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Determination of the Impact of Raindrops on Soils in Auchi Polytechnic using Morgan's Splash Cup

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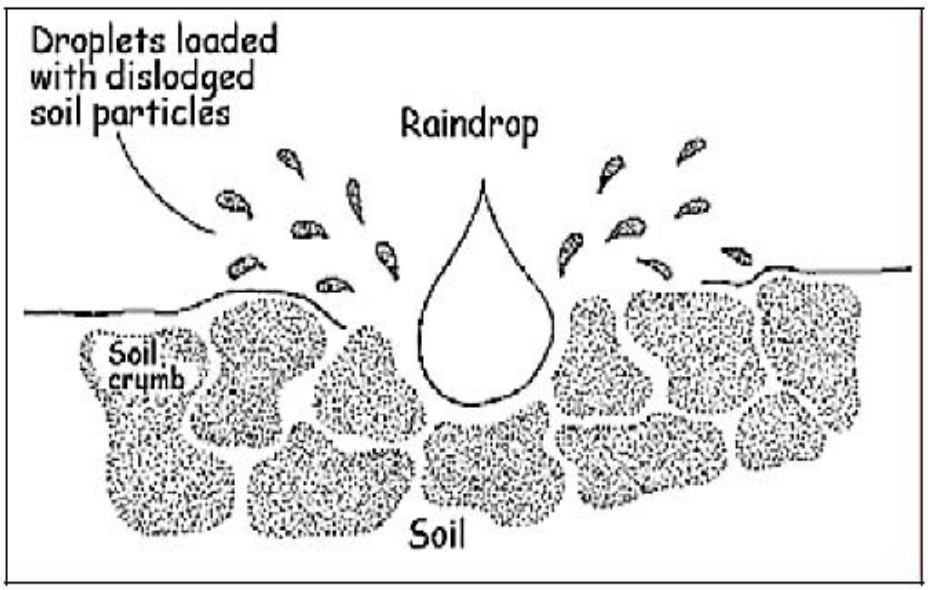
Abstract- Erosion by water, at a global scale, is the main soil degradation process in agricultural areas. Raindrops are among the major soil-detaching agents, and the kinetic energy of falling rain has an important influence on erosion intensity. The aim of this study was to fabricate a Morgan Splash cup and to determine the kinetic energy and amount of soil splashed by raindrops using the splash cup. Three locations were chosen for this study (Agricultural Engineering Demonstration farm (A), e – learning centre (B) and campus two(C)). The result of this study showed that soil splashed was higher in campus 2 with a value of 7 g/m^2. The mean soil splashed for the three locations are 1.78, 0.53 and 2.20 g/m^2 for field A, B and C respectively. The soil splashed is observed to increase with increased Kinetic Energy of rainfall. Thus, the greater the rainfall and Kinetic Energy, the greater the soil splashed. It is therefore recommended that studies of splash erosion on cultivated land should be carried out to determine the effect of cultivation on the soil in the area.

I. Introduction

Soil erosion is recognized as one of the world's most serious environmental problems. Globally, about 80% of the current degradation of agricultural land is caused by soil erosion (Zegeye, 2009). Erosion by water, at a global scale, is the main soil degradation process in agricultural areas. It generates strong environmental impacts and major economic losses from decreased agricultural production to off-site effects on infrastructure and water quality by sedimentation processes (Zegeye, 2009).

Raindrops are among the major soil-detaching agents, and the kinetic energy of falling rain has an important influence on erosion intensity (Morgan 1981). The process of soil detachment by raindrops is often referred to as splash erosion or rain splash. Splash erosion (as shown in figure 1.1) therefore, is a process composed by detachment of soil particles by raindrops hitting the surface followed by splash transport of (a part of) the detached particles.



Source: (Kinnell, 2005)

Figure 1.1: Raindrop impact causing Soil Splash

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Various methods have been used to measure splash erosion both experimentally and on the field. This depends on the objective of the experiment if it is solely to determine splash detachment or to obtain sufficient information to model the splash process. In which case, data are required on the direction, height and distance of movement of the splashed particles. Splash erosion has been measured in the field by splash boards; small funnels or bottles inserted in the soil; monitoring painted stones; and radioactive tracers to mention but a few (Egharevba and Ibrahim 2005).

Most investigations carried out on splash erosion have largely been done in the laboratory. There is need for field studies of splash erosion in specific locations in order to be able to ascertain the extent of damages caused. The aim of this paper therefore is the field study of splash erosion from bare soil using Morgan's splash cups. The understanding of the impact of splash erosion and data obtained from field studies can greatly assist soil conservationists and soil and water engineers in the design of erosion control structures.

II. Materials and Methods

a) Study Area

This study was carried out in three locations namely: Agricultural Engineering experimental field (Field A), the field beside E – learning center (Field B) and campus 2 Auchi Polytechnic Auchi (Field C). Auchi Polytechnic shown in figure 3.1 is located between latitude 7^0 10' and 7^0 20' north of the equator and longitude 6^0 16' and 6^0 36' east of the Greenwich Meridian with an altitude of 207m.

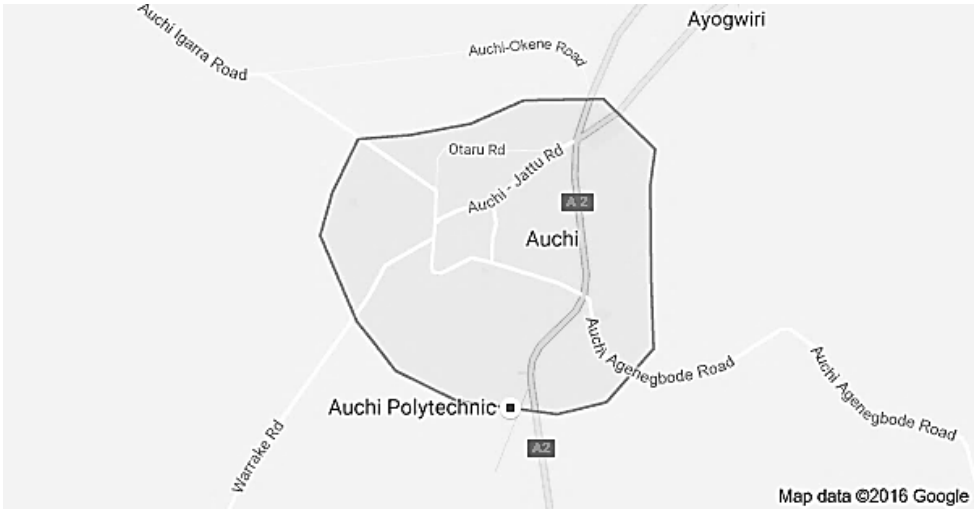

Figure 3.1: Google map of Auchi Polytechnic and its environs

b) Soil Characteristics

The soil characteristics of the study area were obtained from previous studies in the department of Agricultural and Bioenvironmental Engineering, Auchi Polytechnic Auchi, Edo state. The average textural class of the study area is Sandy Loam and Loam soil with an average bulk density of 1.47 g/cm^3.

Table 3.1: Average soil physical characteristics of Field A, B and C

Location	Depth (cm)	%Sand	%Silt	%Clay	Textural Class	θ_i	θ_f	BD (g/cm^3)
A	0-15	60	22	18	Sandy Loam	12.6	44.1	1.48
	15-30	58	23	19	Sandy Loam	13.2	44.2	1.48
B	0-15	57	29	14	Sandy Loam	15.8	44.8	1.46
	15-30	61	20	19	Sandy Loam	13.2	43.9	1.49
C	0-15	45	34	21	Loam	14.3	45.4	1.45
	15-30	46	32	22	Loam	14.8	45.2	1.45

Source: Victory et al., (2015)

c) Description of the Field Experiment

The field study was carried out on three sites. Six Morgan's splash cups was constructed and installed on the selected sites, to determine the soil splash under the same rainfall intensity and kinetic energy. Rainfall data was obtained from the Department of Civil Engineering in order to obtain the rainfall amount and duration per field experiment. The splash cups fabricated were covered with fine linen (muslin cloth) laid at the outside diameter of the cup, to prevent passage

of splashed soil through the drain while also avoiding the ponding of the inner cylinder and also to avoid sediment loss. This allows the water to slowly drain from the cups but prevent the sediment from escaping. And, a thread material was used to tie the linen cloth to the outer diameter to prevent it from being removed during rainstorm impact. Also, hammer was used to drive the inner cylinder into the soil without disturbing the soil surface, so that cylinder rim levels with the soil surfaces. This helps to reduce 'rim effect' (Morgan, 2005).

d) Splash Monitoring and Computation of Kinetic Energy of Rainfall

The soil splashed was carefully collected from the muslin cloth and oven dried at 105°C for 24 hours and weighed after every rainfall event. The kinetic energy of the rainfall was computed using the empirical expression by Kowal and Hassan (1976) given as:

$$KE = 41.4\, R_a - 120.0 \qquad \text{Eq. (1)}$$

Where R_a = Rainfall amount (mm), and KE= energy of rainfall (J/m^2)

R_a = rainfall amount (mm), and K.E = Kinetic energy of rainfall (J/m^2).

III. Results and Discussion

a) Rainstorm depth and Kinetic Energy

Table 4.1 shows the rainfall depth (amount) and the corresponding Kinetic Energy (KE) of the rainstorm in the season. The rainstorm depth ranged from 5 to 81 mm and the computed KE obtained ranged from 87 to 3233.4 J/m^2. A total of 23 rainfall events were recorded in the season under study. The highest rainstorm recorded occurred in the month of August with its amount recorded as 81mm and 3233.4J/m^2 Kinetic energy. The month of September had the highest number of rainfall occurrence.

Table 4.1: Rainfall depth and Kinetic Energy of raindrops

S/No.	Date	Rainfall Amount (mm)	Kinetic Energy (J/m^2)
1	7/8/2016	50.00	1950.00
2	11/8/2016	55.00	2157.00
3	15/08/16	72.00	2860.80
4	16/08/16	9.00	252.60
5	3/9/2016	81.00	3233.40
6	4/9/2016	7.00	169.80
7	6/9/2016	5.00	87.00
8	9/9/2016	11.00	335.40
9	10/9/2016	12.00	376.80
10	13/09/16	69.00	2736.60
11	14/09/16	13.00	418.20
12	20/09/16	11.00	335.40
13	22/09/16	45.00	1743.00
14	23/09/16	67.00	2653.80
15	26/09/16	6.00	128.40
16	29/09/16	60.00	2364.00
17	30/09/16	10.00	294.00
18	2/10/2016	36.00	1370.40
19	4/10/2016	7.00	169.80
20	5/10/2016	10.00	294.00
21	6/10/2016	12.00	376.80
22	8/10/2016	9.00	252.60
23	10/10/2016	45.00	1743.00
Total		702.00	26302.80
Mean		30.52	1143.60

b) Soil splashed for the three fields under Study

Table 4.2 shows the soil splashed (g/m^2) from the three fields under study and for the rainfall event recorded under the Morgan cup.

Table 4.2: Soil splashed (g/m^2) for the three fields under study

S/N	Date	Soil splashed (g/m^2)		
		Field A	Field B	Field C
1	7/8/2016	4.69	1.25	6.37
2	11/8/2016	2.27	0.79	2.19
3	15/08/16	1.17	0.53	1.65
4	16/08/16	0.40	0.10	0.49
5	3/9/2016	0.37	0.09	0.44
6	4/9/2016	4.06	1.54	6.11
7	6/9/2016	0.39	0.05	0.45
8	9/9/2016	4.77	1.99	6.50
9	10/9/2016	0.05	0.03	0.39
10	13/09/16	0.38	0.11	0.54
11	14/09/16	0.37	0.13	0.55
12	20/09/16	1.50	0.15	0.56
13	22/09/16	0.43	0.04	0.59
14	23/09/16	1.10	0.08	0.57
15	26/09/16	4.84	1.57	7.00
16	29/09/16	0.41	0.11	0.51
17	30/09/16	2.30	0.12	0.56
18	2/10/2016	3.79	1.44	6.38
19	4/10/2016	2.20	0.06	0.50
20	5/10/2016	4.43	1.52	6.53
21	6/10/2016	0.37	0.15	0.57
22	8/10/2016	0.45	0.19	0.67
23	10/10/2016	0.12	0.22	0.49

Table 2 also shows that the soil splashed for field C which is the field located at campus 2 are generally higher having the highest value of 7 g/m^2. The soil splashed from the demonstration farm behind the Agricultural Engineering workshop ranged from 0.05 – 4.84 g/m^2, while that of e-learning centre ranged from 0.39 – 1.99 g/m^2, the values of soil splashed around e – learning centre are quite low due to student's activities around the environment which must have compacted the soil thereby making it difficult for the raindrop to erode, erosion in this area will be very minimal since soil movement and detachment is minimal.

IV. Conclusions

The following conclusions are drawn from this study:

1. The observed soil splashed was higher in campus two with a maximum value of 7 g/m^2.
2. The mean soil splashed for the three locations are 1.78, 0.53 and 2.20 g/m2 for Agricultural and Bio-Environmental Engineering demonstration farm, e – learning center and campus two (2) respectively.
3. The soil splashed is observed to increase with increased Kinetic Energy of rainfall. Thus, the greater rainfall and Kinetic Energy, the greater the soil splashed.

References Références Referencias

1. Egharevba N. A. and Ibrahim H.(2005): Prediction of Sediment Yield in Runoff from Agricultural Land in the Southern Guinea Savanna Zone of Nigeria. J. Sustain. Trop. agric. Res.11:pp 1-7. DOI: 45709-49042-1-PB
2. Kinnell P. I. A. (2005). Raindrop-impact-induced erosion processes and prediction: a review. Hydrological Processes (in press), 1-30.Published online in Wiley Inter Science.
3. Kowal, J. M. and Hassan, A. P. (1976). Energy load and instantaneous intensity of rainstorms at
4. Morgan R. P. C. (2005). Soil erosion and conservation.Third Edition Book.National Soil Resources Institute, Cranfield University. Pg 1-316.
5. Morgan R.C.P (1981). Field Studies of splash Erosion, National college of Agricultural Engineering, siloe, Bedford Mk454DT, UK.
6. Victory E., Saturday I., Dunia A., Jovita A., and Friday B. (2015) "Fabrication and testing of double ring and single ring infiltrometer" ND Project submitted to the Department of Agricultural and Bio-Environmental Engineering Technology, Auchi Polytechnic Auchi.
7. Zegeye A. D. (2009). Assessment of upland erosion processes and farmer's perception of land conservation in debre-mewi watershed, near Lake Tana, Ethiopia. A Master's Thesis Presented to the Faculty of Graduate School of Cornell University. Pg 1-104.