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COMPARISON STUDY BETWEEN EPIC AND MODIFIED EPIC MODELS IN ASSESSING ERODIBILITY FOR ALLUVIAL SOILS

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ABSTRACT

The study aimed to determine the effect of spatial variability on the erodibility factor (K-factor) for alluvial soils located at Tigris river bank using two empirical models ,KEPIC and modified KEPIC(Kr).The studied alluvial soils were extended along the adjacent area of Tigris river including three sites (Mosul Dam , Al-Rashidia and Al-Busaif).The results indicated that there is a wide variations between the two models in estimating the soil erodibility. It showed that use of the Kr model (modified KEPIC) would be considerably lead to under - estimation prediction than KEPIC model. The lowest values of Kr model in comparison with KEPIC for three sites is related to that the Kr -model take into account the gravel fraction in their formula while the KEPIC is not. These finding indicate that the computing method of soil erodibility based on the Kr-model is reasonable and most suitable for estimation soil erodibility for scientific and detailed studies of alluvial soils (as in our soil study) or in soils that have a considerable amounts of gravels separate in comparison to KEPIC which can be used to determine the initial values of soil erodibility by water erosion.

INTRODUCTION

Soil erodibility was developed in the Universal Soil Loss Equation (USLE) to evaluate soil reaction to joining action of rainfall and runoff (Zahng *et.al.*, 2008). Erodibility is the resistance of the soil to both detachment and transport. The concept of soil erodibility is commonly represented by the erodibility factor. The soil erodibility factor (K) is a quantitative expression of the inherent susceptibility of a particular soil to erode at different rates when the other factors that affect erosion are standardized (Mahalder *et. al.,* 2018).This factor is a good indicator to assess and determine soil loss

and is a key to predict the soil erosion (Xiaojun, 2004). Therefore, the estimate of K values by using soil physical or chemical properties attracts more attention (Anache ,2017). Two basic methods have been used for K factor determination. First method is, the direct measurement of K factor from standard plots and the second method is USLE nomograph which was derived by a researcher

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(Wei ,2017). In these two methods , researches have used geostatistical models to favour more realistic modeling, once the error related to the process has been attributed (Chou, 2010 and Al-ansari, 2015). USLE has the most useful and frequently used for soil erodibility term, while Erosion Productivity Impact Calculator (EPIC) was developed in 1981 and 1985 the model was ready for use (Batista *et al.*, 2017). Hence, this study is aimed to describe the erodibility of alluvial soils along Tigris river at Mosul city / northern Iraq by determining the soil erodibility factor using EPIC and modified EPIC models (Kr) , and finally examining which is the most appropriate method between these two models that suitable for various purposes of water erosion assessment.

MATERIALS AND METHODS

The study were conducted on three alluvial soil sites located along Tigris river within Mosul city . In this study, 48 soil samples (16 samples from each site) were taken from 0 to 15 cm depth. Some soil physical and chemical properties were determined as follows; particle size distribution by the hydrometer method, total Carbonate content , soil reaction (pH) and EC in 1:1, organic matter content using wet oxidation methods. Soil erodibility factor (K) was estimated in the studied sites were EPIC-model (Sharply and Williams, 1990) as in the Eq. (1):

$$EPIC\text{-}K = f\text{csand} * f\text{cl-si} * f\text{orgc} * f\text{hisand} \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$f\text{csand} = \{ 0.2 + 0.3 \exp[- 0.256.\ ms. (1 - m_{silt} / 100)]\} \quad ((2$$

$$f\text{cl-si} = \left[\frac{m_{silt}}{mc + m_{silt}} \right]^{0.3} \quad \ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$f\text{orgc} = \left[1- \frac{0.25 \text{ org C}}{\text{org C} + \exp(3.72- 2.95.\text{orgC})} \right] \quad \ldots\ldots\ldots \quad (4)$$

$$(f\text{hisand} = \left[1 - \frac{0.7 (1- m_S/100)}{(1- m_S/100) + \exp\{ -5.51+22.9\ 1- m_S/100)) \}} \right] \ldots \quad (5)$$

Where,

ms = % mass of sand

msi = % mass of silt

mc = % mass of clay

% Organic Carbon

Org.C =

K_{EPIC} resulted from Eq.(1) was multiply by the gravel coeficient (M) to obtain .the modified K_{EPIC} (Kr) (Sai *et al.*, 2019).

$$M = 0.0781e^{-0.0249Rm} \qquad Rm > 20\% \qquad (6)$$

$$M = 0.294 - 0.0123Rm \qquad 10\% < Rm \leq 20 \qquad (7)$$

$$M = 1 - 0.0829Rm \qquad Rm \leq 10 \qquad (8)$$

Where: Rm = % gravel

RESULTS AND DISCUSSION

General properties of studied soils :

The descriptive statistics for some physical and chemical properties of the studied soils are shown in Table 1 and 2. According to the data presented in the two tables, the studied soil are characterized with texture ranged from sandy loam in Mosul dam and Al-Rashidia sites and loamy sand in Albusif site. Chemically, the studied soils were alkaline, non-saline, with moderate content of total carbonte and low content of organic matter.

Table (1): Ranges for soil particles distribution in studied soils

Site	Ranges				
	Soil Separates %			Texture	Gravel %
	Clay	Silt	Sand		
Mosul Dam	2.00 ± 7.95	5.09 ± 10.66	5.0 ± 81.30	Sandy loam	7.08 ± 12.27
Al-Rashidia	2.00 ± 6.95	7.50 ± 13.50	7.0 ± 81.05	Sandy loam	2.49 ± 5.30
Al-Busaif	2.50 ± 10.45	3.00 ± 14.75	2.5 ± 74.80	Loamy Sand	5.39 ± 11.77

Table (2): Ranges for some chemical properties of the studied soils

Site	Ranges			
	pH	EC $dS.m^{-1}$	O. M.	T. Carbonate
			%	
Mosul Dam	7.25 ± 0.15	0.437 ± 0.100	1.06 ± 0.21	22.00 ± 0.50
Al-Rashidia	7.50 ± 0.20	0.693 ± 0.159	0.94 ± 0.05	24.75 ± 2.25
Al-Busaif	7.30 ± 0.00	1.994 ± 0.076	1.04 ± 0.29	26.75 ± 0.25

Soil Eroddibility :

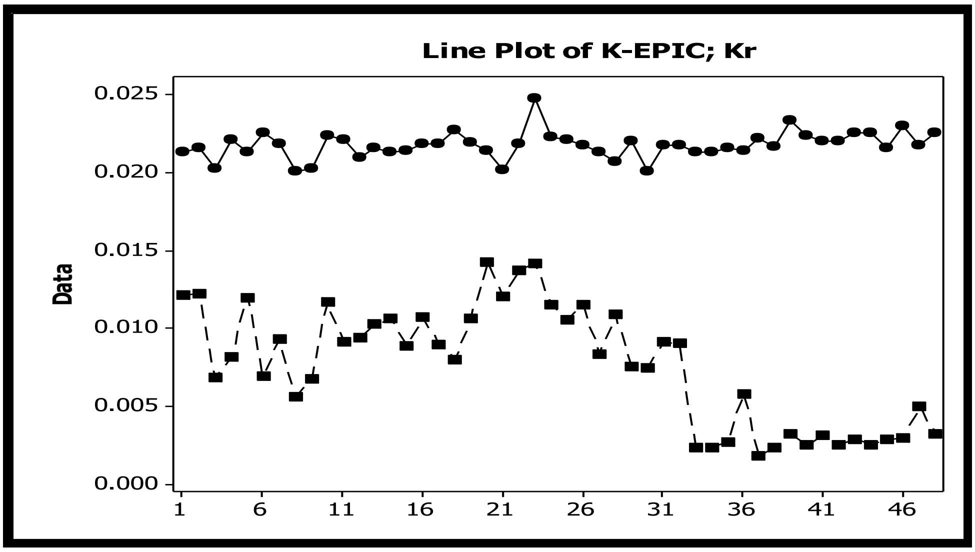
Table (3) shows the result of K_{EPIC} and modified K_{EPIC} (Kr) of the studied locations. It can be observed (from below Table) that the soils of Mosul dam and Al-Rashidia sites are more erodible (with Kr value of 0.00943 and 0.01049 Mg h $MJ^{-1}mm^{-1}$ respectively). While the K_{EPIC} show a different results in comparison to Kr-model (Al-Busaif , Alrashidia and Mosul dam).

Table (3): The mean values of K_{EPIC} and modified K_{EPIC} (Kr) of the studied sois Percent

Site	Mean						
	OrgC*f*	Cl – Si*f*	Csand*f*	Hisand*f*	K-EPIC	*M	Kr
Mosul Dam	0.99621	0.83596	0.20001	0.99632	0.02142	0.43917	0.00943
Al-Rashidia	0.99666	0.83951	0.20008	0.99276	0.02177	0.48204	0.01049
Al-Busaif	0.99615	0.84353	0.20000	0.99367	0.02207	0.13787	0.00303

Equivalent of gravel* = M

In general, the different soil erodibilty from place to another is proportional with the degree of susceptibility of soil to erosion by flow water of river and particle size distribution (soil texture) of soil sediments (Sharma, and Bhatia , 2006). But the different values of soil erodility for the two models (as shown in Table 3) is due to the presence of different gravel fraction content in each of studied sites (Vaezi *et al.*, 2017). The lowest values of Kr- model for three sites in comparison to K_{EPIC}-model is related to that the Kr model takes into account in their formula the gravel fraction while the K_{EPIC} has not.Therefore, the values of Kr –model (0.00303 Mg h MJ-1mm^{-1}) was found to be low in soil at Albusaif site due to presence of high quantity of gravel fraction in this site in comparison to the other two sites.This result is agree with the Sai et al. (2019), who pointed out that is the necessity of introducing the separated gravel as a basic function in calculating the soil erodibility by K_{EPIC} model in alluvial soils or in other soils that have a considerable amount of gravel fraction. This behaviour of the two models can be shown clearly through the secular trend of these models in Figure (1) which show that the values Kr –model distribution of the three studied sites are somewhat has lowest trend than of the K_{EPIC} model after the introduction of an equivalent separated gravel.



Figure(1): Secular trends of Kr and K_{EPIC} models for studied soils

From this results, we can concluded that the EPIC model can be used for erosion assessments to a large extent, whereas modified EPIC model (Kr – model) is more suitable for more detailed studies of erodibility in alluvial soils.

المقارنة بين انموذج ايبك وانموذج ايبك المعدل في تحديد قابلية الترب الرسوبية للتعرية المائية

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الخلاصة

تهدف الدراســة الى تحديد تاثير التغاير المكاني على قابلية التعرية للترب الرســوبية الواقعة على نهر دجلة باســتخدام نموذج ايبك ونموذج ايبك المعدل لثلاثة مواقع امتدت على طول المنطقة المجاورة للنهر حيث شملت موقع سد الموصل وموقع الرشيدية وموقع البوسي ، أشارت النتائج إلى وجود فروق كبيرة بين القيم المحسـوبة بكلا الانموذجين الرياضـين ,حيث اظهرت القيم المحسـوبة من موديل ايبك المعدل قيما اقل من القيم المحســوبة من انموذج ايبك , والذي يعزى ســببه بالدرجة الرئيســية الى مفصول الحصى الذي يقلل من قابلية التربة للتعرية المائية والذي يدخل ضمن الصيغة الرياضية لنموذج ايبك المعدل بينما لم يدخل في الصـيغة الرياضـية لانموذج ايبك ,حيث ان كبر قطر هذا المفصـول تلعب دورا في خفض قابلية التربة للتعرية المائية ولك بسـبب صـعوبة عملية نقله بفعل مياه النهر, الامر الذي يقودنا الى الاستنتاج بانه من الضروري استخدام نموذج ايبك المعدل (الذي يدخل مفصول الحصى في صـيغته الرياضـية) في الدراسـات التفصـيلية لتحديد قابلية الترب الرسـوبية للتعرية المائية او تلك الترب التي تحتوي على كميات معتبرة من مفصـول الحصـى للحصـول على نتائج ادق من انموذج ايبك, الذي يمكن استخدامه في تحديد القيم الابتدائية لقابلية الترب الرسوبية للتعرية المائية.

الكلمات المفتاحية: انموذج ايبك, الترب الرسوبية, التعرية المائية، قابلية التربة للتعرية.

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