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Land Resource Assessment of Landmine-affected Areas, Northwest Coast, Egypt

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LANDMINES and unexploded ordnance (UXO) dating from World (War II) cover an area of 2,500 sq. km at El-Alamain - Qattara area at the Northwest Coast of Egypt. Landmines hindered have significantly the regional agricultural, industrial and touristic development programs of the Matrouh governorate. However, a database resource in a geo-referenced and digital form of the landmine-affected and de-mined areas at the northwest coast of Egypt would insure the implementation of sustainable integrated developmental programs.

The objectives of this study is to assess the natural resources of the landmine-affected areas at Matrouh Governorate by using integrating Remote Sensing (RS), Geographic Information System (GIS) and modeling methodologies to develop a geo-reference resource module in the context of a National Information Management System for Mine Action (IMSMA).

The data obtained indicated that the land suitability classes of the northwest coast zone are: suitable for figs (191500 hectares, 9.5 % of the total area), suitable for all crops (136000 hectares, 6.8% of the total area), suitable for all crops, but after terracing (155000 hectares, 7.7 % of the total area), suitable for vegetables, field crops, and moderately deep rooted crops (168000 hectares, 8.4% of the total area), and rangeland (1080000 hectares, 53.7% of the total area). More than 33 %- 10,000 hectares of the landmine affected area at El Alamian is suitable for figs, where as more than 30%- 9900 hectares are suitable for all crops. At Matrouh, more than 60%- 20,000 hectares of the landmine affected area are suitable for range land where as more than 18%- 6500 hectares is suitable for all crops. The integrated methodology of this study could be considered as a ready module for applying at different locations. The study outputs represent a significant geo-reference resource module to support an Information Management System for Mine Action in Egypt.

Landmines and unexploded ordnance (UXO) dating from World War II cover an area of 2,500 sq. km at El-Alamain -Qattara area, Northwest Coast of Egypt. This hinders significantly the regional agricultural, industrial and touristic development programs of the Matrouh governorate. Since the end of the WWII,

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these minefields worked as death machines and caused permanent disability - estimated at 8,393 (7,671 injured, 722 killed)- to individuals (Table 1- LM. 2005, MMC,1999; Rashwan, 2005; Said, 2003; NCHR, 2005 and Sorour, 2005& 2001). Local inhabitants are reluctant to manage and develop the de-mined areas. However, there is no database resource, in a geo- referenced and digital form, for the landmine-affected and de-mined areas at the northwest coast of Egypt that would insure the implementation of sustainable integrated developmental programs in the area. As a primary step, the Government of Egypt established the National Committee for the Northwest Coast Development and De-Mining Programs aiming to propose and implement regional development programs for the Northwest Coast and its desert back areas up to 2017.

TABLE 1. Number of casualties due to landmines/UXO 1945- 2000.

Date	Injured	Killed	Total	Source
1945-97	7611	690	8301	(MMC, 1999)
1998	20	13	33	(Sorour,A.,2 001)
1999	23	14	37	(Sorour,A.,2 001)
2000	7	5	12	(Sorour,A., 2001)
2004	10	--	10	(Sorour,A., 2005)
Total	7671	722	8393	

Socio-economic impact

- The major socio economic impact is the population increase with only 4% of the land in Egypt being currently populated by over 70 million with an expected increase of approximately 20 million inhabitants over the next 15-20 years.

- Tmpaits of the delays in the irrigation projects are next. El Hammam canal in the Western desert and the El Salaam canal in the Eastern desert still under consideration, with a total irrigation capacity of 833,000 feddans (acres) in need of land to be cleared

- The neglected agricultural development plans of the rain fed Cereal Production / Rangeland Livestock production in need of reclamation of more than 100,000 hectares in the Western desert.

- The power-supply industry development plans still foresee a bilateral support to the development of large-scale 'wind farm' projects.

- The petroleum sector foreseeing mine clearance which is considered as an essential element of the petroleum exploration and exploitation activities.

- The Safaris and eco-tourism in Egypt will serve to the more of the number of tourists from 4 million in 1996/7, to 27 million by 2017.

Commitment of mine clearance activities

According to the Egyptian army, clearance activities in the Western desert are severely hampered by having only limited maps, sketches and minefield records. Maps and data sources that have been provided by Germany, Italy and Britain have proven to be inaccurate or incomplete. The original recording of mine laying activities was of varied quality, with omissions and inaccurate data additions. The fact, that over the years, many reference points and landmarks have disappeared by rain and sandstorms, added to the complexity of drawing a comprehensive picture of the landmine situation. The complete marking and fencing of huge areas in the Western Desert is not considered feasible by the Egyptian military due to climatic conditions, sandstorms and scrap traders (UNMAS, 2000).

Mine/UXO information management in Egypt

The Egyptian military displayed a sophisticated computer database and GIS system that army personnel are developing as a tool for priority setting and planning purposes for mine clearance. This system has mapping functionality and the ability to create overlays and 'dangerous area' zones, but was not yet in use throughout the mine affected areas. It did not appear to include information relating to mine victims, victim assistance or mine awareness activities. Use of the system, at this stage is restricted to the military, with general access to the existing maps of minefield locations, despite some limited information was provided to other line agencies working in infested areas (UNMAS, 2000).

The National committee to develop the northwest coast and mine clearance

PMD 750_2000 formed a Committee to supervise Mine Clearance headed by the Ministry of Planning and International Cooperation. The National Committee changed its name to the National Committee to Develop the Northwest Coast and Mine Clearance in July 2002 (LM, 2005; NCHR, 2005; Sorour, 2005 and UNMAS, 2000). The responsibility of the Committee is to conduct studies and establish programs and necessary plans for Mine Clearance in the designated areas and also revise the financial plans for the programs related to Mine Clearance as well as available grants and assistance from Countries, Agencies, International and Foreign Organizations, and present allocation suggestions within the scope of the designed objectives. Verifying and following-up on the implementation of the programs and plans prepared for Mine Clearance as well as preparing Draft Laws and Decisions and Research necessary for Mine Clearance Projects is all among the imager responses bthihes of the National Committee.

Information management system for mine action IMSMA

IMSMA is an information management system that improves capabilities for decision-making, coordination, and information policy related to humanitarian de-mining (Mine action). It combines a relational database with a geographic information system (GIS), with Field Modules assisting the user in the most important steps involved in identifying, prioritizing, clearing a mine or UXO infected area and showing the progress of these activities. IMSMA Web Services enable mine action programs and impact survey organizations to publish information on the state of the landmine problem in a country as well as on the progress of mine action activities on their website. The system is currently in use in more than 80 % of mine action programs around the world (Arnold, 2005). Egypt's civilian de-mining organizations/ mining action programs are limited and IMSMA is not yet introduced/used.

Objectives

- Assessing the natural resources of the landmine-affected zones at the Matrouh Governorate, Egypt by integrating RS, GIS and modeling methodologies.
- Developing a geo-referenced Resource Module in the context of the National Information Management System for Mine Action (IMSMA).

Specific objectives

- Applying Geostatistical analysis to create a Digital Terrain Model (DTM) to obtain Geomorphic mapping units (Geopedological Approach) and Hydrological feature.
- Applying Multi-spectral analysis (Maximum likelihood and NDVI) to assess natural recourses of the year 2001.
- Evaluating land and water resources of landmine areas of the Northwest coastal zone using map overlays and crossing operations.

DATA Sources and Methods

Data sources

- North Western Coast Soil Survey and Reports: FAO (1970).
- Land Master Plan. : Euroconsult-paçer Consultants (1986).
- The Geology of Egypt. : EGPC (1988).
-Topographic Maps 1: 100,000: Department of Survey and Mines, EGSA (1970).
- Landsat ETM+ of 5 scenes of year 2001(P178 R039, P179 R038, P179 R039, P180 R038, and P180 R039) and Mosaic Landsat TM of zone 35 year 1990.
-Several Reports, Maps, and Theses: Soil and Water Science Department, Alexandria.
- Several Reports and Maps: WWW.

Methods

The map projections of the five images of ETM 2001 (P178 R039, P179 R038, P179 R039, P180 R038, and P180 R039) were used as base maps after performing a mosaic operation by ERDAS Imagine 8.4 software Map projection: Universal Transverse Mercator, with Datum: WGS 1984, Ellipsoid: WGS 84, Ellipsoid parameters: a=6378137.00 and 1/f=298.257, Northern Hemisphere, and Zone 35. Different methods and techniques were used in Remote Sensing and GIS analysis within main five sub modules (Fig. 1).

Step one (Terrain Analysis): Six topographic maps of the Northern coast area with sheets A "Salum", B "Sidi Barrani", C "Matruh", D "Ras El Hakma", 88&92/36 "El Dabah El Alamain" and 88/42 "El Hammam" at scale 1:100,000 (produced by the Egyptian General Survey Authority EGSA, 1970) were used to generate a Digital Terrain Model (DTM). The contour lines and ground control points of the topographic maps of the North Coast area with 10 meters intervals were used to create the DTM. The DTM was created using the Geostatistical analyses of the final contour point's map of the studied area. Due to the computer memory and time consumption and software capacity the area was divided into 16 sub areas before processing and glue map afterward. Geostatistical analysis was carried out at a two step procedure: (a) the calculation of the experimental semi-variogram and fitting a model and (b) interpolation through Ordinary Kriging, with the semi-variogram parameters (Stein, 1998). The semi-variogram is defined as a spatial dependence function of the distance h between locations in the observation space. Ordinary Kriging considers both the structured and random characteristics of spatially distributed variables, thus providing tools for their description and optimal estimation. The histogram operation was used to determine the classes' intervals of the DTM value map. The slicing operation was used to obtain the boundaries of the geomorphic mapping units. Based on DTM, axially information, and the geological map of Egypt (EGPC 1988), physiographic mapping units were assigned using the approach of Zinck (1998). The pre Investment survey of the North Western Coastal Zone database (FAO, 1970) and of Land Master Plan (LMP, 1986) were used with the physiographic mapping units map to generate suitability maps (ILWIS 3.2, 2004).

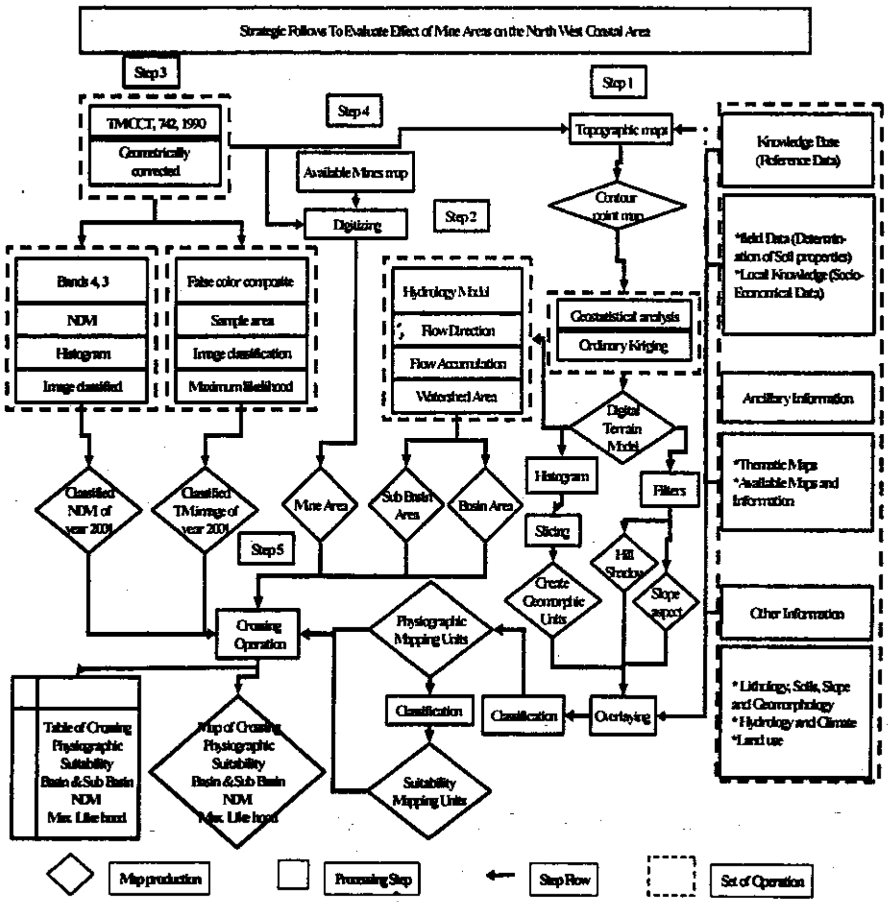

Fig. 1. The methods and techniques used in the main five sub modules.

Step two GIS Analysis of Digital Terrain Model (DTM), the Arc-GIS 9, Hydrological tool (ESRI, 2004) was used to generate the basin and sub basin areas of El Alamian and Matrouh regions starting with fill sinks, flow direction, flow accumulation, stream definition, catchments grid delineation, catchments polygon processing, and ended by drainage line processing. Basin and sub-basin areas were normally defined as the total area flowing to a given outlet, or pour point.

Step three: Image analyses The multi-spectral image classification was used to extract thematic information from satellite images in a semi-automatic way. The maximum likelihood and NDVI (Normalized Difference Vegetation Index) classifications were used to create the vegetation cover classes (Mulders, 1987 and Spanner *et al.*, 1990, ERDAS IMAGINE 8.4 and ILWIS 3.2). The Maximum likelihood classification assumes that spectral values of training pixels are statistically distributed according to a multi-variants normal (Gaussian) probability density function. NDVI values are a measure for the presence and condition of green vegetation and calculated from two satellite bands; one band containing visible or red reflectance values, whereas the other contains near-infrared reflectance values.

Step 4: Digitizing the landmine areas by using available mine maps, MMC (1999); Trevelyan (2001) and Kennedy (2004).

Step 5: Cross operation, this performs an overlay of two raster maps. Cross operation creates an Identifier domain for the output cross map and cross table. This output domain obtains the same name as the output table and is filled with the combinations of class names, IDs or values of both input maps. When an input map has a class or ID domain in which the class names or IDs have codes, then these codes will appear in the output domain. These combinations give an output cross map and a cross table. The cross table includes the combinations of input values, classes or IDs, the number of pixels that occur for each combination and the area for each combination. The crossing operation was used to generate maps and tables of crossing physiographic mapping units, suitability, basin & sub basin, NDVI, and maximum likehood classification with landmine area maps.

Results

Northwest Coast (NW)

The NW Coastal region of Egypt extends over 350 km from the west of Alexandria to the Libyan border with about population of 320,000 Bedouins whose livelihood depends largely upon agriculture. And that have moved into the region from what is now eastern Libya in the 17th century. The region has a low and sporadic rainfall (the 60 year average precipitation at Mersa Matrouh is 144 mm, CV 45%); clearly within the realm of semi-arid non-equilibrium ecosystem conditions, (Abdel-Kader *et al.* 2004) .The study output of the Digital Terrain Model (DTM) is shown in Fig. 2. Illustrating the main geomorphologic mapping units of: coastal plain (592269 hectares, 29.47%), elongated hills (55385 hectares, 2.76%), The first northern plateau (185910 hectares, 9.25%), the second northern plateau (244594 hectares, 12.17%), southern plateau (357393 hectares, 17.78%), the Lybian plateau (528318 hectares, 26.29%), the Mena valley (35831 hectares, 1.78%) and the plain of Maryout Table Land (10189 hectares, 0.51%). The physiographic mapping units, that were compiled from overlying and analyzing the classified DTM, geomorphologic information, and geological map are shown in Table 2 .The data obtained for land evaluation analysis that were undertaken by FAO (1970) and LMP (1986) revealed that the studied fell into four classes, namely as locally suitable for figs (191502 hectares, 9.53%), not suitable for crops (205977 hectares, 10.25%), not suitable, but good range land (1080146 hectares, 53.74%), suitable for all crops (135991 hectares, 6.77%), suitable for all crops, but after terracing (154390 hectares, 7.68%), suitable for shallow rooted crops (4775 hectares, 0.24%), suitable for vegetables, field crops, and moderately deep rooted crops (167814 hectares, 8.35%), and suitable for summer resorts and touristic areas (69242 hectares, 3.45%).

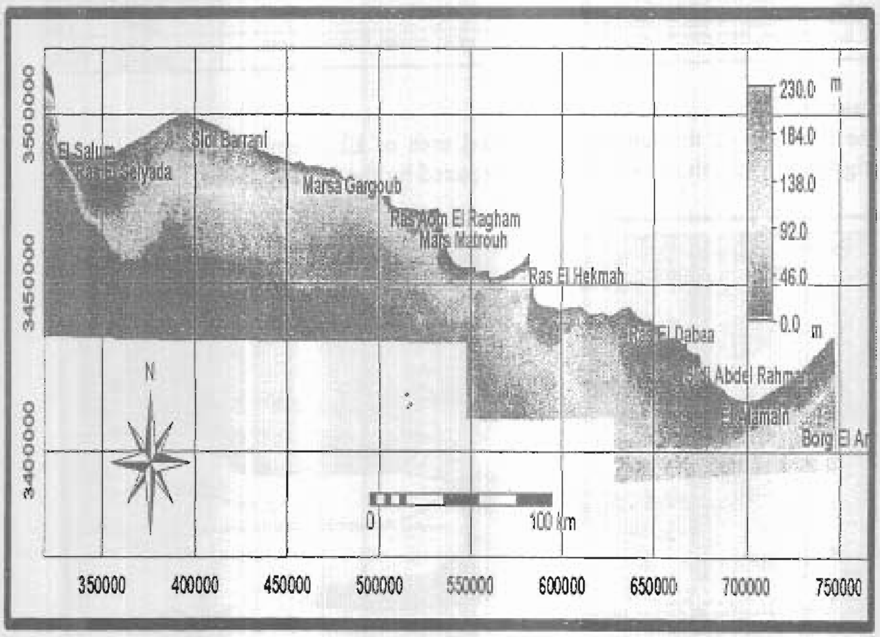

Fig. 2. DTM of the north west coastal area.

Selected landmine affected areas

Two sub regions were selected to study the landmine affected area, *i.e.*, the El Alamian and the Matrouh.

TABLE 2. Physiographic mapping units of the north west coastal area.

Code	Physiographic Mapping Units	Area in Hectars	Area%
Cp111	Coastal Plain, Marmarica formation, Sand Dunes, lluvial-Eoalian deposits, Longitudinal dunes,	12805	0.64
Cp211	Coastal Plain, Sea Beach, Marine deposits, Beach	69169	3.44
Cp212	Coastal Plain, Lagoon Maryout, Marine Deposits, Shore	167781	8.35
Cp311	Coastal Plain, Lagoon Maryout, Marine Deposits, Water	12158	0.60
Cp312	Coastal Plain, Bar, Marine Deposits, Swale	25501	1.27
Cp313	Coastal Plain, Bar, Marine Deposits, Bar	152295	7.58
Cp314	Coastal Plain, Bar, Marine Deposits, Rocky area	4171	0.21
Cp411	Coastal Plain, Lagoon Maryout, Marine Deposits, sand sheet, sloping	144482	7.19
Cp511	Coastal Plain, Lagoon Maryout, Marine Deposits, Depression	3809	0.19
Hi111	Elongated Hills, Extensive Ridges, Marine deposits, Summit	4779	0.24
Hi112	Elongated Hills, Extensive Ridges, Marine deposits, Foot Slope	9908	0.49
Hi113	Elongated Hills, Extensive Ridges, Marine deposits, Toe Slope	40709	2.03
Va111	Mena Vallet, Ameria Depression, Marine Deposits, Outer	15644	0.78
Va112	Mena Vallet, Ameria Depression, Marine Deposits, inner	20197	1.00
Pl111	Plain of Maryout Tableland, Series of Terraces, Collevial deposits, Terrace1	8743	0.43
Pl112	Plain of Maryout Tableland, Series of Terraces, Collevial deposits, Terrace2	1463	0.07
Pu111	Northern Plateau, Marmarica formation,Relativly Low, first escarpement	53547	2.66
Pu112	Northern Plateau, Marmarica formation,Relativly Low, Table	131442	6.54
Pu113	Northern Plateau, Marmarica formation, Relativly Low, pyrimad sand dune	918	0.05
Pu211	Northern Plateau, Marmarica formation, Relativly High, Second escarpement	85457	4.25
Pu212	Northern Plateau, Marmarica formation, Relativly High, Table	154536	7.69
Pu213	Northern Plateau, Marmarica formation, deprision	1386	0.07
Pu214	Northern Plateau, Marmarica formation, Close Vally	3328	0.17
Pu311	Southern Plateau, Marmarica formation, third escarpment	27919	1.39
Pu312	Southern Plateau, Marmarica formation, Table	314545	15.65
Pu313	Southern Plateau, Marmarica formation, lluvial-Eoalian deposits, deprission	11584	0.58
Pu314	Southern Plateau, Marmarica formation, Sand Dunes, lluvial-Eoalian deposits, Pyramidal dunes	3257	0.16
Pu411	Lybian Plateau, Marmarica formation,Fourth escarpement	22751	1.13
Pu412	Lybian Plateau, Marmarica formation,Table	463988	23.08
Pu413	Lybin Plateau, Marmarica formation Deppeision	39392	1.96
Pu414	Lybin Plateau, Marmarica formation, Sand Dunes, lluvial-Eoalian deposits, Pyramidal dunes	2298	0.11
	Total	2009970	100.00

Land suitability

The location of the landmine affected area of El Alamian (30591 hectares) was digitized using the available map prepared by the MMC 1999 (Fig. 3).

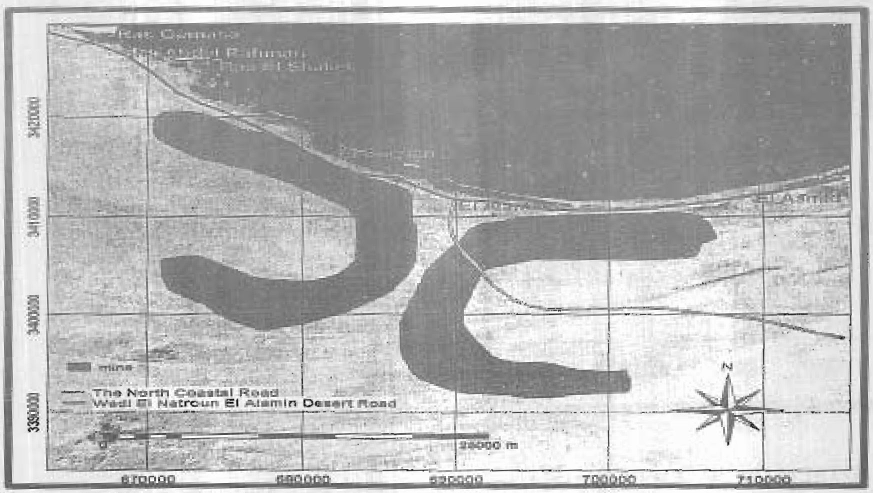

Fig. 3. Location of the landmine affected area of El Alamian.

Table 3. Shows the areas of the physiographic mapping units of El Alamian and the percentages.

TABLE 3. Physiographic mapping units of El Alamian Area.

Mapping Units	Code	Area in Hacters	Area %
Coastal Plain, Marmarica formation, Sand Dunes, Iluvial-Eoalian deposits, Longitudinal dunes,	Cp111	2652	1.87
Coastal Plain, Sea Beach, Marine deposits, Beach	Cp211	21614	15.27
Coastal Plain, Lagoon Maryout, Marine Deposits, Shore	Cp212	19703	13.92
Coastal Plain, Lagoon Maryout, Marine Deposits, Water	Cp311	25	0.02
Coastal Plain, Bar, Marine Deposits, Swale	Cp312	5794	4.09
Coastal Plain, Bar, Marine Deposits, Bar	Cp313	34673	24.49
Coastal Plain, Bar, Marine Deposits, Rocky area	Cp314	16	0.01
Coastal Plain, Lagoon Maryout, Marine Deposits, sand sheet, sloping	Cp411	19405	13.71
Coastal Plain, Lagoon Maryout, Marine Deposits, Depression	Cp511	487	0.34
Elongated Hills, Extensive Ridges, Marine deposits, Summit	Hi111	4217	2.98
Elongated Hills, Extensive Ridges, Marine deposits, Foot Slope	Hi112	8204	5.79
Elongated Hills, Extensive Ridges, Marine deposits, Toe Slope	Hi113	18533	13.09
Mena Vallet, Ameria Depression, Marine Deposits, Inner	Va112	809	0.57
Plain of Maryout Tableland, Series of Terraces, Collavial deposits, Terrace1	Pl111	601	0.42
Northern Plateau, Relativly Low, first escarpement	Pu111	3744	2.64
Northern Plateau, Relativly Low, Table	Pu112	1101	0.78
Total		141577	100.00

The results of the suitability mapping units of the El Alamian area were locally suitable for figs (43129 hectares, 30.45%), not suitable for crops (3759 hectares, 2.65%), not suitable, but good range land (1702 hectares, 1.20%), suitable for all crops (19829 hectares, 14.00%), suitable for all crops, but after terracing (27608 hectares, 19.49%), suitable for shallow rooted crops (4217 hectares, 2.98%), suitable for vegetables, field crops, and moderately deep rooted crops (19703 hectares, 13.91%), and suitable for summer resorts and touristic areas (21674 hectares, 15.30%).

For the Matrouh area, the location of the landmine affected area (27129 hectares) was digitized using the available map prepared by the MMC, 1999 (Fig. 4).

Table 4 shows the areas of the physiographic mapping units and the percentages. The results of the suitability mapping units of El Matrouh area were locally suitable for figs (23374 hectares, 5.96%), not suitable for crops (36249 hectares, 9.24%), not suitable, but good range land (286397 hectares, 73.03%), suitable for all crops (17374 hectares, 4.43%), suitable for all crops, but after terracing (11562 hectares, 2.95%), suitable for vegetables, field crops, and moderately deep rooted crops (9783, hectares, 2.49%), and suitable for summer resorts and touristic (7417 hectares, 1.89%).

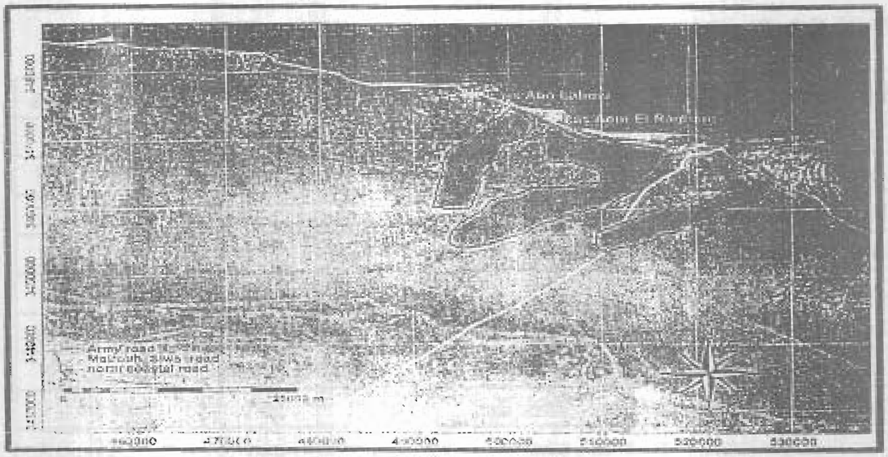

Fig. 4. Location of landmine affected area of Matrouh.

TABLE 4. Physiographic mapping units of Matrouh area.

Code	Mapping Units	Area in Hacters	Area %
Cp111	Coastal Plain, Marmarica formation, Sand Dunes, fluvial-Eolian deposits, Longitudinal dunes,	376	0.10
Cp211	Coastal Plain, Sea Beach, Marine deposits, Beach	7417	1.89
Cp212	Coastal Plain, Lagoon Maryout, Marine Deposits, Shore	9783	2.49
Cp311	Coastal Plain, Lagoon Maryout, Marine Deposits, Water	747	0.19
Cp312	Coastal Plain, Bar, Marine Deposits, swale	5903	1.51
Cp313	Coastal Plain, Bar, Marine Deposits, Bar	16717	4.26
Cp314	Coastal Plain, Bar, Marine Deposits, Rocky area	123	0.03
Cp411	Coastal Plain, Lagoon Maryout, Marine Deposits, sand sheet, sloping	11562	2.95
Pu111	Northern Plateau, Relatively Low, first escarpement	6603	1.68
Pu112	Northern Plateau, Relatively Low, Table	17395	4.44
Pu113	Northern Plateau, Relatively Low, overlaid sand dune	377	0.10
Pu211	Northern Plateau, Relatively High, Second escarpement	14265	3.64
Pu212	Northern Plateau, Relatively High, Table	38818	9.90
Pu213	Northern Plateau, depression	27	0.01
Pu214	Northern Plateau, Close Valiy	3320	0.85
Pu311	Southern Plateau, third escarpment	6772	1.73
Pu312	Southern Plateau, Table	141195	36.00
Pu313	Southern Plateau, Marmarica formation, iluvial-Eolian deposits, depression	10890	2.78
Pu314	Southern Plateau, Marmarica formation, Sand Dunes, iluvial-Eoalian deposits, Pyramidal dunes	2997	0.76
Pu411	Lybian Plateau, Fourth escarpement	7739	1.97
Pu412	Lybian Plateau, Table	85869	21.90
Pu413	Lybin Plateau, Depoeision	3147	0.80
Pu414	Lybin Plateau, Marmarica formation, Sand Dunes, iluvial-Eolian deposits, Pyramidal dunes	122	0.03
	Total	392167	100.00

Potential wet basin for agricultural development.

Figures 5 & 6 show the basin and sub basin areas of El Alamian and Matrouh in drained lines. El Alamian area is characterized by 17 agricultural potential wet basins and 28 wet sub basins. The Matrouh area is characterized by 17 wet basins with 36 wet sub basins.

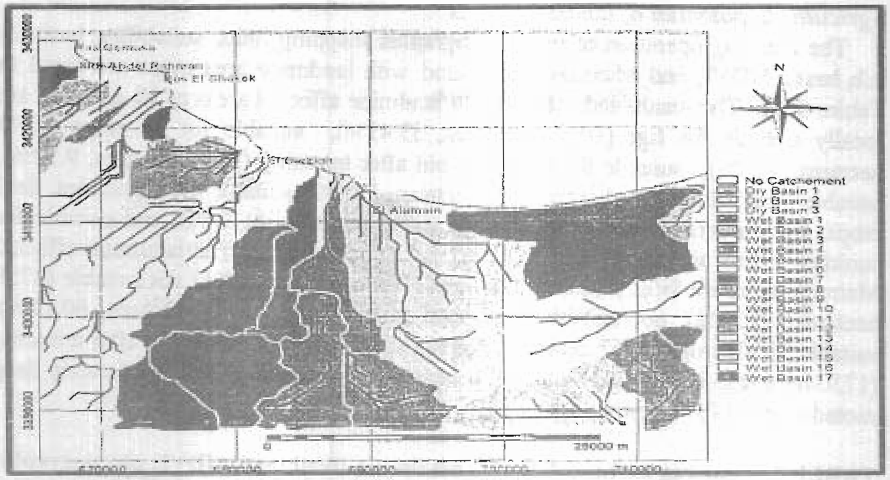

Fig. 5. Basin and sub basin areas of El Alamian in drained lines.

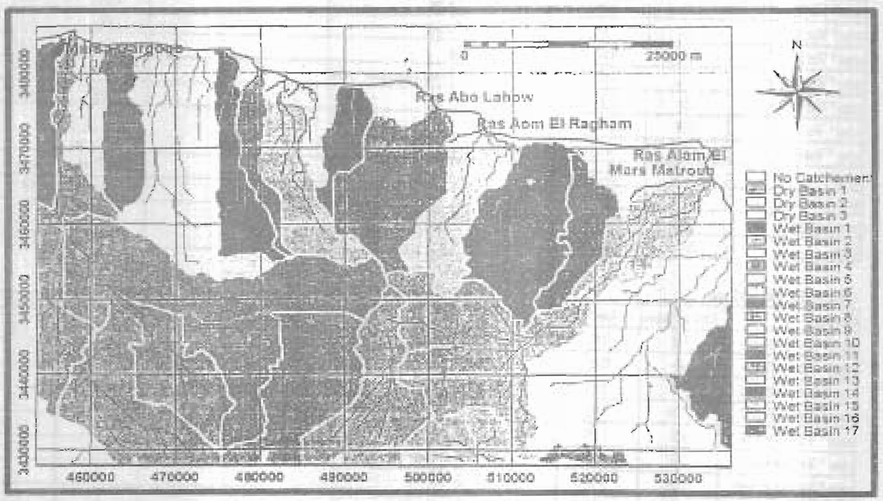

Fig. 6. Basin and sub basin areas of Matrouh in drained lines.

Vegetation cover area

The results show that the total area of vegetation cover using the maximum likelihood classification was 1808 hectares and 1784 hectares using the NDVI classification for the El Alamian area, and for the Matrouh area, the total area of vegetation cover using the Maximum likelihood classification was 5001 hectares and 4636 hectares using the NDVI classification.

Agricultural potential of landmine areas

The crossing operation of the physiographic mapping units, suitability, basin & sub basin, NDVI, and Maximum Likehood with landmine area maps are listed in Tables 5& 6. The results indicate that the landmine affected areas of El Alamian are locally suitable for figs (10236 hectares, 33.45%), suitable for all crops (2778 hectares, 9.08%), suitable for all crops, but after terracing (2913 hectares, 9.52%), suitable for shallow rooted crops (360 hectares, 1.18%), suitable for vegetables, field crops, and moderately deep rooted crops (6652 hectares, 21.74%), and suitable for summer resorts and touristic areas (7662 hectares, 25.04%). The landmine affected Matrouh areas are locally suitable for figs (3168 hectares, 9.44%) not suitable (3758 hectares, 11.20%), not suitable, but good range land (20195 hectares, 60.19%), suitable for all crops (2967 hectares, 8.84%), suitable for all crops, but after terracing (1730 hectares, 5.16%) and suitable for vegetables, field crops, and moderately deep rooted crops (1737 hectares, 5.18).

TABLE 5. Crossing basin, sub basin, maximum likelihood, NDVI, physiographic mapping units and suitability classes with landmine affected areas of El Alamian .

Crossing Mine with Basin

Crossing	Area In Hectars	Area %
mine * Dry Basin 2	128	0.43
mine * Wet Basin 5	49	0.16
mine * Wet Basin 6	862	2.89
mine * Wet Basin 7	260	0.87
mine * Wet Basin 8	2374	7.97
mine * Wet Basin 9	386	1.30
mine * Wet Basin 10	2912	9.78
mine * Wet Basin 11	5757	19.33
mine * Wet Basin 12	6120	20.55
mine * Wet Basin 13	7787	26.15
mine * Wet Basin 14	3143	10.55
Total	29778	100.00

Crossing Mine with Maximum likehood

Cross	Area in Hacters	Area %
Nature vegetation * mine	65	0.21
bair Soils area * mine	23509	76.83
limestone area * mine	68	0.22
sandy area * mine	135	0.44
limestone cover by sand sheet area * mine	6823	22.30
Total	30600	100.00

Crossing Mine with NDVI

Cross	Area in Hacters	Area %
Soils * mine	30518	99.73
Nature Vegetation * mine	84	0.27
Total	30602	100.00

Crossing Mine with Sub Basin

Crossing	Area in Hacters	Area %
mine * Dry Sub Basin4	128	0.43
mine * Wet Sub Basin5	49	0.16
mine * Wet Sub Basin6	260	0.87
mine * Wet Sub Basin7	2374	7.97
mine * Wet Sub Basin8	386	1.30
mine * Wet Sub Basin9	862	2.89
mine * Wet Sub Basin10	939	3.15
mine * Wet Sub Basin11	1743	5.85
mine * Wet Sub Basin12	230	0.77
mine * Wet Sub Basin17	23	0.08
mine * Wet Sub Basin18	3229	10.84
mine * Wet Sub Basin19	2525	8.47
mine * Wet Sub Basin20	1997	6.70
mine * Wet Sub Basin21	1153	3.87
mine * Wet Sub Basin22	2970	9.97
mine * Wet Sub Basin23	2247	7.54
mine * Wet Sub Basin24	5539	18.59
mine * Wet Sub Basin25	3143	10.55
Total	29797	100.00

Crossing Mine with Physiographic Mapping Units

Crossing	Area in Hacters	Area %
mine * Cp111	178	0.58
mine * Cp211	7662	25.04
mine * Cp212	6652	21.74
mine * Cp312	2319	7.58
mine * Cp313	7739	25.29
mine * Cp411	2203	7.20
mine * Hi111	360	1.18
mine * Hi112	709	2.32
mine * Hi113	2778	9.08
Total	30600	100.00

Crossing Mine with Suitability classes

Crossing	Area in Hacters	Area %
mine * Locally suitable for Figs	10236	33.45
mine * Suitable for all crops	2778	9.08
mine * Suitable for shallow rooted crops	360	1.18
mine * Suitable for vegetables, field crops and moderately deep rooted crops	6652	21.74
mine * Suitable for all crops, but after terracing	2913	9.52
mine * Suitable for summer area	7662	25.04
Total	30601	100.00

TABLE 6. Crossing basin, sub basin, maximum likehood, NDVI, physiographic mapping units and suitability classes of the landmine affected area of Matrouh.

Crossing Mine with Physiographic Mapping Units

Cross	Area in Hacters	area %
Cp212 * mine	1737	5.18
Cp311 * mine	2	0.01
Cp312 * mine	471	1.40
Cp313 * mine	2697	8.04
Cp314 * mine	5	0.02
Cp411 * mine	1730	5.16
Cp511 * mine	3	0.01
Pu111 * mine	1028	3.06
Pu112 * mine	4420	13.17
Pu211 * mine	1817	5.42
Pu212 * mine	4874	14.53
Pu213 * mine	14	0.04
Pu214 * mine	2302	6.86
Pu311 * mine	906	2.70
Pu312 * mine	10901	32.49
Pu313 * mine	648	1.93
Total	33554	100.00

Crossing Mine with Sub Basin

Crossing	Area in Hacters	Area %
Wet Sub Basin8 * mine	5	0.02
Wet Sub Basin11 * mine	9	0.03
Wet Sub Basin12 * mine	359	1.08
Wet Sub Basin13 * mine	45	0.14
Wet Sub Basin14 * mine	2478	7.46
Wet Sub Basin15 * mine	946	2.85
Wet Sub Basin16 * mine	3821	11.51
Wet Sub Basin17 * mine	492	1.48
Wet Sub Basin19 * mine	6530	19.66
Wet Sub Basin20 * mine	4348	13.09
Wet Sub Basin21 * mine	2669	8.04
Wet Sub Basin22 * mine	2293	6.90
Wet Sub Basin23 * mine	8811	26.53
Wet Sub Basin24 * mine	18	0.05
Wet Sub Basin28 * mine	387	1.17
Total	33211	100.00

Crossing Mine with Maximum likehood

cross	area in hacters	Area %
Nature vegetation * mine	1077	3.21
baer Soils area * mine	12613	37.59
Limestone cover by sand sheet * mine	15924	47.46
sandy area * mine	112	0.33
limestone area * mine	3829	11.41
Total	33555	100.00

Crossing Mine with Basin

Crossing	Area in Hacters	Area %
Wet Basin 2 * mine	5	0.02
Wet Basin 5 * mine	369	1.11
Wet Basin 6 * mine	45	0.14
Wet Basin 7 * mine	2476	7.46
Wet Basin 8 * mine	946	2.85
Wet Basin 9 * mine	3821	11.51
Wet Basin 10 * mine	492	1.48
Wet Basin 12 * mine	6530	19.66
Wet Basin 13 * mine	7017	21.13
Wet Basin 14 * mine	11123	33.49
Wet Basin 15 * mine	387	1.17
Total	33211	100.00

Crossing Mine with NDVI

Cross	Area in Hacters	Area %
soil * mine	32595	97.14
Nature vegetation * mine	960	2.86
Total	33555	100.00

Crossing Mine with Suitability classes

Crossing	Area in Hacters	Area %
Locally suitable for Figs * mine	3168	9.44
Not Suitable * mine	3758	11.20
Not suitable, but good range land * mine	20195	60.19
Suitable for all crops * mine	2967	8.84
Suitable for vegetables, field crops and moderately deep rooted crops * mine	1737	5.18
Suitable for all crops, but after terracing * mine	1730	5.16
Total	33554	100.00

Conclusion

The GIS/RS provide a significant planning tool for the planners and decision makers to organize land resources data of the Landmine-affected Areas, and to understand their spatial association.

The land suitability classes of the northwest coast zone are : suitable for figs (191500 hectares, 9.5 %), good range land (1080000 hectares, 53.7%), suitable for all crops (136000 hectares, 6.8%), suitable for all crops, but after terracing (155000 hectares, 7.7%), and suitable for vegetables, field crops, and moderately deep rooted crops (168000 hectares, 8.4%).

More than 33 %, 10,000 hectares of the landmine affected area at El Alamian is suitable for figs, where as more than 30%, 9900 hectares are suitable for all crops.

More than 60%, 20,000 hectares of the landmine affected area at Matrouh is suitable for range land where as more than 18%, 6500 hectares are suitable for all crops.

The integrated methodology of this study could be considered as a ready module for applying at different locations. The study outputs represent a significant geo-reference resource module to support an Information Management System for Mine Action in Egypt.

Recommendations

Clear information on the location of known and suspected mined areas needs to be shared with all line ministries, allowing them to plan development activities in safe areas, or plan clearance requirements as a component of the project preparation cycle.

New technologies and devices to resolve tasks in humanitarian demining operations (Ground Penetrating Radar, Remotely Controlled Devices, Ivashov *et al.* (2005) Demining Machines…) need to be reviewed and tested.

Soil properties database for use at the humanitarian, demining aerations consisting of . soil electrical conductivity and soil magnetic susceptibility- is of significant importance to landmine detection efforts both in the development and selection of equipment as well as in predicting their performance in a given region (Das ,Y, J. E. McFee and G. Cross, 2002).

Establishment of the United Nations Information Management System for Mine Action in Egypt is vital to enhance the capacity of the Government to set priorities and plan mine action in a coordinated manner.

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تقنين وتنمية المناطق المتأثرة من الألغام الساحل الشمالى الغربى – مصر

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أدى انتشار الألغام بالساحل الشمالى الغربى – مصر والتى تخلفت عن الحرب العالمية الثانية – إلى توقف استصلاح وتنمية نصف مليون فدان صالحة للزراعة المروية والمطرية – كما توقف استكمال مشروع ترعة الحمام – الصبغة وكذلك مشاريع صناعية – بترولية – وسياحية – وعمرانية أخرى كما أن هناك غياب كامل لقاعدة معلومات أرضية رقمية عن المصادر الطبيعية (أرض – مياه – نبات – بشرية) بالمناطق المتأثرة والتى تم تطهيرها من الألغام بالساحل الشمالى الغربى كأساس لوضع خطط تنموية مستدامة. كذلك تردد وعزوف السكان المحليين عن استخدام وتنمية المناطق المطهرة من الألغام.

وبتطبيق تكنولوجيا نظم المعلومات الجغرافية والاستشعار عن بعد من حيث تحليل ونمذجة بيانات المرئيات الفضائية وتحليل ونمذجة البيانات الطبوغرافية والأرضية والنباتية والمائية تبين أن مناطق العلمين المتأثرة بالألغام بها أكثر من ١٠٠٠٠ هكتار صالحة لزراعة التين وأن أكثر من ٩٩٠٠ هكتار صالحة لمختلف المحاصيل الحقلية والرعوية، فى حين مناطق مرسى مطروح المتأثرة بالألغام بها أكثر من ٢٠٠٠٠ هكتار مراعى، ٦٥٠٠ هكتار صالحة لمختلف المحاصيل الحقلية.

تعتبر منهجية هذه الدراسة حلقة أساسية يمكن أن تدعم نظام إدارة المعلومات لمواجهة الألغام فى مصر، وكما قد تساهم فى تخطيط وتنفيذ برامج تنموية زراعية – صناعية – سياحية محددة وبرامج تأهيلية وتدريبية لتوطين السكان المحليين بالمناطق المطهرة من الألغام فى مصر.