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APPLICATION OF WIND EROSION EQUATION IN IRAQ

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ABSTRACT:

This investigation was conducted to apply wind erosion equation (E = f (IKLCV) in Iraq. The equation has been used to estimate the potential average annual soil loss of El-Zubair, El-Hartha and Nassiriya soils.

The results indicate that the wind erosion was 22.64, 1.12 and 224.2 mt/ha/yr, for the above soils respectively. Example of application follows to :-

(1) determine first estimate of wind erosion (IKLC)
(2) determine vegative cover, v
(3) determine the final estimate of wind erosion (using graph)

Key words : Annual loss, Equation, Vegetative cover, Wind erosion

INTRODUCTION

The wind erosion equation (E = ICKLV) has been suggested by Chepil and Woodruff in 1963. This equation expresses mathematically the many factors (soil erodibility, I, local wind erosion climatic factor, C., soil surface roughness, K, width of the field, L, and quantity of vegative cover, V) involved in soil losses from erosive wind effects. The relation

among these factors is derived from four major studies (Chepil, 1950, Chepil and Woodruff, 1954; Chepil, 1960 and Chepil, 1962). The equation was also described by many investigators (Hayes, 1965, Woodruff and Sidoway, 1965; Skidmore et al, 1970).

The use of wind erosion equation is receiving a great deal of attention throughout the world. However, in Iraq; no attention has been made on this issue. the application of the equation is of particular importance, since, it can be used to estimate the potential amount of wind erosion for a given field under local climatic conditions. It also can serve as a guide to reduce potential wind erosion to a minimum. As a first step for the application of wind erosion equation in Iraq, the climatic factor (C) which is a vital factor has been determined for different regions (Abdulla, 1988). Other factors involved in soil losses from erosive wind effects can be derived or modified from previous studies (Zingg and Woodruff, 1951; Chepil, 1959 and 1962; Woodruff and Siddoway, 1965; Skidmore and Woodruff, 1968; Skidmore et al., 1970).

MATERIALS AND METHODS

Field measurements

Soil samples were collected from unprotected top soil 0-5 cm depth of 0.625 acre (0.25 hectare) area 165 feet (50 m) field length. Soil ridge height and plant tops have also been determined. The mentioned measurements have been taken from sample areas of five - square meter plots selected at random. The locations considered are as follows :

1. El-Zubair and El-Hartha from Basrah district

2. Nassiriya dune sand from Thee Kar district

After air drying the soil and plant samples for two days, mechanical analysis, dry sieving and dry matter of plant tops were done (tables 1 and 2). Ridge heights are also presented in table 2.

Information needed for estimating wind erosion

The factors that influence wind erosion must be determined before the potential soil loss can be estimated.

They are as follows :

1. **Soil erodibility factor, I,** determined from percentage of non-erodible soil fractions > 1mm in diameter. The percentage of non-erodible fractions is determined by dry seiving (Chepil, 1962). Soil with non-erodible fractions are rarely found in nature, the lowest value of non-erodible fraction is taken as 3% (Zachar, 1982), with an erodibility

of 220 t/a/yr ($I = \frac{220}{220} = 1.0$).

Table 3 contains percentage of non-erodible fractions (A) and the soil erodibility factor (I). The best regression equation found to represent the relationship between A and I is :

$$I = 1.3687 - 0.31 \ln A \quad \ldots\ldots\ldots\ldots (1)$$

$$r^2 = 0.98$$

This equation can be used to estimate I for a given A.

2. **Local wind erosion climatic factor (C) :** C is estimated for various locations in Iraq (Abdulla 1988). These values are presented in table 4.

Table 1. Dry seiving and mechanical analysis of the investigated soil.

Soil Fraction (mm)		Location: El-Zubair	Location: El-Hartha	Location: Nassiriya sand dune
		Dry seiving		
> 1.00	%	5.1 + 0.05	29.0 + 1.45	4.0 + 0.2
1.00 – 0.50	%	9.8 + 0.3	16.2 + 0.4	3.0 + 0.07
0.50 – 0.05	%	19.7 + 1.0	18.8 + 0.6	6.3 + 0.3
< 0.05	%	65.4 + 2.6	36.0 + 1.4	86.7 + 4.3
		Mechanical analysis		
2 – 0.2	%	8.4 + 0.4	1.2 + 0.05	72.1 + 2.09
0.2 – 0.02	%	83.4 + 4.1	46.6 + 1.3	26.7 + 0.75
0.02 – 0.002	%	3.4 + 0.1	28.1 + 1.1	1.2 + 0.02
< 0.002	%	4.8 + 0.1	24.1 + 0.8	nil
Total		100 + 4.7	100 + 3.25	100 + 2.86
Texture class		loamy sand	silty loam	sand

Table 2 : The dry matter of plant tops and soil ridge heights

Measurement	Location		
	El-Zubair	El-Hartha	Nassiriya sand dune
Dry matter			
(Kg)	108.73 ± 5.2	278.8 ± 2.3	35.9 ± 3.1
(lb)	239.21 ± 11.4	613.36 ± 5.1	78.98 ± 6.8
Ridge height			
(cm)	1.25 ± 0.25	10 ± 2.3	0.5 ± 0.01
(in)	0.5 ± 0.1	4.0 ± 0.4	0.2 ± 0.05

Table 3 [1] : Soil erodibility factor (I) for standard soils.

% soil fraction, A > 1 mm	Soil erodibility T/a	Soil erodibility [2] factor (I)
1	310	1.41
3	220	1.00
5	180	0.82
10	134	0.61
15	117	0.53
20	98	0.45
30	74	0.34
50	38	0.17
80	2	0.01

(1) (partly modified after Skidmore and Woodruff, 1968)

(2) $I = \frac{\text{soil loss where A = varable}}{\text{soil loss where A = 3\%}}$

Table 4. Location and wind erosion climatic factor (c) for various locations in Iraq (Abdulla 1988).

Location	climatic factor %	Location	climatic factor %
1. Penjwin	1.1	27. Jalawla	15.8
2. Rawenduz	0.5	28. Mansuria	15.8
3. Agra	0.5	29. Baiji	21.0
4. Sirsink	0.5	30. Amara	20.0
5. Shaqlawa	1.1	31. Fao	46.5
6. Amadia	1.1	32. Baghdad	25.3
7. Dokan	1.1	33. Hai	100.0
8. Chwarta	1.6	34. Kut	21.6
9. Bakroja	2.1	35. Basrah	41.0
10. Zakho	0.5	36. Ana	20.5
11. Sulaimaniya	0.5	37. Samaria	29.5
12. Salahddin	2.6	38. Budaa	61.6
13. Halabja	2.6	39. Diwaniya	47.7
14. Shikhan	3.2	40. Habbaniya	19.5
15. Duhok	1.1	41. Nasiriya	157.9
16. Arbil	5.8	42. Al-Maqil	69.5
17. Sinjar	15.9	43. Ritba	89.5
18. Mosul	5.8	44. Hit	26.3
19. Kirkuk	6.8	45. Hindiya	70.0
20. Telafar	17.5	46. Samawa	48.4
21. Khanagin	4.7	47. Najaf	71.7
22. Mandily	17.4	48. Kerballa	87.9
23. Hawija	15.9	49. Nukhaib	115.8
24. Ali Algharbi	16.9	50. Mussiyib-project	68.9
25. Iftikhar	18.8	51. Ramady	41.6
26. Tuz	10.5		

3. **Soil surface ridge roughness factor (k):** k is equal to the average heights of clods or ridges of which the surface is composed (Zingg and Woodruff, 1951, Chepil, 1962). Several measurements can be made with a ruler and average calculated (see table 2). The relation between soil ridges roughness (h) and soil ridge factor (k) are illustrated by the following equation :

$$K = 0.8466 - 0.142\,h + 0.14\,h^2 \quad \ldots\ldots\ldots (2)$$

$$r^2 = 0.88$$

4. **Field width length (L)** : According to Woodruff and Zingg, 1952 and Chepil, 1959, the width of unprotected part of the filed (D), is obtained from the differences between the distance along prevailing wind erosion direction across the field (D_f) and the distance along prevailing wind erosion direction protected by barrier (D_b). Table 5 contains the field width (D) and field length factor (L). In addition, the following equation describes the best relationship between D and L.

$$L = -0.011 + 0.02\,D \quad \ldots\ldots\ldots (3)$$

$$r^2 = 0.99$$

5. **Vegative factor (V)** : V (see table 2) is estimated by sampling, cleaning, drying and weighing the plant tops or plant residues above the ground, roughly, the equivalent cover in thousands of pounds per acre is :

Grain Sorghum 1.5 time actual weight

Grain Sorghum 2.3 " " "

Table 5. Estimated field length factor

Distance across field Df (m)	assumed barries heights (m)	field length, Db (m)	field length, D (m)	field length factor (L)
50	0	0	50	1.0
50 (1)	0.2	9.73	40.3	0.8
50	0.4	19.47	30.5	0.6
50	0.6	29.2	30.8	0.4
50	0.8	38.93	11.1	0.2
50	1.0	48.66	1.3	0.03

(1) example of calculation :

$$Db = \frac{365\ H}{V} = \frac{365 * 0.2}{7.7} = 9.73\ m$$

where H the barrier heights (m)

V the wind velocity taken as 7.5 m s-1 (average mean of maximum wind velocity in Iraq)

$$D = Df - Db = 50 - 9.73 = 40.3m$$

$$L = \frac{40.3}{50} = 0.8$$

12 in, tall

Grain Sorghum 3 " " "

20 in tall

Wheat stubble, standing 6 time actual weight

Desert range vegetation 7 to 8 time actual weight

The first estimate of erosion and final values in relation to vegative cover are illustrated in figure 1. Estimating wind erosion losses

According to the previously mentioned information, the soil loss may be readily calculated. So in order to illustrate how wind erosion is estimated, El-Zubair, El-Hartha and Nassiriya soil were taken as an example (table 5). The results are compiled in tables 1,2,3,4 and 5 and figure 1. The wind erosion was 10.1 t/a/yr (22.64 mt/ha/yr), 0.5 t/a/yr (1.12 Mt/ha/yr) and 100 t/a/yr (224.2 mt/ha/yr) for El-Zubair, El-Hartha and Nassiriya respectively (table 6). It is interesting to note the influence of vegative cover on the expected erosion, for example if the equivalent cover for El-Hartha location was only 6000 lb/a the estimated erosion would be about 0.8 t/a/yr (1.79 mt/ha/yr), and not 10.1 t/a/yr (22.64 mt/ha/yr).

Further research is needed at various parts of the country to evaluate some of the equation factors.

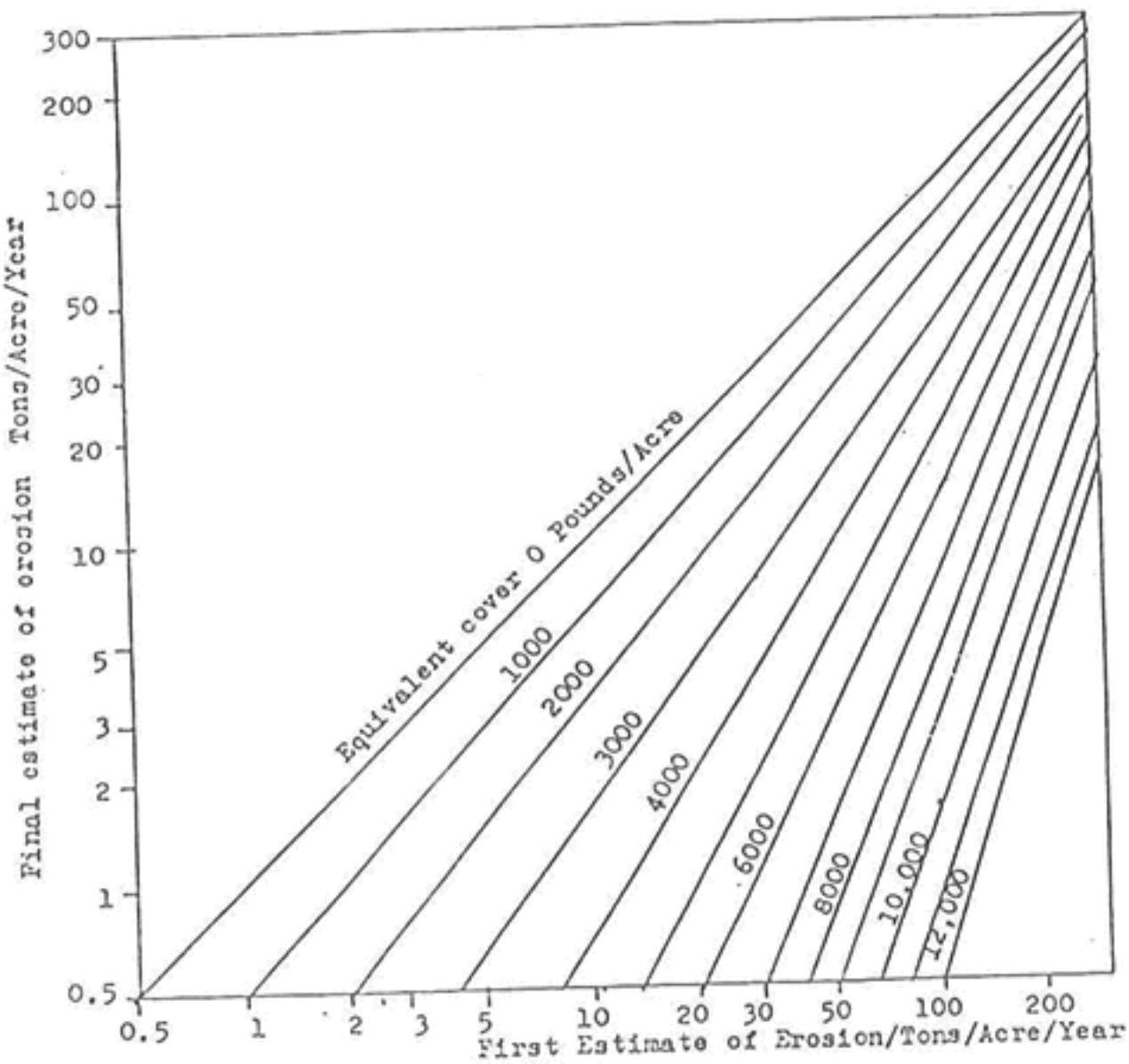

Figure (1): The first estimate of erosion and final values in relation to vegetation cover. (after Skidmore et al., 1970).

Table 6. The estimated wind erosion for the investigated areas

Factor	El-Zubair	El-Harth	Nassiriya
I	0.86	0.32	0.94
K	0.78	0.50	0.83
C	41.0	41.0	157.9
L	0.89	0.79	0.99
Wind erosion (1)			
first estimate	24.48	5.18	121.96
V (lb) (2)	1913.7	4906.9	631.8
Wind erosion (3)			
final estimate			
(t/a/yr)	10.1	0.5	100.0
(Mt/ha/yr)	22.64	1.12	224.2

(1) first estimate = IKCL

(2) The effective cover is calculated as 8 time the weight (see table 2)

(3) Use the graph of figure 1

(4) T / a / yr * 2.242 = mt / ha / yr

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مجله الأمارات للعلوم الزراعية (١٩٩١) ٢٠ : ٩٧ - ١١١

تطبيق معادلة تعرية التربة الريحية في العراق

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الخلاصـــــة :

اجريت هذه الدراسة لتطبيق معادلة تعرية التربة الريحية (E = f (IKLCV في العراق. ولقد استخدمت المعادله لتقدير المعدل السنوى لتعرية التربة الريحية لتربة الزبير ، الهارثة في البصرة وتربة الكثبان الرملية في الناصرية.

اظهرت النتائج ان التعرية كانت ٢٢ر٦٤ ، ١ر١٢ ، ٢ر٢٢٤ طن متري / هكتار/ السنة للترب اعلاه على التوالى .

وتلخص طريقة تطبيق المعادلة بتعين ما يلي :

١. تقدير اولي للتعرية الريحية (I K L C) .
٢. تعيين الغطاء الخضرى . V
٣. تقدير نهائي للتعرية (باستخدام منحني خاص) .

كلمات مفتاحية : تعرية التربة ، الغطاء النباتى ، الفقد السنوى ، معادلة .