

Image Processing and Land Information System for Soil Assessment of El-Maghara Area, North Sinai, Egypt

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Abstract

Land assessment is of great importance in guiding decisions for planning land uses. The main objective of this study is to determine land resources, soil degradation and to evaluate land utilization types and their suitability in El-Maghara area. Field verification, digital soil data and land use related (satellite data, DEM and ancillary maps) data were used and analyzed with Remote Sensing (RS) and Geographic Information Systems (GIS) techniques and a new digital soil maps and database were generated for El-Maghara area. The soils of El-Maghara area were classified using last U.S.D.A. Soil Taxonomy. RS and GIS techniques were successfully applied in this land assessment study. GIS software was used to determine potential land use groups and suitability classes for agricultural uses of the study area. Five mapping units were identified using the most effective soil properties in the spatial distribution pattern. Each map unit is characterized by different soil properties and the mode of sedimentations. The resulted suitability factors maps for agricultural uses are soil classification units, fertility, capability, suitability of water and environmental conditions. The capability soil map is classified as class C2, C3, C4, C5 and C6 and the soil fertility was classified into five classes. The suitability results showed that 16.4% to 66.8% of the studied soils are found to be poorly to highly suitable for agricultural uses. These soils are classified as *Typic Torrifluvents*, *Typic Quartzipsamments* and *Typic Torripsamments*. The land suitability classifications of El-Maghara soils area are classified in good, fair, poor, very poor and non-agriculture soils grades. The current work discusses various approaches for soil erosion hazard assessment and deriving temporal ecosystem changes. Manifestation of soil degradation of El-Maghara area includes mining, quarrying, salinity of water irrigation, land deterioration by intensive grazing and infringement of mobile sand bodies or sand duns and water erosions.

Keywords: Land mapping units, Land evaluation, soil properties, soil degradation, Environmental impacts.

Introduction

The world population has been increased rapidly for the last few years. According to experts, if this increase continues at the present rate, the population will double in the next 60 years. However, our land resources are not infinite. The Food and Agriculture Organization of the United Nations (FAO) (1993) has indicated that there is an urgent need to match land types and land uses in the most practicable and logical way to continue sustainable production and to meet the needs of society while conserving fragile ecosystems. Land evaluation is concerned with the assessment of land performance when used for a specified purpose (FAO, 1977). In other words, land

evaluation is likely to be the prediction of land potential for productive land use types, and then generally a comparison or match of the requirements of each potential land use with the characteristics of each kind of land. The results are a measure of the suitability of each kind of land use for each type of land (Dent, 1981; Beek, 1978).

One of the main tasks of scientists working in land development is to interpret resources inventories for users and planner of land. These groups must know the suitability of land areas for actual and expected land uses, in the face of pressing needs (Rossiter, 1990). Egypt becomes dependent on imported. A number of experts agree that this problem could be relieved to a great extent if land outside the Egyptian Nile Delta were to be cultivated. However, in the modern world with its rapid population growth and increasing environmental degradation, changes in land use must be faster, hence the need for land planning or re-planning at national, regional, local and farms levels. Different kinds of land are unequally suited to various uses even in the same level. Among the differences between land areas are their soil physical, chemical, fertility, climate and water resources database. These are the subject of natural resources inventories as soil or land system survey (Morsy et al, 2002).

El-Maghara area is one of the most important areas in north Sinai that received a special governmental attention. Moreover, its sustainable development is one of this particular area is supported by its characteristic economic resources, that are manifested by the availability of soil, coal deposits, building materials and water. Remotely sensed data and GIS give a revolution in research of agriculture, land, water and marine resources and geomorphology. It data offers the researcher to facilitate the investigations, assessments and they may lead to a more understanding of sustainable development. To reach a sustainable development, the effect of development social, economic, environment and resources will require decision-maker to manage the large quantity and various information on environment.

The present study is aimed to apply (RS) and (GIS) techniques for soil assessment of El-Maghara area. GIS is designed to manage, analyze, integrated and display all types of spatial data. This capability makes GIS a powerful tool in the successive analysis of spatial data can partitions large area into small units upon that a model of soil assessment can be applied. Image enhancement is used to provide more detailed information that describes areas that are difficult to reach, and not covered by monitoring network.

One of the primary sources of geographic database used in GIS is the information obtained through interpreted enhanced images. The result can be fed into the GIS and integrated with other spatial and non-spatial database. The ultimate use of GIS lies in its capability for modeling, constructing models of the real world from the digital database and using the models to simulate a given scenario (FAO, 1988 and Alcamo, 2001).

Study Area

El-Maghara area is one of several domes, which characterize north central Sinai. It is the largest Jurassic exposure in Egypt, being dissected by several wadis, the largest of which flows eastwards into a large sand and gravel-plain. The North Sinai dune-fields, composed of large dunes of aeolian sand, encroach upon the northern part of El-Maghara and the adjoining plains. A lot of geological, geophysical, hydrological, and geophysical studies were carried out in El-Maghara area, some of these are done by Al-

Far (1966), EGSMA (1985 & 1986), Hasanin (1997), Abd El-Samie (2001), Abd Monsef, et al., (2001), El-Hefnawy et al., (2001), El-Alfy and Soussa (2001).

The study area is located in the northern Sinai part Peninsula lying between 30° 41' 10" & 30° 48' 46" N latitude and 33° 16' 00" & 33° 36' 30" E longitude. The area is covered by Landsat ETM+7 image (175 Path / 39 Raw) (2000) and Digital Elevation Model (DEM) produced from the topographic contour maps scale 1: 50000 (20 meters contour interval) (Fig. 1), covering a total area of 335 km². Five geomorphic units were identified, namely; mountain and escarpment, Present Wadis, Sand dunes, Gravel plain and Flood plain, according to the U.S.D.A. Soil Taxonomy (1999). Generally, it is characterized by mild winter, hot summer, relatively low precipitation and high evaporation. The area is exposed to north - eastern and northern winds with a mean velocity of about 11 knots (Fig. 2) (Climatic Atlas of Egypt, 1996). The area receives between 20 to 50 mm of rain annually; falling mainly in winter and the mean maximum temperature is 27.5 mainly in summer, allowing fairly good vegetation cover of considerable diversity to grow on open flood plains, as well as in wadis. Dwarf shrubs (*Fagonia*, *Anabasis*) and grasses (*Stipagrostis*, *Panicum*) dominate the vegetation on the gravel-plain (W. El-Shiehk Hamad). *Artemisia* is common and widespread (W. El Khariq) on fine sandy substrates. Substantial stands of *Acacia* trees are found in the larger wadis (W. El-Shiehk Hamad). The vegetation on the hills of El-Maghara area includes many Mediterranean relicts, such as *Juniperus phoenicea*, which grows on the north-facing slopes and is found nowhere in Egypt outside the hills of north-central Sinai.

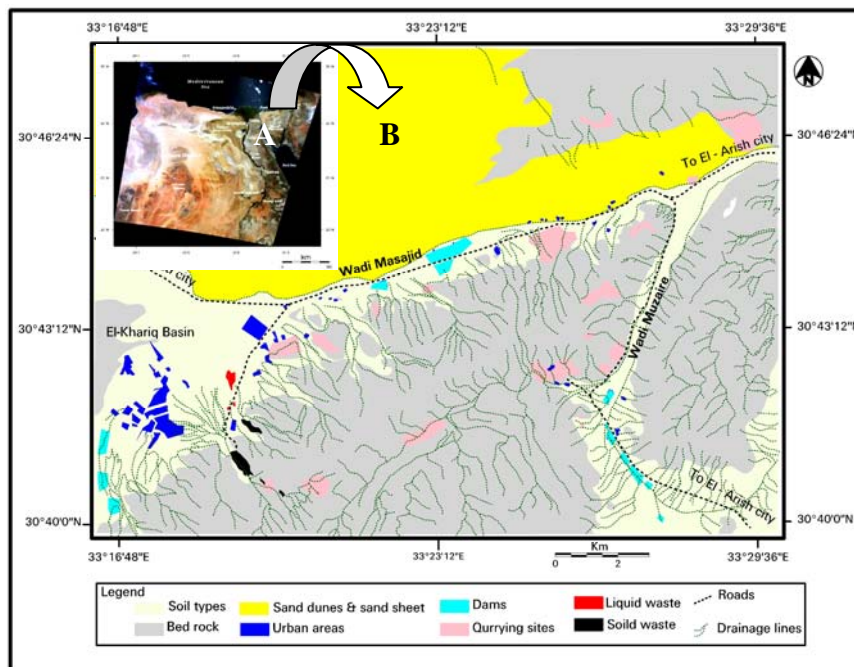


Figure (1): Landsat image showing the location (A) and land cover map (B) of El-Maghara area.

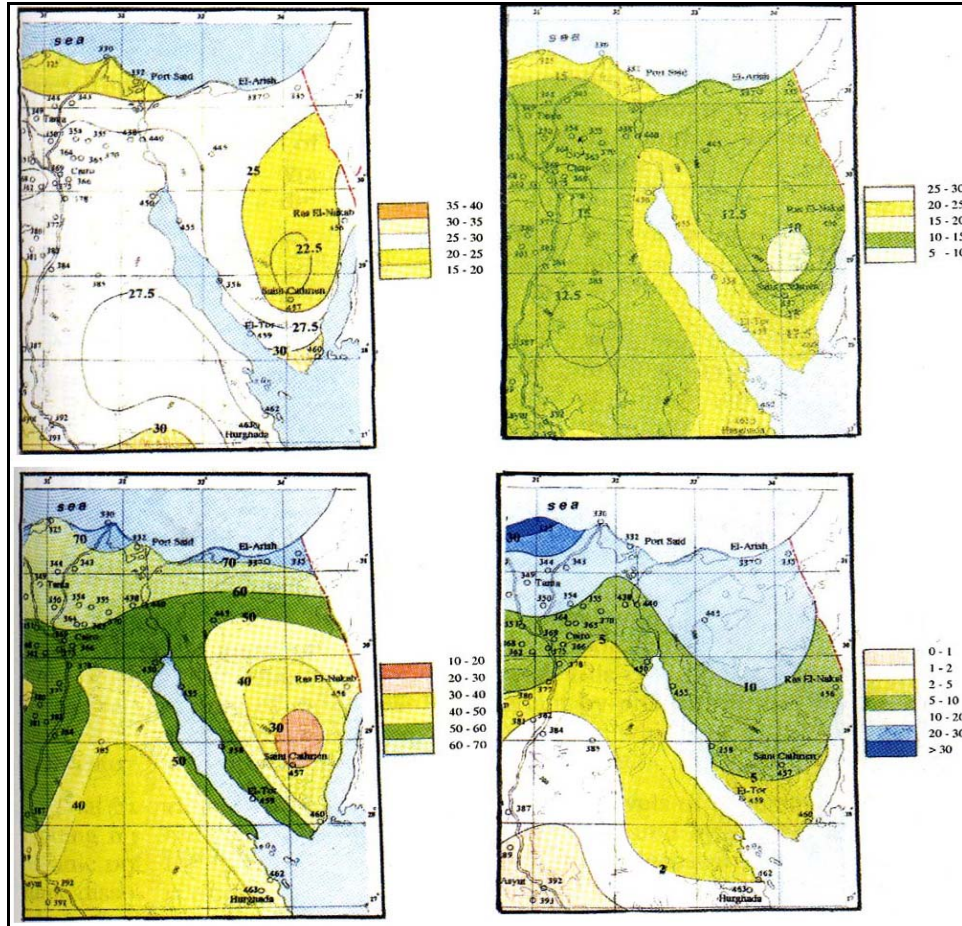


Figure (2): Isotherm maps of annual means of daily maximum (A) and minimum (B) air temperature in C, relative humidity in percent (C) and isohyetal of annual rainfall in mm (D). (After the Egyptian Meteorological Authority, 1996).

Materials and Methods

Soil assessment of the study area is based on building a geographic database of El-Maghara soil area, depending on the material inputs and methods as follows:-

Material inputs

(1) Hardware: PC Pentium 4, GPS, Hipad digitizer, scanner, color and black and whit printers.

(2) Software: Mainly ERDAS Imagine 8.5, ARC GIS 8.3 and ARC INFO 7.2 software and partly surfer 7 have been using to construct the geographic database and image enhancement.

(3) Remote Sensing data: Landsat ETM+7 image with 15 meter resolution dated 2000, TM Satellite image dated 1986 (Two image in same season, September month).

(4) Geo-reference maps: Topographic contour maps sheets 1: 50000 scale and Geological map of Sinai 1: 100000 scale

(5) Field verification: Pedological study on soil profiles and surface sampling achieved the fieldwork. The field soil survey data in 2005 for 13 soil profiles and 48 soil samples to delineate mapping unit's boundaries and repeated the ground truth for the land cover types in 2005. Soil layers were sampled according to the FAO Guidelines of soil description (1970) and standard the soil survey Manual, Soil Survey Staff (2003) for laboratory analysis of the different physical, chemical, and nutritional properties (Fig. 3).

Methods and Techniques

There are several methods and techniques are used to carry out soil assessment of El-Maghara area as follows:

(1) Image processing

There are many types of image enhancement techniques are used in the present work such as:

*** Image Classification Technique**

Standard classification procedures namely unsupervised and supervised classifications continue to be applied in the generation of land use classes. Unsupervised is based on grouping pixels into clusters which depend on the algorithm applied. On the other hand, supervised classification involves first establishing training sets which are subsequently used to assign image pixels to the training samples that best fits the corresponding data. Similarity different algorithm exists for instance minimum distance, Likelihood, Stepwise linear classification and Maahalonolois distance.

The ETM+7 satellite data is subjected to image classification techniques in order to classify the land cover units of El-Maghara area.

The enhanced unsupervised classification image has been verified in the field before the sampling location has been selected to cover all the suggested classes. However, the enhanced supervised classification image has been used to cover all the suggested classes of the land cover units of El-Maghara area. In the present study, the best three ETM – band combination have the highest covariance among the ETM-bands. There are two methods have been used to select the optimum three band combination as Sheffield (1985) that is depend on the use of variance covariance matrix for a scene. The second method was given by Chavez et al., (1984), that is based on the amount of total variance and correlation within and between various band combinations. Both methods are shown that best band combination is (2, 3 and 4) assigned as (Red, Green and blue) to increase the discrimination between some land cover units.

*** Change detection and Post - classification comparison techniques**

Change detection is the process of identifying differences in the state of an object or phenomena by observing it at different times. It is useful in such diverse applications as land use change analysis, monitoring of shifting cultivation, assessment of deforestation and so on. It is essential for studying change on the earth's surface. In the

Post-classification technique, two independently classified images will be compared holding promise of minimizing the effect of normalizing for atmospheric and sensor differences between the two dates by using histogram matching and projected into same projection type to prevent any fuzziness of data. The accuracy of the change images produced is likely to be the product of multiplying the accuracies of each individual classification (Karanja and Lohmann, 2000). It has been used in change detection in semi-arid environments.

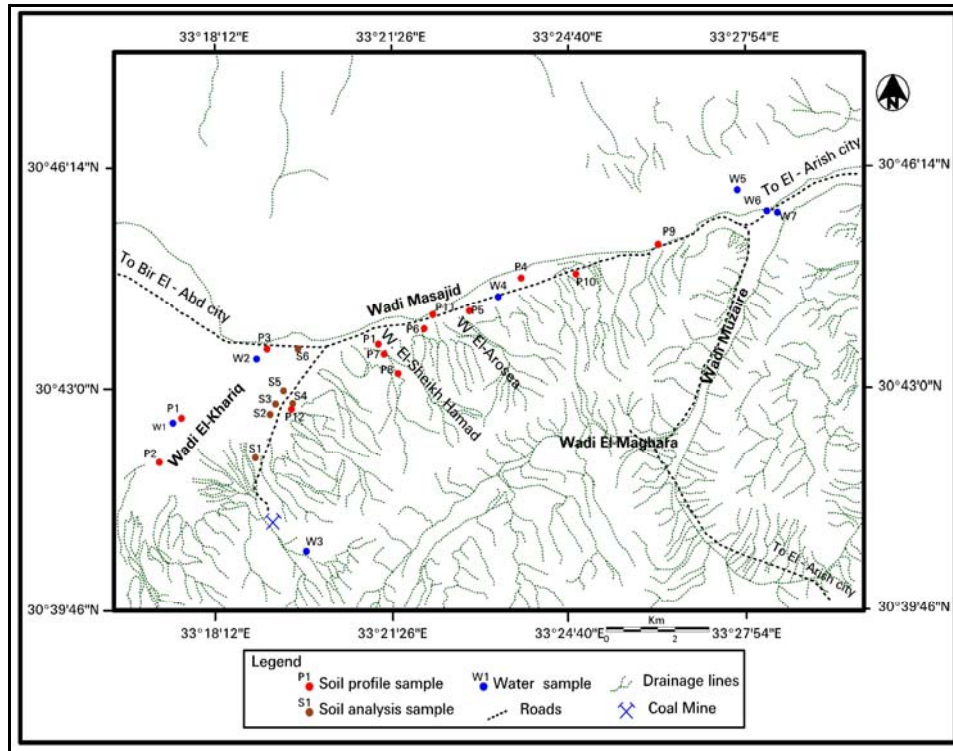


Figure (3): Sample soil and water locations map of El-Maghara area.

In the current work, our analysis, post-classification, image differencing change detection techniques were applied. Post-classification change detection involved computing the area covered by each of the two unsupervised classified images from the two data sources independently and comparison made first of the 1986 data and then between 200 data sets from the RGB images. Images overly based on the classification of 1986 and 2000 RGB images involved analyzing the temporal extent of the classes separately with the RGB 1986 as background image. Specifically areas classified developed in 1986 and 2000 and in both years i-e, areas of no change are highlighted and this was repeated for the other classes namely transition and reserved. On the other hand, image differencing using the 1986 and 2000 simulated image were employed based on the intensity bands generated by transforming the RGB data sets into HIS color space.

(2) Geographic Information Systems (GIS)

The land information system was used for analytical and data management features including input for editing and reformatting and output for constructing maps and useful arrays of spatial operations for provided vector or raster based modeling capabilities for overlay and buffer analysis creation. Finally, all vector layers were imported into GIS. GIS is used for design spatial modeling of the soil assessment of El-Maghara area. The average weight values were calculated for each property of each profile using horizon thickness and profile depth. Different range of values or features should have a different score in a scale according to its importance in potentiality of the soil properties.

An overlay operation would then evaluate the intersected region by a sum of the score, so that each resulting region is characterized by a score measuring its potential. Based on this method the capability of soil properties condition of the present study area is estimated. In the present study, features of an individual soil parameters theme has been score in the 1 –10 scale in the ascending order of soil significance. The raw score for each feature is then normalized using the following relation to ensure that no layer exerts an influence over the other.

$$X_j = (R_j - R_{\min}) / (R_{\max} - R_{\min}) \quad (\text{Shahid and Nath, 2002})$$

Where; X_j is the normalized score R_j is the raw score
 R_{\max} is the maximum score, and R_{\min} is the minimum score of a layer.

(3) Soil Evaluation

There are many approaches in land capability classification according to the collected samples and land cover data. In the present study, the collected soil samples were chemically, physically analyzed where, some soil parameters were measured in the field or interpreted from the enhanced ETM images. These parameters are climate condition, texture, soil depth, CaCO₃ %, Gypsum %, gravel %, salinity, alkalinity, slope and drainage pattern. Storie (1964), Sys (1991) and FAO (1996) have used these parameters for land evaluation and land capability classification. The same parameters in addition the irrigation water availability and quality has been used by Sys (1991) to determine the soil suitability or capability index according to the following equation (Table 2):

$$CI = A/100 \times B/100 \times C/100 \times D/100 \times E/100 \times F/100 \times G/100 \times H/100 \times I/100 \times J/100 \times L/100 \times 100$$

Where; CI = Capability Index, A = Availability and quality of irrigation, B = Texture class, C = Soil profile depth, D = Gypsum Content, E = Slope %, F = Wetness, G = Salinity level, H = Sodicity (ESP), I = Calcium carbonate Content, J = Erosion, L = Climate.

Results and Discussion

The soil assessment of El-Magara area is based on the soil mapping units, the soil evaluation and soil degradation factors as follows:

Soil mapping units:*** Soil classification and mapping units**

The image enhancement of ETM satellite image of El-Maghara area by supervised and unsupervised classification techniques (Fig. 4). The study area is classified into five major classes based on the geomorphology and formed from two main parent materials as sand and calcareous deposits. Among the different profiles, statistical parameters were used to differentiate between the various depositional environments. The texture classes are show variations of texture, indicating that water and wind actions are the main factors responsible the formation of these soils.

Generally, the soils representing the soil association of main Wadi (flat and nearly flat, profiles 2, 9 and 10) are mineral soils devoid of any observable signs of soil development and do not have any diagnostic horizons. The texture is sand and loam sand, sand loamy and loam texture soils are usually dry in all parts of the year and do, not have cracks or lithic and or paralithic contact within 50 cm. of the soil surface. They are a torric moisture regime and thermic characteristics. Therefore, these soils are placed in the order Entisols, suborder Orthents, great group Torriorthents and subgroup Typic Torriorthents. Soil representatives for the different wadis are not having any diagnostic horizons. They have sand to medium texture, a high content of CaCO_3 , and the soil temperature regime being thermic. The different values of CaCO_3 content are revealing the original deposits formations in these soil, which may be due to derivation from calcareous parent rocks and it was distributed in coarse sand, fine, silt and clay fractions. These soils are usually dry at all parts of the year in soil profile No. 3 at Wadi El-Shiekh Hamad therefore, these soils can be classified into order Entisols, suborder Psamments, great group Quartzipsamments and subgroup Typic Quartipsamments.

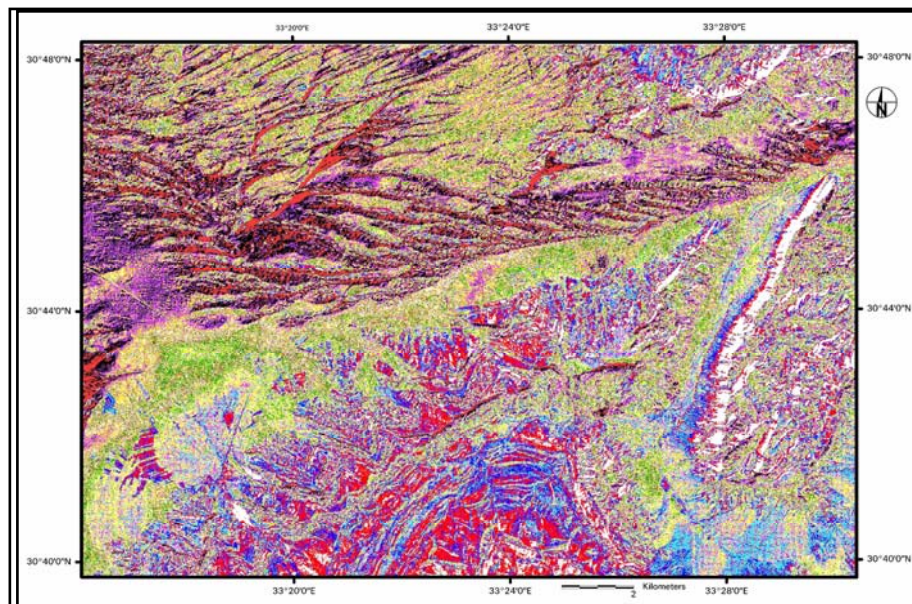


Figure (4): Unsupervised enhanced classified ETM+7 image of El-Maghara area, showing the different types of soil.

*** Soil mapping units characteristics:**

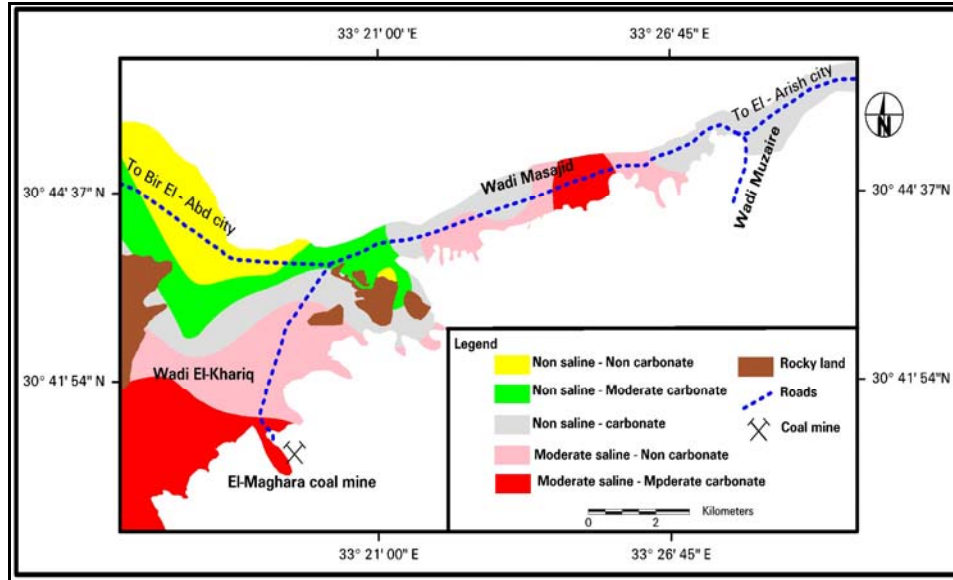
The final soil map was prepared by using ARC/INFO and ARC GIS software after the achievement the field verification of the classified images, soil sampling and laboratory analysis of the physical and chemical soil properties (Fig. 5). Statistical analysis of soil properties indicate that the most effective soil properties were the texture %, silt %, calcium carbonate %, available K and P in addition to electric conductivity and pH. An integrated soil units by GIS of El-Maghara area for each soil mapping units including representative profile, area size, some chemical soil properties such as EC, pH, OM %, CaCo₃ %, available K and P (Table 1).

Generally, the organic content in the study area is low values may be due to virgin soils and climate effect (arid conditions). The high values of organic matter content may be due to residues of root from natural vegetation. The low content gypsum may be due to derivations from natural formations of parent materials. Data of pH values in the soil samples are ranging between 7.12 to 8.85 that are indicating slightly to strong alkaline soil reaction and it may be due to relatively high concentration of alkaline cations. The EC values are classified into non- saline to high saline soil range according to Soil Survey Manual (1999). The low EC values may be due to soil texture and low concentration of soluble salts in this soil solution. The higher content of Ca²⁺ may be an indicator to their derivation from calcareous parent rocks. The slightly high values of CEC may be due to fine texture (loam and sand loam) in El-Khariq, Wadi El-Aroseah and Wadi Massajid soil samples. Moreover, the low concentration from soluble salts in soil solution. The slightly high values of ESP may due to relatively high concentration of sodium cations in soil solution and slightly high percentage of fine particle (silt and clay). The low values of nitrogen and moderately high level of phosphorus may be due to their origin of deposits and fine texture. The total potassium values may relate to the status of less weathering of potash feldspars in the parent rocks and less transformation of fine particle fractions. The concentration of micronutrients values (Fe²⁺, Mn²⁺, Zn²⁺, and Cu²⁺) are in agreement with SILLANPAA (1982).

According to the results of the physical and chemical properties of El-Maghara soil are reveal that these soils do not have any diagnostic horizons and no visible diagnostic horizons that could be recognized in any studied soil profiles in all wadis of El-Maghara area, that undeveloped and immature.

Table (1): Showing the description soil mapping units of El-Maghara area.

Soil mapping units	area %	EC ds/m	pH	SAR	CaCo ₃ %	O. M.%	P ppm	K ppm
Non saline – Non Carbonate	14.97	0-4	7.4-8.3	2-8	2-36	0.3-0.12	8-16	9-28
Low saline – Low carbonate	14.63	8	7.4-8.8	4-10	4.34	03.0.18	7-20	10-29
Moderate saline – Moderate carbonate	24.96	12-16	7.4-8.4	2-14	6-30	0-0.22	7-18	12-29
slightly high saline – slightly high carbonate	25.13	20-32	7.4-8.3	6-22	10-32	0-0.21	8-20	16-28
High saline – High carbonate	20.31	36-48	7.5-7.9	12-26	14-28	011-0.20	8-16	20-25



Figuer (5): Soil mapping units of El-Maghara area.

Soil evaluation parameters:

The soils will be evaluated from the agricultural point of view according to Sys System (1991). The data sets were collected from thirteen-soil profile to build database displaying the study area. Using ARC/INFO GIS software, the all parameters used in Sys's equation, physical and chemical parameters have been contoured to construct line digital maps (Layers). These layers have been converted into polygon layers. Average weight of soil physical and chemical properties were used to evaluate the soil capability, soil fertility and soil suitability. All layers have been integrated into one layer. The integrated layer is used to classify or rate the soil in the study area into Five categories (Fig. 6) on the basis of classification criteria given by Stories (1964) and Sys System (1991). The capability final index ranged between 16.4 % and 66.8 %, so the area classified as class C2, C3, C4, C5 and C6 with 66.8 %, 48.5 %, 29.8 %, 16.4 % and 10.03 % from the total area of the study area (Table 2). Furthermore, soil fertility of the study area is classified into five classes (Fig. 7).

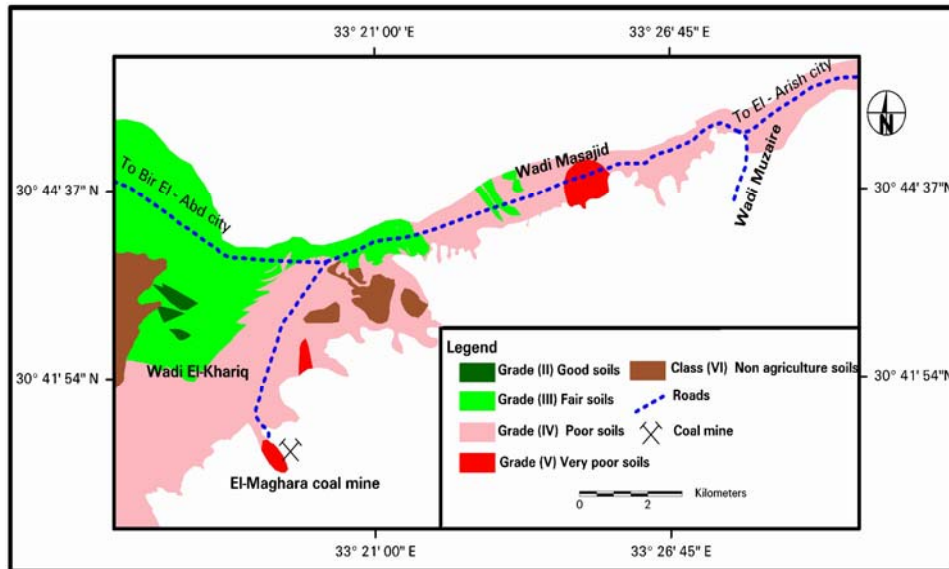


Figure (6): An integrated land capability classes of El-Maghara area

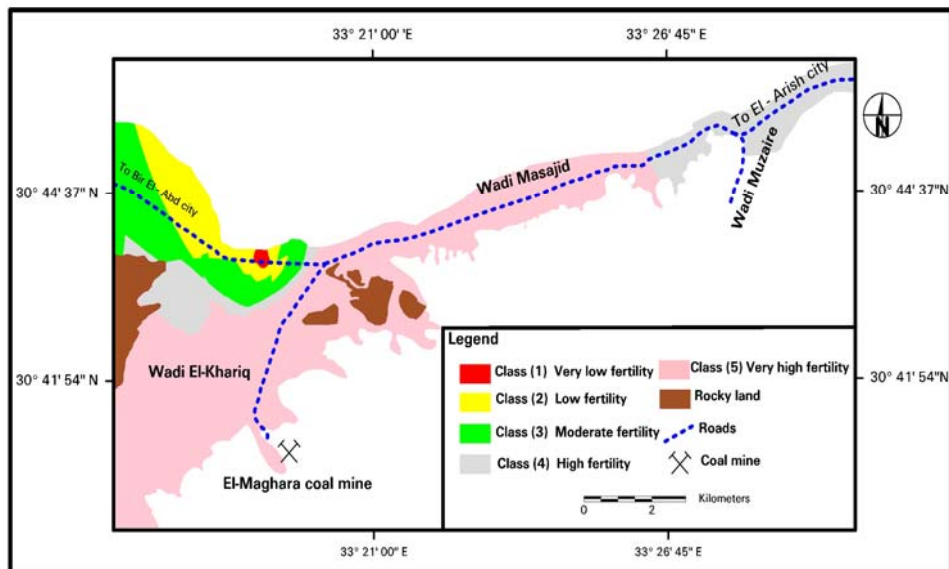


Figure (7): An integrated fertility classes map of El-Maghara area

Table (2): Suitability rating and classes for agricultural use in El-Maghara area.

Capability class	Average %	Land Suitability class	Suitability class for agriculture
C2	66.8	Highly S.	Good
C3	48.5	Moderately S.	Fair
C4	29.8	Marginally S.	Poor
C5	16.4	Currently not S.	Very poor
C6	10.03	Permanently not S.	Non-agricultural

Soil Degradation of El-Maghara Area

Soil degradation is defined as deterioration in the physical and chemical properties of the soil due to environmental change causing soil erosion, loss of fertility and salinization (Arnous, 2004). (RS) image analyses systems and (GIS) show great functionality for the integration of a wide variety of spatial information supporting tasks such as natural resources management, regional planning and environmental monitoring. (RS) technology and GIS offer the ability to facilitate ecosystem change investigations leading to a more complete understanding of human impact on the ecosystem. This research gives the approaches of deriving temporal ecosystem change. Furthermore, this study analyses the process of natural and human induced landscape transformation on the study area.

Climatic condition, geographical situation, unfavorable winds and the influence of sand activity and movement, salinity and waterlogging are of the broad indicators of desertification monitoring. Desertification is the processes of deterioration in the ecosystem that can be measured by reduced productivity of desirable plants, undesirable change in the biomass, accelerated soil deterioration and increased hazard for human occupancy (MAB, 2005). Soil degradation by accelerated water and wind-induced erosion is a serious problem and will remain so during the 21st century, especially in developing countries of tropics and subtropics. Erosion is a natural geomorphic process occurring continually over the earth's surface. However, the acceleration of this process through anthropogenic perturbations can have severe impacts on soil and environmental quality. According to the satellite image enhancement, analysis, interpreted and the field verification the soil degradation manifestation of in El-Maghara area soils includes:

- (1) Growth and encroachment of active sand bodies.

Desertification in the study area is recognized by increase in active sand activities and by the extensive deterioration of the natural vegetation cover due to over-grazing, quarrying activities, creation of mobile sand barriers damage the ecosystem, and construction of new cities, frames, highways, and subways that was mostly based on irrational control measures. The spatial and temporal change patterns of land use were quantified by interpreting (RS) data and used a (GIS). Satellite images (1986 & 2000) were used to classify and study the change detection of the study area. The resulted enhanced images showed that the study area were effected by extensive and large amount of sand accumulations and encroachment around El-Maghara area that is due to change the soil quality, biodiversity and decreasing the exposure area for agriculture (Fig. 8).



Figure (8): The effect of sand dunes encroachment along Wadi Massajed

(2) Deterioration of range lands.

The formation and persistence of cover soil in El-Maghara area are strongly influenced by the arid climate. The scarcity of water for reactions within the soil and for the leaching of soluble components from the soil itself restricts the extent of soil formation processes. All soils in the area are considered to be very young and immature, and as highly influenced by the geological and geomorphological conditions of their formation. Soil texture is controlled by geological and geomorphological factors as well. Weathering of the limestone produces soils of medium texture, sandy loam or less commonly, sandy clay loam, but this can be altered by two main factors. The first one is the presence of aeolian sediments, these are deposited quite close to their source, and are consequently very sandy; the second factor is the sorting of sediments. The sparseness of the vegetation cover and the harsh climate cause extensive soil erosion. Water is not enough to eliminate most of the eroded material that accumulates in depressions. High standing surface are generally bare, also because of the hard parent rock, while soils of medium to high depth are formed by accumulation processes in depressions (Fig. 9).



Figure (9): The formation and persistence of cover soil in El-Maghara area (Aeolian sediments) , sandy dune habitat

According to the results of interpreted image enhancement by change detection and post-classification comparison techniques for the study area, El-Maghara area is subjected to nature and human activities due to change of physical and chemical properties of land cover. Especially, at El-Khariq plain, along Wadi Massajed, and Wadi Sheikh Hamad, where the spectral characteristics of the soil classes are completely altered from TM image (1986) to ETM image (2000) (Fig 10). The field verification of the enhanced satellite images show that the man-made hazards include the mine and quarrying dumps, which strongly reshaped the geomorphology of the area and has a bad impact on the environmental conditions. Therefore, Quarrying activities should be considered another environmental impact. Huge amounts of tailings represented as accumulate loose sediments are produced from quarrying activities. Mining wastes are classified into liquid and solid wastes and sometimes gases emissions. These wastes and emissions depend on the type of manufacturing and the type of product. They generally have served impacts that upon the environment because they contain large amount of pollutants such as heavy metals and poisonous substances. Mining and quarrying activities due to pollution and degradation El-Maghara soil area at W. Safa, W. El - Khariq and along W. El-Massajed (Figs. 1 and 11).

Table (3) shows the result of analysis for six samples from the area that is influenced by solid and liquid wastes. The analyzed showed increasing the amount and types of bacteria, fungi, nematode, yeasts and protozoa. The highest number of isolated microorganisms and nematode were observed in the soil samples numbers 5 and 6, on contrast the lowest number was detected in the soil sample No. 1. The microscopically examination of the isolated fungi from soil samples 1, 2 and 3 were suffering from

distortion in their structures accompanied with a noticeable rate of malformation may be referred to the effects of carbon content of soil (Fig. 2 & 3).

The results of soil analysis are indicated El-Khariq plain and Wadi. Safa subjected to environmental impacts by acid mine of El-Maghara coal mine where the concentration of the Total Petroleum Hydrocarbon (TPH) is increased with Fe and moisture content. This pollution is due to change of physical, chemical and biological properties of water

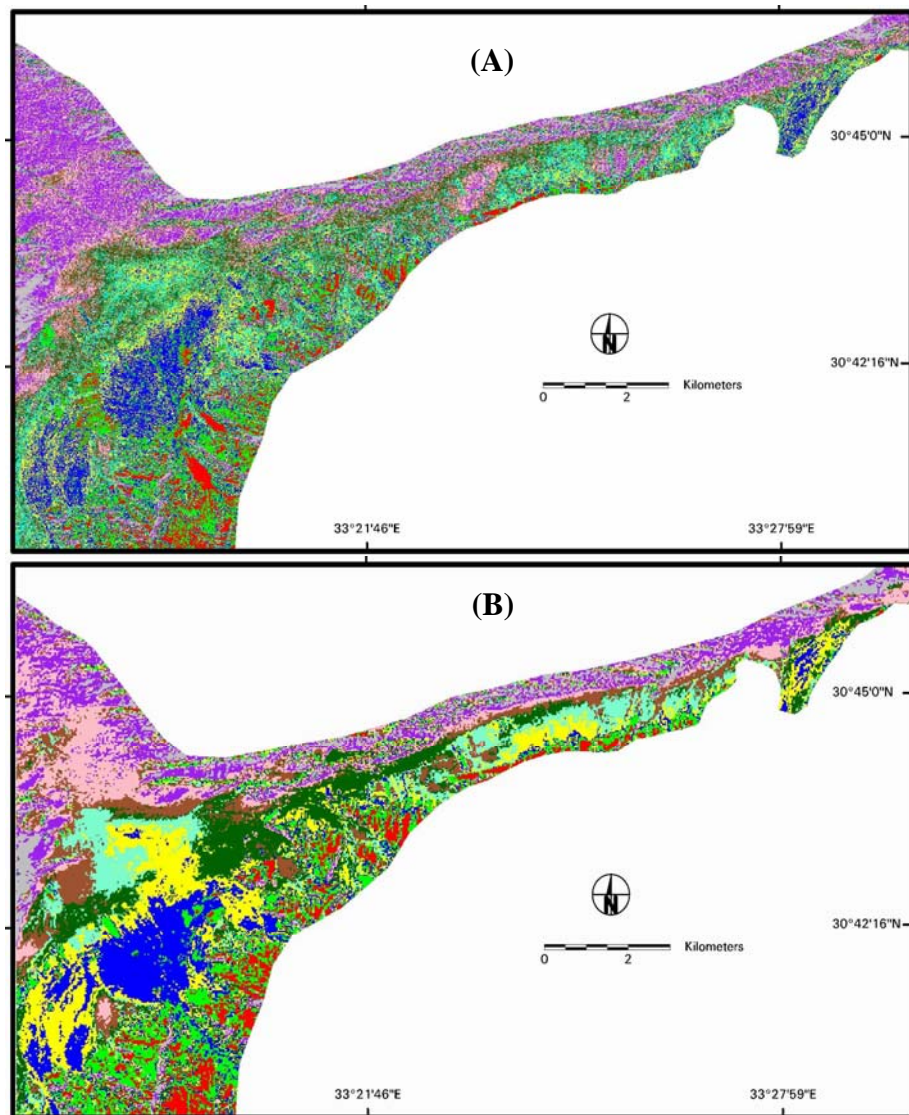


Figure 10: Post-classification enhanced images of El-Maghara area (A) TM image 1986 and (B) ETM image 2000, showing the soil changes according to the environmental impacts.



Figure (11): Quarrying activity threatening the plant life in W. Sheikh Hamad, dominated with Acacia trees.

Table (3): Soil samples analysis near El-Maghara coal mine in El-Khariq plain

	S1	S2	S3	S4	S5	S6
Moisture	0.8	0.4	0.3	0.8	0.7	0.3
TPH (ppm)	500	300	400	300	300	2600
Fe (ppm)	16500	10800	10400	5400	10700	5000

preventing its use in various applications. In this case, the waste affects directly and indirectly the soil quality, the groundwater, the biodiversity and the public health of El-Maghara area.

Quarrying, mining and agricultural activities have changed the natural pathways for floodwater. In wadi El-Sheikh Hamad the sand and gravel pits have forced floodwater to abandoned their old tracks and initiate new active wadi channel. This has affected the natural vegetation in this wadi. Agricultural activities (Cisterns and Oqum and cultivated basins) in wadi El-Khariq have diverted the natural floodwater path and left natural vegetation without water supply. The distribution of human activities should take into consideration the natural water systems (Fig. 1 & 12).



Figure (12): Typical cistern is constructed in Wadi El-Khariq to store water during flood season, El-Maghara area.

Consequently, there is another parameter due to soil degradation of the study area is the flash flood. The results of calculation the morphometric parameters the study area due to El-Khariq main tributary reflecting high probable floods, but they represent only about 40 km² of the whole basin. The drainage patterns of the main tributaries are mainly parallel to sub-parallel controlled by joint patterns predominating in the area. The main tributaries have gentle slope ranging from 6° to 22°, and also appear to be structurally controlled (Al-Far, 1966 and Abd El-Samie, 2001). Generally, the flash flood of El-Maghara area is lead to soil erosion and the flash flood through W. Safa into El-Khariq plain due to soluble solid mine waste, transport and interact with the soil of the study area. Therefore, the flash flood is owing to change the soil quality, the groundwater, the biodiversity and the public health of El-Maghara area.

(3) Sanitation of water soil degradation.

The increased concentrations of heavy metals in soil irrigated were due to degradation of El-Maghara area. The results analyses of seven water wells along the study area (Fig. 3) showed that there are traces from (AS < 0.0001 to 0.0247 ppm), (Cd < 0.001 ppm), (Sr 0.948 to 6.56 ppm) and (Fe < 0.0054 to 0.0520 ppm) in water. Salinization is another side effect on soil using irrigation water excess of salts (TDS ranging from 1100 to 18940 ppm), that tend to accumulate under high rate of evaporation. According to the salinity content, the main groundwater samples of the study area are unsuitable for irrigation purposes, which require artificial drainage almost all the time.

Conclusions

The main objectives of this study were to assess the utility of RS and GIS techniques, to determine land resources, soil degradation and to evaluate land utilization types and their suitability in El-Maghara area. RS is a very powerful tool for collecting and monitoring land cover and land use information at a very low cost and high accuracy. Developments in GIS technologies process large amounts of spatial data and provide more accurate and accessible information about the land. In the current work, these technologies were successfully used to generate the different an integrated soil maps and land environmental impact assessment in El-Maghara area, north Sinai, Egypt. Where, El-Maghara area is one of the most important areas in north Sinai that received a special governmental attention. Its sustainable development is one of this particular area is supported by its characteristic economic resources, that are manifested by the availability of soil, coal deposits, building materials and water resources. The resulted suitability factors maps are soil classification units, fertility, capability, suitability of water and environmental conditions. Five mapping units were identified using the most effective soil properties in the spatial distribution pattern. Each map unit is characterized by different soil properties and the mode of sedimentations. The capability soil map is classified as class C2, C3, C4, C5 and C6 and the soil fertility was classified into five classes. The suitability results showed that 16.4% to 66.8% of the studied soils are found to be poorly to highly suitable for agricultural uses. These soils are classified as Typic Torrifluvents, Typic Quartzipsamments and Typic Torripsamments. The land suitability classifications of El-Maghara soils area are classified in good, fair, poor, very poor and non-agriculture soils grades. Soil degradation of El-Maghara area includes mining, quarrying, salinity of water irrigation, land deterioration by intensive grazing and infringement of mobile sand bodies or sand duns and water erosions. This study was carried out to emphasize the necessity of land assessment and will help and leads to the sustainable use of El-Maghara area. Finally, the techniques that are used in the present study can be applied in anther areas that are having the same conditions.

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تقييم الأراضي بمعالجة الصور ونظم المعلومات الأرضية بمنطقة المغارة، شمال سيناء، مصر

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استهدفت الدراسة تقييم المصادر الطبيعية وتحديد مدى تدهور الغطاء الأرضي؛ بهدف تنمية منطقة المغارة بشمال سيناء، مصر، وللتوصل لذلك تم إجراء تحليل وتكامل للبيانات الحقلية، والمناخية، والجيومورفولوجية، والبيانات الخاصة بالتربة والغطاء الأرضي، وقد تم استخلاص البيانات من خلال الصور الفضائية المعالجة، ومن نماذج الارتفاعات الرقمية، ومن خلال إنشاء قاعدة بيانات جغرافية متكاملة خاصة بمنطقة الدراسة؛ وذلك بهدف التعرف على الأنواع المختلفة للتربة وتصنيفها تبعاً لخواصها الطبيعية والكيميائية والتقسيم الأمريكي للأراضي. ومن أبرز نتائج الدراسة تقييم مجموعة من الخرائط الرقمية المتكاملة الخاصة بتصنيف التربة، وتحديد معامل القدرة الإنتاجية، ومعامل الخصوبة، ومعامل الصلاحية، بالإضافة لتقييم الوضع الراهن لمنطقة المغارة، وتحديد حالة التدهور البيئي للتربة، وللعوامل الطبيعية والبشرية بمنطقة الدراسة.

الكلمات المفتاحية: تكامل البيانات، تصنيف الأراضي، تدهور التربة، المخاطر البيئية، استخدامات الأراضي.