Integration of Aerial Photos and Satellite Image with GIS for Natural Resources Mapping of Umm El-Rakham Area, Egypt.

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ABSTRACT

Aerial photograph interpretation and Satellite image processing techniques were used to evaluate the natural resources of the studied area west of Matrouh city, which includes part of Umm El-Rakham and El-Qasr regions. It represents the arid region in the western north coast of Egypt. The area is characterized by different geomorophological features and is covered by, twelve out of sixteen exposures on three strips, panchromatic vertical aerial photographs at scale of 1: 25,000 and two satellite images, TM and SPOT acquired in 1999.

The photos interpretation, image processing, field checks and topographic maps enabled to construct different map types. The digital elevation model shows that elevation ranged between zero and 175 m elevation. Slope ranged from 0.0 to 0.5 % for the coastal basin and up to 2.0 % for the top surface of plateaus, while for the escarpment and some wadis sides raise up to 10 %. In the same time, the dominant aspects are north-east and north direction.

The compilation of such data used to recognize and draw the physiographic unites, watershed area of the wadis and agro-ecological units. Three major land facet systems exist in the physiographic map, coastal basin and escarpment, northern plateau and southern plateau. The area classification leads to ten subclasses of unites represent surface physical features and land cover. The hydrological analysis recognized seven main watershed areas with their topographical characteristics. The integration of all processed data used to identified the agro-ecological system. The agro-ecological features represent by three main zones with four main units and subdivided to thirteen subunits within the seven located tribes' boundaries. The main limiting factors for potential land use were soil salinity, soil texture, slope, and soil depth.

These maps are important for creating data base system for environmental monitoring and socio-economical evaluation and help the decision makers in planning, management and conservation the natural resources of that area.

INTRODUCTION

Egypt has about 96 % of the country's territory is represented by true desert; out of which stony deserts occupy 76 %, clay deserts 0.3 %, salt deserts 2.5 % and sandy deserts 16.9 %. The remaining land is mostly made up of alluvial plains of the Nile Valley and Delta (**Matrouh Resource Management Project (M.R.M.P.) 1992**).. So, the western north coast region of Egypt is a center of attraction for agricultural development since the Roman times. At the present time, the area has gained a great interest and consideration from both governmental authorities and scientific organizations, to build up a development plan for rehabilitation and improvement on a sound of scientific basis (**M.R.M.P.**

1992). Many investigators have studied it from different disciplines, which have resulted in an accumulation of great amount of information. Mapping of natural features depends in large part upon the mapping procedure, which involves an understanding of plant ecology, geomorphology, geology and soil sciences, for a given landscape.

The availability of advanced and up-to-date technologies such as remote sensing (RS) and geographical information system (GIS) for extracting, collecting and managing such significant amount of information will help the end users to organizing that data.

Aerial photography interpretation was the first method for large scale identification of objects in the environment and for many applications in the earth sciences such as geology, hydrology, terrain, land use, land cover and agricultural mapping (**Slater,1987**). Photogrammetric process has relied on a set of measured ground control points to scale and orientate stereo models for monitoring purposes by creating Digital Elevation Models (DEM) in order to allow accurate change detection (**Mills J.P, et al., 2003**);. Even today in the age of satellites and electronic scanners, aerial photographs still remain the most widely used type of remotely sensed data. The main six characteristics of aerial photo that make it so popular are, its availability, economy, synoptic view point, time freezing ability, spectral and spatial resolution, and the three dimensional perspective. **Besenicar and Bilc, (1986)**, used the aerial photo-interpretation for different purposes for human environment planning. They used it for evaluation of land resources and soil survey especially for the zone of a complex relief. **Maged M. et al, (1989)** used the aerial photos for defining the physiographic units. Also, **Field and Collins, (1986)**, and **Fuller et al.,(1989)**, used panchromatic aerial photos for studying the ecology and land use systems. After that, **Weller and Stow** in **(1991)**, used an existing land use and land cover maps and the aerial photos for mapped a number of different landscape setting by spatial analysis techniques.

One of the key elements that the interpreters use to identify and analyze images is clearly the spatial arrangement of color and tone that form natural visual texture. Texture is the visual effect which is produced by the spatial distribution of tonal variation over relatively small areas (**LI Y. and J. Peng, 2003**).

Updating maps and other data with geographical information system (GIS) is more efficient and accurate than conventional methods. GIS (a spatial analysis tool) can focus discussion on spatial distributed units. Nowadays, Natural resources mapped by (GIS), for spatial relationships of all mapped units. Maps are the best form to represent the spatial relations for better analysis. Therefore, better management at all levels of responsibility can be accomplished only through adequate collection of data which identify present land resources and provides a basis for evaluation of land resources capabilities with respect to future needs (**NASA, 1987**; **and Milanov, 1990**). Thematic mapping of natural resources attracts the land users and the decision makers (**Choudhury, 1990**). Land resources evaluation is concerned with making

assessments about man's potential use of land for specific purposes. It involves analysis of the capacities and constrains imposed by the physical characteristics of a region and is usually conducted in support of some decision making process in land management and assessments (Ringros, 1991).

Therefore, the ground data are essential in driving a preliminary classification of natural features within the map area, providing and verifying the accuracy of the mapped units. So, ground support is a complementary rather than a competitive effort. The products of region classification and mapping are developed to communicate factors important to human. The key to successful area mapping with remote sensing is not so much in the capability of aerial photography to differentiate features by a variety of characteristics; but rather, that products of this area either of direct consequence to land use or closely related to human's needs.

The main objective of the current research is using the integrated ability of GIS and the high potential ability of aerial photographs interpretation and image processing to identify the land resources of the study area. Also, the hydrological analysis of the drainage patterns to identify water shed areas and evaluate the land use potential within local tribes boundaries with a view to provide basic data for planners and decision makers for area management and development.

MATERIALS AND METHODS

THE STUDY AREA

The study area, is situated in the coastal zone of the western desert and extends for more than 25 km inland. It is located between west of Matrouh city and east of Abo Laho city and extends from west Agiba to east Matarih settlement (Fig.1). The study area is located between longitudes 31:24:37.02 to 31:14:41.62 north and latitudes 27:00:39.58 to 27:07:03.65 east. It is bounded by the Mediterranean Sea in the north and in the south, by 175 m elevation, and covers about 50 km^2. It was chosen as a watershed area. Therefore, it is located in arid region with Mediterranean Sea climate (FAO, 1970). This climate, gradually changes to the south. The annual means of temperature, precipitation, and wind speed are 25° C, 150 mm and 21.1 km/hr, respectively. The morphological characteristics of the region are easily distinguished. The northern part of the area has uniform topographical features prevail with a narrow coastal belt. It followed by a wide area of gentle uniform slopes extending to the escarpment. In the south, the first plateau ended with 135 m elevation while the southern one ended with 175 m elevation. Several intermittent streams traverse this land area.

The collected ground truth data (GTD)

The GTD are the primary sources of data for photos and image interpretation. The different described units were distinguished from aerial photos and satellite images based on their identification in field and all available

collected previous data ,especially, the final report of the project **M.R.P.M. 1992**. These data were modified and including tribes information, soil factors, and current and potential of land use types. All this information is used as a reference data for making different map types.

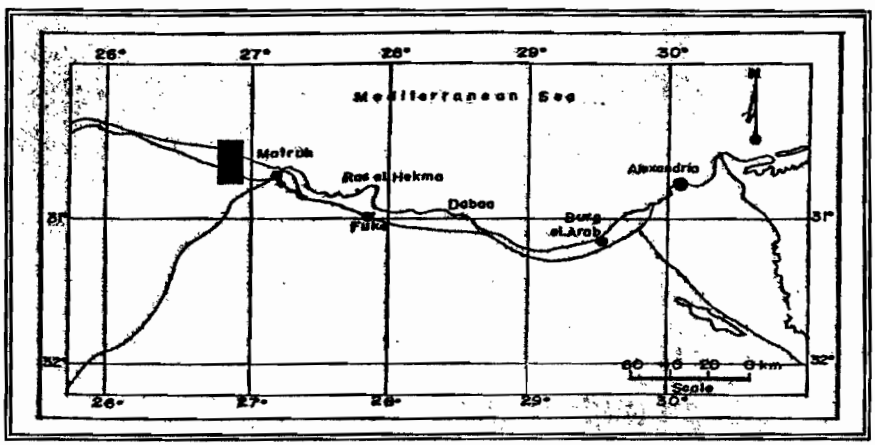

Figure 1: The study area location

Aerial Photos Interpretation

A good quality panchromatic vertical aerial photograph, (dated 1985, with a scale of 1:25,000 and 12,800 m altitude),were used. Twelve out of sixteen exposures (Fig. 2) on three strips no.7 (2793 – 2788),8 (2599– 2596), and 9 (2758– 2754) were overlay and interpreted.

A conventional mirror and a simple lens stereoscope are the only equipment necessary for this study. Viewing overlapping photos in a stereoscope gives a 3_D impression, allowing studies of all terrain features or land forms. In the same time, different tones, patterns and textures on aerial photos provide good interpretive information. The building up of the required maps based on the methods described in **Prasad et al., 1990**. All extracting mapping units were drawn to give spatial maps for the previous objectives to represent an attempt of mapping activities of the study area.

Figure 2:Aerial Photos Mosaic of three strips in the study area.

Image Processing

Image processing were done by ERDAS software (**ERDAS, 2000**).The TM and SPOT images acquired in 1999 were used to extract the area of interest (AOI) for the current research. Global positional system (GPS) instrument was used for TM image registration; then TM image to SPOT image rectification was done. Digital data classification had three stage methods. First, separate each satellite image to number of images according to the wavelengths, so, there are 4 images for SPOT and 7 images for TM. Second, subtract the pixel values of the red, green and blue wavelengths for Spot and TM images. Third, overlay the three previous differences images and used to create classes for map types. The classified classes were regrouped for less number. The compilation of aerial photographic interpretation and image processing used to map boundaries of mapping units and subunits with the aid of GTD to substantiate or modify the original hypothesis.

GIS Analysis

The coordinates of the four corners of the covering area were transformed from Lat-Long coordinate system to Universal Transverse Mercator (UTM) projection system using specifically designed software. Topographic map sheets at scale 1:50,000 were digitized into Terrasoft GIS software (**Digital Resource System, 1991**). The maps were separated into a group of features, as point, line and polygon, each of them comprise a homogenous dataset. During digitizing, the map sheets were edge matched to ensure connecting the features that cross the map boundary, and produce a seamless coverage. By the end of the data input process, all the features exported to Arc/Info GIS software, and displayed and analyzed using Arc View GIS software (**ESRI, 1997**). This is handling the geo-referenced data in a digital and vector format to construct different types of maps through sequential field trips.

Last step including digitizing tribes boundaries and the contour lines, which converting such line to draw DEM map. The slope and aspect maps were extracted from the DEM. Overlay of drainage pattern map on DEM was used to calculate and draw the watershed area of each wadi in the study area. The analysis was carried out by compiling the previous maps with extracted data from photos and image analysis.

RESULTS AND DISCUSSION

GIS ANALYSIS

The most advantage ability of GIS is to process data in digital and vector format and obtain valuable information about the land surface such as DEM, slope and aspect (table 1 and fig. 3 and 4). The land forms units, namely, the coastal plain ended with escarpment (zone 1), northern plateau (zone 2)and southern plateau (zone 3) are distributing in sequence to the south, respectively. These units are mapped on topographic transect from the sea shore in north to the inland plateau in south. This map has been rescaled in order to overlay the contour lines on it for elevation analysis.

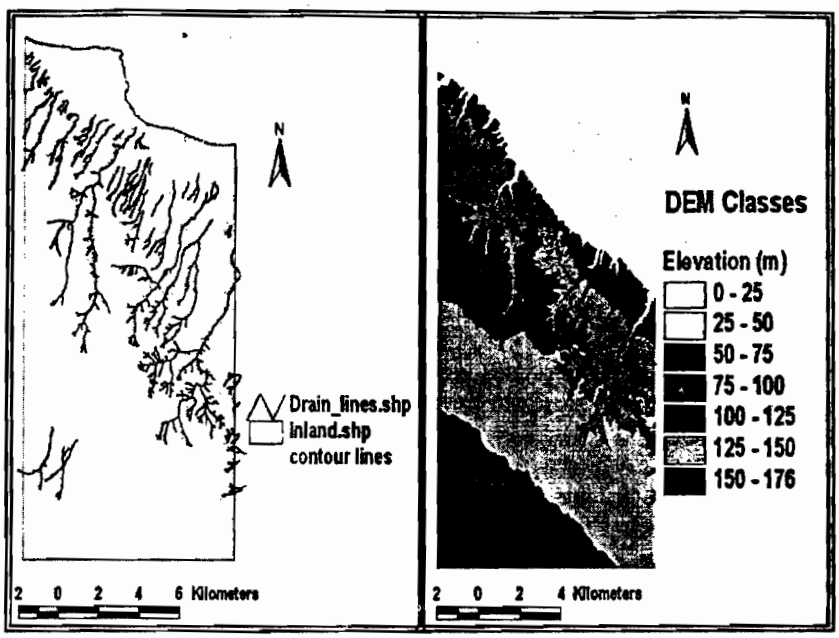

Figure 3: Drainage patterns and Digital Elevation Model.

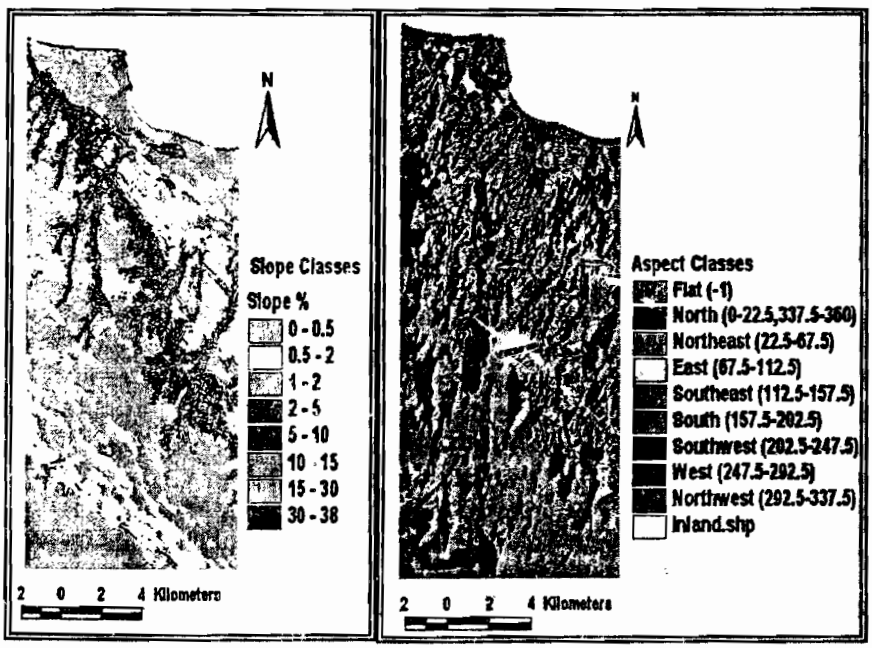

Figure 4: Slope and Aspect classes of the study area.

The contour lines from topographic map sheets and shaded relief of TM image were used to produce a DEM. Elevation ranged between 0.00 meter (sea level) and 175 meter above sea level (ASL) in the south. Slope and aspect parameters were derived from the DEM analysis. The slope ranges from 0.0 to 0.5% for the coastal area and 5 to 10% for the escarpment. The surface of the both plateau is flat with slope less than 0.4 %. Aspect was classified into eight classes representing the major and minor compass directions and varied mainly between north direction (29.09 %)and north-east directions (39.03 %), which are distributed in all three zones (Fig. 4).

Table 1 : Attributes of DEM, Aspect and Slope Classes.

Elevation (m)	Area (ha)	Area (%)	Aspect Class	Area (ha)	Area (%)	Slope (%)	Area (ha)	Area (%)
0 – 25	2620.12	15.16	N	5028.24	29.09	0- 0.5	7941.20	45.94
			NE	6746.52	39.03	0.5- 2	5937.40	34.35
25 – 50	1312.76	7.59	E	1568.60	9.07	2 - 5	1594.36	9.22
50 – 75	1136.44	6.57	SE	899.20	5.20	5 - 10	1199.40	6.94
75 –100	2313.32	13.38	S	588.16	3.40	10-15	432.32	2.50
100–125	2653.44	15.35	SW	468.76	2.71	15-30	179.52	1.04
125 –150	4603.60	26.63	W	607.76	3.52	30-37	2.12	0.01
150 –176	2646.64	15.31	NW	1379.08	7.98			

Aerial Photo and Satellite Images Interpretation

The classified images were printed in false color composite (FCC), (Fig. 5) to show the spectral variation of the regrouped ten land units classes beside sea water class (Fig. 6). The sand beach (0.23 %) is a very narrow band closed to coastal line and the coastal sand dunes unit (3.93 %) has different wide area. It is very narrow north east salt marshes and increases toward east, while it is very wide in the north west and decreases toward west. Salt marshes (0.62 %) locates in the coastal basin with different size spots. Trees plantation areas (2.25 %) mostly located in small size spots in the north and middle zones but the barely fields (27.87 %) distributed in the all studied area with concentrated in the wadi's bottoms and ends, besides the top surface of the northern plateau. The rock outcrop (13.38 %) and sotney calcareous soils (20.77 %), mostely found in the northern plateau while the hummocky soil (4.79 %) and shallow sandy soils (6.35 %) in the southern plateau. But the most area of the northern plateau represents as shallow calcareous soils (19.81 %) and it represents less size in the southern plateau.

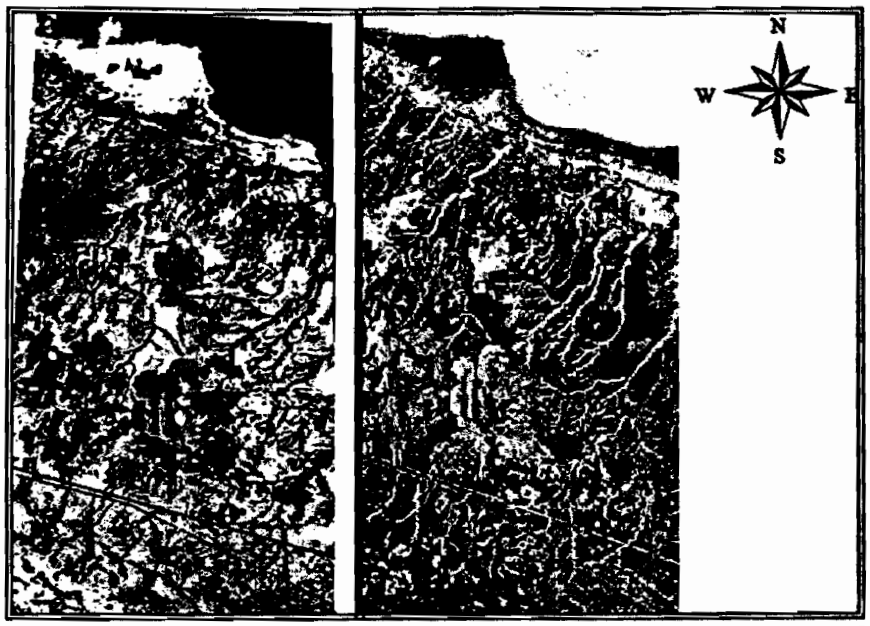

Figure 5:False Color Composit of TM (left) and SPOT images (right).

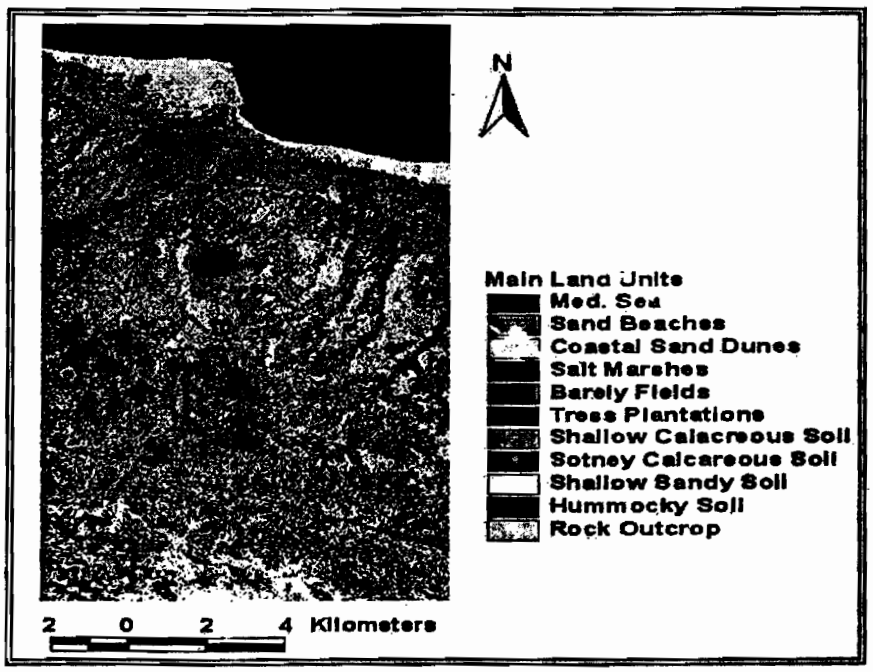

Figure 6: The physiographic Units of the study area.

These classes represent the irrigated cultivation land around cisterns; rain fed cultivated land in coastal area and up to the middle of northern plateau and non cultivated land especially at the southern part of northern plateau and most of southern plateau. The suitability of these soils based on the limiting productivity factors such as available amount of water, soil depth, salinity, rock outcrop and physiographic position. So, the combination of the edaphically features and their magnitudes provide a base for the land resources classification. It helps to assess the primary productivity of ecosystems and depict the distribution pattern of classes in different land facets to representing different habitats, as well as, the level of human pressure on land resources. It resulted that the cultivated area, barely fields and tree plantation, is concentrated in the north and middle of the study area due to the presence of water wells and rainfall, but, there is a little or no cultivation in the south because of the decreased amount of rainfall. The grazing activity increased in the south and it enumerates and delineates the extent of different kinds of human manipulations upon land resources.

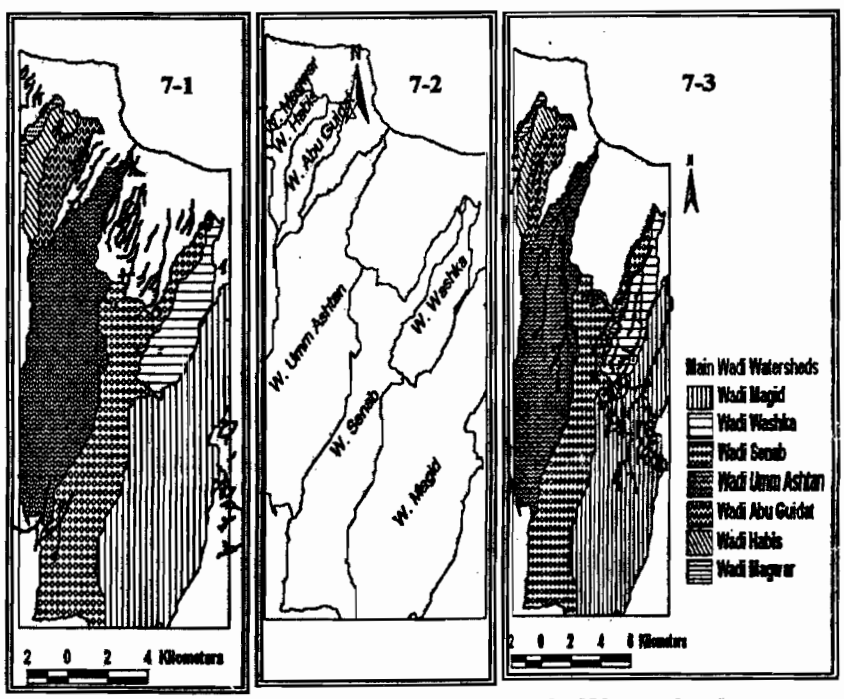

Figure7:Small wadis and main Watershed areas.

Water Delineation

The scarcities of water supply in this area restrict the maximum use of the available land resources. So, the optimum benefits of rainfall (50 – 200 mm/year); should be achieved by constructing some sort of dikes through the wadi course and along the foot slopes to catch the rainfall. The area has seven main watershed areas with different topographic characteristics (Fig.7 and tables 2). Figure 7 shows the drainage patterns of small unimportant observed wadis (Fig. 7-1) and shows (Fig. 7-2 and 7-3) from west to east the three main watershed areas in Umm El-Rakham region are Magwar, Habis and Abu Guidat with total area 10.703 km^2, which represents 2.0 % of the total catchment's area in that region and average elevation 65 m and average area 3.568 km^2 /wadi. So, the Estimated quantities of annual Runoff usable (m^3/km^2) and total annual usable runoff (m^3) are 2000 and 7136,respectively. And in El-Qasr region, are found the Umm Ashtan, Senab, Washka and Magid wadis with total area 110.748 km^2 as 26.42 % of the total catchment's area with average elevation 110 m and average area 27.687 km^2 /wadi. So, the Estimated quantities of annual Runoff usable (m^3/km^2) and total annual usable runoff (m^3) are 2300 and 55.374, respectively.. Data show that wadis Magid and Umm Ashtan are the main wadis in studied area. They are followed by Senab, Washka, Abu Guidat, Habis and Magwar wadis, and their lengths are 45.14, 30.30, 19.21, 16.54, 5.41, 4.72 and 2.48 Km respectively.

Table 2. Topographic characteristics of the main watershed areas.

Wadi Name	Total area (km^2)	Length (km)	Mean slope (%)	Mean Aspect (degree)	Mean Elevation (m)
Umm El-Rakham region (main three wadis)					
Magwar	1.040	2.48	3.46	161.05	56.09
Habis	4.177	4.72	3.42	192.26	67.68
Abu Guidat	5.485	5.41	2.64	126.61	68.50
El-Qasr region (main four wadis)					
Umm Ashtan	33.062	30.3	1.71	107.18	116.56
Senab	29.243	16.54	1.24	96.79	133.04
Washka	8.718	19.21	2.62	125.52	67.98
Magid	39.724	45.14	1.95	98.15	123.33

Distribution of Tribes

Regarding the population, the study area is thinly populated. Six tribes are found (Fig. 8 and table 3), out of fifteen in Matruh governorate. One of them, Sherif tribe, is concentrated completely within the study area in zone one and part of zone two around wadi Senab. Also, Switia tribe concentrated around wadi Washka in both zones. Different parts of the other four tribes are concentrated in the study area. Amira and Asheibat tribes are concentrated in the three zones of agro-ecological land system. Amira has different wadis, from west to east, Umm El-Rakahm, Magwar, Habis and wadi Abu Guidat. Agerma

tribe is concentrated in zonetwo and three and Kamilat tribe in zone two only. Most of Agerma are centered sround wadi Umm Ashtan. Table 3 shows the tribes population, their agroecological zone and ativity.

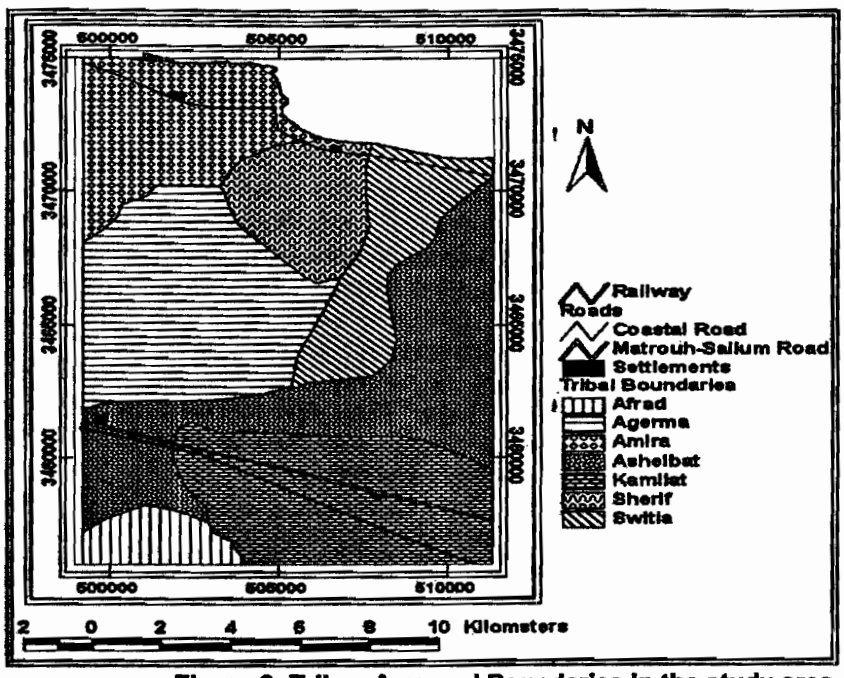

Figure 8: Tribes Area and Boundaries in the study area.

Table 3 : Tribes population and activity at the study area.

Tribes	Population (1992)	Activity Zone (#)			Main Activity types (%)		
		1	2	3	Range land	barley	Fruit tree
Asheibat	4800	X	x	x	74.0	10.0	2.0
Kamilat	2600		x		70.0	5.0	0.003
Amira	2400	X	x	x	86.0	4.0	0.009
Sherif	2400	X	x		65.0	0.07	0.03
Agerma	1300		x	x	82.0	8.0	0.7
Switia	500	X	x		68.0	7.0	3.0

Agro-Ecological System

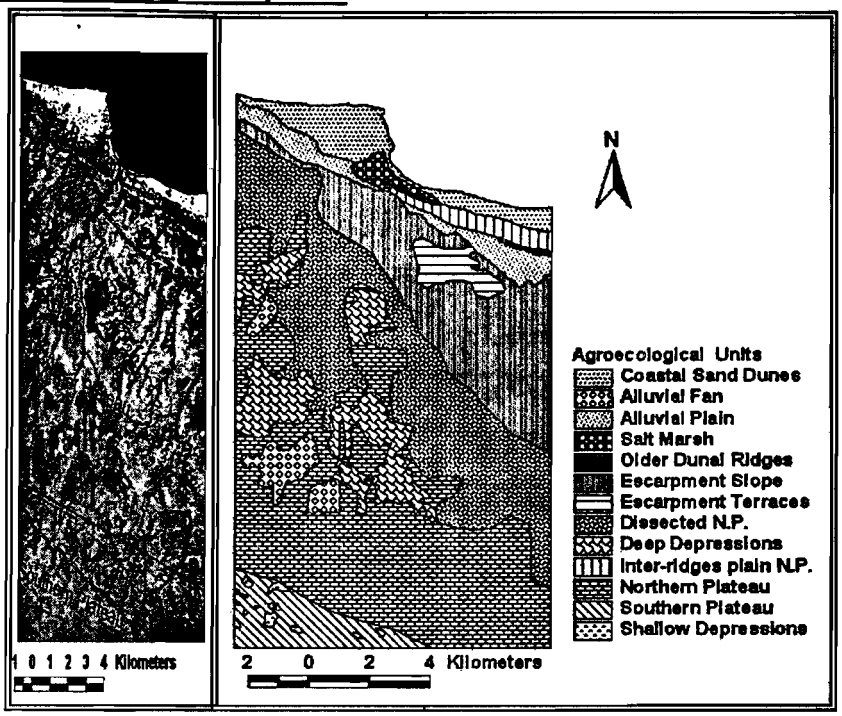

Figure 9: Main Agro-Ecological zone, units and Subunits.

Table 4: The percent of the current types of land use.

Sub-unit	Fruit trees	Barley	Total cultivated Area	Range land as separated dense or Mixed
Coastal Sand Dunes (C_csd)	0.3	0.2	0.5	9.2 separated
Alluvial Fan (C_af)	13.0	0.0	13.0	23.2 separated
Alluvial Plain (C_ap)	23.0	10.0	33.0	33.0 separated
Salt Marsh (C_sm)	1.8	3.5	5.3	28.5 mixed
Older Dunal Ridges (C_odr)	0.0	0.0	0.0	50.7 separated
Escarpment Slope (E_s)	2.1	6.4	8.5	67.0 separated
Escarpment Terraces (E_t)	3.4	15.2	18.6	33.1 mixed
Dissected Land (NP_dl)	0.2	5.4	5.6	70.3 mixed
Deep Depression (NP_dd)	1.5	5.5	7.0	71.7 mixed
Inter-Ridges Plain (NP_irp)	0.2	1.0	1.2	80.6 mixed
Northern Plateau (NP)	0.0	0.0	0.0	1.3 dense and 31.8 separated
Southern Plateau (SP)	0.0	0.0	0.0	0.3 dense and 21.8 separated
Shallow Depressions (SP_sd)	2.7	4.5	7.2	10.9 dense and 38.5 separated

Notes: Wheat, vegetables and windbreak trees are zero in all units

The compilation results of GIS, aerial photos and images processing of the study area show that the agro-ecological system can be divided to four main units presented in three zones and thirteen subunits (Fig. 9 and table 4). These main units are coastal basin, escarpment, northern plateau and southern plateau. The northern zone has five subunits in the coastal basin and two in the escarpment. The middle zone has four subunits, while the southern one has two subunits. All information about the sub-units description are presented in tables 4, 5 and 6.

Table 5: Soil limiting factors for potential land use.

Sub-unit	Soil Texture	Soil Depth, m	Salinity ds/m	SLOPE	MAIN CURRENT USE
C_csd	Sand	1.0-5.0	0.5-1.0	2-10	Sprayed rangeland and some fig farms
C_af	Loamy to sandy loam	0.8-2.0	2.5-6.0	0.1-0.3	Little of rangeland
C_ap	Loamy or loam to sandy loam	0.7-2.0	0.8-1.4	0.1-0.5	Fruit trees, vegetables, dense barley and wheat
C_sm	Sandy loam to loam	0.6-2.0	0.2-1.7	0.3-0.7	Trees, vegetables, dense barley and wheat
C_odr	Rocky area	0.0-0.15	–	0.0–0.10	———
E_s	Sandy loam with stones	0.0-0.5	0.5-0.8	1.3-4.0	Dense rangeland
E_t	Sandy loam	0.6-1.5	0.2-0.8	0.7-1.3	Barley and rangeland
NP_dl	Sandy loam to loamy sand	0.2-0.6	0.5-2.5	0.4-1.0	Barley, rangeland and old garden
NP_dd	Sandy loam to loamy sand	0.0-0.4	0.5-0.8	0.7-1.6	Dense rangeland for goats and sheep
NP_irp	Sandy loam to loamy sand	0.0-0.4	0.5-0.8	0.7-1.6	Dense rangeland for goats and sheep
NP	rocky area with lime stone	0.0-0.15	0.3-0.5	0.1-0.5	Extended rangeland
SP	sand sheets or lime stones to 80 cm depth)	0.2-0.35	0.2-0.8	0.0-0.2	Dense rangeland and some fig and olives
SP_sd	surface sand sheets or sand loam to Sandy loam	0.4-1.0 or 0.5– 1.4	0.1-0.4	0.1-0.3	Dense rangeland and some barley fields in depressions

Table 5 shows the soil main limiting factors effecting on the land use potential of each unit related to the main zones types. These limiting factors are soil texture, depth, salinity and slope. Table 6 shows the main current use,

which are fruit trees, barley and types of range land. while table 6 shows the percent potential for the desired land use within each agro-ecological subunit such as fruit trees, barley, wheat, vegetables, wind breaks and range land types.

Table 6: The percent of the potential types of land use.

Sub-unit	Fruit trees	Barley	Wheat	vegetable	Wind-break	Total cultivatd Area	Range land : as Dense or Separated or Sparse
C_csd	5.1	0.0	0.0	0.0	10.0	15.1	0.0
C_af	20.9	0.0	0.0	0.0	15.0	35.9	4.7 dense
C_ap	41.9	11.1	18.1	7.2	12.1	90.4	0.0
C_sm	2.3	1.5	1.2	0.8	4.4	10.2	8.8 dense
C_odr	3.0	1.5	1.2	0.8	4.4	10.9	6.8 dense
E_s	6.6	6.4	0.0	0.0	5.0	18.0	36.3 dense
E_t	14.0	12.1	6.0	0.0	1.0	33.1	12.1 dense & 42.3 sparse
NP_dl	1.1	4.2	1.2	0.0	0.4	6.7	46.3 dense & 45.3 sparse
NP_dd	2.0	3.8	0.5	0.0	1.0	7.3	50.8 dense & 32.0 sparse
NP_irp	0.3	1.1	0.0	0.0	0.0	1.3	36.2 dense & 59.4 sparse
NP	0.6	0.1	0.0	0.0	14.5	15.2	33.4 dense
SP	0.0	0.0	0.0	0.0	0.5	0.5	8.6 dense & 50.4 sparse
SP_sd	52.4	5.4	5.4	3.3	21.7	88.2	7.4 dense

Tables 4 and 6 show that the total cultivated areas in all subunits has a good potential to increase. In the coastal subunits the potential ability is higher for fruit trees > wheat > barely > wind-break > vegetables. The vegetables are suitable only in the alluvial plain of the coastal basin and shallow depression of the southern plateau, while the southern plateau is suitable for range land only. Also, northern plateau is suitable for wind break and range land. The most suitable types for land use are barely, fruit trees and wind break for all subunits with different potential degrees with exception on the surface of both plateaus.

CONCLUSION

The surface features and drainage patterns, as identified by aerial photo interpretation and new technique of pixel values differences in different wavelengths of TM and SPOT images, are integrated with the spatial distribution of land units and hydrological analysis by GIS system. GIS enable us to visualize the implementation of landscape features by draping the land units over a DEM, which permit derivation of different geomorphological information such as slope, stream networks and catchment's boundaries. The

collected previous studies and the field checks play an important rules with the very high techniques of photos and image processing and GIS analysis and considered as a very important factor for data verification.

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الملخص العربي

تكامل الصور الجوية و صور الأقمار الصناعية مع البيانات الجغرافية لرسم خرائط الموارد الطبيعية لمنطقة أم الرخم-غرب مطروح بمصر

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تـم تفسير الصور الجوية و تحليل صور الأقمار الصناعية لمنطقة غرب مدينة مطروح بين عجيبه و المطـاريح بمحافظة مطروح وتعتبر هذه المنطقة من المناطق الممثلة للساحل الشمالي الغربي لمصر من حيث المـناخ والظواهـر الطـبوغرافية و تقع بين خطوط طول ٣١:٢٤:٣٧,٠٢ و ٣١:١٤:٤١,٦٢ شمالاً ودائرتي عرض ٢٧:٠٠:٣٩,٥٨ و ٢٧:٠٧:٠٣,٦٥ شرقاً. ولبناء قاعدة بيانات لهذه المنطقة تم عمل سلسلة من الزيارات الحقـلية واستخدام جهاز تحديد المواقع GPS لتسجيل الإحداثيات وربط النقط الأرضية بالخرائط الطبوغرافية والصـور الجويـة الملـتقطة عـام ١٩٨٥ وصور الأقمار الصناعية لعام ١٩٩٩. ثم باستخدام برامج نظم المعـلومات الجغـرافية تم رسم خرائط نماذج الارتفاعات الرقمية DEM وحساب الميول السطحية واتجاهاتها وكذلك رسم خرائط حدود القبائل البدوية والتصريف الطبيعي للوديان والمعبرة عن تأثير حركة المياه على سطح الأرض .

باستخدام ١٢ صورة من ١٦ صورة جوية بمقياس رسم ١:٢٥,٠٠٠ تم التقاطها في ثلاثة خطوط طيران بارتفاع ١٢,٨٠٠ قدم عن سطح البحر تم تفسيرها بالرؤية الاستريوسكوبية (المجسمة) باستخدام إستريوسكوب الجيـب وآخـر ذو المـرايا . هـذا بالإضافة إلى عمل الموزايك MOSAIC للمساعدة في التفسير الظاهري

لمحتويات الصور. كذلك تم تحليل صورتين من صور الأقمار الصناعية (صورة القمر الأمريكي TM وصورة القمر الفرنسي SPOT) باستخدام برنامج الإيرداس ERDAS. وتم معاملة صور الأقمار الصناعية بأسلوب جديد يتضمن الحصول على كل المعلومات والتفاصيل الموجودة بكل منها . يتمثل هذا الأسلوب في فصل صور الأطوال الموجيه لكل نوع حيث تم الحصول على ٤ صور من القمر الفرنسي و ٧ صور من صورة القمر الأمريكي. تلي ذلك طرح الصور ذات الأطوال الموجية المترادفة من بعضها البعض خاصة للضوء الأحمر و الأخضر و الأزرق . ثم دمج صور الاختلافات للألوان الثلاثة . تم تقسيم الصور الناتجة من الدمج باستخدام أسلوب التقسيم الغير موجه ثم أسلوب إعادة التقسيم بالتجميع للوحدات المتشابهة البصمة الضوئية.

مما سبق تم مناقشة خرائط الموارد الطبيعية في منطقة الدراسة باستخدام الوحدات الفسيوغرافية الثلاثة وهى السهل الساحلي والهضبة الشمالية والهضبة الجنوبية مع تسجيل حدود القبائل البدوية على الخرائط. وقد وجد أن بعض المساحات الخاصة بتلك القبائل يقع كاملا في منطقة الدراسة مثل قبيلة شريف (فى المنطقة الساحلية غرباً) و بعضها يقع جزئيا في منطقة الدراسة مثل قبيلة أميره حيث تمتد من الساحل الى الهضبة الجنوبية (وتقع فى أقصى الغرب من منطقة الدراسة) وقبيلتى أجيرما و أشبياط حيث تمتدا من الساحل الى الهضبة الجنوبية(وتقع فى جنوب منطقة الدراسة) و قبيلة سويطات تقع في الشمال الغربي بينما قبيلة كاميلات تقع في الجنوب الغربي. والخرائط التي تم الحصول عليها هي كما يلي:

خرائط الوحدات الفسيوغرافية Physiographic Unites

تم رسم عشرة وحدات تمثل مظاهر سطح الأرض وكذلك بعض النباتات المزروعة مثل حدائق الفاكهة و حقول الشعير والتي تظهر تأثير الإنسان على الموارد الطبيعية و استغلاله لها كما في باطن الأودية وميولها الجانبية . بالاضافه إلى الظواهر الطبيعية السطحية والتي تسبب عائقاً لاستغلال الإنسان مثل انتشار الأملاح والصخور على السطح خاصة في المناطق الساحلية والصخور السطحية في المنطقة المتوسطة والجنوبية.

خرائط التحليل الهيدرولوجى Hydrological Analysis

هناك عدد من الأودية تقع في منطقة الدراسة منها ما هو صغير المساحة والطول وتنتشر في جنوب منطقة السهل الساحلي تم استبعادها من التحليل بينما تم تحليل سبعة أودية رئيسيه. منهم ثلاثة رئيسيين في منطقة أم السرخم (ماجوار و حابس و أبو جيدات) وتعتبرُ ذات مساحات صغيرة نسبيا أقل من عشرة كم مربع والأربعة الأخرى تقع في منطقة القصر (أم أشطن و سناب و واشكا و ماجد) وهى أودية ذات مساحات كبيرة نسبيا أكبر من عشرة كم مربع ماعدا وادى واشكا حيث تبلغ مساحته ٨,٧٢ كم مربع. تختلف تلك الأودية في مساحتها و أطوالها وعدد فروعها ويتوسطها وادي أم أشطن ويعتبر الوادي الرئيسي في منطقة الدراسة بالاضافه الى وادى ماجد . وتنتشر المناطق الزراعية للإنسان في المناطق الجنوبية للأودية بينما تنتشر المراعى الطبيعية حول الأودية وفى شمالها في حين أن زراعة الأشجار المختلفة تنتشر في نهاية وبطن الأودية.

خرائط الوحدات الزراعية البيئية Agro-ecological Units

مـــن واقـــع المعـــلومات السابقة وبعد تجميعها و إيجاد العلاقات المتداخلة بينها تم رسم خرائط تقسيم الوحـــدات الـــزراعية البيـــئية Agro-ecological Units والـــتي تظهر تداخل الأنشطة البشرية مع البيئة الطبيعية. حيث تم تقسيم النظام إلى ثلاثة مناطق تشتمل على أربعة وحدات رئيسية والتي بدورها تم تقسيمها إلى ثلاثـــة عشـــر تحـــت وحدة مع توضيح خصائص كل منها. كما تم تحديد العوامل المحددة للاستغلال الزراعي للوحدات المختلفة مثل قوام التربة وعمقها ودرجة الملوحة وميل سطح الأرض وعلاقة ذلك بالاستغلال الحالي. وفى الـــنهاية تم استنباط أوجه الاستغلال الأمثل الممثلة في زراعة أشجار الفاكهة والقمح والشعير والخضراوات ومصدات الرياح بالإضافة إلى النشاط الرعوي في الوحدات البيئية المختلفة.