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# MODELING TO IDENTIFY SUITABLE AREAS FOR THE DEVELOPMENT IN THE DESERT REGIONS IN EGYPT

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## ABSTRACT

The area of Egypt is 1.01041 million km<sup>2</sup> and the Inhabited area (Valley and Delta) represents 79.29 thousand km<sup>2</sup> which means that only 7.85% of the total area is used. The remaining space of the Egypt is desert and it represents more than 90.9% of Egypt. Their special feature and distinctive properties are quite different from the Valley, which requires study of the General characteristics of the Egyptian desert and development possibilities and limitations, because the inhabited from area (the valley and delta) completely saturated and groaning many problems. That's why desert (Eastern Desert - Western Desert - the Sinai Peninsula) is the scope of any development process or urban extension as it could play an important role in solving many of the problems at the national and regional level, including potential and untapped resources. But Due to the current situation in Egypt We find that there is a problem in the resettlement of economic activities commensurate with the nature of the sites that are indigenization, which could affect the environment or on the practicing of the activity itself. This leads us to the conclusion that the traditional ways of dealing with this kind of decisions is a poor and cannot be relied upon in case we want to make informed decisions with a positive impact on the current situation in Egypt, This directs us to the modern technology that provide support in decision-making, In this field of study we can turn to the GIS because of its extraordinary ability in dealing with a huge amount of information and. spatial data.



Map No. (1): describes the four geographic regions of Egypt.

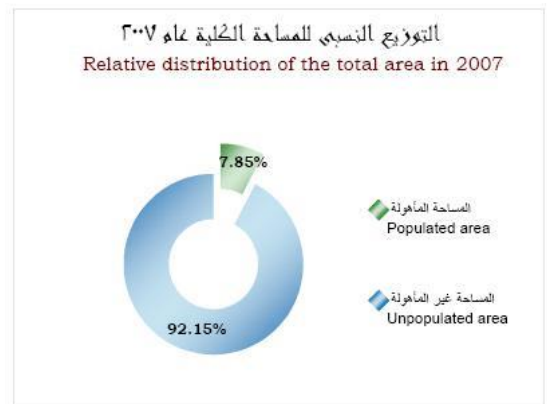


Fig (1): Distribution of Egypt's total area. Source: the cabinet- Information and Decision Support Center – Egypt's description by information 2009 - eighth edition

Accordingly this research aims to build model to select sites for urban development in desert areas and specifies the activity that the Urban areas will depend upon, accordance the natural characteristics of the area so that this form suitable for application on any Egyptian desert region through to enter properties of desert region (Climatic characteristics, Geographical characteristics, Topographical characteristics, Hydrological characteristics, geological characteristics .....). Taking into account the installation of social and economic characteristics, the model make some calculations based on the Settlement activities requirements and give results identify suitable sites for the establishment of Urban communities based on a particular activity (agricultural - tourist - Industrial -), this model will be built using GIS 9.3 ESRI-ArcGis.

Alexandria region (Alexandria, Beheira and Matrouh Governorate) Has been selected as a study area to apply the model , because it occupies almost the half area of the Western Desert and has wide variety in desert environments, the application ends with extracted suitable sites for development in the region and specify the type of the most suitable activity resettled everywhere in these places, so that this result Represent source of support in case we make any development decisions in this region, or in any other regions that will be applied to the model.

## **ARID AREAS DEVELOPMENT FACTORS**

All researches indicators and field studies confirm that the Desert areas have a development potential not yet exploited, it should be noted that the most important features of these areas are: land, water resources, natural resources, infrastructure and road network, urban communities, tourism, human resources

- In the case study development potential in desert regions we must first identify the available resources 'whether human or natural' defined in terms of excellence fragileness and the risks that may affect them negatively in the presence status, as well as its excellence or uniqueness which requires maintenance and conservation plans.

Consequently, we are going to study the existing and potential activities in the region, where these activities interfere with resources in two ways:

1. In terms of their impact on resources, negatively or positively.
2. In terms of their need for resources (relationship of impact and requirement).

We must also determine the reciprocal influence between resources and activities with each other. As relative weights that govern the importance of each resource for the activity (Priority). This is an important step as It puts frameworks and foundations on which building model process and describes the relationship of the proposed criteria and relative weights required orientations in the development process.

## **Methodology**

Work must be done at the theoretical level by reviewing the literature and concepts of spatial analysis and knowledge of the properties of the Egyptian desert areas linked to the activities to be resettled and on a practical level during phases of building the model for site analysis and determine its suitability for develop.

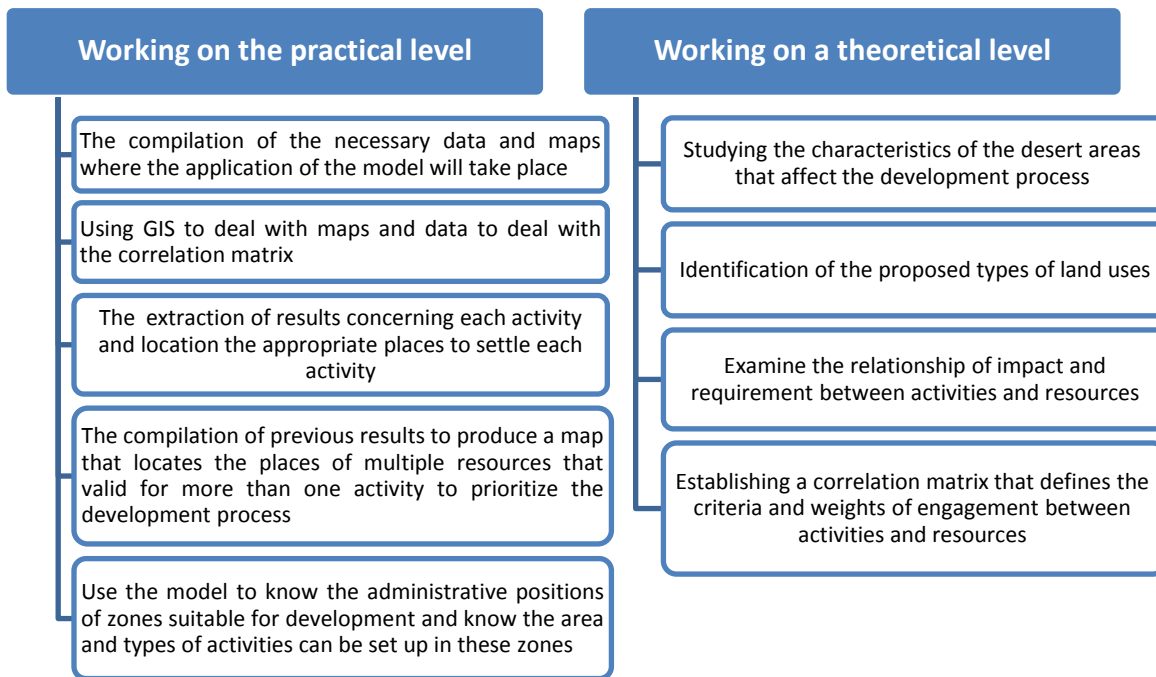


Fig2: Proposed logical framework for the preparation of model settlement activities in places suitable for development in the desert areas

**After studying the properties of desert areas that affect the development process** (CLIMATIC CHARACTERISTICS, GEOGRAPHICAL CHARACTERISTICS, TOPOGRAPHICAL CHARACTERISTICS, HYDROLOGICAL CHARACTERISTICS, GEOLOGICAL CHARACTERISTICS .....)**This step comes:**

**Identifying the types of proposed land uses:**

Suitability analysis process begins with defining the land use that we need to resettlement in the studying area for identifying their characteristics and requirements. The attached table shows the different types of expected future land uses.

Table 1: Definition of the activities to be settled:

Uses and possible activities	
Activity	Characteristics
<b>1 construction</b>	
urbanism	Urban communities characterized by medium and high densities and punctuated by Group variety of activities (tourism, commercial and industrial)
<b>2 tourism</b>	
Historic And Religious Tourism	like visiting the religious sanctuaries, knowing the history of religions and the archaeological sites
Beaches Tourism	Spread out near the coast and beaches safe for swimming and diving or offers various marine attractions.
Safari Tourism	Depends on the deserts and oases and areas wich characterized by the existence of mountains , dunes and nature reserves.
<b>3 Agriculture</b>	
agriculture based on surface water	It means the agriculture using irrigation water from canals , waterways.

	agriculture based on rains and ground water	Meant to agriculture using well water and rain.
4	<b>industry</b>	
	industry based on the existence of quarries	Extractive industries such as construction materials and marble, and manufacturing such as cement , gypsum
	industry based on the presence of mines	Mineral extraction industries, such as iron, phosphate, gold and others.
	industry based on the presence of Petroleum	It's like petroleum extraction and refining, which is dependent on the presence of oil wells.

### **Determination of the relationship between the proposed land uses and the properties and available resources in the region:**

This step based on building matrix of relationships between activities be resettled and the characteristics of the site, which include a description of the extent relationship to the requirements of activities from natural and human environments surrounding. In this step we determined (Weight) to each resource of natural and human resources impact strength on the various activities (for example the importance of selecting new sites for industrial clusters such as proximity to sources of raw materials , proximity to main roads or the presence of energy sources), as well as the relative weights that govern the importance of each resource for activity (the importance of the availability of fertile soil more than the availability of electricity for agricultural activity for example, Some features may have an impact extending away from them (such as roads) and these features have been enclosed belts (Buffers) varies in width in the range of several kilometers, according to the power of the factor on the area surrounding, in the same way we have been identified weights of these belts according to their impact on the different resources, we also determined the areas of special nature such as nature reserves or sand dunes, which must be excluded in some types of development (such as in the industrial development the industries polluting have negative impact on the flora and wildflowers) while prefer in other types of development, such as tourism development.

These relationship between resources and activity – effect and needs relationship- is the main driver for analysis in its various forms (vulnerability analysis, appropriate analysis, analysis of the potential and limitations, etc. ...), it Also describes the criteria and the relative weights and trends required, whether these trends inclined toward the preservation of the environment or economic development that drive the Urban Development locomotive in the area, or the human development of local communities. It can be also a combination of balanced development between the previous three trends.

The relationship between the activities proposed for resettlement and desert properties is shown as follows:

Symbols A-B-C-D means that there is a certain relationship, where A is strong relationship, B is an average correlation, while C is a weak relationship. D appears as a negative relationship, which means if this assets show in place, this place is not valid for this activity (such as the presence of natural reserves and localization industries or construction). Finally, the X symbol exists when there is no impact relationship, no relationship or impact of this property settlement activity (such as the relationship between rainfall and the oil industry).

**TABLE 2: THE RELATIONS BETWEEN ACTIVITIES AND RESOURCES**

			4			3				2		1	<div style="border: 1px solid black; padding: 5px; text-align: center;"> <b>Activities</b>  <hr style="border: 0; border-top: 1px solid black;"/> <b>Affecting Factors</b> </div>
Mines	Quarry	Petroleum	Industry	Underground water	Irrigation	Agriculture	Historical	Safari	Beach	Tourism	Urban	Urban	
C	C	C		C	C		C	C	B		B		<b>Topographic</b>
A	A	A		A	A		A	A	A		A		slop 0%-10%
B	B	B		B	B		B	B	B		B		slop 10%-20%
C	C	C		C	C		C	C	C		C		slop 20%-40%
X	X	X		X	X		X	C	X		X		slop > 40%
													<b>Climate</b>
X	X	X		C	C		C	C	C		C		<b>Temperature</b>
X	X	X		A	A		A	A	A		A		Temp 10 - 15
X	X	X		A	A		A	A	A		A		Temp 15 - 20
X	X	X		A	A		A	A	A		A		Temp 20 - 25
X	X	X		B	B		B	B	B		B		Temp 25 - 30
X	X	X		B	B		B	B	B		B		Temp 30 - 35
X	X	X		C	C		C	C	C		C		Temp 35 - 40
X	X	X		C	C		C	C	C		C		Temp >40
X	X	X		C	C		C	C	C		C		<b>Relative humidity</b>
X	X	X		A	A		A	A	A		A		R- humidity 30% - 40%
X	X	X		A	A		A	A	A		A		R- humidity 40% - 50%
X	X	X		B	B		B	B	B		B		R- humidity 50% - 60%
X	X	X		B	B		B	B	B		B		R- humidity 60% - 70%
X	X	X		C	C		C	C	C		C		R- humidity 70% - 80%
X	X	X		C	C		C	C	C		C		R- humidity > 80%
X	X	X		A	B		X	X	X		X		<b>precipitation</b>
X	X	X		C	C		X	X	X		X		precipitation < 25mm/m2
X	X	X		B	B		X	X	X		X		precipitation 25-50mm/m2
X	X	X		A	A		X	X	X		X		precipitation > 50 mm/m2
C	C	C		B	B		C	C	C		C		<b>land cover</b>
D	D	D		C	C		D	D	D		D		Sabkha and wetlands
D	D	D		D	D		D	D	D		D		Dunes
A	A	A		D	D		A	A	A		A		Sand and rocks
D	D	D		A	A		D	D	D		D		Nile and Valley Deposits
D	D	D		D	D		D	D	D		D		Cultivation
X	X	X		X	X		C	C	C		A		<b>Distance from the urbanization</b>
X	X	X		X	X		D	D	D		D		urbanization
X	X	X		X	X		B	B	B		A		Dis 25 - 60 km from the urbanization
X	X	X		X	X		B	B	B		B		Dis 60-100 km from the urbanization
X	X	X		X	X		C	C	C		C		Dis > 100 km from the urbanization
													<b>Hydrology</b>
X	X	X		X	A		X	X	X		c		Canals buffer
X	X	X		X	A		X	X	A		c		Lakes buffer

X	X	X	X	A	X	X	X	x	Irrigation buffer
X	X	X	X	A	X	X	A	A	Nile buffer
X	X	X	A	X	X	X	X	B	Underground water buffer
X	X	X	A	X	B	A	X	X	Wells buffer
X	X	X	X	X	A			X	Tourism
X	X	X	X	X	A	X	X	x	monuments
X	X	X	X	X	X	A	X	x	Safari sites
X	X	X	X	X	C	X	B	x	Shore line &view shed
									Infrastructure
B	B	B	B	B	A	C	B	A	Roads
C	C	C	C	C	C	X	C	C	Airport
C	C	C	C	C	C	X	C	B	Railway
B	B	B	B	B	B	C	B	A	High pressure lines
C	C	C	C	C	C	X	C	C	Harbors
				X	X	X	X	X	Natural resources
X	X	A	X	X	X	X	X	X	Petroleum Wells
X	A	X	X	X	X	X	X	X	Quarry
A	X	X	X	X	X	X	X	X	Mines
X	X	X	X	X	B	A	X	X	protected area
D	D	D	D	D	D	D	D	D	Planned protected area
X	X	X	X	X	A	A	X	X	Dis Of Planned protected area
D	D	D	D	D	D	D	D	D	Existing protected area
X	X	X	X	X	A	A	X	X	Dis Of Existing protected area

## USING GIS FOR ASSESSING THE SUITABILITY OF THE STUDY AREA FOR THE DEVELOPMENT

The process of assessing the validity of lands for future development in order to ensure that the projects are Placed for future development in their right locations is a complex processes that require a lot of time and effort , especially for the study areas with vast areas that require the collection, storage and analysis of a lot of information , spatial data and metadata, with the advent of GIS as a powerful tool capable of collecting, storing, retrieval, analysis and show geo-referenced data , recently it has adapted and used efficiently to help planners to support decision-making task concerning economic, social environmental and urban issues, assess the suitability lands for the future development comes in priority of those decisions to establish a solid base platform for settlement various lands uses in its rightful place.

The main objective to prepare the proposed model is the preparation of methodology with active tools that enable the planners to take their proper decisions based on the suitability of the different types of land development and environmental determinants of whether those parameters as a result of the maintenance requirements or because of natural risks and threats, so that this methodology has been transferred to determine the suitability of the lands to a program can be run on the computer where this program facilitates the stages of the work , generally the purpose of preparing this program is as follows:

- Provide easy and accessible tool for schema can be used to determine the suitability of the different urban land uses to include all parameters affecting the selection of areas suitable for development in various forms that model is focused on the desert areas and facilitate its application to all Egyptian desert areas.
- Providing flexibility in the use of the program so that you can update the data and modify the criteria and different weights at the discretion of the planning group and in accordance

- with the goals and visions of planning which may vary from region to region.
- Use GIS program ArcGIS SOFTBANK between planners and experts of urbanism and environment in Egypt.
- Model can deal with geographical indications in their various forms (Vector-Raster Base).
- Model focuses on the natural and environmental determinants, as there is flexibility to add any new specification.

## PUTS THE GROUNDWORK AND PLANNING STANDARDS

The analytical studies of natural and environmental characteristics proved that future development of various urban activities will be greatly influenced by several specific properties and therefore possible design constraints associated with these characteristics and conditions for an integrated system of geographic information that can be used to determine the suitability of the land in the area of urban development in the future, these design constraints have been limited in two sets of constraints which are general and special restrictions

Table (3) prepared by the researcher explains, public and private constraints that will be used in the preparation of the model:

		Layer name	suitability criteria and rating			
			least	low	medium	high
			Avoid	C	B	A
Risk Assessment		Earthquake events	Inside +buffer 3km			
		Faults	Inside +buffer 250m			
		Active flood plains	Inside +buffer 500m			
		Steep slopes	Inside			
		Sand dunes	Inside			
		Landmine	Inside			
		Radioactive zones	Inside +buffer 1000m			
		High voltage power line	buffer 250m			
Sensitivity assessment		Protected areas	Inside			
		Existing agriculture	Inside			
		Reclaimed areas	Inside			
		Water resources	Inside			
Development cost assessment		Road network	buffer 30m	>30km	10-30km	<10km
		Railways	buffer 50m	>500m	100-500m	<100m
		Airport	Inside +buffer 5km	>100km	10-100km	<10km
		Seaport	Inside +buffer 1km	>30km	10-30km	<10km
		Existing settlements	Inside	>5km	3-5km	<3km
		Proposed settlements	Inside	>5km	3-5km	<3km
		Power lines		>5km	3-5km	<3km
Economic potential assessment	Agri suitability	Water resources(Nile, lakes, canals, Rains, Aquifers)	Inside	>1500m	500-1500m	<500m
		Soils suitable for Agriculture	outside			Inside
		Reclaimed areas	Inside	>5km	3-5km	<3km
		Power supply		>5km	3-5km	<3km
	Ind suitability	Potential industrial (mining – quarry –Petroleum)		>30km	3-30km	<3km
		Power supply		>5km	3-5km	<3km
		Near to cities	Inside	<10km	10-100km	<100km



Tourism suitability	Soils suitable for industry	outside			Inside
	Touristic sites		>10km	3-10km	<3km
	Safari roads and sites		>5km	3-5km	<3km
	Shores	buffer 400m	>5km	3-5km	<3km
	Potential industrial (mining – quarry –Petroleum)		<30km	30-35km	>35km
	Airports , Ports	Inside +buffer 5km	>100km	10-100km	<10km
	Near to cities	Inside	>10km	3-10km	<3km
	Bedwian settlements (wells)		>5km	3-5km	<3km
	Sand dunes	Inside	>5km	3-5km	<3km

## MODELING THE ACTIVITIES THAT SHOULD BE SETTLED

This step was built upon the matrix results, after converting data into spatial maps; both of which reflect an influential factor in the development and process each map as shown earlier in table 2. We used digital maps that express each specified factor in the Cartography model using identical maps (Map Overlay) and using the software ESRI-ArcGIS the following are the main factors and parameters selected in the study of development of the various activities:

Table 4: criteria and the relative weights that were used in the model to produce maps suitability of each activity of economic activities which proposed indigenization:

LAYER	DISCRIPTION	WEIGHT	Suitability of land for settlement of agricultural activity (on the surface):	A - THE MODEL USED IN THE STUDY OF THE SUITABILITY OF THE LAND FOR AGRICULTURAL DEVELOPMENT:		
SLOP	Slop Suitability	C				
NILE	Distance To Nile Suitability	B				
LAKE	Distance To Lake Suitability	A				
IRRIGATION	Distance To Irrigation Suitability	A				
CANALS	Distance To Canals Suitability	A				
AIR PORT	Distance To Air Port Suitability	C				
HARPORT	Distance To Harbor Suitability	C				
HIGH ELECTRIC LINES	Distance To Power Supply Suitability	B				
ROADS	Distance To Roads Suitability	B				
LAND COVER	Land Cover Suitability	B				
HUMIDITY	Humidity Suitability	C				
TEMPERATURE	Temperature Suitability	C				
PRECIPITATION	Precipitation Suitability	C				
TOTAL		100				
LAYER	DISCRIPTION	WEIGHT	Suitability of land of agricultural for settlement activity (on groundwater and rain):	A - THE MODEL USED IN THE STUDY OF THE SUITABILITY OF THE LAND FOR AGRICULTURAL DEVELOPMENT:		
SLOP	Slop Suitability	C				
AIR PORT	Distance To Air Port Suitability	C				
HARPORT	Distance To Harbor Suitability	C				
HIGH ELECTRIC LINES	Distance To Power Supply Suitability	C				
ROADS	Distance To Roads Suitability	B				
LAND COVER	Land Cover Suitability	B				
HUMIDITY	Humidity Suitability	C				
TEMPERATURE	Temperature Suitability	C				
PRECIPITATION	Precipitation Suitability	B				
WATER BODY	Distance To Water body Suitability	A				
WELLS	Distance To Wells Suitability	A				
TOTAL		100				
LAYER	DISCRIPTION	WEIGHT			Suitability of land to resettle the tourist activity (tourism beaches):	B - THE MODEL USED IN THE STUDY OF THE SUITABILITY OF LAND FOR TOURISM DEVELOPMENT:
LAND COVER	Land Cover Suitability	B				
LAKE	Distance To Lake Suitability	B				
AIR PORT	Distance To Air Port Suitability	B				
HARPORT	Distance To Harbor Suitability	B				
HIGH ELECTRIC LINES	Distance To Power Supply Suitability	B				
ROADS	Distance To Roads Suitability	B				
HUMIDITY	Humidity Suitability	C				
TEMPERATURE	Temperature Suitability	C				
SETTLEMENTS	Distance To Settlements Suitability	B				
RAILWAY	Distance to Railway Suitability	C				
SHOOR LINE	Distance to Shoreline Suitability	A				
VIEW SHED	View shed Suitability	B				
TOTAL		100				
LAYER	DISCRIPTION	WEIGHT	Suitability of land to resettle the tourist activity (safari):	B - THE MODEL USED IN THE STUDY OF THE SUITABILITY OF LAND FOR TOURISM DEVELOPMENT:		
LAND COVER	Land Cover Suitability	B				
ROADS	Distance To Roads Suitability	B				
WATER BODY	Distance To Water body Suitability	A				
WELLS	Distance To Wells Suitability	A				
DONS	Distance To Dons Suitability	B				
MOUNTAINS	Distance To Mountains Suitability	C				
MONEMENTS	Distance To Monuments Suitability	A				
PROTECTORATES EXEST	Distance To exist Protectorates Suitability	A				
PROTECTORATES PLANED	Distance To planed Protectorates Suitability	A				
TOTAL		100				

LAYER	DISCRPTION	WEIGHT <sup>1</sup>	Suitability of land to resestle the tourist activity (cultural and archaeological tourism):	C - THE MODEL USED IN THE STUDY OF THE SUITABILITY OF LAND FOR INDUSTRIAL DEVELOPMENT:
LAND COVER	Land Cover Suitability	B		
SLOP	Slop Suitability	C		
ROADS	Distance To Roads Suitability	B		
WATER BODY	Distance To Water body Suitability	B		
WELLS	Distance To Wells Suitability	B		
MONEMENTS	Distance To Monuments Suitability	A		
PROTECTORATES EXEST	Distance To exist Protectorates Suitability	B		
PROTECTORATES PLANED	Distance To planed Protectorates Suitability	B		
SHOOR LINE	Distance to Shoreline Suitability	C		
HUMIDITY	Humidity Suitability	C		
TEMPERATURE	Temperature Suitability	C		
AIR PORT	Distance To Air Port Suitability	B		
HARPORT	Distance To Harbor Suitability	B		
HIGH ELECTRIC LINES	Distance To Power Supply Suitability	B		
SETTLEMENTS	Distance To Settlements Suitability	B		
RAILWAY	Distance to Railway Suitability	C		
TOTAL		100		
LAYER	DISCRPTION	WEIGHT <sup>1</sup>	Suitability of the land for the settlement of industrial activity (Inhng):	
SLOP	Slop Suitability	B		
AIR PORT	Distance To Air Port Suitability	B		
HARPORT	Distance To Harbor Suitability	B		
HIGH ELECTRIC LINES	Distance To Power Supply Suitability	A		
ROADS	Distance To Roads Suitability	A		
RAILWAY	Distance to Railway Suitability	B		
SETTLEMENTS	Distance To Settlements Suitability	B		
LAND COVER	Land Cover Suitability	B		
MINES	Distance To mines Suitability	A		
TOTAL		100		
LAYER	DISCRPTION	WEIGHT	Suitability of the land for the settlement of industrial activity (quarter):	
SLOP	Slop Suitability	B		
AIR PORT	Distance To Air Port Suitability	B		
HARPORT	Distance To Harbor Suitability	B		
HIGH ELECTRIC LINES	Distance To Power Supply Suitability	A		
ROADS	Distance To Roads Suitability	A		
RAILWAY	Distance to Railway Suitability	B		
SETTLEMENTS	Distance To Settlements Suitability	B		
LAND COVER	Land Cover Suitability	B		
QUARRY	Distance To Quarry Suitability	A		
TOTAL		100		
LAYER	DISCRPTION	WEIGHT	Suitability of the land for the settlement of industrial activity (Petroleum):	
SLOP	Slop Suitability	B		
AIR PORT	Distance To Air Port Suitability	B		
HARPORT	Distance To HarPor Suitability	B		
HIGH ELECTRIC LINES	Distance To Power Supply Suitability	A		
ROADS	Distance To Roads Suitability	A		
RAILWAY	Distance to Railway Suitability	B		
SETTLEMENTS	Distance To Settlements Suitability	B		
LAND COVER	Land Cover Suitability	B		
OIL GAS	Distance To oil gas Suitability	A		
TOTAL		100		
LAYER	DISCRPTION	WEIGHT	Suitability of the ground for urban settlement:	. D - THE CRITERIA USED IN THE STUDY OF THE SUITABILITY OF LAND FOR URBAN DEVELOPMENT:
LAND COVER	Land Cover Suitability	B		
SLOP	Slop Suitability	B		
ROADS	Distance To Roads Suitability	B		
RAILWAY	Distance to Railway Suitability	C		
HUMIDITY	Humidity Suitability	C		
TEMPERATURE	Temperature Suitability	C		
AIR PORT	Distance To Air Port Suitability	B		
HARPORT	Distance To Harper Suitability	B		
HIGH ELECTRIC LINES	Distance To Power Supply Suitability	B		
SETTLEMENTS	Distance To Settlements Suitability	A		
SHOOR LINE	Distance to Shoreline Suitability	B		
OIL GAS	Distance To oil gas Suitability	B		
QUARRY	Distance To Quarry Suitability	B		
MINES	Distance To mines Suitability	B		
TOTAL		100		

## CASE STUDY

### The definition of the Region:

The Region of Alexandria includes Alexandria, Matruh and Al behera inter space approximately 224,000 km<sup>2</sup>, representing 22.2 percent of the total area of the Republic. It is the second region in seven regions of Egypt. It is inhabited by about 9.2 million people according to the 2006 Census. Region of Alexandria occupies the North Western section of the Republic, it extends along the Mediterranean coast to 560 km, and extends far south till the northern boundary of the new Valley, deep up to 400 km to the South of the Mediterranean beach. The Region is considered The west road entrance of the (al Maghreb al Arabia) Morocco through Salloum and the main north entrance of Mediterranean States and Europe through the port of Alexandria( Egypt's first port).

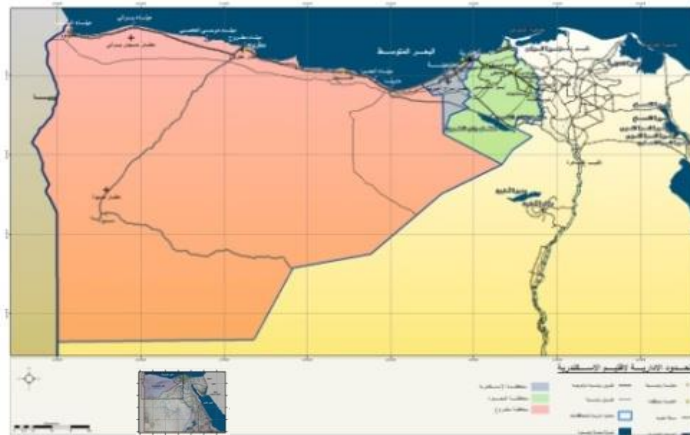


Fig 3: Administrative boundaries of the region of Alexandria

### Applying Model:

The penultimate step comes from the process of preparation of the analysis of the Suitability of land through the use of the previous matrices .plus implementing them on the geographic database to extract maps of land suitability for urban, agricultural, industrial and tourism. stored digital maps and geographic data base treatment have been used, expressing each factor has been assigned to be used in Cartography model using identical maps( Map overlay) and using Weighted analysis process( Overlay) in GIS (ESRI-ARCGIS advantage of 9.3) this methodology to control the relative weights of each of the factors used to increase the importance of a factor rather than the other in accordance with the requirements of the analysis , decisions of decision maker and the specialist team.

#### I. Suitability of the land for the settlement of agricultural activity

Two models were applied to agricultural development, first: agricultural development based on surface irrigation that depend on sources of the Nile and lakes, most notably in the scope of the study of al mahmoudiyah Canal, Al Hamam, and al Hamam extension, the second: agricultural development based on groundwater and rainfall.

**a. The results of applying the suitability of land model for the settlement of agricultural activity (on surface water):**

- 1) Increasing the suitability of land for farming in Al Behera and Alexandria (the eastern part of the region). This is because of the presence near the Nile, canals, water drains and Lakes.
- 2) For land reclamation in the study area: less suitability in the southern and Western parts of the region, because of several reasons which are:
  - The rareness of water surface like Streams canals and lakes.
  - The spread of sand formations in all forms such as sand dunes, sand seas, and sand covers.
  - The rareness of the arable soil under the condition of the currently available techniques.



Fig (4) suitability of land for agricultural development based on surface water irrigation

**b. The results of applying the suitability of land model for the settlement of agricultural activity (aquifer).**

- 1) Suitability of land for irrigation of fresh groundwater increases in some areas in the middle of the study area and where there are relatively convenient underground reservoirs.
- 2) Increase the Suitability of the land for agricultural reclamation by irrigation-based on rainwater in the northern areas because of the increase rainfall in these regions.

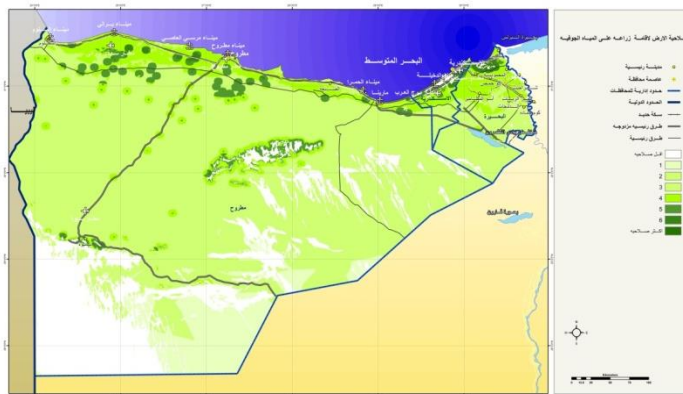


Fig (5): suitability of land for agricultural development based on irrigation using groundwater.

## II. The suitability of land to resettle tourism activity

Based on the examination of the previous matrices and understanding the potential ,limitations of desert areas. We identified the most important factors of tourism development in the Region land which varies according to the pattern of tourism

### a. The suitability of land to settle tourism (tourism beaches)

The potential (factors) and determinants for the development of Beach tourism based on the previous matrices .Moreover the use of maps prepared by the geographical database and reflecting those factors that have been processed like the coastline, lakes, as well as the proliferation of the existing urban areas near the coast, along with the proximity of main roads, ports and airports.

Results: suitability of land rises to development the coastal tourism along the Northwest Coast, particularly near major urban centers.

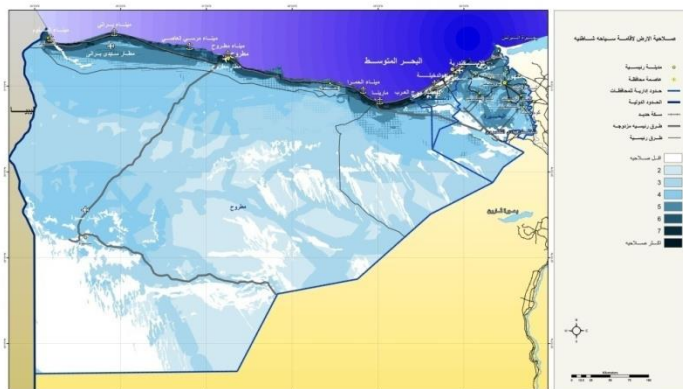


Fig (6): suitability of land for tourism development based on beach tourism.

### b. Land Suitability to settle the Touristic activity (safari tourism)

The potentials and limitations of safari tourism development have been set based on the previous matrices. and The maps prepared by the geographical database that express these factors after being processed like the presence of (natural reserves, mountains and archaeological sites) plus other factors which are: Bedouin gatherings, sand dunes, and being near the main and secondary roads.

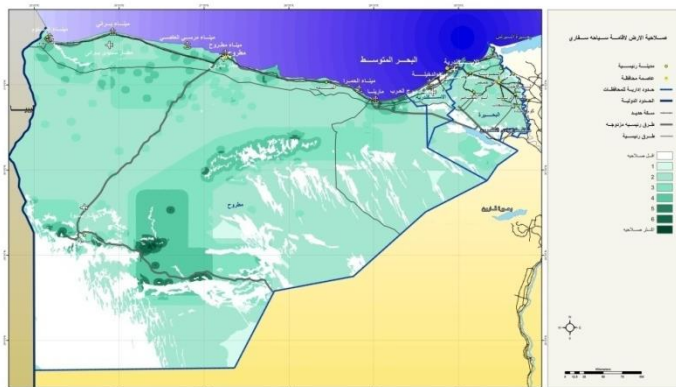


Fig (6): suitability of tourist development based on safari.

Results and analysis:

The suitability of land increased to develop safari tourism in most parts of the desert in



the region. Especially along the natural reserves, the secondary roads and around the sand dunes and Bedouin settlements.

**c. The Suitability of land to settle touristic activity (cultural tourism)**

Factors and limitations were set to develop the cultural tourism based on the previous matrices, The prepared maps by the geographic data base were used, which express these factors after being processed such as being near the archaeological sites. In addition to other factors like the current urban settlement (cities and Bedouin settlements) also being near to the main roads, the ports and airports is a good factor.

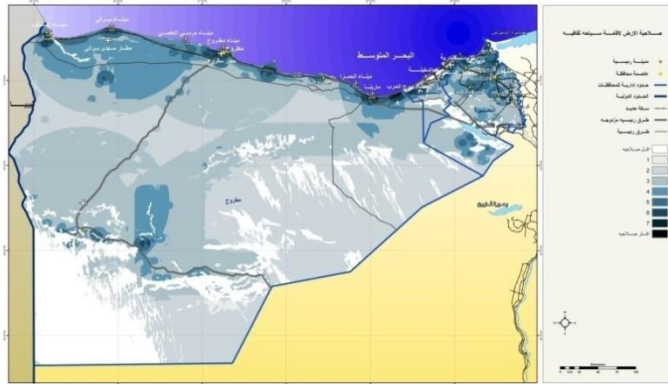


Fig (7): suitability of tourist development based on cultural tourism.

**Results and analysis:**

The suitability of lands rises to develop the cultural tourism especially in north and middle of Al- Behera governorate, also in Al Alamin, siwa oasis, and other places in the western desert affected by the presence of the archaeological sites.

**III. Land suitability to settle industrial activity**

We set the most important factors of the industrial development in the Region that vary according to the type of industry as it is mentioned Previously, Based on the study of the previous matrices, and the understanding of potentials and limitations of the desert areas. We applied 3 models of industrial development: 1<sup>st</sup> was the industrial development based on mining, 2<sup>nd</sup> the industrial development based on quarries, 3<sup>rd</sup> industrial development based on oil wells.

**a. The results of applying the suitability of land to settle industrial activity (mines)**

The Suitability of land rises to develop mining and extractive industry in the west-northern coast in the desert and the mining sites in the western desert. Except the natural reserves regions and bearing in mind keeping a long distance far from the cities in order not to affect them negatively.

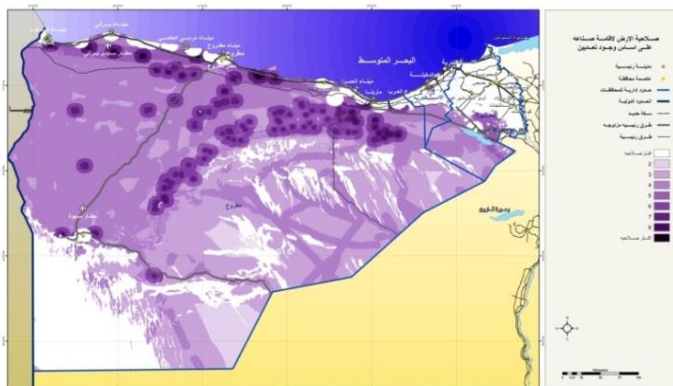


Fig (8): suitability of land for industrial development based on mining.

**b. The results of applying the suitability of land to settle the industrial activity (quarries)**

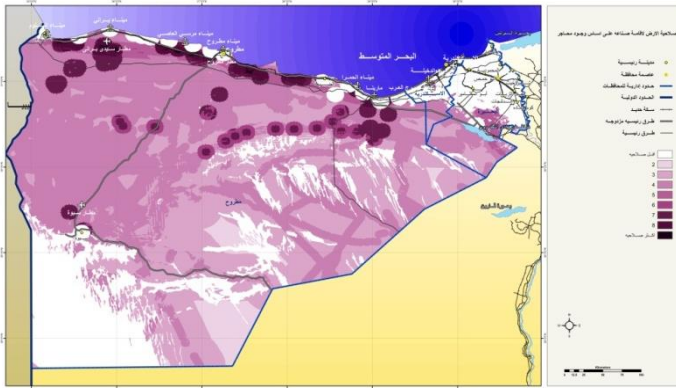


Fig (9): Suitability of land for industrial development based on quarries

The suitability of land rises to develop the industries that are based on the presence of quarries in the north western coast of the desert with the exception of the natural reserves regions. Putting into consideration being far away from the cities in order not to affect it negatively.

**c. The results of applying the suitability of land to settle the industrial activity (oil)**

The suitability of land increases to develop the industries based on the presence of oil in the desert. Around the sites of petrol wells in the western desert with the exception of the natural reserves regions. Bearing in mind being far away from the cities in order not to affect them negatively.

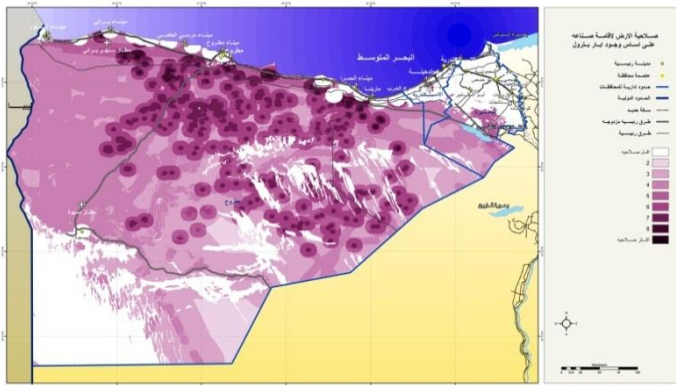


Fig (10): suitability of land for industrial development based on oil

**IV. Land suitability to settle the urban activity.**

One model has been applied to the urban development, the potentials and limitations have been set for the urban expansion from the results of the previous matrices. We also used the maps designed via the geographical database that show these factors which are: being near from ports and airports in addition to other factors like being near from the current urban settlements, the coast line and the appropriate land slope (the more the slope increases the less it fits)



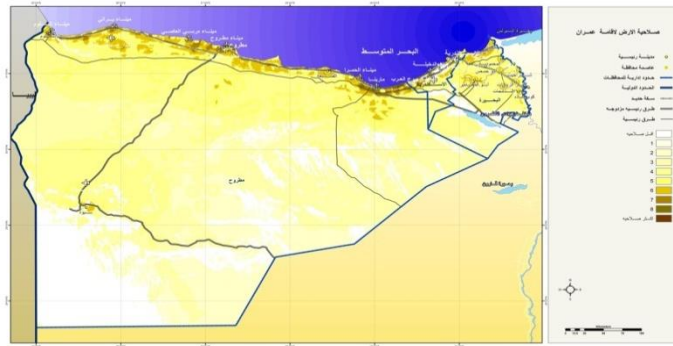


Fig (11): suitability of land for urban development.

The results of suitability model application to settle urban activity:

The Suitability increases in the northern parts of the studying area and this for the following reasons:

- The concentration of urban settlements in the northern parts
- The concentration of the seaports and the airports.
- The presence if the coast line that has and effective influence.

### THE MAP OF THE MULTIPLE ACTIVITY PLACES:

This step is considered the final step in this model, as we compile the final fitting maps for the activities that were previously produced through the model application. This to produce One final map that defines the multiple activity places that are valid to establish more than one activity. Since the suggested activities in the model are 9 activities, the places will take the numbers from 0 to 9. Zero means that this region is not valid for any activity, one suites for one activity, 2 suites for 2 activities..Etc

In this step we will use the suitability maps in making the cartogravea models using the identical maps( Map overlay) and the use of the analysis process (weighted Sum) in the geographic information system ESRI-ArGis9.3 and this by giving all the maps the same value(1).

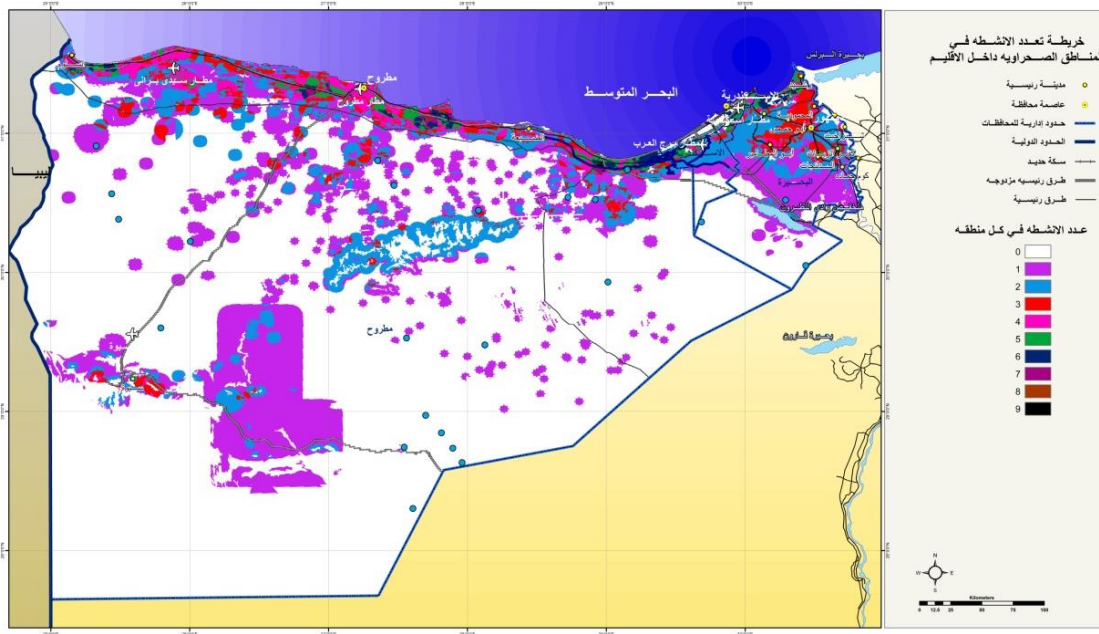


Fig (12): suitability of land to set up more than one activity.

## Results and analysis

- The multiple activity regions are concentrated in the northern part of the region.
- The Areas that are not valid for any type of development are not occupied by any suggested usage in the current time. These places don't cause any problems for the planner or the decision maker because they are not valid for the development activities according to the current requirements (or to warn from establishing any development activity because of its sensitivity or importance).
- The place that is occupied by one suggested use only is preferable to be used for this purpose only.
- It's possible to establish many activities in the places that are occupied by more than one suggested activity. Its economic base depends on more than one job unless these activities contradict each other like urbanism and agriculture.

## COCNLUSION AND RECOMMENDATIONS

To make a balance between population and the environment in the valley and Delta through the redistribution of the population at the national level should be directed development thinking about desert regions and exploit the best use.

Using GIS technology offers better planning results from the use of traditional methods.

Whenever digital data available for the study areas whenever led to accurate results.

Land suitability analysis involves the application of multi-criteria to assess where land is most and least suitable for development .the critical aspect of multi-criteria analysis is that it involves evaluation of the geographical events based on the criterion values and the decision makers preferences with respect to a set of evaluation criteria.

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