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Original Research Article

Suitability of Universal Soil Loss Erodibility, Inter-rill and Rill Erodibility Models for Selected Tropical Soils

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Abstract

The universal soil loss equation (USLE) and water erosion prediction project (WEPP) (inter-rill and rill) erodibility factors are important indicators for land degradation assessment all over the world, which were primarily developed for the United States of America (USA). However, information on suitability of USLE and WEPP for tropical environment is scarce. Therefore, studies were carried out to investigate the suitability of USLE and WEPP for selected tropical soils of Southwestern Nigeria. Four pedons classified based on USDA soil taxonomy as Plinthic Petraquept (Adio series), Kanhaplic Haplaustalf (Oyo series), Typic Plinthustalf (Temidire series) and Typic Haplaustalf (Owutu series) were used for the study. Soil erodibility factor was determined using USLE and WEPP models. Origin-Pro. 8.1 software was employed to compare USLE and WEPP models for conformity and suitability. The results showed perfect agreement ($R^2 = 1.0$; $P < 0.001$) between the two WEPP (inter-rill and rill) erodibility models in all the four soil types investigated. In addition, WEPP models (inter-rill and rill erodibility) significantly ($R^2 = 0.82$; $P < 0.001$) related to USLE (El-Swaify and Dangler, 1977) erodibility model. There was a poor relationship ($R^2 = 0.46$; $P < 0.06$) between USLE (Wischmeier and Mannering, 1968) and the WEPP erodibility factors. The WEPP erodibility models with a perfect relationship with soil properties of the four soil types are more suitable than USLE models for predicting soil erodibility of the identified soil types in tropical environments.

Keywords: land degradation; soil properties; soil type; water erosion.

INTRODUCTION

Soil erosion is a natural phenomenon that poses serious environmental, social and economic issues (Wang et al., 2012). In Nigeria, just as in many other developing countries of the world, soil erosion causes severe and extensive land degradation with greater impact expressed in the destruction of the top-soil at a faster rate than the soil forming process (Babalola, 2000). Roose (1977) reported soil erosion losses ranging from (0.02–1.2) t ha^{-1} $year^{-1}$ for cropped soil to (3–570) t ha^{-1} $year^{-1}$ for bare fallow in West Africa. In Nigeria, Lal (1976) reported an average soil erosion loss of up to 9.4 t ha^{-1} $year^{-1}$ for bare fallow for tropical Alfisols. Soil erosion depends not only on rainfall erosivity but also on the soil's resistance to erosion, which is usually measured as the soil erodibility factor (*K*). Wang et al. (2013) defined soil erodibility as the amount of soil loss per unit of erosive force, whether it is rainfall, surface flow or seepage. In view of the high costs and long periods of time associated with direct field measurement of soil erodibility, there is need to adapt the nomogram method for estimating erodibility of tropical soils (Vanelslande et al., 1984). The USLE model is the oldest erodibility model developed from 23 benchmark soils of the USA employed in soil erosion prediction. However, Vanelslande et al. (1984) reported that the use of the USLE (Wischmeler and Mannering, 1969; El-Swaify and Dangler, 1977) for prediction of erosion requires site specific values of the parameters concerned. Also, very little is known about the appropriate values of these parameters for tropical sites, making it difficult to evaluate the adaptability of this equation to tropical soils. Manique (1988) reported the following tropical values: $K = 0.18$ for Hawaii; $K = 0.20$ for Island of Mali and $K = 0.31$ for Panama soils. Computer simulation models like the WEPP (Nearing et al., 1989) – developed by the United States Department of Agriculture (USDA) require the input of two erodibility values for each soil type: inter-rill (Ki) and rill (Kr) erodibility. The development of the process based WEPP model began in the mid-1980s (Laflen et al., 1991; Flanagan and Nearing, 1995). WEPP is a continuous simulation model that uses a steady state continuity equation that represents detachment, transport, and deposition processes. Song et al. (2005) noted standard tropical rill *K*-values of 0.38 for Brazil; 0.40 for Hawaii (Manique, 1988); and 0.22 for south-east Nigeria (Ezeabasili et al., 2014).The WEPP model is based on the concept that erosion takes place by the two afore-mentioned differently but complementary sub-processes: inter-rill and rill erosion. Wang et al. (2013) reported that the WEPP models which have been validated against a large soil loss dataset can be applied to many un-gaged areas and can accommodate with a considerable measure of confidence spatial and temporal variations relative to soil properties, topography, hydrology, and land uses.

To date, the use of USLE, RUSLE, WEPP (Inter-rill and rill), EPIC and Dg models have been widely reported all over the world (Romkens et al., 1988). However, it is not certain which of the erodibility prediction models is the best for a given soil type at specific geo-location other than the United States, where these models were developed from soil data of the USA (Wang et al., 2013). Exotic comparisons have established diverse results regarding which model is the best for soil erodibility estimation (Romkens et al., 1988; Torri et al., 1997). In addition, tremendous efforts have been made to compare soil erodibility models for specific locations (Zhang et al., 2004; Hussein et al., 2007; Zhang et al., 2008; Wang et al., 2012). Albeit erodibility is a fraction of erosion prediction whose model performance depends predominantly on the active process in a particular condition, researchers still emphasize that it is tough to conclude which erodibility model presents the best erodibility prediction as one model always tends to overestimate or underestimate soil erodibility compared with the others with regards to the component processes used for evaluation, or even some comparisons are not based on observed data. Nigeria has diversified soil types due to soil heterogeneity and different landforms. Therefore, testing which soil erodibility model is suitable to a given soil type in Nigeria is needed.

The objective of this study was to examine the suitability of USLE (Wischmeier and Mannering, 1969 and El-Swaify and Dangler 1977) and WEPP (Inter-rill and Rill) erodibility models for selected tropical soils of Southwestern Nigeria.

MATERIALS AND METHODS

Soil description

Four pedons classified based on USDA soil taxonomy as Plinthic Petraquept (Adio series), Kanhaplic Haplaustalf (Oyo series), Typic Plinthustalf (Temidire series) and Typic Haplaustalf (Owutu series) were used for the study (latitudes 7°8′10″N and 8°4′40″N and longitudes 3°31′40″E and 3°32′30″E) in Iseyin, Oyo state, Nigeria. The four standard profile pits were sampled including their surface coverage's giving rise to 88 samples. Origin-Pro. 8.1 software was employed to compare USLE and WEPP models for conformity and suitability for aforementioned soil types. Adio series is associated with impeded drainage and strongly mottled with plinthite and concretions at about 60 cm depth. Oyo series is well drained yellowish-red in colour, clay illuviation with penetrable plinthic layer at depth of 80 cm. Temidire series is light textured, grayish coloured soils occurring immediately above mapping unit A with impenetrable petro-plinthite encountered at depth of 81 cm. Similarly, Owutu series is light textured with a mixture of pear shaped iron-manganese concretions and quartz gravel dominating at depth of 45 cm. It also contains flakes of feldspar, mottled clay and highly deformed saprolites down the profile.

Calculations of soil erodibility factor (K)

The USLE and WEPP models were used to estimate soil erodibility factors following Wang et al. (2013)'s procedure. USLE soil erodibility factor (K) developed by El-Swaify and Dangler (1977) was employed as presented in eq. 1. All symbols used in eq. 1 are defined in Table 1.

$$K = -0.03970 + 0.00311X_1 + 0.00043M + 0.00185X_2 + 0.00258X_3 - 0.00823X_4 \quad (1)$$

In addition, USLE soil erodibility factor (K) developed by Wischmeier and Mannering (1969) was employed as presented in eq. 2. All symbols used in eq.2 are defined in Table 1.

$$K = (0.043\ R + 0.62/OM + 0.0082\,\%\ \text{sand} - 0.0062\ C)\ \%\ \text{silt} \quad (2)$$

$$\text{Clay ratio (C)} = \frac{\text{sand (g kg}^{-1}) + \text{silt(g kg}^{-1})}{\text{clay (g kg}^{-2})} \quad (3)$$

WEPP soil erodibility K values (Inter rill and rill erodibility models) were used as reported by Flanagan and Nearing (1995) in Wang et al. (2013) (eqs. 4 and 5). All symbols used in eqs.4 and 5 are defined in Table 1.

$$K_{ib} = 2.728 \times 10^6 + 1.921 \times 10^7 fs \quad (4)$$

$$K_{rb} = 0.00197 + 0.030fs + 0.03863e^{-1840M} \quad (5)$$

Data Analysis

Soil data were subjected to correlation and regression analysis using Origin Pro. Software version 8.1 to ascertain the degree of conformity between the USLE and WEPP erodibility models with regards to the identified soil types.

RESULTS

Suitability of soil erodibility models for soil types

Soil erodibility factors for identified soil types in the study area were presented in Table 2. The USLE and WEPP erodibility values varied down the profiles and among the soil types. Plinthic Petraquept had mean erodibility values of 5.83 and 14.8 for USLE and WEPP models respectively. Suitability or erodibility

Table 1. List of symbols and abbreviations

Symbol	Definition	Unit
USLE	Universal Soil Loss Equation	
WEPP	Water Erosion Prediction Project	
USA	United States of America	
USDA	The United States Department of Agriculture	
R^2	Coefficient of determination	
t ha^{-1} $year^{-1}$	tonne per hectare per year	
K	Soil Erodibility Factor	
Ki	Inter-rill Soil Erodibility Factor	
Kr	Rill Soil Erodibility Factor	
EPIC and Dg	El-Swaify and Dangler (1977) model	
Eq	Equation	
X_1	Unstable-aggregates >0.25 mm	%w
$\mathbf{X_2}$	Soil water content	%v
X_3	%silt + %fine sand	%w
X_4	Sand fraction (0.01 - 2 mm)	%w
R	Soil reaction	
C	Clay ratio	
K_{ib}	WEPP soil erodibility factor for inter-rill erosion	
K_{rb}	WEPP soil erodibility factor for rill erosion	
Fs	Fine sand	%w
OM	Organic matter	%w
CV	Coefficient of variation	%
MWD	Mean Weight Diameter	mm

%w = decimal percent by weight basis; %v = decimal percent by volume basis

models for Plinthic Petraquept was in the order of Wischmeier and Mannering (39.4%CV) > Inter-rill erodibility model (67.5%CV) > Rill-erodibility model (74.5%CV) > El-Swaify and Dangler model (94.7%CV). For Kanhaplic Haplustalf, USLE and WEPP erodibility models gave mean coefficients of 5. 6 and 18.8 respectively. Corresponding CV values were 51.4% and 40.1% respectively. Suitability of erodibility models for Kanhaplic Haplustalf was in the order of Inter-rill erodibility model (38.8%CV) > Wischmeier and Mannering (40.1%CV) > Rill-erodibility model (41.3%CV) > El-Swaify and Dangler model (62.7%CV). Typic Plinthustalf had mean erodibility values of 5.0 and 37.7 from USLE and WEPP models respectively. Corresponding CV values were 33.9% and 26.9% respectively. Suitability of erodibility models for Typic Plinthustalf was in the order of Wischmeier and Mannering (23.7%CV) > Inter-rill erodibility model (26.4%CV) > Rill-erodibility model (27.3%CV) > El-Swaify and Dangler model (44.1%CV). For Typic Haplaustalf, USLE and WEPP erodibility models gave mean coefficients of 7.0 and 7.9 respectively. Corresponding CV values were 49.7% and 105.3% respectively. Suitability of erodibility models for Typic Haplaustalf was in the order of Wischmeier and Mannering (20.7%CV) > El-Swaify and Dangler model (78.6%CV) > Inter-rill erodibility model (98.8%CV) > Rill-erodibility model (111.7%CV).

Relationship between USLE and WEPP erodibility models

Regression coefficients between USLE and WEPP erodibility models were presented in Table 3. The result showed a perfect relationship ($R^2 = 1.0$; $P < 0.01$) between inter-rill and rill erodibility models for all the four soil types. Also, USLE erodibility devised by El-Swaify and Dangler (1977) gave the highest significant relationship ($R^2 = 0.9$; $P < 0.01$) between USLE model and WEPP models (Inter-rill and rill erodibility). There was a poor correlation ($R^2 = 0.2$; $P < 0.3$) between Wischmeier and Mannering (1969) USLE erodibility model and WEPP erodibility models (Table 3). The result of the regression analysis between USLE erodibility factor of El-Swaify and Dangler (1977) and USLE erodibility factor of Wischmeier and Mannering (1969) was presented in Table 3 revealing highest relationship in Kanhaplic Haplustalf ($R^2 = 0.45$; $P < 0.05$), followed by Plinthic Petraquept ($R^2 = 0.30$; $P < 0.06$) and Typic Plinthustalf ($R^2 = 0.18$; $P < 0.07$), and least by Typic Haplaustalf ($R^2 = 0.02$; $P < 0.4$).

Table 2. Suitability of USLE and WEPP erodibility models for soil types obtained from South-western Nigeria

Soil Type	DEPTH (cm)	USLE ERODIBILITY		WEPP ERODIBILITY	
		Wischmeier and Mannering	El-Swaify and Dangler	Inter-rill Erodibility	Rill Erodibility
Plinthic Petraquept	0–17	15.90	1.15	48.91	0.72
	17–36	14.34	0.30	10.26	0.12
	36–54	6.61	0.05	10.49	0.12
	54–78	6.57	0.02	14.22	0.18
	78–95	8.43	0.01	9.72	0.11
	95–119	6.96	0.54	39.00	0.57
	119–146	6.83	0.68	47.30	0.70
	146–162	9.60	0.72	53.56	0.80
	χ	**11.23**	**0.43**	**29.18**	**0.42**
	CV%	**39.4**	**94.7**	**67.5**	**74.5**
Kanhaplic Haplustalf	0–20	8.90	0.76	45.49	0.67
	20–41	7.01	0.33	31.81	0.46
	41–69	7.29	0.66	53.67	0.80
	69–113	6.17	0.04	15.79	0.21
	113–137	14.99	0.80	39.11	0.57
	χ	10.58	0.59	37.17	0.54
	CV%	40.1	62.7	38.8	41.3
Typic Plinthustalf	0–15	9.30	2.03	105.81	1.61
	15–30	9.61	0.90	56.40	0.84
	30–69	5.85	0.82	67.27	1.01
	69–85	8.69	0.82	62.16	0.93
	85–144	11.82	1.41	79.45	1.20
	χ	**8.84**	**1.20**	**74.21**	**1.12**
	CV%	**23.7**	**44.1**	**26.4**	**27.3**
Typic Haplaustalf	0–20	12.30	0.09	6.26	0.06
	20–41	16.48	0.31	6.26	0.06
	41–64	11.17	0.17	11.33	0.17
	64–81	10.74	0.62	38.23	0.56
	χ	**13.61**	**0.30**	**15.52**	**0.21**
	CV%	**20.7**	**78.6**	**98.8**	**111.7**

Perfect relationship ($R^2 = 1.0$; $P < 0.01$) was obtained between inter-rill and rill erodibility of WEPP for all the four soil types (Table 3). Similarly, regression coefficients between WEPP erodibility (inter-rill and rill) and El-Swaify and Dangler's USLE erodibility models were in Table 3. The results revealed that Typic Plinthustalf had the highest relationship ($R^2 = 0.93$; $P < 0.01$) followed by Typic Haplaustalf ($R^2 = 0.81$; $P < 0.01$) and Plinthic Petraquept ($R^2 = 0.80$; $P < 0.01$), and least by Kanhaplic Haplustalf ($R^2 = 0.75$; $P < 0.01$). Table 3 presented the regression between inter-rill erodibility and Wischmeier and Mannering (1969) USLE erodibility models but the relationship was insignificant for all the soil types.

Relationship between predicted soil erodibility factors and soil properties

The correlations between the predicted soil erodibility factors (USLE and WEPP) and soil physical properties were presented in Tables 4 and 5. The results showed highly significant correlations between predicted soil erodibility values and soil physical properties with varying degree of relationships among the four soil types. For Plinthic Petraquept, soil bulk density and saturated hydraulic conductivity were highly significantly ($P < 0.05$) correlated with USLE and WEPP models. However, soil texture and MWD did not have significant relationship with USLE and WEPP. For Kanhaplic Haplustalf, MWD was inversely significantly ($P < 0.05$) correlated with USLE while saturated hydraulic conductivity ($P < 0.05$) and silt content ($p < 0.05$) directly significantly related to WEPP. In addition, bulk density significantly ($P < 0.05$) correlated with Wischmeier and Mannering model while clay content significantly ($P < 0.05$) related to El-Swaify and Dangler model. For Typic Plinthustalf, saturated hydraulic conductivity ($P < 0.05$), bulk

Table 3. Regression coefficient (R^2) between WEPP and USLE models for soil types obtained from South-western Nigeria

Soil Type	Erodibility	WEPP MODELS		USLE MODELS	
		Inter-rill Erodibility	Rill Erodibility	Wischmeier and Mannering	El-Swaify and Dangler
Plinthic Petraquept	Inter-rill Erodibility	1.00	1.00**	0.04	0.81**
	Rill Erodibility	1.00**	1.00	0.04	0.81**
	Wischmeier and Mannering	0.04	0.04	1.00	0.30*
	El-Swaify and Dangler	0.81**	0.81**	0.30*	1.00**
Kanhaplic Haplustalf	Inter-rill Erodibility	1.00	1.00**	0.36*	0.36*
	Rill Erodibility	1.00**	1.00	0.36*	0.36*
	Wischmeier and Mannering	0.36*	0.36*	1.00	1.00**
	El-Swaify and Dangler	0.36*	0.36*	1.00**	1.00
Typic Plinthustalf	Inter-rill Erodibility	1.00	1.00**	0.05	0.94**
	Rill Erodibility	1.00**	1.00	0.05	0.94**
	Wischmeier and Mannering	0.05	0.05	1.00	0.18
	El-Swaify and Dangler	0.94**	0.94**	0.18	1.00
Typic Haplaustalf	Inter-rill Erodibility	1.00	1.00**	0.64**	0.64**
	Rill Erodibility	1.00**	1.00	0.64**	0.64**
	Wischmeier and Mannering	0.64**	0.64**	1.00	0.16
	El-Swaify and Dangler	0.64**	0.64**	0.16	1.00

* and ** are significant levels at $P < 0.05$ and $P < 0.01$, respectively

Table 4. Relationship between erodibility models and selected soil physical properties for soil types obtained from South western Nigeria

Soil Type	Erodibility	Selected soil physical properties					
		Sand	Silt	Clay	Bulk density	SHC	MWD
			(g kg^{-1})		(Mg m^{-3})	(cm hr^{-1})	(mm)
Plinthic Petraquept	Inter–rill Erodibility	–0.22	–0.22	0.18	0.51*	–0.57*	0.48
	Rill Erodibility	–0.22	–0.22	0.18	0.51*	–0.57*	0.48
	Wischmeier and Mannering	–0.85**	0.96**	–0.18	–0.80*	0.27	–0.32
	El–Swaify and Dangler	–0.45	0.45	–0.01	–0.10	–0.41	0.35
Kanhaplic Haplustalf	Inter–rill Erodibility	0.16	0.26	–0.24	0.09	–0.18	–0.64*
	Rill Erodibility	0.16	0.26	–0.24	0.09	–0.18	–0.64*
	Wischmeier and Mannering	0.14	0.98**	–0.47	0.62*	0.69*	0.27
	El–Swaify and Dangler	0.37	0.89**	–0.56*	0.30	0.70*	–0.30
Typic Plinthustalf	Inter–rill Erodibility	0.81*	–0.10	–0.79*	–0.87**	0.68*	–0.11
	Rill Erodibility	0.81*	–0.10	–0.79*	–0.87**	0.68*	–0.11
	Wischmeier and Mannering	0.27	0.92**	–0.49	–0.66*	0.56*	0.70*
	El–Swaify and Dangler	0.80*	0.36	–0.87**	–0.90**	0.70*	0.30
Typic Haplaustalf	Inter–rill Erodibility	–0.78*	–0.40	0.85**	–0.09	–0.53*	0.95**
	Rill Erodibility	–0.78*	–0.40	0.85**	–0.09	–0.53*	0.95**
	Wischmeier and Mannering	0.33	0.97**	–0.62*	0.81*	–0.25	–0.77*
	El–Swaify and Dangler	–0.80*	0.26	0.80*	0.80*	–1.00**	0.40

SHC = Saturated hydraulic conductivity; MWD = Mean weight diameter * and ** are significant levels at $P < 0.05$ and $P < 0.01$, respectively.

density ($P < 0.05$) and clay content ($P < 0.05$) significantly related to both USLE and WEPP. In addition, sand content was significantly ($P < 0.05$) correlated with USLE alone. MWD ($P < 0.05$) and sand content ($P < 0.05$) individually significantly correlated with Wischmeier and Mannering and El-Swaify and Dangler models respectively. For Typic Haplaustalf, clay ($P < 0.05$), sand content ($P < 0.05$), MWD ($P < 0.01$) and saturated

Table 5. Relationship between erodibility models and selected soil chemical properties for soil types obtained from South-western Nigeria

		Selected soil chemical properties					
Soil Type	**Erodibility**	**TN (g kg^{-1})**	**EA**	**Na (cmol kg^{-1})**	**ECEC**	**BS (%)**	**OM (g kg^{-1})**
Plinthic Petraquept	Inter-rill Erodibility	−0.46	0.26	0.65*	0.77*	0.33	−0.52*
	Rill Erodibility	−0.46	0.26	0.65*	0.77*	0.33	−0.52*
	Wischmeier and Mannering	0.44	0.76*	0.19	0.54*	−0.54*	0.22
	El-Swaify and Dangler	−0.08	0.60*	0.53*	0.82*	−0.05	−0.20
Kanhaplic Haplustalf	Inter-rill Erodibility	0.11	0.26	−0.03	0.13	−0.32	0.11
	Rill Erodibility	0.11	0.26	−0.03	0.13	−0.32	0.11
	Wischmeier and Mannering	−0.30	−0.55*	−0.30	0.06	0.52*	−0.30
	El-Swaify and Dangler	−0.30	−0.56	−0.20	0.30	0.50	−0.30
Typic Plinthustalf	Inter-rill Erodibility	−0.37	0.46	0.56*	0.79*	0.22	−0.48
	Rill Erodibility	−0.37	0.46	0.56*	0.79*	0.22	−0.48
	Wischmeier and Mannering	0.55*	0.76*	−0.47	0.16	−0.41	0.42
	El-Swaify and Dangler	−0.20	0.53*	0.45	0.85*	0.22	−0.30
Typic Haplaustalf	Inter-rill Erodibility	−1.00**	0.60*	0.60*	−0.40	−0.40	−1.00**
	Rill Erodibility	−1.00**	0.60*	0.60*	−0.40	−0.40	−1.00**
	Wischmeier and Mannering	0.56*	−0.61*	−0.97**	−0.75*	0.00	0.62*
	El-Swaify and Dangler	−0.80*	0.10	0.10	−0.80*	−0.20	−0.80*

*TN = Total Nitrogen; EA = Exchangeable Acidity; ECEC = Effective Cation Exchange Capacity; BS = Base Saturation; O.M = Organic Matter; * and ** are significant levels at $P < 0.05$ and $P < 0.01$, respectively.

hydraulic conductivity ($P < 0.05$) variably significantly correlated with both USLE and WEPP. In addition, soil bulk density ($P < 0.05$) was linearly significantly related to WEPP while silt content ($P < 0.01$) was positively significantly related to Wischmeier and Mannering model.

DISCUSSION

There is a perfect relationship between the erodibility factors of rill and inter-rill erodibility, entailing that both models are suitable prediction models for computing erodibility factor for all the four soil types. This perfect agreement could be attributed to the process-based nature of both models with uniform inputs parameters (clay, silt, and very fine sand). Song et al. (2005) earlier reported that the WEPP erodibility factors were strong and accurate models for predicting soil erodibility of coarse textured soils. However, there are variations in the relationship between Wischmeier and Mannering (1969) USLE erodibility and El-Swaify and Dangler USLE erodibility factor across the four soil types. The highest relationship was observed in Kanhaplic Haplustalf with a perfect relationship between Wischmeier and Mannering (1969) and El-Swaify and Dangler (1977) USLE models, indicating that both models are suitable for computing erodibility factor for Kanhaplic Haplustalf. In addition, a very strong agreement was obtained between USLE (El-Swaify and Dangler) and WEPP (rill and inter-rill) models for all the four soil types. The strong relationship between El-Swaify and Dangler USLE erodibility and WEPP models could be attributed to the similarity in the fine sand content used for the estimation of erodibility factor for both USLE and WEPP models. However, this result is contrary to earlier reports of Laflen et al. (1991) which established that no satisfactory correlation existed between the USLE soil erodibility factor and the WEPP soil erodibility coefficients. Wischmeier and Mannering (1969) USLE erodibility factor had a poor relationship with WEPP erodibility factors (K_{ib} and K_{rb}) for Plinthic Petraquept and Typic Plinthustalf. However, Kanhaplic Haplustalf and Typic Haplaustalf had moderate (60%) and strong (80%) negative relationships between Wischmeier and Mannering's USLE model and WEPP model (rill and inter-rill). Variation in the relationship between Wischmeier and Mannering's USLE and WEPP models could be attributed to the fact that Wischmeier and Mannering's USLE model gave more credence to the use of soil reaction (soil pH) and silt in estimating erodibility factor while El-Swaify and Dangler's USLE model makes use of soil texture and organic matter content. The implication is that suitability and applicability of Wischmeier and Mannering (1969) USLE erodibility factors are limited to Kanhaplic Haplustalf and Typic Haplaustalf alone. It is important to note that Wang et al. (2013) reported that the WEPP erodibility coefficient was developed as a process-based erosion prediction equation to enhance the potential of soil loss prediction for situations that could not be readily obtained with the limited capability of the factor-based Universal Soil Loss Equation (USLE). Therefore, WEPP model was considered more efficient in predicting soil loss in areas with different soil types, land uses, cropping practices as well as topographies. Albeit the USLE model has been a tremendous conservation management tool, the WEPP model was established to have a greater universality and applicability that would cover a wider range of soil conditions (Wang et al., 2013). With regards to the ease of computing the WEPP erodibility coefficient as well as its numerous advantages over the USLE erodibility factor (*K*), it can be suggested that the WEPP model be employed in predicting soil loss for the identified soil types.

CONCLUSIONS

The WEPP (inter-rill and rill) erodibility models had a strong relationship with El-Swaify and Dangler (1977) USLE erodibility factor implying that either of the two erodibility models could be used to predict vulnerability of Plinthic Petraquept, Kanhaplic Haplustalf, Typic Plinthustalf, and Typic Haplaustalf to water erosion. However, poor agreement between WEPP (inter-rill and rill) erodibility models and Wischmeier and Mannering (1969) USLE erodibility models confirmed differences in their applicability and suitability. Therefore, the WEPP (inter-rill and rill) erodibility with a perfect relationship for the four soil types could be considered more suitable than the conventional USLE erodibility model for compared soil erodibility of these soil types in the tropics.

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