Land Evaluation and Soil Erodibility in Relation to Their Properties of Some Soils in Northwest Nile Delta

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ABSTRACT: The current research aims to investigate soil characteristics, estimate the soil erodibility factor (K) and define the important soil properties affecting erodibility, wind erosivity factor (C), rainfall erosivity factor (R) and to find out the land capability and soil suitability classification in Abis region at south Mariut Lake. Representative forty one soil profiles were chosen to represent lacustrine soils at Abis region. The results indicated that the soils were developed in the lacustrine deposits of Lake Mariut and characterized by sandy loam to sandy clay loam texture in most profiles. The EC values ranged between 0.77 and 10.91 dS/m, ESP values being in the range of 1.73 to 18.26, total carbonate content ranged between 2.0 and 34.0%, pH values ranged between 7.51 and 8.83 at the surface layers. In the subsurface layers the corresponding values 0.83 and 13.86 dS/m for EC, 1.02 to 36.32 for ESP, 1.0 and 46.0% for total carbonate, 7.66 and 8.46 for pH. The result also, shows that the water table depth ranged from 25 to 120cm. The EC_w and SAR of water table vary from 1.19 to 35.80 dS/m and from 3.16 to 47.18, respectively.

The values of soil erodibility factors "K" ranged between 0.088 - 0.112 for the studied area. Most of the studied profiles belong to class 2 which represent soils that are moderate erodible, while some of the studied profiles belong to class 1 which represent soils that non erodible. The K- values are positively correlated with %silt (r =0.68), %very fine sand (r=0.48) and %sand (r=0.33). In contrast they are negatively correlated with %$CaCO_3$ (r = 0.21), %organic matter (r=0.31) and %clay (r=0.51). The total value of Rainfall erosivity factor (R) is low (41.0) due to the relative dry climate, while wind erosivity factor (C) ranged between 3.33 and 18.28. The annual value of C was 134.5 and this relatively high value may be attributed to increasing of wind velocity in this area. With regard to Land capability, most of the study area was classified as class 2 (C2), while limited areas belong to class 3 (C3) which reflects fair or moderate capability with available water, hydraulic conductivity, soil depth and soil salinity as limiting factor. With respect to soil suitability, most soils were suitable (class 2) for the tested crops, while some soils were highly suitable (class 1) and limited soils belong to class 3 or class 4 which reflect moderate or marginal degree of soil suitability for some of the traditional tested crops. Regarding the sub classes, main limiting soil properties in most of the studied soils are available water, hydraulic conductivity, soil depth, salinity and exchangeable sodium percent.
Keywords: Abis area, soil characteristics, Soil Erodibility, Wind Erosivity, Rainfall Erosivity, Land evaluation

INTRUDUCTION

Agriculture expansion in Egypt especially in sandy and saline soils at northern lakes depends mainly on irrigation. Land management is useful for improving soil characteristics, and achieving the agriculture sustainability. Therefore, better soil management and conservation are essential to improve soil production and reduce soil degradation.

Many studies have been carried out to characterize lacustrine soils, among them, Labib and Sys (1970), El-Husseiny et al. (1988) and Fayed (2011). They pointed out that lacustrine soils are salt- affected, stratified, poorly drained to water logged, heavy to light textured, poor in organic matter and $CaCO_3$, percent and underlain by shelly lagoonal or lake deposits.

The morphological characteristic of the lacustrine soils located south of Lake Maruit were studied by Morgan (1976), Darwish (1977), El-Husseiny et al. (1985), El-Attar et al. (1987), El-Zahaby et al (1999) and Fayed and El-

Menshawy (2006). They found that these soils are stratified and salt affected in some locations. Shells are abundant but irregularly distributed in both the vertical and horizontal direction. The texture ranges from silty clay to clay loam. The pedognic processes include the aggregation, salinization, alkalization, and gleyzation in addition to the phenomena of slickensides.

The chemical properties of the deposits located south of Lake Maruit were studied by many authors. El-Attar and Bakr (1963), Mahmoud (1978) and El-Zahaby et al. (1999) reported that the high $CaCO_3$ content of these soils may be attributed to the frequent occurrence of shells, while the high content of soluble Na^+, Ca^{++}, Cl^- and SO_4^{--} is due to the saline nature of their parent material. In another study, El-Husseiny et al. (1985) compared the chemical properties of some soils in the lacustrine deposits of Lake Maruit and found that the northern soils (at Abis) are moderate to non saline-affected as a result of leaching by irrigation and perfect drainage, while the southern soils (at trouga) are saline alkali with a surface crust formed by the upward movement of salts. They also reported that the total carbonate of these soils is low to moderate (1.0-11.6%) but greatly increase with depth in the layer of shell accumulations (28-35%). El-Attar et al. (1987) studied the soils of El-Nahda project, which are developed on calcareous lacustrine deposits. They found that these soils are characterized by secondary salt accumulations due to the capillary mechanism of soluble salts under the conditions of the dry hot climate, the presence of clay layers and the shallow saline ground water.

A soil inherent erodibility, which is a major factor of erosion prediction and land-use planning, is a complex property depends on its infiltration capacity, and its capacity to resist detachment and transport by rainfall and runoff. Soil erosion is the greatest hazard to the long-term maintenance of soil fertility in most environments. It reduces soil depth and causes loss of topsoil that has most nutrients, most organic matter and the best structure for root growth. Moreover, erosion can reduce crop yields (Wild, 1996).

Erosion and sedimentation are land resource problems that lead to significant economic, environmental, and social impacts (Morgan, 1996).Soil erosion involves the detachment of sediment and soil from the soil surface by raindrop impact, flowing water and winds (Bahr and Vogtle, 1999; Nikkami et al., 2002; El-Hassanin et al. 2002 and Gomez et al., 2004). Egypt as located in semi-arid region suffers from this problem. The rate of erosion depends on erosive forces of rainfall and runoff (erosivity) and susceptibility of the soil for detachment by these factors (erodibility). Accurate information on soil erodibility is important for soil erosion prediction and control, as well as, for planning of modern farming techniques. Soil erodibility factor (K) represents both susceptibility of soil for erosion and the rate of runoff. Many attempts have been made to devise a simple index for erodibility based either on the properties of soil or on its response to rainfall and winds. Wischmeier and Mannering (1969) showed that soils high in silt and low in clay and organic matter are the most erodible.

Wischmeier et al. (1971) indicated that the organic matter content reduces erodibility because it reduces the susceptibility of the soil to detachment, and it increases infiltration, which reduce runoff and thus erosion. Also, they revealed that (K) could be estimated if the grain size distribution, organic content, structure index, and permeability of the soil are known.

Romkens et al. (1977) indicated that erodibility factor (K) could be predicted by some soil properties [(Silt + v. f. s) x (silt + sand)], organic carbon, permeability, and soil structure. Beasley et al. (1984) showed that, the flow of water causes the movement of minerals, plant nutrients, soil particles, and other organic and inorganic pollutants. Kukal et al. (1991) found that erodibility of some Indian soils was strongly correlated (r = 0.98) with amounts of (silt + v. f. s). Bahnassy (1992) estimated soil loss for wadi El-Haraka, North Western Coast, Egypt, and found that it varied from 4 to 25 t/ha/yr. In Egypt, limited data are available for the surface runoff, soil erodibility and erosivity, as will as, field practices which control soil erosion.

Land evaluation has been defined as the process of assessing or predicting the performance of land for specific purposes (FAO, 1976). Soil attributes needed in land evaluation may be obtained from soil databases and are typically used alone or in conjunction with other land characteristics to derive the distribution of land suitability, limitations or potential ratings for various land use types. The land evaluation could be performed using soil interpretative groupings, productivity ratings or crop growth models.

Many investigators suggested that land evaluation should be made according to most of the following parameters: soil texture, salinity, exchangeable sodium percentage, pH, $CaCO_3$, organic matter, level of water table, salinity of water table, profile depth and necessity of drainage (Omar and El-Kholie, 1970; El-Nahal et al., 1977; Mansour, 1979; El-Menshawy et al., 2005 and Abd El-Rahman et al., 2009). El-Fayoumy (1989) modified a system to include soil fertility and irrigation water factors in addition to soil properties. Each of the above mentioned factors was described as an index value to give its status as a percentage. These indices were calculated using empirical equations. In general, all land evaluation systems are very similar in the concept, although there are some differences between them in the parameters, which they are based on.

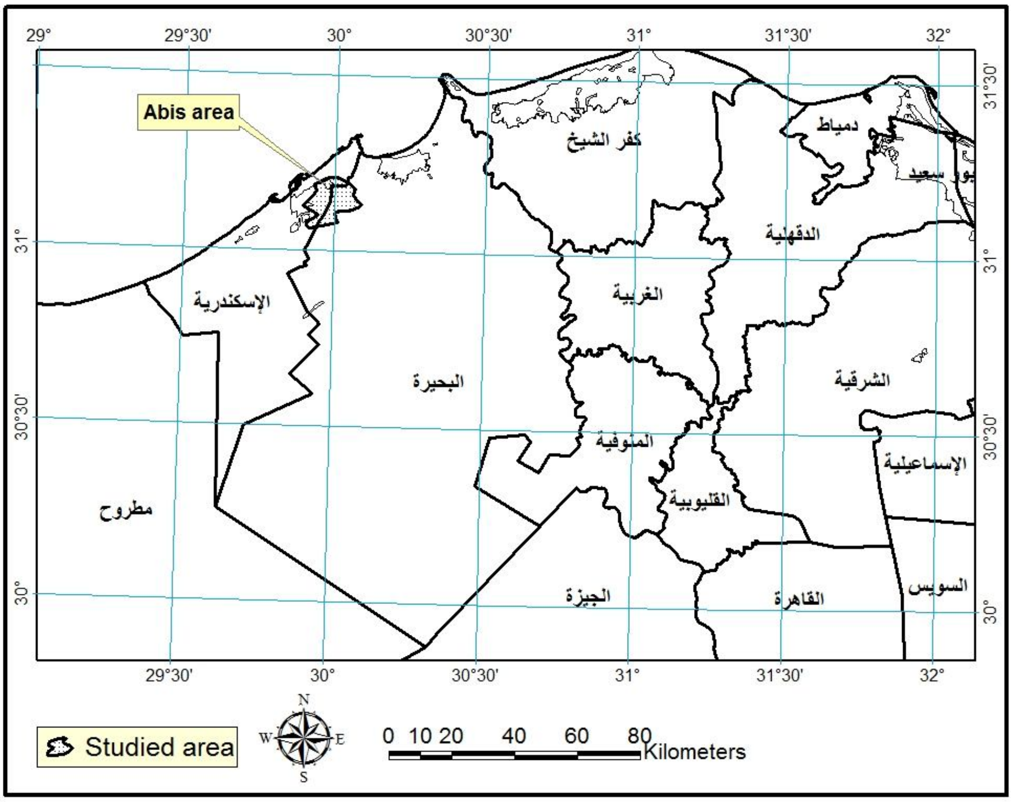
Agricultural Land Evaluation System for arid region (ALES-Arid) is a new approach for land capability and suitability evaluation. The calculation of capability index by ALES-Arid is an indication of land capability according to multiplication method (Abdel Kawy et al., 2004). ALES-Arid evaluates the suitability for different crops (field crops, vegetables, forage crops, and fruit tress) to identify the optimum land use. Land suitability classes were identified using the matching between standard crop requirements (FAO, 1985; Sys and Verheye, 1974; and Sys et al., 1993) and actual land characteristics.

The objectives of the this work are to study and discuss soil characterization, assessment the soil erodibility factor (K) and define the important soil properties affecting erodibility, wind erosivity factor (C), rainfall erosivity factor (R) and to find out the land capability and soil suitability classification using reliable soil qualities to be helpful in better soil management and land use in the lacustrine soils of Abis region at south Mariut Lake since a very limited work was reported for this area.

MATERIALS AND METHODS

Study area:

The studied area is located at the North Western part of the Nile Delta, which represent soils developed from lacustrine deposits at Abis region south of Mariut Lake. It is located approximately between Latitudes $31^{o}00^{\backslash}$ and $31^{o}\ 30^{\backslash}$ N and between Longitudes $29^{o}30^{\backslash}$ and $30^{o}\ 30^{\backslash}$ E. It situated in two main governorates of Egypt with a total area about 40000 fed. About 52% of the total area lies in the eastern part of Alexandria governorate while 48% in the western part of El Behira governorate as shown in map (1). The reclamation strategy of this area started at the late of sixties by drying part of Maruit Lake. This reclamation was done in three stages; the third one named Abis extension and covered about 8000 fed.



Map 1: General location of the study area

The study area is characterized by Mediterranean climate with relatively cold and rainy winter and hot and dry summer. Table (1) shows the climatic data for the studied area which obtained from Central Laboratory for Agriculture Climate (2006).

The studied area is covered by Holocene formations (Said, 1962). The soil of this area was derived from the lacustrine deposits of Mariut Lake with an elevation of about 2.5m below sea level with almost flat surface.

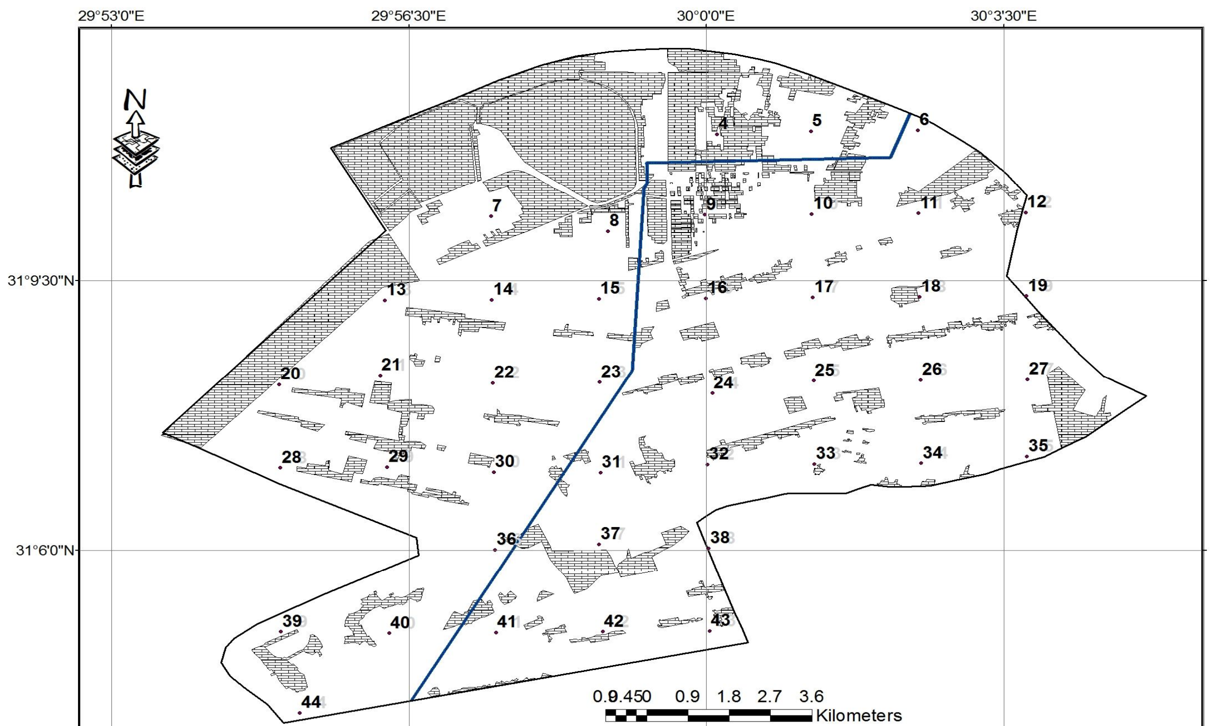
The main source of irrigation water in the studied area is the Mahmodia canal and the surface irrigation system is used for irrigation. The drainage system is tile drains with moderate efficiency.

The cropping pattern in the studied area involves the plantation of field crops, vegetables and fodder in addition to minor areas of fruit trees. The main field crops in the area are maize and peanut in summer and fababean and wheat in winter season. The dominant fodders are maize and alfalfa in summer and clover and barley in winter season. The main vegetables in summer season are watermelon, tomatoes and eggplant, while onion, potatoes and squash are considered the main vegetables in winter season. The dominant fruits are grapes, oranges, banana and guava.

Table 1: Meteorological data of Alexandria Region (2006)*

Month	Temperature, ^{o}C Max	Min.	Average	Relative Humidity	wind Sp. m/sec	Total rain (mm)	ETP (mm/day)
January	18.4	9.1	13.5	70	3.96	54.9	2.2
February	19.3	9.3	14.1	68	3.96	26.6	2.6
March	21.3	10.8	15.8	65	4.12	12.9	3.4
April	23.5	13.1	18.3	65	3.85	4.2	4.1
May	26.6	16.4	21.2	67	3.59	1.5	4.9
June	28.6	20.2	24.3	69	3.59	0.0	5.7
July	29.7	22.0	25.9	72	3.91	0.0	5.8
August	30.6	22.7	26.5	71	3.59	0.3	5.5
September	29.6	21.1	25.6	68	3.27	1.0	4.9
October	27.6	17.6	22.5	68	2.80	9.3	3.7
November	24.2	14.4	19.1	69	3.06	33.1	2.7
December	20.3	10.8	15.2	70	3.69	55.6	2.3

* Central Laboratory for Agriculture Climate



Map 2: Soil profiles location of the study area

Fieldwork:

Forty one soil profiles representing the study area were dug as shown in map (2). The soil profiles were described in the field according to FAO (2006). Soil samples were collected from the subsequent horizons according to morphological variations. Water table samples were collected from some profiles to characterize their chemical properties.

Laboratory analysis:

The collected soil samples were prepared to determine the electric conductivity in dS/m and soluble cations and anions in saturation soil extract and soil reaction (pH) in 1:2.5 suspension (Page et al., 1982). Sodium adsorption ratio (SAR) was calculated according to Richards (1954). In addition, total carbonates were determined by Collin's calcimeter. Hydrometer method (FAO, 1970) was used for the determination of silt and clay fractions, while wet sieving was used for very fine sand fractions. The chemical characterizations of water table samples were determined according to Page et al. (1982).

Soil erodibility factor (K):

Soil erodibility factor (K) represents both the susceptibility of soil to erosion and the rate of runoff. It is estimated by the equation of Wischmeier and Smith (1978) as follows:

$$K = 2.1 * 10^{-6} (12\text{-}OM) (M^{1.14}) + 0.0325 * (S-2) + 0.025 * (P-3)$$

Where: OM= organic matter content M= (v. f .sand + silt) (100- clay)
S = structure index, which is coded as follows:-
(1) Very fine granular. (2) Fine granular.
(3) Medium to coarse granular. (4) Blocky, platy, or massive.
P= permeability class, which is coded as follows:-
(1) Rapid (Kh 50-16 cm/hr) (2) Rapid to Moderate (Kh 16-5 cm/hr)
(3) Moderate (Kh 5-1.5 cm/hr) (4) Moderate to slow (Kh 1.5-0.5 cm/hr)
(5) Slow (Kh 0.5-0.16 cm/hr) (6) Very slow (Kh < 0.16 cm/hr)

Soil erodibility classified into three classes as follows:
(i) non erodible (< 0.10) (ii) moderately erodible (0.1-0.25)
(iii) sever erodible (0.25 - 0.40)

Wind erosivity factor (C):

Wind erosivity factor (C) refers to the effect of plants, soil cover, soil biomass, and soil disturbing activities on wind erosion. It was calculated using the equation adopted by FAO (1978):

$$C = V^3 / 100 * (PET - P / PET) * n$$

Where: V= mean monthly wind speed at 2m height (m/sec)
P= precipitation (mm/day) PET= potential evapotranspiration (mm/day)
n= number of days in month

Rainfall erosivity factor (R):

Rainfall erosivity factor is the average of annual summation values in a normal year's rain. It is calculated by the equation of Fournier (1960) as follows:

$$R = P_m^2 / P$$

where: P_m = mean monthly rainfall (mm) P =mean annual rainfall (mm)

Assessment of Land capability using ALES software:

Land capability was calculated by application of Agricultural Land Evaluation System for arid region (ALES-Arid) as described by Abdel Kawy et al. (2004). In this system, six soil classes (Table 2) were introduced, where four factors (soil properties, environmental conditions, soil fertility and irrigation water quality) were taken into consideration. Each factor is described as an index value to give its status in the percentage form. These indices are calculated using some empirical equations. The final index of land evaluation (F.I.L.E) was calculated according to the following equation:

$$F.I.L.E = \frac{4}{\frac{1}{(S.I)} + \frac{1}{(E.I)} + \frac{1}{(W.I)} + \frac{1}{(F.I)}}$$

Where: S.I: soil index E.I: Environmental index

W.I: Water index F.I: Fertility index

Table 2: Land capability classes and ratings according to Storie (1964)

Class	Degree of Capability	Final value%
C_1	Excellent	100 – 80
C_2	Good	79 – 60
C_3	Fair (Moderate)	59 – 40
C_4	Poor (Marginal)	39 – 20
C_5	Very poor	19 – 10
C_6	Non-agricultural	< 10

RESULTS AND DISCUSSION

Soil characteristics:

Tables (3 and 4) show minimum, maximum and average values of main chemical and physical properties and soil erodibility factor "K" in the surface and subsurface horizons of the studied area. The data shows that the studied soils are characterized by sandy loam to sandy clay loam texture in most profiles, while, some profiles have a sandy clay texture. Concerning the surface horizons, data in Table (3) reveal that sand, silt and clay contents vary from 47.80 to 82.50%, 2.8 to16.5% and 12.5 to 44.0% respectively. Data of total soluble salts, as expressed by the electrical conductivity (dS/m), and exchangeable sodium percentage (ESP) indicate that most of the studied soils are characterized by their moderate to high EC and ESP values as shown in Table (3). The EC values ranged between 0.77 and 10.12 dS/m, ESP values being in the range of 1.73 to 18.26. pH values ranged between 7.51 and 8.33, total carbonate content differ between 2.0 and 34.0%. Regarding the subsurface horizons data in Table (4) show that, corresponding values were 47.7 to 80.7%, 2.8 to 27.5%, and 13.7 to 44.1% for sand, silt and clay respectively, while it vary from 0.83 to 13.86 dS/m for EC, 1.02 to 36.32 for ESP, 7.66 to 8.46 for pH and 1.0 to 46.0% for total carbonate. The high content of soluble salts of these soils may be attributed to the saline nature of their parent material, while the high $CaCO_3$ content is due to the frequent occurrence of shells. The results also, show that the water table depth ranged from 25cm to 120cm with mean value of about 79 cm. The coefficient of variation (C.V.) of the soil depth (0.40) shows that the soil depth was low homogeneity in the study area. For the surface layer the coefficient of variation show that pH and SP%, were high homogeneity (CV=0.04 and 0.16 respectively). The lowest homogeneity properties were for Ca and Cl (CV=0.92 and 0.94 respectively) and for EC (CV=0.69) as shown in table (3). In the subsurface samples the result shows that the high homogeneity was found for pH and SP% (CV=0.02 and 0.17 respectively) as in the surface layer. While, the highest values of coefficient of variation (C.V.) accordingly lowest homogeneity were found for Na and Cl (CV=0.91 and 0.98 respectively) as shown in table (4).

Table 3: The main the statistical parameters of soil characteristics and Erodibility Factor K) for the surface samples

	Min.	Max.	Range	Medi.	Mean	S.D.	Var.	C.V
soil depth,cm	25.00	120.00	95.00	75.00	79.13	31.60	998.57	0.40
SP, %	43.30	95.00	51.70	73.30	73.26	11.93	142.30	0.16
pH	7.51	8.83	1.32	8.18	8.17	0.32	0.11	0.04
EC, dS/m	0.77	10.91	10.14	2.81	3.32	2.28	5.19	0.69
Ca, meq/L	1.00	34.00	33.00	5.00	7.44	6.83	46.64	0.92
Mg, meq/L	1.00	31.00	30.00	6.00	9.43	7.70	59.23	0.82
Na, meq/L	4.00	80.00	76.00	19.00	23.18	18.85	355.40	0.81
K, meq/L	0.12	1.20	1.08	0.40	0.46	0.28	0.08	0.61
HCO_3,meq/L	1.00	10.00	9.00	2.50	3.66	2.80	7.84	0.77
Cl, meq/L	3.00	101.50	98.50	17.50	21.07	19.80	391.95	0.94
SO_4, meq/L	0.30	56.66	56.36	13.66	15.57	13.62	185.46	0.87
ESP	1.73	18.26	16.53	8.12	8.74	4.90	24.04	0.56
$CaCO_3$, %	2.00	34.00	32.00	18.50	15.60	9.90	98.00	0.64
O.M.%	0.45	1.82	1.37	0.36	0.52	0.48	0.23	0.92
Sand%	47.8	82.50	34.70	72.55	68.59	9.78	95.73	0.14
V.F. sand%	6.10	31.59	25.49	13.58	15.38	8.03	64.55	0.52
Silt%	2.80	16.500	13.70	8.20	8.81	3.10	9.60	0.35
Clay%	12.50	44.00	31.50	19.25	22.61	8.44	71.16	0.37
Erodibility(K	0.088	0.112	0.024	0.099	0.100	0.006	0.001	0.061

S.D=Standard deviation, C.V=Coefficient of variation=Standard deviation/Mean, var.= variance

Table 4: Soil characteristics and the main statistical parameters for the subsurface samples

	Min.	Max.	Range	Medi.	Mean	S.D.	Var.	C.V
SP, %	49.95	98.00	48.05	72.05	73.23	12.13	147.12	0.17
pH	7.66	8.46	0.80	8.02	8.02	0.17	0.03	0.02
EC, dS/m	0.83	13.86	13.03	3.01	3.77	2.69	7.24	0.71
Ca, meq/L	2.00	25.00	23.00	4.50	7.27	6.17	38.03	0.85
Mg, meq/L	1.55	30.50	28.95	7.75	10.58	7.85	61.68	0.74
Na, meq/L	2.85	131.50	128.65	17.00	26.28	23.97	574.75	0.91
K, meq/L	0.11	1.33	1.22	0.47	0.52	0.29	0.08	0.55
HCO_3,meq/L	1.00	6.00	5.00	2.50	2.71	1.53	2.33	0.56
Cl, meq/L	4.50	123.50	119.00	14.75	20.95	20.54	421.79	0.98
SO_4, meq/L	2.58	77.60	75.03	14.97	21.51	19.02	361.82	0.88
ESP	1.02	36.32	35.21	7.69	8.75	6.23	38.86	0.71
$CaCO_3$, %	1.00	46.00	45.00	18.50	16.85	12.54	157.20	0.74
O.M.%	0.29	0.62	0.33	0.32	0.39	0.30	0.65	0.76

Sand%	47.70	80.70	33.00	69.70	67.82	7.33	53.66	0.11
V.F. sand%	6.00	28.56	22.56	11.38	14.25	7.13	42.36	0.50
Silt%	2.80	27.50	24.70	11.00	11.66	4.90	23.98	0.42
Clay%	13.70	44.10	30.40	19.20	20.52	6.82	46.56	0.33

Water table analysis:

Data in table (5) shows the values of some chemical properties of water table collected from the studied profiles at Abis region. These data indicate that the EC_w and SAR vary from 1.19 to 35.80 and from 3.16 to 47.18 respectively, while the pH values ranged between 7.76 and 8.49.

Table 5: Some chemical properties for the water table in the study area

P.	EC_w	pH	Cations (meq/L)				Anions (meq/L)				SAR
No.	dS/m		Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4	
4	12.81	7.85	12.5	37.5	86.0	1.3	4.0	6.0	117.5	9.8	17.2
6	5.74	7.88	6.0	16.0	44.0	1.2	5.0	5.0	15.0	12.2	13.3
7	6.24	8.04	3.0	22.0	40.0	0.4	5.0	5.0	51.0	4.4	11.3
8	3.89	8.27	6.0	11.0	28.0	0.9	2.0	3.0	40.0	0.9	9.6
9	5.31	7.86	5.0	11.0	37.0	1.0	2.0	8.0	41.5	2.5	13.1
10	1.99	8.46	2.0	5.0	16.0	0.6	3.0	8.0	9.0	3.6	8.6
11	35.80	8.23	18.0	74.0	320	3.8	6.0	7.0	387	15.8	47.2
12	7.70	8.08	12.0	38.0	41.0	1.2	0.0	3.0	55.0	34.2	8.2
13	3.21	7.91	5.0	8.0	25.0	0.10	3.0	2.0	22.5	11.6	9.8
14	1.86	7.93	7.0	2.0	12.8	0.2	0.0	3.0	11.0	7.9	6.0
15	1.19	8.37	2.0	5.0	6.0	0.2	2.0	3.0	6.5	1.7	3.2
19	2.56	8.49	3.5	9.0	25.0	0.4	0.0	3.0	17.0	17.9	10.0
20	5.94	7.91	12.0	23.0	36.0	0.3	2.0	2.0	28.5	38.8	8.6
22	2.56	7.79	8.0	12.0	10.0	0.1	0.0	2.0	8.5	19.6	3.2
29	1.66	8.17	2.0	8.0	8.0	0.7	0.0	2.0	8.0	8.7	3.6
31	6.17	8.01	12.0	18.0	43.0	0.5	0.0	4.0	33.5	35.6	11.1
36	8.27	7.91	20.0	22.0	43.0	0.2	0.0	4.0	41.5	39.7	9.4
38	4.11	7.83	8.0	10.0	25.0	0.6	0.0	3.0	25.0	15.6	8.3
40	5.63	8.00	12.0	16.0	24.0	0.5	0.0	3.0	33.5	15.9	6.4
42	4.55	7.76	4.0	16.0	27.5	0.5	1.0	1.0	27.5	18.5	8.7

Soil Erodibility Factor (K):

Table (3) show summary of statistical parameter for soil erodibility factor "K" in the studied soil. The values of soil erodibility factors "K" ranged between 0.088 - 0.112. Most of the studied profiles belong to class 2 which represent soils that are moderate erodible (K values ranged between 0.1 and 0.25), while some of the studied profiles belong to class 1 which represent soils that non erodible (K values < 0.1). The coefficient of variation (C.V.) of the soil erodibility factor "K" was 0.061 which reflect high homogeneity in the study area.

Relation between soil erodibility factor and soil properties:

Regarding the correlation coefficients matrix between soil erodibility factor and soil properties are given in Table (6). The K- values are strongly positively correlated with silt content (r =0.68). Soils having high silt content are the most erodible one. They are easily detached; tend to crust and produce high rates of runoff (Wischmeier et al., 1971). The positive correlation of K with silt values are in agreement with those of Wischmeier and Mannering (1969), Romkens et al. (1977), and El-Menshawy et al. (2005), but disagree with findings of El-Asswad and Abufaied (1994) and El-Menshawy et al. (1997).

Data in table (6) also shows that the K- values are positively correlated with very fine sand content (r=0.48) which agree with findings of Wischmeier et al. (1971) Romkens et al. (1977), Wischmeier and Smith (1978), Kukal et al. (1991) and El Menshawy et al. (1997). The positive correlation of K values with silt and very fine sand data are attributed to the easiness of detaching of these particles in comparison with clay and to their transferability in comparison with the coarser particles. The K- values have moderate positive correlation with sand percent (r=0.33). These results are in agreement with those obtained by Wischmeier et al. (1971), Wischmeier and Smith (1978), Kukal et al. (1991) and El Menshawy et al. (1997).

In contrast the K values are negatively correlated with clay content (r = 0.51) and this may be attributed to the hardness of detaching of these particles due to aggregation. Also, the K values have low negative correlation with % $CaCO_3$ (r = 0.21) this may be attributed to the presence of calcium carbonate as of cementing materials for soil particles which reduce the susceptibility of the soil to detachment. Also, the K- values were negatively moderate correlated with percent of organic matter (r=0.31) since increasing organic matter improves the permeability of soil surface and decreases runoff. Also organic matter and clay act as cohesion factors and resist erodibility (Wischmeier and Mannering, 1969). These results are in accordance with those obtained by Meyer and Harmon (1984) and El-Asswad and Abufaied (1994). Generally, No significant correlation was found between K values and pH, EC or ESP values.

The above discussions indicated that the soil becomes less erodible with the decrease in silt fraction, regardless of the corresponding increase in the sand fraction or the clay fraction. However, percentages of silt, clay and sand must be considered in relation to other physical and chemical properties.

Table 6: Correlation matrix of different soil properties in the study area

	pH	EC_e	ESP	$CaCO_3$	O.M	VFS.	Sand	Silt	Clay	K
pH	1.00									
EC_e	-0.20	1.00								
ESP	0.10	0.69	1.00							
$CaCO_3$	-0.13	-0.06	0.04	1.00						
O.M	0.18	-0.43	-0.43	-0.58	1.00					
V.F.S.	0.22	0.22	0.41	-0.08	-0.25	1.00				
Clay	0.26	-0.25	-0.28	0.17	-0.51	0.56	1.00			
Silt	0.05	-0.20	-0.10	0.04	0.64	-0.4	0.29	1.0		
Sand	-0.24	0.28	0.05	-0.16	0.06	-0.4	-0.95	-0.6	1.00	
K	-0.17	0.01	-0.06	-0.21	-0.31	0.48	0.33	0.68	-0.51	1.0

Wind Erosivity Factor "C":

Wind erosivity factor (C) varies greatly with location because it affects by soil cover, soil biomass, and soil disturbing activities as well as velocity of wind. The C monthly values in the studied areas ranged between 3.33 and 18.28 as shown in Table (7). The annual value of C was 134.5, this relatively high value may be attributed to that the increasing of wind velocity in this area as shown in table (7). The highest values were observed in March through August, this may be due to the absence of rainfall in these months. El-Menshawy et al. (2005) studied the wind erosivity factor in some soils of southeast El-Manzala Lake and reported that the total value of C was 127.05, this relatively high value may be attributed to that most of these soils are non cultivated.

Rainfall Erosivity Factor (R):

Table (7) shows the variability of rainfall erosivity factor "R" throughout 2006 season. The annual rainfall erosivity factor "R" for the studied area is low (41.035) due to the relative dry climate. The monthly rainfall erosivity factor "R" is related to the amount of received rain for each month. Approximately 90 percent of the erosivity occurs in the months of January, February, November and December in the studied area. The highest values were in January (15.11) and December (15.50), whereas the lowest values appeared in June, July and August.

Table 7: wind erosivity factor (C) and rainfall erosivity factor (R) of the studied area

Month	C	R
January	3.637	15.115
February	11.808	3.548
March	18.283	0.835
April	16.571	0.088
May	13.726	0.011
June	13.868	0.000
July	17.872	0.000
August	13.843	0.000
September	10.440	0.005
October	6.034	0.434
November	5.089	5.495
December	3.331	15.503
total	134.500	41.035

Land evaluation and land use planning

Land capability classes:

The ALES Model (Agricultural Land Evalution System) provides prediction for general land use capability for a broad series of possible uses (Abdel Kawy et al., 2004). Evaluation results from the application of ALES model on the study area indicate that the capability of most area belongs to Class 2, which means soils are good for agriculture, regardless to the existing management practices. Only C2aw, kh and C2aw are the land capability subclasses which recognized in the study area which indicates that the main limiting factors are available water and/or hydraulic conductivity. Limited areas belong to class 3 which reflects fair or moderate capability. This class (C3) divided to four land capability subclasses. These Subclasses are C3 aw, ece; C3 aw, kh, sd; C3 aw, sd and C3 aw, sd, ece with available water (aw), hydraulic conductivity (kh), soil depth (sd) and soil salinity (ece) as limiting factor.

Soil suitability classes for specific uses:

The ALES model was used to predict soil suitability for some common crops cultivated in the study area including: wheat, maize, alfalfa, cabbage, cotton, fababean, onion, pea, rice, sorghum, tomato and watermelon. Data of soil suitability class and subclasses are presented in Table (8). These data indicate that most of the studied soils are suitable (class 2) for wheat, maize, cabbage, cotton, fababean, pea, sorghum, tomato, watermelon. Some of the studied soils are highly suitable (class 1) for alfalfa, onion and rice, regardless to the existing management practices. However, limited areas belong to class 3 which reflect moderately degree of soil suitability or class 4 which reflect weak or marginal degree of soil suitability for some of the traditional tested crops. Regarding the subclasses, data show that the main limiting soil properties in most of the studied soils are hydraulic conductivity (kh), salinity (ece), saturation percent (sp), soil depth (sd) and exchangeable sodium percent (esp) as shown in Table (8).

Table 8: Soil suitability classes for each crop of some selected profiles in the study area

p. No	wheat	maize	alfalfa	fababean	onion	pea
5	S2 t kh	S2	S2 kh	S2	S2	S2
7	S2t kh	S2 kh	S2 kh	S3 ece	S3 ece kh	S3 ece
10	S2	S2kh	S2 kh	S2	S2	S2
14	S2t kh	S2	S2 kh	S2	S2 kh	S2
17	S2	S2 kh	S1	S3 kh	S1	S2 kh
22	S2t kh	S2	S2 kh	S2	S2 kh	S2
25	S2	S2 kh	S1	S3 kh	S1	S2 kh
29	S2 t kh	S2	S2 kh	S2	S2 kh	S2
34	S1	S2kh	S1	S2 kh	S1	S2 kh
37	S2	S2kh	S1	S4 sd kh	S2	S2
40	S2t kh	S3 ece sp	S2 kh	S4 ece esp	S4 ece kh	S4 ece
42	S2	S2 kh	S1	S4 sd kh	S2	S2

Table 8: **Cont.**

p. No	rice	cotton	sorghum	watermel.	cabbage	tomato
5	S2 t	S2 sd	S2	S2	S2	S2
7	S2 t	S4 sd	S2	S2	S2	S2
10	S2 t	S2 sd	S2	S1	S1	S2
14	S2 t	S2 sd	S2	S2	S2	S2
17	S1	S2sd kh	S2 kh	S2 kh	S2 kh	S2 kh
22	S2 t	S2 sd	S2	S2	S2	S2
25	S1	S2 sd kh	S2 kh	S2 kh	S2 kh	S2 kh
29	S2 t	S2 sd	S2	S2 kh	S2	S2
34	S1	S2 kh	S2 kh	S1 kh	S2 kh	S2 kh
37	S1	S2 kh	S2 kh	S2 kh	S2 kh	S2 kh
40	S3 ece t kh	S4 sd	S3 esp	S3 ece esp	S3 esp	S3 esp
42	S1	S2 kh	S2 kh	S2 kh	S2 kh	S2 kh

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الملخص العربي

تقييم بعض الأراضى ودراسة قابليتها للتعرية وعلاقتها ببعض خواصها فى المناطق الواقعة شمال غرب دلتا النيل

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معمل بحوث الأراضى الملحية والقلوية بالإسكندرية–معهد بحوث الأراضيو المياه والبيئة– مركز البحوث الزراعية– مصر

يهدف هذا البحث الى دراسة خصائص الأرض، حساب معامل الانجراف الأرضي (K)و التعرف على الخصائص الأرضية المؤثرة فيه، وكذلك حساب معامل التعرية الرياحي (C) وأيضا معامل التعرية المطرية (R) بالاضافة الى تقييمالقدرة الإنتاجية للأر اضى ومدى ملاءمتها للمحاصيل المختلفة في بعض الأراضي الواقعة فى منطقة أبيس جنوب بحيرة مريوط. تم حفر ٤١ قطاع أرضي لتمثل منطقة الدراسة، وقد تم وصف كل القطاعات مورفولوجيا. أظهرت النتائج أن هذه الأراضى نشأت من رواسب بحيرية ببحيرة مريوط وتميزت بقوام رملى لومي الى رملى طيني لومي فى معظم القطاعات. و تراوح محتوى الأملاح (EC) بين ٠.٧٧ و١٠.٩١ ديسيسيمنز/متر والنسبة المئوية للصوديوم المتبادل (ESP) بين ١.٧٣ و ١٨.٢٦ والمحتوى من الكربونات الكلية بين ٢ و ٣٤% و قيم ال pH بين ٧.٥١ و٨.٨٣ ذلك بالنسبة للطبقة السطحية. أما بالنسبة للطبقة تحت السطحية فتراوح محتوى الأملاح بين ٠.٨٣ و١٣.٨٦ ديسيسيمنز/متر والنسبة المئوية للصوديوم المتبادل بين ١.٠٢ و ٣٦.٣٢

والمحتوى من الكربونات الكلية بين ١ و ٤٦% و قيم ال pH بين ٧.٦٦ و٨.٤٦ .وتشير النتائج أيضا الى أن عمق الماء الأرضى تراوح من ٢٥ الى ١٢٠سم ومحتواه من الأملاح بين ١.١٩و٣٥.٨ ديسيسيمز/متر أما نسبة الصوديوم المدمص(SAR) فكانت بين ٣.١٦ و ٤٧.١٨.

تراوحت قيم معامل الانجراف الأرضي (K) بين ٠.٠٨٨ الى ٠.١١٢ وكانت معظم القطاعات تنتمي إلى قسم ٢ الذي يمثل أراضى بها معامل انجراف أرضي متوسط. وقد ارتبطت قيم معامل الانجراف الأرضي ايجابيا مع نسبة السلت (r =0.68)و الرمل الناعم جدا (r=0.33) و الرمل (r=0.48) بينما ارتبط سلبيا مع نسبة الطين (r=0.51) ونسبة المادة العضوية (r=0.31)ونسبة كربونات اكالسيوم (r=0.21). معامل التعرية المطري (R) منخفض (٤١.٠) بسبب المناخ الجاف نسبيا حيث يتوقف على كميات المطر الشهري. و تراوحت قيم معامل التعرية الرياحي (C) بين ٣.٣٣– ١٨.٢٨ بينما قيمته الكلية كانت ١٣٤.٥ وهذه تمثل معامل تعرية رياحي مرتفع وذلك لزيادة سرعة الرياح فى هذه المنطقة لقربها من البحر. أظهرت نتائج تطبيق برنامج التقييم ALES أن معظم الأراضى المدروسة تقع فى قسم ٢ (C2) من أقسام القدرة الانتاجية أى ذات قدرة إنتاجية عالية نسبيا، بينما مساحة محدودة تقع فى قسم ٣ (C3) وهو ذات قدره إنتاجيه متوسطة. بخصوص مدى ملائمة الأراضى المدروسة للمحاصيل المختلفة فقد أظهرت النتائج أن معظم الأراضي تحت الدراسة ملائمة (S2) لمعظم المحاصيل وبعض منها ذات ملائمة عالية (S1) بينما قليل منها ذات ملائمة متوسطة الى ضعيفة (S3, S4) لبعض المحاصيل. مع وجود بعض العوامل المحددة للانتاجية مثل التوصيل الهيدروليكى، عمق الماء الأرضى، الملوحة (EC) ونسبة الصوديوم المتبادل (ESP).