SOIL GROUPS RELATIVE SUSCEPTIBILITY TO EROSION IN PARTS OF SOUTH-EASTERN NIGERIA

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ABSTRACT
Insitu rainfall simulator runs were carried out on 15 *soil groups located in various parts of South Eastern-Nigeria, namely Abia, Ebonyi and Imo States of South- eastern Nigeria. The tests were carried out under 'dry' and 'wet' soil conditions, each at rainfall intensities of 40, 60, and 90mmlhr. The resulting soil losses were analysed, and the relative susceptibility of the various soil groups to erosion by water determined based on the amount of soil lost during the various runs. Based on the 'erodibility ratings' the soils were finally categorised into 'moderately erodible', 'highly erodible', and 'very highly erodible' The moderately erodible (under wet run considerations), include Typic Dystropepts, (from sand stone), Gross Arenic Paleudult, Eutric Tropofluents, and Aquic Paleudult. The highly erodible include Typic. Tropaquept (Eutric Gleyso1s), Plinthic Tropudult, Arenic Ptdeudalt, Typic Tropoudult (Dystric ferralsol), and Orthoxic Tropudult (Rhodic Ferralsol). The very highly erodible erodible include Typic Dystropepts (from shale), Typic Tropudult (Orthic acrisol), Typic Tropudalf, Typic Hapludult, Orthoxic Tropudult (Dystric ferralsol), and Typic Tropaquept (Dystric Gleysol}. These groupings agree to some extent with those under the 'dry run' condition.*

Keywords: *erosion; rainfall; soil relative suscebility*

INTRODUCTION

Erosion risk assessment is an integral part of erosion control as it lends hand to policy formulation on erosion prevention and control strategies. Quantitative and qualitative assessment of this risk or hazard requires full knowledge of the many factors of soil erosion including factors related to soil properties, as well as the spatial variability of such properties. Since soil erodibility envelopes the inherent soil properties related to erosion, it was decided to study how this parameter varies amongst soil groups in Abia, Ebonyi, and Imo States of Southeastern Nigeria. This will assist in the erosion hazard assessment of this part of the country.

2.0 MATERIALS AND METHODS

2.1 The Soils

Three major soil groups are found in the former Imo State of Nigeria (now Abia, Ebonyi, and Imo states). These are the ferralitic soils covering about 61 % of the area, the hydromorphic, soils which cover about 31 %, and the alluvial soils covering 8% [1]. 15 subgroups identified within these three major groups [2] were selected for study. The subgroups, their parent materials and locations in the study area are presented in Table 1, while the study area is shown in Fig. 1.

2.2 Data Acquisition and Processing

A portable rainfall simulator of dimensions 1.0m by 0.5m and height 1.5m, and capable of producing variable rainfall intensities (the Zandin/Amsterdam simulator) was carried to the locations of the soils and used to run insitu tests. Three rainfall intensities - 40, 60, and 90mm/hr were used in the tests. 40mm/hr was found (by analysis of four years of rainfall charts) to be in the modal frequency class. 90mm/hr was about the highest rainfall obtainable from the simulator and was used to represent high rainfall intensities. 60mm/hr intensity was used to provide for possible comparison with similar studies conducted elsewhere. Moreover, each of these intensities is obtainable in the area of study at one time or the other during most rainy season.

Table 1: Representative Soil Groups and their Locations in the Study Area (Imo, Abia and Ebonyi States)

Soil Group

S/N	USDA	FAO	Parent Material	location	state
1	Aquic Paleudult	Dystric Nitosol	Shale	Akaeze	Abla
2	Arenic PaleuduIt	Dystric Nitosol	Sandy Alluvium	Akwete	Abia
3	Eutric Tropofluents	Eutric Fluvisol	Sandy Alluvium	Egbema	!mo
4	Orthoxic TropoduIt	Dystric Ferralsol	Coastal Plain Sands	Owerri	Imo
5	Gross Arenic Paleudult	Dystric Nitosol	Sandstone	Isuochi	Abia
6	Orthoxic Tropodult	Rhodic Ferralsol	Sandstone	Igbere	Abia
7	Plinthic Tropudult	Plinthic Acrisol	Shales	Okposi	Ebonyi
8	Typic Dystropepts	Dystric Cambisol	Sandstone	Afikpo	Ebonyi
9	Typic Dystropepts	Dystric Cambisol	Shale	Bende	Abia
10	Typic Hapuldult	Orthic Acrisol	Shale and Sandstone	Okwele	Imo
11	Typic Tropaquepts	Dystric Gleysol	Shale and Sandstone	Isieke Ibeku	Abia
12	Typic Tropaquepts	Eutric Gleysol	Shales and Siltstone	Umuna	Imo
13	Typic Tropudalis	Eutric Nitosol	Siltstone	Orlu	Imo
14	Typic Tropudult	Dystric Ferralsol	Coastal Plain Sands	Aba	Abia
15	Typic Tropudult	Ferric Acrisol	Shale and Sandstone	Owutu-Edda	Ebonyi

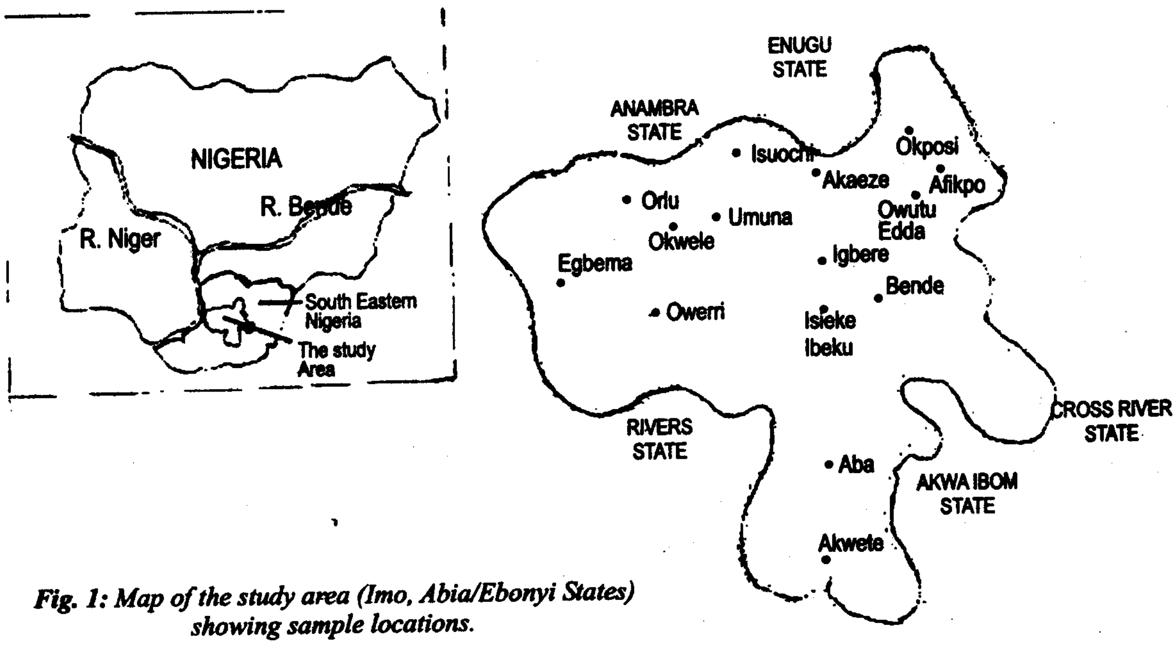

Fig. 1: Map of the study area (Imo, Abia/Ebonyi States) showing sample locations.

For a given test the simulator was set over a 1.0m x 0.5m plot prepared to 9% slope. Each test consisted of rainfall simulator runs, first on an initially dry soil for 1 hour, followed about 24 hours later by another 1 hour-rainfall run. A seperate plot was used for each rainfall intensity. Each test was replicated. Thus, for each soil group in a location, 12 tests were conducted, giving 180 runs for the 15 soil groups. The resulting soil losses were oven-dried in a laboratory, weighed, and used in the . erodibility ranking of the soils relative to one another. The rankings were based on the amount of soil loss at each rainfall intensity during each of the dry (the first 1 hour) and wet (the second 1 hour), runs, as well as on the cumulative soil loss from the three intensities.

3.0 RESULT SAND DISCUSIONS

3.1 Results

Results of the relative susceptibility of the soils at the various intensities during wet runs are given in Table 2. Columns 3, 5 and 7 show the amount of soil lost by each soil group at the various intensities. Columns 4, 6 and 8 show the relative positions of the soils with respect to amount of soil lost at the respective intensities. '1' denotest the highest soil loss, while' 15' denotes the least soil loss (in that order from 1 to 15). Column 9 is the sum of the ranks in columns 4, 6 and 8 for each soil. It is an attempt to approximate to what extent each soil can be said to be more erodible or less erodible than the others irrespective of the rainfall intensity used. The highest erodible should sum up to 3, (assuming it ranks 1 irrespective of the rainfall intensity), while the lowest erodible should rank 45 (assuming it ranks 15 under each of the three intensities). Column 10 sums up all the soils lost during the three runs (columns 3, 5 and 7), while column 11 is an attempt to still rank the soils based on total soil loss.

The results for the dry run conditions are presented in Table 3. The various columns follow after those of Table 2.

Influence of rainfall intensity on (relative) erodibility of soils

Table 2: Erosion Susceptibility Poistions (Ranks) Of Soils During Wet Runs (at various rainfall intensities)

S/N	Soil Group	40mm/hr Soil Loss Rank	Rank	60mm/hr Soil Loss Rank (Kg/m^2)	Rank	90mm/hr Soil Loss Rank (Kg/m^2)	Rank	Rank Sum	Total Soil Loss (Kg/m^2)	Total Soil Loss Ranks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.	Dystropepts) (from Shale)	0.239	2	0.405	1	0.474	4	7	1.118	1
2.	Typic Tropudult (Orthic Acrisol)	0.286	1	0.356	2	0.465	5	8	1.109	2
3	Typic Tropdudalf	0.158	5	0.296	5	0.654	1	13	1.108	3
4	Typic Hapludult	0.152	6	0.348	3	0.504	2	11	1.004	4
5	Orthoxic Tropodult	0.216	3	0.308	4	0.442	6	13	0.966	5
6	Typic Tropaquent (dystric Gleysol)	0.170	4	0.268	6	0.482	3	13	0.920	6
7	Tyic Tropaquept (eutric Gleysol)	0.135	7	0.220	10	0.386	7	22	0.791	7
8	Plinthic Tropudult	0.121	8	0.264	7	0.301	9	18	0.686	8
9	Arenic Paleudult	0.055	12	0.150	13	0.381	8	33	0.586	9
10	Typic Tropudult (dystric Fluviaol)	0.079	9	0.175	11	0.260	10	30	0.514	10
11	Orthoxic Tropudult	0.059	10	0.258	8	0.174	12	30	0.491	11
12	Typic Dystropepts (fron Sandstone)	0.054	13	0.121	14	0.235	11	38	0.410	12
13	Gross Arenic Paleudult	0.034	14	0.255	9	0.094	13	36	0.383	13
14	Gross Arenic Paleudult	0.059	11	0.166	12	0.077	14	37	0.302	14
15	Aquic Paleudult	0.026	15	0.113	15	0.048	15	45	0.187	15

Table 3: Erosion Susceptibility Oistions (Ranks) of Soils During Dry Runs (at various- rainfall intensities)

S/N	Soil Group	40mm/hr Soil Loss Rank (kg/m^2)	Rank	60mm/hr Soil Loss Rank (Kg/m^2)	Rank	90mm/hr Soil Loss Rank (Kg/m^2)	Rank	Rank Sum	Total Soil Loss (Kg/m^2)	Total Soil Loss Ranks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	Typic Tropodalf	0.134	8	0.542	3	0.981	1	12	1.660	1
2	Eutric Tropofluents	0.284	2	0.682	1	0.653	4	7	1.619	2
3	Arenic Paledult	0.121	9	0.547	2	0.898	2	13	1.566	3
4	Typic Tropudult (ferric acrisol)	0.256	3	0.473	4	0.657	3	12	1.386	4
5	Typic Hapludult	2.30	4	0.436	5	0.603	5	14	1.269	5
6	Typic Tropaquept (Eutric Gleysol)	0.342	1	0.321	9	0.545	7	17	1.208	6
7	Orthoxic Tropodult (Dystric Gleysol)	0.186	6	0.403	6	0.371	11	21	0.960	7
8	Typic Tropquent (Dystric ferralsol)	0.106	12	0.271	11	0.568	6	29	0.945	8
9	Typic Dystropepts (from Shale)	0.084	13	0.351	7	0.465	8	28	0.900	9
10	Tryoic Tropudult (Dystric feralsol)	0.115	11	0.350	8	0.429	10	29	0.894	10
11	Plinthic Tropudult)	0.188	5	0.273	10	0.430	9	27	0.891	11
12	Gross Arenic Paleudult	0.116	10	0.268	13	0.232	13	33	0.616	12
13	Aquic Paleudult	0.142	7	0.266	12	0.196	14	33	0.604	13
14	Typic Dystropepts (from Sandstone)	0.076	14	0.123	15	0.304	12	41	0.503	14
15	Orthoxic Tropudult (Rhodic ferrasol)	0.049	15	0.193	14	0.145	15	44	0.387	15

3.2 **Discussions**

The results presented in Table 2 (wet run condition} simulates soil/erodibility conditions during the greater part of the rainy season when frequency and amount of rainfall are usually high thus leaving soils generally wet or near field capacity. In Nigeria this is usually between April and September. The fact that a given soil does not rank the same under all the rainfall intensities indicates that soil erodibility is not totally independent of rainfall erosivity. This indication has been clearly demonstrated by Morgan [7]. Thus, using 2 or 3 characteristic rainfall intensities in a region to study the relative susceptibility of its soils to erosion by rainfall could be a better approach than using just one rainfall intensity as has been done by previous researchers [5, 8). Sum of the ranks (Column 9) and/or total soil loss or its rank (Column 11), could then give a better indication of the erodibility ratings of the oils. Although Columns 9 and 11 do not completely agree in the rating of the soil, but it is clear from both and from Columns 4,6 and 8 that the first six soil groups are among the most highly erodible, and that the last four are invariably the least erodible. The other soils come in-between these two in their erodibility. Thus, for the study area (Abia, Ebonyi and lmo states) three divisions with respect to erodibility rating can be described as in Table 4.

Although the ratings under 40mm/hr for the dry run (Table 3) does not show a definite order, those of the higher intensities (60mm/hr and 90mm/hr) show a better trend, and suggest the distribution presented inTable5.It should be noted that the, dryrun simulates soil conditions during the first few rains and the last rains of the year during which time frequency of rains is low, thus permitting 'soil dryness' between one rain and another. The antecedent soil moisture condition at this time differs significantly from that during the wetter parts of the year.

Since antecedent soil moisture condition influences the amount of soil loss within a given soil, it is likely that this is also true between soils. This explains the change in position of some of the soils in Tables 4 and 5. However, since most soil loss occurs during the greater part of the rainy season (April to September), Tables 2 and 4 are more reflective of the relative susceptibilities of the soils to erosion, by water.

Table 4: Relative erodibility levels of soil groups in lmo and Abia States under 'wet' conditions

Moderately Erodible	Highly Erodible	Very Highly Erodible
1. Type Dystropepts (from Sandstone)	1. Typic Tropaquent (Eutric Gleysol)	1. Typic Dystropepts (from Shale)
2. Gross Arenic Paleudul	2. Plinthic Trodult (Orthic Acrisol)	2. Tropic Tropudult
3. Eutric Tropofluents	3. Arenic Palendult	3. Typic Tropudalf
4. Aquic Paledult	4. Typic Tropudult (Dystric Ferralsol)	4. Typic Tropudult
	5. Orthoxic Tropudult (from Sandstone)	5. Orthoxic Tropudult
		6. Typopaquent (Dystric Gleysol)

*soil saturated 24 hours before test run.

Table 5: Relative erodibility levels of soil groups in Abia, Ebonyi and Imo States under dry conditions

Moderately Erodible	Highly Erodible	Very Highly Erodible
1. Gross Arenic Paledult	1. Typic Tropaquent (Euric Gleysol)	1. Typic Tropdalf
2. Aquic Paledult	2. Orthoxic Tropudult (Dystric Ferralsol)	2. Eutic Tropofluents
3. Typic Dyatropept (from sandstone)	3. Typic Tropaquent (Dystric Gleysol)	3. Arenic paleudult
4. Orthoxic Trodudult (Rhodic ferralsol)	4. Typic dystropepts (from shale)	4. Typic tropudult (ferric acrisol)
	5. Typic tropudult	5. Typic hapludult
	6. Plinthic tropudult	

CONCLUSION

This study has identified the relative erodibility of the major groups of Abia, Ebonyi, and lmo states with respect to microscopic rills (so-called Sheet) erosion. Thus, the relative risk of erosion of these soils are now known and can be used with other erosion factors for the erosion hazzard assessment of the study area. The results in Tables 2 and 4 are recommended for this purpose. Results of erosion hazzard assessment will be useful in land use and conservation planning.

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