or poorly drained sandy and gravelly clays had 0.086; the EN 53 or poorly drained soils with medium over fine textured profiles had 0.1187; the EN 31 or perfectly drained fine textured soils had 0.093; the EN 71 or very poorly drained clays had 0.0719; The EN 73 or very poorly drained soils with medium over fine texture profiles had 0.0644; EN 75 or poorly to very poorly drained soils with medium over coarse textures had 0.572 while EN 81 or very poorly drained clays with some highly organic subsoil layers had 0.575. The EN 75 and 81 had sublayer texture-modified duplex soils in Ikpa basin. Their content of organic and or coarse particles influence produced moderate to rapid, rapid or very rapid saturated hydraulic conductivities leading to high flow-through of infiltered water, hence groundwater or sub-surface flow which reduces the chances of surface pondage in micro-topographic depressions and erosive flows on slopes in erosional channels [20].

Thus, the order of erodibility increased with soil series of the upper and lower tributary swamps (i.e. Enyong Creek and Ikpa river wetlands) as follows: EN 81>EN 75 > EN 51 > EN 53 > EN 31 > EN 52 > EN 71 > EN 73.The range of soil erodibility on this wetland (being between 0.0073 to 0.575 in all (Table 1), was within the range of 0.02 to 0.69 obtained in [10, 20,22]. The average K_{fact} and their erodibility class for the soil series are summarized in Table 4. These were generally low to high for the lower tributary basin wetland but were moderate to high for upper tributary wetland.

The identification of the erodibility classes of these inland agricultural wetlands with respect to their component soils series would benefit our knowledge of the inherent soil properties which have key roles in the prospect and ability of water erosion of their soils where the soil series are mono-dominant or mixed; also, the identified erodibility gave baseline data of the catchments wetlands thereby exposing such soils (with their vulnerable soil series) to be managed under suitable project developments that will reduce the level of soil's erodibility and the prospects of wetland soil erosion.

4.2 Correlation

Correlation was investigated between erodibility as intrinsic soil property and other inherent properties of the soil in the two wetlands, which should influence erodibility, namely:granulometry or the soil particles distribution, organic matter and structure. In the wetlands, P_{silt}correlated withK_{fact} with regression coefficient r = 0.353 for Enyong Creek wetland soils and r = 0.508 for Ikpa river wetland soils indicating equality of effect on K-factor from both wetlands. P_{om} and P_{clay} had low correlations between them (r = 0.444 (Enyong), r = 0.399

(Ikpa)) indicating marked differences. P_{om} and P_{clay} were higher in Ikpa than Enyong creek soil series. Attempt to correlate erodibility factors with hydraulic conductivities of the wetland soil series did not yield significant information as the regression coefficient was very low (r = 0.180) and insignificant. Further investigation may be undertaken on this relationship.

V. Conclusion

The erodibility factors (or erosion susceptibility) of the Enyong Creek and Ikpa river wetland soils, comprising many different soil series, were investigated using soils granulometry and other inherent properties in the mathematical formulation of Wischmeier et al(1971). Inherent soil particle distribution (percentages of clay, silt, sand), soil organic matter (SOM), as well as profile permeability class and soil structure were determined and evaluated. Significant difference (P < .05) existed between the upper and lower tributary wetland soils' properties. Soil erodiblity was observed to be high generally (0.06 – 0.121) but with values of 0.05 in Ikpa river wetland (lower tributary swamps) being lower than and significantly different (P < .05) from those of the uppe tributary swamps (0.1187).

Factors influencing erodibility were also evaluated with silt (%) and (SOM %) contributing significantly to lowering K.The study is of benefits to collection of baseline data on soil erodibility of soil drainage type and providing information on erodibility to assist reduce soil susceptibility to erosion under appropriate project development on the wetland.

Acknowledgement

The author is very thankful to Akwa Ibom State Agricultural Development Project (AKADEP) for all assistance on data availability and permission for field trips with the field staff on their project area.

References

[1] R. Suresh, Soil and water conservation engineering (New Delhi: Standard Publishers Distributors; 2006)
[2] U.S. Department of Agriculture, Natural Resources Conservation Services, (NRCS),National SoilSurvey handbook, title 430 – VI, 2005. Available at: http://soil.usda.gov/technical/handbook/.
[3] A.T. O'Geen, R. Elkins, D. Lewis, D. Erodibility of agricultural soils, withexamples in Lake and Mendocino countries (Oakland: University of California, Division of Agriculture and Natural Resources, 2006), Publication 8194.
[4] FAO, Natural Resources Management and Environment Department. The land husbandrycomponents and strategy: soil erodibility.(Rome: Natural Resources Management and Environment Department, 2008) Accessed 22 July, 2013. Available at www.fao.org/docrep/t1765e/t1765eof.htm
[5] O. Babalola, Soil properties affecting infiltration, runoff, and erodibility, In V. O. Saqua, E. E. Enabor, G. E.K. Ofomata, K. O. Ologe and L. Oyebande (Eds.),Ecological disasters in Nigeria, (Lagos, Nigeria: Fed. Min. Sci. Tec., 1988).
[6] W. E. Wildman, K. D. Gowans. Some physical environment and how it affects plant growth. (Oakland: Division of Agricultural Sciences, University of California, 1978), Leaflet 2280.
[7] K. Bhattachanya, A. M. Michael, Land drainage principles, method and application (NewDelhi, India: Konark Publishers Pvt. Ltd, 2003).
[8] W. H. Wischmeier, J. V. Mannering, Relation of soil properties to its erodibility. Soil Science Society of America Journal (SSSAJ) 33 (1), 1969, 131-137.
[9] S. J. Goldsman, K. Jackson, Bursztynsky, T. A. Erosion and Sediment Control Handbook, (New York W87- 08688:Mc.Graw Hill Book Co., 1986).
[10] W. H. Wischmeier, C. B. Johnson, B. U. Cross, and contracted sites, Journal of soil and waterconservation 28, 1971, 189 – 192. ISSN 1941 – 3300.
[11 Anon, Soil erodibility factor, Available at: epas.pennlgov/mepas/formulations/source_term/5_0/5_32/5.hmtl. Accessed 19 June, 2013.
[12] Akwa Ibom Agricultural Development Project (AKADEP), Northern Akwa Ibom Swamp ResourcesDevelopment Study: Stage 2 Report:Typographical and land use and land capability; Vol.4 (Uyo, Nigeria: AKADEP,1995)
[13] P. R. Day, Particles fractionation and particle size analysis. In: Black et al (eds.), Methods of soil analysis part 1. Agronomy 9, 1965, 544 – 567.
[14] C. Liu, J. B. Evett, Soil properties testing, measurement and evaluation, 4 edition. (New Jersey: Prentice Hall, 2000).
[15] G. W. Gee, D. Or. Particle size analysis. In methods of soil analysis part 4 physical methods (A. D. Warren (Editor). Soil Sci Soc Am Inc., 2002, 255-295.
[16] A.Walkley and I. A. Black, An examination of a Degtjareff method for determining organic carbon in soil: effect of variations in digestion conditions and of inorganic soil constituents, Soil Sci.6, 1934,251-263.
[17] M. A. Atawoo and J. M. Heerasing, Estimating soil erodibility and erosivity of rainfall patterns in Mauritius, AMAS, 1997, 219-223.
[18] L. Lepacha, K. K. Singh, P. M. Ondal and T.K Misra, Sikkim Forest (Gangtok, Thailand: Sikkim State Council of Science & Technology, 2006).
[19] O. E. Essien, and A. Y. Sangodoyin, Basin-scale temporary distribution of water resources and sensitivity to components contributions in Ikpa catchments of Nigeria, Global Journal of Engineer. & Technology. 2(2), 2009, 147-153.
[20] D. Flavis – Mortlock, Water erosion, 2008. Accessed 28 June, 2013. Available at: www.soil erosion.net/doc/water_erosion.html
[21] Earth Manual, PART 1,3rd edition (Denver, Colorado:Bureau of Reclamatiom, Department of Interior,1998)
[22] J. K. Mitchel, G. D. Bubenzer, Soil loss estimation, in Kerby, R. P. C. Morgan (Eds): soil Erosion. (London:John Wiley and Sons Ltd.,1980, 17 – 62).