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# Assessment Soil Profile Homogenity of some Salt Affected Soils of Egypt

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THIS WORK was carried out on some salt affected soils adjacent to the lakes Qarun, El Borollus and Edko, of Egypt to study their profile homgenity by using some statistical measures on both total soluble salts and soluble $Na^+$, *i.e.*, weighted mean (W), trend (T) and specific range (R) . Four soil profiles were taken from each area at the distances of 1,5,10 and 15 Km from the lake shoreline. The disturbed soil samples were taken from each soil profile at the depths of 0-30 , 30-60, 60-90 and >90 cm. The samples were analyzed for determining total soluble salts, soluble ions , pH , CEC , exchangeable cations and the content of organic matter and $CaCO_3$. The obtained data showed that the studied soil profiles have high contents of total soluble salts and soluble ions, and their values tended to decrease with increasing both soil depth and the distance from the lake shoreline. The high content of total soluble salts and soluble ions were more pronounced in the soil samples of El-Fayoum area (Qarun lake) followed by those of Kafr El Sheikh (Borollus lake) and El Beheira (Edko lake) .The values of soil pH in the studied soil samples ranged between 7.8 and 8.8, the exchangeable cations were predominated by $Na^+$and $Mg^{2+}$,the values of CEC ranged from 28.69 to 58.49 c mol /kg soil, and the soil contents of both organic matter and $CaCO_3$ was relatively low and tended to decrease with increasing soil depth. The relationship between CEC values and both organic matter or $CaCO_3$ along the distance from the lake had no specific trend. The data of W emphasized a high content of either total soluble salts or soluble $Na^+$ , which showed pronounced decreases with increasing either soil depth or the distance from the lake shoreline . The values of T exhibited a symmetrical distribution of total soluble salts and soluble $Na^+$. The data of R indicate to apparent homogeneity for the parent materiales of the studied soil profiles of each area .

**Keywords:** Salt affected soils, Salinity, Sodicity, Weighted mean, Trend, Specific range.

Salt-affected soils occur in all continents and under almost all climatic conditions. Their distribution is relatively more extensive in the arid and semi-arid regions compared to the humid regions. The nature and properties of these soils are also diverse such that they require specific approaches for their reclamation and management to maintain their long term productivity. For any long-term solutions, it is necessary to understand the mode of origin of salt-affected soils and to classify them, keeping in view the physio-chemical characteristics, processes leading to their formation and the likely approaches for their reclamation and successful management ( Ramadan, 1986; Yadav, 1986; Szabolcs, 1989 and Tanji, 1990).

Szabolcs (1989) reported that, continental sediments have primary importance in the formation of salt-affected soils. These sediments, which are distributed diversely on geophysical elements and are transported mainly by water occupy different places with different petrographic and chemical composition along the slope.

Balba (1995) showed that, the sources of salts in soils might be listed as following:

- Continental, due to weathering of igneous, or secondary rocks rich in salts.
- Marine sources where salts accumulate from the sea water in sea shores, especially in arid regions.
- Deltaic sources characterized with salt supply from the continent by means of rivers and from the sea in various periods.
- Anthropogenic sources which result from man's activities.

Salinity due to the first three sources is usually termed primary, while that due to the latter source is described as secondary salinity.

This investigation was carried out to estimate some chemical properties of salt affected soils adjacent to the lakes of Qarun, El Borollus and Edko, Egypt . Also ,the statistical measures were applied assessing soil profile homogenity .

## Material and Methods

*Soil sampling and analysis*

This study was carried out to study the chemical properties of three salt affected areas , *i.e.*, El- Fayoum , Balttim and Edko which located near the lakes of Qarun, El-Borollus and Edko, respectively.Four soil profiles were selected from different locations of each area.The different information about the studied locations are presented in Table 1 . The soil samples were taken from different profiles at depths of 0-30,30-60,60-90 and >90 cm.The collected soil samples were air -dried , ground sieved through a 2 mm sieve and kept for some chemical analyseis , *i.e.*, total soluble salts(EC), soluble ions, soil pH, the contents of organic matter and $CaCO_3$ , CEC and exchangeable cations using the methods described by Richards (1954); Jackson (1973); Cottenie *et al.* (1982) and Page (1982).

**TABLE 1. Location,distance from the lake shoreline and cultivated plants of the studied soil profiles .**

| Govern-orate | Lake name | Studied area | Profile No. | Distance from lake (km) | Location name | Cultivated plant |
|---|---|---|---|---|---|---|
| El-Fayoum | Qarun | El-Fayoum | 1 | 1 | Manshaat Sannuris | Barren |
| | | | 2 | 5 | Abu Leteaa | Barren |
| | | | 3 | 10 | Kassr Rashwan | Olives |
| | | | 4 | 15 | El- Ghaba | Un cultivated |
| Kafr El-Sheikh | El-Burollus | Baltim | 5 | 1 | El- Beharia | Cotton |
| | | | 6 | 5 | El-Khashea | Cotton |
| | | | 7 | 10 | Khamees | Rice |
| | | | 8 | 15 | Abu El-Dahab | Rice |
| El-Beheira | Edko | Edko | 9 | 1 | Korkor | Cotton |
| | | | 10 | 5 | Diab | Cotton |
| | | | 11 | 10 | Diab | Rice |
| | | | 12 | 15 | Tulumbat Halk El-Gamal | Rice |

*The applied statistical measures*

Oertal & Gilles (1963) suggested three measures for trace elements, namely the weighed mean (W), trend (T) and specific range (R). The weighed mean was calculated as, trace element concentration of each sample horizon of the solum multiplied by the thickness of the horizon or layer and divided the sum of these products by the total thickness of all analyzed horizons or layers. According to these authors , the weighed mean is the most satisfactory measure of the trace element status of a soil profile. Any change in concentration of trace element with depth is called the trend and defined by T= (W - S)/W and by T= (W-S)/S, where W= the weighed mean concentration, and S= the concentration in the surface horizon or layer. Oertal & Gilles (1963) stated that, all values for T lie in the range from -1 to + 1 and are more symmetrical distribution when T is small. The specific range is defined by R= (H-L)/W, where R is the specific range, H and L are the highest and the lowest concentrations in the solum, and W is the weighed mean. The weighed mean concentration of a trace element is probably determined by pedogenic processes, except where the parent material is markedly heterogeneous in trace element content.

## Results and Discussion

*Some chemical properties of the studied soils*

The presented data in Tables 2 - 4 show that , EC values (dS/m) of the studied soil samples were decreased with the increase of both soil depth and the distance from the lakes . The highest value of EC (34.92 dS/m ) was found in the surface layer of profile number 1 and the lowest one (1.45 dS/m ) was found at depth more than 90 cm of profile number 12 . The arrangement of the studied areas according to their mean content of total soluble salts was El-Fayoum (20.16 dS/m) >Balttim (9.68 dS/m) > Edko (6.93 dS/m) . This order may be resulted from :1) The long cultivation periods and increasing agriculture activity of Balttim and Edko areas, 2) The high rates of rainfall (39.20 and 35.00 mm/year)in the two areas respectively,compared with El- Fayoum (28.00 mm/year) and 3) The high temperature degree of El-Fayoum.

**TABLE 2. Total soluble salts , soluble ions and SAR of soil samples of El Fayoum area .**

| Profile No. | Distance from Lake (km) | Soil depth (cm) | E C | | Soluble ions (meq/L) | | | | | | | | SAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Cations | | | | Anions | | | | |
| | | | dS/m | R.D % | $Ca^{+2}$ | $Mg^{+2}$ | $Na^{+}$ | $K^{+}$ | $Cl^{-}$ | $CO_3^{2-}$ | $HCO_3^{-}$ | $SO_4^{2-}$ | |
| 1 | 1 | 0-30 | 34.92 | - | 45.00 | 80.00 | 215.35 | 9.23 | 256.45 | - | 3.78 | 89.35 | 27.23 |
| | | 30-60 | 31.86 | 8.76 | 38.00 | 74.00 | 199.00 | 7.41 | 242.36 | - | 3.63 | 72.42 | 26.60 |
| | | 60-90 | 30.31 | 13.20 | 36.00 | 67.00 | 193.04 | 6.90 | 227.95 | - | 3.78 | 71.21 | 26.89 |
| | | 90< | 28.86 | 17.35 | 33.00 | 64.00 | 185.67 | 5.21 | 216.45 | - | 3.21 | 68.22 | 26.68 |
| | | Mean | 31.32 | - | 38.00 | 71.25 | 198.27 | 7.19 | 236.30 | - | 3.10 | 75.30 | 26.85 |
| 2 | 5 | 0-30 | 25.95 | - | 33.00 | 49.00 | 170.04 | 7.45 | 207.31 | - | 3.00 | 49.18 | 26.57 |
| | | 30-60 | 20.90 | 19.46 | 27.38 | 41.64 | 133.60 | 6.38 | 168.13 | - | 3.37 | 37.50 | 22.72 |
| | | 60-90 | 18.10 | 30.25 | 21.75 | 33.89 | 120.46 | 4.80 | 152.86 | - | 3.00 | 25.04 | 22.81 |
| | | Mean | 21.65 | - | 27.38 | 41.51 | 141.37 | 6.21 | 175.43 | - | 3.79 | 37.24 | 24.03 |
| 3 | 10 | 0-30 | 21.90 | - | 25.00 | 40.00 | 147.26 | 6.32 | 174.85 | - | 3.28 | 40.45 | 25.84 |
| | | 30-60 | 19.10 | 12.79 | 21.90 | 37.63 | 126.23 | 4.24 | 152.78 | - | 3.65 | 33.57 | 22.95 |
| | | 60-90 | 14.60 | 33.33 | 15.00 | 31.00 | 95.47 | 4.09 | 116.40 | - | 3.23 | 25.93 | 19.89 |
| | | 90< | 12.50 | 42.92 | 14.34 | 23.00 | 84.13 | 3.13 | 107.39 | - | 3.00 | 14.21 | 19.57 |
| | | Mean | 17.03 | - | 19.06 | 32.91 | 113.27 | 4.45 | 138.11 | - | 3.04 | 28.54 | 22.06 |
| 4 | 15 | 0-30 | 14.10 | - | 20.00 | 31.80 | 84.03 | 4.77 | 110.38 | - | 3.15 | 27.07 | 16.51 |
| | | 30-60 | 9.70 | 31.21 | 15.00 | 20.00 | 58.35 | 3.45 | 75.01 | - | 3.00 | 18.79 | 13.96 |
| | | 60-90 | 8.10 | 42.55 | 12.00 | 18.00 | 49.67 | 1.19 | 65.00 | - | 3.00 | 12.86 | 12.84 |
| | | Mean | 10.63 | - | 15.67 | 23.27 | 64.02 | 3.14 | 83.13 | - | 3.38 | 19.57 | 14.44 |

**TABLE 3. Total soluble salts , soluble ions and SAR of soil samples of Balttim area .**

| Profile No. | Distance from Lake (km) | Soil depth (cm) | E C | | Soluble ions (meq/L) | | | | | | | | SAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Cations | | | | Anions | | | | |
| | | | dS/m | R.D % | $Ca^{+2}$ | $Mg^{+2}$ | $Na^{+}$ | $K^{+}$ | $Cl^{-}$ | $CO_3^{2-}$ | $HCO_3^{-}$ | $SO_4^{2-}$ | |
| 5 | 1 | 0-30 | 25 20 | - | 33.46 | 45 89 | 166 17 | 5 64 | 113.34 | - | 3.00 | 35.36 | 26.38 |
| | | 30-60 | 17 10 | 32 14 | 25 50 | 34 43 | 107 09 | 3.77 | 138.53 | - | 3 39 | 28.87 | 19.58 |
| | | 60-90 | 15 24 | 39 52 | 19 00 | 33 28 | 96 61 | 3 21 | 128 16 | - | 3 00 | 20.94 | 18 91 |
| | | 90 < | 11 80 | 53 17 | 15 00 | 21 75 | 78 40 | 2 65 | 96.08 | - | 3.00 | 18.72 | 18.28 |
| | | **Mean** | 17.34 | - | 23 24 | 33 84 | 112 07 | 3 82 | 143 28 | - | 3 85 | 25.97 | 20 79 |
| 6 | 5 | 0-30 | 19 60 | - | 29 00 | 40.19 | 122.83 | 3 97 | 164 26 | - | 3.00 | 28.73 | 20.89 |
| | | 30-60 | 14 00 | 28 57 | 24.57 | 31 88 | 80 47 | 3 08 | 111.07 | - | 3 00 | 25.93 | 15.13 |
| | | 60-90 | 12 80 | 34.69 | 21 35 | 29 79 | 74.20 | 2 65 | 103 42 | - | 3.00 | 21.57 | 14.66 |
| | | 90< | 10.00 | 48 98 | 17 96 | 24.71 | 55 35 | 1.98 | 81 47 | - | 3.00 | 15.53 | 11 98 |
| | | **Mean** | 14 10 | - | 23.22 | 31.64 | 83 21 | 2 92 | 114 56 | - | 3.50 | 22.94 | 15.67 |
| 7 | 10 | 0-30 | 6 29 | - | 16.00 | 20 69 | 24 54 | 1.37 | 38 76 | - | 3.00 | 20.84 | 5.73 |
| | | 30-60 | 5 57 | 11 45 | 14 32 | 17.24 | 22 64 | 1 12 | 33.50 | - | 3 00 | 18 82 | 5 70 |
| | | 60-90 | 3 70 | 41 18 | 9 00 | 12 65 | 14 57 | 0 76 | 22 89 | - | 3.00 | 11.09 | 4.43 |
| | | 90< | 3 10 | 50 72 | 8 67 | 11 33 | 10 38 | 0 62 | 19 05 | - | 3.00 | 8 95 | 3.29 |
| | | **Mean** | 4 67 | - | 11.99 | 15.48 | 18.03 | 0.97 | 28.30 | - | 3 25 | 14.93 | 4.79 |
| 8 | 15 | 0-30 | 3 72 | - | 9 18 | 12.05 | 15 21 | 0 76 | 22.23 | - | 3 00 | 11.97 | 4.68 |
| | | 30-60 | 2 59 | 30 38 | 7 00 | 8 76 | 9 36 | 0.60 | 14.37 | - | 3.13 | 8.22 | 3 33 |
| | | 60-90 | 2 26 | 39 25 | 6.00 | 7.47 | 8 67 | 0 42 | 12.00 | - | 3.33 | 7 27 | 3.33 |
| | | 90< | 1 86 | 50 00 | 4.80 | 6 49 | 7.05 | 0.26 | 9.74 | - | 3.30 | 5 56 | 2.96 |
| | | **Mean** | 2 61 | - | 6 75 | 8.37 | 10 41 | 0.51 | 14.59 | - | 3.19 | 8.26 | 3.58 |

**R.D=Relative decrease.**

**TABLE 4.Total soluble salts , soluble ions and SAR of soil samples of Edko area .**

| Profile No. | Distance from Lake (km) | Soil depth (cm) | E C | | Soluble ions (meq/L) | | | | | | | | SAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Cations | | | | Anions | | | | |
| | | | dS/m | R.D % | $Ca^{+2}$ | $Mg^{+2}$ | $Na^{+}$ | $K^{+}$ | $Cl^{-}$ | $CO_3^{2-}$ | $HCO_3^{-}$ | $SO_4^{2-}$ | |
| 9 | 1 | 0-30 | 17.54 | - | 15 00 | 54 00 | 100 62 | 5.77 | 126.52 | - | 3 38 | 45 49 | 17.14 |
| | | 30-60 | 17.15 | 2 22 | 14.00 | 53.00 | 98.43 | 5.77 | 123.37 | - | 3.81 | 44.02 | 17.00 |
| | | 60-90 | 8 25 | 52 96 | 13.00 | 32.00 | 34.79 | 2 71 | 51 53 | - | 3.00 | 27.97 | 7 34 |
| | | 90< | 7.77 | 55.70 | 12.00 | 30.00 | 33.14 | 2.56 | 48.70 | - | 3.00 | 26.00 | 7.24 |
| | | **Mean** | 12.68 | - | 13.50 | 42 25 | 66.75 | 4 20 | 87.78 | - | 3 05 | 35.87 | 12.18 |
| 10 | 5 | 0-30 | 13.70 | - | 18.50 | 33 00 | 80 67 | 4.81 | 112 00 | - | 3 00 | 21.98 | 15.91 |
| | | 30-60 | 9.15 | 33.21 | 13.00 | 23.00 | 52.13 | 3.21 | 72.00 | - | 3.00 | 16.34 | 12.29 |
| | | 60-90 | 8.28 | 39.56 | 11.00 | 20.50 | 48.74 | 2.56 | 65.31 | - | 3.00 | 14.49 | 12.28 |
| | | 90< | 7.23 | 47.23 | 10.00 | 18 36 | 42.34 | 1.60 | 56 04 | - | 3.00 | 13.26 | 11.23 |
| | | **Mean** | 9.59 | - | 13.13 | 23.72 | 55 97 | 3.05 | 75 59 | - | 3.75 | 16.52 | 12.93 |
| 11 | 10 | 0-30 | 4.64 | - | 10.00 | 12.00 | 23.11 | 1.22 | 29.65 | - | 3.00 | 13.75 | 6.96 |
| | | 30-60 | 3 50 | 24 57 | 8 00 | 9.00 | 16.96 | 1 04 | 21.64 | - | 3.00 | 10.36 | 5.81 |
| | | 60-90 | 3.38 | 27.16 | 8.00 | 8.56 | 15.89 | 0.92 | 20.59 | - | 3.00 | 10.21 | 5.52 |
| | | 90< | 3.21 | 30.82 | 8.00 | 8.56 | 14.65 | 0.89 | 19.43 | - | 3.00 | 9.67 | 5.09 |
| | | **Mean** | 3.68 | - | 8.50 | 9 53 | 17.65 | 1.02 | 22.83 | - | 3.00 | 10.99 | 5.85 |
| 12 | 15 | 0-30 | 2.11 | - | 4.00 | 6.00 | 10.30 | 0.80 | 11.93 | - | 4.00 | 5.17 | 4.60 |
| | | 30-60 | 1.85 | 12.32 | 3.50 | 5.00 | 9 20 | 0.80 | 9.67 | - | 4.00 | 4.83 | 4.47 |
| | | 60-90 | 1 64 | 22.27 | 3.00 | 4 50 | 8.21 | 0.69 | 8.95 | - | 3.00 | 4.45 | 4.23 |
| | | 90< | 1 45 | 31.28 | 2.54 | 3.80 | 7.59 | 0.57 | 7.13 | - | 3.00 | 4.00 | 4.26 |
| | | **Mean** | 1.76 | - | 3.26 | 4.83 | 8.83 | 0 72 | 9.42 | - | 3.50 | 4.61 | 4.39 |

R.D=Relative decrease.

(31.72 C° ) compared with that of Balttim (25.68C° ) and Edko (20.40 C° ). The relative decrease (RD %) in the EC values with depth varied widely according to the studied area, soil depth and the distance from the lakes . The highest values of RD (%) were found between surface (0-30 cm) and subsurface (30-60 cm) layers (Tables 2-4 ) . The arrangement of the studied areas according to the mean values of RD(%) of EC was Balttim >Edko >El-Fayoum . This trend was attributed to the high rate of soluble leaching from upper layers to deeper one (Bahlawan , 1997 and Abou Hussien & Abou El-Khir,1999) . The obtained results are in agreement with those obtained by Ibrahim (2001); El-Sanat (2003) and Shaban (2005). Based on EC values and according to National Soils Handbook 430,VI (1983),except the soil profiles number 8,11 and 12, the studied soil samples of other profiles can be classified as saline soils (Table 5). The dominant soluble cation in the studied soil samples was $Na^+$ followed by $Mg^{2+}$or $Ca^{2+}$, while the dominant anion was $Cl^-$ followed by $SO_4^{2-}$ (Tables 2 - 4) .

**TABLE 5. Classification of the studied soil samples according to EC, pH and ESP.**

| Distance from lake (km) | Soil depth (cm) | El-Fayoum | | | Balttim | | | Edko | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | EC dS/m | pH (1:2.5) sus. | ESP | EC dS/m | pH (1:2.5) sus. | ESP | EC dS/m | pH (1:2.5) sus. | ESP |
| 1 | 0-30 | Saline | Saline | Sodic | Saline | Saline | Sodic | Saline | Saline | Sodic |
| | 30-60 | Saline | Saline | Sodic | Saline | Saline | Sodic | Saline | Saline | Sodic |
| | 60-90 | Saline | Saline | Sodic | Saline | Saline | Sodic | M. saline | Sodic | Sodic |
| | 90< | Saline | Saline | Sodic | Saline | Saline | Sodic | M saline. | Sodic | Sodic |
| | **Mean** | Saline | Saline | Sodic | Saline | Saline | Sodic | S.saline | Sodic | Sodic |
| 5 | 0-30 | Saline | Saline | Sodic | Saline | Saline | Sodic | S. saline | Saline | Sodic |
| | 30-60 | Saline | Saline | Sodic | Saline | Saline | Sodic | M. saline | Saline | Sodic |
| | 60-90 | Saline | Saline | Sodic | Saline | Saline | Sodic | M. saline | Saline | Sodic |
| | 90< | - | - | Sodic | M. saline | Saline | Sodic | M. saline | Saline | Sodic |
| | **Mean** | Saline | Saline | Sodic | Saline | Saline | Sodic | M. saline | Saline | Sodic |
| 10 | 0-30 | Saline | Saline | Sodic | V.S. saline | Saline | Sodic | S. saline | Saline | Sodic |
| | 30-60 | Saline | Saline | Sodic | V.S. saline | Saline | Sodic | V.S.saline | Saline | Sodic |
| | 60-90 | Saline | Saline | Sodic | V.S. saline | Saline | Sodic | V.S.saline | Saline | Sodic |
| | 90< | Saline | Saline | Sodic | N. saline | Saline | Sodic | V.S.saline | Saline | Sodic |
| | **Mean** | Saline | Saline | Sodic | V.S. saline | Saline | Sodic | V.S.saline | Saline | Sodic |
| 15 | 0-30 | Saline | Saline | Sodic | V.S. saline | Saline | Sodic | V.S.saline | Saline | Sodic |
| | 30-60 | M. saline | Saline | Sodic | N. saline | Saline | Sodic | N. saline | Saline | Sodic |
| | 60-90 | M. saline | Saline | Sodic | N. saline | Saline | Sodic | N. saline | Saline | Sodic |
| | 90< | - | - | Sodic | N. saline | Saline | Sodic | N. saline | Sodic | Sodic |
| | **Mean** | M. saline | Saline | Sodic | N. saline | Saline | Sodic | N. saline | Saline | Sodic |

According to National Soils Handbook 430. VI., (1983) and U.S. Salinity lab. (1954).
M. saline = Moderatly saline. S. saline = Slightly saline.
V.S. saline = Very slightly saline . N. saline = None saline.

The highest content of both soluble cations and anions was found in the soil samples of El-Fayoum , whereas the lowest content was found in the Edko soil samples. Also , the content of soluble ions tended to decrease with increasing soil depth and the distance from the lake shoreline .This decrease was more pronounced in Edko soil profiles (Bahlawan, 1997; Ibrahim, 2001; Mohamed, 2002 and Shaban , 2005) .

Regarding to the calculated values of SAR (SAR $_{cal}$) of the studied soil samples as presented in Tables (2 - 4 ), it can be noticed that , except the profiles Nos. 7 and 8, the studied soil samples were characterized by high values of SAR which resulted from the high content of soluble $Na^+$ in these samples . The arrangement of the studied areas based on their SAR values and its relation with both soil depth and the distance from the lake shoreline were followed the same trend which found with soluble $Na^+$ . Similar results were found by Mohamed (2002) .

The pH values of the studied soil samples ranged between 7.8 to 8.8 (Tables, 6 to 8). The high pH values were found in Edko soil samples followed by those of El-Fayoum soil samples. In all studied soil profiles , pH values tended to increase with increasing soil depth which may be resulted from the high content of soil organic substances in the surface layers ( Mohamed, 2002 ). Un clear trend was observed between soil pH and the distance from the lakes in the studied areas.Most of the studied soil samples were classified as saline –sodic soils, where the values of ECe and ESP were > 12 dsm$^-$ and > 15, respectively, as well as pH values were less than 8.5 (Table 5). Ahmed & El- Taweil (1993)and Bahlawan (1997) obtained on similar results. The studied soil samples characterized by low content of organic matter, where it ranged from 0.61 to 2.80% (Tables 6 to 8 ). According to the content of organic matter, the studied areas take the following order :Edko > Balttim > El- Fayoum . This trend may be related with the soil content of basic ions ($Na^+$), which resulted in more dissolved of soil organic matter (Stevenson, 1994). The soil content of organic matter tended to decrease with increasing soil depth as well as its content was not related with the distance from the lake shoreline (Bahlawan, 1997and Mohamed,2002) . The data also showed that ,the content of $CaCO_3$ % in the soils under study ranged between 0.50 and 3.37 % ,where the studied areas take the order of El-Fayoum > Edko >Balttim according to their content of $CaCO_3$ % . The relationships between the content of $CaCO_3$ and both soil depth and the distance from the lake shoreline had no specific trend. Anter (2000) and Mohamed (2002) obtained on the similar results .

The CEC values of the studied soil samples ranged between 28.69 and 58.49 (Tables 6 to 8) . These values were more related with the soil content of clay and organic matter hense the relationship between CEC and the distance from the lake had no specific trend . The highest values of CEC were found in the samples of Edko soil followed by those of Balttim soils . Anter (2000) and Ibrahim (2001) found similar results . In all studied soil samples , the dominant exchangeable cations were $Na^+$ and / or $Mg^{2+}$ followed by $Ca^{2+}$ . The relationship between the content of exchangeable cations and either soil depth or distance from the lake in the three studied areas was almost similar with that found with CEC. Also , the data in Tables (6 to 8 ) show that , the values of ESP varied widely and ranged between 23.51 and 43.46 %. The arrangement of the studied soils at the investigated areas based on their ESP values was taken the descending order : El-Fayoum >Edko >Balttim . The values of ESP had no specific trend with the distance from the lake. The data in Table (5) show that , the studied soil samples were classified as sodic soils where their values of ESP were more than 15 %. These results may be due to the high content of soluble $Na^+$ in these soil samples. Abo Soliman *et al.* (1992) ; Anter (2000) and El- Sanat (2003) obtained on the similar results . Concerning the values of EMgP, it can be noticed that , the values of EMgP were higher than those of ESP as well as higher than 30 %, which caused a deterioration effect on the soil physical properties . These results are similar with those found by Tayel (1981) and Dosoky (1999). In this consern, Saffan & Mourad (1986) showed that, $Na^+$ is the dominant soluble cations in the cultivated soil near Burollus lake, while $Mg^{2+}$ is the dominant exchangeable cation . These results were more attributed to the wash out of Na- salts and hence reduction of ESP in the cultivated soils .

**TABLE 6. Soil pH, CEC, exchangeable cations, ESP, EMgP and the contents of organic matter and $CaCO_3$ % of soil samples of El-Fayoum area .**

| Profile No. | Distance from Lake (km) | Soil depth (cm) | pH (1:2.5) sus. | OM % | $CaCO_3$ % | CEC (c mol/ kg soil) | Exchangeable cations (c mol/kg soil) | | | | ESP | EMgP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Ca^{+2}$ | $Mg^{+2}$ | $Na^+$ | $K^+$ | | |
| 1 | 1 | 0-30 | 8.1 | 2.13 | 3.37 | 42.36 | 8.37 | 12 44 | 17.97 | 3.43 | 42.42 | 29.37 |
| | | 30-60 | 8.2 | 1.52 | 3.28 | 40.74 | 8.21 | 10.81 | 17.65 | 3.39 | 43.32 | 26.53 |
| | | 60-90 | 8.2 | 1.22 | 2.36 | 40.67 | 7.45 | 10.11 | 16.97 | 3.38 | 41.73 | 24.86 |
| | | 90< | 8.3 | 0.91 | 2.68 | 35.32 | 6.63 | 9.75 | 15.35 | 3.17 | 43.46 | 27.61 |
| | | **Mean** | - | 1.45 | 2.92 | 39.77 | 7.67 | 10.78 | 16.99 | 3.34 | 42.73 | 27.09 |
| 2 | 5 | 0-30 | 7.9 | 1.98 | 3.36 | 47.73 | 11.43 | 15.74 | 17.10 | 3.39 | 35.83 | 32.98 |
| | | 30-60 | 8.0 | 1.52 | 2.95 | 43.56 | 10.76 | 13.35 | 15.78 | 3.37 | 36.23 | 30.65 |
| | | 60-90 | 8.2 | 1.37 | 2.27 | 40.64 | 9.35 | 12.23 | 15.54 | 3.22 | 38.24 | 30.09 |
| | | **Mean** | - | 1.62 | 2.86 | 43.98 | 10.51 | 13.77 | 16.14 | 3.33 | 36.77 | 31.24 |
| 3 | 10 | 0-30 | 8.1 | 1.52 | 3.11 | 50.72 | 12.63 | 16 76 | 17.36 | 3.77 | 34.23 | 33.04 |
| | | 30-60 | 8.1 | 1.06 | 2.91 | 49.76 | 13.86 | 15 73 | 16.65 | 3.50 | 33.46 | 31.61 |
| | | 60-90 | 8.2 | 1.22 | 2.52 | 44.87 | 12.59 | 14.56 | 14.19 | 3.33 | 31.63 | 32.45 |
| | | 90< | 8.2 | 0.61 | 2.41 | 38.46 | 10.09 | 11.29 | 13.65 | 3.03 | 35.49 | 29.36 |
| | | **Mean** | - | 1.10 | 2.74 | 45.95 | 12.29 | 14.59 | 15.46 | 3.41 | 33.70 | 31.62 |
| 4 | 15 | 0-30 | 8.0 | 1.52 | 2.99 | 49 72 | 12.81 | 15.96 | 17.06 | 3.39 | 34.31 | 32.10 |
| | | 30-60 | 8.1 | 1.06 | 2.91 | 45.48 | 12 43 | 13.85 | 15 73 | 3.36 | 34.59 | 30.45 |
| | | 60-90 | 8.2 | 1.06 | 2.66 | 39.72 | 10 74 | 11.37 | 13.98 | 3.21 | 35.20 | 28.63 |
| | | **Mean** | - | 1.21 | 2.85 | 44.97 | 11.99 | 13.73 | 15.59 | 3.32 | 34.70 | 30.39 |

**TABLE 7. Soil pH, CEC, exchangeable cations, ESP, EMgP and the content of organic matter and $CaCO_3$ % of soil samples of Balttim area .**

| Profile No. | Distance from Lake (km) | Soil depth (cm) | pH (1:2.5) sus. | OM % | $CaCO_3$ % | CEC (c mol/ kg soil) | Exchangeable cations (c mol/kg soil) | | | | ESP | EMgP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Ca^{+2}$ | $Mg^{+2}$ | $Na^{+}$ | $K^{+}$ | | |
| | | 0 - 30 | 8.1 | 2.13 | 1.25 | 58.49 | 15.31 | 20.38 | 17.92 | 4.75 | 30.64 | 34.84 |
| | | 30 - 60 | 8.2 | 1.67 | 1.00 | 50.68 | 14.69 | 17.19 | 14.13 | 4.47 | 27.88 | 33.92 |
| 5 | 1 | 60 - 90 | 8.2 | 1.52 | 0.83 | 38.27 | 10.78 | 11.57 | 11.65 | 3.97 | 30.44 | 30.23 |
| | | 90 < | 8.3 | 1.06 | 0.67 | 35.69 | 9.96 | 11.34 | 10.95 | 2.94 | 30.68 | 31.77 |
| | | Mean | - | 1.60 | 0.94 | 45.78 | 12.69 | 15.12 | 13.66 | 4.03 | 29.91 | 32.69 |
| | | 0 - 30 | 8.0 | 1.98 | 1.00 | 50.98 | 15.99 | 16.46 | 13.51 | 4.72 | 26.50 | 32.29 |
| | | 30 - 60 | 8.3 | 1.83 | 0.92 | 47.26 | 14.57 | 15.31 | 12.64 | 4.54 | 26.75 | 32.40 |
| 6 | 5 | 60 - 90 | 8.3 | 1.67 | 0.58 | 35.43 | 10.97 | 11.58 | 8.33 | 4.34 | 23.51 | 32.68 |
| | | 90 < | 8.4 | 0.91 | 0.50 | 28.69 | 7.44 | 10.26 | 7.13 | 3.75 | 24.85 | 35.76 |
| | | Mean | - | 1.60 | 0.75 | 40.59 | 12.24 | 13.40 | 10.40 | 4.34 | 25.40 | 33.28 |
| | | 0 - 30 | 8.0 | 2.74 | 1.67 | 56.33 | 15.26 | 17.43 | 19.08 | 4.31 | 33.87 | 30.94 |
| | | 30 - 60 | 8.2 | 1.43 | 1.00 | 48.51 | 14.85 | 15.73 | 13.60 | 4.03 | 28.04 | 32.43 |
| 7 | 10 | 60 - 90 | 8.3 | 1.28 | 1.17 | 36.97 | 10.52 | 11.39 | 11.00 | 4.02 | 29.75 | 30.81 |
| | | 90 < | 8.3 | 1.13 | 1.17 | 33.89 | 9.67 | 10.96 | 9.22 | 3.74 | 27.21 | 32.34 |
| | | Mean | - | 1.65 | 1.25 | 43.93 | 12.58 | 13.88 | 13.23 | 4.03 | 29.72 | 31.63 |
| | | 0 - 30 | 7.8 | 2.13 | 1.17 | 52.86 | 15.00 | 18.17 | 15.58 | 3.91 | 29.47 | 34.37 |
| | | 30 - 60 | 7.9 | 1.52 | 0.83 | 50.97 | 14.36 | 17.62 | 15.15 | 3.72 | 29.72 | 34.57 |
| 8 | 15 | 60 - 90 | 8.1 | 1.38 | 0.58 | 44.59 | 12.75 | 14.47 | 13.64 | 3.59 | 30.59 | 32.45 |
| | | 90 < | 8.3 | 1.22 | 0.58 | 40.74 | 11.93 | 13.29 | 12.00 | 3.50 | 29.46 | 32.62 |
| | | Mean | - | 1.56 | 0.79 | 47.29 | 13.51 | 19.09 | 14.09 | 3.68 | 29.81 | 33.50 |

**TABLE 8. Soil pH, CEC, exchangeable cations, ESP, EMgP and the content of organic matter and $CaCO_3$ % of soil samples of Edko area .**

| Profile No. | Distance from Lake (km) | Soil depth (cm) | pH (1:2.5) sus. | OM % | $CaCO_3$ % | CEC (c mol/kg soil) | Exchangeable cations (c mol/kg soil) | | | | ESP | EMgP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Ca^{+2}$ | $Mg^{+2}$ | $Na^{+}$ | $K^{+}$ | | |
| | | 0 - 30 | 8.3 | 2.13 | 0.67 | 52.53 | 15.41 | 18.57 | 14.00 | 4.53 | 26.65 | 35.35 |
| | | 30 - 60 | 8.4 | 1.67 | 0.67 | 44.85 | 13.97 | 14.63 | 11.85 | 4.24 | 26.42 | 32.62 |
| 9 | 1 | 60 - 90 | 8.6 | 1.52 | 0.59 | 39.73 | 11.34 | 13.81 | 10.34 | 3.94 | 26.03 | 34.76 |
| | | 90 < | 8.8 | 1.06 | 0.59 | 35.59 | 10.96 | 11.68 | 9.63 | 3.00 | 27.06 | 32.82 |
| | | Mean | - | 1.60 | 0.63 | 43.18 | 12.92 | 14.67 | 11.46 | 3.93 | 26.54 | 33.89 |
| | | 0 - 30 | 8.0 | 1.98 | 1.43 | 48.34 | 12.79 | 16.43 | 14.65 | 4.32 | 30.31 | 33.99 |
| | | 30 - 60 | 8.1 | 1.83 | 1.26 | 41.18 | 10.32 | 12.95 | 13.52 | 4.04 | 32.83 | 31.45 |
| 10 | 5 | 60 - 90 | 8.2 | 1.67 | 1.18 | 37.75 | 9.97 | 11.63 | 12.14 | 3.71 | 32.16 | 30.81 |
| | | 90 < | 8.2 | 0.91 | 1.18 | 33.29 | 8.33 | 10.75 | 10.75 | 3.36 | 32.29 | 32.29 |
| | | Mean | - | 1.60 | 1.26 | 40.14 | 10.35 | 12.94 | 12.77 | 3.86 | 31.90 | 32.14 |
| | | 0 - 30 | 8.0 | 2.74 | 1.43 | 47.67 | 12.43 | 16.31 | 14.46 | 4.08 | 30.27 | 34.21 |
| | | 30 - 60 | 8.2 | 1.43 | 1.01 | 42.77 | 9.65 | 15.27 | 13.43 | 4.06 | 31.40 | 35.70 |
| 11 | 10 | 60 - 90 | 8.4 | 1.28 | 0.83 | 38.88 | 8.93 | 13.69 | 12.61 | 3.42 | 32.43 | 35.21 |
| | | 90 < | 8.4 | 1.13 | 0.67 | 31.60 | 6.18 | 10.35 | 11.73 | 3.18 | 37.12 | 32.75 |
| | | Mean | - | 1.65 | 0.99 | 40.23 | 9.30 | 13.91 | 13.06 | 3.69 | 32.81 | 34.47 |
| | | 0 - 30 | 8.3 | 2.13 | 1.25 | 46.44 | 11.02 | 16.21 | 14.24 | 4.75 | 30.66 | 34.91 |
| | | 30 - 60 | 8.4 | 1.52 | 1.17 | 40.24 | 10.73 | 12.50 | 12.54 | 4.36 | 31.16 | 31.06 |
| 12 | 15 | 60 - 90 | 8.4 | 1.38 | 1.08 | 36.96 | 10.03 | 11.66 | 11.37 | 3.79 | 30.76 | 31.55 |
| | | 90 < | 8.5 | 1.22 | 1.08 | 30.84 | 8.57 | 9.42 | 9.56 | 3.09 | 31.00 | 30.55 |
| | | Mean | - | 1.56 | 1.15 | 38.62 | 10.09 | 12.45 | 11.93 | 4.00 | 30.90 | 32.02 |

*The statistical measures for soil salinity and soluble sodium*

This chapter was suggested to answer the question of the possibility of applying the statistical measures, *i.e.*, weighed mean, (W) trend (T) and specific range(R )which defined by Oertal & Gilles (1963) for both total soluble salts and soluble $Na^+$. The contents of both total soluble salts (EC in $dSm^{-1}$) and soluble $Na^+$ in meq/L were calculated as mg/ kg and the obtained values were used to calculate the statistical measures of W, T and R using the same equations which applied with the trace elements. The obtained values of these statistical measures of total soluble salts and soluble $Na^+$ were recorded in Table 9. The data show that, the high content of total soluble salts and soluble $Na^+$ were found in the surface layers. of all studied soil profiles. Also, these values tended to decrease with increasing the distance from the lakes shoreline. The high values of W of both total soluble salts and soluble $Na^+$ were found in the soil profiles of El-Fayoum followed by that found in Balttim soils. This order was confirmed with that found and prementained with the absolute values of total soluble salts as $dSm^{-1}$ and soluble $Na^+$ as meq/L.

Regarding the calculated values of T (Table 9), it can be noticed that, there is a symmetrical distribution of both total soluble salts and soluble $Na^+$, with a more symmetrical distribution for total soluble salts in most studied soil profiles. Soil profile No.1.

**TABLE 9. Weighed mean (W),trend (T) and specific range (R) of total soluble salts and soluble sodium in the studied soil profiles .**

| The studied area | Profile No. | Distance from lake(km) | Total soluble salts | | | Soluble sodium | | |
|---|---|---|---|---|---|---|---|---|
| | | | W | T | R | W | T | R |
| El-Fayoum | 1 | 1 | 20152.00 | -0.11 | 0.19 | 4560.10 | -0.09 | 0.15 |
| | 2 | 5 | 13856.00 | 0.20- | 0.36 | 3251.43 | -0.20 | 0.35 |
| | 3 | 10 | 10896.00 | -0.29 | 0.55 | 2605.27 | -0.30 | 0.56 |
| | 4 | 15 | 6805.33 | -0.33 | 0.56 | 1472.38 | -0.31 | 0.54 |
| Balttim | 5 | 1 | 11094.40 | -0.45 | 0.77 | 2577.55 | -0.48 | 0.78 |
| | 6 | 5 | 9024.00 | 0.39 | 0 68 | 1913 89 | -0.48 | 0.81 |
| | 7 | 10 | 2985 60 | -0.35 | 0.68 | 414.75 | -0.36 | 0.79 |
| | 8 | 15 | 1668.80 | -0 43 | 0 71 | 231 67 | -0 51 | 0.81 |
| Edko | 9 | 1 | 8113 60 | -0 38 | 0 77 | 1535.14 | 0.51- | 1.01 |
| | 10 | 5 | 6137 60 | -0.43 | 0.68 | 1287.31 | -0.44 | 0.69 |
| | 11 | 10 | 2356.80 | -0.26 | 0.39 | 330.26 | 0.61- | 0.59 |
| | 12 | 15 | 1128.00 | --0.20 | 0.38 | 202.98 | -0 18 | 0.31 |

at El-Fayoum area exhibited a more symmetrically distribution of total soluble salts and $Na^+$, while the less symmetrically distribution was found in soil profile No. 5 at Balttim area.The soil profiles of Edko represented the intermediate case . The less symmetrically distribution of soluble $Na^+$ was found in the soil profile No. 11 at Edko area.

The values of specific range (R) as recorded in Table 9 showed that, the studied soil profiles represented the studied three areas (El-Fayoum, Balttim and Edko) were composed and formed from homogenous materials. These results were emphasized by the relatively low values of R for total soluble salts and soluble $Na^+$.

From the previous discussion of W, T and R for both total soluble salts and soluble $Na^+$, it could be concluded that these statistical measures gave a similar trend or criterion as suggested from the same measures of trace elements,(Ahmed,2005). Moreover, this technique by using the determination of both total soluble salts and soluble $Na^+$ was more reliable, easily and less expensive as compared with the determination of the trace elements .

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# تحديد مدى تجانس القطاع الأرضى في بعض المناطق المتأثرة بالأملاح في مصر

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أجريت هذه الدراسة على بعض الأراضى المتأثرة بالأملاح والمتاخمة لبحيرات قارون ، البرلس ، ادكو - مصرلأستبيان مدى تجانس القطاع الأرضى بأستخدام بعض المقاييس الإحصائية على كل من الأملاح الكلية الذائبة والصوديوم الذائب وهى المتوسط الموزون و الاتجاة والمدى النوعى . وقد أخذ من كل منطقة أربعة قطاعات على ابعاد ١ ،٥ ، ١٠ ، ١٥ كم من شاطىء البحيرة ،كما أخذ من كل قطاع عينات مثارة على أعماق ٠-٣٠، ٣٠-٦٠ ، ٦٠-٩٠ ، > ٩٠ سم وتم تحليل العينات لتقدير محتواها من الأملاح الكلية الذائبة والأيونات الذائبة ورقم الحموضة والسعة التبادلية الكاتيونية و الكاتيونات المتبادلة والمادة العضوية وكربونات الكالسيوم .

وتشير النتائج المتحصل عليها الى أن القطاعات الأرضية تحت الدراسة ذات محتوى مرتفع من الأملاح الكلية الذائبة و الأيونات الذائبة وتميل قيمها للانخفاض بزيادة العمق و البعد عن البحيرات وقد كانت قيم المحتوى من الأملاح الكلية الذائبة و الأيونات الذائبة أعلى بدرجة محسوسة في عينات أراضى الفيوم (بحيرة قارون) يليها فى ذلك عينات أراضى بلطيم(بحيرة البرلس) وأراضى ادكو (بحيرة ادكو). ولقد تراوحت قيم الرقم الأيدروجينى للتربة ما بين ٧,٨ ، ٨,٨ وأن الكاتيونات المتبادلة السائدة تتمثل فى الصوديوم والماغنسيوم وقد تراوحت قيم السعة التبادلية الكاتيونية ما بين ٢٨,٦٩، ٥٨,٤٩ سى مول/كجم تربة وكان محتوى العينات من المادة العضوية و كربونات الكالسيوم منخفض نسبياً" مع تناقص نسبتهما بزيادة العمق. و كانت العلاقة بين كل من قيم السعة التبادلية الكاتيونية وكلا المحتوى من المادة العضوية أو كربونات الكالسيوم بالأضافة للبعد عن البحيرات لا تأخذ اتجاه محدد .

ولقد أوضحت نتائج المتوسط الموزون ارتفاع محتوي عينات الأراضى تحت الدراسة من الأملاح الكلية الذائبة و الصوديوم الذائب ،مع ميل قيمهما للتناقص بزيادة العمق و البعد عن البحيرات.وكذلك أوضحت قيم الاتجاه وجود تجانس كبير في توزيع الأملاح الكلية الذائبة و الصوديوم الذائب فى القطاع الأرضى . كما أوضحت قيم المدى النوعى وجود تجانس لمادة الأصل التى تتكون منها قطاعات الأراضى تحت الدراسة فى كل من المساحات المدروسة لكل منطقة.