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# THE EFFECT OF SOIL PROPERTIES ON SOIL EROSION AND ITS RELATION TO ENVIRONMENTAL PROTECTION CAPACITY ($EPC_G$)

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## ABSTRACT

Sixteen soil profiles representing the soils of the area at the western beach of Suez Canal according to the different in sediments and land use period such as alluvial-windborn, and Recent Aeolian sand deposits. Soil classification reveals that soil ranged between Typic Torrifluvents, Typic Torrifluvents, Typic Torriorthents and Typic Torripsamments.

From the physical and chemical characteristics of the soils, the clay distribution is significantly different between high and low parts while there is no significant difference in sand fraction distribution. OM distribution affected by topography, land use and cover vegetation. There is no significant difference in $CaCO_3$ distribution. CEC values differented from parts to another refered to the clay content. Bulk density values differented according to the difference in texture. Stability aggregate values varied from high parts and low parts refered to difference in topography, parent material, period of landuse and clay content. From the study the pervious condition caused increase of the negative effect of wind erosion as well as of environmental protection capacity ($EPC_G$).

Environmental Protection Capacity ($EPC_G$) as a factor to study the wind erosion shows that there is highly significant correlations between $EPC_G$ factor and sand, silt, clay OM, $CaCO_3$, CEC, exchangeable ($Ca^{++}$, $Mg^{++}$, $Na^{+}$ and $Na^{+}$), stability aggregate and bulk density, while no significant correlation with pH, EC and C/N ratio in soils.

Path analyses show that soil properties such as OM, bulk density, clay, dispersion ratio, stability aggregate and $CaCO_3$ have direct effect on the $EPC_G$.

**Keywords:** Soil Erosion, Environmental Protection Capacity, Alluvial-windborn, Recent Aeolian sand deposits.

## INTRODUCTION

Most of the soils of the area west of Suez Canal are sand. The climatic conditions in the area located west of Suez canal indicated that the chemical weathering and the development are weak and there is mostly physical weathering due to variation in temperature and wind erosion in most parts of this area and scarcity of rainfall, Shata 1984. Erosion is a significant problem on agricultural lands throughout in many parts of the world (Oldeman, 1991). Erosion is particularly severe in arid and semiarid areas, which constitute one-third of the world’s population (Mirzamosta, et. al, 1998). The main object of the current work is to illustrate the effect of Erosion on the soils under investigation.

**Climatic Conditions:**

According to the average meteorological data of the period from (1951 to 1985) in Table 1 and exerthermic diagram Fig. 1 indicate that arid conditions prevails in the studied area during most of the year:

The present arid nature of the climate has a great effect on the landscape of this area. This is manifested in the several phenomena of wind deflation including formation of desert pavement on the top soil as well as in the accumulation of sand dunes in the plains. In addition features related to the previous climatic conditions occur as a result of changes in climate during the Pleistocene period, which had their effect on soil formation. The numerous dry drainage lines which occur in the southern part of the area are good indication of the past climate condition.

**Table 1: The climatological normal data of the investigated area**

| Month | Temperature (°C) | | | Rainfall | Evapora-tion | Humidity Relative | Wind speed |
|---|---|---|---|---|---|---|---|
| | maximum | Minimum | Mean | (mm) | (mm/day) | (%) | m/sec |
| January | 20.4 | 8.1 | 14.2 | 4.4 | 4.7 | 55 | 3.5 |
| February | 21.7 | 9.1 | 15.4 | 4.7 | 5.4 | 52 | 4.6 |
| March | 23.9 | 11.0 | 17.4 | 3.0 | 6.8 | 46 | 4.7 |
| April | 27.6 | 13.6 | 20.6 | 1.1 | 7.0 | 45 | 4.1 |
| May | 32.1 | 17.3 | 24.7 | 0.8 | 9.8 | 42 | 3.8 |
| June | 34.8 | 20.2 | 27.5 | 0.0 | 9.7 | 45 | 3.2 |
| July | 36.4 | 22.2 | 29.3 | 0.0 | 9.3 | 48 | 3.8 |
| August | 36.5 | 22.5 | 29.5 | 0.0 | 9.6 | 49 | 3.5 |
| September | 33.9 | 20.7 | 27.3 | 0.0 | 7.5 | 52 | 3.0 |
| October | 30.7 | 17.8 | 24.2 | 2.2 | 6.4 | 54 | 3.2 |
| November | 26.6 | 13.9 | 20.2 | 4.7 | 4.7 | 58 | 2.6 |
| December | 21.5 | 10.0 | 15.8 | 8.5 | 3.8 | 65 | 3.2 |
| Annual mean | 28.8 | 15.5 | 22.2 | 2.8 | 7.06 | 50.8 | 3.6 |

**Fig. 1: Xerothermic diagram of the west Suez canal area.**

**Geology and geomorphology:**

According to Ball 1939, said 1962, El-Fayomy 1968, Abu Al-Izz 1971, and Shata 1978, the area west of Suez canal is totally occupied by sedimentary rocks belonging to the tertiary and the quaternary epochs. Land from recognized in this area are named alluvial fans, out wash plain, wadi plains, wadi Bottoms, wind blown sand, river terraces and deltic stage of the river terraces. Bayoumy (1971) reported that the elevation decreases from south (Ismaleyia Canal) to north (Manzala Lake). He added the natural vegetation is obviously related to the past atmospheric climate in the region of the Nile Delta. The natural vegetation is found to be scarce and the production of organic matter in the soil is low because the rate of its decomposition is rather high. He also mentioned that the climate of this area is more arid than the Mediterranean coastal zone, yet it is relatively milder than that of the internal desert. Shata (1984) showed that as a result of climatic conditions in the area located west of Suez Canal, chemical weathering and development are weak and there is mostly physical weathering due to variations in temperature, wind erosion in most parts of this area and acarcity of rainfall. El-Fayoumy (1968) associated the underground water with the dominant geomorphology in the region west of Suez Canal and distinguished the following, fluviomarine plain water which unsuitable for irrigation as well as Salhiya plain water pavement plain water suitable for irrigation.

**Soil Erosion:**

Most of wind tunnel studies of aeolian have been concerned with the threshold velocity for particle environment, the nature of particle trajectories, and grain interactions (Bagnold, 1973, Anderson, 1987, Ungar and Haff, 1987, Iversen *et al.*, 1987, and Werner (1988) according to Wassif *et al.*, (2000) as the results showed that the values of threshold velocity ranged between 6.1-6.6m/s. Such values varied according to the particle size distribution of soil.

## MATERIALS AND METHODS

According to parent material, land use and topography of soils of the area sixteen soil profiles have been chosen to represent the different soils.

Description of the soil profiles were recorded on the bases guidelines by FAO (1990). Soil samples were collected from the morphologically different layers. The samples were dried, ground, passed through a 2 mm stainless steel sieve and kept in polyethylene bags for analyses. Particle size distribution was carried out according to Piper (1950), The water extract components were determined in the soil extract (1:1) and the following determinations were carried out using the standard methods of analysis by Jackson (1979) and Page *et al.* (1982). Exchangeable cations were determined using ammonium acetate extraction. Cations exchange capacity was determined using sodium acetate method Jackson (1979) and Page *et al.* (1982). Soil reaction (pH) was determined in the soil extract (1:1), Richards (1954). Exchangeable cations were determined according to

Jackson (1979) and Page *et al.* (1982). Collin's calcimeter were used for $CaCO_3$ determination according the method described by Wright (1939). Organic matter was determined following the modified Walkley and Black method, Jackson (1979) and Page *et al.* (1982). Soil classification according to Soil Survey Staff (1996). Bulk density stability aggregates according to Klute (1986)

**Statistical analysis for Erosion:**

In the area under investigation the environmental protection capacity ($EPC_G$) of these soil profiles was determined. This parameter is based on the organic matter content of the soil, the stability coefficient characterized by the quality of organic matter and the thickness of top soil. The general $EPC_G$ is expressed as follows:

$EPC_G = D_x H^2 K$

Where ($D_x$) is the thickness of top soil (in cm), (H) is the humus content (in %) and (K) is the stability coefficient characterized by humus quality.

Path analysis, a statistical technique that differentiates between correlation and causation, was used to describe $EPC_G$ values in soil. Path analysis is a model has been chosen to evaluate the effect of soil properties on $EPC_G$ values by soil samples.

## RESULTS AND DISCUSSION

The area under investigation is bordered in the east by the Suez Canal, in the west by Nile Delta, in the north by El-Manzala Lake, and south by the Ismaleiya Canal. The area is situated longitudes 31º 10⁻ west and 32° 20⁻ east, and latitudes 31º north and 30º 30⁻ south, as shown in Fig. 2. The northern part of the area is occupied by fluviomarine plains and swamps around El-Manzala Lake, while sandy gravelly terraces (Pavement plain) occupy the southern part. A flat sandy plain (Salhiya plain) partially occupied by sand dunes is located between these two land forms.

The area under investigation could be classified according to parent material and period of land use to alluvial – wind blown deposits represented by profiles 1, 2, 3 and 4, and recent aeolian sand deposits represented by profiles 5, 6, 7, 8, 9,10, 11,12,13, 14, 15 and 16. The period of land use 15, 40 years represented by soil profiles 1, 2, 3 and 4, while the period of land use 20 years represented by soil profiles 9, 10, 11 and 12. The period of land use 10 years is represented by profiles 8, and 14 and the period of land use 5 years 5, 13, 15 and 16. The barren soil is represented by soil profile 6.

**Alluvial-wind born deposits:**

### The period of land use 40 years:

These soils are represented by soil profiles 1, 2, 3, 4 and morphologically described, Physical, and chemical analyses data showed in Tables 2, 3, 4. The morphological data as colour textures, structure and consistence showed that there is variation between the layers of soil profiles which could be referred to the parent material and land use.

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The texture is varied from clay loam in the surface layer to loamy sand in the deepest layer pH lies in the moderately alkaline range $CaCO_3$ ranged between 3.42 and 0.98%, O.M ranged between 2.35% in the surface and decrease with depth to 0.32%, EC is low, CEC ranged between 28.49 meq/100g soil and decrease with depth to 6.86 meq/100g soil, ESP is less than 15% and the soil classified as Typic torrifluvents.

**Fig.2: Locations of the studied profiles**

**Table 3: Mechanical analyses, clay ratio, $EPC_G$, St. coefficient (K), thick- of layers (cm) for soil profiles.**

| Prof. No. | Depth (cm) | Sand % | Silt % | Clay % | Texture Class | Clay ratio | Sepa-ration ratio | EPC | St Coeff. | Thick-Ness cm |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0-20 | 40.50 | 30.30 | 29.20 | Clay loam | 0.4124 | 1.5616 | 51.335 | 0.4647 | 20 |
| | 20-50 | 8.48 | 29.40 | 28.50 | Clay loam | 0.7524 | 1.5000 | 68.646 | 0.6406 | 30 |
| | 50-80 | 33.65 | 13.18 | 21.32 | S.C. loam | 0.4553 | 1.4000 | 27.513 | 0.9782 | 50 |
| | 80-120 | 50.50 | 18.08 | 22.42 | Loam | 0.3269 | 1.3002 | 4.4351 | 1.0181 | 40 |
| 2 | 0-20 | 55.62 | 19.41 | 24.97 | S.C. loam | 0.3328 | 1.3997 | 24.718 | 0.1192 | 20 |
| | 20-60 | 60.81 | 10.44 | 28.75 | S.C. loam | 0.4035 | 1.4000 | 96.293 | 0.5958 | 40 |
| | 60-90 | 70.52 | 18.59 | 10.89 | S. loam | 0.1222 | 1.1993 | 26.784 | 0.9296 | 30 |
| | 90-120 | 80.83 | 10.19 | 8.98 | L. sand | 0.0986 | 1.1002 | 4.6425 | 1.0174 | 30 |
| 3 | 0-30 | 41.89 | 27.55 | 30.56 | Clay loam | 0.4401 | 1.5000 | 76.916 | 0.4804 | 30 |
| | 30-60 | 59.50 | 18.08 | 22.42 | Loam | 0.2889 | 1.3002 | 16.508 | 0.9782 | 30 |
| | 60-90 | 55.62 | 19.41 | 24.97 | S.C.loam | 0.3328 | 1.4001 | 11.514 | 0.9984 | 30 |
| | 90-120 | 65.21 | 15.43 | 13.36 | S.loam | 0.1656 | 1.3795 | 3.1276 | 1.0180 | 30 |
| 4 | 0-20 | 65.34 | 9.03 | 25.63 | S.C. loam | 0.3446 | 1.3999 | 50.655 | 0.5233 | 20 |
| | 20-50 | 51.21 | 28.69 | 22.42 | Loam | 0.2806 | 1.3002 | 35.123 | 0.8853 | 30 |
| | 50-80 | 69.21 | 15.43 | 14.22 | S. loam | 0.1680 | 1.2960 | 16.508 | 0.9782 | 30 |
| | 80-120 | 80.83 | 10.19 | 8.98 | L. sand | 0.0986 | 1.1002 | 4.9888 | 1.0181 | 40 |
| 5 | 0-30 | 89.33 | 5.43 | 6.24 | Sand | 0.0658 | 1.0993 | 11.514 | 0.9984 | 30 |
| | 30-70 | 90.56 | 4.44 | 5.76 | Sand | 0.0606 | 1.1007 | 0.9067 | 1.0075 | 40 |
| | 70-110 | 90.72 | 4.21 | 4.87 | Sand | 0.0513 | 1.1006 | 0.4850 | 1.002 | 40 |
| 6 | 0-30 | 89.82 | 4.54 | 5.64 | Sand | 0.0597 | 1.0993 | 9.4608 | 1.0056 | 30 |
| | 30-70 | 92.21 | 3.80 | 3.99 | Sand | 0.0416 | 1.0977 | 5.5739 | 1.0178 | 40 |
| | 70-100 | 90.92 | 4.21 | 4.87 | Sand | 0.0512 | 1.1006 | 0.0743 | 0.9918 | 30 |
| | 100-130 | 70.11 | 4.68 | 5.21 | Sand | 0.0696 | 1.0998 | 0.1463 | 0.9955 | 30 |
| 7 | 0-30 | 93.00 | 4.00 | 3.49 | Sand | 0.0359 | 1.1003 | 9.7911 | 1.0045 | 30 |
| | 30-60 | 90.14 | 4.65 | 5.21 | Sand | 0.0549 | 1.0998 | 3.7416 | 1.0181 | 30 |
| | 60-90 | 89.33 | 5.43 | 6.24 | Sand | 0.0658 | 1.0993 | 1.9048 | 1.0159 | 30 |
| | 90-120 | 90.56 | 4.66 | 5.76 | Sand | 0.0605 | 1.1007 | 0.3637 | 1.0019 | 0.0604 |
| 8 | 0-30 | 60.99 | 19.79 | 14.22 | S. loam | 0.1760 | 1.1947 | 26.784 | 0.9296 | 30 |
| | 30-80 | 80.83 | 10.19 | 8.98 | L. sand | 0.0986 | 0.8775 | 12.603 | 0.9943 | 30 |
| | 80-110 | 90.87 | 4.24 | 4.89 | Sand | 0.0514 | 1.1002 | 0.0633 | 0.9898 | 40 |
| | 110-150 | 91.21 | 3.80 | 3.99 | Sand | 0.0419 | 1.1002 | 1.9633 | 1.0141 | 40 |

**S.= Sand** **C.= Clay** **L. =Loam**

**Table 3. Cont.**

| Prof. No. | Depth (cm) | Sand % | Silt % | Clay % | Texture class | Clay ratio | Sepa-ration ratio | EPC | St Coeff. | Thick-ness cm |
|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 0-30 | 65.45 | 13.98 | 20.57 | S.C. loam | 0.2589 | 1.3996 | 39.142 | 0.8624 | 30 |
| | 30-60 | 84.23 | 4.79 | 10.09 | S.loam | 0.1133 | 1.2001 | 22.584 | 0.9504 | 30 |
| | 60-90 | 90.63 | 4.81 | 10.00 | L. sand | 0.1077 | 1.1000 | 1.6104 | 1.0147 | 30 |
| | 90-120 | 90.87 | 4.25 | 4.82 | Sand | 0.0513 | 1.1004 | 0.3637 | 1.0021 | 30 |
| 10 | 0-20 | 73.78 | 13.79 | 22.45 | S.C. loam | 0.2563 | 1.4008 | 36.567 | 0.7610 | 20 |
| | 20-50 | 91.47 | 3.75 | 15.98 | S. loam | 0.1678 | 1.2002 | 1.9049 | 1.0159 | 30 |
| | 50-80 | 82.76 | 7.24 | 10.00 | L. sand | 0.1111 | 1.1000 | 8.4999 | 1.0086 | 30 |
| | 80-120 | 91.57 | 4.45 | 3.98 | Sand | 0.0414 | 1.1005 | 2.2344 | 1.0133 | 50 |
| 11 | 0-30 | 67.36 | 8.44 | 24.23 | S.C. loam | 0.3197 | 1.3999 | 71.405 | 0.6071 | 30 |
| | 30-70 | 68.55 | 21.36 | 10.09 | S.loam | 0.1122 | 1.2001 | 26.537 | 0.9630 | 40 |
| | 70-110 | 90.76 | 4.32 | 4.92 | Sand | 0.0517 | 1.1016 | 0.3236 | 0.9989 | 40 |
| | 110-150 | 91.57 | 4.45 | 3.98 | Sand | 0.0414 | 1.1005 | 1.9633 | 1.0141 | 40 |
| 12 | 0-30 | 65.98 | 10.16 | 23.86 | S.C. loam | 0.3137 | 1.3998 | 59.354 | 0.7267 | 30 |
| | 30-70 | 68.67 | 15.35 | 15.98 | S. loam | 0.1901 | 1.2002 | 20.392 | 0.9834 | 40 |
| | 70-110 | 91.68 | 4.00 | 4.32 | Sand | 0.4515 | 1.0995 | 1.7875 | 1.0133 | 40 |
| 13 | 0-30 | 91.57 | 4.45 | 3.98 | Sand | 0.0414 | 1.1005 | 17.755 | 0.9727 | 30 |
| | 30-60 | 90.87 | 4.25 | 4.88 | Sand | 0.0513 | 1.0983 | 8.4999 | 1.0086 | 30 |
| | 60-80 | 93.56 | 3.22 | 3.22 | Sand | 0.0332 | 1.0994 | 1.9565 | 1.0179 | 20 |
| | 80-120 | 90.11 | 4.68 | 5.21 | Sand | 0.0549 | 1.0614 | 0.7226 | 1.0035 | 50 |
| 14 | 0-30 | 69.10 | 12.39 | 18.51 | S. loam | 0.2271 | 1.1998 | 57.139 | 0.7440 | 30 |
| | 30-60 | 82.76 | 7.24 | 10.00 | L. sand | 0.1111 | 1.1000 | 21.230 | 0.9568 | 30 |
| | 60-90 | 42.89 | 6.22 | 3.11 | Sand | 0.0526 | 1.0996 | 9.4609 | 1.0056 | 30 |
| | 90-120 | 42.89 | 6.22 | 40.89 | Clay | 0.6917 | 1.4554 | 5.3785 | 1.0163 | 30 |
| 15 | 0-20 | 90.87 | 4.25 | 4.88 | Sand | 0.5130 | 1.0983 | 17.856 | 0.9296 | 20 |
| | 20-50 | 91.68 | 4.00 | 4.32 | Sand | 0.0451 | 1.0995 | 11.872 | 0.9971 | 30 |
| | 50-80 | 90.76 | 4.32 | 4.92 | Sand | 0.0517 | 1.0995 | 5.1275 | 1.0167 | 30 |
| | 80-120 | 90.63 | 4.81 | 4.56 | Sand | 0.0477 | 1.1008 | 0.7226 | 1.0035 | 50 |
| 16 | 0-20 | 92.89 | 4.00 | 3.11 | Sand | 0.0321 | 1.0996 | 13.857 | 0.9589 | 20 |
| | 20-40 | 93.56 | 3.22 | 3.22 | Sand | 0.0333 | 1.0994 | 7.4399 | 0.9997 | 20 |
| | 40-70 | 90.71 | 4.32 | 4.92 | Sand | 0.0517 | 1.0996 | 4.8822 | 1.0171 | 30 |
| | 70-110 | 90.87 | 4.25 | 4.88 | Sand | 0.0513 | 1.0021 | 0.4850 | 1.0021 | 40 |

**S.= Sand** **C.= Clay** **L. =Loam**

**Table 4: Some chemical properties, cation exchange capacity, exchangeable cations and ESP for the Soil profile layers at the soil of the west bank of Suez Canal.**

| Prof. No. | Depth (cm) | pH | $CaCO_3$ (%) | O.M (%) | EC (dS/m) | CEC meq/100 g soil | Exchangeable cations (meq/100 g soil) | | | | ESP |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | |
| 1 | 0-20 | 7.79 | 2.11 | 2.35 | 0.92 | 28.49 | 16.26 | 8.08 | 3.62 | 0.83 | 12.89 |
| | 20-50 | 7.79 | 2.21 | 1.89 | 0.75 | 26.89 | 14.78 | 7.09 | 3.33 | 0.97 | 12.40 |
| | 50-80 | 7.75 | 1.99 | 0.75 | 0.47 | 19.94 | 13.61 | 2.73 | 2.19 | 0.80 | 10.79 |
| | 80-120 | 7.55 | 2.00 | 0.33 | 0.63 | 20.95 | 10.87 | 7.25 | 2.07 | 0.76 | 9.90 |
| 2 | 0-20 | 7.56 | 3.42 | 2.22 | 1.82 | 20.72 | 10.75 | 6.23 | 2.45 | 0.64 | 11.18 |
| | 20-60 | 7.63 | 2.75 | 2.01 | 0.73 | 23.21 | 13.10 | 8.21 | 3.25 | 0.67 | 13.13 |
| | 60-90 | 7.72 | 1.86 | 0.98 | 0.39 | 9.12 | 4.65 | 2.64 | 1.21 | 0.62 | 11.81 |
| | 90-120 | 7.75 | 1.65 | 0.39 | 0.42 | 7.86 | 3.98 | 3.01 | 0.65 | 0.31 | 9.41 |
| 3 | 0-30 | 7.70 | 1.75 | 2.31 | 0.39 | 27.20 | 13.37 | 9.24 | 3.82 | 0.77 | 14.85 |
| | 30-60 | 7.71 | 1.45 | 0.75 | 0.33 | 20.95 | 14.03 | 4.15 | 2.01 | 0.76 | 9.90 |
| | 60-90 | 7.65 | 1.32 | 0.62 | 0.35 | 21.63 | 12.17 | 6.23 | 2.55 | 0.68 | 10.82 |
| | 90-120 | 7.39 | 0.98 | 0.32 | 0.42 | 11.22 | 6.21 | 2.89 | 1.32 | 0.80 | 11.44 |
| 4 | 0-20 | 7.57 | 2.86 | 2.20 | 0.86 | 22.72 | 12.25 | 7.23 | 2.60 | 0.64 | 11.18 |
| | 20-50 | 7.67 | 1.71 | 1.15 | 0.39 | 20.95 | 14.03 | 4.15 | 2.01 | 0.76 | 9.90 |
| | 50-80 | 7.66 | 1.21 | 0.75 | 0.31 | 12.34 | 6.99 | 3.40 | 1.33 | 0.62 | 10.72 |
| | 80-120 | 7.56 | 1.45 | 0.35 | 0.35 | 6.86 | 3.78 | 2.48 | 0.65 | 0.31 | 9.41 |
| 5 | 0-30 | 7.65 | 1.97 | 0.62 | 0.28 | 6.69 | 2.98 | 2.87 | 0.81 | 0.02 | 12.11 |
| | 30-70 | 7.62 | 1.69 | 0.15 | 0.24 | 5.22 | 2.11 | 2.78 | 0.21 | 0.02 | 4.02 |
| | 70-110 | 7.56 | 1.21 | 0.11 | 0.39 | 5.56 | 2.22 | 2.91 | 0.40 | 0.03 | 7.19 |
| 6 | 0-30 | 7.14 | 1.94 | 0.56 | 3.73 | 5.69 | 2.32 | 2.64 | 0.52 | 0.01 | 9.13 |
| | 30-70 | 7.10 | 2.12 | 0.37 | 4.46 | 5.50 | 2.01 | 2.75 | 0.64 | 0.01 | 11.63 |
| | 70-100 | 7.00 | 2.22 | 0.05 | 7.47 | 5.22 | 2.11 | 2.78 | 0.21 | 0.02 | 4.02 |
| | 100-130 | 7.14 | 1.85 | 0.07 | 6.65 | 5.56 | 2.22 | 2.91 | 0.40 | 0.03 | 7.19 |
| 7 | 0-30 | 7.79 | 0.66 | 0.57 | 1.63 | 5.58 | 2.40 | 2.51 | 0.61 | 0.56 | 10.93 |
| | 30-60 | 7.86 | 0.28 | 0.35 | 0.94 | 5.45 | 2.23 | 2.70 | 0.51 | 0.31 | 9.35 |
| | 60-90 | 7.75 | 0.30 | 0.25 | 0.86 | 5.69 | 2.32 | 2.64 | 0.52 | 0.01 | 9.13 |
| | 90-120 | 7.67 | 0.35 | 0.11 | 0.56 | 5.50 | 2.01 | 2.75 | 0.64 | 0.01 | 11.63 |
| 8 | 0-30 | 7.98 | 2.28 | 0.98 | 0.28 | 12.34 | 9.99 | 4.87 | 1.86 | 0.62 | 10.72 |
| | 30-80 | 7.54 | 1.28 | 0.65 | 0.63 | 6.86 | 6.98 | 4.36 | 1.21 | 0.31 | 9.41 |
| | 80-110 | 7.53 | 0.48 | 0.04 | 0.92 | 3.21 | 2.05 | 2.78 | 0.32 | 0.06 | 6.14 |
| | 110-150 | 7.65 | 0.31 | 0.22 | 0.88 | 2.42 | 2.23 | 2.70 | 0.51 | 0.31 | 9.35 |

**Table 4: Cont.**

| Prof. No. | Depth (cm) | pH | $CaCO_3$ (%) | O.M (%) | EC (dS/m) | CEC meq/100 g soil | Exchangeable cations (meq/100 g soil) | | | | ESP |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | |
| 9 | 0-30 | 7.30 | 1.57 | 1.23 | 2.32 | 19.32 | 13.87 | 8.65 | 2.10 | 0.70 | 8.29 |
| | 30-60 | 7.70 | 0.28 | 0.89 | 0.52 | 8.77 | 12.84 | 5.62 | 2.79 | 0.52 | 12.81 |
| | 60-90 | 7.60 | 0.28 | 0.23 | 0.62 | 7.86 | 7.35 | 3.41 | 1.78 | 0.32 | 13.84 |
| | 90-120 | 7.65 | 0.31 | 0.11 | 0.47 | 3.70 | 2.26 | 2.81 | 0.60 | 0.03 | 10.52 |
| 10 | 0-20 | 7.72 | 0.94 | 1.55 | 0.58 | 20.82 | 13.61 | 8.72 | 2.89 | 0.80 | 10.72 |
| | 20-50 | 7.89 | 0.57 | 0.25 | 0.27 | 14.67 | 7.21 | 6.31 | 1.78 | 0.80 | 10.67 |
| | 50-80 | 7.72 | 0.46 | 0.53 | 0.39 | 8.26 | 7.89 | 2.98 | 1.78 | 0.62 | 13.42 |
| | 80-120 | 7.65 | 0.57 | 0.21 | 0.47 | 2.60 | 2.99 | 2.20 | 0.40 | 0.61 | 7.14 |
| 11 | 0-30 | 7.62 | 0.75 | 1.98 | 0.57 | 20.95 | 16.72 | 8.25 | 2.20 | 0.01 | 7.87 |
| | 30-70 | 7.64 | 0.66 | 0.83 | 0.54 | 8.32 | 8.67 | 3.64 | 1.40 | 0.61 | 10.51 |
| | 70-110 | 7.71 | 0.78 | 0.09 | 0.40 | 3.72 | 2.36 | 2.65 | 0.22 | 0.52 | 3.85 |
| | 110-150 | 7.57 | 0.85 | 0.22 | 0.47 | 2.18 | 2.01 | 1.51 | 0.43 | 0.23 | 10.28 |
| 12 | 0-30 | 7.77 | 1.22 | 1.65 | 0.39 | 20.73 | 14.53 | 7.53 | 3.67 | 0.80 | 14.06 |
| | 30-70 | 7.70 | 2.75 | 0.72 | 0.34 | 13.67 | 8.21 | 5.31 | 1.78 | 0.62 | 10.67 |
| | 70-110 | 7.62 | 2.12 | 0.21 | 0.47 | 13.18 | 2.01 | 1.51 | 0.43 | 0.23 | 10.28 |
| 13 | 0-30 | 7.46 | 0.48 | 0.78 | 0.86 | 5.60 | 2.99 | 2.20 | 0.40 | 0.01 | 7.14 |
| | 30-60 | 7.75 | 0.51 | 0.53 | 0.95 | 4.18 | 2.01 | 1.51 | 0.43 | 0.23 | 10.78 |
| | 60-80 | 7.63 | 0.56 | 0.31 | 0.72 | 4.81 | 2.04 | 2.23 | 0.50 | 0.04 | 10.79 |
| | 80-120 | 7.50 | 0.49 | 0.12 | 0.39 | 5.75 | 2.36 | 2.65 | 0.22 | 0.52 | 3.83 |
| 14 | 0-30 | 7.38 | 0.75 | 1.60 | 1.06 | 15.22 | 8.29 | 6.62 | 2.79 | 0.52 | 15.31 |
| | 30-60 | 7.40 | 1.69 | 0.86 | 1.46 | 8.56 | 3.99 | 3.56 | 0.78 | 0.23 | 8.16 |
| | 60-90 | 7.38 | 1.23 | 0.56 | 1.51 | 2.10 | 2.40 | 2.20 | 0.40 | 0.01 | 12.90 |
| | 90-120 | 7.75 | 2.94 | 0.42 | 2.20 | 35.55 | 19.78 | 14.34 | 5.31 | 0.98 | 13.09 |
| 15 | 0-20 | 7.66 | 0.29 | 0.98 | 0.78 | 5.60 | 2.99 | 2.20 | 0.40 | 0.01 | 7.14 |
| | 20-50 | 7.80 | 0.48 | 0.63 | 0.93 | 5.96 | 2.87 | 2.31 | 0.75 | 0.03 | 12.58 |
| | 50-80 | 7.72 | 0.39 | 0.41 | 0.89 | 5.70 | 2.26 | 2.81 | 0.60 | 0.05 | 10.58 |
| | 80-120 | 7.57 | 0.47 | 0.12 | 0.85 | 5.75 | 2.45 | 2.65 | 0.52 | 0.05 | 10.82 |
| 16 | 0-20 | 7.80 | 0.65 | 0.85 | 0.71 | 4.57 | 1.90 | 2.08 | 0.51 | 0.08 | 11.59 |
| | 20-40 | 7.78 | 0.37 | 0.61 | 0.63 | 4.81 | 2.04 | 2.23 | 0.50 | 0.04 | 10.39 |
| | 40-70 | 7.67 | 0.45 | 0.40 | 0.75 | 5.75 | 2.45 | 2.65 | 0.60 | 0.05 | 10.83 |
| | 70-110 | 7.60 | 0.41 | 0.11 | 0.56 | 5.96 | 2.87 | 2.31 | 0.75 | 0.03 | 12.58 |

**Recent Aeolian sand deposits**

## The period of land use 20 years:

The soil represented by soil profiles 9, 10, 11, 12 and their data of morphological description, physical and chemical analyses showed in Tables 2, 3, 4. A brief morphological description as colour texture, structure, consistence and morphological features indicated that the effect of land use to improve the surface horizon as Ap than the subsurface layers. The texture changed from sandy clay loam in the surface to sand in the deepest layer. The pH ranged between 7.30 and 7.89. $CaCO_3$ is low which ranged between 2.75 and 0.28%. O.M ranged between 1.98 and 0.09%. EC ranged between 2.32 and 0.27%. CEC ranged between 20.95 meq/100g soil and decrease with depth to 2.60 meq/100g soil. ESP is less than 15%. These soils are classified as Typic torrifluvents.

## Period of land use is 10 years:

The soils represented by soil profiles 8 &14 and morphological description, physical and chemical data analyses are shown in Tables 2, 3, 4. Morphological description as colour, texture, consistence and morphological features show low variation between surface layers and lower layers. Texture ranged between sandy loam in the surface layer and sand in the deepest layers. The pH of soil ranged between 7.98 and 7.38. $CaCO_3$ content is 2.28% in the surface layer and decreased with depth as in profile 14 to 0.75%. O.M is low and decrease with depth. EC is low and varied from layer to another. CEC values are moderately high in surface as 15.22 meq/100g soil and decreased with depth except the deepest layer in profile 14 which is high and could be refered to the high content of clay tafla. ESP is less than 15%. These soils are classified as Typic Torriorthents.

## Period of land use is 5 years:

The soils represented by soil profiles 5, 7, 13, 15 and 16 morphological description, physical and chemical analyses showed in Tables 2, 3 & 4. Morphological description revealed there is very low variation between surface and deepest layers. The texture class is sand, the pH ranged between 7.86 and 7.38, $CaCO_3$ content is low less than 2%, O.M less than 1%, EC is less than 2 dS/m, CEC is less than 6 meq/100g soil and ESP is less than 15%. These soils are classified as Typic Torripsamments.

## Period of land use is zero years:-

The soils represented by soil profile 6 and its morphological description, physical and chemical analyses showed in Tables 2, 3 & 4. Morphological description showed that there is no variation between the surface and the deepest layers. The texture class is sand, pH ranged between 7.14 and 7.00, $CaCO_3$ ranged between 2.22 and 1.85%, O.M less than 1%, E C is moderately and ranged between 7.47 and 3.73 dS/m, CEC is low and less than 5.69 meq/100g soil and ESP is less than 15%. These soils classified as Typic Torripsamments.

**Physical and chemical characteristics of the studied soils:**

Topography of the area under investigates represented by microcatchment Fig.3 which combined the elevation, longitude and latitude distance of the area under investigation. The physical and chemical properties of the studied soils are shown in Table 3, 4. Data showed that the soil texture are widely varied such as sandy, loamy sand, sandy loam, sandy clay loam, loam, clay loam and clay. The clay content of the soils have significant different from the upslope and the foot slope or the high parts and lower parts, Fig. 5. The spatial pattern suggested that the clay fraction was probably transported down with the rains plash or over land flow. However, there is no significant difference in the sand content under 1.5%, Fig. 4. The relatively high content of organic matter was found in the areas which have land use for long time and the greatest vegetation cover and parent material tends to the alluvial which located on the middle and foot slope. OM is significantly different between the aggregates from the upper and lower deposition sites of the area, Table 5 and Fig. 6. $CaCO_3$ content of the soils varied from 0.28 to 3.42%. There is no significant difference between the values of $CaCO_3$ in the high and low parts of the studied soils, Fig. 8. There is no saline and no alkaline in the soils under study.

CEC values are widely varied from 2.18 and 35.55 meq/100 g soil. The high values of CEC are mainly influence by the clay content through the layers of the soil profiles. There is a significant difference in the values of CEC between the upper and lower parts of the soils under study, Fig. 7. The bulk density is significantly different between the upper and lower parts of the studied area, Fig. 9, this is could be due to the variation in the soil textures. Stability aggregates Table 5 and Fig 10 are significantly different between the upper and lower parts of soils area which could be due to the topography, parent material, period of land use and clay content.

**Statistical analysis for soil erosion:**

Data presented in Table 5 showed that the values of $EPC_G$ in the studied soils ranged between 0.06 and 96.29 with an average of 17.48. The data reveal that the sequence distribution of $EPC_G$ values is high in the surface layers and decreases with depth and increases by increasing of organic matter and clay content in the soils. Furthermore, the $EPC_G$ values showed different significant values between the upper and lower sites, Table 5 and Fig 11. The highest $EPC_G$ values was found in areas with greatest vegetation and relatively high content of organic matter, located in the middle and footslope. The soils which have high CEC values have clay content and high stability aggregate; these conditions increase the negative effect of wind erosion and increase the effects of environmental loads caused by reuse of farmyard manure, organic manure, residual of plant and improper soil use etc.

The $EPC_G$ values and the soil load are higher than in the above mentioned soil types. In all areas where the erosion effects have been only slight or are absent, soil use (e.g. cultivation) has created more favourable conditions, which may also occur in sandy or sandy loam, or loamy sand. The $EPC_G$ values are ranged between 9 and 57. There was high significant correlation coefficients between $EPC_G$ values and sand (r= -0.62**) silt (r= 0.58**), clay % (r= 0.69**), O.M (r= 0.86**), $CaCO_3$ % (r=0.39**) CEC (r= 0.64**), clay ratio (r= 0.66**), exchangeable Ca (r=0.72**), exchangeable Mg (r= 0.58**), exchangeable Na (r=0.65**) exchangeable K (r=0.45**), stability aggregate (r=0.70**), and bulk density (r= -0.66**), respectively.

Fig3,4,5

fig6,7,8

fig9,10,11

The data showed that the variation in the $EPC_G$ values of the studied soil profiles are due to variations in organic matter, soil texture, bulk density and aggregates.

There is no significant correlation between $EPC_G$ values and pH, EC, and C/N ratio in soils. Path analysis, a statistical technique differentiates between correlation and causation, was used to describe $EPC_G$ values in soil. Path analysis model has been chosen to evaluate the effect of soil properties on $EPC_G$ values by soil samples taken from El-Ferdain area.

Path analysis values of soil from El-Ferdain area are listed in Table 6. Simple correlation coefficients ( r ) values between pH, $CaCO_3$, O.M, EC, sand, silt, clay, CEC, ESP, exch. Ca, exch. Mg, exch. Na, exch. K, stability of aggregate, bulk density, clay ratio and dispersion ratio and $EPC_G$ values are listed for comparison with path analysis values.

**Table 5: Stability aggregate, bulk density (BD) and environmental protection capacity ($EPC_G$) values of soil profile layers at the soil of the west bank of Suez Canal.**

| Prof. No. | Depth (cm) | Stability aggregate | Bulk density (g/cm$^3$) | $EPC_G$ | $EPC_G$ Total |
|---|---|---|---|---|---|
| 1 | 0-20 | 31.9838 | 1.186 | 51.33 | 151.91 |
| | 20-50 | 31.1045 | 1.226 | 68.64 | |
| | 50-80 | 23.9781 | 1.365 | 27.51 | |
| | 80-120 | 24.7552 | 1.390 | 4.43 | |
| 2 | 0-20 | 28.6013 | 1.149 | 24.71 | 152.42 |
| | 20-60 | 31.3950 | 1.215 | 96.29 | |
| | 60-90 | 14.6242 | 1.421 | 26.78 | |
| | 90-120 | 12.5767 | 1.481 | 4.64 | |
| 3 | 0-30 | 33.1982 | 1.179 | 76.91 | 108.04 |
| | 30-60 | 24.9775 | 1.357 | 16.50 | |
| | 60-90 | 27.2253 | 1.349 | 11.51 | |
| | 90-120 | 16.5189 | 1.455 | 3.12 | |
| 4 | 0-20 | 28.6611 | 1.223 | 50.65 | 107.25 |
| | 20-50 | 25.1891 | 1.327 | 35.12 | |
| | 50-80 | 17.5278 | 1.416 | 16.50 | |
| | 80-120 | 12.5556 | 1.484 | 4.98 | |
| 5 | 0-30 | 10.2092 | 1.483 | 11.51 | 12.89 |
| | 30-70 | 9.5244 | 1.522 | 0.90 | |
| | 70-110 | 8.6946 | 1.532 | 0.48 | |
| 6 | 0-30 | 9.6324 | 1.492 | 9.46 | 15.24 |
| | 30-70 | 8.0328 | 1.518 | 5.57 | |
| | 70-100 | 8.6629 | 1.536 | 0.07 | |
| | 100-130 | 8.9823 | 1.532 | 0.14 | |
| 7 | 0-30 | 7.6844 | 1.506 | 9.79 | 15.79 |
| | 30-60 | 9.1306 | 1.511 | 3.74 | |
| | 60-90 | 10.0134 | 1.511 | 1.90 | |
| | 90-120 | 9.5033 | 1.525 | 0.36 | |
| 8 | 0-30 | 17.6495 | 1.398 | 26.78 | 41.40 |
| | 30-80 | 12.7144 | 1.461 | 12.60 | |
| | 80-110 | 8.6758 | 1.537 | 0.06 | |
| | 110-150 | 7.9534 | 1.529 | 1.96 | |

**Table 5: Cont.**

| Prof. No. | Depth (cm) | Stability Aggregate | Bulk density (g/cm$^3$) | $EPC_G$ | $EPC_G$ Total |
|---|---|---|---|---|---|
| 9 | 0-30 | 23.5508 | 1.334 | 39.14 | 63.67 |
| | 30-60 | 13.8498 | 1.434 | 22.58 | |
| | 60-90 | 13.4188 | 1.486 | 1.61 | |
| | 90-120 | 8.7038 | 1.532 | 0.36 | |
| 10 | 0-20 | 25.4281 | 1.295 | 36.56 | 49.18 |
| | 20-50 | 18.8622 | 1.442 | 1.90 | |
| | 50-80 | 13.5775 | 1.463 | 8.49 | |
| | 80-120 | 7.9390 | 1.530 | 2.23 | |
| 11 | 0-30 | 27.2728 | 1.250 | 71.40 | 100.21 |
| | 30-70 | 13.8181 | 1.439 | 26.53 | |
| | 70-110 | 8.7295 | 1.533 | 0.32 | |
| | 110-150 | 7.9443 | 1.529 | 1.96 | |
| 12 | 0-30 | 26.7620 | 1.278 | 59.35 | 99.27 |
| | 30-70 | 19.1109 | 1.406 | 20.39 | |
| | 70-110 | 8.2479 | 1.528 | 1.78 | |
| 13 | 0-30 | 8.2407 | 1.486 | 17.75 | |
| | 30-60 | 8.9260 | 1.499 | 8.49 | 11.16 |
| | 60-80 | 7.3015 | 1.527 | 1.95 | |
| | 80-120 | 9.0088 | 1.528 | 0.72 | |
| 14 | 0-30 | 21.8751 | 1.320 | 57.13 | 93.19 |
| | 30-60 | 13.7522 | 1.437 | 21.23 | |
| | 60-90 | 7.3338 | 1.509 | 9.46 | |
| | 90-120 | 41.5827 | 1.252 | 5.37 | |
| 15 | 0-20 | 9.1642 | 1.465 | 17.85 | 85.56 |
| | 20-50 | 8.4703 | 1.495 | 11.87 | |
| | 50-80 | 8.8988 | 1.508 | 5.12 | |
| | 80-120 | 8.4184 | 1.533 | 0.72 | |
| 16 | 0-20 | 7.4874 | 1.487 | 13.85 | 26.64 |
| | 20-40 | 7.4603 | 1.505 | 7.43 | |
| | 40-70 | 8.8936 | 1.509 | 4.88 | |
| | 70-110 | 8.7037 | 1.532 | 0.48 | |

Low uncorrected residual (U) values and significant coefficient of determination ($R^2$) values indicate that the Path analysis model explains most of the variation in $EPC_G$ values by soil properties. Partitioning showed strong ($p<0.01$) OM, clay and bulk density direct effect on $EPC_G$ values.

In general, direct effect of soil properties on $EPC_G$ values are OM > bulk density > clay > dispersion ratio > stability aggregates > $CaCO_3$. Path analysis direct effect of OM (0.45), bulk density (0.35) Fig 12, clay (0.23), desperation ratio (-0.15), stability aggregates (0.14), and $CaCO_3$ (-0.13). This means that direct effects are higher than indirect ones for $EPC_G$ values. Also, results showed that the partition of direct and indirect effects may allow insight into mechanisms of $EPC_G$ values. Path analysis could be a valuable tool to record relationships between soil properties and other measured chemical parameters.

**Table 6: Path analysis of direct effect of soil properties on $EPC_6$ values for the soil investigation.**

| Soil properties | Direct effect | r |
|---|---|---|
| Sand | -0.05 | -0.97 |
| Silt | 0.09 | 0.94 |
| Clay | 0.23 | 0.91 |
| EC | -0.08 | -0.28 |
| O.C | 0.43 | 0.84 |
| $CaCO_3$ | -0.13 | 0.54 |
| CEC | -0.01 | 0.93 |
| ESP | 0.03 | 0.51 |
| Clay % | 0.05 | 0.85 |
| Dispersion | -0.15 | -0.08 |
| Exch. Ca | 0.07 | 0.33 |
| Exch. Mg | 0.01 | 0.74 |
| Exch. Na | -0.07 | 0.78 |
| Exch. K | -0.01 | 0.58 |
| Stability aggregate | 0.14 | 0.79 |
| Bulk density | -0.25 | -0.55 |

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**تأثير خواص التربة على إنجراف الأراضى وعلاقتها بمعامل $EPC_G$**

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أخذ ١٦ قطاع أرضى تمثل أراضى المنطقة بالساحل الغربى لقناة السويس تحت الدراسة على أساس اختلاف الترسيبات وفترة الاستخدام كأراضى ترسيبات نهرية ريحية وأراضى الترسيبات الرملية الحديثة. تقسم الأراضى إلى:

Typic Torrifluvents, Typic Torriorthents, Typic Torripsamments

من الخواص الطبيعية والكيماوية للأراضى فإن توزيع الطين يكون مختلف بدرجة معنوية بين الأجزاء المرتفعة والمنخفضة بينما لا يوجد اختلاف معنوى فى توزيع الرمل. توزيع المادة العضوية يتأثر بالطبوغرافية واستخدام الأراضى والغطاء النباتى. لا يوجد اختلاف معنوى فى توزيع كربونات الكالسيوم. السعة التبادلية الكاتيونية تختلف من جزء إلى آخرى تبعاً لتوزيع الطين. قيم الكثافة الظاهرية تختلف تبعا لإختلاف القوام. ثبات التجمعات تختلف قيمها بين الاجزاء المرتفعة والمنخفضة وهذا يرجع إلى الطبوغرافية ومادة الأصل وفترة الاستخدام والمحتوى الطينى. من الدراسة السابقة يتضح انها تقلل من تأثير الانجراف الريحى مع زيادة معامل القدرة التحملية للظروف البيئية ($EPC_G$ ).

يرتبط معامل القدرة التحملية للظروف البيئية ($EPC_G$) كمعامل لدراسة الانجراف الريحى ارتباطاً معنوياً عالى المعنوية مع الرمل والسلت والطين والمادة العضوية وكربونات الكالسيوم والسعة التبادلية الكاتيونية والكاتيونات المتبادلة (كا$^{++}$، مغ$^{++}$، ص$^{+}$، بو$^{+}$) والتجمعات الثابتة والكثافة الظاهرية بينما لا يوجد ارتباط معنوى مع الملوحة ورقم C/N, pH فى الأراضى.

يتضح من دراسة معامل Path analysis أن عدداً من خواص الأراضى مثل المادة العضوية والكثافة الظاهرية والطين والتجمعات الثابتة وكربونات الكالسيوم لها تأثير وارتباط مباشر مع $EPC_G$ .

## Table (2): Micromorphological description of soil profiles of the investigated area.

| Parent Materials | Land Use | Soil Classification | Prof. No. | Horizon Symbol | Depth (cm) | Colour | | Texture Class | Structure | Consistence | | | Bound-ary |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Dry | Moist | | | Dry | Moist | Wet | |
| Alluvial widborn Deposits | Cultivated with Crops 40 years | Typic Torrifluvents | 1 | Ap | 0-20 | 10YR4/2 | 10YR3/2 | CL | Mmsb | H | F | S&P | GD |
| | | | | C1 | 20-50 | 10YR5/2 | 10YR4/2 | CL | Slsb | H | F | S&P | Cg |
| | | | | C2 | 50-80 | 10YR5/3 | 10YR3/3 | SCL | Mlsb | Mh | Mf | Ms&p | Cs |
| | | | | C3 | 80-120 | 10YR5/3 | 10YR3/3 | L. | Mssb | Mh | Mf | Ms&p | |
| Alluvial windborn Deposits | Cultivated with Crops 40 years | Tyipc Torrifluvents | 2 | Ap | 0-20 | 10YR4/2 | 10YR3/2 | SCL | Mmsb | Mh | Mf | Ms&p | GD |
| | | | | C1 | 20-60 | 10YR4/2 | 10YR3/2 | SCL | Mcsb | Mh | Mf | Ms&p | Cg |
| | | | | C2 | 60-90 | 10YR5/3 | 10YR3/3 | SL | Mmsb | Sh | Fr. | Sds&p | C s |
| | | | | C3 | 90-120 | 10YR5/3 | 10YR3/3 | LS | Smsb | Vsh | Sfr. | Vss&p | |
| Alluvial windborn Deposits | Cultivated with Crops 40 years | Tyipc Torrifluvents | 3 | Ap | 0-30 | 10YR4/2 | 10YR3/2 | VCL | Mcsb | H. | f. | S&p | Ci |
| | | | | C1 | 30-60 | 10YR5/3 | 10YR3/3 | L | Mmsb | Mh. | Mf. | Ms&p | GD |
| | | | | C2 | 60-90 | 10YR5/3 | 10YR33 | SCL | Mmsb | Mh. | Mf. | Ms&p | Cg |
| | | | | C3 | 90-120 | 10YR5/3 | 10YR3/3 | SL | Smsb | Sh. | Fr. | Ss&p | CS |
| Alluvial windborn Deposits | Cultivated with Crops 40 years | Tyipc Torrifluvents | 4 | Ap | 0-20 | 10YR4/3 | 10YR3/3 | SCL | Mcsb | Mh. | Mf. | Ms&p | CI |
| | | | | C1 | 20-50 | 10YR4/3 | 10YR3/3 | L | Mmsb | Mh. | Fr. | Ss&p | CW |
| | | | | C2 | 50-80 | 10YR4/3 | 10YR3/3 | SL | Mssb | Sh. | Fr. | Vaa&p | GD |
| | | | | C3 | 80-120 | 10YR5/3. | 10YR3/3 | LS | Smsb | Vsh. | Vsfr. | Vss&p | CW |
| Recent Aeolian Sand Deposits | Cultivated with Vegetables 20 years | Tyipc Torrifluvents | 9 | Ap | 0-30 | 10YR5/4 | 10YR4/4 | SCL | Mmsb | Mh | Mf. | Ms&p | CS |
| | | | | C1 | 30-60 | 10YR6/4 | 10YR5/4 | SL | Mssb | Sh | Sfr. | Vss&n | Gd |
| | | | | C2 | 60-90 | 10YR5/4 | 10YR4/4 | LS | Wssb | Vsh | Vsfr. | Non | Cw |
| | | | | C3 | 90-120 | 10YR6/4 | 10YR5/4 | S | Sg | l. | l. | Non | Cs |
| Recent Aeolian Sand Deposits | Cultivated with Vegetables 20 years | Tyipc Torrifluvents | 10 | Ap | 0-30 | 10YR5/3 | 10YR2/3 | SCL | Mmsb | Mh. | Mf. | Ss&p | Cw |
| | | | | C1 | 30-70 | 10YR6/4 | 10YR5/4 | SL | Mssb. | Ser. | Sfr. | Non | Gs. |
| | | | | C2 | 50-80 | 10YR4/3 | 10YR5/2 | LS. | Wsg | Vsh | Vsfr. | Non | Cs. |
| | | | | C3 | 80-120 | 10YR6/4 | 10YR5/3 | S. | Sg | L. | L. | Non | |
| Recent Aeolian Sand Deposits 20 years | Cultivated with Vegetables 20 years | Tyipc Torrifluvents | 11 | Ap | 0-30 | 10YR5/3 | 10YR3/3 | SCL. | Mmsb | Mh. | Mf. | Ss&p | Cw. |
| | | | | C1 | 30-70 | 10YR6/4 | 10YR5/4 | SL. | Wsg | Sh. | Sfr | Non | Gs. |
| | | | | C2 | 70-110 | 10YR6/3 | 10YR4/3 | S. | Sg | L. | L. | Non | CI. |
| | | | | C3 | 110-150 | 10YR6/3 | 10YR4/3 | S. | Mmsb | L. | L. | Non | |
| Recent Aeolian Sand Deposits 20 years | Cultivated with Crops 20 years | Tyipc Torrifluvents | 12 | Ap | 0-30 | 10YR5/3 | 10YR4/3 | SCL | Wsg | Mh. | Mf. | Ss&p | GD. |
| | | | | C1 | 30-70 | 10YR6/4 | 10YR5/4 | SL. | Sg | Sh. | Sfr. | Non | CS. |
| | | | | C2 | 70-110 | 10YR6/3 | 10YR5/2 | S. | Msg | L. | L. | Non | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recent Aeolian | Cultivated with | Typic | 8 | Ap | 0-30 | 10YR6/4 | 10YR5/4 | SL. | Wsg | Sh. | Sfr. | Non | GS. |

## Table (2): Cont.

| Parent Materials | Land Use | Soil Classification | Prof. No. | Horizon Symbol | Depth (cm) | Colour | | Texture Class | Structure | Sss | | | Bound-ary |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Dry | Moist | | | Dry | Moist | Wet | |
| Sand | Vegetables | Torriorthents | | C1 | 30-80 | 10YR5/4 | 10YR3/3 | LS. | Sg | Vsh. | Vsfr. | Non | Cl |
| Deposits 10 years | 10 years | | | C2 | 80-110 | 10YR6/4 | 10YR5/4 | S. | Sg | L. | L. | Non | CS. |
| | | | | C3 | 110-150 | 10YR5/4 | 10YR3/3 | S. | Wssb | L. | L. | Non | |
| Recent Aeolian | Cultivated with | Tyipc | 5 | Ap | 0-30 | 10YR7/4 | 10YR6/4 | S. | Vwssb | Sh. | Sfr. | Vss&p | GD. |
| Sand | Fruties 5 years | Torripsamments | | C1 | 30-70 | 10YR7/4 | 10YR6/4 | S. | Sg | Vsh. | L. | Non | CS. |
| Deposits 5 years | | | | C2 | 70-110 | 10YR7/4 | 10YR6/4 | S. | Sg | L. | L. | Non | |
| Recent Aeolian | Borren | Tyipc | 6 | C1 | 0-30 | 10YR7/4 | 10YR6/4 | S. | Sg | L. | L. | Non | Cl |
| Sand | | Torripsamments | | C2 | 30-70 | 10YR5/2 | 10YR3/2 | S. | Sg | L. | L. | Non | Cg. |
| Deposits. | | | | C3 | 70-100 | 10YR6/3 | 10YR5/3 | S. | Sg | L. | L. | Non | CS. |
| | | | | C4 | 100-130 | 10YR6/3 | 10YR5/3 | S. | Sg | L. | L. | Non | |
| Recent Aeolian | Cultivated with | Tyipc | 7 | Ap | 0-30 | 10YR6/3 | 10YR4/3 | S. | Wg | Sh. | Sfr. | Non | GD |
| Sand | Vegetables | Torripsamments | | C1 | 30-60 | 10YR | 10YR | S. | Wssb | Vsh. | Vsfr. | Non | CS. |
| Deposits. | 5 years | | | C2 | 60-90 | 10YR | 10YR | S. | Vwssb | Vsh. | Vsfr. | Non | CW. |
| | | | | C3 | 90-120 | 10YR | 10YR | S. | Sg. | L. | L. | Non | |
| Recent Aeolian | Cultivated with | Tyipc | 13 | Ap | 0-30 | 10YR | 10YR | S. | Wsg. | Sh. | Sfr. | Non | CS. |
| Sand | Vegetbles | Torripsamments | | C1 | 30-60 | 10YR | 10YR | S. | Vwsg. | Vsh | Vsfr. | Non | Cl |
| Deposits. | 5 years | | | C2 | 60-80 | 10YR | 10YR | S. | Vwssb. | Vsh | Vsfr | Non | CS. |
| | | | | C3 | 80-120 | 10YR | 10YR | S. | Sg. | L. | L. | Non | |
| Recent Aeolian | Cultivated with | Tyipc | 14 | Ap | 0-30 | 10YR | 10YR | SL | Msg. | Sh. | Sfr | Non | GW. |
| Sand | Crops 10 years | Torriorthents. | | C1 | 30-60 | 10YR | 10YR | LS. | Wsg | Vsh | Vsfr. | Non | GD. |
| Deposits. | | | | C2 | 60-90 | 10YR | 10YR | S. | Wssb | L. | L. | Non | CS. |
| | | | | C3 | 90-120 | 10YR | 10YR | C. | Scsb | Vh | Vf. | Vs&vp | |
| Recent Aeolian | Cultivated with | Tyipc | 15 | Ap | 0-20 | 10YR | 10YR | S. | Wsg | Sh | Sfr. | Non | Cl |
| Sand | Vegetables | Torripsamments | | C1 | 20-50 | 10YR | 10YR | S. | Wssb | Vsh | Vsfr | Non | CS. |
| Deposits. | 5 years | | | C2 | 50-80 | 10YR | 10YR | S. | Vwssb | L | L | Non | CS. |
| | | | | C3 | 80-120 | 10YR | 10YR | S. | Sg | L | L | Non | |
| Recent Aeolian | Cultivated with | Tyipc | 16 | Ap | 0-20 | 10YR | 10YR | S. | Vwsg | Sh | Sfr | Non | CS |
| Sand | Vegetables | Torripsamments. | | C1 | 20-40 | 10YR | 10YR | S. | Vwssb | Vsh | Vsfr. | Non | Cl |
| Deposits. | 5 years | | | C2 | 40-70 | 10YR | 10YR | S. | Sg. | L | L. | Non | CS |
| | | | | C3 | 70-110 | 10YR | 10YR | S. | Sg. | L | L. | Non | |

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