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Soil quality indices for agricultural potentiality in shalateen area- Egypt- using remote sensing and GIS

Rehab Mohamed[1], M. Shendi[1], A. Belal[2] and Mahmoud Abdelfattah[1*]

[1]Soils and Water Department, Faculty of Agriculture, Fayoum University, Fayoum 63514, Egypt

[2]National Authority for Remote Sensing and Space Sciences (NARSS), 1564 Alf-Maskan, Cairo, Egypt

ABSTRACT

Shalateen is considered one of the strategic areas for the security of Egypt from the south-eastern side which requires agricultural development. The objective of this study is to evaluate the soil quality using the integration of remote sensing and GIS. Thus, geopedological soil map was generated including the required soil characteristics. Twenty-six soil profiles were selected to represent the different mapping units. Assessment of soil quality is based on three main quality indices, chemical index (CI), physical index (PI), and fertility index (FI). The results revealed that chemical quality ranges from high to low quality, where most of the study area has a moderate quality. Physical quality varies from high to moderate, where most of the study area is classified as high quality. Fertility index in the study area fell into moderate and low classes. Finally, integration of the three indices showed that the study area is classified as a moderate soil quality. These results can be utilised to plan for the agriculture development taking into consideration the limiting factors and the potential use of the entire area.

Key words: Soil Quality; Remote Sensing (RS); Geographic Information Systems (GIS); Shalateen; Egypt.

INTRODUCTION

Egypt is among the lowest countries in terms of the per capita share of agricultural land. This could be attributed to many reasons, from which is the rapidly growing population. Where the annual average of Egypt's population is about 1.8%, compared to an average growth rate of 1.3% per annum for agricultural land. Therefore, the Government of Egypt adopted policies for self-sufficiency in food production, e.g., extension of cultivated land and maximization of production of the existing agricultural land. Such yearly progressive increase requires paying considerable attention to conserve our limited land resources to optimize our agricultural productivity per unit area and to maximize the agricultural reclaimed lands, through a series of projects to develop new land in the desert. Therefore, the Egyptian Government places a high priority on defining and exploring the natural resources in the Eastern Desert. Shalateen triangle is considered one of the strategic areas for the security of Egypt from the south-eastern side, which requires agricultural development in the area.

* Corresponding outhor : maa06@fayoum.edu.eg
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Soil quality (SQ) is one of the most common concepts that has been developed over the last decades and used to assess soil under different systems. Practically, the judgment of SQ depends on the impacts of soil on crop yield, erosion, and quality of surface and ground water, food, and air. SQ means the “capacity of the soil to sustain biological productivity" (Doran and Zeiss, 2000). Therefore, SQ evaluation and monitoring is crucial to sustain agricultural production and SQ assessment methods focused on measuring dynamic soil properties mostly from surface soil at 0 - 25 cm depth (Karlen et al., 2003). Subsequently, a range of soil parameters that represent the soil functions is identified using landscape characteristics and knowledge of pedology to understand how the soil is functioning and to select appropriate indicators for evaluation (Norfeet et al., 2003). Soil quality assessment is an exercise in measuring the changes in soil properties due to management, change in land use, deforestation, etc. Soil quality per se is a series of threshold value of selected soil properties as indicators of SQ. The indicators are defined as “the soil properties and processes which are most sensitive to changes in soil function” (Doran and Parkin, 1996). Essentially, threshold values of indicator properties are necessary to draw comparisons and identify whether soil quality is degrading or improving after the imposed management in both the short and long term (Biswas et al., 2017). Andrews et al. (2004) developed a quantitative formula, and they suggested that the SQ must be monitored by focusing on soil functions. In recent times, SQ is used as a method to evaluate land-use systems at various scales from regional to the national level (Mukherjee and Lal, 2014; Vasu et al., 2016). It is difficult to assess the change in soil quality unless there is an irreversible change in any of the soil properties (Nortcliff, 2002). Therefore, it became necessary to identify a few soil properties as soil quality indicators which to overcome various climate changes on soil functions. Soil quality evaluation can help the farmers, farm managers, extension workers, and policymakers to identify the sustainability of a given land use. The quantification and comparison of soil quality among different land use, crop production systems, and management practices facilitate better land-use planning for sustainable utilization of the nonrenewable soil resources (Norfeet et al., 2003).

can reflect the changes in soil quality. Soil quality indicators are properties that are sensitive to soil functions and should be easy to measure (Dumanski and Pieri, 2000; Aparicio and Costa, 2007). The soil quality indicators are generally classified into four categories: visual, physical, chemical, and biological indicators (More, 2010).

The visual indicators are field observations of mostly qualitative soil properties, viz., soil depth, color, erosion, salt deposition, drainage, soil structure, rooting depth, earthworm population, etc. These indicators are assessed in the field and interpreted by both experts and farmers. The main advantage of visual SQ indicators is that they are immediately interpreted without time-consuming laboratory analysis (Bünemann et al., 2018; Emmet-Booth et al., 2016).

Physical properties such as texture, structure, hydraulic conductivity, bulk density, and aggregate stability are used as physical SQ indicators. They are used to evaluate physical SQ and linked with seedling emergence, root growth, water movement, water holding capacity, penetration resistance, etc. Physical properties play a vital role in determining the soil erodibility and soil-plant-water-atmosphere relationships (More, 2010). More recently, Dexter (2004) proposed the “S-value” as an indicator to measure soil physical quality. The “S-value” is related to hydraulic conductivity, compaction, water content, penetration resistance, and aggregate stability (Dexter and Czyz, 2007).

Important soil chemical processes are ionic diffusion, leaching, acidification, alkalinization, salinization, mineralization, etc. Maintaining a favorable nutrient content is critical to soil chemical quality. The chemical indicators of SQ are pH, EC, salinity, sodicity, organic carbon, nitrogen fractions, phosphorus concentration, cation exchange capacity (CEC), and heavy metal concentrations. Among the chemical indicators, P concentration, cation exchange capacity, exchangeable sodium and magnesium, and hydraulic conductivity are considered important in rainfed agriculture production systems, and they are also used to assess chemical and physical degradation (Vasu et al., 2016; Vasu et al., 2018). Soil pH and available P are the most used chemical indicators in SQ assessment as they indicate most of the nutrient-related transformations in soil.

Concerning the biological indicators, the microbes have the capacity to alleviate the consequences of disturbances on soil ecosystem services, due to their resistance, resilience, and/or functional redundancy (Allison and Martiny, 2008). The soil microbes reciprocate rapidly to changes in soil and indicate the factors and processes modifying the soil quality. The high sensitivity of microbes to the changes in the soil processes is an advantage as they can be used to monitor the short-term changes in the soil effectively (De La Rosa, 2005).

Remote sensing has the potential of playing a determinant role as a spatial information source. As it is a method for obtaining information concerning objects by special instruments that are not in physical contact with the objects being investigated (Diker and Unlu, 1999). Ahmed et al. (1998) reported that agricultural applications of remote sensing include i.e., mapping of natural resources, soil characteristics, land degradation, crop type classification, precision agriculture, and irrigation scheduling. Moreover, Lillesand and Kieffer (2003) stated that remote sensing technique is one of the most important methods used for soil survey, mapping, and environmental investigation. Furthermore, the satellite imagery applications for soil properties prediction are rapidly developing as the multispectral data is already available from different sources, such as Sentinel-2, and hyperspectral satellites such as Prisma (Dvorakova et al., 2020).

On the other hand, geographical information systems (GIS) provide a powerful capability for manipulating spatial data. GIS has been defined as a computer assisted system for the acquisition, storage, analysis, and display of geographic data according to user-defined specifications (Laurini and Thompson, 1992). GIS techniques have been used for farm-related assessments at national and regional scales for many years. These techniques have been combined with GIS and remotely sensed data to support assessments of land capability crop condition, yield range condition flood, drought, soil erosion, soil compaction surface and ground water contamination (Usery et al., 1995).

The main objective of this study is to assess the soil quality using the integration of remote sensing and GIS technologies for better utilization of the available resources in the study area.

MATERIALS AND METHODS

Location of the study area

The study area is one of the selected areas for sustainable development in the southeast desert of Egypt and located between latitudes 23˚ 09` 04.49`` and 23 ˚ 45 ` 25.26`` N, and longitudes 35˚ 09` 04.49`` to 35˚ 33.00` 55.77`` E, and bordered in the south by Halaib, in the east by the Red Sea and in the west and the north by the Red Sea Mountain range. It covers about 2947.7 km^2 (701833.33 Feddans) as shown in Figure (1).

Climate of the study area

The climate is a typical dessert arid with long hot rainless summer, mild winter with very low or no rainfall. However, some rare and irregular storms may take place over scattered localities during winter. Table (1) shows the average of meteorological data for 30 years (1985 - 2015 available) extracted from historical weather simulation data and ground stations data, collected from the website: https://www.meteoblue.com. Where the mean maximum and minimum annual temperatures are 33.4 ° C and 17.9 ° C, respectively. According to the USDA Soil Taxonomy system (USDA, 2014) the Soil temperature regime is **Hyperthermic** as the mean annual soil temperature is higher than 22 °C, and the difference between mean summer and mean winter soil temperature is 6 °C at a depth of 50 cm from the soil surface. The soil moisture regime is Torric or Aridic except for soils that have high water table, where soil moisture regime could be Aquic condition.

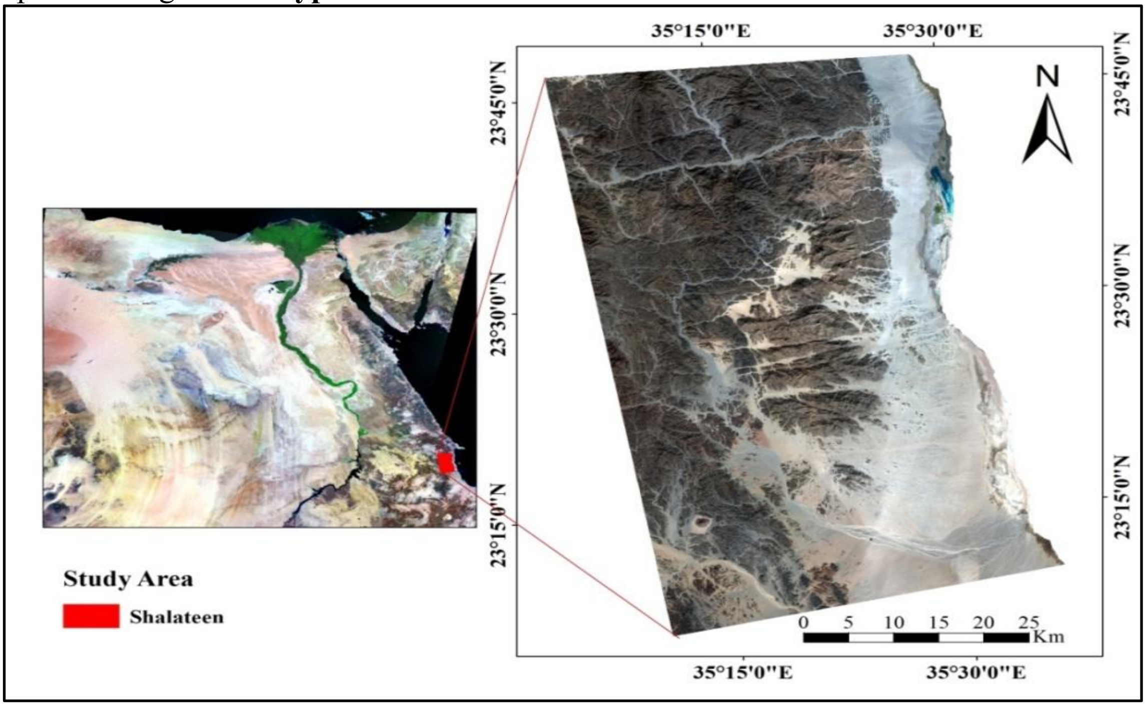

Fig (1): Location map of the study area.

Table 1.Climatic data of Shalateen station, average of 30 years (1985-2015).

Months	Temperature (°C) Max.	Min.	Mean.	Precipitation (mm)	Wind Speed	Humidity
January	24.0	12.0	18.0	1.0	14.0	55.0
February	26.0	12.0	19.0	1.0	14.0	55.0
March	29.0	14.0	21.5	1.0	14.0	45.0
April	33.0	16.0	24.5	1.0	12.0	40.0
May	37.0	19.0	28.0	1.0	12.0	30.0
June	40.0	21.0	30.5	0.0	12.0	28.0
July	42.0	23.0	32.5	0.0	10.0	26.0
August	42.0	23.0	32.5	0.0	11.0	27.0
September	39.0	22.0	30.5	0.0	13.0	30.0
October	34.0	21.0	27.5	1.0	12.0	45.0
November	29.0	18.0	23.5	2.0	13.0	43.0
December	26.0	14.0	20.0	0.0	14.0	45.0
Average	**33.4**	**17.9**	**25.7**	**0.7**	**12.6**	**39.1**
Total (annual)				**8.0**		

Geology of the study area

The southern part of the Eastern Desert of Egypt represents a part of the Arabo-Nubian Shield. The surface of the study area is occupied by many rock formations belonging to Precambrian, Miocene, and Quaternary ages (Abu Al-Ezz, 1971; EGSMA, 1981; Said, 1990 and Conoco, 1987) as shown in Figure (2). According to NARSS (2016) quaternary deposits cover the Red Sea coastal plain and partly cover the sedimentary and Precambrian rock units. The Quaternary sediments comprise gravel plain, wadi deposits, sabkhas.

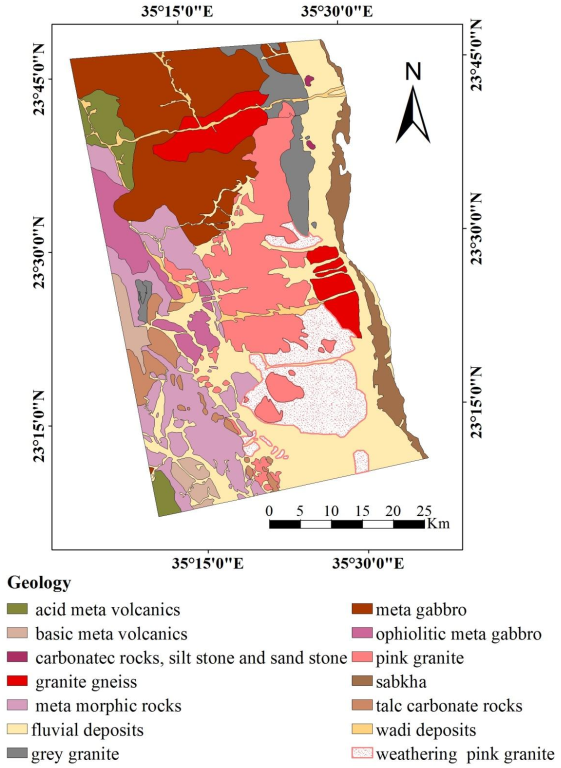

Fig (2): Geological map of the study area, modified after Conoco (1987).

Natural vegetation: *The natural vegetation in the area is characterized by mixed plant types: natural grasses, trees, shrubs, and pasture grass. The density of plants varies according to the available water, and increases with the increased rainfall (Girgis,* 1971). According to Adam (2003) the distribution of plant communities in the area depends mainly on soil property, moisture, and geological formations, which include: marine algae, sea-weeds, mangrove plants, halophytes, desert plants, mountain and hill plants.

Water Resources: The main water resources in the study area are surface water (precipitation rock basin), sea water condensation and ground water (NARSS, 2016). There are three main groundwater aquifers namely, Quaternary, Nubian sandstone, and fractured basement (Hammad, 1994 and Hassan et al., 1996, Yousef et al., 2009 and DRC, 1994).

Spatial data processing

Sentinel-2 is an Earth Observation mission from the Copernicus Program that systematically acquires optical imagery at a high spatial resolution of 10 m, 20 m, and 60 m. It is an open and free data policy for the public. The Sentinel-2 satellites each carries a single multi-spectral instrument (MSI) with 13 spectral channels in the visible/near-infrared (VNIR) and short-wave infrared spectral range (SWIR). Getting data from both satellites enables temporal resolution of 4 days. To cover the study area with S-2 data, two imageries acquired on 9th November 2016 were merged and then clipped to the boundaries of the study area. The S-2 data was downloaded from (https://scihub.copernicus.eu/dhus/#/home). In addition, the Digital Elevation Model (DEM) of the study area (Figure 3) was obtained from the available ALOS PALSAR DEM data with a spatial resolution of 12.5 m and downloaded from the website (https://vertex.daac.asf.alaska.edu/).

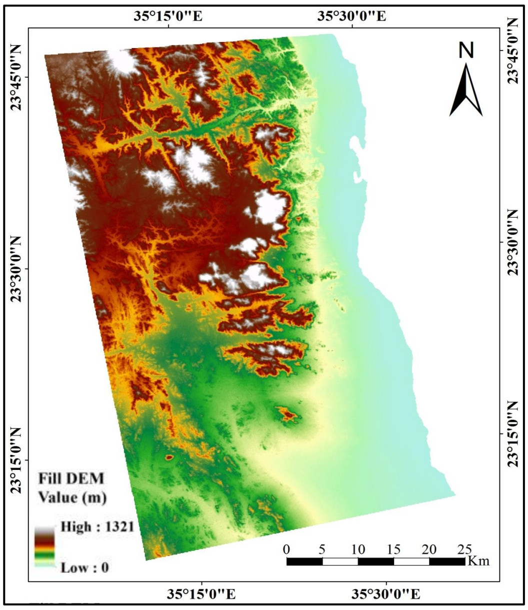

Fig (3): Digital Elevation Model (DEM) of the study area.

Soil mapping

The physiographic map of the study area was generated according to geopedological approach (Zinck 2013). Where Sentinel-2 data was displayed in natural color composite (RGB: 4, 3, 2) to float over the previously prepared digital elevation model (DEM) in ArcScene 10.3 to create a 3D vision for the study area. Therefore, different geomorphological units (i.e., landscape, and landform) could be recognized. In addition to the field trip observations and photographs, and previous studies (FAO, 1966; El Nahry, 1996 and Mohamed, 2006) to give appropriate nomenclature to the landforms.

A. Fieldwork

The obtained physiographic map was used as the base map, where 26 soil profiles were dug to recognize the different landform units, as shown in Figure (4). The investigated soil profiles were described morphologically in the field according to FAO (2006) and Soil Survey Manual (2017). Soil samples were collected from the studied soil profiles to determine the physical and chemical characteristics.

B. Laboratory analyses

The collected soil samples were prepared for physical and chemical analysis. Which include particle size distribution (Gee and Bauder 1986), Soil color in both dry and moist conditions with the aid of the Munsell soil color charts (1975), and saturation percentage. Also, according to USDA (2004), the following analyses were carried out: calcium carbonate content, soil reaction (in 1:2.5 soil : water suspension), electrical conductivity (EC_e), soluble cations and anions, and organic matter content (O.M.). In addition to available macro and micronutrients in surface soil, according to Soltanpure and Workman (1979).

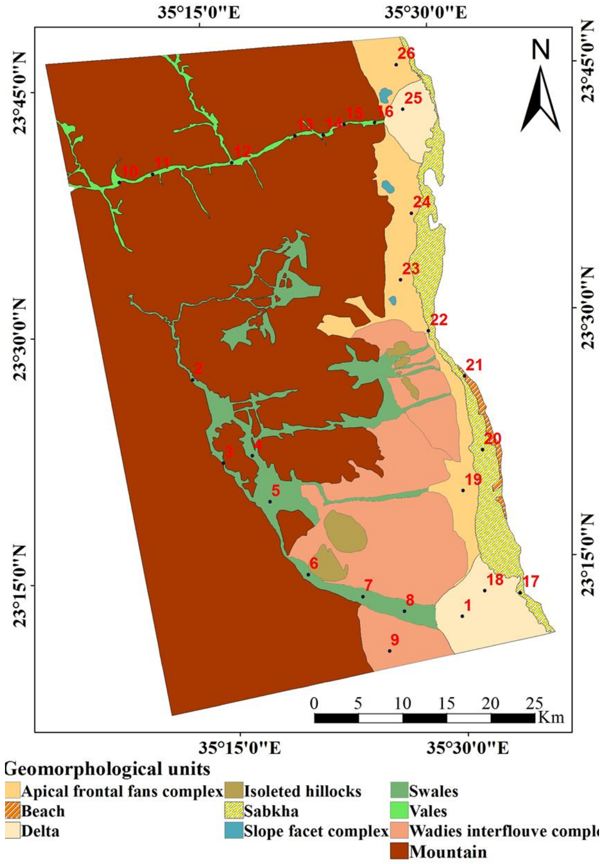

Fig (4): Geopedological map of the study area, and location of the studied soil profiles.

After completion of laboratory analysis, the representative soil profiles were classified according to the American system of soil taxonomy (USDA, 2014). Generation of soil map is the outcome of all the previous stages including the results of soil analysis, soil taxonomy, in addition to the physiographic units. All of that, were used in creating the final soil map according to the geopedological approach of Zinck (2013) where one ideal soil profile was selected to represent each soil map unit characteristics. The type of mapping units was defined according to Soil Science Division Staff (1993) based on the degree of homogeneity for these units which was noticed in the field survey.

Assessment of soil quality (SQ) in study area

Soil quality index is developed to combine chemical, physical and fertility indices, according to Follet and Lindsay (1970); Sepehr et al. (2007) and Abdellatif et al. (2021). The used SQ classes are shown in Table (2).

Table 2.Quantitative scores and qualitative classes of considered indicators (indices).

Indicators	Range	Class
	< 1.13	S1 (High quality)
Soil quality	1.13–1.46	S2 (Moderate quality)
	> 1.46	S3 (Low quality)

Results and Discussion

According to digital elevation model (DEM) data, the study area has the lowest elevation of zero, where the highest elevation is 1321 m above sea level. The slope of the study area ranges from flat (0 - 0.2 %) to very steep (>60%).

Description of geomorphological units

The geomorphological map of the study area was obtained according to geopedological approach of Zinck (2013), and indicated that, the area is characterized by four landscape types (Figure 5).

- **Mountain:** the mountain is subdivided into two relief types (hills, and escarpment). The hills relief was differentiated into different lithology and subdivided into eighteen landforms.
- **Piedmont:** is subdivided into four relief types (hills, dissected, interfluve, and fans). The relief was differentiated according to different lithology formation and subdivided into eight landforms.
- **Valley:** is subdivided into two relief types (valley, and fans). The relief was differentiated into different lithology and subdivided into three landforms.
- **Coastal plain:** is subdivided into one relief type (low terrace). The relief was differentiated into two lithology and subdivided into two landforms as indicated in the geomorphological map legend (Table 3).

The main geomorphological units were identified in the study area. Where, Sabkhas is covering 28506.5 Feddan (4.1%). Delta is covering 27538.1 Feddan (3.9%). Wadis are covering 49970.1 Feddan (7.1%). Apical frontal fans complex is covering 41548.2 Feddan (5.9 %). Wadies interfluve complex are covering 81466.5 Feddan (11.6 %). In addition to, mountains, hills and rock out crops are covering 472803.9 Feddan (67.4 %).

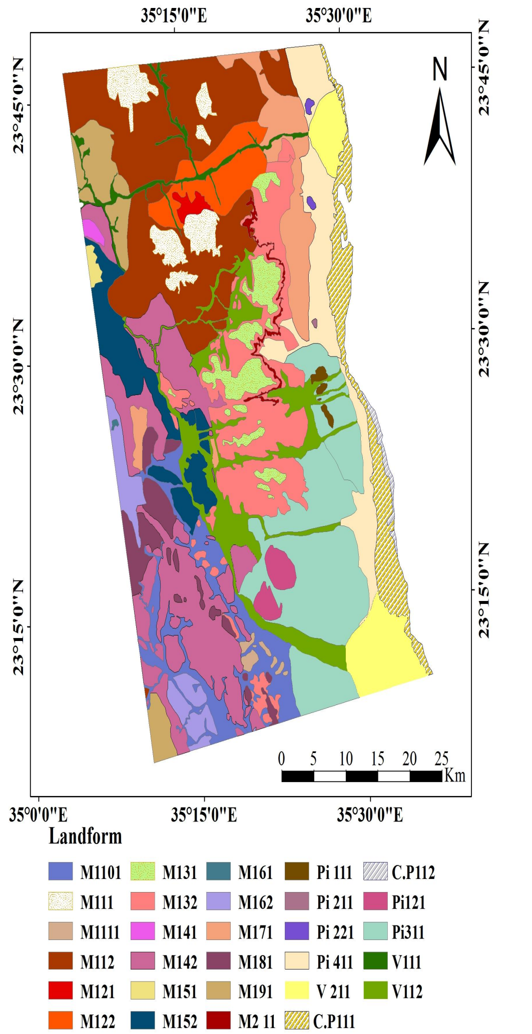

Fig (5): Geomorphological map of the study area.

Table (3): Legend of the physiographic soil map.

Landscape	Relief	Lithology	Landform	Landform
Mountain (M)	Hills	Meta gabbro	Summit	M111
			Back slope	M112
		Gneiss, Gneiss granite	Summit	M121
			Back slope	M122
		Pink granite	Summit	M131
			Back slope	M132
		Metamorphic rocks	Summit	M141
			Back slope	M142
		Ophiolitic meta gabbro	Summit	M151
			Back slope	M152
		Basic meta volcanics	Summit	M161
			Back slope	M162
		Acid meta volcanics	Back slope	M171
		Grey granite	Back slope	M181
		Sand, Alluvial fans,	Back slope	M191
		Talc carbonate and	Back slope	M1101
		Pink granite	Back slope	M1111
	Escarpment	Pink granite	Escarpment	M211
Piedmont (Pi)	Dissected	Gneiss, Gneiss granite	Isolated hillocks	Pi 111
		Pink granite	Isolated hillocks	Pi 121
	Hills	Grey granite	Slope facet	Pi 211
		Carbonate rock, Silt	Slope facet	Pi 221
	Interfluve	Alluvial deposits	Wadies interfluve	Pi 311
	Fans	Sand, Alluvial fans,	Apical frontal fans	Pi 411
Valley (V)	Valley	Alluvial deposits	Vales	V 111
			Swales	V 112
	Fans	Alluvial deposits	Delta	V 211
Coastal Plain	Low terraces	Marine deposits	Sabkha	C.P 111
			Beach	C.P 112

Soil properties of the study area

Soil properties of the studied profiles indicated that soils are slightly to high alkaline with pH values ranges from 7.5 to 9.1. Total soluble salts content differs widely from location to another and has a wide range, as ECe ranges between 0.43 and 217 dS/m. The calcium carbonates content of the soils has a wide range, as it ranges between 0.15 - 20.7 %. The organic matter content O.M. % ranged from 0.12 – 2.45 %. The available N ranges from 4.16 to 42.16 mg/kg. The available P ranges from 2.75 to 16.78 mg/kg. The available K ranges from 55 to 470 mg/kg. The available Fe ranges from 3.2 to 6.1 mg/kg. The available Zn ranges from 0.140 to 0.399 mg/kg. And the available Cu ranges from 0.110 to 0.349 mg/kg. Table (4) shows the main characteristics of the representative profiles of soil mapping units

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Table (4): Some soil characteristics of the soil mapping units.

Landform	Profile No.	Soil Properties										
		pH	EC	$CaCO_3$	OM	N	P	K	Fe	Cu	Zn	Texture
Sabkha	17	8.3	37.6	0.5	0.5	35.2	6.8	388.5	3.70	0.29	0.21	sandy loam
Delta	1	8.2	14.8	2.5	0.4	14.6	2.9	73.1	3.42	0.13	0.17	loamy sand
Apical frontal fans complex	23	8.0	3.9	0.5	0.8	21.6	6.4	138.1	5.42	0.22	0.18	loamy sand
Swales	3	8.2	1.4	0.6	0.7	20.5	4.1	61.3	6.12	0.19	0.24	sand
Vales	14	8.1	0.6	0.4	0.3	18.5	3. 6	63.4	5.53	0.18	0.14	sand
Wadies interfluve complex	9	8.3	20.8	0.3	0.5	31.5	7.1	175	5.54	0.18	0.27	loamy sand

Soil Quality in the study area

Soil is a key parameter that intervenes in the assessment of soil desertification. Physical, chemical, and fertility quality parameters are the key indicators of soil quality (SQ). SQ was calculated by using the following formula:

$$\mathbf{SQ = (CI \times PI \times FI)^{1/3}}$$

where: SQ = soil quality; CI = chemical index; PI = physical index; and FI = fertility index. An optimal combination of these parameters increases agronomic productivity and reach to management systems sustainability.

Chemical index

Spatial distribution map of chemical index, Figure (6), shows a wide range of chemical quality with high, moderate, and low quality, with an area of 9538.8, 157686.8 and 61803.8 Feddan (4.2%, 68.9%, 26.9% of the study area), respectively. The results showed that most of the study area located under moderate quality which represents 68.9% of the study area.

Physical index

The data given in Figure (6) indicates that PI in the study area varies from high to moderate physical index with an area of 184993.7 and 44035.7 Feddan, respectively. As shown, 80.8% of the study area located under high quality.

Fertility index

Soil fertility mapping is a key issue for a lot of implementations in research fields ranging from sustainability of soil management to the precision farming concept. According to FI, the study area fell into moderate and low-quality classes, with an area of 75732.2 and 153297.2 Feddan (33.1% and 66.9% of the study area), respectively. Which indicate that 66.9% of the study area has low fertility index, Figure (6).

Assessment of soil quality

Soil physical, chemical, and biological quality parameters are the key indicators of SQ. An optimal combination of these parameters increases agronomic productivity and reach to management systems sustainability (Martinez-Salgado et al., 2010). According to Figure (6), the soils in study area has moderate soil quality.

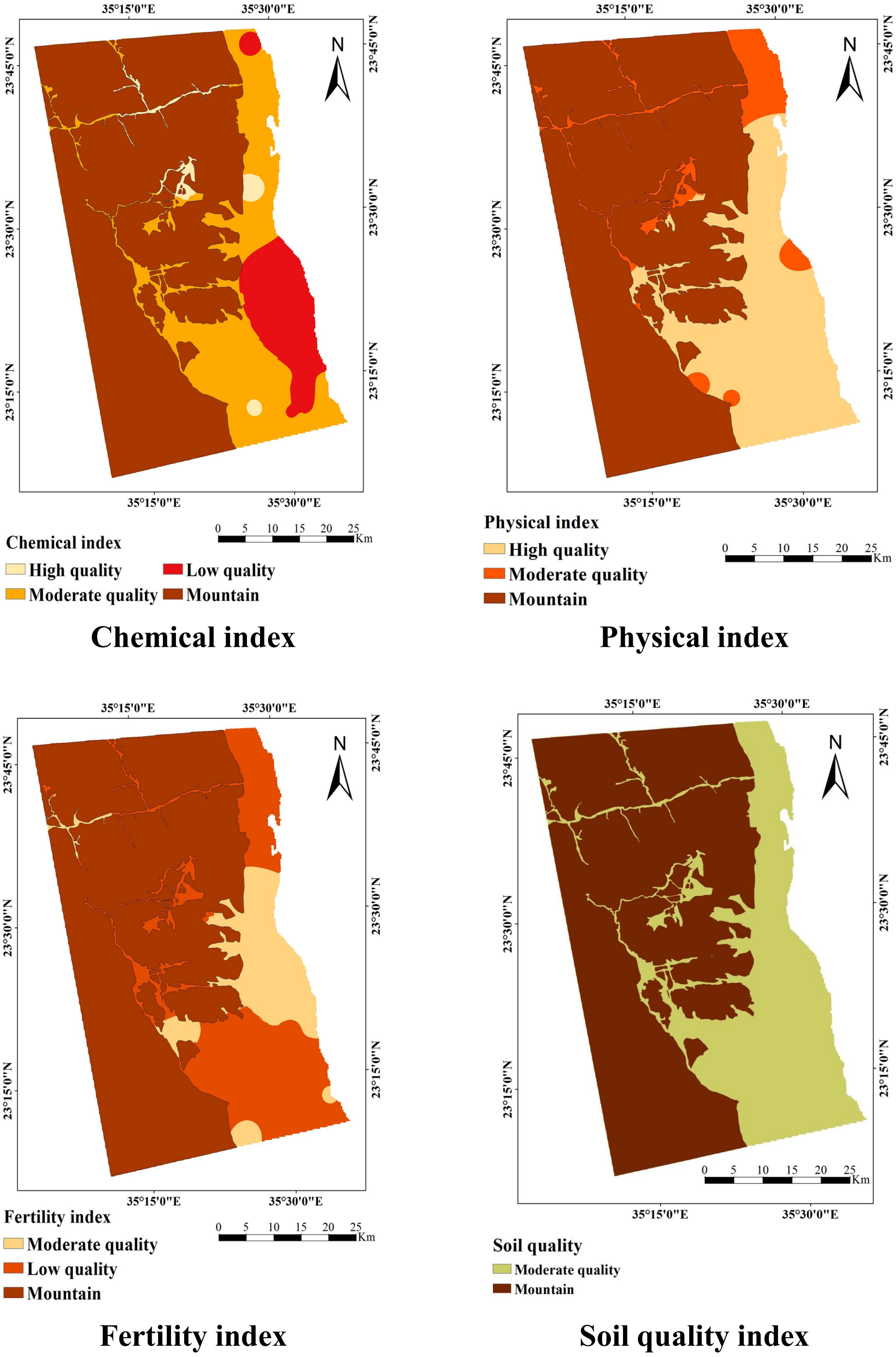

Fig (6): Spatial distribution of chemical, physical, fertility, and soil quality indices in the study area.

Conclusion

Soil quality (SQ) is one of the most common concepts that has emerged over the last decades and has been used to assess soil under different systems. Shalateen triangle is considered one of the strategic areas for the security of Egypt from the south-eastern side, which requires agricultural development in the area. It is one of the selected areas for sustainable development in south Egypt. The study area covers about 2947.7 km^2 (701833.3 Feddan).

The main objective of this study is to assess soil quality using the integration of remote sensing and GIS technologies for better utilization of the available resources in agricultural development. Sentinel-2 images acquired on 9th November 2016 were used to increase the information availability and to provide the best possible product for analysis and interpretation. Digital Elevation Model (DEM) of the study area was obtained from the available ALOS PALSAR DEM data with a spatial resolution of 12.5 m. In addition to the average meteorological data extracted from nine sites from historical weather simulation data and ground stations data for 30 years (1985 - 2015 was available).

The geomorphological map of the study area was produced applying the geopedological approach of Zinck (2013). The field work was carried out to check, confirm, correct, and modify the geomorphologic mapping unit boundaries. Twenty-six soil profiles were selected to represent the different geomorphological units. 100 disturbed soil samples were collected for determining different soil properties. Soil physical and chemical analyses were carried out. The geomorphological units were classified into subgroup level on the basis of the Keys to Soil Taxonomy (Soil Survey Staff, 2014) to generate digital soil map.

The main geomorphological units were identified in the study area are: Sabkha covers 28506.5 Fadden (4.1%), delta covers 27538.1 Fadden (3.9%), Valley covers 49970.1 Fadden (7.1%), Apical frontal fans complex covers 41548.2 Fadden (5.9%) and Wadies interfluve complex covers 81466.5 Fadden (11.5%). In addition to, mountains, hills, and rock out crops, which cover 472803.9 Fadden (67.5%).

Based on Soil Survey Stuff (2014), two soil orders were identified: Entisols and Aridisols which are represented by three subgroups. Soil order in Aridisols covers about 28506.5 Fadden (4.1% of the total area). Where the representative soil profiles are classified as Typic Aquisalids and concentrated in sabkha. While soil order Entisols covers about 200522.9 Fadden (28.6%) and distributed in most units. Soils of this order are placed in the subgroup Typic Torrifluvents covers about 151014.9 Fadden (21.5% of the total area) and concentrated in delta, swales and wadies interfluve complex. Typic Torriorthents which covers about 49508 Fadden (7.1% of the total area) and concentrated in vales and apical frontal fans complex.

Chemical analysis indicated that soils are slightly to high alkaline with pH values ranges from 7.5 to 9.1. Total soluble salts content differs widely from location to another and has a wide range, as ECe ranges between 0.43 and 217 dS/m. The calcium carbonate content ranges between 0.15 - 20.7%. The organic matter content (O.M. %) ranges from 0.12 – 2.45%.

Assessment of soil quality, based on three main quality indices, Chemical Index (CI), Physical Index (PI) and Fertility Index (FI). Chemical quality ranging from high, moderate, and low quality; most of study area is located under moderate quality. Physical quality is varied from moderate to high and most of the study area is located under high quality. Fertility index is characterized between low to moderate classes. Finally, the assessment of the overall soil quality was classified as moderate quality.

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مؤشرات جودة التربة لتحديد القدرة الزراعية في منطقة شلاتين ـ مصر ـ باستخدام الاستشعار عن بعد ونظم المعلومات الجغرافية

رحاب احمد جابر محمد[1]، محمود محمد محمد شندي[1]، عبدالعزيز بلال عبدالمنطلب بلال[2] ومحمود علي عبد الفتاح[1]

1. قسم الأراضي والمياه ـ كلية الزراعة ـ جامعة الفيوم ـ الفيوم ـ مصر
2. **صغيت بمجظثئكبث بمشزيغئت ىبمجسيت ىغمژن بمپسبز ـ بمىچتت بمكژنئت م شجضغبز نپ پغر ىغمژن بمقنبآ ـ بمكبوسيت ـ نمس**

يعتبر مثلث شلاتين من المناطق الاستراتيجية لأمن مصر من الجانب الجنوبي الشرقي مما يتطلب تنمية زراعية في المنطقة. الهدف الرئيسي من هذه الدراسة هو تقييم جودة التربة، باستخدام تكامل تقنيات الاستشعار عن بعد ونظم المعلومات الجغرافية من أجل استخدام أفضل للموارد المتاحة في التنمية الزراعية. تم اختيار ستة وعشرين قطاع تربة لتمثيل الوحدات الجيومورفولوجية المختلفة. تم إنشاء خريطة التربة الرقمية بناءً على نموذج الارتفاع الرقمي المستخدم وبيانات القمر الصناعي Sentinel-2، بالإضافة إلى البيانات المناخية خلال 30 عامًا. ساد نوعان من بيئة الترسيب في منطقة الدراسة، الرواسب الغرينية والرواسب البحرية.

تم تقييم جودة التربة على أساس ثلاث أدلة رئيسة Fertility Index (FI), Physical Index (PI) Chemical Index (CI). تتراوح الجودة الكيمائية من عالية الي متوسطة الي منخفضة ومعظم منطقة الدراسة تقع في الجودة المتوسطة، أما الجودة الفزيائية في منطقة الدراسة تتراوح من عالية الي متوسطة ومعظم منطقة الدراسة تقع في منطقة الجودة العالية. وبالنسبة لجودة الخصوبة فتتراوح من متوسطة الي ضعيفة، والتقييم الكلي لجودة التربة تم تصنيفها على أنها متوسطة.

الكلمات المفتاحية: جودة التربة، الاستشعار عن بعد، نظم المعلومات الجغرافية، شلاتين، مصر.