Influence of Land Use in Some Quseir Shale Derived Soils in Dakhla and Kharga Oasis, Egypt

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Four soil profiles have been selected from virgin Quseir shale, in Balat village at Dakhla oasis and Bedkhlo village at Kharga oasis. Another four cultivated profiles with field crops and/or vegetables, through about 25 years, from the same areas have been sampled.

Texture analysis, total and type of salts, O.M., CaCO₃, gypsum and trace elements status (Fe, Mn, Zn and Cu) have been determined. Field observations and analytical analyses proved that distinct changes have occurred on this shale derived soils. The Halic Haplotorrets have been developed to Typic Haplotorrets in certain locations. Total soluble salts are higher in the virgin shales compared with the cultivated sites. The DTPA extractable trace elements from the cultivated shales were higher than those of the virgin shales, with the exception of Zn in virgin shale (profile no. 3). Zn and Cu represent the co-precipitate with Fe and Mn oxides, which are higher in cultivated shale particularly in the surface layers. Surface horizons included more DTPA-extractable trace elements due to the enrichment with organic residues and chemical fertilizers additions in cultivated shales. The amorphous MnO (Mn-DCB extracts) are high in virgin shales, while there is no difference between Fe₂O₃ (Fe-DCB extracts) contents in both types of shales.

Keywords: Virgin and cultivated Quseir Shale, Egypt. Extractable trace elements, Amorphous oxides.

The objective of this study is to show the influence of land use for about 25 years on the development of Quseir shales in The New Valley and their content of available trace elements.
Ageeb (1999) studied the distribution and characteristics of different shale deposits in Egypt and concluded that there are nine types of shales distributed over approximately 41,484 km² of Egypt mostly at the western desert and some parts of eastern desert. Quseir Formation cover about 3,137 km², from the previous area, which mostly located in Dakhla, Kharga oasis and Idfu at Aswan.

Said (1990) reported that these Quseir shales were formed after deposition of Campanion deposits, which covers most of the upland along Dakhla and Kharga oasis. Quseir shale is believed to have deposited during the Campanion epoch, approximately 84-74 million yr. Soils formed in the Quseir sediment, therefore are older than 74 million yr.

The distribution of Fe, Mn, Zn and Cu in alluvial profiles in Haryana (India) were studied by Kudeep et al. (1990). They found that available Fe, Mn and Zn were high in the surface horizons and decreased with depth, while Cu showed no regular distribution pattern. Labib and Rahim (1998) compared the content of Fe, Mn, Zn and Cu in virgin and cultivated salt affected soils and they concluded that total Fe and B are higher in the saline soils. While total Zn and Cu showed reverse trend as they have higher concentration in the reclaimed soils, total Mn had a limited increase in the cultivated soils compared to the virgin saline soils.

Material and Methods

Four soil profiles (from no.1 to 4) representing virgin shale deposits from the following locations: Balat village, Bedkhulo village at Dakhla oasis, Kharga district and El-Sherka Waheed at Kharga oasis, respectively. Another four profiles (from no. 5 to 8) have been sampled from the same areas under cultivation for about 25 years with: maize, tomato, rice and date palm, respectively (Fig. 1). Also four water wells samples representing the study areas were collected.

The representative profiles were described in the field according to FAO guidelines (1990). The collected samples were subjected to the following determinations according to USDA (1991).

Grain-size distribution and texture class, soil reaction (pH) of soil-water suspension (1:2.5), EC (dSm⁻¹) and ion species concentration of soil paste.
Results and Discussion

The virgin shale profiles were lacking to any natural vegetation. The morphological criteria of the profiles are recorded in Table 1. The studied sites

have a deep profile (>150cm). The differentiation of profile layers is not an easy task and subdivisions are largely based on variations in structure and/or colour. Therefore, A/C horizon sequence is most common in virgin shales. Concerning soil colour, most profiles have 2.5 YR hue, value between 3 and 7, and chroma between 4 and 8. The cultivated profile (no. 6) have a 5 YR hue, value 7 and chroma 3 to 5. Also, the surface layer of two virgin profiles (no. 1 and 4) and the surface layer of the cultivated profile (no.8) have the same hue degree with different value and chroma degrees, under dry conditions. Variegated colour that is predominant in Quseir Formation is present in the subsurface layer of virgin shale (profile no.2). Mottling characteristics produce olive or brownish patches of different sizes due to iron and manganese status, and its content. The structure of these virgin and cultivated shales is generally coarse subangular blocky and/or blocky. Prismatic structure is present only as subsurface layer of the virgin shales (profile no.3) and not present in the cultivated shales. Virgin shales were very hard and hard in dry conditions and some layers were slightly hard. The opposite is present with the cultivated shales where the dominant consistence is slightly hard and some layers was hard. Boundary of the surface layers was clear and diffuse in the virgin shales and gradual in maize profile (no.5) and tomato profile (no.6), clear in rice profile (no.7) and diffuse in date palm profile (no.8).

Data in Table 2 indicate that total soluble salts in these profiles range between 2.23 and 18.0 dS/m in the surface layer of profile 4 in Bedkhulo at Dakhla oasis.

According to USDA soil taxonomy (Soil Survey Staff, 1999), profiles No.1, 2 and 3 are classified as Typic Haplortherts, profile no.4 at Bedkhulo, the salt content is between 8.0 to 18.0 dS/m which satisfy the requirements of Halic Haplortherts.

The various management practices have been carried out on some areas of virgin shale derived soils at Balat, Bedkhulo, Kharga district and El-Sherkkaa Waheed at Dakhla and Kharga oasis. Those areas have been cultivated for about 25 year with crops such as rice (limited areas were grown with rice for the local consumption), maize and vegetables (tomatoes and potatoes). The morphological features of these profiles show the formation of the plough layer Ap as a result of continuous cultivation, rich with root and plant residues and decomposed organic materials. The boundaries between horizons are gradually/or clear wavy or irregular. Diffuse smooth boundary is also present. The profiles are deep (>150cm) and moderately drained.

TABLE 1. Morphological criteria of the studied Quseir shale.

<table>
<thead>
<tr>
<th>Profile No.</th>
<th>Horizon</th>
<th>Depth (cm)</th>
<th>Meaned colour (dry)</th>
<th>Texture</th>
<th>Dry consistence</th>
<th>Lower boundary</th>
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<td>H</td>
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<td>30-70</td>
<td>2.5YR 7/6</td>
<td>C</td>
<td>a</td>
<td>Sh</td>
</tr>
<tr>
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<td>C2</td>
<td>70-150</td>
<td>2.5YR 6/6</td>
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<td>b</td>
<td>Vh</td>
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<td>Vh</td>
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<td>50-90</td>
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<td>Vh</td>
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<td>Vh</td>
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<tr>
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<td>C</td>
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</tr>
</tbody>
</table>

* Texture abbrev. C = clay
* Structure abbrev.: m=massive; sb=subangular blocky; b=blocky; p=prismatic
* Dry consistence abbrev.: sh=slightly hard; h=hard; vh=very hard
* Lower boundary abbrev.: a=abrupt; c=clear; g=gradual; s=smooth; w=wavy; i=irregular; d=diffuse (FAO 1990).
* Profiles no. 5, 6, 7 and 8 are cultivated with maize, tomato, rice and date palm, respectively.
TABLE 2. Selected chemical properties of the studied virgin and cultivated profiles.

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<tr>
<th>Levels</th>
<th>Base</th>
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<th>Silt %</th>
<th>Clay %</th>
<th>OC/ %</th>
<th>N/C</th>
<th>EC/dm</th>
<th>pH</th>
<th>CaCO_3</th>
<th>% Water</th>
<th>OM %</th>
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The chemical properties (Table 2) indicate that pH values of virgin profiles are slightly higher than the corresponding values of the cultivated profiles. The lower values of pH are associated with the presence of gypsum (p.8).

The cultivated profiles have a relatively low content of soluble salts (from 0.8 to 4.7 dS/m). The distribution of salts by depth was heterogeneous, as salts accumulated in Cl and/or C2 due to imperfect drainage (profiles no.5, 6 and 8).

The heavy clay texture and massive structure at the soil surface followed by subangular blocky structure characterize the cultivated profiles at Kharga district and El-Sherka Waheed. The surface horizon Ap is relatively high in organic matter content.

The only source of irrigation water in the New-Valley is the wells. The chemical analysis of this irrigation water of the four tested wells (Table 3) shows that they contain low content of soluble salts (< 1.0 dS/m). The soluble iron range between 88.5-105.2 ppm. Irrigation water have high soluble iron coupled with low pH value (6.72) in Balat followed by Bedkhulo well water as 6.94.

**TABLE 3. The chemical composition of the tested well water.**

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<th>Well</th>
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<th>K(^+)</th>
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<th>Mg(^{2+})</th>
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<th>CO(_3)</th>
<th>Cl</th>
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<tr>
<td>Kharga</td>
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<td>0.71</td>
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<td>0.20</td>
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<tr>
<td>Bedkhulo</td>
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<td>1.00</td>
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<td>0.80</td>
<td>0.50</td>
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<td>0.80</td>
<td>101.80</td>
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<tr>
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<td>1.10</td>
<td>0.10</td>
<td>1.00</td>
<td>0.50</td>
<td>0.10</td>
<td>1.60</td>
<td>1.00</td>
<td>105.20</td>
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</tr>
</tbody>
</table>

The soluble iron is oxidized after short time and precipitates as ferric oxides, hydroxides and sulphates. The morphology of surface and subsurface horizons of cultivated profiles having rusty mottles. However, the cultivated profiles have been strongly affected by iron compounds coming from irrigation water. Therefore, these profiles can be classified as Entic Haplotorrets. Profile no.7 at Kharga district satisfy the requirements of Typic Haplotorrets.

Changes in trace elements status (Table 4) show the available form of trace elements in virgin profiles compared to the cultivated sites. The obtained values of available Fe are exceptionally higher in the cultivated profiles, which may be due to the irrigation water as it is rich in that component which is easily precipitated in high amounts at the surface.

Available form of Zn and Cu (as DTPA extract) showed the same trend in the virgin profiles and cultivated profiles. Zn is exceptionally higher in cultivated...
profiles (P.5 and 6). The addition of agrochemical which contains Zn through cultivation practices, is the main cause of this increase. Concerning the available Mn, a limited increase in the cultivated profiles compared to the virgin profiles is occurred.

TABLE 4. The DTPA-extracted trace elements in virgin and cultivated profile (mg/kg).

<table>
<thead>
<tr>
<th>Profile No.</th>
<th>Virgin Depth</th>
<th>Zn</th>
<th>Fe</th>
<th>Cu</th>
<th>Mn</th>
<th>Prof. No.</th>
<th>Cultivated Depth</th>
<th>Zn</th>
<th>Fe</th>
<th>Cu</th>
<th>Mn</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>13.7</td>
<td>3.4</td>
<td>3.9</td>
<td>5</td>
<td>0-20</td>
<td>22.2</td>
<td>20.3</td>
<td>4.0</td>
<td>12.2</td>
</tr>
<tr>
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<td>30-70</td>
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<td>16.5</td>
<td>4.0</td>
<td>4.0</td>
<td></td>
<td>20-50</td>
<td>14.9</td>
<td>15.6</td>
<td>3.9</td>
<td>4.7</td>
</tr>
<tr>
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<td>11.9</td>
<td>3.3</td>
<td>3.4</td>
<td></td>
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<td>3.8</td>
<td>4.5</td>
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<td>0-20</td>
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<td>13.6</td>
<td>3.3</td>
<td>3.4</td>
<td>6</td>
<td>0-20</td>
<td>18.0</td>
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<td>6.4</td>
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<tr>
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<td>11.5</td>
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<td>3.5</td>
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<td>14.3</td>
<td>3.5</td>
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<tr>
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<td>11.0</td>
<td>3.3</td>
<td>3.5</td>
<td></td>
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<td>1.4</td>
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<tr>
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<td>13.2</td>
<td>3.4</td>
<td>3.5</td>
<td></td>
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<td>13.4</td>
<td>3.5</td>
<td>3.5</td>
<td>4.5</td>
</tr>
<tr>
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<td>0-40</td>
<td>14.8</td>
<td>13.9</td>
<td>3.6</td>
<td>4.3</td>
<td>7</td>
<td>0-15</td>
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<td>16.2</td>
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<td>80-120</td>
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<td>12.9</td>
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<td>4.8</td>
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<td>3.4</td>
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</table>

Data in Table 5 of the dithionite-citrate-bicarbonate extraction of Fe and Mn (calculated as Fe₂O₃ and MnO) show that the cultivated profiles contained higher level of Fe₂O₃ and MnO than the virgin profiles. The only source of irrigation water in the study area and New Valley as general is artisan water wells that affects chemically the soil properties.

These soils have been cultivated with some field crops and vegetables and irrigated with iron-rich ground water, which adds great amount of iron components to the surface and subsurface layers (Abd El-Hady, 1995).

TABLE 5. The DCB-extracted trace elements in virgin and cultivated profile (mg/kg).

<table>
<thead>
<tr>
<th>Profile No.</th>
<th>Virgin</th>
<th></th>
<th></th>
<th>Cultivated</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Depth (cm)</td>
<td>Fe$_2$O$_3$</td>
<td>MnO</td>
<td>Depth (cm)</td>
<td>Fe$_2$O$_3$</td>
<td>MnO</td>
</tr>
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<td>0-20</td>
<td>1696.3</td>
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<td>30-70</td>
<td>1375.3</td>
<td>159.1</td>
<td>20-50</td>
<td>1692.2</td>
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<tr>
<td></td>
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<td>1360.5</td>
<td>176.6</td>
<td>50-150</td>
<td>1662.1</td>
<td>172.2</td>
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<tr>
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<td>0-20</td>
<td>1440.7</td>
<td>230.2</td>
<td>0-20</td>
<td>1725.7</td>
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<td>80-90</td>
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<td>1818.4</td>
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<td>60-120</td>
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</tbody>
</table>

Amorphous iron (Fe$_2$O$_3$) ranges between 1304.1 and 2151.9 mg/kg in virgin shale profiles compared with 1696.3 and 2421.3 mg/kg in cultivated shales of the same location. The increase is due to the processes associated with cultivation practices, i.e. ploughing, irrigation at intervals lead to solubility through reduction and oxidation of iron and manganese forms and precipitate as amorphous compounds. This type of shale is rich in total iron as mentioned by Abu Zeid (1974) and associated with the dominating colour (5 YR 7/3, 4, 5 and/or 6).

Conclusion

The results of this study show the changes occurred in Quseir shale due to land use. Cultivated shales have a low soluble salts content comparing with...
virgin shales in the same area due to the leaching effect of irrigation water. For that there are highly promising areas for agricultural investment in the New Valley. Quseir shales at Kharga and Dakhla oasis have a slightly high amount of amorphous iron oxides and available Fe especially in cultivated shales, so that, it is called purple-red soils (Abdel Aal et al., 1988). This amount is correlated well with the chemical composition of artisan irrigation water (cultivated shales) and the initial content of iron in the shales itself (cultivated and/or virgin shales). There is no variation in the available forms of Zn and Cu in both kinds of shales as a general. Concerning the available Mn, a limited increase in the cultivated profiles compared to the virgin profiles occurred.

References


(Received 12/2000)
تأثير الاستخدام الزراعي على بعض الأراضي الطفيلة بالواحات الداخلية والخارجة في مصر

إبراهيم سعيد رحيم و جميل وهيب عجيب
قسم الإراضي واستغلال المياه - المركز القومي للبحوث - القاهرة - مصر

تم اختيار أربع قطاعات أرضية من طفيلة القصير غير منزوعة في الواحات الداخلية والخارجية وأربعة قطاعات أخرى مزوعة بمحاصل الحقل والخضروات لمدة حوالي 25 عام من نفس الأماكن.

أجريت التحليات الأساسية مثل تقدير القوام وكمية ونوع الأملاح الذائبة والمادة العضوية وكربونات الكالسيوم والجبس وكذلك حالة العناصر الصغيرة (الديد - المغنيزي - الزنك والناضج).

وقد بنيت الدراسات الحقلية ونتائج التحليات العملية حدود Halic تغييرات في هذا النوع من الأراضي فقد تطورت أراضي Typic Haplotorrens إلى أراضي Haplotorrens الأملاح الكلية ذاتية كانت عالية في الأراضي البكر بالمقارنة بالأراضي المزوّعة. الصورة المبسطة للعناصر الصغيرة كانت أعلى في الأراضي المزروعة منها في الأراضي البكر. أكاسيد الزنك والنحاس تشتت ون سطح من أكاسيد الحديد والمنجنيز في أنتمرت في الأراضي المزروعة خاصة في الطبقة السطحية. ويرجع ارتفاع الصورة المبسطة للعناصر الصغيرة في الطبقة السطحية إلى غناها ببقايا عضوية وكذلك التسميد الكيميائي. أكاسيد المنجنيز الأموزية كانت عالية في الأراضي البكر بينما لا يوجد فرق بين أكاسيد الحديد الأموزية في كل من النوعين.