Nigerian Journal of Social and Development Issues. Vol. 1. No. 1 June 2001

ANALYSIS OF RAINSPLASH EROSION IN THE HUMID TROPICS: A CONSIDERATION OF RAINFALL PARAMETERS

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ABSTRACT

Rainsplash erosion measurements were undertaken on five land use surfaces and the results related to known parameters of rainfall such as total amount, peak intensity, total intensity, total kinetic energy, the EI_{30}, AI_{10}, AI_{15}, KE > 25 and antecedent precipitation (API) indexes. Splash was measured using Morgan's splash cups while the rainfall parameters were computed from rainfall charts of a self-recording rain gauge. The study gives insight to the process of splash erosion and the rainfall parameters that influence detachability in the humid tropics. For instance, the result reveals that splash erosion takes place on all land use surfaces in the study area whether vegetated to the level of the natural forest or completely bare. Five models relating splash with the rainfall parameters were obtained. The models show that the rainfall parameters of peak intensity (PI), total rainfall amount (RFM), the EI_{30}, Total rainfall intensity (TNT) and the AI_{15} were the significant rainfall factors affecting splash erosion in the study area. However, the most significant rainfall factor was the AI_{15} index. The result generally points to the obvious role of rainfall intensity and/or their combination (amount and intensity) on splash detachment in the humid tropical environment.

1.0 INTRODUCTION

Raindrops on impact dislodge soil particles at rest. Failing raindrops breakdown the soil surface layer by expending or dissipating their energy on the soil mass thereby detaching the soil particles from the mass. The detached particles are splashed in all directions. On the vegetated surfaces of the humid tropics, only raindrops that can penetrate the vegetation canopy cause splash erosion.

It is therefore through the process of splash detachment that transportable fragments of soil materials are made available for run-off or sheet erosion. In other words, the disintegration and separation of soil particles by splashaction is a pre-condition to the transportation of soil particles or their entrainment by flowing water. hence, soil detachment by impacting raindrops remain the first and initial phase of the well-known process of erosion by water (Farmer, 1973). Indeed, it is common knowledge that soil erosion involves the twin processes of detachment and the removal of particles. In order to understand better the removal process via flowing water, we must also understand the splash sub-process.

Unfortunately, the splash sub-process is usually mentioned only in passing in the geomorphological study of erosion by water (Faniran and Jeje, 1983). And as Bredikhin (1989) rightly pointed out, splash remains the least studied exogenous process. One possible reason for the neglect of splash study is the contention that it is almost impossible to separate it from flow erosion because both form phases of one continuous process (Faniran & Jeje, 1982).

With reference to the splash controlling factors, , Morgan (1982) summarized them in broad terms as rainfall ,wind, soil, slope and plant cover. The rainfall variables (erosivity parameters) have so far received the greatest attention in the literature and yet it has been poorly analyzed with respect to splash erosion especially in the humid tropics where rainfall is characteristically high in intensity and energy. This study is therefore aimed at identifying the parameters of rainfall which control splash erosion in a humid tropical setting.

2.0 LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

Both laboratory and field experiments have revealed certain rainfall factors or parameters that are crucial to splash erosion in the humid tropics. These parameters are rainfall intensity, momentum, velocity, drop size and kinetic energy. All these factors have been found to correlate positively with the volume of splashed materials (Hudson 1965; Bubenzer and Jones, 1971; Van Asch Roels, 1979; Ghadiri and Payne, 1988). Rose (1960) for instance has shown that detachment by raindrop was closely related to momentum per unit area. Bisal (1960) on the other hand, established detachment as being proportional to the 1.4 power of drop velocity under simulated rainfall. Ekern (1951) indicated that splash was proportional to Kinetic energy when the amount of applied water was constant.

Intensity is another significant characteristic of rainfall that affects splash detachment. This fact is acknowledged by many researchers such as Ellison (1944), Ekern (1950), Bisal (1960) and Hudson (1965). However, Farmer and Van Haveren (1971) and also Martinez et al (1979) demonstrated that rainfall intensity did not influence mean weighted splash distances. More recently, Govers (1991) equally proved that the relationship between splash detachment and especially high intensity rainfall leads to an over estimation of splashed sediments. This was contingent on the discovery that the relationship between splash and soil texture was most significant for low intensity rainfalls.

The drop size of rain is also a major parameter of rainfall that is often studied with respect to splash erosion most especially by agricultural engineers (Laws and Parson, 1941; Morgan, 1982; Osuji, 1989). Bisal (1960) had reported that there existed a linear relationship between drop size and sand splash. Moldenheur (1965) also discovered a relationship between structural stability of the soil and a variety of drop sizes. Lal (1980) associated big drop sizes and high drop density with high intensity storms. Raindrop sizes are often related to velocity, intensity and kinetic energy of the rainfall. Laws (1940) using the popular flour-pellet method to determine drop sizes was the first to relate drop size to Kinetic energy of rain. Laws observed that 1200 per cent increase in erosion occurred when drop size was increased from 1mm to 5mm diameter. He attributed the increase in erosion rate to the great Kinetic energy of the larger drops. Information on the drop size of natural tropical rain storms can be obtained from the studies of Aina, et al (1976), Kowal and Kassam (1976). Lal (1979), Osuji (1989), attributed the disparity in energy values to the inadequate height of fall of simulated rainfall which did not permit the drops to achieve a terminal velocity. Kinetic energy is simply the energy of motion which falling raindrops transfer to soil particles that they come in contact with. Free (1952) related splash detachment to the 0.9 power of Kinetic energy for sand and to the 1.46 power for other soils. Bubenzer and Jones (1971) expressed splash as a function of kinetic energy in the form: $SS = a(K.E.))^b$, where SS is splash detachment, a and b are constants and K.E. is the kinetic energy of the rain. A similar equation is also given by Poesen (1983) who stated the relationship between weight of splashed materials (S) and kinetic energy (K>E) as $S = a(K.E.)^b$. The coefficients (a) and (b) are similarly a function of material properties of the soil and to a lesser degree of rainfall properties. The importance of the kinetic energy of rain in splash studies has been given wide recognition by Wilkinson (1975), Van Asch and Epema (1983), Gilley and Finker (1958), to mention but a few.

However, most researchers do not consider the kinetic energy as a sufficient and an all important detachability factor. Govers (1991), for example, stated that the use of kinetic energy as an erosivity index leads to an underestimation of splash detachability during high intensity rains. Kinnel (1982) in a similar mind observed that splash detachment increased much more rapidly increasing with drop size than with kinetic energy or momentum. He therefore, concluded that kinetic energy does not accurately predict rainfall detachment. Daura (1995) in his review of the literature on rainfall intensity in relation to erosion by runoff, noted that the best predictors of runoff include the EI_{30}, $KE > 25$, EI_{15} and AI_m indices. These parameters have been discussed in detail by Daura (1995) and need not be repeated here.

Finally, the fact that humid tropical rains are expected to be highly erosive due to their characteristic high intensity, high kinetic energy load and larger drop sizes provided a compelling reason for this study.

3.0 THE STUDY AREA

This study was carried out in experimental plots located within the University of Ibadan campus. A total of 5 plots were utilized each located on a different land use surface. The land use surfaces selected for the study included:

i. bare surface
ii. teak plantation surface
iii. cropped surface
iv. grass covered surface and
v. Natural Forest Surface

The bare, cropped and grass covered surfaces were located at the University's climate station while the teak plantation and natural forest surfaces were sited in the botanical garden. The surfaces were located on gentle slopes of 4°C - 6°C. The cropped surface was cultivated to mixed crops, namely, maize, cassave and okra.

4.0 METHODS

The data used in this study was obtained directly from the field. Soils splashed by each rainfall event was measured using the Morgan's splash cup (Morgan, 1982). Splashed soils collected from each experimental plot were oven dried in the laboratory at a temperature of 105°C for 24 hours. Rainfall was measured using a self-recording rain gauge. The daily rainfall charts of the self-recording rain gauge were analysed for parameters such as rainfall amount, duration, intensity, kinetic energy etc. The rainfall parameters of amount, duration and intensity were read and computed directly from the rainfall (autograph) charts. The Amount-Intensity product (AI_m), the product of amount and 15 - minute Intensity (AI_{15}) were calculated using Lal's (1976) approach. The Antecedent precipitation Index (API) was determined following Gregory & Walling's (1973) modification of Butler's (1957) method. The other factors of kinetic energy, peak Intensity, and total kinetic energy of intensities greater than 25 mm hr^{-1} (KE>25), were calculated following Foster et al (1981), Morgan (1979) and Daura (1995).

All the above (9) parameters of rainfall, namely, Rainfall amount (RFm), Total Intensity (TNT), Peak Intensity (PI), AIm, Total Kinetic energy (TKE), EI_{30} KE > 25, and API are examined in relation to splash in the study area.

5.0 RESULTS AND DISCUSSION

Table I shows the quantity of materials splashed from the different land use surfaces. From this table, it can be seen that splash erosion occurred on all the five land use surfaces. The highest amount of splash was expectedly obtained from the bare plot (99.39kg/m^2) while the lowest was 49.25kg/m^2 which was obtained from the grass covered surface. Splash erosion from the bare surface was therefore twice that of the grass covered surface. Table II shows the rainfall parameters computed from the autograph charts for all the rainstorms

TABLE 1: **Splash Detachment Rates from Different Land Use Surfaces (kg/m^2)**

Storm. No	Date	Teak Plantation	Cropped Surface	Grass Surface	Bare-Open Surface	Natural
1	31-3-93	2.77	2.80	0.93	3.63	1.22
2	19-4-93	2.19	2.15	1.59	3.55	1.02
3	26-4-93	1.44	1.82	1.63	3.08	1.50
4	28-4-93	1.01	0.67	0.59	1.37	0.87
5	6-5-93	0.20	0.61	0.37	0.21	0.24
6	9-5-93	1.56	1.39	0.88	2.26	1.73
7	14-5-93	3.74	1.46	0.94	2.16	2.34
8	15-5-93	2.58	2.85	2.28	3.36	2.29
9	18-5-93	1.84	2.11	1.92	3.82	2.77
10	20-5-93	0.57	0.69	0.47	1.17	0.45
11	24-5-93	2.10	2.24	1.35	2.70	2.16
12	26-5-93	1.84	1.99	1.13	3.14	1.31
13	2-6-93	1.42	1.36	0.66	2.49	1.42
14	4-6-93	2.33	2.07	1.07	3.38	2.60
15	6-6-93	2.74	2.53	1.27	4.13	1.76
16	9-6-93	0.00	0.00	0.00	0.06	0.00
17	12-6-93	2.24	1.93	0.99	3.14	1.34
18	14-6-93	2.40	3.07	1.03	3.69	2.09
19	15-6-93	1.79	2.51	2.46	3.94	00.50
20	16-6-93	0.85	0.56	0.50	0.99	0.52
21	18-6-93	0.00	0.00	0.00	0.02	0.00
22	20-6-93	3.66	3.47	1.88	4.75	3.12
23	27-6-93	1.32	1.04	1.49	3.30	1.40
24	28-6-93	1.22	1.01	0.93	1.48	1.07
25	01-7-93	0.75	0.69	0.70	0.95	0.62
26	4-7-93	0.80	0.76	0.79	1.02	0.89
27	5-7-93	0.24	0.29	0.80	0.42	0.09
28	30-7-93	1.84	2.04	1.34	2.85	1.55
29	8-8-93	1.07	1.74	1.31	2.62	0.78
30	9-8-93	0.00	0.00	0.00	0.04	0.00
31	15-8-93	1.13	0.10	0.06	0.22	0.00
32	5-9-93	1.73	1.44	0.81	1.45	0.18
33	6-9-93	0.38	0.36	0.62	1.03	0.36
34	7-9-93	1.21	0.55	1.03	0.36	0.76
35	15-9-93	0.77	1.40	1.32	1.36	0.57
36	16-9-93	3.27	3.07	1.62	1.91	2.04
37	22-9-93	0.00	0.00	0.00	2.93	0.00
38	23-9-93	1.73	1.06	1.53	0.01	1.51
39	27-9-93	0.48	0.62	0.37	2.01	0.51
40	3-10-93	0.75	1.04	0.84	0.83	0.69
41	7-10-93	0.98	1.30	0.83	1.11	0.47
42	10-10-93	1.81	0.93	0.75	2.54	0.64
43	11-10-93	1.34	1.46	1.22	1.20	0.60
44	14-10-93	0.51	0.27	0.34	1.81	0.46
45	16-10-93	0.55	0.85	0.69	0.70	0.15
46	17-10-93	1.31	1.44	1.13	0.89	0.67
47	23-10-93	0.94	0.70	0.66	2.70	0.53
48	25-10-93	1.81	0.06	2.53	1.06	2.09
49	25-10-93	0.19	0.27	0.11	2.98	0.14
50	26-10-93	1.31	1.01	0.49	1.62	0.76
Total **(Mean)**		67.99 1.36	66.97 1.34	49.25 0.99	99.32 1.99	50.87 1.02

SOURCE:* *Fieldwork, 1993

which resulted in splash erosion. Over 60 rainstorms were measured out of which the 50 shown on this table generated splash erosion. The least amount of rainfall which generated splash was 0.9 mm on the bare surface.

TABLE II; Rainfall Parameters

S/No	Date	Rainfall Amount (mm) (RFM)	Total Intensity (mm h⁻¹) (TNT)	Total Kinetic Energy (TKE)	EI_{30}	KE > 25	AI_{15}	API	Peak Intensity (PI)	AI_m
1	31-03-93	25.7	062.8	669.90	07636.06	532.00	1028.00	000.00	022.8	0585.96
2	19-04-93	14.7	058.3	329.50	02240.60	268.00	0300.00	01.35	042.0	0617.40
3	26-04-93	18.0	072.0	471.40	05001.70	321.00	0856.80	02.10	047.6	0856.80
4	28-04-93	06.0	024.0	114.90	00000.00	000.00	0000.00	09.00	016.0	0096.00
5	6-05-93	00.9	003.6	005.04	00000.00	000.00	0000.00	00.75	003.6	0003.24
6	9-05-93	09.9	039.6	241.70	01995.80	188.04	0293.04	00.30	007.4	0073.36
7	14-05-93	09.4	037.6	248.20	02013.40	248.20	0000.00	01.40	037.6	0353.44
8	15-05-93	25.8	103.2	720.50	18733.00	712.50	2580.00	09.40	100.00	2580.00
9	18-05-93	17.1	058.4	350.13	02520.94	137.94	0328.32	08.60	022.8	0389.88
10	20-05-93	05.1	020.4	120.11	00000.00	000.00	0000.00	08.55	020.4	0104.04
11	24-05-93	17.2	068.4	419.30	01425.62	398.40	0443.76	01.28	032.0	0550.40
12	26-05-93	18.2	020.4	382.53	02295.18	250.80	0182.00	08.60	038.0	0691.60
13	2-06-93	12.1	068.8	232.75	02094.75	000.00	0125.84	02.60	020.0	0242.00
14	4-06-93	13.2	072.8	232.05	02088.45	000.00	0195.36	06.05	014.8	0195.36
15	6-06-93	18.0	048.4	472.40	02137.00	400.00	0252.00	06.60	057.6	1036.60
16	9-06-93	02.3	052.8	008.97	00000.00	000.00	0009.20	06.00	005.2	0011.96
17	12-06-93	14.0	071.6	353.50	01944.25	284.10	0190.40	00.77	042.4	0593.60
18	14-06-93	16.4	007.4	424.91	02287.50	421.04	0078.72	07.00	060.8	0997.12
19	15-06-93	33.9	056.0	850.68	08506.80	519.80	1627.20	16.40	048.0	1627.20
20	16-06-93	04.9	065.6	073.31	00000.00	000.00	0005.88	33.90	010.8	0052.92
21	18-06-93	01.2	135.6	003.87	00000.00	000.00	0000.00	02.45	004.8	0005.76
22	20-06-93	19.6	019.6	520.30	00000.00	430.00	0321.44	00.60	062.0	1215.20
23	[illegible]-06-93	13.8	004.8	244.59	[illegible]857.36	105.00	0187.68	06.53	018.[illegible]	[illegible] 92
[illegible]	[illegible]	06.[illegible]	078.4	[illegible]	[illegible] 63	000.00	0055.44	13.80	[illegible]	[illegible] 96
[illegible]	[illegible]-93	03.8	055.2	[illegible]	00000.00	000.00	0036.08	02.10	[illegible]	[illegible] 96

TABLE II: Cont'd

S/No.	Date	Rainfall Amount (mm) (RFM)	Total Intensity (mm h⁻¹) (TNT)	Total Kinetic Energy (TKE)	EI_{30}	KE > 25	AI_{15}	API	Peak Intensity (PI)	AI_{m}
26	4-07-93	03.4	025.2	069.45	00000.00	000.00	0000.00	01.27	013.6	0046.24
27	5-07-93	02.9	015.2	017.05	00000.00	000.00	0004.64	03.40	010.0	0029.00
28	30-07-93	11.3	013.6	214.33	00000.00	126.10	0054.24	02.90	021.2	0239.56
29	8-08-93	33.0	011.6	823.61	26849.00	700.15	0435.60	01.41	041.6	1372.80
30	9-08-93	02.4	045.2	011.88	00000.00	000.00	0000.00	33.00	005.6	0015.44
31	15-08-93	03.2	012.8	063.36	00000.00	000.00	0000.00	00.40	012.8	0040.96
32	5-09-93	21.5	086.0	513.11	07901.89	236.33	0774.00	00.15	026.0	0774.00
33	6-09-93	05.5	022.0	068.33	00000.00	000.00	0039.60	21.50	008.8	0048.40
34	7-09-93	17.0	068.0	410.67	02464.02	323.35	0680.60	05.60	040.0	0680.00
35	15-09-93	19.2	076.8	508.42	05084.20	266.12	0000.00	02.13	056.8	1090.56
36	16-09-93	15.2	060.8	357.35	02970.30	176.73	0121.60	19.20	024.8	0376.96
37	22-09-93	01.2	004.8	003.87	00000.00	000.00	0000.00	02.53	004.8	0005.76
38	23-09-93	17.6	070.2	483.67	00000.00	483.67	0017.55	01.20	069.2	1214.46
39	27-09-93	05.8	025.2	113.25	00000.00	000.00	0023.20	04.39	019.2	0111.36
40	3-10-93	08.3	033.0	115.05	00851.37	000.00	0023.00	00.97	014.0	0115.50
41	7-10-93	15.2	060.8	389.22	00000.00	212.49	0255.36	02.06	044.0	0668.80
42	10-10-93	11.5	046.0	263.16	00000.00	295.93	0036.80	15.20	032.8	0377.20
43	11-10-93	09.8	039.2	228.28	00000.00	224.41	0047.04	05.75	034.4	0337.[illegible]
44	14-10-93	21.3	092.4	560.77	10991.00	526.17	0127.80	09.80	047.2	1005.36
45	16-10-93	04.5	018.0	102.23	00000.00	000.00	0000.00	07.10	018.0	0081.00
46	17-10-93	13.7	054.8	376.37	11674.60	376.37	0000.00	02.25	054.8	0750.76
47	23-10-93	09.7	038.8	225.19	00000.00	206.40	0000.00	13.70	032.0	0310.40
48	25-10-93	37.3	149.2	988.19	25890.58	986.81	1894.84	01.62	052.4	1954.52
49	25-10-93	04.5	017.8	493.29	[illegible]	000.00	[illegible]	18.65	016.8	0874.76
50	26-10-93	16.9	067.6	108.06	[illegible]	[illegible]	[illegible]	[illegible]	046.0	0777.30

SOURCE: [illegible]

The degree of correlation between the rainfall factors and splash erosion vary from surface to surface (see table III). The highest value of correlation is the one on the grass surface where splash correlated with total Intensity (TNT) at $r = 0.79$. The lowest r - value is on the natural forest surface where the correlation coefficient ranged from 0.46 to -0.19. The performance of the total Intensity factor (TNT) contradicts the findings of Osuji and Sangodoyin (1989) who discovered that splash correlated more significantly with rainfall kinetic energy.

A step-wise multiple Regression of the 9 rainfall factors on splash was carried out from surface to surface. The result show five equations which are displayed on table IV. From these equations, it can be observed that out of the 9 rainfall factors involved in the regression, only 5 factors proved significant in the explanation of splash erosion in the study area. The five factors are peak intensity (PI), the total rainfall amount (RFM, the Kinetic energy and 30 - minute maximum intensity (EI_{30}), the total rainfall intensity (TNT) and the product of amount and maximum 15 minute intensity (AI_{15}).

Factors such as the product of Amount and Peak Intensity (AI_{m}), the total Kinetic Energy (TKE), the total Kinetic energy of intensities greater than 25mm hr^{-1} (KE>25)and the antecedent precipitation index (API) were not significant.

Going from surface to surface, the most significant rainfall factor was the product of amount and maximum 15 - minute intensity (AI_{15}). This parameter explained 70.88% of the variance in splash erosion on the grass covered surface. On the other hand, the least explanation was offered by the total rainfall (RFM) factor which explained 21.88% of the variation in splash on the natural forest surface. The performance of the AI_{15} factor confirms the findings of Lal (1976). Aina (1977), Jeje (1986) and Daura (1995), all of whom found runoff erosion from vegetated surfaces to be very much related to the AI_{15} index.

TABLE III: Correlation Structure of Rainfall parameters with Splash Detachment from Various Land Use Surface

S/N	Rainfall Parameter	Task Plantation	Cropped Surface	Grass Surface	Bare-Open Surface	Natural Forest Surface
1	RFM	0.52	0.71	0.78	0.68	0.46
2	TNT	0.48	0.68	0.79	0.66	0.46
3	TKE	0.52	0.70	0.76	0.66	0.45
4	EI_{30}	0.15	0.40	0.48	0.30	0.19
5	KE 25	0.45	0.63	0.69	0.57	0.42
6	AI_{m}	0.29	0.52	0.65	0.42	0.32
7	API	-0.21	-0.17	-0.16	-0.22	-0.19
8	PI	0.55	0.61	0.67	0.58	0.45
9	AI_{15}	0.64	0.64	0.75	0.57	0.42

$r > 0.40$ is Sig. at 0.05 Level.

TABLE IV: Summary Table of the Regression of Rainfall Factors on Splash Erosion

Surface	Equation	Independent Variable(s)	b. Coeff.	b. Stand. Error	Multiple R	Level of Expl.	Increase in the level of Expl.	F Value
Teak Plantation	$Y_1 = 0.15 + 0.025PI$	PI	0.252	0.00054	0.5598	31.33	31.33	21.9077
Cropped	$Y_2 = 0.13 + 0.10RFM$ $-0.00005EI_{30}$	RFM EI_{30}	0.1041 -0.00005	0.01619 0.00002	0.71 0.74	50.69 53.43	50.69 4.73	29.2208
Grass	$Y_3 = 0.21 + 0.01TNT$ $-0.00004\ EI_{30}$ $+0.0003\ AI_{15}$	TNT EI_{15} AI_{15}	0.016 -0.00004 0.003	0.003 0.00001 0.00001	0.80 0.82 0.84	63.42 66.86 70.88	63.42 5.02 3.44	37.32
Bare	$Y_4 = 0.32 + 0.16\ RFM$ $-0.00001\ EI_{30}$	RFM EI_{30}	0.1601 -0.00001	0.20214 0.00003	0.6863 0.7672	47.12 58.86	47.12 11.74	33.61
Natural Forest	$Y_5 = 0.29 + 0.07\ RRM$ $-0.000052\ EI_{30}$	RFM EI_{30}	0.0697 -0.00052	0.0173 0.00002	0.4678 0.5329	21.88 28.41	21.88 6.53	9.3245

F Value above 2.90 is Significant at 0.05% Level

DEPENDENT VARIABLES

Y_1 = Splash from the teak plantation surface
Y_2 = Splash from the cropped surface
Y_3 = Splash from the gross surface
Y_4 = Splash from the bare surface
Y_5 = Splash from the natural forest surface

DEPENDENT VARIABLES

PI = Peak Intensity of Rainfall
RFM = Total Rainfall Amount
EI_{30} = Kinetic Energy and 30 minute maximum Intensity
TNT = Total Rainfall Intensity
AI_{15} = The product of Amount and maximum 15 - minute Intens

The significance of this index appears to have also been captured by Oyegun (1982) when he observed that the study area (Ibadan) is characterized by rainfall which dissipates most of its energy to work in the first 15 minutes of fall. The poor performance of the total rainfall factor (RFM) was rather not surprising considering the fact that the total amount of rainfall has little effect on splash erosion since splash occurs mostly at the beginning of the rainfall event and stops as soon as runoff begins. Infact, the effect of rainfall amount on sheet and gully erosion may be overwhelming but it is neglible in splash erosion.

CONCLUSION:

This study has attempted to determine the important rainfall (erosivity) factors which influence splash erosion from the different land use surfaces in the study area. However, the result of field measurement of the process of splash erosion shows that splash erosion occurred on all the surfaces due to the high intensity nature of the rainstorm events. The rainfall factor of total intensity correlated most significantly with splash erosion, suggesting the influence of these factor above all other factors. Furthermore, the result of the regression showed the rainfall factor of AI_{15} (the product amount and maximum 15 - minute intensity) contributed most significantly to the explanation of the variation in splash. In other words, the AI_{15} index is the most critical detachability factor which can effectively explain splash erosion in the study area and is therefore considered as an important erosivity index of tropical rains. In general, the result points at the obvious role of rainfall intensity and/or their combination (e.g. amount and intensity) on splash erosion.

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