Utilization of Remote Sensing and Geographic Information System in the Sustainable Development of the Central Eastern Desert Area of Egypt

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The investigated area is located in the central part of the Eastern Desert of Egypt. It is bounded by Idfu – Marsa Alam and Qift – Quseir roads. The area represents one of the most important parts of Egypt for development. It has the best attractive beach and very beautiful coast for marine tourist activities. It has also a considerable natural resources represented by metallic and none metallic mineral deposits in addition to the unique atmosphere and the biodiversity that the area characterized with. In the same time the area own a valuable wealth of the human heritage represented by the ancient mines. It is also suffered of scarce of water and from flooding during very short time in the winter. The flood usually causes some damages on the urban area. This area exhibits uneven surface, where its landscape is characterized by the high mountainous ranges of the Eastern Desert and the coastal sedimentary stretch along the Red Sea coast.

The data has been collected about the study area are different and variable. It has been subjected to several and suitable processes to be useful in a G I S environments. deducing a land capability and land suitability for the sustainable development in the area.

Introduction

This paper deals with the sustainable developmentof the area extends from the Red Sea coast to the Nile River between the two roads Idfu -Marsa Alam, and Qeft – Al Quseir in the eastern desert of Egypt and covers about 25000 Km^2. This area lies between longitudes 32° to 35° and latitudes 25° to 26° .

Objectives

The scope of the study is to build up a Land suitability map by establishing a geo-environmental database for the study area in a Geographic Information System Environment and to give suitable recommendations to the development strategy of the area under consideration with respect to the all-available data.

Physiography

The study area includes three main physiographic categories

1- The Red Sea Coastal plain. 2- The Nile Valley 3- The Red Sea mountains.

1- The Red Sea Coastal Plain extends parallel to the Red Sea mountains from (Quseir in the north to Marsa Alam in the south) It

varies in width from few hundreds of meters up to several kilometers and is mostly a gravel desert. Shallow channels of numerous wadis draining the Red Sea Mountains transect it. Deltas of major wadis made of fine alluvial deposits push the coastline into the sea. Except for the main drainage channels or deltas of wadis, the coastal plain is mostly devoid of plant and animal life**.**

2- The Red Sea mountain area is a part of the Red Sea high mountain area. It is part of the Arabo – Nubian massive. It is characterized also by good exposures with hilly nature relief up to 1611 m above sea level (G. El Meatiq) and 1610 m. above sea level (G. El Atawy). Many Wadis, mostly draining either eastwards to the Red Sea or westwards to the Nile Valley dissect the hilly area. The topographic relief over the wadi floor range from 50 to 600 m above sea level. The floors of most wadis are flat and wide ranging betwen 400 and 500 m. in width (e.g. Wadi Alam, Wadi Abu Dabbab, Wadi Igla, Wadi Mubarak.) The orientation of the mountain ridges is not persistent and generally reflects the geological and morpho-tectonic features of the area.

3- The Nile is one of the longest rivers allover the world. It extends from south to north passing through the Indigo countries. The Indogo countries include Ethiopia, Uganda, Kenya, Rwanda, Burundi, Tanzania, Eritrea, Congo, Sudan and Egypt. In Egypt it extends from Halfa northeasterly till Aswan where its direction become northerly, at Idfu it changed to northwest, getting its north direction again at Isna, and it is abruptly bind to the east near El Edisat village then east north and changed another time to the northwest at El Gabalaw village. At Dandara it starts a southwest direction to Nagaa Hamadi and then returned to its north direction till Cairo and then bifurcate into Rosetta and Damietta branches. The Nile Valley divides Egypt into two distinct parts (Eastern and Western Deserts). It is low land slopped to the north. The Nile Valley area is intensively cultivated where it is covered by the most fertilized soil.

Methodology

The study deals with all available data about the area such as geomorphological, meteorological, geological, geophysical (Aeromagnetic, seismic), geochemical, Remote Sensing, Biologic diversity, and hydrogeological data. The collected data were converted into digital format and reformatted to (GIS) environment through four steps as follows:

1-In put data. 2- data management (data storage and retrieval). 3- manipulation and analysis. 4- out put data.

These steps were applied using the following softwares Arc/Info, Imagine Erdass, Surfer 32, Sy-base, Power Builder, Microsoft Excel, and Microsoft Word Softwares).

The original data exist in form of maps, tables, reports, figures, statistics, etc. are described in the system as follows:

Meteorological data was referred to Egyptian Authority for Meteorology obtained from eight Stations (Hurgada, Quseir and Ras Banas) along the Red Sea and (Asuit, Sohag, Qena, Luxor and Aswan) along the River Nile for 30 years cycle (1966 to 1995) and plotted in charts by Microsoft Excel.

Five Topographic map of scale 1: 250.000 published by Egyptian Survey Authority 1991(ESA), namely (Marsa Alam, Luxor, Qena, El Barramya, and Al Quseir) are used

Imagery data the area of study is covered by four **Landsat Thematic Mapper (TM) images** of numbers 173/43, 173/44, 174/43, and 174/44. TM images were acquired in 1984 (30 meters ground resolution). These images were subjected to most of the image

processing such as (rectification (based on topographic map1: 250.000), Spectral and Radiometric Correction, contrast matching, mosaicing. The TM mosaic image covering the study area Fig. (I-2) that produced to be used in compiling the geologic map of the study area. Stretching, principal components analysis, rationing, merging processes were applied to the TM mosaic image.

Radiometric data (interpreted by Aeroservices Division Western Geophysical Company of America; (1985), of Potassium, Thorium, Uranium, anomalies and their ratios are used. All of the thematic data were scanned, reprojected into UTM projection type and vectorized to be in suitable format for GIS.

Instrumental Seismic epicentre data were also used.

Hydrologic map of Scale 1:2,000,000 published by Institute of Water Research (1988) and five maps of scale 1:100,000 represented the areas around Nile River (Qena, Esna, West Esna, Kom Umbo, and Luxor are also used and the groundwater properties compared with the standard properties for water usage are added to the GIS system.

The geologic map of Marsa Alam of scale 1: 100,000 published 1990 by Egyptian Geological Survey And Mining Authority (EGSMA, a **Geologic map of Egypt** scale 1:2,000,000 published 1991 by (EGSMA) and two **Geologic maps** scale 1:250000 (Quseir 1992 and Barramiya 1992) and geologic map of Qena - Idfu area of scale 1:200,000 published by EGSMA 1968 with the help of the geologic map of Aswan area 1978 of scale 1: 500,000 and the remotely sensing data to compile a general geologic map of scale 1:250,000 for the study area.

Geochemical data of spectrum analyses for 7842 rock samples analysed by Sabet et al, (1976) and five geochemical anomaly maps which are Umm Gheig, El Igla, El Sibai, El Barramiya and El Laquita, EGSMA 67/73) of scale1: 100,000 were used. These data cover most of the area. Each sample includes analyses of 16 elements. So a 16 maps for 16 elements are produced. The sample location coordinates are extracted from the already scanned sample location map and linked to its analyses table using Microsoft Excel software, acquisition of the geochemical maps for each element is done using Surfer 32 software. Finally all layers are vectorized by Imagine Erdass.

The mineral resources obtained from the Quarries and Mining Sector, EGSMA, (2001) were plotted in digital maps.

The above mentioned data are organized to built the database management system. Finally several GIS analysis such as overlaying, buffering, and intersecting were done to deduce and conclude the relation between the different types of data layers.

Planning and Management

land resources planning is the process of evaluation of options and subsequent decision-making which precedes implementation of a decision or plan. Land resources management, in its narrow sense is the actual practice of using the land by the local human population, which should be sustainable

Zoning, Resource Management Domains, Allocation

The term "zoning" is used as subdivision of the land on the basis of its physical and biological characteristics (climate, soils, terrain forms, land cover, and to a degree the water resources), and is used as a tool for agricultural land use planning

The evaluation of the land and planning for different actual or potential uses requires a series of steps, as follows:

(I) In collaboration with the stakeholders, the establishment of achievable goals and objectives framed within an enabling policy environment for sustainable land use;

(II) The identification and delineation of land, on the basis of comparable physio-biotic characteristics (climate, elevation, landforms, soils, hydrology), into natural land units or zones;

(III) The assessment of the inherent land qualities, and their constraints and opportunities, of the identified land units.

(IV) The identification and characterization of the present forms of land cover or land use per land unit or land zone.

(V) The identification of prospective land utilization types or production systems in accordance with the wishes of the stakeholders;

(VI) The identification of the physio-biotic and socio-economic requirements of the agreed land utilization types.

(VII) The matching of the inherent land qualities of (iii) with the requirements of the utilization types of (vi).

(VIII) The formulation of alternative land uses or non-use per land unit or zone as a result of (vii);

(IX) The assessment of the alternative land uses against the needs and aspirations of all population groups (to be) involved and affected, through the use of platforms for negotiation and decision making that include all stakeholders;

(X) The decision to proceed with one acceptable and recommended land use; and

(XI) The identification of policies, strategies and measures to be taken to move from the current to the recommended land use and with the active participation of all stakeholders.

It is noted that a distinction is made between **land cover and land use**. **land cover** is the observed cover of the land as seen on the ground or by remote sensing; it comprises the vegetation (natural or planted) and any human constructions which occur on the earth's surface. Open water bodies, ice, bare rock, mobile sands and similar surfaces are included. **Land use** concerns the function or purpose for which land is used by the local human population and can be defined as "the human activities, which are directly related to land, making use of its resources or having an impact on them". Data on the sequence and type of activities, the inputs (labor, capital, water, fertilizer, etc.), and resulting outputs (type of produce, and length of the cropping cycle) permit precise definitions of a land use, economic and environmental impact analysis, and modeling of the effects of modification of the land use, or its substitution by another land use

Natural Resources in the Study Area

Climatic resources

The climatic resources includes both of wind and sunshine that can be used in generating energy, and rain fall that can be used as water resources

Water resources

The water resources in the investigated area are the River Nile water, the ground water, the transported water, the rainfall water, and the desalinated water.

The ground water occur when the precipitation occurs in the area, and less than about eight to ten millimeters, there is typically rare runoff of rainwater; most of this water either evaporates or percolates into the subsoil. When the rainfall amounts to more than ten millimeters, runoff may occur and wadi beds will begin to carry water depending on the amount and duration of rainfall, the intake capacity of the basin’s soils and their moisture content.

Generally, the groundwater within the area may be classified into two main types as follow: -

1-Shallow groundwater, occurring mainly within the highly fractured zone of igneous and metamorphic rocks, Quaternary rock and Recent deposits such as wadi fill or sediments
2-Deep groundwater, mainly occurring in confined and semi-confined aquifers of pre-Quaternary formations.

Much potable and irrigation water in the studied region is drawn from the ground. Much of the groundwater is high in total dissolved solids or salinity. After a rain, a large part of the flow in the wadis may percolate beneath surface. There is thus an important interrelationship between surface and subsurface water resources. This occurrence and movement of subsurface water in the wadis are closely related to the geological structure of the water basins. Seepage from wadis into permeable gravels is likely to be a major source of recharge.

The transported water can be provided from other areas, that not far from the investigated area such as Idfu and Qift cities along the River Nile. The government did a plan for establishing a water pipe from the Nile River to supply all the cities lie on the Red Sea Coast, and now the pipeline supply the area until Hurgada and still working to feed the other areas to the south until Halaieb area. Because of the investigated area lies along the Red Sea Coast, the Desalination water can be used perfectly, especially for using in the tourist buildings and for the human settlement. A number of desalination planets are established along the Red Sea Coast.

Agricultural Resources

The agricultural resources in the investigated area are limited to the Nile Valley zone except some scattered small areas that can be used for growing some plants and vegetables. The factories that controlled the agriculture in the area are the type of soil and the sources of irrigated water.

Soil

The soils of the investigated area consist principally of unconsolidated deposits formed from alluvial, aeolian, or lacustrine deposits and developed primarily under arid conditions. Soil profiles in the area exhibit evidence of maturity, as reflect by the absence of conspicuous soil horizons. Mature profiles, where present, are probably due to long past conditions when the area had more humid climate. Near the coast, the slopes level off to low basins, which receive rainwater, but the water soon evaporates and leaves behind a dry wadi bed, sometimes with crust of salt.

The soils with agricultural potential consist of alluvial æolian deposition. All soils in the investigated area have a very low organic matter content, and their water retention capacity is low. Most of the soils are well drained except for the deltaic and lacustrine clay deposits of the located in the different wadis that crossed the area. They lie at Sea level or slightly above, with high water tables, and are difficult to drain and leach.

Important considerations in the evaluation of soils include: -

*-Quality of water to be used for irrigation,
*-Infiltration and permeability rates of the soil,
*-Leveling required providing a suitable surface for leaching
*-Ability of substrata to transmit the necessary leaching water
*-The level of salinity or sodic conditions, and
*-Availability or absence of gypsum to replace sodium in sodic soils.

Irrigation water

According to the surveying of the area and study all the possible resources that can be used for irrigation, the three resources of irrigation water are the Nile River water rainfall water and the desalination water as well as some shallow groundwater.

Types of agricultural

The analysis of past surveys show that there are widely dispersed of soils suitable for crop production in most of the areas that suitable for agricultural. They are not very good soils but could be improved with use.

High levels of production can be expected because of the sunny climate if good soil management practices are followed; on other hand agriculture will be hindered by such problems as high water table, salinity, high percolation rates, windiness (high evaporation rates), relatively small plots interspersed with poorer soils, and wind and water erosion.

In additions to areas suitable for irrigated cropping, there are many areas suitable for livestock grazing and tree crops. Both could benefit from the use of water from deep aquifers and, on an interim basis, Nile and or drainage water

Mineral Resources

The study area is very rich in mineral resources such as (Gold, Lead, Zinc, Niobium, Tantalum, Tin, Tungsten, Copper, Strontium, Arsenic, Barium, Beryllium, Lanthanum, Yttrium, Iridium, Zirconium, and Molybdenum)

The final land suitability map can be concluded for the study area to be considered as a strategic development plane.

The land suitability map includes the following categories to be considered in the sustainable development

1- The first category is the buffered zone around the roads and the shoreline to protect the marine organisms and obey the all environmental rules and regularities concerning the roads and shorelines.

2- Recreational zone along the seaside where that area characterized by its fresh air, good atmosphere, the Different nature and scenery such as mountains desert atmosphere, animals, marine life and beautiful seashores, the availability of special sports such as mountaineering, surfing, gliding, yachting, swimming, diving and snorkeling.

3- The mining sites were zoned to isolate the surrounding areas from the possible pollution that may be result from such activity.

4- The reclaimation areas zoned where it characterized by the suitable soil and presence of irrigation water supply.

5- The archeological sites were zoned to protect such area and it is recommended to move all these treasures in a large open desert museum to secure the all sculptures where it found in inhibited areas.

6- Five safari routes were suggested to pass through most of the archeological sites.

7- The industrial zones that have been specified to such activity were decided by presidential decision and according to the investment map of Egypt till 2017.

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