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# 5. SUMMARY

The current study are distinguished by including soils of Wadi El-Arish from its springs to its debouchments and so, important tributaries.

The aim of the current study is to evaluate morphological, physical, chemical and mineralogical characteristics soils of Wadi El-Arish in the eastern north of Sinai Peninsula. Addition to some tributaries, which effect on it from pedological aspects. On the other hand, classification and quantitative land evaluation of these soils were also carried out.

So, suitable suggestion could be attained to help in planning the reclamation processes and to understand how to deal with these soils for agricultural use.

The studied area of Wadi El-Arish and its tributaries are located in the eastern north of Sinai, latitudes 29° 50$^{=}$ to 31° 08$^{=}$ N and longitudes 33° 40$^{=}$ to 34° 20$^{=}$ E, and covers an area of about 553660 feddans.

Climatic data indicated that the studied area is classified under a torric or aridic soil moisture regime and hyperthermic soil temperature regimes. The water resources are ground water, rainfall and El-Salaam canal.

Twenty four soil profiles were suited and examined to represent the different characteristics of the studied area.

These profiles were morphologically described, sampled and subjected to the different physical, chemical and mineralogical properties determinations.

The obtained results could be summarized for different representative soil profiles of Wadi El- Arish and its tributaries as follows:

* The soil profiles were dug deep down to 150 cm, morphologically described and sampled. Also, sites characteristics such as topography, slope, elevation, natural vegetation and land use were observed and registered.
* Interpretation and analysis of thematic mapper (TM) landsat image covering the studied area led to identify three geomorphic units in the soils of Wadi El-Arish and its tributaries, as follows:

a) The alluvial terraces unit occupy in north of Wadi El-Arish part, with nearly level to gently undulating topography and few to common natural vegetation and some area was cultivated by wheat and barley. This unit is consists of three classes:

1- The upper terraces 2- The middle terraces

3- The lower terraces.

b) The flood plain unit occupies a considered portion between Nekhal city at the south and El-Arish city at the north, with nearly level and gently undulating topography, few to common natural vegetation, some thin salt crusts, and some small hummocks scattering are occurred.

c) The present channel unit extend from El-Arish city to Awlad Ali region at north of the studied area.

d) The tributaries of Wadi El-Arish.

**Soil classification:**

* According to Soil Taxonomy system under taken by Soil Survey Staff (1975, 1999 and 2006), soils of the studied area could be classified into two orders (Aridisols and Entisols).
* The soils under consideration are divided into three geomorphic units; their soils could be classified as follows:

**1- Soils of the alluvial terraces of Wadi El-Arish:**

* *Sodic Haplocalcids ,clayey, mixed, hyperthermic* (upper terraces - profile 1).
* *Sodic Haplocalcids, fine silty, mixed, hyperthermic* (upper terraces – profile 6).
* *Sodic Haplocalcids, coarse loamy, mixed, hyperthermic* (middle terraces – profile 12).
* *Sodic Haplocalcids, sandy, mixed, hyperthermic* (lower terraces – profiles 8 and 10).

**2- Soils of the flood plain of Wadi El-Arish and their affect tributaries:**

* *Sodic Haplocalcids, fine loamy, mixed, hyperthermic* (profiles 3, 5, 20, 22 and 23).
* *Sodic Haplocalcids, clayey, mixed, hyperthermic* (profiles 2, 14 and 17).
* *Sodic Haplocalcids, coarse loamy, mixed, hyperthermic* (profiles 16 and 18).
* *Typic Haplocalcids, fine loamy, mixed, hyperthermic* (profile 13).

* *Typic Haplocalcids, coarse loamy, mixed, hyperthermic* (profile 15).
* *Typic Calcigypsids, coarse loamy, mixed, hyperthermic* (profile 19).
* *Typic Calcigypsids, sandy, mixed , hyperthermic* (profiles 21 and 24).
* *Typic Haplocalcids, sandy, mixed , hyperthermic* (profile 7).

**3- Soils of the present channel and sand dunes :**

* *Typic Torripsamments, siliceous, mixed , hyperthermic* (profiles 4 and 9).
* *Sodic Haplocalcids, sandy over loamy, mixed, hyperthermic* (profile 11).

**Micronutrients status in the studied soils:**

**a. Total contents.**

* Total Fe varies from 5500 to 26500 mg/Kg.
* Total Mn ranges between 30 and 461.5 mg/Kg.
* Total Zn varies from 6.3 to 121.5 mg/Kg.
* The highest content of total Fe, Mn and Zn are in the upper terraces, middle terraces, the flood plain and the most study Wadies, while the lowest content is in the lower terraces, the present channel and the soils of sand dunes.
* Total Cu changes from 1.7 to 89.8 mg/Kg. the highest content is in the most soils of the studied geomorphic units and the studied Wadies, while the lowest values is recorded in the soils Wadi El-Gurur.

* The wide ranges of Fe, Mn, Zn and Cu may be attributed to the difference of structure the type and natural of soil materials

**Distribution of micronutrients**:

* Data of weighted mean (W) in the studied soils vary widely, indicating that geogenic factors are more effective rather than pedogenic factors.
* The most trend values (T) are a high, indicating the symmetrical distribution of total elements.
* Specific range (R) in the soils of the studied geomorphic units illustrate that soil profiles are formed from uniform parent material with the cause of the mild effect of the pedogenic processes, while the other soil profiles are heterogeneous in the texture with depth with the cause of suffering from different level of pedogenic processes.

**b- Available fraction:**

* According to **Lindsay and Norvell (1978)** the critical levels for available trace elements are as follows:
* The most soils of geomorphic units have adequate level from available Fe, Mn andZn. The soils of different geomorphic units belong to marginal and adequate levels, while some layers have deficient level.
* The content of available Cu exceeds that level and the soils have well supply of cupper for plant need.

**Particle size analysis:**

* The current work aimed at identifying, the nature of the

depositional media and sediment characteristics of Wadi El-Arish and its tributaries. This target could be achieved throughout studying the statistical size parameter, i.e., Mz, $\sigma^2$, KG, deposition environment and C-M pattern.

In general, data of grain size parameter appear that the common values of mean size (Mz) ranged between fine and very fine sand. Sorting ($\sigma^2$) values fluctuate between poorly and very poorly sorting, indicate that water was the main factor resulted in transportation and deposition of soil materials , except of soils of the present channel having that sorting values of moderately and moderately well sorted. The Latter were more effected by wind and water in depositional media, while sorting values of well and very well sorting that wind is the main agent in transportation and deposition of the same soil materials and soils of W.El-Haradine. Fine and strongly fine skewed were the predominant skeweness values except for soils of present channel which showed a nearly symmetrical in nature, Lepto and very leptokurtic were recorded as predominant of kurtosis.

Depositional environment is fluvial (deltaic) condition except soils of present channel which is aeolian process. Hydrodynamic conditions of the studied soils have an aqueous environment and appear many mechanisms of transportation, i. e., rolling & suspension and suspension & rolling.

The statistical parameters emphasize characteristics of different geomorphic units and explain the relationship between soils of Wadi El-Arish and its tributaries.

**Soil mineralogy:**

**a- Mineralogy of sand fraction.**

* The microscopic investigation using polarized light indicated that quartz was dominate, with the amount ranged from 94.9 to 96.5% of the light minerals .Feldspars constituted the rest, where orthoclase and plagioclase were the principal members, while microcline represented the last content. The higher amount of quartz indicates its resistance to weathering, whereas presence of considerable amounts of feldspar reveals that the studied soils are still young.
* The obtained results indicated that opaque minerals were the most abundant in heavy fraction. Non–obaque minerals were dominated by pyroxenes and amphiboles (pyroboles) that are extremely unstable minerals, followed by slightly stable minerals of garnet and epidote and ultra stable minerals of zircon, rutile and tourmaline. Other minerals abidotite, monazite, glauconite, apatite and ziosite were presented in less pronounced.
* Regarding soil profile uniformity and development, data reveal that the studied soils are heterogeneous, confirmed to that they are formed under multi-origin and/or multi-depositional regimes.
* Values of weathering ratio indicate that the soils under consideration are stile young from pedological point of view. It is worthily to mention that data of sand mineralogy are used to classify at the family level, either, it is siliceous or mixed.

* The obtained data of soil properties indicate that climate, parent material, as main soil forming factors have an effective rule formation of the studied soils, where as living organism and time have less effect.

**b-Mineralogy of the clay fraction:**

* Mineralogical identification of clay samples using X-ray diffraction fellow's smectite (montmorillonite) as the predominant minerals followed by kaolinite then illite.
* Accessory minerals are mostly calcite followed by quartz then feldspars and apatite.

**Land suitability classification:**

* Data of current suitability show that soils of representative profiles belong to marginal suitable land (S3) except soils of profiles 1, 3, 6, 17, 21 and 23 appear moderately suitable while soils of profile24 have not suitable level (N1). Potential suitable of the studied soils could be distinguished into one order (S), as follows:
* S1: It is represented by soil profiles 6, 17 and 23.
* S2: It is represented by soil profiles 1, 12, 3, 5, 14, 16, 21, 2, 15, 18, 20 and 22.
* S3: It is represented by soil profiles 8, 10, 24, 4, 11, 9, 7, 7, 13 and 19.

**suitability for specific crops:**

* More suitable crops are discussed for 27 field crops, vegetables and fruits.

**Consumptive use for selection crops:**

* Consumptive uses also an important limitation for selection crops. So, it is calculated for the most suitable crops, i.e., 4713.4 - 3969.2, 3461.3 - 2914.8, 5018.5 - 4226.1, 5868.7 - 4942.0, 4389.4 - 7212.0, 4099.6 - 3452.3, 4986.6 - 4198.8, 5698.6 - 4796.3, 1495.6 - 1259.5, 4796.8 - 5695.8 $m^3$/fed./season for citrus, olive, guava, date palm, grabs, peaches, mango and alfalfa, with sprinkler and drip irrigation systems, respectively; 3248.4 - 3857.5, 2617.3 - 3108.0, 2408.4 - 2028.2, 1422.0 - 1197.6, 3376.8 - 2843.6, 4329.7 - 3646.0, 2300.3 - 1137.1, 1495.5 - 1259.5 $m^3$/fed./season for summer crops maize, sorghum, water melon, potato, carrot, green pepper, sweet potato and tomato with sprinkler and drip irrigation, respectively. Concerning the winter crops were 1558.8 - 1298.5, 1650.8 - 1390.2, 1308 - 1102.2, 1488.6 - 1253.6, 1768.4 - 1489.4, 1789.3 - 1506.8, 3358.2 - 2828.6, 1706.6 - 1437.1, 3030.1 - 2551.8, 1352.3 - 1138.8 $m^3$/fed./season, for beans, Soya, sun flower, seasum, wheat, barley, ground nut, onion, cabbage and pea with sprinkler and drip irrigation systems, respectively.

**Evaluation of water quality for irrigation:**

* Water wells of the studied soils were evaluated for irrigation use as follows:

1- ECe of water wells ranged from 2.10 to 2.90 dS/m for wells 4, 14 and 17, which suffer from increasing problem (class 2), while salinity in water wells 1, 21 and 24 change between 3.5 and 4.5 dS/m, indicating a sever problem.

2- Water of wells 4 and 24 have EC > 0.5 dS/m and Adj. SAR values > 9 , so, it haven't permeability restriction, while wells 1, 14, 17 and 21 appear Adj. SAR > 9, but haven't clayey texture class, which will prevent the permeability restriction, but it can't affect soil permeability with sandy texture.

3- Boron content varies from 0.09 to 0.11 mg $L^{-1}$, indicates class 1 (non-toxic).

4- The values of sodium contents vary from 9.5 to 30.4 me $L^{-1}$, causing increase values Adj. SAR, which indicate a severe restriction (class 3).

5- The values of chlorides contents vary from 5.04 to 16.7 me $L^{-1}$, indicating a severe restriction.

6- Bicarbonate content for wells 4, 14, 21 and 24 were < 1.5 me $L^{-1}$ donating non-restriction (class 1), while wells No. 1 and 17 were > 1.5 indicating a slightly too moderate restriction.

7- pH values range between 7.25 and 7.70, indicating non restriction, since, they fall within the normal range.

* Trickler and sprinkler are more suitable irrigation systems especially for the soils of coarse texture, due to limitation and shortage the suitable water in the region.