

pedological studies bearing on genesis, morphology and classification of soils of wadi el natrun depression

Samira Abdel Gilil Ashmawy

This work aim to identify soil genesis, morphology, classification and evaluation of soils of Wadi El Natrun depression. The studied area is located at the north eastern part of the Western desert between longitudes 30° 00' and 30° 30' East and latitudes 30° 15' and 30° 30' North .The prevailing climate characterized by a long dry summer from April to September and a short warm winter from October to March, with a total annual rainfall about 15.24 mm/day. Soil moisture and temperature regimes were defined as Tonic and Thermic, respectively. Under such climatic conditions natural vegetation is scanty and dominated by some desert shrubs Halophytic namely *Zygophyllum album* and *Sporobolus spicatus* associate highly strongly salt affected. At Wadi El Natrun Depression ,the surface is underlain by both Tertiary and Quaternary sediments, with local outcrops of both basalt and dolomite. These rocks display different litho faces (sand, gravel, sandstone, clay, limestone .etc..) The area embodies mainly of three main geomorphic units, i.e., Modern gravelly plain , Talus slopes and Depression, the latter occupied by (Sand sheets and dunes) and sabkha . Soils of Modern gravelly plain; occupy the upland area in the north portion, an elevation 10 - 50 m. a.s.l. , surface fine and medium gravel, mostly undulating or gently sloping to south. Soils of the Depression; occupy in the central portion of area between the north and south Talus slopes .They cover a rather wide spectrum of altitudes ranging from zero level to (-20 m. a.s.l.). This area is characterized by a series of salt lakes, i.e., El — Fasda, Om El — Risha and El Ruzyna on the southern part, El-Hamra, El Bedia, El —Khadra lakes on in the northern part .Soil surface is almost flat to gently undulating , marked by ripple marks low hummocks of drift sand around few natural vegetation . Sabkha soils occupy low areas near the lakes. Attaining land elevation of about (-19 m. b.s.l.) land surface cover with salt crust, water table exist at 40 to 90 cm and texture is sandy to sandy loam, Soils of Talus slopes ;surrounding the depression from the northern and southern edges ,surface elevation increase gradually from zero (sea level) to about +10m. a.s.l. in the northern direction, while the southern slopes have surface elevation from zero to about 50 m. a.s.l. This geomorphic unit has severely gullies formation, these gullies is ascribed to wet climate previously prevailed. The deposition environments of these soils are ascribed to aeolian , alluvial and lacustrine deposits. To classify such soils from the pedological and capability point of view, twenty four soil profiles were stretching along the studied area to represent the different geomorphological units, and 114 soil samples were collected to represent the morphological variation within the chosen soil profiles. These profiles were described in the field morphologically and representative sample were collected for physical, chemical and mineralogical analyses. Results of soil characteristics as concluded from the current investigation could be outlined in the following :) Morphological characteristics : The morphology of soil profiles of the distinguished landforms indicate that, topography of terrain are almost flat, gently undulating and gently sloping. The studied area is characterized by a cover sandy surface that may be very deep throughout or underlain by loamy or clay subsoil. Water table is mostly very deep within the upland plain or deep to shallow within Wadi El Natrun Depression . Soil texture is coarse or heavier, with a dominant soil structure of single grains or weak massive for sandy soils. The medium (loam) and heavy textures are

characterized by massive broken, to moderate fine to medium subangular blocky for loamy soils, while clay textured horizons have strong medium to coarse subangular blocky. Soil colour (moist) is mostly varying from light yellow orange (2.5Y 7/4) to bright yellow brown (10YR 7/6). However sabkha soils have colour varying from brownish black (7.5Y 2/2) to black (10YR 1.7/1) and lacustrine soils mostly have dark grayish colour (2.5Y 5/2). Dry consistence range from loose to very hard, stickiness and plasticity ranges from non sticky, non plastic with sandy textured to very sticky and very plastic for clay soils. Pedological features are extremely low and take features of soft CaCO₃ nodules, fine red mottles of iron oxides, black mottles of organic matter and fine fragments of sandstone cemented with salts and CaSO₄. Particle size distribution varied widely throughout the respective horizons of the studied soils, which ranged between fine to coarse sand and clay. Some statistical size parameters are also applied to characterize the grain size distribution curves of the respective horizons of soil profiles. The statistical size parameters reveal that soil sediments transported by wind are well sorted, while those of soils developed on the alluvial deposits are poorly sorted. The soils developed on the interference zone are normal sorted, and the skewed are coarse to fine skewed. Soil moisture characteristics, i.e., moisture contents at field capacity (held at 0.1 atmosphere for sandy textured soils and 0.33 atmosphere for medium or fine textured soils, at wilting point held at 15 atmosphere) revealed a close relationship with soil texture. The aforementioned soil moisture concepts are used as criteria for method of irrigation water, irrigation schedule and land evaluation.

1) Chemical characteristics : Soils have low organic matter, this is ascribed to the tonic and thermic soil moisture and temperature regime. Soil organic carbon and total nitrogen tended to increase in cultivated soils, especially in the surface horizons where organic matter ranges from traces to 3 %. CaCO₃ content is generally very low (i.e. < 3 %) except Sabkhas soils that have relatively high amounts of CaCO₃ (9 -17%), ascribed to another parent material relatively more calcareous in nature. Amounts of gypsum throughout profile horizons are generally very low (occurs as few fine soft white segregation, needle like crystals or few concentration), except soils within lacustrine deposits accumulation of gypsum with such soils could be defined as lagoon relicts (i.e. not pedogenic). Soil—pH indicating a neutral to moderately alkaline reaction most of samples have moderately alkaline reaction as pH values laying, the range 7.9 to 8.4. Soils are free or slightly salt affected in cultivated soils and moderately to strongly salt affected soils in virgin area, with shallow water table and maximum accumulation of salts with surface horizons. Soluble salts are mostly dominated by sodium chloride followed by calcium and magnesium sulfate.

Mineralogical analysis : X- ray diffraction patterns of the clay fraction 2 μ separated from soils within Talus slopes and Depression revealed that smectites are the dominant clay minerals, followed by kaolinite and traces of quartz, gypsite and interstratified mica-hydrous mica species found in all layers. Vermiculite was detected in pronounced amounts within 2C horizon (105-145 cm.) of profile No.7 in the Depression unit.

Soil classification: Soils of Wadi El Natrun area classified according to Soil Taxonomy System (Soil Survey Staff, 1975) and Keys to soil taxonomy (Soil Survey Staff, 1998) into two main orders, namely Aridisols and Entisols, which including suborders, great groups and subgroups. The Tatters are also differentiated to families of the system on basis of particle size clay, mineralogy and soil temperature regime. The systematic classification was carried out from the higher categories to the lower soil taxonomic unit (i.e. families), and the main soil subgroups associated are illustrated in the following.

Geomorphic Unit Subgroup Sand Sheets and dunes Typic Haplosalids Gypsic Haplosalids Typic Torripsamments Modern gravelly plain Typic Torripsamments Typic Torriorthents Talus slopes Typic Torripsamments Typic Torriorthents Gypsic Haplosalids Sabkha Aquic Haplocalcids Typic Psammaque soils in Wadi El Natrun Family level Sand, siliceous, thermic Sand, siliceous, thermic Sand, siliceous, thermic Sand, siliceous, thermic Coarse loamy, mixed, thermic Sandy over coarse loamy, mixed, thermic Sand, siliceous, thermic Coarse loamy, mixed, thermic Sandy over fine loamy, mixed, thermic Clay over coarse loamy, smectitic, thermic Coarse loamy, mixed, thermic Sand, siliceous, thermic Coarse loamy, mixed, thermic

5) Land Evaluation: The systems of land capability or suitability classification outlined by FAO (1976) and FAO (1979) are used to Evaluate the studied soils and their limitations as follows : Limitations affected the soils of the area under study include:

- Topography: Severe or very severe limitation throughout the area between Wadi El Natrun and Wadi el Fagrih (Talus slopes),
- Available water

capacity (A.W.C.) Very severe limitation at Talus slopes and within depression, where highly salt affected soils (Sabkhas). AWC is very low range from (5 to 7.5 cm/m and less than 5 c/cm/m), under such conditions non traditional types of irrigation are only suitable (i.e drip or sprinkler irrigation).•Coarse fragments (fine and coarse gravel) are moderate severe limitation at the surface >1'5 % in some profile. •Calcium carbonate and gypsum have no limitation in the studied area. •Drainage at the studied area: Highly salt affected soils of Sabkhas have limitation with regard to both drainage and salinity .The studied area was differentiated in view of type number and degree of agriculture limitations to the following :1. Moderately suitable (S2): Soils within this suitability class have limitations in which aggregate are moderately severe for sustained application of a given use, the limitations well reduce productivity or benefit and increase required inputs to the extent that the overall advantage to be gained from the use .Soils within this capability class are deep ,with sandy clay loam textured and have adequate available moisture capacity(>10 cm/m).Soil salinity ranged between 4 and 8 dSm-l2. Marginally suitable (S3): Soils within this capability class have more limitations, i.e. low available moisture capacity 5 to 8 m/cm for the effective root zone, due to their coarse texture, moderate to severe salinity, surface rock fragments of 15 —35 % in some soil profiles and water table is deep.3. Currently not suitable (N1): These soils may be surmountable in time but they cannot be corrected with existing knowledge at currently acceptable cost . Limitation of land within this class are so severe to sustained use of the land in the given manner. Limitations include shallow water table (40 - 90 cm), very low available water capacity (4 - 6 cm/m), topography soil surface is undulating and is highly enriched with gravel.