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Evaluation of Wind Erosion Models Under Egyptian Conditions

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MANY REGIONS in Egypt subjected to wind erosion hazards that accelerates soil degradation and desertification. Northwestern coast zone (NWCZ) and Sinia are of these regions which have fragile agricultural land characterized by poor soil, limited rainfall, several drought periods and erosive wind. The current study was conducted to evaluate the amount of eroded soil estimated by different wind erosion equations with the measured values that were obtained under field condition.

Three sites were selected for field measurments at Foka area,215 km west of Alexandria. The sites differ in their soil erodibility, soil roughness and vegetative cover. Airborne material was collected from eroding soil with Big Spring Number Eight (BSNE) sampler through 30 months.The results indicated that the amount of measured soil loss ranged between 2.43 to 10.63 Mg ha^{-1} y^{-1}, however, the soil loss amount estimated by WEQ ranged between 5.17 to 71.29 Mg ha^{-1} $y^{-1.}$ The values obtained by RWLQ ranged between 3 1.95 to 64.87 $Mgha^{-1}$ y. Based on the relationship between measured and corrected estimated soil loss, it could be concluded that every method can be used for estimating annual soil loss under NWCZ conditions. It is a clear need to conduct intensive further studies in Egypt to identify the best wind erosion model to halt desertification resulted from wind erosion.

Keywords : Wind erosion model, northern coast, Sinai.

Many regions in Egypt subjected to wind erosion hazards that accelerates soil degradation and desertification. Northwestern coast zone (NWCZ) and Sinai are of these regions which have fragile agricultural land characterized by loose, dry, a smooth soil surface devoid of vegetative cover, large fields, frequency of drought and precipitation is low. Wassif (1997) showed that the amount of airborne materials expressed as t. $100m^{-1}$ width were 0.78, 3.16 and 86.19 for bare soil of south Abou Lahu (NWCZ), El Sheikh Zowaied, and El Maghara (North Sinai) over 93, 193, and 340 days, respectively. Also, he showed that the enrichment ratios for organic matter, total nitrogen, available phosphorus and exchangeable potassium were greater than one. In South Sinai, Wassif *et al.* (1999) found that the quantity of airbrone wind eroded material reached 30.7 $t.100m^{-1}$ width over 83 days.

The ability to accurately predict soil loss by wind is essential for conservation planning from wind ersion hazards. The wind erosin equation (WEQ) puplished by Woodruff and Siddoway (1965) was used by Arroug (1994) for assessing average annual soil loss by wind in El- Omayed area (NWCZ) of Egypt. He showed that the value reached $100t.ha^{-1}$ yr^{-1}. The objective of the current investigation is to estimate annual soil loss by wind erosion using different models as well as comparing estimated value to a measured one under different land use and management practices.

Material and Methods

The study area is in the northwestern coastal zone (NWCZ) at Fuka about 215 Km west of Alexandria. Generally, NWCZ is characterized by arid conditions, indicating torric soil moisture and thermic soil temperature regimes. Soil is generally shallow and $CaCO_3$ content varies from the lower limit of 10 to as high as 94.5% in the oalitic ridges. Fuka area is bounded by longitudes 27° 30' -28° east and latitudes 30° 30'-31° north. The soils in the immediate vicinity of the sampling site are sandy loam to sandy clay loam (Typic calci). The upper 5cm of the soil surface ranges from 53.4 to 56% sand, 22 to 25% silt and 18 to 23% clay. Total carbonate varies from 27 to 30.6%. In general, the soil is calcareous, poor in organic matter and low in fertility. The site is surrounded by 1.5 m height rubble-stone fencing and stony soil as non-erodible area.

Samples of eroded soil particles were collected from April 1, 1995 to October 8, 1997 at heights of 0.10, 0.50, 0.75 and 1.0m with Big Spring number Eight (BSNE) dust samplers described by Fryrear (1986). The samplers were positioned in three Parcles which their areas are 4.8, 10.6, and 4.9 ha. The first one was cultivated with fig and olive trees, 3 years old, the second parcel was cultivated with fig trees 10 years old and the third one was covered with wheat residues. In Parcel one tillage practice was conducted perpendicular to the mean erosine wind. In Parcel two, intensive tillage was conducted by the farmer, however, in parcel three, perpendicular tillage to the erosive wind direction was conducted for soil covered with wheat residues.

Samples of the eroded material were collected for 16 periods from April 1, 1995 to October 8, 1997. At the time of sampling eroded soil particles were transferred from the samples to plastic containers. In the laboratory, the samples were dried at 55°C for 72 hr before weighing. Soil surface roughness parameters, *i.e.* the heights of ridge spacing for plowed soil were measured on April 1, 1995,1996, on October 17, 1996 and on May, 22, 1997. Their averages were used to determine soil roughness factor, $K^{/}$ (Woodruff and Siddoway, 1965) . Four separate plant samples were used to measure vegetation parameters which included numbers of natural grown plants per feddan and their canopy diameters, the weight of surface and buried residues within 5 cm depth and expressed as g. m^{-2} followed the method of Fryrear (1985) and the percentage of soil cover was calculated by the method described by Bilbro (1987,1989).

Wind speed (ms^{-1}), air temperature °C, wind direction (degrees), rainfall (mm), and relative humidity (%) were measured by recording automatic weather station installed in the study area at a height 3 m above the soil surface.

The annual soil loss was estimated by wind erosion equation (WEQ) as described by Woodruff and Siddoway (1965) using three different methods for calculation described by Troeh *et al.* (1980), Schwab *et al.* (1993) and Morgan (1995). Revised wind erosion equation (RWEQ) as described by Fryrear *et al.* (1994) was also used to estimate soil loss by wind erosion.

Results and Discussion

The average wind speed varied from 4.53 ms^{-1} in July, 1996 to 2.19 ms^{-1} in November, 1997, with a monthly mean of 3.68 ms^{-1} during the study period . Hours number of $<0.5, 0.5-5, 5-10$ and > 10 ms^{-1} wind speed during study period were 803, 9535, 3899 and 76, respectively (Table 1). Wind speed as high as 14.29 ms^{-1} was recorded during September, 1997. The most erosive period occurred from March through July, 1997. The dominant wind direction is from west to north (WWN, represented 23.77% of the total wind direction) .

TABLE 1. Meterological records at the study area from April 1, 1996 to November 19, 1997.

Month	Average daily temp. (c)	Total monthly rainfall (mm)	Average wind speed (ms^{-1})	Periods of wind speed								Max. hourly wind speed (ms^{-1})
				0-0.5 ms^{-1}		0.5-5ms^{-1}		5-10ms^{-1}		Over 10 ms^{-1}		
				Hours	% of time	Hours	% of time	Hours	% of time	Hours	% of time	
April, 1996	16.86	4.60	4.51	6	0.83	448	62.22	258	35.83	8	1.12	12.08
May	21.15	-	3.56	13	1.81	527	73.19	173	24.03	7	0.97	13.96
June	23.59	-	3.78	1	0.14	498	69.17	221	30.69	-	-	9.50
July	25.33	0.20	4.53	2	0.27	393	52.82	348	46.77	1	0.14	10.05
August	26.28	-	3.86	5	0.67	513	68.95	226	30.38	-	-	8.01
September	26.26	-	3.43	9	1.25	554	76.94	157	21.81	-	-	9.21
October	21.19	6.60	3.27	19	2.55	592	79.57	133	17.88	-	-	9.14
November	18.72	9.40	3.35	37	5.14	525	72.92	158	21.94	-	-	7.41
December	14.82	0.20	3.29	21	2.83	590	79.41	125	16.82	7	0.94	11.55
January, 1997	13.69	15.20	3.07	40	5.38	586	78.76	118	15.86	-	-	9.25
February	12.94	14.40	3.82	14	2.08	505	75.15	142	21.13	11	1.64	12.46
March	14.32	14.00	4.17	23	3.09	473	63.58	237	31.85	11	1.48	12.66
April	16.47	-	4.26	8	1.11	450	62.50	255	35.42	7	0.97	11.79
May	20.22	0.04	3.14	128	17.21	436	58.60	178	23.92	2	0.27	10.64
June	24.43	-	4.07	61	8.47	396	55.00	253	35.14	10	1.39	12.39
July	26.45	-	4.33	52	6.99	372	50.00	312	41.94	8	1.07	11.00
August	25.89	-	3.49	76	10.21	446	59.95	222	29.84	-	-	8.42
September	23.94	0.80	3.76	28	3.89	471	65.51	216	30.04	4	0.56	14.29
October	21.60	22.0	3.12	110	14.78	508	68.28	126	16.94	-	-	8.91
November	18.21	2.20	3.19	150	33.86	252	56.88	41	9.26	-	-	9.65
Monthly mean	20.62		3.68									
Total	-	-	-	803	5.61	9535	66.62	3899	27.24	76	0.53	

* Indicates results based on hourly climateological data at 3 meter height.

TABLE 2. Amount of airborne materials (g cm^{-2}) collected by BSNE samplers at 4 heights, 0.1 to 1.0 m for fire measurments periods, and during the study period (30 months).

Parcel No.	Measurement Periods	Eroded materials (g cm^{-2}) at 4 height.				Amount of eroded material (gm cm^{-1} Width)
		0.1 m	0.5 m	0.75 m	1.0 m.	
1	1/4 - 4/10/1995	0.13	0.09	0.08	0.06	8.23
	4/10/95 - 31/3/96	13.26	4.98	4.02	3.36	495.36
	31/3 - 17/10/96	0.84	0.60	0.57	0.54	56.34
	17/10/96 - 22/5/97	32.21	12.38	8.47	7.43	1161.4
	22/5 - 8/10/97	3.99	2.98	2.46	1.78	257.19
	Total	50.43	21.03	15.60	13.17	1978.52
2	1/4 - 4/10/1995	0.44	0.25	0.17	0.09	21.63
	4/10/95 - 31/3/96	44.73	6.25	3.62	0.59	980.01
	31/3 - 17/10/96	6.55	1.77	1.27	0.82	183.07
	17/10/96 - 22/5/97	68.86	7.36	4.52	3.26	1082.96
	22/5 - 8/10/97	9.76	4.20	3.17	2.61	390.84
	Total	130.34	19.83	12.75	7.37	2658.51
3	1/4 - 4/10/1995	0.18	0.11	0.09	0.06	9.9
	4/10/95 - 31/3/96	2.8	1.09	0.82	0.77	107.73
	31/3 - 17/10/96	2.43	1.31	1.05	0.93	118.37
	17/10/96 - 22/5/97	8.45	3.15	2.04	1.78	291.64
	22/5 - 8/10/97	1.10	1.02	0.83	0.53	79.09
	Total	14.96	6.68	4.83	4.07	606.73

The amount of soil eroded material in each measurement period varied with height, parcel No. and wind speed (Table 2). For every Parcel the bulk of the eroded soil particles was carried close to the soil surface. The amount of soil eroded from Parcel No.2 was the greatest for every measurement period. The fourth period gave the highest amount of eroded soil for every parcel, (Fig. 1.).

Analysis were performed on the data given in Table 2 to examine relationships between amount of eroded soil collected and sampler height. It was found that the power function is the best. The equation is as follows:

$$Y=aX^b$$

Where Y mass of soil eroded collected g/cm^2; X= height of sampler, m; and a and b = regression coefficients. In this respect Fryrear and Saleh (1993), and Vories and Fryrear (1991) reported that power equation described the quantity of eroded materials transported by wind above the soil surface.

The total amount of eroded soil which was collected by a 10 mm wide slot extending from a height of 0.10 to 1.0 m (Q) was estimated by integrating the regression equations between the limits of 0.10 and 1.0 m. Table 3 shows the annual soil loss Q gm cm^{-1} width and average annual soil loss as kg m^{-1} width and ton ha^{-1}. It is clear that the highest quantity of eroded soil was obtained from parcel No.2, however, the lowest one was associated with parcel No.3. Soil loss from parcel No. 1 lies between those extreme ones. Differences in annual soil loss between parcels depended upon type of tillage and plant residues.These results are in harmony with that obtained by Chepil and Woodruff (1963), Fryrear *et al.*(1991) and Hagen (1996). Concerning plant residues, Unger and McCalla (1981) and Bilbro (1987) reported that the fallowing-cropping was effective in reducing potential wind erosion in semi-arid areas during the fallow periods where plant residues were left in field.

TABLE 3. Annual soil loss for every Parcel.

Parcel No.	Annual soil loss Q g. cm^{-1}	Average annual soil loss	
		Kg m^{-1} width*	Ton ha^{-1}**
1	791.4	79.14	7.91
2	1063.4	106.34	10.63
3	242.7	24.27	2.43

The amount of soil loss expressed in ton ha^{-1} yr^{-1} that could occur under different conditions at Fuka area was estimated using two models; Wind Erosion Equation (WEQ) and Revised Wind Erosion Equation (RWEQ).

Wind Erosion Equation WEQ

The basic equation of WEQ (Woodruff and Siddoway, 1965) was used to compute the annual soil loss from the experimental fields. Such equation is as follows

E=f(I,K,C,L,V)

Where

E : Potential annual soil loss (Mg ha^{-1} yr^{-1}). It is a function , f of :

I$'$:Soil erodibility index, Mg. ha^{-1}

$K^{/}$:Soil surface roughness factor, dimensionless .,

$C^{/}$:Local wind reosion climatic factor, %.

$L^{/}$: Equivalent field length (unsheltered distance across the field along the prevailing wind direction,) meter, and

V : Equivalent vegetative cover variable, Kg. Ha^{-1}

The measured parameters for each parcel used in the wind erosion equation are listed in Table 4 . The values needed for predicting annual soil loss via wind erosion were calculated as follows :

1 .Soil erodibiliy factor $I^{/}$

Two methods were used to calculate soil erodibility factor, I. The first one was described by Woodruff and Siddoway (1965). It is based on the percentage of dry stable non-erodible fractions. The second one is described by Schwab *et al.* (1993). It is based on the regression equation between soil erdibility, I (Mg ha^{-1}) and the percentage of dry soil faction > 0.84mm, f; as follows

$$I^{/} = 525 \times 2.718^{(-0.04f)}$$

2.Soil roughness factor, $K^{/}$

This parameter includes at first the calculation of ridge roughness Kr, using the equation given by Woodruff and Siddoway (1965) as follows:

$$Kr = \frac{4\,(\text{ridge height})^2}{\text{Distance between ridges}}$$

Afterwards, the dimensionless soil-ridge roughness, k, was calculated by three different methods: a. According to Schwab *et al.*, (1993).

$$K = 0.34 + \frac{12}{(Kr + 18)} + 6.2 \times 10^{-6}\, Kr^2.$$

b. According to Woodruff and Siddoway (1965),

c. According to the relationship between K and Kr described by Morgan (1995) as follows

$$K = 1 \qquad , K_r < 2.27$$

$$K = 1.125 - 0.153\ \ln Kr \qquad , 2.27 \le Kr < 89$$

$$K = 0.336 \exp(0.00324\ Kr) \qquad , Kr \ge 89$$

3.Climiatic factor, C .

The climatic factor has been estimated using the equation described by Chepil *et al.*(1963) and Woodruff and Siddoway (1965).

$$C = \frac{100\ \ U^3}{2.9\ \ (P-E)^2}$$

TABLE 4. Soil properties and field measured parameters for the study area used for the prediction of annual soil loss.

Parcel No.	Periods	O.M. (%)	$CaCO_3$ (%)	Non-erodible fractions (>84mm) %	Particle size distribution %			Ridge* Height (mm)	Silhouette** Area Cm^2-m^{-2}	Soil Cover %	Standing and buried residues		
					Sand	Silt	Clay				Diameter of stalk (cm)	Specific Weight $Gm.cm^{-3}$	Weight $Gm.m^{-2}$
1	1/4 - 4/10/95	0.33	28.0	52.65	56.28	23.01	20.71	52.0	-	1.30	-	-	-
	4/10/95 - 31/3/96	0.30	28.5	36.95	52.62	24.20	23.18	46.0	-	2.20	-	-	-
	31/3 - 17/10/96	0.37	27.9	43.45	53.92	23.90	22.18	53.0	-	1.30	-	-	-
	17/10/96 - 22/5/97	0.38	28.1	30.15	59.85	22.32	17.83	50.0	-	1.30	-	-	-
	22/5 - 8/10/97	0.42	28.5	43.65	56.33	23.72	19.95	49.0	-	0.80	-	-	-
	Average	0.36	28.2	41.37	55.80	23.43	20.77	50.0	-	1.38	0.50	0.40	27.10
2	1/4 - 4/10/95	0.28	28.0	39.25	60.43	22.33	17.24	11.0	-	-	-	-	-
	4/10/95 - 31/3/96	0.31	27.6	30.85	64.81	19.87	15.32	10.0	-	-	-	-	-
	31/3 - 17/10/96	0.33	27.9	42.7	62.19	20.50	17.31	10.0	-	-	-	-	-
	17/10/96 - 22/5/97	0.30	28.0	11.2	64.29	20.00	15.71	9.0	-	-	-	-	-
	22/5 - 8/10/97	0.28	27.0	34.9	62.38	19.30	18.32	10.00	-	-	-	-	-
	Average	0.30	27.7	31.78	62.82	20.40	16.78	10.0	-	-	0.50	0.40	10.80
3	1/4 - 4/10/95	0.45	27.4	55.63	52.18	21.98	25.84	53.0	100	4.10	-	-	-
	4/10/95 - 31/3/96	0.49	28.1	51.83	50.49	23.17	26.34	45.0	-	9.10	-	-	-
	31/3 - 17/10/96	0.53	26.9	45.50	52.73	20.15	27.12	51.0	-	4.50	-	-	-
	17/10/96 - 22/5/97	0.52	27.0	37.80	52.20	22.80	25.00	49.0	-	5.60	-	-	-
	22/5 - 8/10/97	0.46	26.1	44.83	53.40	21.90	24.70	52.0	-	3.20	-	-	-
	Average	0.49	27.1	47.12	52.20	22.00	25.80	50.0	20	5.30	0.43	0.33	43.30

* Ridge is 500 mm for all and the ridges are perpendicular to dominate wired direction

* Silhouette area is calculated form the number of plant stalks (10) perm2 X height (25 cm) xd imeter

Where :

C is climatic index, %, the climatic index C is expressed as a percentage of its value of 2.9, *i.e* C 2.9/100, for Garden City, Kansas, USA.

U is the mean annual wind speed, ft s^{-1}, at a height of 30 foot, and (P-E) is the thornthwait index:

$$(P - E) = 115 \sum_{i=1}^{i=12} \left(\frac{Pi}{Ti - 10}\right)^{10/9}$$

Where :

Pi ≥ 0.5 inch, is the mean monthly precipitation, and

Ti ≥ 28.4 °F is the mean monthly temperature.

The wind speed were measured at 3 m height and adjusted to 9.1 meter (30 foot) height by a power law exponent of 1/7 in the equation given by Hagen (1996) describing wind speed profile, as follows:

$$U_2 = U_1 \left(\frac{Z_2}{Z_1}\right)^{1/7}$$

Where:

U_1 and U_2 are wind speed at height Z_1 (3m) and Z2 (9.1m), respectively.

4. Length of the unsheltered field L

According to Schwab *et al.* (1993), the actual field length is taken as (L, m) assumed to be 100 m.

5. Vegetative cover factor, V

The equation described by Lyles and Allison (1980, 1981) has been used to estimate vegetative cover (V) as follows:

$$(SG)_e = 0.162\ R_w/d + 8.708\ (Rw/dy)^{1/2} - 271,\ r = 0.96.$$

Where:

$(SG)_e$ is small grain equivalent for weight of the residues (Kg ha^{-1})

(R_w) is standing and buried residues weight to be converted (Kg ha^{-1}).

(d) is average stalk diameter (cm), and

(γ) is average specific weight of stalk (gm cm^{-3}).

The annual soil loss, E; Mg ha^{-1} yr^{-1}, was calculated by the methods described by Troch *et al.* (1980), Schwab *et al.* (1993) and Morgen (1995). Table 5 shows the calculated values of each parameter required for the calculation of the predicted annual soil loss values. Data shows that the main factors affecting wind erosion are $I^{/}$, $K^{/}$, and V but the values of $C^{/}$ and $L^{/}$ are the same for all Parcels. The soil of parcel No. 2 was highly erodible due to the highest I value and to the lowest V value. However, the soil of parcel No.3 was the least

TABLE 5. Predicting annual soil loss under the prevailing conditions at Fuka area, NWCZ, using wind erosion equation (WEQ).

Models of predicting annual soil loss according to	Estimated WEQ parameters											Predicted annual soil loss ($Mg\ ha^{-1}\ yr^{-1}$)		
	Soil erodibility (I', Mg, ha^{-1})			Soil roughness (K', dimensionless)			Vegetative cover (V, $kg\ ha^{-1}$)			Climatic* Factor (C',%)	Field** length (L',m)			
	Parcel 1	Parcel 2	Parcel 3	Parcel 1	Parcel 2	Parcel 3	Parcel 1	Parcel 2	Parcel 3			Parcel 1	Parcel 2	Parcel 3
Troeh et al. (1980)	120.52	158.88	98.40	0.636	0.816	0.639	137.5	25.38	373.44	0.677	100	17.00	47	8.5
Schwab et al. (1993)	100.34	147.26	79.73	0.659	0.978	0.659	137.5	25.38	373.44	0.677	100	8.38	38.76	5.17
Morgan (1995)	120.52	158.88	98.40	0.667	1.00	0.667	137.5	25.38	373.44	0.677	100	26.7	71.29	22.81

* Climatic factor is estimated from climateological data for the study area, Table (1).
** The actual field length, L, is assumed to be 100 m.

erodible one . The value of $K^{/}$ varied between parcels depending upon the intensity of tillage operations. The highest value of K/ was obtained for the soil of parcel No. 2. Data generally show that the estimated soil loss for parcel No.3 was the least. It is accepted that predicted annual soil loss values varied between 5.17 and 22.81 Mg ha^{-1} yr^{-1}. On the other hand, the soil of parcel No. 2 is susceptible to wind erosion where its predicted annual soil loss varied between 38.76 to 71.29 Mg ha^{-1} yr^{-1}. Evidently, the differences in erodibility between soil parcels are probably the prime reason for the large differences in annual soil loss.

Revised wind erosion equation (RWEQ)

Revised wind erosion equation (RWEQ) developed by Fryrear *et al.* (1994) was used as follows:

Average soil loss = Wind vactor x soil factors x Crop factors. Soil factors includes soil erodible fraction (EF), soil wetness (SW), soil roughness (K) and soil crust factor (SCF). Crops factors includes flat residues (SLR_f), crop canopy (SLR_c) and standing residues (SLR_s).

Data given in Table 4 and the weather parameters recorded during the period of field experiment were used in the calculation of REWQ. Table 6 shows the estimated RWEQ parameters required to predict the annual soil loss for several periods in Fuka area. It is clear that the estimated annual soil loss for parcel No. 2 was higher than those obtained for parcels No. 1 and 3. This difference is attributed to the nature and size distribution of erodible particles in the soil surface layer, where the erodible fraction for parcel No. 2 was 26.42% versus 23% and 22.13% in average for parcels No.1 and 3, respectively.

To evaluat the relationship between predicted annual soil loss and measured values (Fig. 2). r^2 values were calculated and regression equation for every method are listed in Table 7. Obviously, the highest r^2 value was obtained by method of Troeh *et al.* (1980). Consequently, such method may be used for the assessment of annual soil loss using WEQ as abasic equation.

On the other hand, correction value for each estimated one was calculated using the regression equation of each method, where, x = estimated value by the model and y = corrected estimated value. The correction values are given in Table 7 and Fig.3.

From the above mentioned results, it can be concluded that corrected estimated value of each method could be used for predicting annual soil loss

TABLE 6. Predicting soil loss under the prevailing conditions at Fuka area, NWCZ, using Revised wind erosion equation (RWEQ).

Parcel No.	Period	Estimated RWEQ parameters											Predicted soil loss Mg ha^{-1}
		WF	SW	EF	SCF	K' *	SLR_F	SLR_s	SLR_c	S	Q_{INF}	Q_x**	
1	1/4 - 17/10/1996	20.164	0.970	22.44	1	0.65	0.945	1	1	68.29	2399.42	2118.33	21.18
	17/10/1996-22/5/1997	30.273	0.352	24.08	1	0.67	0.945	1	1	73.17	1445.94	1222.60	12.22
	22/5 - 8/10/1997	24.676	0.832	22.48	1	0.69	0.966	1	1	67.347	2737.86	2435.94	24.36
	Total (1/4/1996-8/10/1997)	-	-	-	-	-	-	-	-	-	-	-	57.76
	Annual	-	-	-	-	-	-	-	-	-	-	-	37.94
2	1/4 - 17/10/1996	20.164	0.970	25.00	1	0.90	1	1	1	64.99	3916.71	3549.69	35.50
	17/10/1996-22/5/1997	30.273	0.352	25.77	1	0.95	1	1	1	68.54	2321.81	2045.53	20.46
	22/5 - 8/10/1997	24.676	0.832	28.49	1	0.90	1	1	1	63.91	4685.15	4280.16	42.80
	Total (1/4/1996-8/10/1997)	-	-	-	-	-	-	-	-	-	-	-	98.76
	Annual	-	-	-	-	-	-	-	-	-	-	-	64.87
3	1/4 - 17/10/1996	20.164	0.970	21.48	1	0.67	0.821	1	1	69.46	2056.79	1797.94	17.98
	17/10/1996-22/5/1997	30.273	0.352	21.76	1	0.69	0.782	1	1	75.08	1113.53	924.61	9.25
	22/5 - 8/10/1997	24.676	0.832	23.14	1	0.66	0.869	1	1	68.22	2425.02	2142.18	21.42
	Total (1/4/1996-8/10/1997)	-	-	-	-	-	-	-	-	-	-	-	48.65
	Annual	-	-	-	-	-	-	-	-	-	-	-	31.95

* K' is determined according to Troeh et al. (1980).

** Q_x is quantity of soil mass being transported at 100 meters field length.

TABLE 7. The relationship between measured and estimated values of soil loss (Ton.ha^{-1}. y^{-1}) by different models.

Parcel Number	Measured	WEQ (Troeh et al., 1980)		WEQ (Schwab et al., 1993)		WEQ (Morgan, 1995)		RWEQ (Fryrear et al., 1994)	
		Estimated value (x)	Corrected estimated value (y)	Estimated value (x)	Corrected estimated value (y)	Estimated value (x)	Corrected estimated value (y)	Estimated value (x)	Corrected estimated value (y)
1	7.91	17.47	5.68	8.38	5.32	26.70	5.19	37.94	5.42
2	10.63	47.00	11.00	38.76	10.79	71.29	10.54	64.87	10.80
3	2.43	8.50	4.07	5.17	4.74	22.81	4.73	31.95	4.22
Regression eq.		Y = 0.18 x + 2.54		Y = 0.18 x + 3.81		Y = 0.12 x + 1.99		Y = 0.20 x - 2.17	

r^2 for WEQ (Troeh et al., 1980) Model = 0.77
r^2 for WEQ (Schwab et al., 1993) Mode = 0.65
r^2 for WEQ (Morgan, 1995) Model = 0.64
r^2 for RWEQ (Fryrear et al., 1994) Model = 0.73

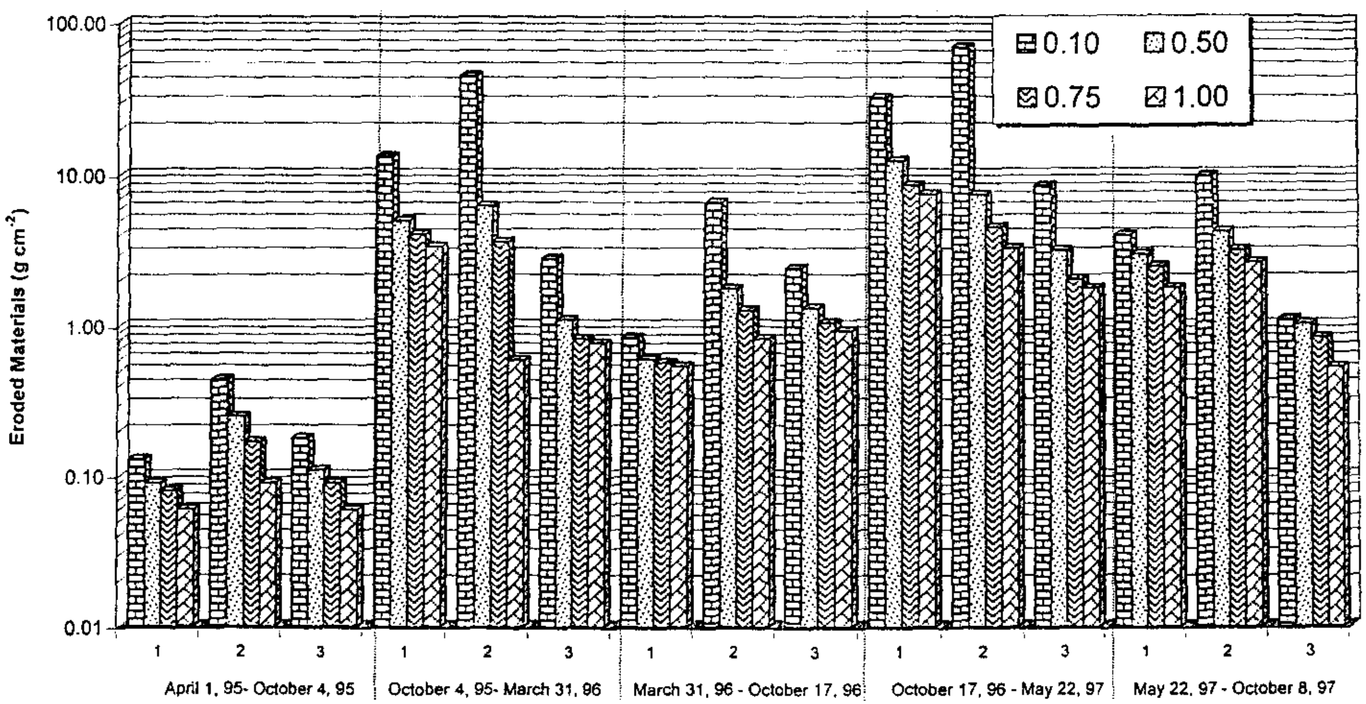

Fig. 1. Amount of eroded soil collected by BSNE samplers at different heights for every measurement period at every parcel .

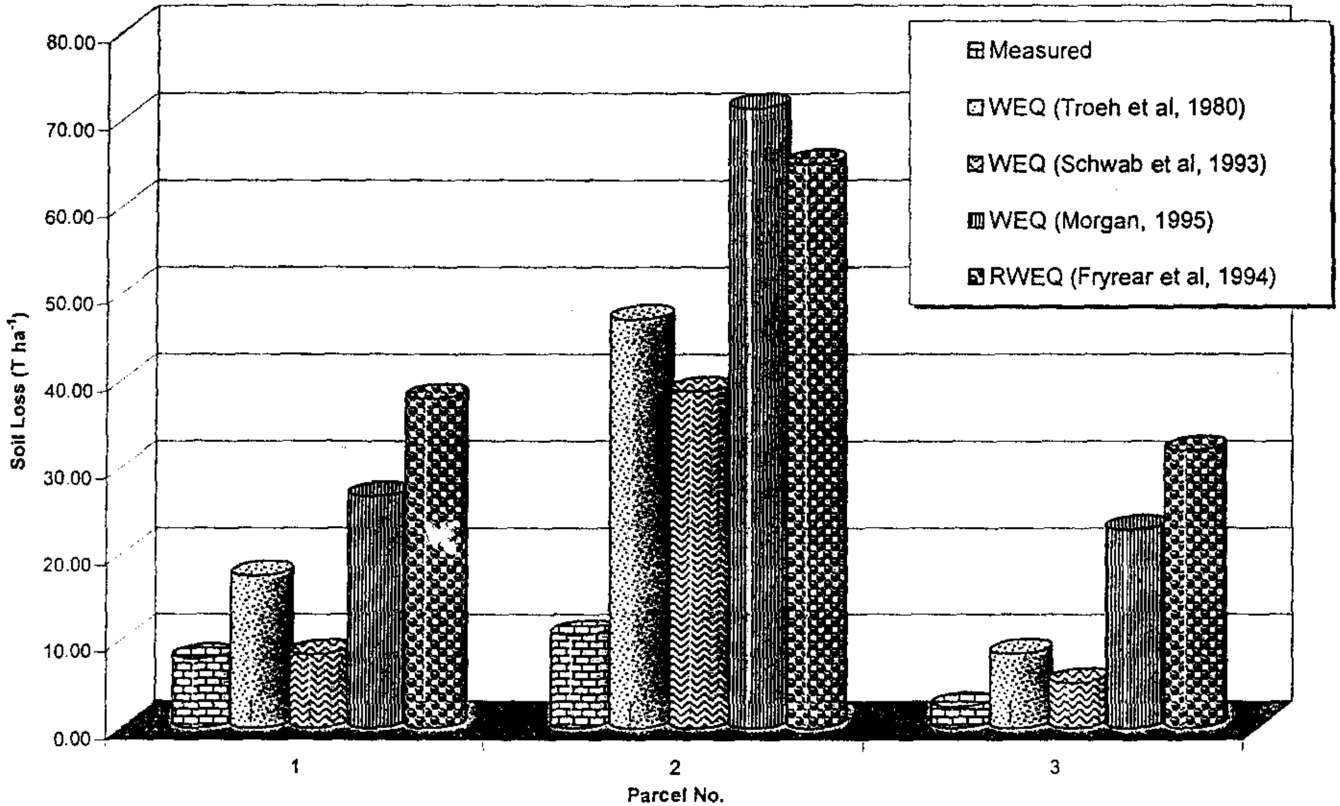

Fig. 2. Measured versus estimated soil loss under the prevailing conditions at Fuka area, NWCZ.

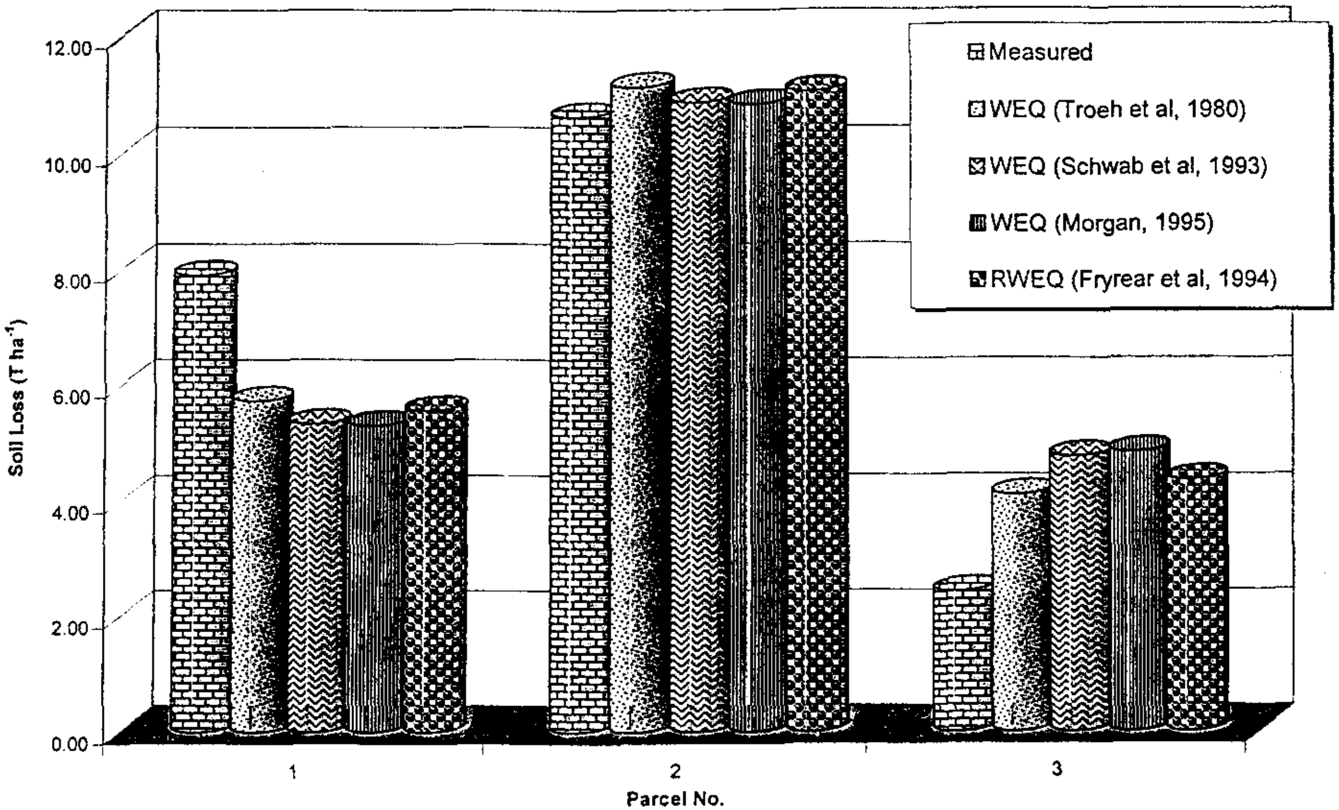

Fig. 3. Measured versus corrected estimated soil loss by different models under the prevailing conditions at Fuka area, NWCZ.

under the conditions of NWCZ. However, further studies should be carried out to select the appropriate model for assessing annual soil loss by wind erosion under Egyptian conditions.

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تقييم نماذج الإنجراف بالرياح تحت الظروف المصرية

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تعانى العديد من الأقاليم فى مصر من مخاطر الإنجراف بالرياح والتى تسرع من تدهور الأراضى وتفاقم ظاهرة التصحر . ويعتبر الساحل الشمالى الغربى وسيناء من هذه المناطق التى تتصف بالأراضى الزراعية الهامشية حيث فقر التربة ومحدودية الأمطار وفترات الجفاف العديدة الرياح القوية التى تؤدى إلى الإنجراف بالرياح. أجريت الدراسة الحالية بهدف تقييم كمية التربة المفقودة بالإنجراف بالرياح واختيار نماذج الإنجراف بالرياح المناسبة للظروف المصرية من دراسة العلاقة بينها وبين التقديرات الحقلية فى هذا المجال.

أختيرت ثلاثة مواقع فى منطقة فوكة على بعد ٢١٥ كم غرب الاسكندرية تختلف فى قابلية التربة للإنجراف وخشونة سطح التربة والغطاء النباتى ، استخدمت مصايد من نوع BSNE لتقدير المادة المنجرفة خلال ٣٠ شهرا.

تشير النتائج أن كمية التربة المفقودة والمقدرة فى الحقل تترواح بين ٤٣ . ٢ – ٦٣ . ١٠ طن / هكتار / سنة بينما الكمية المحسوبة بمعادلة الإنجراف بالرياح WEQ تترواح بين ١٧ . ٥ -٢٩ . ٧١ طن / هكتار/سنة، والكمية المحسوبة من معادلة الإنجراف بالرياح المعدلة (RWEQ) تترواح بين ٩٥ . ٣١-٨٧ . ٦٤ طن / هكتار / سنة وعلى أساس العلاقة بين القيم المقدرة والمحسوبة من النماذج المختلفة لكمية التربة المفقودة بالإنجراف بالرياح فيمكن استنتاج أن الطرق التى استخدمت لحساب الفقد السنوى للتربة بالإنجراف بالرياح تناسب ظروف الساحل الشمالى الغربى. ومن الواضح أنه من الضرورى إجراء دراسات أخرى مكثفة فى مصر لتحديد نموذج الإنجراف بالرياح المناسب لمقاومة ظاهرة التصحر الناتجة عن الإنجراف بالرياح.