PREPARATION OF DATABASE FOR LANDUSE MANAGEMENT IN NORTH EAST OF CAIRO

By

Abeer Mohamed El-Ghawaby

B.Sc. (Electronics and Communication Engineering)

Faculty of Engineering, Ain Shams University, 1991

A Thesis Submitted for Partial Fulfillment
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The Requirements for the Master Degree
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ABSTRACT

Environmental management in urban areas is difficult due to the amount and miscellaneous data needed for decision making. This amount of data is splendid without adequate database systems and modern methodologies. A geo-database building for East Cairo City Area (ECCA) is built to be used in the process of urban land-use suitability to achieve better performance compared with usual methods used. This Geo-database has required availability of detailed, accurate, updated and geographically referenced data on its terrain physical characteristics and its expected environmental hazards that may occur.

A smart environmental suitability model for ECCA is developed and implemented using ERDAS IMAGINE 9.2. This model is capable of suggesting the more appropriate urban land-use, based on the existing spatial and non-spatial potentials and constraints.

SUMMARY

Environmental management is difficult due to the amount and miscellaneous data needed for any kind of environmental decision making. This amount of data is splendid without adequate database systems and modern methodologies. A geo-database for NORTH EAST OF CAIRO is built to be used in the process of urban land-use suitability to achieve better performance compared with usual methods used. This Geo-database has required availability of detailed, accurate, updated and geographically referenced data on its terrain physical characteristics and its expected environmental hazards that may occur.

A smart environmental suitability model for NORTH EAST OF CAIRO is designed and implemented using ERDAS IMAGINE 9.2. This model is capable of suggesting the more appropriate urban land-use, based on the existing spatial and non-spatial potentials and constraints.

The main goal of this study is to design and develop an urban suitability model whose output is the final integrated suitability map for urban development, through building a good and up-to-date spatial database for the target area. This geo-database helps analyzing, manipulating and integrating the spatial data using land suitability programs.

STATEMENT OF THE PROBLEM

For many years, agencies at the various governmental levels have been collecting data about land, but for the most part they have worked independently and without coordination. Too often, this has meant duplication of effort, or it has been found that data collected for a specific purpose were of little or no value for a similar purpose only a short time later.

The demand for standardized land use and land cover data can only increase as we seek to assess and manage areas of critical concern for environmental control such as flood plains and seismic activities, and areas such as major residential and industrial development sites.

MOTIVATION

Cairo city "Egypt's Capital" is located on a narrow strip of the Nile valley, just to the south where Nile River diverts to its Damietta and Rosetta branches enclosing the Nile Delta. Cairo city is bounded with two high plateaus to the east and the west, called Qattamia and Pyramids respectively. The prevailing wind direction in Cairo city is from north all over the year except the period from April to June; winds come from south and called Khamasin winds.

During the last five decades, a growth of industrial zones have been erected at the northern "Shobra" and the southern "Helwan" entrances of Cairo city, on the expense of agricultural activities. Population growth has increased rapidly in Cairo due to many reasons.

As a sequence of this population overgrowth and disregarding environmental and social consideration in design and urban planning, a large shortage of housing, growth of slums and informal housing have existed. For all these reasons, NORTH EAST OF CAIRO has been chosen to be our case study.

MATERIALS AND METHODS

In order to build a GIS database useful for urban development planning purpose, one might define the essential requirements for development and management. These requirements involve data of the physical features and the environmental hazards that influence urban development in the target area. Geo-database has to be provided by suitable software to run, manipulate and integrate spatial data. Both graphical and attribute data might have the possibility to be incorporated to the Geo-database.

As the majority of information used in urban land-use planning is spatial in nature, the geo-database system might have the capability to handle different land-use management issues and to enable storage, retrieval, analysis and modeling of these spatial data.

Once the main target to study NORTH EAST OF CAIRO is to provide a model answers how to re-evaluate its urban development plan, the controlling factors and the influencing parameters were specified within a model, to achieve such specific objective.

Criteria for urban development were based on the potentialities and constraints. Potentialities include natural and human resources, while constraints include natural hazards and unsuitable lands. Both criteria were weighted and arranged according to their importance in the process of site selection and were used in a Geographic Information System (GIS) model. Urban suitability model which is based on multi-criteria evaluation technique was established to produce the land suitability maps for urban development.

Running the overlay process on the weighted layers (urban development potentials and constraints) produced a suitability index map, which were reclassified into four zones of urban development suitability.

RESULTS AND DISCUSSIONS

Development of Remote Sensing Techniques (RST) and Geographical Information Systems (GIS) have helped much to design and build an integrated urban plan, that requires to deal with large volumes of basic data formats. Application of these recent techniques and spatial data processing systems provides the decision maker a chance to compare between numbers of choices of different solutions.

In this study, suitability of the area for urban development was evaluated using Geographic Information Systems (GIS)-based approach. Urban suitability model that incorporated land use/cover, types of soil, fractures, slopes, distances to major faults and streams, road network, and city boundaries was established to create a map of urban suitability for NORTH EAST OF CAIRO. Model weights were developed using the multi-criteria evaluation approach. Current urban land use within NORTH EAST OF CAIRO falls into four classes of suitability. These four classes provide decision makers and planners with an integrated approach and essential needs to rational land-use sustainability for urban development.

The output map for urban suitability of NORTH EAST OF CAIRO tells differences in suitability range across the area. The suitability ratings appear to be primarily controlled by the factors related to urban suitability. Analysis of the map for urban suitability suggests that most of the land of NORTH EAST OF CAIRO is suitable for urban development. As can be seen, about 15% of the area is highly suitable for urban development. If one extends the boundary to moderately suitable areas, the total area of NORTH EAST OF CAIRO suitable for urban development increases the fraction to >70% of the total area. Thus, it appears that NORTH EAST OF CAIRO location is suitable for urban development. Areas not suitable are concentrated in the northeastern portion of the area due to agricultural areas around Ismailia channel and also in the upper central part due to sand dunes. These areas represent about 30% of the total area of NORTH EAST OF CAIRO. Based on examination of the map of suitability, we suggest that the central part of the region, below the sand dunes area, should be given the first priority for urban development. This region is in between the Cairo-Ismailia road and Cairo Suez road.

Although the development of NORTH EAST OF CAIRO is already underway, the developed areas were also investigated. If this investigation identifies urban development over unsuitable areas, the obtained maps from this study can raise awareness of potential hazards in such areas. Thus, we restate the question: Is urban development occurring over suitable areas? To address this question, an urban land use map was created from a supervised classification of the ASTER image acquired on 2002, using Band2 VNIR (0.66 µm, 15 m), Band3N VNIR (0.81 µm, 15 m), Band3B VNIR (0.80 µm, 15 m), and Band4 SWIR (1.66 µm, 30 m). Current urban land use within NORTH EAST OF CAIRO falls into four suitability classes. Approximately 20% of all areas urbanized are in not suitable class, which suggests that the map of urban suitability can serve as a good base for planning sustainable development in NORTH EAST OF CAIRO.

CONCLUSIONS

Accurate information and perfect data are rarely available, which lead to a kind of uncertainty in building a geo-database. This, in turn, affects the accuracy of the criteria assessment. To accommodate the propagation of uncertainty through the established geo-database, input data should be of suitable spatial resolution for the analysis, factors should be selected carefully, and the manner in which the selected factors are combined and analyzed should be suitable for the desired objectives.

A GIS-based assessment of urban suitability can help identify optimal areas for urban development while promoting preservation of environmentally sensitive or hazardous areas. The map of urban suitability obtained from this study can provide decision-makers with useful information to determine the general trends and spatial distribution of classes of suitability for urban development in NORTH EAST OF CAIRO. For assessment of urban suitability, GIS can manage a large number of spatially related data and integrate multiple layers of surface and subsurface information to extract new, useful information.

The multi-criteria approach was used to create appropriate weights for the different factors affecting the suitability of the area for urban development.

RECOMMENDATIONS

- ❖ The GIS technique is a powerful tool for performing the urban development analysis, managing data, and transforming data into visual information in map form.

- GIS model provides a basis for informed decision making to support integrated sustainable development. However, the developed approach integrating GIS and multi-criteria technique can be adapted and used to assess suitability of any other area, wherever multi-criteria decision making is needed.
- In the context of extreme data limitations and methodological constraints, the accuracy and reliability of the technique needs to be checked with experienced human knowledge of the area. In other words, human skills will always still the final judgment to verify computerized results.
- The application could be extended to different landuse development activities.
- Participation of all Egyptian governmental authorities in all possible phases is a must.

DEFICIENCY ASPECTS

- The study is concerned with the possibility of potentials, land capabilities and constraints while some factors do not have the same attention and this will reflect on the resulting final suitability map.
- Using old topographic maps due to the lack of data.

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List of Abbreviations

CAPMAS: Central Authority for Public Mobilization and Statistics

COM: Component Object Model

CRT: Cathode Ray Tube

EEAA: Egyptian Environmental Affairs Agency

ESA: Egyptian Survey Authority

ESRI: Environmental Systems Research institute

ETM+: Enhanced Thematic Mapper plus

FEMA: Federal Emergency Management Agency

GIS: Geographical Information System

GPS: Global Positioning System

GUI: Graphical User Interface

HRV SPOT: High Resolution Visible SPOT

LSA: Land Suitability Analysis

LUP: Land Use Planning

MMI: Man Machine Interface

NARSS: National Authority for Remote Sensing and Space Sciences

OOUI: Object-Oriented User Interface

RIGW: Research Institute for Ground Water

RS: Remote Sensing

SAR: Synthetic Aperture Radar

SDSS: Spatial Decision Support Systems

TM: Thematic Mapper

UTM: Universe Transverse Mercator

VBA: Visual Basic for Applications

WLC: weighted linear combination

CHAPTER ONE

INTRODUCTION

CHAPTER ONE

INTRODUCTION

1.1 Background

Urban planning leads to a choice between a set of alternatives to satisfy certain objectives. Yet the realization of these objectives may cause a conflict between the environment and the adverse impacts of human activities which may lead to environmental deterioration. Therefore, we ensure the sustainability of an urban development in a simple and comprehensive approach through building a spatial database for the target area to be suitably planned for urban development.

NORTH EAST OF CAIRO is chosen to be presented in this thesis as a case study to support the decision makers for choosing the best suitable urban extensions to meet the growth of population and direction of expansion and type of urban land use taking into consideration the environmental sustainability.

According to 2006 census the population of Egypt is 74.9 million inhabitants, with 1.99% annual increase rates, this population expected to be more than 185 million inhabitants at 2052 [CAPMAS (2006): Egypt in Figures-2005 Central Agency for Public Mobilization and Statistics CAPMAS: Cairo]. Many problems will face the Egyptian decision makers with this large population and high rates of growth. And the consequent problems include the pressures on the natural resources, financial support of development processes, need for new jobs opportunities, need of support and upgrade for infrastructure, need for new urban extensions and preservation to enhance the quality of life.

Most of these problems are present in the main cities such as Cairo, Alexandria and the governorate capitals. These cities have many attractive features for the country people. Therefore they have the highest rate for inter-regions migration. Adding this migration to the natural population growth, these cities shall have many challenges to create new urban extensions to include the new populated society within the desert areas, or cultivated lands. To overcome the urban sprawl on the agricultural land, a solution is to make tightly connected urban areas in the desert terrain and not on the cultivated lands.

1.2 Statement of the problem

For many years, agencies at the various governmental levels have been collecting data about land, but for the most part they have worked independently and without coordination. Too often, this has meant duplication of effort, or it has been found that data collected for a specific purpose were of little or no value for a similar purpose only a short time later [James R. Anderson, Ernest E. Hardy, John T. Roach, and Richard E. Witmer (2001): A Land Use And Land Cover Classification System For Use With Remote Sensor Data, United States Government Printing Office, Washington].

There are many different sources of information on existing land-use and land-cover and on changes that are occurring. Local planning agencies make use of detailed information generated during ground surveys involving measurement and observation. Interpretation of large-scale aerial photographs and high resolution satellite images also has been used widely [Avery, T. Eugene, (1968): Interpretation of aerial photographs, 2nd ed., Minneapolis, Burgess Pub. Co.,329 p.]. Major problems are present in the application and interpretation of the existing data. These include changes in definitions of categories and data collection methods by source agencies, incomplete data coverage, varying data age, and employment of incompatible classification systems. In addition, it is nearly impossible to aggregate the available data because of the differing classification systems used [James R. Anderson, Ernest E. Hardy, John T. Roach, and Richard E. Witmer (2001): A Land Use And Land Cover Classification System For Use With Remote Sensor Data, United States Government Printing Office, Washington].

The demand for standardized land use and land cover data can only increase as we seek to assess and manage areas of critical concern for environmental control such as flood plains and seismic activities, and areas such as major residential and industrial development sites [James R. Anderson, Ernest E. Hardy, John T. Roach, and Richard E. Witmer (2001): A Land Use And Land Cover Classification System For Use With Remote Sensor Data, United States Government Printing Office, Washington].

1.3 Motivation

The continuous growth of Egyptian population will lead to a growth in main urban settlements and a parallel continuous pressure on land use and natural resources. Sustainable communities are based on the equilibrium between development and environment. Keeping this equilibrium requires complete information about the demands and capabilities of these communities in the future. The nature of environment/development planning system has many dimensions, some of these dimensions are temporal and some others are spatial [Mahmoud, W. E. M. (2008): Development of a Geospatial Model for Projection of Land Use Changes; Case Study: Marsa Matrouh City. PhD. Thesis, Institute of Graduate Studies and Research (IGRS), Alexandria University, Egypt]. A traditional modeling approaches concerns with the temporal elements in the system without considering the spatial dimensions of these elements. To get an accurate urban development planning, modeling should to treat the spatial elements in the environment/development system as it treats the temporal elements.

Urban planning decisions have to deal with large volumes of basic data where technical knowledge must be coordinated with the decision maker views. This makes urban planning quite a complex process, if you deal with them manually.

1.4 Objectives

The main goal of this research is to develop a model, through building a spatial database and applying the advanced techniques of data analysis, manipulation and integration using GIS programs for land evaluation and suitability modeling and user interface system design.

So we have to formulate the framework for spatial modeling to solve and provide sustainable urban planning requirements. To achieve the objectives of this thesis the following steps are done:-

- Establishing a digital geo-environmental database in a GIS environment, for NORTH EAST OF CAIRO.
- Applying the advanced techniques of land evaluation analysis and choosing the best compatible analysis for our study area.
- Designing the urban suitability model of NORTH EAST OF CAIRO for selecting areas suitable for future urban planning with grade levels of suitability from highest to lowest suitability excluding the areas not suitable for urban development.
- Designing a user interface application system for NORTH EAST OF CAIRO.

Urban planning requires well understanding of direct and indirect relationships of physical, environmental and cultural characteristic features of the target area, on its prospective land use activities. This means that the data of characteristics of physical and environmental features of NORTH EAST OF CAIRO have to be collected, updated, spatially rectified, projection-unified and digitally organized in a format of ARC-GIS desktop geo-database.

1.5 Thesis Structure

This research aims at develop a model of a multidisciplinary digital geo-environmental database of NORTH EAST OF CAIRO as a case study. This geo-database is used as input for urban GIS suitability model to select suitable lands for urban development in a priority order. To achieve these objectives, it is seen that this thesis has been prepared in a structure like the following:-

The first chapter concerns with the introduction, that includes a statement of the problems, motivation of that problems, Also the main goal of this study and its specific objectives, and how to be done.

The second chapter surveys the scientific publications related to the objectives of the thesis. This review attempts to build a knowledge base about the materials and methods and trends of data analysis and modeling for selecting lands suitable to urban development. The materials dealt with in this study are mainly data types and data formats. Also the tools to input, store, organize, manipulate and output the spatial and attribute data have been discussed.

This review discussed the trials of scientists to enhance the data analysis processes either for satellite images or digital geo-referenced maps with attributes. The spatial data analysis is concerned only with land suitability analysis and modeling for urban development.

Then, the characteristic features of the case study area, either its physical features such as its physiographic and its soil and surface rock cover and structures, or its environmental conditions such as the prevailing, climate conditions are presented in chapter three. Also this chapter is ended with the known natural resources and the expected environmental hazards in the area of study.

Chapter four is a demonstrative part for the controlling factors and influencing parameters of land suitability for urban development. Also, the constraints that restrict urban development in NORTH EAST OF CAIRO have been defined.

The focus of chapter five is how to build the multidisciplinary geographic database of the case study area. It includes the steps and operations that have to be followed up for the characteristic features data to be fit with the GIS-environ.

The sixth chapter discusses applied procedures for the urban suitability model developed in this study. Operations such as buffering, ranking and weighting of various controlling factors and influencing parameters on the urban development of the study area have been included in the model. Also, integration of these weighted factors and parameters and their map overlay processes based on the applied algebra using urban suitability model to produce the integrated land suitability map for urban land-use development. This chapter also provides the design of land suitability user interface application for easily data extraction and spatial data analysis and is ended with a long summary for the methods applied, the steps been followed to achieve the objectives of this study and the recommended strategy that offers a framework including specific projects, plans and schedules and also, with some essential recommendations that might be followed up to provide decision makers with a proper urban development and its alternatives.

CHAPTER TWO

LITERATURE REVIEW

CHAPTER TWO

LITERATURE REVIEW

2.1 Data Types, sources and Structure

2.1.1 Introductory statement

Sustainable Urban Development and Land Use Planning depend on accurate, detailed, up-dated and verified investigated data of physical characteristics and environmental prevailing conditions on the target terrain. Briefly good information brings good urban planning.

Urban development planning requires well understanding of direct and indirect impact relationships of physical, environmental and cultural characteristic features of the target area, on its prospective land-use activities.

Planners are generally met with difficulties, not to design a land use plan, but to find out a definite priority order of development activities, to select sites of optimum urban development and to provide alternative scenarios to develop an area and / or to mitigate losses of hazards and crises [El-Ghawaby, M. (2006): A Standard Procedure to Weigh Controlling Factors On Land Use Planning Of Arid Regions through Spatial Modeling; 2nd International Conference on Water Resources and Arid Environments "ICWRAE"].

Spatial modeling requires well understanding of the terrain features, i.e. accurate, detailed and updated inventory on the target area, as well as the recent data integration processes and multi-criteria land evaluation analyses based on GIS software systems.

2.1.2 Data Types

Three types of data are needed to achieve a good urban development plan for an area. These three types are:

1. Satellite or Remote Sensing Digital Data
2. Non-Digital maps and Graphic Data
3. Descriptive Textural and Tabular Data

2.1.2.1 Satellite or Remote Sensing Digital Data

There are many types of satellite images. Planning and urban development needs regional and detailed high resolution images. Landsat ™ and Spot images are the most common regional scale data required for urban development planning, while Ikonos and QuickBird images represent the detailed remote sensing data sources. All of them provide us data on the terrain surface characteristics.

There are other images reflect the properties of the terrain at shallow and deep subsurface such as remotely sensing Radar images and aero-geophysical investigation charts and maps.

TM image is composed of seven multi-spectral bands; the band number six locates spectrally in the thermal infrared region, while ETM+ image is composed of eight spectral bands. Bands six and seven represent the thermal infrared bands and the band eight is an additional panchromatic band. The pixel size of this TM images reaches at 28.5 m for the multi-spectral bands and 14.25 m for the panchromatic one [Mahmoud, W. E.

M. (2008): "Development of a Geospatial Model for Projection of Land Use Changes; Case Study: Marsa Matrouh City". PhD. Thesis, Insitute of Graduate Studies and Research (IGRS), Alexandria University, Egypt].

Spot images have 10 by 10 m spatial resolution for the multi-spectral bands with one panchromatic black and white band with 0.51 to 0.73 m resolution. It has a radiometric resolution of 8-bits [Jensen, J.R., (1986): Solid and Hazardous Waste Disposal Site Selection Using Digital Geographic Information Systems Techniques. Science of the Total Environment, 56, pp. 265-276].

Radar data type is collected with a Synthetic Aperture Radar (SAR) sensor. Radar-sat imaging system uses a single frequency. It can steer its radar beam to image swath widths between 50 km and 500 km, with resolutions from 10 to 100 m, respectively [ERDAS, inc. (1997): ERDAS Field Guide; ERDAS Incorporation, 4th edition; Atlanta, Georgia, USA]. A significant property of Radar is its ability to produce images of the subsurface terrain, in case the land cover material is to be smooth, fine-grained, dry and homogeneous in order to permit Radar signal to penetrate without significant attenuation. If the cover material is rough enough, it will generate backscatter.

Ikonos and QuickBird images represent the detailed, high-resolution images needed for urban development planning and reassessment of such plans. This digital data type assists in building up the geographic information system. Ikonos and QuickBird images have a spatial resolution ranging from one to four meters. This data set is used to upgrade the information contents in the maps.

2.1.2.2 Non-Digital maps and Graphic Data

Maps can be classified into two categories:

- Primary measurable map data
- Thematic or secondary interpreted data

The primary maps include information contents on the geographic orientation of the target area, in relation to the three geographical axes of the earth (X, Y & Z). This map type is represented by the topographical elevation contour features. The projection that is used to draw such map type is mostly the Universal Transverse Mercator (UTM). The scale of such maps ranges from 1:25000 to 1:250000.

The second category which is called thematic maps, include information about specific geographical features, physical or interpreted phenomenon. The scale of these maps varies as well according to the described phenomenon or feature. Some of these maps are projected to the UTM and others are not projected to any projection system.

2.1.2.3 Descriptive Textural and Tabular Data

These data are in different formats, some of them are in a tabulated form and some others are textural reports. Also, sometimes the inter-relation between the units or features of terrain or climate in the study area is expressed quantitatively and sometimes is expressed qualitatively. Both types are collected and inserted as attributes to the GIS layers.

2.1.3 Data Sources

The various data types need to be acquired from different sources. Most of these sources are governmental authorities and departments, and some others are private sector and companies. Also, researchers can get data on their targeted areas from the previous academic theses and published works in addition to the technical reports. Nowadays, many of the satellite images, thematic maps and descriptive data are available on the "Internet", either be bought or free of charge.

The satellite images are available from Google Earth Site except Spot, which can be bought from private companies authorized to deal with this data type. Maps of different types and scales that cover the target area are to be studied including topographical contour maps that are produced by the Egyptian Military Survey authority, the Egyptian Survey Authority or Ministry of Public works and water resources.

Thematic maps are required from different agencies sources. For example, the geological maps are mostly produced by the Egyptian Authority of Mineral Resources, the Egyptian Remote Sensing and space Studies Authority and the Geological Departments in the Egyptian Universities. The soil maps are mostly available in the Pedi-logical Research Institute "Agricultural Research Center of Egypt", the Soil Studies Departments of the Egyptian Universities. The hydrological and hydro-geological maps are mostly produced by the Egyptian Water Research Institute and the Civil Engineering Departments of the Egyptian Universities.

2.1.4 Spatial Data Structure

GIS was first developed as a powerful mean to store, organize and analyze data that can be described or modeled spatially or geographically. The use of computers for spatial analysis and mapping was accompanied by several developments in related areas like automated spatial data capture, spatial data transformation and spatial data presentation. Essentially, all these fields need a powerful set of tools for collecting, storing, retrieving, transforming and displaying spatial data from the real world. This set of tools constitutes the Geographical Information Systems [Malheiro B. and Oliveira E. (1995): An Intelligent Distributed System for Environmental Management, Kluwer Academic Publishers].

Existing geographical information systems draw up maps faster and cheaply, produce user specific maps, allow simulation, easy map updating and facilitate data analysis. Data storage and database management are concerned with the structure and organization of the topological data and the geographical entities attributes.

2.2 Spatial Data Management Tools

2.2.1 Spatial Database Building

A geo-database is a database designed to store, query, and manipulate geographic information and spatial data. It is also known as a spatial database. Within a Geographic Information System (GIS), a spatial database is one component that can be used to store and manipulate data. Typically a complete system will also include client software user interface system to view and edit the data stored within the database. The geo-database is the common data storage and management framework for ArcGIS. It combines "geo" (spatial data) with "database".

The geo-database offers the ability to:

- ❖ Store a rich collection of spatial data in a centralized location.
- ❖ Apply sophisticated rules and relationships to the data.

- ❖ Define advanced geospatial relational models (e.g., topologies and networks).
- ❖ Maintain integrity of spatial data with a consistent and accurate database.
- ❖ Work within a multi-user access and editing environment.
- ❖ Integrate spatial data with other IT databases.
- ❖ Leverage the spatial data to its full potential.

The primary purpose of spatial database planning and design is to specify how the GIS will perform the required applications. It involves defining how graphics will be symbolized (i.e. color, weight, size, symbols… etc.), how graphics and monographic attribute files will be structured, how file directories will be organized, how files will be named, how the project area will be subdivided geographically and how GIS products will be presented (e.g. map sheet layouts, report formats, etc).

This can be done by implementing the following activities:

a) Select a source (document, map, digital file, etc) for each entity and attribute. This involves matching each entity and its attributes to a source.

b) Set up the actual database design (logical/physical design). This activity involves converting the conceptual design to the logical/physical design of the GIS database.

c) Define the procedures for converting data from source media to the database. The collection of data from diverse sources and its

i) Getting the data

ii) Fixing any problems in the data source "map scrubbing"

iii) Converting to digital data,

iv) Change control,

v) Building the GIS database

d) Define procedures for managing and maintaining the database. Because the physical world is constantly changing, the GIS database must be updated to reflect these changes. Once again, the reliability of the GIS database is at stake if the data is not current.

The maintenance process should be planned well in advance. Once again, the equipment and personnel must be ready to take over the maintenance of the database when the data conversion effort and database building processes are complete.

The structural elements of a geo-database, listed below, are some of the elements used to develop a rich GIS database of NORTH EAST OF CAIRO, such as

- ❖ Attribute data
- ❖ Geographic features
- ❖ Satellite and aerial images (raster data)
- ❖ CAD data
- ❖ Surface modeling or 3D data

- ❖ Utility and transportation systems
- ❖ GPS coordinates
- ❖ Survey measurements

Geo-database can represent these types of data as the following data objects: annotation, feature class, feature dataset, network dataset, relationship class, schematic dataset, survey dataset, table and terrain.

There are eleven steps to outline a general GIS database design process. The initial design steps 1 through 3 help you to identify and characterize each thematic layer. These three steps are: identifying the information products that you will create and manage with your GIS, identifying the key data themes based on your information requirements and specifying the scale ranges and spatial representations of each data theme at each scale.

In steps 4 through 7, you begin to develop representation specifications, relationships, and ultimately, geo-database elements and their properties. Those steps are: decomposing each representation into one or more geographic datasets, defining the tabular database structure and behavior for descriptive attributes, defining the spatial behavior and integrity rules for your datasets and proposing a geo-database design.

In steps 8 and 9, you will define the data capture procedures and assign data collection responsibilities. Those two steps are: designing the editing workflows and map display properties, and assigning responsibilities for building and maintaining each data layer.

In the final stage (steps 10 and 11), you will test and refine your design through series of initial implementations. You will also document your design. Those final steps are: building a working prototype and review and refine your design, and document your geo-database design [ESRI support center: Arc GIS server for the Java platform 9.3 help.

http://webhelp.esri.com/arcgisserver/9.3/java/index.htm#geodatabases/geodat-1640971471.htm].

2.2.2 Graphical User Interface Design

A graphical user interface (GUI) is a type of user interface item that allows people to interact with programs in more ways than typing such as computers. The term GUI is historically restricted to the scope of two-dimensional display screens with display resolutions capable of describing generic information.

The user interface (also known as human-computer interface or man-machine interface (MMI)) is the aggregate of means by which the users interact with the system such as computer program. The user interface provides means of data input, allowing the users to manipulate a system and output, allowing the system to indicate the effects of the users' manipulation.

To work with a system, users have to be able to control the system and assess the state of the system. The term user interface is often used in the context of computer systems and electronic devices. User interfaces are considered by some authors to be a prime ingredient of Computer user satisfaction. The design of a user interface affects the amount of effort the user must expend to provide input for the system and to interpret the output of the system, and how much effort it takes to learn how to do this. It might make the process of using the system effective, efficient and satisfying.

In computer science and human-computer interaction, the user interface (of a computer program) refers to the graphical, textual and auditory information the program presents to the user, and the control sequences the user employs to control the program. Graphical user interfaces (GUI) accept input via devices such as computer keyboard and mouse and provide articulated graphical output on the computer monitor. There are at least two different principles widely used in GUI design: Object-Oriented User Interfaces (OOUIs) and Application Oriented Interfaces (AOIs).

Object-Oriented User Interface (OOUI) is a type of user interface based on an object-oriented programming metaphor. In an OOUI, the user interacts explicitly with objects that represent entities in the domain that the application is concerned with. The user may explicitly select an object, alter its properties (such as size or color), or invoke other actions upon it (such as to move, copy, or re-align it).

To use Visual Basic for Application (VBA) with an application such as Access, Word, or Excel, terminology and language constructions are needed to interact with the application. This portion of VBA is called the Object Model for the application. A map of the object model is online for Excel and for Word. Much of the difficulty in using VBA is related to learning the object model, which uses names invented by the originators of the model that may be less than transparent to a new user.

2.3 Spatial Data Manipulation Processes

2.3.1 Background

Land-use refers to "man's activities on land which are directly related to the land [Clawson, Marion, and Stewart, Charles L., (1965): Land use information. A critical survey of U.S. statistics including possibilities for greater uniformity, Baltimore, Md., The Johns Hopkins Press for Resources for the Future, Inc., 402 p]. Land-cover on the other hand, describes "The vegetation, agriculture, urban and industrial" activities covering the land surface [Burley, Terence M., (1961): "Land use or land utilization", Prof. Geographer, v. 13, no.. 6, pa. 18-20]. In determining land cover, it would seem simple to draw the line between land and water. Actually it is a complex problem due to the seasonal variation of wet areas, tidal flats, or marshes, with various kinds of plant cover. Sustainability means pursuing individual and community well being in a way that promotes equity both within and between generations [Gurran, N. (2003): Housing policy and sustainable urban development: "Evaluating the use of local housing strategies in Queensland, new south wales, and Victoria". Australian Housing and Urban Research Institute: Sydney].

From the previous statements, data on the terrain characteristics, natural resources, and environmental hazards projected land use activities have to be updated, field verified and prepared in an adequate format to be stored, manipulated and retrieved in an efficient computer tool. The urban development planning has to use computer model and information analytical techniques such as GIS and Remote Sensing, which are powerful tools for performing updated information and urban development changes through time and space. GIS and image processing base modeling can provide maps showing information as guidance for planning and development as well as early warning regarding problematic aspects.

Sustainable land-use planning is based on;

1. Accurate, detailed, up-dated data and verified field investigation, using Remote Sensing data processing
2. Integration of the enhanced remotely sensing data with the digital spatial map format data, through GIS data processing
3. Land suitability evaluation for urban development through multi-criteria data analysis assessment
4. Decision support data modeling to provide possible alternative solution choices through potential modeling programs

2.3.2 Remote Sensing Image Processing

Because field surveys are usually too time consuming and expensive to conduct over a continuum of scales, remote sensing must be used to scale-up field observations. It could be an ideal tool for monitoring urban development. The most common sensors optimized for urban development planning are Landsat "Thematic Mapper" ™, "Enhanced Thematic Mapper plus" (ETM+), and High Resolution Visible (HRV) SPOT for the regional survey and IKONOS and QUICKBIRD multi-spectral High Resolution Imageries for the detailed survey locations.

The satellite images might be corrected and analyzed to provide more information about the target area. The correction operation involves rectification, while the analysis involves mainly classification and change detection.

Various image processing and enhancement techniques can be applied in urban development planning. It is common that an image goes through a series of such details intended for a specific application. It is the difficult task for an interpreter to find a technique which fit his specific interest [Abdel-Kader, A. F. (1989): Geological studies on Southern Sinai using Satellite data. Ph.D. thesis, Fac. Of Sci., Mansoura Univ., Mansoura, Egypt, 319p]. Multiple image processing techniques take place on the satellite images such as Landsat, Spot, IKONOS and QuickBird through ERDAS Imagine Software Systems. These processes include spectral enhancement and classifications. These detailed image processing techniques are presented in a chart, (figure 2.1).

Image processing and enhancement operations are ways to modify and alter the original raw data to bring out visual details. Digital image processing, manipulation and interpretation are categorized into the following operations.

2.3.2.1 Image Rectification and Restoration

Map projection is any system designed to represent the surface of a sphere or spheroid (such as the earth) on a plane (figure 2.2). Since flattening a sphere to a plane causes distortion to the surface, each map projection system comprises accuracy between certain properties such as conservation of distance, angle or area. Map projection system is associated with a map coordinate system (Longitude / Latitude coordinate system) [Lillesand, T. M. & Keifer. R. W. (2000): Remote Sensing and Image Interpretation. New York: John Wiley and Sons]. Generally most maps of Egypt are projected using Universe Transverse Mercator (UTM).

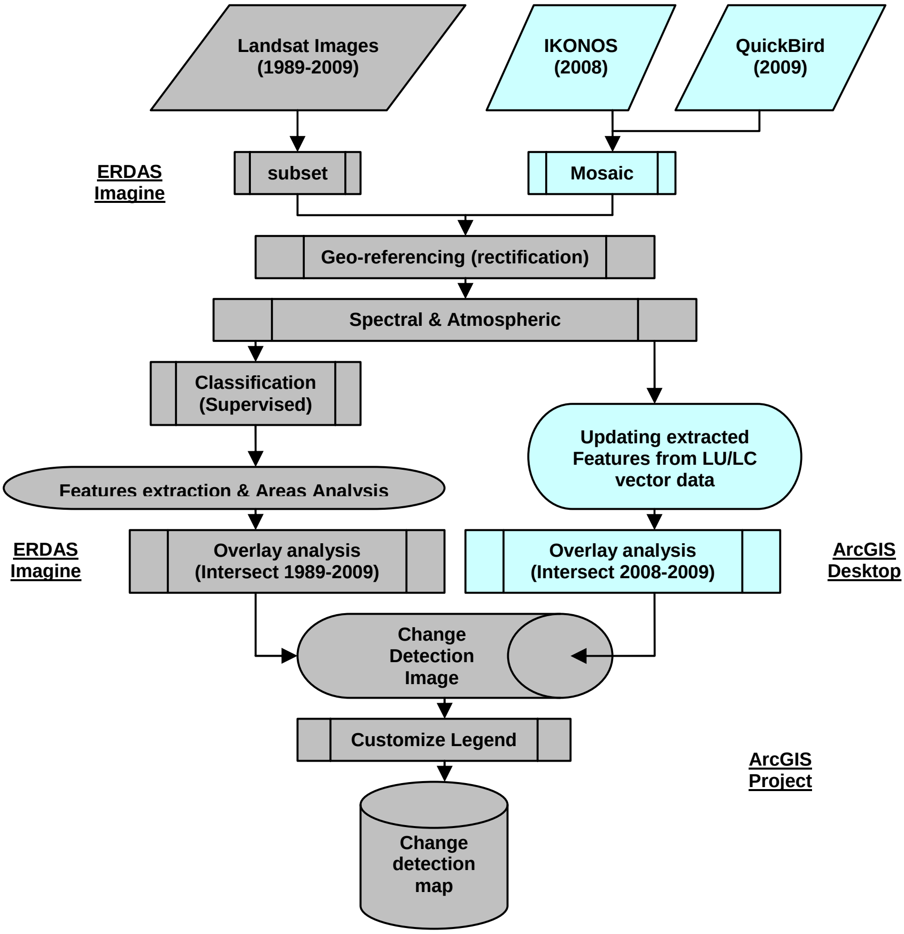


Figure 2.1: Flow chart of satellite image processing procedures (After Amasha A. A. I., 2009)

Registration or rectification is the process of projecting the data onto a plane and making it to conform to a map projection system. Assigning map coordinates to the image data is called geo-referencing. Since all map projection systems are associated with map coordinates or other geo-registered image by matching it to the base image geometry. Some ground control points has to be measured using GPS to improve the accuracy of images to map rectification and to verify the constructed land-cover / land-use maps.

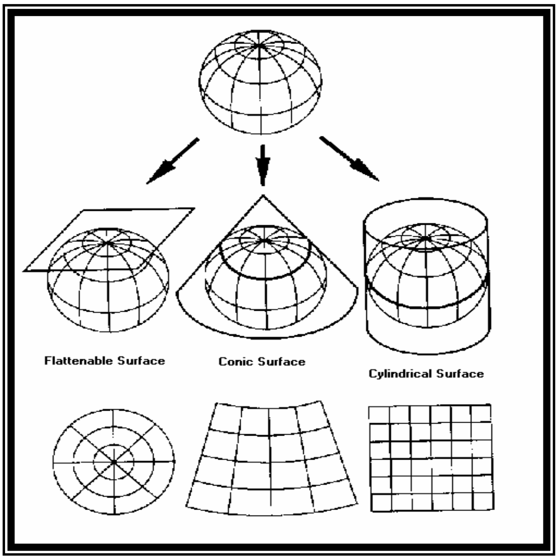


Figure 2.2: Map projection types to convert three dimensional map into two dimensional

2.3.2.2 Image Enhancement

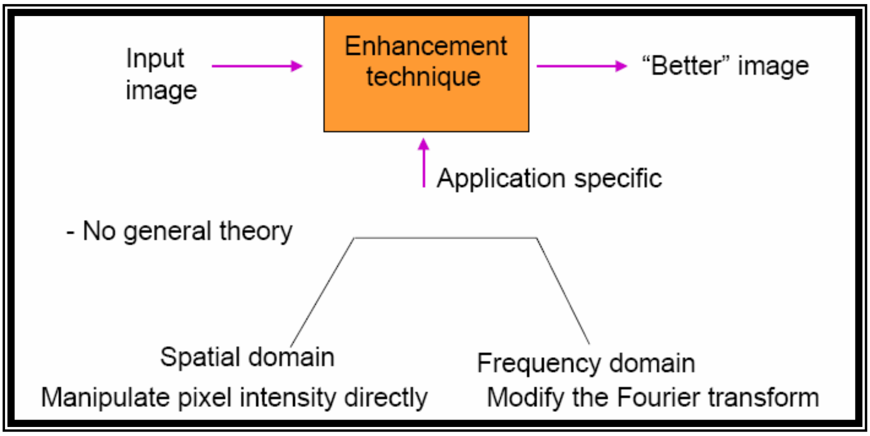


Figure 2.3: Image Enhancement

Image enhancement is utilized to improve the visual interpretability of an image by increasing the apparent distinction between the features (figure 2.3). The process of visually interpreting digitally enhanced imagery attempts to optimize the complementary abilities of the human mind and the computer.

There are a wide variety of image enhancement techniques to improve the clarity of land-use / land-cover changes. Rationing method, for example, enhances spectral differences between surface cover types and suppresses topographic relief effects [Sbains, F. F. (1987): Remote Sensing Principles and Interpretation. Second edition. W: H:`Freeman and Company, New Yourk 449p]. Edge enhancement, stretching technique and high pass filter techniques are used to enhance the resolution of the image components and to discriminate between the different features, like water, desert, agriculture and urbanization. Enhancement techniques can generally be divided into either pixel to pixel comparisons or post-classification comparisons [Mather, P. M. (1999): Computer processing of remotely-sensing images, an introduction (2nd ed.). Chichester: John Wiley and Sons. pp. 1–75].

2.3.2.3 Image Classification

Classification is the process of sorting pixels into a finite number of individual classes, or categories of data based on their data file values. If a pixel satisfies a certain set of criteria then the pixel is assigned to the class that corresponds to that criterion. There are two ways to classify pixels into different categories: unsupervised and supervised.

Unsupervised classification is more computer-automated. It allows us to specify parameters that the computer uses as guidelines to uncover statistical patterns in the data. Performing an unsupervised is simpler than a supervised classification, because the signatures are automatically generated by the ISODATA or K-means algorithm. This method is used when the knowledge about data is less than expected, so the responsibility of classes' interpretation lies on analyst to attach meaning from output. Unsupervised classification may be useful for generating a basic set of classes and then supervised classification can be used for further definition of the classes.

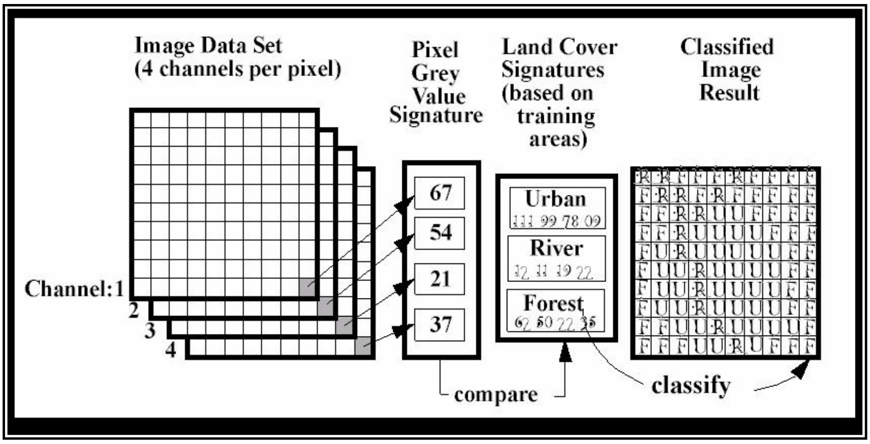


Figure 2.4: Steps in Supervised classification

Supervised classification is more closely controlled by user than unsupervised classification. In this process, pixels that represent patterns recognized or that they can be identified with help from other sources (figure 2.4). By identifying patterns in the imagery, we can train the computer system to identify pixels with similar characteristics. By setting priorities to these classes, one supervises the classification of pixels as they are assigned to a class value. If the classification is accurate then each resulting class corresponds to a pattern that we originally identified. Supervised classification is usually appropriate when analyst wants to identify relatively few classes or when he has selected training sites that can be verified with ground truth data.

2.3.3 Spatial Data Processing

Spatial modeling requires well understanding of the terrain features to simulate reality in a mapable form as well as detailed inventory of the influencing parameters on urban land-use development activities projected to achieve. These data, which is simulating reality of the terrain characteristic features have to be organized in a mapable grid cell network, transformed to a digital format, rectified to a suitable projection system, and incorporated in a database shape file and attributes. The thematic maps have to be coordinated with field investigation and the primary map data to validate results of data analysis and strengthen interpretation in formulating the overall environmental development plan of the target area.

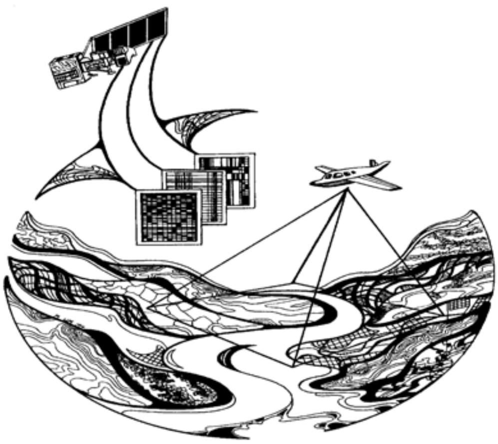


Figure 2.5: Standard operating procedures for spatial data processing

The spatial data and the influencing physical, environmental and social parameters on urban development of an area have to be treated statistically through a computational method called "factor analysis" [Cormey, A.L.

(1973): A first course in factor analysis. Academic Press; New York; 316 pp]; to extract meaningful factors pertained to a specific theme from among the set of measured variables and parameters. These computational processes are installed in computer software programs under names of GIS or spatial data processing systems "e.g. ERDAS-Imagine, etc).

To model a particular aspect of the real world, the specialist needs to represent, in the geographical information system, every relevant spatial data available. Usually, a wide range of thematic maps and imagery data are available. The specialist must select those that are more relevant to his specific needs, so that the combined information will provide him with an integrated overview, reclassification or generalization.

2.3.4 Urban Land-use Suitability Assessment Methods

Urban planning requires understanding of direct and indirect impact relationships of physical, environmental and cultural characteristic features of the target area, on its prospective urban land use activities. Data manipulation is the step to apply GIS software processes of data analysis and modeling.

Urban land use planning depends on reconnaissance of the development activities aimed at, to carry on, in the target area, as well as, the controlling factors that comprise the physical terrain characteristic features, and the socio-economic and the technological parameters [El-Ghawaby, M. (2006): A Standard Procedure to Weigh Controlling Factors On Land Use Planning Of Arid Regions through Spatial Modeling; 2nd International Conference on Water Resources and Arid Environments

"ICWRAE"]. Value of these factors or parameters are either directly estimated by taking spatially oriented measurements, indirectly evaluated by statistical or graphical representation, or approximately assessed by relative comparison with similar cases, occurred previously all over the world.

Methods of designing spatial models for site planning were first discussed over 40 years ago before the advent of automated geographic information systems. In his seminal paper McHarg [Mcharg, Ian L, (1969): Design with Nature, Published for the American Museum of Natural, Garden City, N.Y.] mapped thematic site criteria onto Mylar transparencies and, when superimposed, was able to differentiate between acceptable and unacceptable zones. The methods that were developed were applied to a variety of social, economical, and environmental problems. In effect, each Mylar layer served as an input to the "maximum benefit - minimum cost" model [Mcharg, Ian L, (1969): Design with Nature, Published for the American Museum of Natural, Garden City, N.Y.].

2.3.4.1 Controlling factors (potentials and Constraints)

Application of factor analysis to multivariate data sets is considered meaningful only, if the original variables are highly correlated. Standard statistics are generally applied to the raw data to compute means of dispersion measures and normality check for each variable characteristic feature. This statistical treatment of variables through procedures of factor analysis had been incorporated in various GIS programs; to extract meaningful factors related to the target from among the set of measured variables on grid form maps.

2.3.4.2 Approaches and techniques for selecting suitable urban sites

a) <u>Traditional approach</u>

Making the regional plan:

There are several scientific fundamentals for making the regional development plan, which are number of studies focusing on all the problems and the potentials of the region, then draw the framework or put the vision of the plan.

The regional development plan process has two main stages and each has sub-stages [Alam K. Ahmed (1995): Regional planning, The Anglo library, 1st edition. Cairo, Egypt].

Stage one: Preparing the Essential Studies for the Development Plan

At this stage there are two sub-stages; general survey and data analysis and study preparation.

General Survey Stage

The general survey is the field survey and data collection for exploring the region and how to be used, and also exploring the demands and real problems of the region and it consists of; Natural and urban survey and Socioeconomic survey.

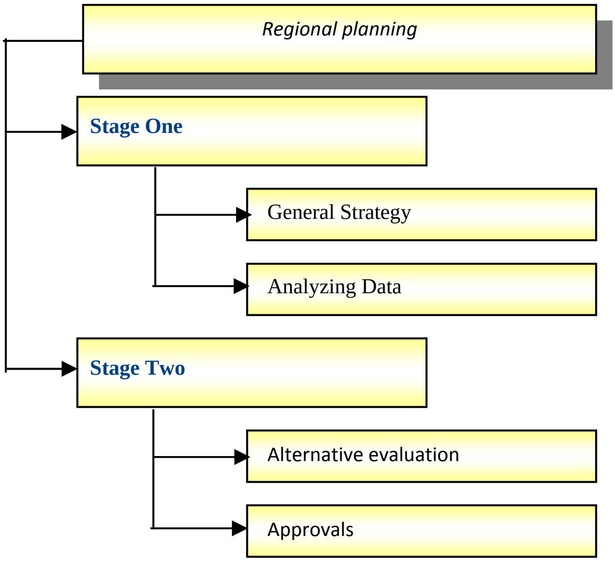


Figure 2.6: Regional Planning Process (Source: Alam, 1995)

Natural and urban survey:

Natural Survey	Urban Survey
• Natural resources	• Location
• Water resources	• Administration borders
• Social classification	• Settlements distribution
• Land surface forms	• Land use
• Water features	• Infrastructure
• Geological formation	• Urban and rural
• Natural hazards	• Rank and size
	• Urban growth direction
	• Urban condition

Socioeconomic survey:

This is the study of economic activities and its trends through the economic structure of the main economic activities (agriculture, industry, tourism) [Alam K. Ahmed (1995): Regional planning, The Anglo library, 1st edition. Cairo, Egypt].

Data Analysis and Study Preparation

Collecting data in the previous stage is not a target, but it is a step for studying the data and analyzing it to be a start for the planner to reach certain conclusions for guiding the planning process. These conclusions should be taken into consideration when making the proposed regional plan.

The theoretical studies for development have three main elements [Bushara A. Aida (1966): Entrance to regional planning. Cairo, Egypt]; place, folk and work. These elements are combining to give an image for the study region.

Stage Two: Making the strategic Regional Plan

At this stage there are two sub-stages; making alternatives and evaluation and approvals for the selected alternatives.

After these stages, the implementation and assessment phases can be done. Usually the planner starts his work by putting objectives and drawing the headlines for all the development sectors “urban, economic….etc.” and this should be in the framework of the national plan.

On the light of the analysis and with the assist of planning standards and the objectives, the regional plan is made and it consists of; long target socioeconomic plan and general land use plan for the region including the settlements and infrastructure and other uses

Sometimes there could be an idea or a model, to give solutions for certain problems. So there must be an evaluation for the alternatives and compare its potentials to reach the best proposal.

After choosing an alternative, it is signed from the governor of the region or the minister and approved by the supreme council of planning and urban development and it is an official document for the development process in the region.

b) <u>Computational and analytical approaches</u>

Within computer programs, meaningful factors pertained to the target activity, from among a set of measured parameters, could be extracted. Because the experience-driven approach is based on observation and expert knowledge of the planner, the produced models are more or less qualitative [George, H. and G.F. Bonham-Carter (1990): Spatial modeling of geological data for gold exploration, Star Lake Area, Saskatchewan; Statistical Application in Earth Sciences, F.P. Agterberg and G.F. Bonham-Carter (eds). Geological Survey of Canada, Paper 89-9, pp.157-169]. It can be applied in case of absence of either numerical measurements or analytical quantitative values.

To overcome difficulties of qualitative data irregularities met with, each parameter has to be relatively ranked, depending on either the expert knowledge or direct observation of the terrain or by comparison with key factors and information in similar well-known case studies, in the world [El-Ghawaby, M. (2006): A Standard Procedure to Weigh Controlling Factors On Land Use Planning Of Arid Regions through Spatial Modeling; 2nd International Conference on Water Resources and Arid Environments "ICWRAE"] (Table 2.1).

Table (2-1): Rating Chart of some Controlling Parameters [El-Ghawaby, M. (2006): A Standard Procedure to Weigh Controlling Factors On Land Use Planning Of Arid Regions through Spatial Modeling; 2nd International Conference on Water Resources and Arid Environments "ICWRAE"]

Parameter Rank	5	4	3	2	1
Parameter Grade	Ideal	Good	Normal	Marginal	Poor
Normalized Score	1.00	0.75	0.5	0.25	0.01
Precipitation (mm/y)	>250	200	150	100	<50
Slope (degrees)	$<1^o$	4^o	8^o	12^o	$>16^o$
Geomorphic Stability	Stable				Unstable
Wind Erosion Potential	Low				High
Engineering Properties	Good				Bad
Remediability	Easy				Difficult
Bed Rock Type (Qualitative)	Sands & Silts				Gravel Clay
Effective Porosity(Percent)	Intermediate				High Low

Factors weighting are based on the level of importance of a factor that influences urban development. The weight for each factor is determined by pair-wise comparisons in context of decision-making process known as the analytical hierarchy process [Canada, J.R., W.G. Sullivan, and J.A. White, (1996): Capital investment analysis for engineering and management. Prentice Hall International Inc, USA. 566 p]. The suitability rating for each level of a factor is determined from the result of the survey and expert opinions. Suitability ratings are established in terms of suitability of land for defined uses.

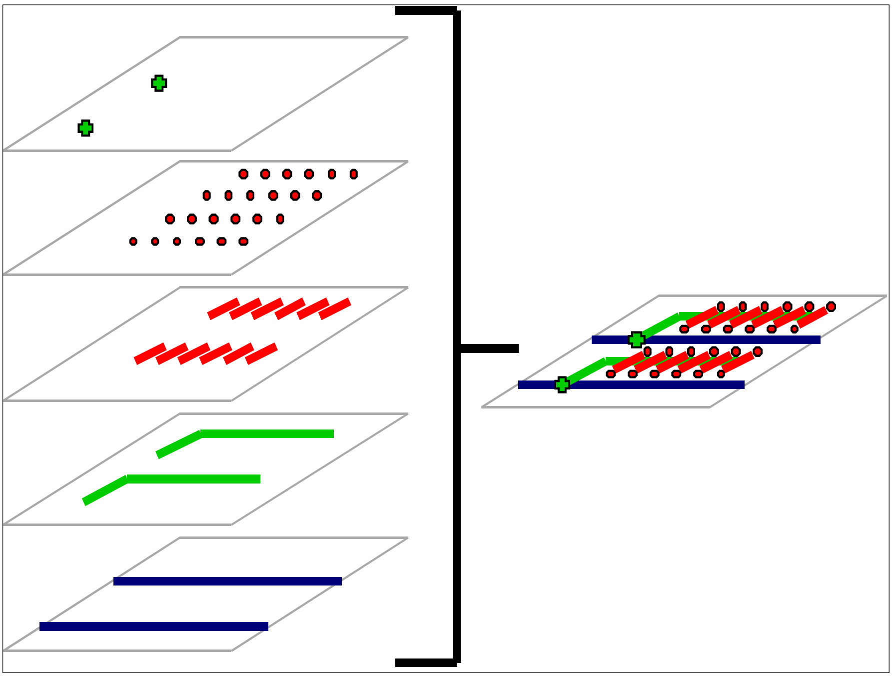


Figure2.7: Map overlay technique

Map overlay technique

Wei-Ning Xiang said that in land suitability assessment, the map overlay technique is often used in conjunction with a weighting scheme [Xiang, W.-N. and Whitley, D.L., (1994): Weighting land suitability factors by the PLUS method. Environ. Plann. B: Plann. Design 21 3, pp. 273–304]. A person first determines parent maps' weights by his perceptions about the importance or relative importance of these maps to land suitability. These weight values are then incorporated into the map overlay process. On the resultant overlaid maps, the higher suitability scores are always assigned to those sites that have better conditions on the more important parent maps, (Figure 2.7).

Direct assessment approach

One common approach to determining maps' weights is direct assessment, which requires a person to quantitatively state either the importance or relative importance of each map. Major methods under this approach include ranking, rating, and ratio questioning [Hobbs, B.F. and Meier, P.M., (1994): Multicriteria methods for resource planning: an experimental comparison. IEEE Trans. Power Syst. 9 4, pp. 1811–1817]. In ranking, a person ranks all the maps according to their relative importance. The higher a map's rank position, the more important it is. The actual importance (weight) value of each map is then determined mathematically on the map's rank position [Dennis, D.F., (2000): An ordered probit analysis of public values for use in multiple objective decision-making. Comput. Electron. Agric. 27 1–3, pp. 127–137]. In rating, a person rates each map's importance on a scale of 0-1 (or equivalently, 0–10, 0–100), with 1 being the highest level of importance [Klosterman, R. (1999): The What if?: Collaborative Support System. Environment & Planning B: Planning & Design, 26, 393-408].

In these direct assessment methods, the term "importance" is either defined implicitly as, for example, "the level of contribution or significance of a map layer to land suitability", or not defined at all. The user is granted the freedom to express perceptions about maps' importance or relative importance based upon his interpretation of importance.

Tradeoff weighting approach

An alternative and more precise approach is tradeoff weighting, which is widely reported in the multi-criteria evaluation and decision-making literature (for example, Cohon [Cohon, J.L., (1978): Multi-objective Programming and Planning, Academic Press, New York]; Hobbs [Hobbs, B.F., (1980): A comparison of weighting methods in power plant siting. Decision Sci. 11, pp. 725–737]; Keeney and Raiffa [Keeney, R.L., Raiffa, H., 1976. Decisions with Multiple Objectives: Preferences and Value Tradeoffs. Wiley, New York]). This approach does not require a person to assign weights to, nor state relative importance of, the attributes or criteria (in the case of map overlays, maps) directly. Instead, it asks one to state how much compromise he is willing to make between two attributes or criteria when an ideal combination of the two is not attainable.

Weighting-by-choosing technique

Weighting-by-choosing method requires a person's awareness about map's importance through site selection exercises. The exercises use reference sites as manipulative to help a person make tradeoffs when an ideal combination of land capability ratings is not attainable. Because the information on the reference sites is specific and comprehensible, an otherwise demanding tradeoff exercise becomes simple and informative.

Areas relatively suitable for urban development can be identified and divided into different categories namely not suitable, less suitable, and most suitable. They define the criteria for urban development, based on the environmental baseline information.

El-Ghawaby stated that the controlling factors are classified into environmental and cultural determinants. Everyone comprises one or more factors which by turn each factor involves one or more criteria and every criterion is structured into one or more parameter [El-Ghawaby, M. (2006): A Standard Procedure to Weigh Controlling Factors On Land Use Planning Of Arid Regions through Spatial Modeling; 2nd International Conference on Water Resources and Arid Environments "ICWRAE"]. Thematic coverage of the terrain under investigation represents map layers of variable parameters. Each map shows polygons with absolute or relative values, based on the adopted modeling approach. These polygonal areas might have scores according to their suitability degree to realize the target activity.

Rank value of every parameter is selected, according to numerical measurements or qualitative evaluation, to make sure that unsuitable areas remain zero, while the suitable areas are rated 5, 4, 3, 2 and 1.

Two elements are essential in estimating parameter weights; they are the relative impact of various parameters on the target activity planned to achieve, and the rank of every influencing parameter in a unified normalized scheme.

By multiplying parameter impact and parameter rank, parameter weighed value is obtained. By adding these weighed values of parameters within one factor, then total weighed values of this factor will be determined. Also, by summation of weighed values of all factors, an actual total factor weights are get on.

Multi-criteria analysis technique

Multi-criteria analysis is used when a single objective is desired but there are various criteria to be analyzed. According to multi-criteria analysis, certain methods are used to study various possibilities in relation to multiple criteria and conflicting priorities. These methods allow the systematic incorporation of social, economic, technical, and environmental aspects, serving as a way to aid decision makers or planners to re-evaluate their points of view. The first step in the multi-criteria analysis is the selection of those attributes that will function as potentials and those that will function as constraints.

Many authors have tried to ensure the sustainability of an urban development in a simple and comprehensive approach. They dealt with different land suitability assessment methods, ranging in degree of computational and analytical sophistication. Hopkins [Hopkins, L.D. (1977): Methods of generating land suitability maps: A comparative evaluation. J. of American, Institute of Planners. 43(4):386–400] reported a comparative evaluation of alternative methods of assessing land use suitability. Steiner [Steiner, F. (1987): Agricultural land evaluation and site assessment in the United States: An introduction. Environmental Management. 11(3): 375–77] reviewed land evaluation and site assessment. Anderson [Anderson, L.T., (1987): Seven methods for calculating land capability/suitability, Planning Advisory Service Report, American Planning Association, Chicago] surveyed different methods of land capability/suitability analysis ranging in degrees of computational and analytical sophistication. Guillermo A. Mendoza said that Land suitability assessment is a multi-criteria problem. That is, land suitability analysis is an evaluation/decision problem involving several factors [Guillermo A. Mendoza (1997): A GIS-Based Multicriteria Approaches To Land Use Suitability Assessment And Allocation]. In general, a common model of land suitability can be described as:

$$S = f(x1, x2, \ldots, xn)) \qquad (1)$$

Where S = suitability measure; x1, x2…, xn = are the factors affecting the suitability of the land.

The main problem of suitability analysis is to measure both the individual and cumulative effects of the different factors; x1, x2…, xn. Then, it commonly involves determining a suitable approach to combine these factors. Some approaches to combining these factors are mentioned by; Hopkins [Hopkins, L.D. (1977): Methods of generating land suitability maps: A comparative evaluation. J. of American, Institute of Planners. 43(4):386–400], Anderson [Anderson, L.T., (1987): Seven methods for calculating land capability/suitability, Planning Advisory Service Report, American Planning Association, Chicago], Diamond and Wright [Diamond J.T. and J. Wright (1988): Design of an integrated spatial information system for multi objective land use planning. Environment and Planning B: Planning and Design 15:205–14], Guillermo A. Mendoza [Guillermo A. Mendoza (1997): A GIS-Based Multicriteria Approaches To Land Use Suitability Assessment And Allocation], Xiang and Whitley [Xiang, W.-N. and Whitley, D.L., (1994): Weighting land suitability factors by the PLUS method. Environ. Plann. B: Plann. Design 21 3, pp. 273–304], Jankowski and Richard [Jankowski, P., and L. Richard. (1994): Integration of GIS-based suitability analysis and multicriteria evaluation in a spatial decision support system for route selection. Environment and planning B: Planning and Design. 21: 323–40].

Benedita Malheiro and Eug.nio Oliveira [Benedita Malheiro and Eug.nio Oliveira (1995): An Intelligent Distributed System for Environmental Management, Dept. of Electrical Engineering, Faculty of Engineering, University of Porto, Portugal] presented and discussed an intelligent environmental management system capable of suggesting the more appropriate land-use actions based on the existing spatial and non-spatial constraints. Another method of land-use evaluation for urban development is to apply the weighted linear combination (WLC) formula [Voogd, H. (1983): Muticriteria Evaluation for urban and regional planning. Planologisch, studiecentrum TNO, Delft, The Netherlands] as following:

$$S = \sum_{i=1}^{n} W_i x_i$$

In which S is the suitability score of a land use alternative for a defined land use planning goal. This score is based on the standardized criterion score x and the priority weight W assigned to that criterion on basis of the chosen Land Use Planning (LUP) goal. The alternative i will be judged better than alternative j’ if Si > Sj’.

2.4 Decision Support Modeling

In ERDAS Imagine 9.2, a valuable feature called Model-Maker, so as to allow the user to construct basic process flow diagrams to solve spatial problems. Spatial Modeler make it possible to create and run models for image processing and GIS analysis as it is a highly flexible tool that uses Spatial Modeler Language. This Language is a modeling language that is used internally by model maker to execute the operations specified in the graphical models that is created.

Model-Maker permits to save models and rerun them using different input data, thus, enabling them to calibrate their models or examine how they perform using different sets of values. Portions of models can be copied within a model, and smaller models can be combined to build larger models.

On the one hand, in a GIS, the data is distributed over different layers of information which, whenever integrated, provides new knowledge dimensions. On the other hand, the knowledge in a Multi-Criteria Systems is distributed over different criteria that cooperate among themselves, solving complex problems that they would never be able to do individually[Sunil, H.K., (1998): Site suitability analysis for residential development using satellite data and GIS (A case study of Jaipur city). Project Report of Indian Institute of Remote Sensing, Dehradun].

The same author said that the selection of suitable sites is based upon a specific set of local criteria. The characteristics of a site influence its suitability for a specific land use type. To assess the overall suitability, a scoring and weighting system is applied to the various aspects of suitability.

The range of suitability score has been divided into five parts. The areas have been divided into very suitable for higher range value to unsuitable for lower range value. They concluded that land use suitability analysis for urban development is necessary to overcome the problem with limited land availability against drastic growth of urbanization.

Kamal Jain and Y. Venkata Subbaiah [Jain, K. and Y.V. Subbaiah, 2007. Site suitability analysis for urban development using GIS. J. Applied Sci., 7: 2576-2583] carried out a study to find out the suitable sites for further urban development around Roorkee town. Its land suitability map is prepared for 1967 and 1996 and the results are compared with land use maps of 1996 and 2003 respectively and found that urban development is following with the methodology proposed.

The components of a "true" Spatial Decision Support Systems SDSS as defined by Densham include the integration of a geographic database management system with analytical modeling capabilities, a visualization component or graphical user interface (GUI), and the decision making knowledge of domain experts [Densham, P.J. (1991): Spatial decision support systems. In: D.J. Maguire, M.S. Goodchild and D.W. Rhind, Editors, Geographical Information Systems: Principles and Applications, Longman (1991), pp. 403–412].

Armstrong and Densham [Armstrong, M.P., and P.J. Densham, (1990): Database Organization Strategies for Spatial Decision Support Systems, International Journal of Geographical Information Systems, 4, No. 1, pp. 3-20] discussed two groups of decision making approaches that may be incorporated into SDSS: programming techniques and heuristic methods. Programming techniques tend to be computationally intensive but always yield an optimal solution. Heuristic techniques yield sub-optimal solutions, however are able to provide recommendations more efficiently by means of suggesting a range of solution alternatives.

Within ArcInfo, spatial data including both location data and attribute information is stored as coverage for vector based data and a grid for cell or raster based data. The properties of each data model must be taken into consideration before their incorporation into the site selection system. Users require quick and efficient results so that decisions may be made in a timely manner.

2.5 Summary

Being a sustainable city means "improving the quality of life in a city, including ecological, cultural, political, institutional, social and economic components without leaving a burden on future generations. One of the best promising approaches to solve the challenging task of thematic mapping in urban environments is the integration of multiple data sources to benefit from the complementary types of available information.

To achieve good urban development, three types of data are needed; satellite digital data, non-digital maps and descriptive data. These data has to be managed spatially through geo-database building to be ready for manipulation processes such as remote sensing image processing, spatial data processing and urban assessment methods.

Using the geo-database to store, queries, and manipulate geographic information and spatial data is preferred. In addition, designing a user interface enables planners to communicate with a computer through the use of symbols, visual metaphors, and pointing devices.

Land use suitability assessment is an important fundamental work in urban planning. Be restricted by technology and means, qualitative analysis methods be wider used in evaluating land use suitability. This method can't impersonally and quantitatively indicate the difference in land use suitability, and make urban planning more subjectively because the influences on land use suitability are in many aspects and the impacts on objective evaluation are different. It is necessary to explore a land for urban planning quantitative evaluation method to provide a reliable basis for the in-depth analysis of urban planning and improve the persuasiveness of the decision-making and objectivity and science of the urban planning.

The approaches used for selecting suitable urban sites are two main approaches; the traditional approach and the computational and analytical approaches. The computational and analytical approaches have some different techniques as the map overlay technique, direct assessment technique, trade-off weighting technique, weighting by choosing technique and the multi-criteria analysis technique.

CHAPTER THREE

CHARACTERISTIC FEATURES

OF

NORTH EAST OF CAIRO

CHAPTER THREE

CHARACTERISTIC FEATURES OF NORTH EAST OF CAIRO

3.1 NORTH EAST OF CAIRO; the case study

3.1.1 Justifications of choosing the case study

Egypt has numerous environmental issues. This country's agricultural land is being lost to urbanization, windblown sands \ and desertification. In addition, Egypt has had a rapid growth in population, the extreme density of the population gives rise to significant environmental pollution.

Cairo City," Egypt's capital" has been center of industry and commerce for a long time. Therefore it has become a magnet for millions of people moving from the rural areas of Egypt. It provides more potentials and improved standards of living for the migrants. Cairo city has a huge impact on the national environment. As it grew ever larger to become called "Greater Cairo", its habitants consume more and more of its natural resources to meet the rising demand for water, energy, goods and services.

Greater Cairo expanded to the degree that it becomes one of the worst urban air polluted cities in the world. This severe air pollution-related ailments cost huge amounts for medical care and worker weak effort [Khalifa, Y. A. (2006): The Environmental Considerations for New Urban Planning; A study from Architectural, Social and Environmental Perspectives. M.Sc. thesis, Dept. of Engineering, Inst. Of Environmental Studies and Research, Ain Shams Univ., Cairo, Egypt]. The consequence of this overgrowth of population density in Greater Cairo has been represented in a large shortage of housing, growth of slums and informal housing, disregarding environmental and social considerations in design and urban planning.

While the Egyptian central government and five local governorates included in greater Cairo City; "Cairo, Kaliobia, Giza, Helwan and 6th October" have faced unprecedented challenges, a number of steps can make the city more livable and protect the environment. These include better urban planning, more accessible transportation network, better sanitation and rational water use policies, energy conservation and waste recycling.

To overcome the urban sprawl on the agricultural land, a solution was to make a tightly connected urban area in the desert near Greater Cairo city. It means that its urban expansion is to the north and south, surrounding the Nile course might be stopped, while it could expand to the east and to the west in the desert area. The first step was to implement independent towns away to the east of Greater Cairo such as 10th of Ramadan, El-Shrouk, El-Obour and Badr towns. The later step might tend to build new satellite settlements such as New Cairo to the east. This step aims to solve the existing problems in Greater Cairo city such as the deterioration of services, infrastructures and suitable environment. It may support to redistribute the population and reduce its density.

The previous works for urban planning of a desert mostly deal with scattered and discrete information, not unified data formats, not rectified and not updated. The recent software programs of spatial data analysis, manipulation and integration are not applied most of the time. Therefore, it has, in this study, to present a model that might be followed up to provide a supportive urban planning to the decision makers with the best alternative solutions that minimize the unexpected problems and maximize the positive benefits socially, economically and environmentally. The backbone to achieve this goal is to build a geo-database for the case study area, NORTH EAST OF CAIRO.

3.1.2 Case study location

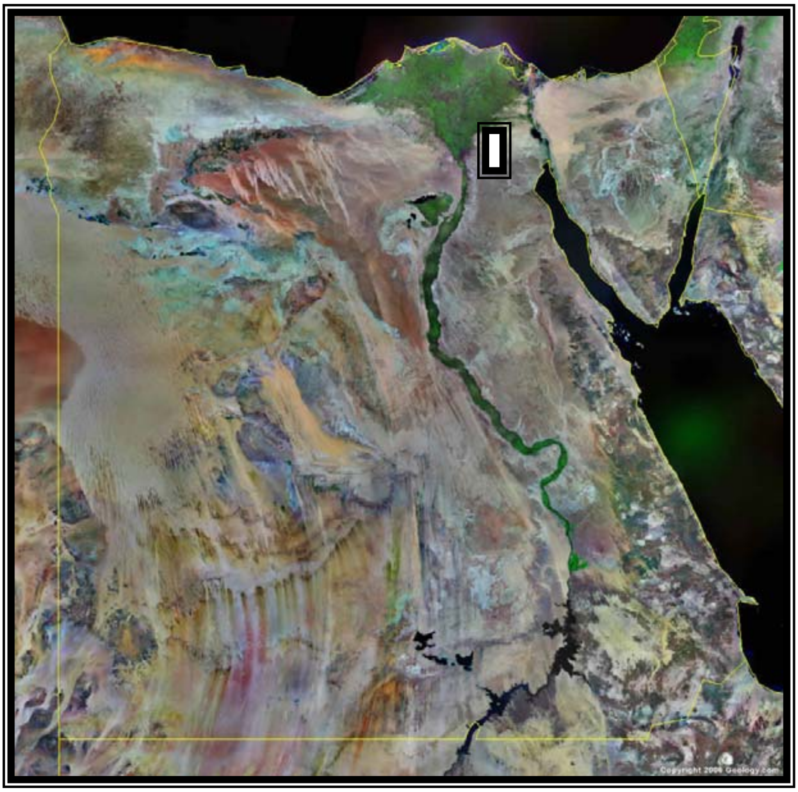


Figure 3.1: Location map of the study area in a satelitte Image of Egypt

Source: http://geology.com/world/egypt-satellite-image.shtml

Figure 3.2: Location map of the study area in a Map of Egypt

Source: http://geology.com/world/egypt-satellite-image.shtml

NORTH EAST OF CAIRO is located to the east and north east of Heliopolis and Madinet Nasr districts (figure 3.1 and 3.2). It is bounded by latitudes 29^{o} $58^{/}$ and 30^{o} $18^{/}$ and longitudes 31^{o} $21^{/}$ and 31^{o} $33^{/}$ (figure 3-2). Parts of this area are urbanized or planned to be urbanized since three decades as extensions to the capital Cairo. Now, these urbanized satellites are accessible through paved roads. Generally, the case study area is dissected by Cairo-Ismailia, Cairo-Suez and Cairo-Belbeis Highways (figure 3.3).

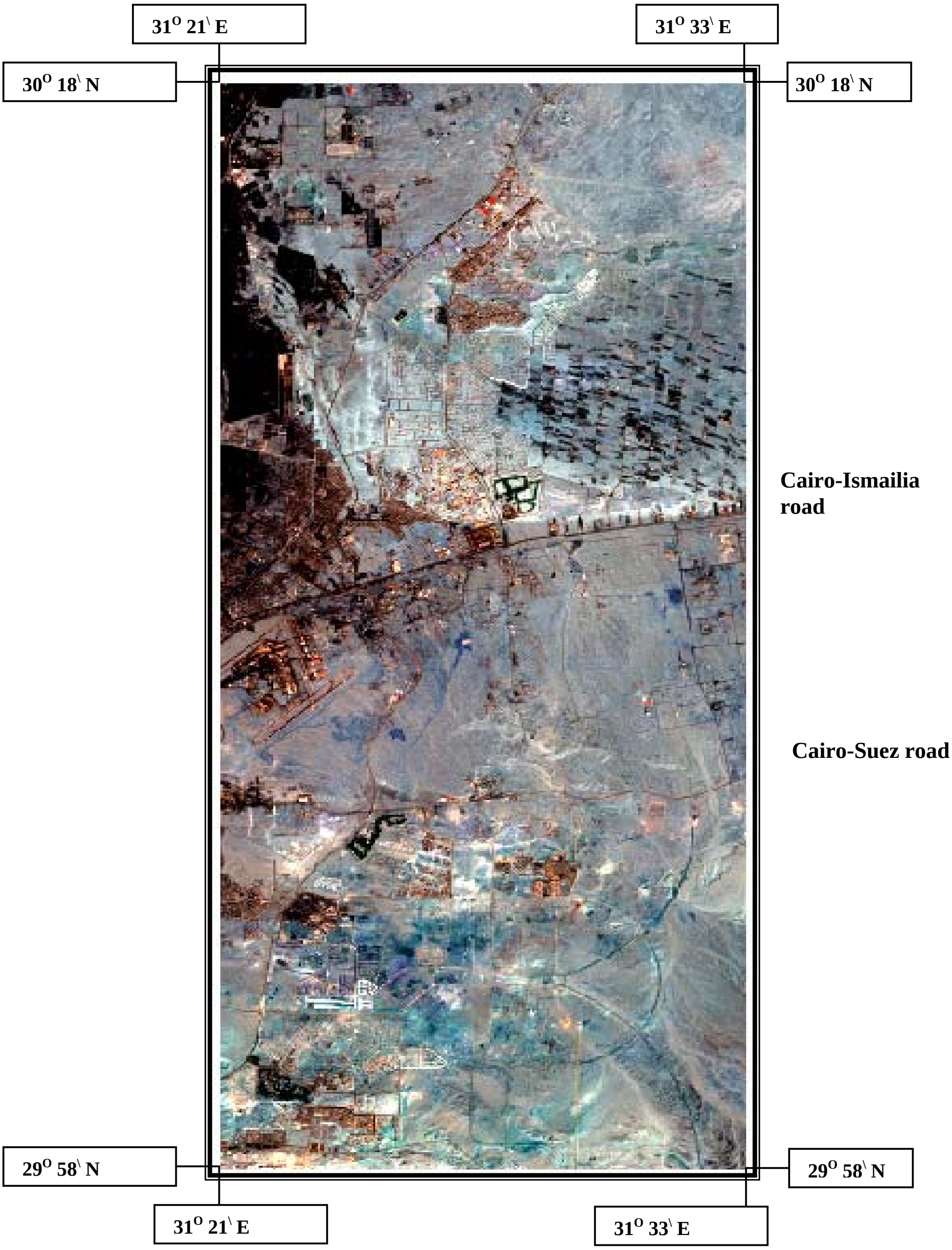


Figure 3.3: ETM+ Landsat7 Enhanced Thematic Mapper plus - Image – taken in 2000 – of North East of Cairo (case study)
Spatial resolution = 30 meter

The study area is extended from the northern parts of El Moqattam-Ataqa plateau to the south, into the fresh water Ismailia Canal to the north. It is limited from the west by the urbanized districts of Cairo city, the capital of Egypt, and from the east by the boundaries of tenth of Ramadan town.

El Obour and El Shorouk towns are built to be satellites and Madinet El Sallam and El Kahira El Gedida to be district extensions for the Capital of Egypt; Cairo City.

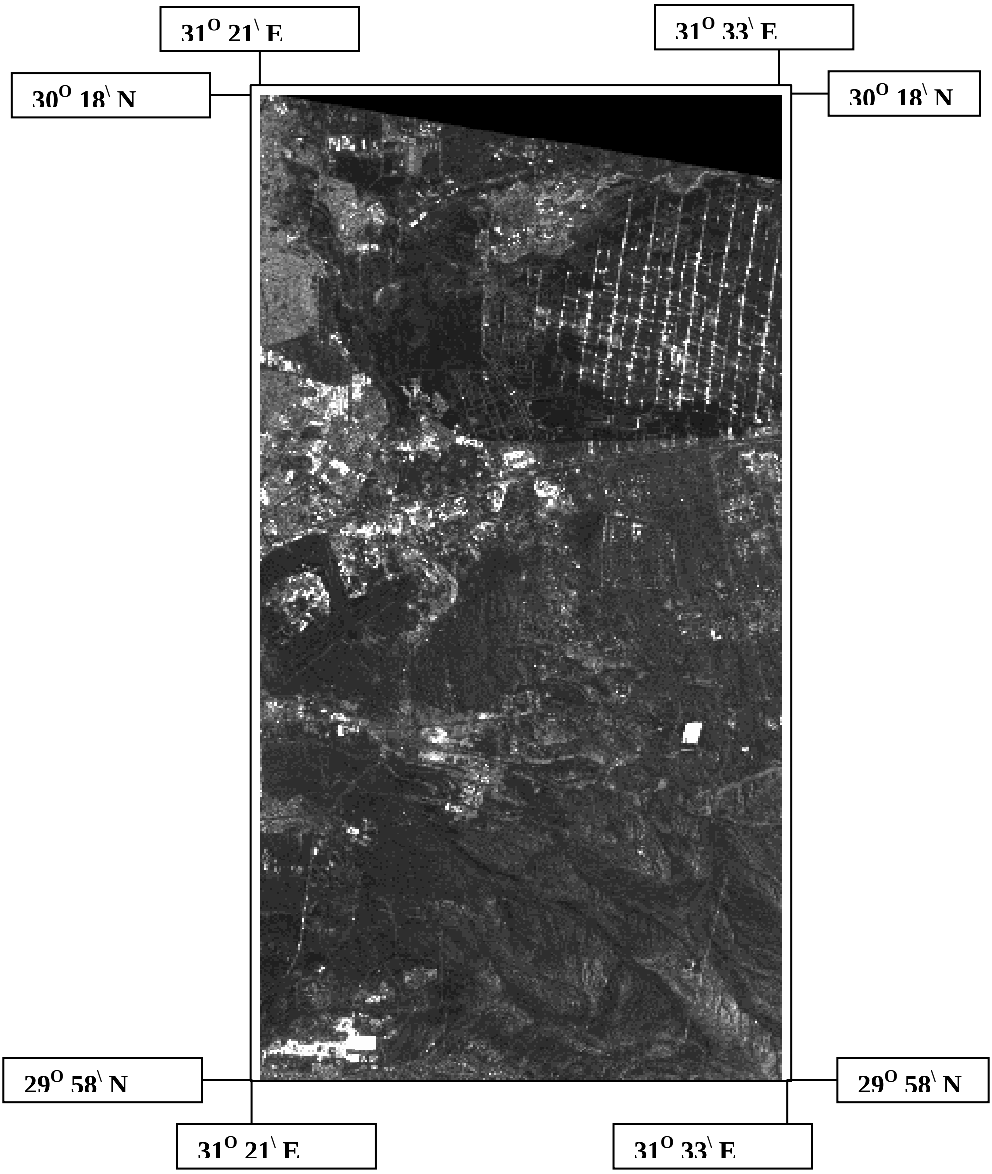


Figure 3.4: Radarsat image of case study area – used in different enhancement methods to discriminate structural landforms, subsurface landforms, dune forms and vegetation that exists in case study area

Figure 3.5:

Subset of Landsat TM image 1984

Figure 3.6:

Subset of Landsat TM image – 1972

3.1.3 Population density in NORTH EAST OF CAIRO

The population density in Cairo City reaches about 31,000 person / km2. The built residential satellites and extensions are established during the last three decades to decrease the population density. In case of proper urban development planning for NORTH EAST OF CAIRO, the population density will decrease more and more.

3.2 Essential criteria for urban planning of NORTH EAST OF CAIRO

NORTH EAST OF CAIRO area exists in three governorates; El Sharqiya, El Kaleobeya and Cairo

The northern part of our area represents a part of El Sharkeya government - Belbeis center.

- **El Sharqiya governorate**

El Sharqiya is a governorate located in the north-east of Egypt with El Qalyoubiya Governorate to its south, Ismailiya to its east , El Daqahlia to its west and El Manazala Lake to its north. It covers about 4911 km² and comprises of a large number of administrative centers, cities and towns. It is linked with neighboring governorates including Port Said, Gharbia and Cairo with railroad that facilitate commercial transactions among them. It encompasses a wide range of agricultural lands and the most important agricultural crops in it are wheat, cotton, soybeans and rice. The main economic resources of the governorate are driven from agriculture, raising poultry, logistic services and food industries. The governorate is supplied with most of the essential services of water supply, sanitation, health care services. On its land stands El Zaqaziq University, one of the major universities in Egypt that has numerous branches. Additionally, Arab tribes of El Sharqiya Governorate are famous for raising best races of camels and horses and training them for participating in national races.

Belbeis

Belbeis town is the eastern entrance of Egypt, therefore, it is considered one of the most important and historical towns from the military point of view. Many of military forces units are distributed around Belbeis town.

Belbeis is a major city in El Sharqiya Governorate located about 35 km to the east of Cairo on the eastern edge of the southern Delta. The inhabitants of the city are both Bedouins and farmers. The Arab Horses Festival is one of the important annual celebrations in El Sharqiya that takes place on the lands of Belbeis. Blessed with a strategic location near the capital city, the city had been always the arsenal of military forces. As a consequence, it suffered a great deal of destruction caused by the different forces that invaded Egypt.

On the lands of Belbeis, there are some fascinating monuments including Emir El Gaysh Mosque that was established in 640 and restored in 1593 and Belbeis Barrage that was constructed by El Zaher Baybars.

The climate condition on the northern part is characterized by the following ranges:

The daily temperature varies from 7 – 19 ^{O}C in January, while in August; it varies from 22 to 34^{O}C.

The precipitation monthly rate in Belbeis reaches its maximum in January then November, December, March, February, October, and April and the rainfall disappears in the other months.

The evaporation annual rate increases to 16 in August, and decreases to its minimum which is 7 in January and February.

There are some sand dunes in the northern part of the area which has a negative impact in land reclamation. Accordingly, most of the low lands are covered by eolian sands that are transported by wind action.

Population in Belbeis is approximately 549,701 in 2002. There is a road network inside and outside Belbeis town. There are two investments areas in Belbeis center, one for natural land resources, such as Quarries of sands, clays and boulders and the second for production of citrus fruits.

The city is small in size but densely populated. It also houses the Egyptian Air Force Academy complex.

❖ El Qalyubiya Governorate

El Qalyubiya is a governorate in the north of Egypt and a part of Greater Cairo that comprises of Cairo, Giza and El Qalyubiya. It is a land of a great history that traces back to the ancient Egyptian times since Banha was one of the major cities at that time and was inhabited by Amenhotob Ben Habo, one of the prominent ministers in the Pharos time.

El Qaluybiya Governorate covers about 100.09 km² and its capital is Banha, about 60 km from Cairo. It is bordered with El Dakahlia and El Gharbeya from the north , El Sharqeya from the east , El Menufeya from the west and Cairo from the south. The main economic resources for the governorate are agriculture, food industry, and poultry breeding farms. The most important agricultural products in it are wheat, cotton and rice and many other vegetables that are used in food industry.

On its land stands Banah University that is regarded as one of the major universities in Egypt. There are various means of transportation for linking between the governorate and other governorates in Egypt such as Metro, train and bus.

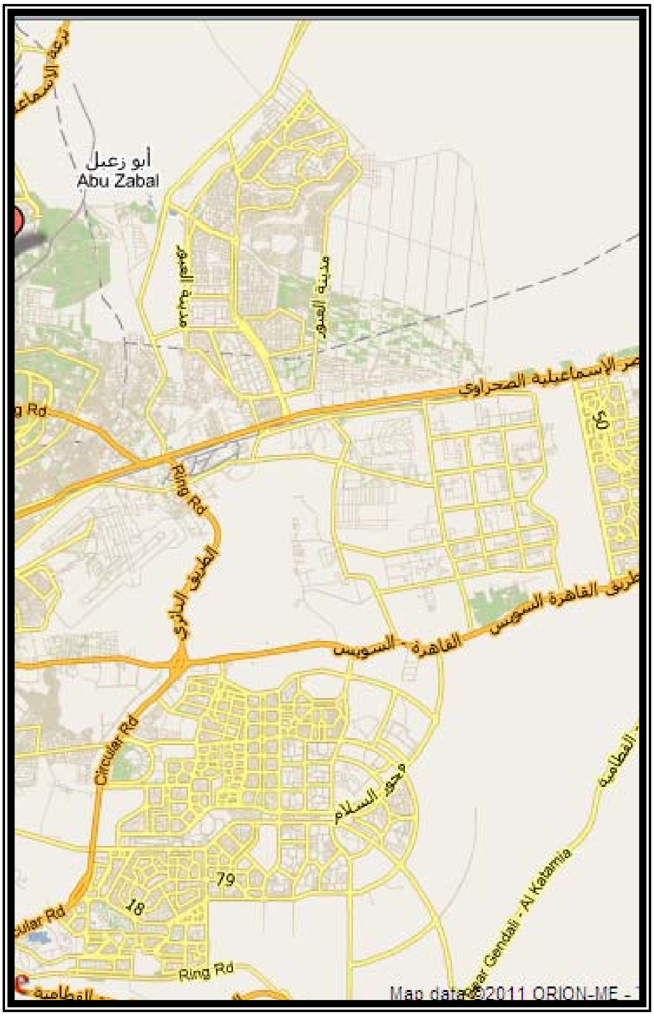


Figure 3.7: The study area

Cities in the Qalyubia Governorate include Banha, Khanka, Qaha, Qalyub, Shibin Al-Qanater, Shubra-el-Khema and Tukh

Qalyubia is known for its agricultural production of crops, fruits and vegetables. The most important of these crops include maize, cotton, wheat, citrus fruits, bananas, oranges and apricots. Qalyubia is also the leading Egyptian governorate in the production of chicken and eggs

- **Cairo**

Cairo is the major governorate and the capital of Egypt located on the head of the Delta of the Nile River. Cairo, Giza and El Qalyoubiya governorates form what is known as Greater Cairo and this region is the most densely populated area in Egypt. Till 2008, 6th of October and Helwan were regarded as parts of Cairo but currently they are regarded as two separate governorates because of the increase of population of these regions.

New Cairo is a new satellite city of Cairo in the newly formed Helwan Governorate of Egypt located in what was formerly deserted. It is the home of the new campus of the American University in Cairo, as well as the German University in Cairo, the Future University in Egypt (FUE), and the Canadian International College (CIC). New Cairo has been a means of escape for many from Egypt's upper-middle and upper classes from the noise and pollution of Cairo. Many of the residences are luxury villas and condominiums located in housing developments and gated communities. Because of the rapid growth of population in New Cairo an expansion to the Suez desert road will occur.

Neighborhoods

El Shrouq City is one luxury project established in New Cairo. With its clean roads the area has attracted many residential and commercial inhabitants. Among the many successful projects of El Shrouq City are Mayfair, Shrouq 2000, Beverly Hills and Wadi el Misk..

Rehab City is another project in New Cairo. Rehab City has many shopping malls as well as a cinema complex. Many future projects have been planned in New Cairo, the biggest and most expensive being Madinaty, which is adjacent to El Shrouq City.

One of the advantages of New Cairo is that its weather is much cooler than downtown Cairo, approximately 5 degrees Celsius lower. This makes New Cairo only slightly hot during summer and quite cold during winter, when highs reach an average of around 14 degrees and lows around 1 degree. Frost is a regular winter phenomenon in New Cairo. Heavy fog is also common. Low winter temperatures are due in part to the altitude of new Cairo, which ranges between 250 meters and 350 meters above sea level. A rapid cooling at night which is characteristic of desert environments also occurs in New Cairo. The contrast to Cairo is also exaggerated due to Cairo's urban heat island effect.

Greater Cairo Region

Transportation and infrastructure

Although the road network represents nearly 25 per cent of the total GCR area, its practical capacity is inadequate owing to many problems. Lack of maintenance, poor driving habits, low vehicle occupancy, bottlenecks, and lack of parking lots and garages are among the major problems that decrease the efficiency of the network. In 1983 more than 530,000 vehicles were on the road. Owing to the sharp increase in car ownership in the GCR in the past decade, this figure has now doubled to reach more than 1 million vehicles. Mass transportation is owned and operated by the public sector and is, by any standards, overloaded. In response to this problem, privately owned passenger vans have begun to function all over the GCR.

The General Organization for Water in the GCR provides almost 3 million of potable water per day. This amount is sufficient by international standards to supply the population. However, owing to the lack of maintenance of pipelines, equipment, and fittings, more than 25 per cent of this capacity is lost or wasted. The water network is old and pipe diameters are small, adding more problems to the distribution of water to many areas of the city. The situation with respect to the sewer network is even worse, even in districts connected to the system. Because of the sharp increase in population densities, the discharge in many districts of the GCR far exceeds the capacity of the sewerage system. This causes frequent overflows and represents a dangerous source of pollution.

In 1994, 14 per cent of the buildings in the Cairo and Giza sections were not connected to any infrastructure system. Of the remaining 86 per cent, 9 per cent are still not connected to the water system, 8 per cent have no electricity, and 38 per cent are unconnected to sewage disposal networks. Solid waste disposal is a major problem in Cairo, where more than 3,000 tons of solid waste is produced every day: 60 per cent is collected by private contractors and the remaining 40 per cent by local municipalities. Informal sector operators based in "refuse settlements" pay for the rights to collect refuse from wealthier parts of the city, using female household labour to sort it into recyclable waste for sale, organic waste for animal fodder, and unusable waste, which is burnt. An effective system, it results in very poor environmental conditions in the settlements concerned [Findlay, A. M. 1994. The Arab World. Routledge, London]. However, owing to the increased volume of solid waste and the geographical expansion of the city, neither private contractors nor the municipalities are able to keep up with the need.

Problems of traffic congestion and inadequate services have combined to increase environmental pollution. High levels of air pollution, due to suspended particulate matter and lead generated by traffic and industry (especially cement manufacture), are exacerbated by wind-blown dust [WHO/UNEP (World Health Organization and United Nations Environment Programme). 1992. Urban Air Pollution in Megacities of the World. Blackwell, Oxford].

Social problems and inequality

Wage jobs in the formal sector have not kept pace with demand. As a result, the informal sector, which it was hoped would diminish over time, has shown clear signs of expansion. Levels of unemployment, real and disguised, have risen sharply, particularly during the past decade. Interclass and inter-sector disparities have widened over time to add a new dimension to the polarization process, despite protests by the urban poor and, increasingly, the lower rungs of the middle classes.

Data on income distribution in Egypt are very scarce. The only available figures are from a series of three consumer budget surveys conducted by the Central Agency for Population Mobilization and Statistics [CAPMAS (Central Agency for Population Mobilization and Statistics). Various dates. Egypt Statistical Year Book. Cairo] in 1958, 1964, and 1974. The 1974 surveys showed that the share of the top 20 per cent of the population was around 47 per cent of total income, while the share of the lowest 40 per cent was 17 per cent. A later study by the World Bank, in 1980, showed that the share of the top 5 per cent of the population had increased from 17 per cent of the national income in the late 1960s to 27 per cent in the late 1970s; and the share of the lowest 20 per cent had decreased from 7 per cent to 5 per cent during the same period [Abdel Khalek, G. and R. Tignor, eds. 1982. The Political Economy of Income Distribution in Egypt. Holmes and Meier, New York]. In addition, the share of wages in national income, which decreased from 50 per cent in 1967 to less than 34 per cent in 1986, indicates the shift towards an increasingly unequal distribution of wealth.

Social problems, such as lack of safety, illiteracy, and crime, have appeared in many parts of this mega-city, affecting both rich and poor areas. It has become evident, during recent decades, that government institutions are not able to cope properly with the ever-increasing rate of growth of Cairo and to manage it.

Policies, plans, and future prospects

National and Greater Cairo Region plans

Such concentrations of population, economic activities, wealth, and power have led to serious urban problems, resulting in several attempts since 1960 to manage and reorganize the growth of the GCR and to decentralize population and activities.

At the national level, the country was divided into eight homogeneous planning regions in 1975, with the aim of developing peripheral regions in order to absorb the additional expected growth of the urbanized areas. In 1982, a national urban policy study identified several goals for the future planning of the GCR [Advisory Committee for Reconstruction (1982); The National Urban Policy Study. Cairo]. First, it was suggested that Cairo's urban growth be redirected from an essentially north-south axis to an east-west orientation on vacant desert areas in proximity to the current built-up area.

At the city level, a master plan was formulated in 1970 incorporating two major concepts on which it recommended that the future management of the region be based (Ministry of Housing, 1970). First, it was suggested that a ring road surrounding the existing built-up area be constructed to control its growth and stop the invasion of agricultural areas. Secondly, it was recommended that self-sufficient new communities be established at suitable distances from the city to attract additional expected growth. Although the ideas of this plan were not fully implemented in the following years, they formed the basis for policies adopted in the 1970s and for the structural plan of 1983, which remains the major guide for the urban development of the GCR to date.

In the 1983 plan, demographic studies produced estimates that the population of the GCR would increase from 6,700,000 in 1977 to 9,660,000 in 1982 and 16,500,000 by the year 2000 (table 4.6; GOPP, 1983), in addition to 1,400,000 people in surrounding rural areas that it expected to be included in the region by that date. This population would be absorbed both within and outside the existing built-up area. Within the existing area it was considered that population could be accommodated by incremental development, in proposed major housing projects, on vacant desert land inside the ring road to the north and east, and in pockets of agricultural land and peripheral areas to the north, east, and west. This, it was suggested, will require a restructuring of the metropolitan region using the concept of "homogeneous sectors". By the year 2000, it was estimated that an additional 5,055,000 could be accommodated within the built-up area and on marginal arable land. Secondly, the rest of the population will be accommodated outside the built-up area through the establishment of new satellite or independent communities on major radial axes and 10 smaller settlements adjacent to the ring road. It was estimated that 4,745,000 inhabitants would be absorbed in these communities and settlements by the year 2000.

The new cities, satellite or independent, were intended to be developed as growth centers in order to attract economic activities and population from the core region. The cities are situated along the major regional radials to tie the GCR to other economic regions such as Suez, Ismailia, and Alexandria. Ten new settlements were suggested, primarily as an alternative to squatter and informal areas encroaching on agricultural land. These settlements were intended to be separate from the existing built-up area and to provide development affordable to the squatter population. Their size is intended to be large enough to guarantee an adequate level of self-sufficiency in terms of employment and services. It was hoped that the private sector would be the primary investor in these settlements, in order not to compete for public investment with the new towns. Finally, these settlements were to be located near existing labor pools in order to attract employment in the short and medium term.

The present situation

The structural plan of 1983 was revised in 1991 (GOPP, 1991). New data showed a decline in the rate of growth in the city centre in favor of the middle and outer urban rings, particularly to the west. In the 1970s, most of this outer growth had taken place on agricultural land, indicating the urgency of providing desert land for urban expansion. However, the construction of new towns in the 1980s directed most of the urban growth to desert lands. The 1991 plan showed that encroachment on agricultural land decreased from 590 ha in 1980 to just fewer than 150 ha in 1989. This was mainly due to sharp increases in land prices, declining purchasing power, and stringent legal controls.

In addition to the six new cities and satellite towns that have been established (10 Ramadan, El-Sadat, Badr, 6 October, 15 May, and El-Obour), ten new settlements along the ring road have been started. The population capacity *of* the new settlements has been revised upwards to 5,382,000 from the 1983 estimate of 4,745,000. However, implementation is well short of that intended, and by 1994 only 448,850 people were living in the settlements (8.3 per cent of the planned population).

Many infrastructure and transportation projects have been implemented in the GCR: parts of the ring road have been finished; the first line of the metro between El Marg and Helwan has been completed; two major water treatment plants have been constructed; and extensions to Cairo airport and the wholesale market in El-Obour have been completed. Other major projects are under way, such as the extension of sewage collection networks, the second line of the metro, a second wholesale market in 6October City, and thousands of low-cost housing units in the new cities and settlements.

However, the GCR is still facing serious urban problems in terms of a lack of job opportunities; informal and illegal expansion of the built-up area;

deterioration of the housing stock; and social, health, and environmental problems. It has become very evident that the major impediment to the implementation of planned projects is mismanagement and lack of sectoral and geographic integration. The GCR is still managed by three different governors (in Cairo, Qalyubia, and Giza sections), each having their own authority, local departments, and resources. At the same time, some facilities and services, such as planning, transportation, water supplies, and sewage disposal, are administered by regional authorities. These local and regional institutions are not integrated and coordination of policy and implementation is poor. In addition, sectoral ministries, which are also located in Cairo, interfere in the affairs of these regional institutions. Moreover, the resources available for public investment are limited, discontinuous, and mismanaged. The result is usually the cancellation, delay, or alteration of planned urban development policies and projects. Proposals for the homogeneous sectors have also not been successfully carried out owing to management problems and lack of planning expertise at the local level. It is clear that the urban development policies for the GCR have not yet achieved their major goal of decentralizing population and economic activities. Because the government did not take appropriate measures to change the social, political, economic, and institutional structures radically, the effects of the policies are likely to be limited, or may even add to the polarization process.

Future prospects

It is expected that if the current pattern of growth continues in the future, the GCR will continue to expand rapidly along its major regional axes

Land uses

Great cities have grown up along the banks of the Nile River. Thus, population and economic activities concentrated in this narrow and limited area, and polarization became the pattern of Egyptian life.

In 1982 the GCR was delineated by administrative boundaries encompassing 131,260 hectares, including the built-up area (32,609 ha), government property (11,219 ha), vacant land (839 ha), and agricultural land (86,593 ha). This area did not include the River Nile and desert land, which amounted to almost 130,000 hectares [GOPP (General Organization for Physical Planning). 1991. Evaluation of the Implementation of the Structural Plan of Greater Cairo Region. Cairo (in Arabic)].

Residential land use thus accounted for 67 per cent of the total built-up area in 1983. Economic activities and service facilities shared the remaining area, with 17 per cent and 16 per cent respectively. A closer look at the spatial distribution of land uses shows that in 1982, when the Giza section had attracted migrants from Cairo and other parts of the country, residential land use was dominant (74 per cent). Qalyubia section was, in contrast, characterized by the number of economic activities that were located in Shubra El-Khima and Mustorod (27 per cent of the total built-up area).

3.3. NORTH EAST OF CAIRO Characteristic Features

3.3.1. Physiography

- **Topography**

Most of the study area has a mild to moderate relief terrain. The northern part is considered the extension of eastern Nile delta flat cultivated land. The southern part of the terrain represents the western part of a wide table land (platform) extended from the Nile Delta to the west to the Suez Canal and Gulf of Suez to the east. The study area is implicated by a series of elongated structural ridges of low relief, oriented WNW-ESE and E-W [El-Shazly, E., Abdel Hady, M, El-Shazly, M. M., El-Ghawaby, M., El-Khassas, I., Salman, A. and Morsy, M. (1975a): Geological and groundwater potential studies of Ismailia master plan study area. Remote Sensing Res. And Tech., Cairo, Egypt, pp. 1-24]. These ridges are represented by Hamza mountain (210m), and Umm Gamar mountain to the north and Nassuri mountain, (308m) Anqabiy mountain (333m) and Sawanet El Dibba mountain (250m) to the south. These ridges are dissected by a valley network that terminates towards northwest and west at Heliopolis depression which extends for a distance of about 50 km east of Cairo city. The average altitudes of these ridges and depressions range from 250m (asl) to less than 15m (asl), (figure 3.4).

- **Dry valleys**

The study area starts from south by foot slopes of an east-west extended plateau that nominated El Moqattam mountain to the west and Ataqa mountain to the east. Starting from the slopes of this southern highly elevated plateau, irregular short and shallow valleys and gullies drain to the north and the northwest direction to form wadi el-Hag (valley). These short gullies starts from Nassuri mountain, (308m) and Anqabiya mountain (313m) ridges located to the south. To the north, there is another main valley called W. Hamza which is draining from Hamza mountain, (210 m) and Umm Gamar mountain, to the east towards west. Both wadies, El Hag and Hamza meet together at what is called Heliopolis depression on where Madinet El Salam exists, (figure 3.8).

3.3.2 Climate

Climate is one of the main driving forces that control the dynamic geomorphic changes in the landscape as weathering and erosion processes. These processes have an impact on the urban development operations. The climatic elements that control these processes include temperature, precipitation, relative humidity and wind direction and speed.

- **Temperature**

The climatic conditions of Cairo are gathered from nearby Helwan Meteorology Station (International Number 377) and NARSS, (1997) [Amasha, A. A. I. (2009): "Application of Remote Sensing, GIS and Multi-Criteria Evaluation in Hazard Assessment for Sustainable development of Gabal Mokattam Area, East Cairo, Egypt". PhD. Thesis, Faculty of Science, Mansoura Univ., Ismailia, Egypt.]. The maximum temperature of Egypt, in general, increases from north to south. The desert climate that is hot and dry most of the year dominates in Cairo region, especially in the summer months (June to August).

The average maximum temperature ranges from 18^{O}C to 34^{O}C whereas the average minimum temperature ranges from 10^{O}C to 23^{O}C. (figures 3-9, 3-10). The variance between diurnal and night temperatures vary monthly. It reaches 13^{O}C in May and 8^{O}C in January, (figure 3-11).

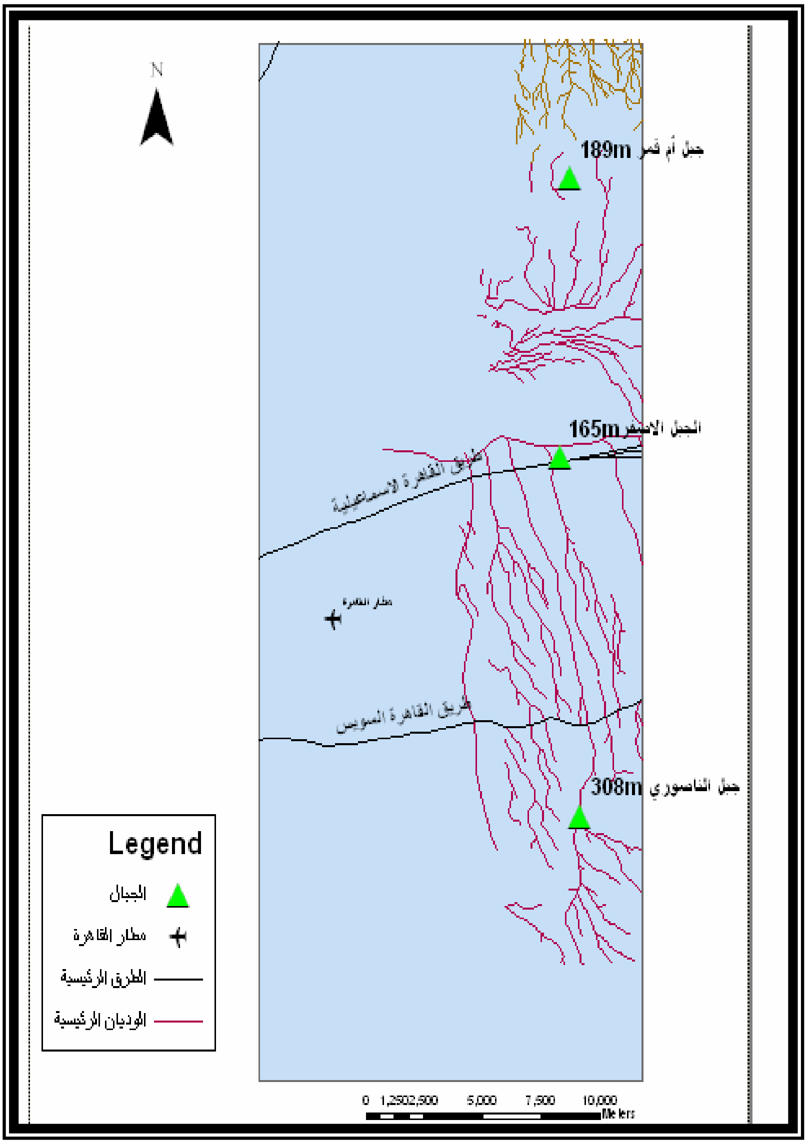


Figure 3.8: Physiographic map of the study area

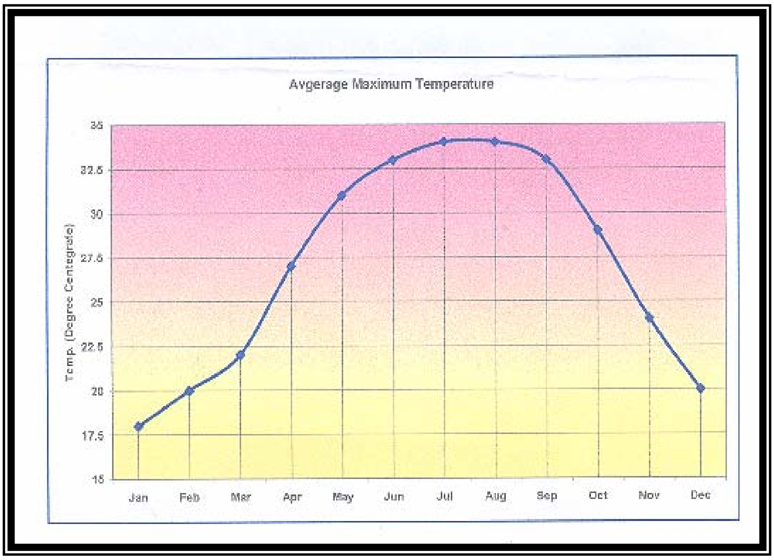


Figure 3.9: Shows the average maximum temperature of Cairo (source data NARSS, 1997) (after Amasha A. A. I., 2009)

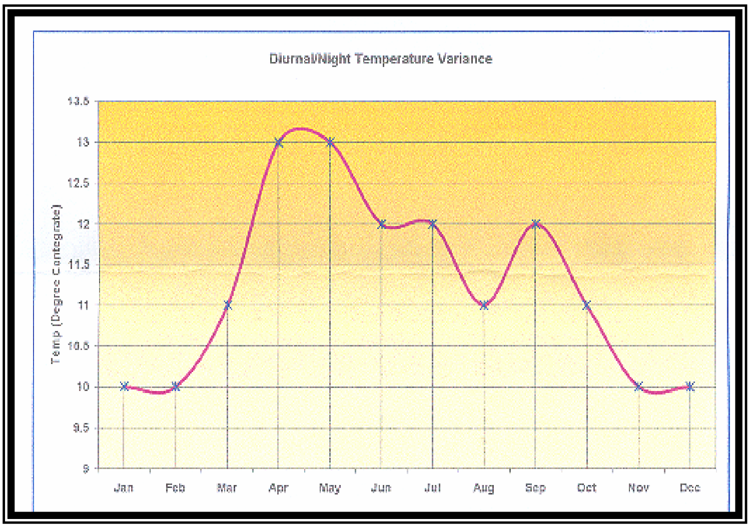


Figure 3.10: Shows the average minimum temperature of Cairo (source data NARSS, 1997) (after Amasha A. A. I., 2009)

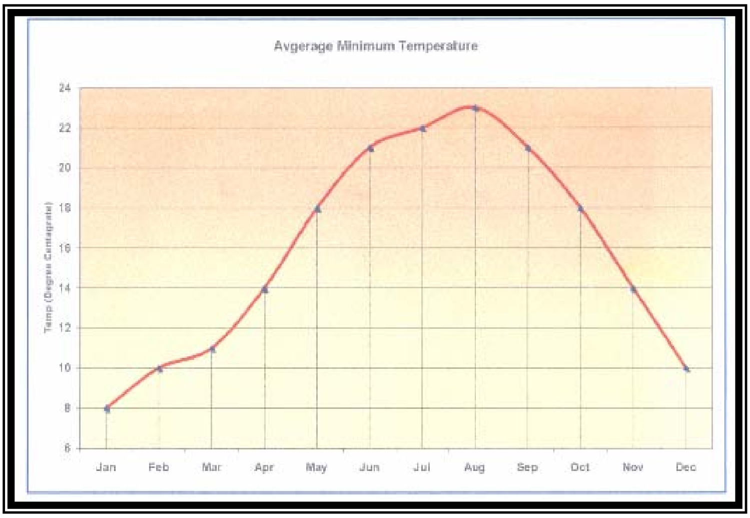


Figure 3.11: Shows the diurnal/night temperatures variance of Cairo (source data from NARSS, 1997) (after Amasha A. A. I., 2009)

❖ Rain

Cairo has an arid desert climate, where the days are hot but the nights are relatively cold. The weather in winter months is mild, with occasional rainfall. The evaporation rates exceed many times the precipitation rates. The maximum rainfall in the study area is mainly from October to April. Generally, the trend of rain fall shows a tendency of southward decrease in precipitation (figure 3-13). The highest annual rainfall (17mm) exists at Enshas followed by Cairo (14.7mm) and Qattamia (10mm). The average annual rainfall contour map of the study area during the period from 1978 to 1998 is given in figure 3-12.

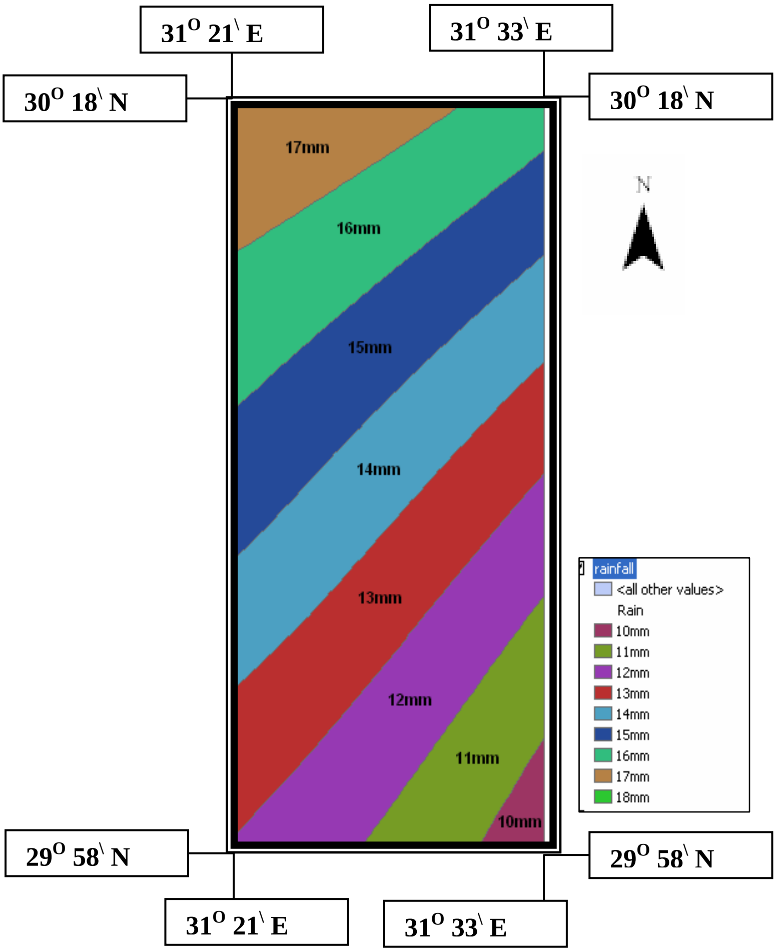


Figure 3.12: Average annual rainfall contour map of the study area

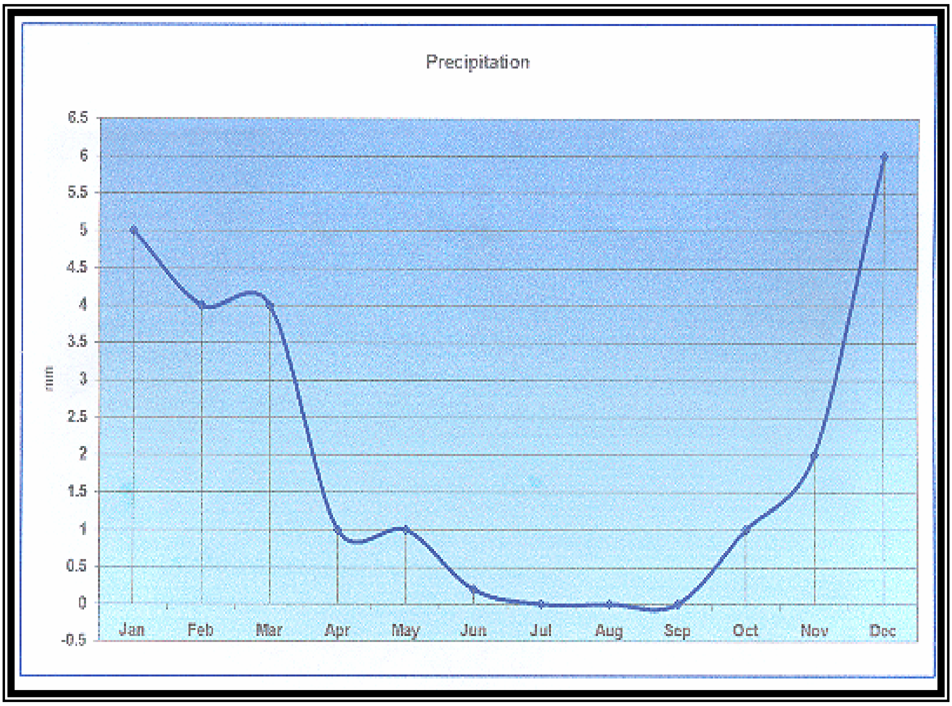


Figure 3.13: Shows the average precipitation rates over Cairo (Source data from NARSS, 1997) (after Amasha A. A. I., 2009)

❖ Relative Humidity

The humidity in Egypt is related to the neighborhoods to the water bodies and vegetation cover. So, the highest humidity rates occurs at the nearest areas to the coasts reaching to about 65% in winter. It decreases to the south reaching about 35%. Figure 3.14 shows the percent of monthly humidity rate (relative daily humidity).

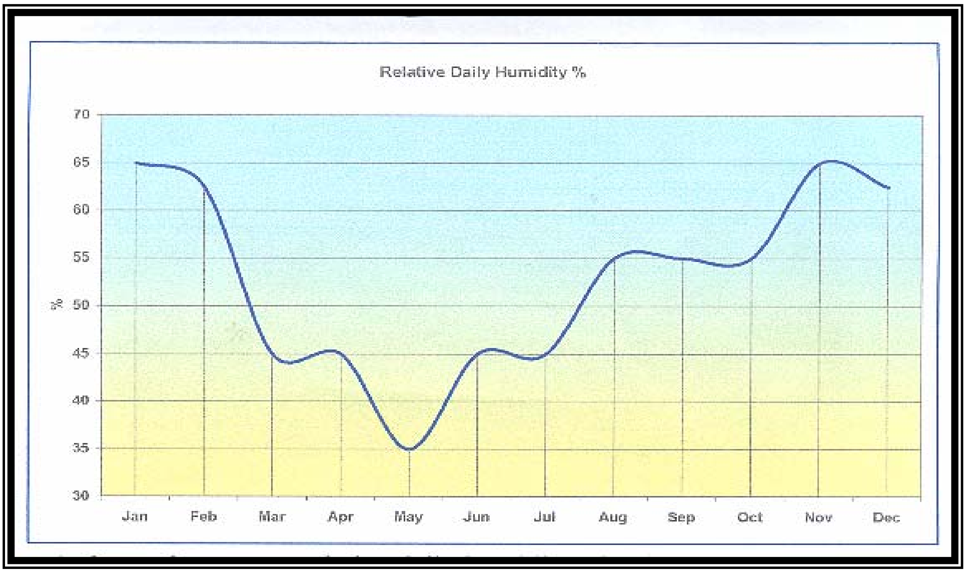


Figure 3.14: Shows the percent relative daily humidity of Cairo (Source data from NARSS, 1997) (after Amasha A. A. I., 2009)

❖ Wind

Different meteorological stations around Cairo, have recorded the NW, N and NE wind trends dominating most of the year, which may change to SE for short periods. The Khamasin westerly winds blow sometimes in spring and autumn which is mostly hot and sandy.

3.3.3 Soil cover and surface geology

3.3.3.1 Soil types (fig 3.15)

❖ Exposed Rocky surfaces

The ridges are built up of sandy limestone, gravels, sands and basalts. The exposed rocks surrounding Heliopolis depression are mainly composed of consolidated limestone, marl, gravelly sand and sandy gravels. These consolidated rocks are sometimes covered by thin unconsolidated deposits which can be referred as soils. This soil cover is characterized by lack of soil profile development, e.g. poorly suitable to be cultivated, but at the same time its suitability in urban development is very high and it takes a reclassified grade equals 4 which is highly suitable.

- ❖ **Alluvial fan soils**

Heliopolis basin is filled by alluvial fans which are composed of unconsolidated deposits of calcareous and ferruginous loamy sands and gravels. The nature of soil profile in the basin varies from place to place according to its topographic position. Also, the texture ranges from very coarse gravels to medium loamy sand texture.

The thickness shows also a marked change and varying from just a thin mantle to a fairy thick soil profile. The surface is smooth undulating and the basin soil profile is characterized by thin desert topsoil that overlies deep gypsieos, calcareous and loamy sand subsoil horizon. The Alluvial fan soils have an urban suitability degree equals three in this analysis which means that it is suitable in urban development.

❖ **Alluvial soils of old Nile Delta**

The top part of such soils is composed of soft yellowish brown to greenish grey calcareous fine sandy loam, with few pebbles. This soil type shows a typical desert terrace pavement which its surface is covered by a residual gravelly layer resulting by wind deflection from the old delta deposits. This soil type is moderately suitable in urban development and takes a reclassified grade equals two.

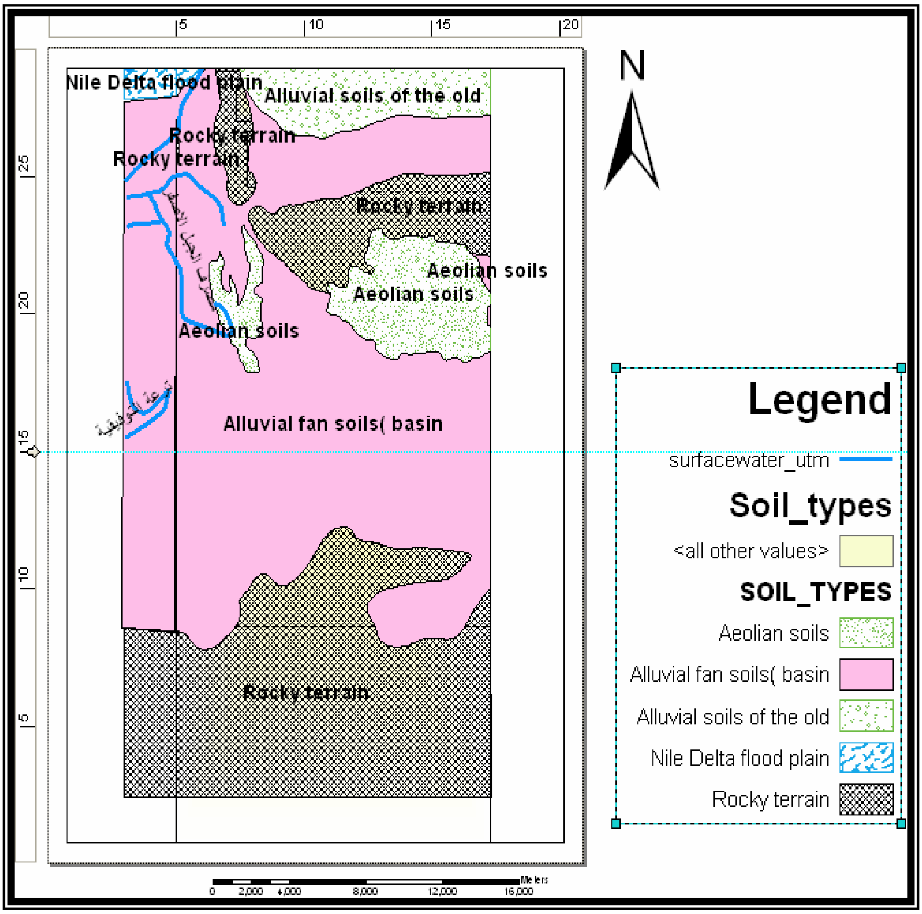


Figure 3.15: Soil types map of case study area, interpreted from TM images and ancillary data.

❖ Flood plain soils of present Nile Delta

These soils dominate on the surface of the present Nile Delta and represent a portion of the recent Nile floods. The soil profile of such type shows some primitive signs of pedogenic development due to irrigation and cultivation processes. The Nile delta flood plain is the least grade in urban suitability and so it takes a grade equals one when reclassified.

❖ Aeolian soils

Aeolian soils are considered undeveloped soils. They are present in different morphological features including dunes, hammocks, sandy sheets and ripple marks. Aeolian soils are widely distributed in the northern portion of the study area, within the Heliopolis depression.

Locally, primitive signs of development are witnessed, such as regosoils associated with stable dunes or even regolith with moving sand dunes and sand sheets. So this type of soil is not suitable in urban development and takes a grade value equals zero to be excluded from analysis.

3.3.3.2 Surface Geology

❖ Lithology (Land Cover) (figure 3.16)

The study area is covered with a sedimentary succession ranging in composition from limestones, sandstones, and clay-stones to basalts. The following is a brief description of the lithological units, exposed in the study area:

The Upper Eocene rocks are composed of shelly sandy limestone, dolomitic limestone and sandy marl, with thin clay laminae. They form scattered outcrops at El-Nassuri mountain and Anqabiya mountain of about 60 to 100 m thick. It is suitable in urban development and takes a grade three which is equal to suitable.

The Oligocene rocks are represented by continental sands with silicified wood and gravels as well as volcanic basalt sheets. They are exposed in the area namely at Abu Zaabal and Umm Gamar mountain. This type of rock is highly suitable in urban development and so it takes a grade equals 4 which is the highest score in the lithological factor in urban suitability.

Non-marine Miocene sediments are mainly composed of sands, sandstones, flints, pebbles, gravels and sometimes some sandy limestones. So, it's least suitable in urban development with grade equals 1 which means least suitable. Small Pliocene outcrops mentioned by Said and Beheri [Said, R. and Beheri, S. (1961): Quantitative geomorphology of the area to the east of Cairo. Bull. Soc. Geographie Egypte, (34)] along the margins of Heliopolis basin are represented by non-fossiliferous clays with carbonaceous contamination.

The recent sediments exist in the study area in the form of barchans sand dunes, limestone screens and clay debris. Wind blown sands and Wadi deposits form a thin superficial layer.

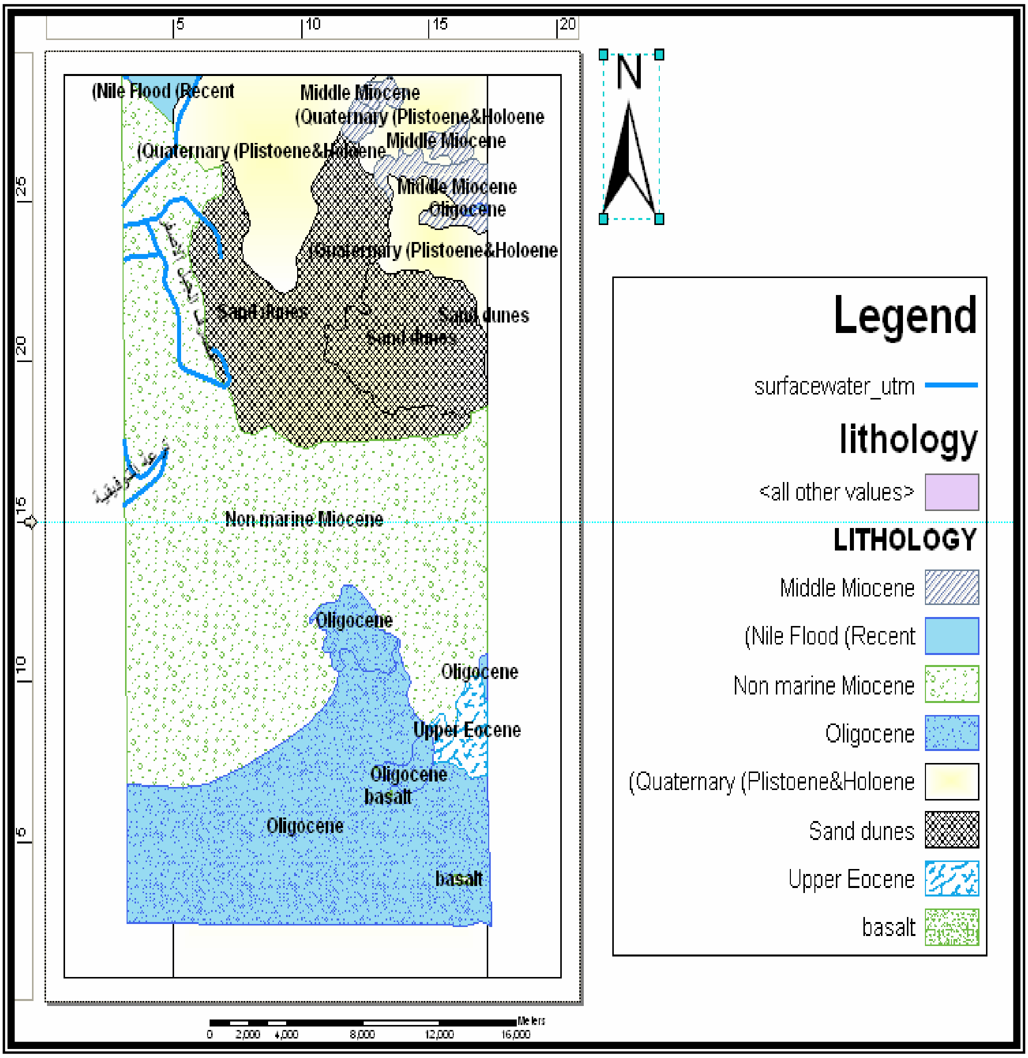


Figure 3.16: Lithological map of the study area integrated from interpreted enhanced TM images merged with radar images.

❖ Geological structures (figure 3.17)

The resulted structural lineaments map of surface and subsurface data has been done, to recognize the main structural features of the area under investigation, and to reveal the centers of the probable seismic activities and its strength.

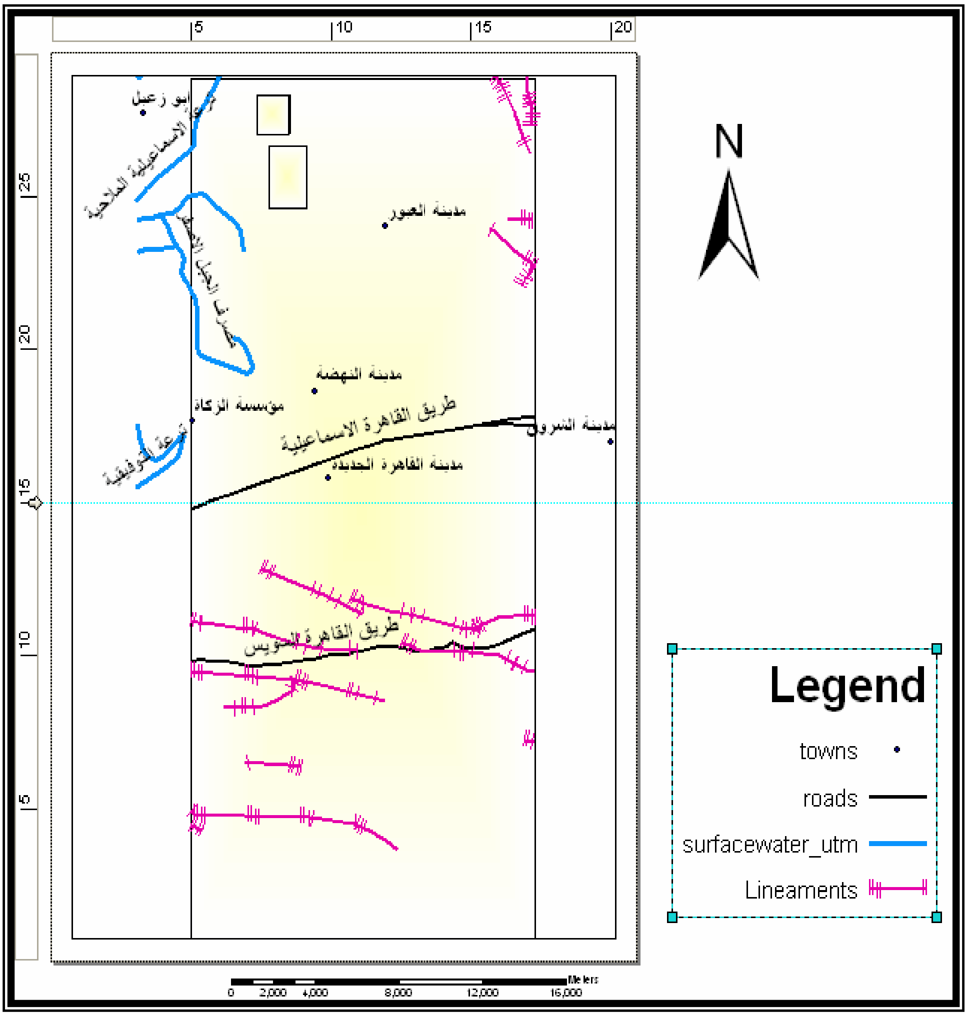


Figure 3.17: Structural lineaments map of case study area, integrated from enhanced satellite images and ancillary geological surface and subsurface data.

3.3.4 Land Uses

Land-use is an important item for sustainable urban development planning. In the present study, land-use map has been achieved (figure 3.18) using landsat images acquired in 2002; Land-use types are investigated and recorded as follows:

Urban areas (including Industrial lands), Agricultural lands and Extracting Quarries.

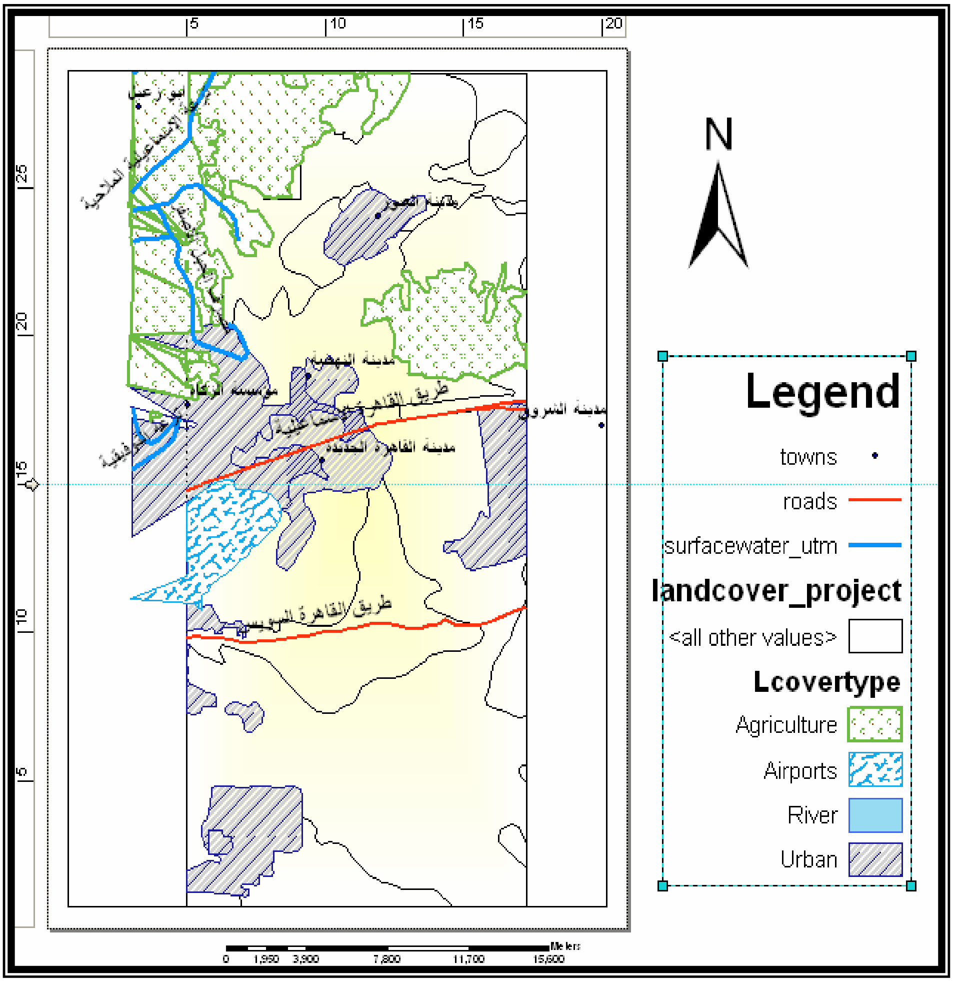


Figure 3.18: Land-use / Land-cover map of case case study area, integrated from enhanced satellite images

3.3.4.1 Agricultural lands (figure 3.19)

Agriculture areas were mapped and recorded mainly in the northern part of the area surrounding Ismailia fresh water Canal. These areas will be excluded from the urban development plan as they are constraints. So, they take score "zero" in urban suitability analysis.

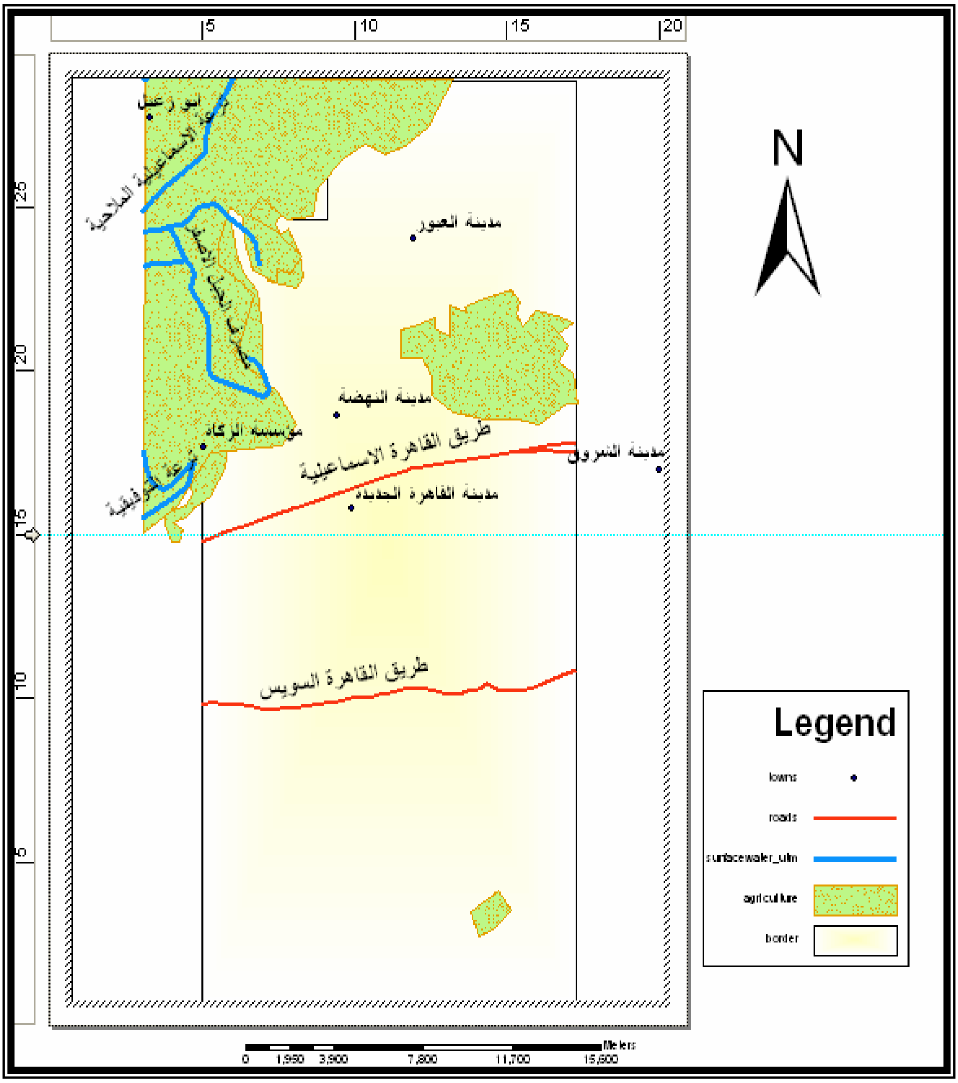


Figure 3.19: Agriculture area map of case study area, integrated from enhanced satellite images

3.3.4.2 Urban areas (figure 3.20)

Urban areas were mapped as Cairo City extensions in addition to newly established satellite residential communities. Some of the urban sites are old towns and rural villages. Some other towns include industrial zones, and military camps.

This map will be used as a potential for urban suitability development, as we give the existing urban areas the highest score of suitability and the areas around it will take scores that are decreased as we go far from existing urban areas.

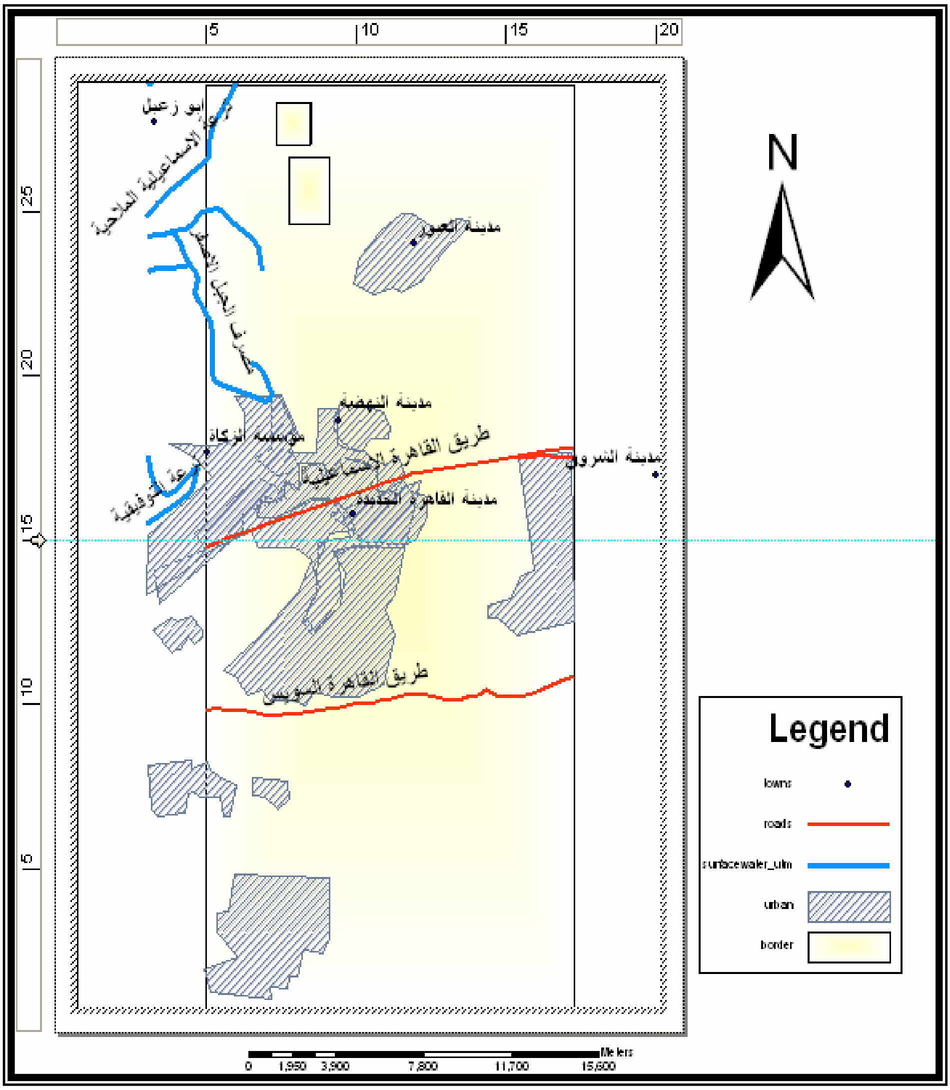


Figure 3.20: Urban area map of case study area, integrated from enhanced satellite images

3.3.4.3 Extracting Quarries (figure 3.21)

The area under investigation has many locations for building materials extraction such as limestones, dolomites, sands, gravels clays, conglomerates and basalts.

Dolomite mining is important for industry. Dolomite is the main mineral component composed of Dolomite and Dolomite limestone. The dolomite can be used in building materials, porcelain and glass.

Limestone is of rather low value, but nevertheless it is probably the most important mineral. It is mined and used in large amounts, which often conflicts with the protection of karst areas and caves. Various kinds of limestone and marble were used for walls, pilars and much more.

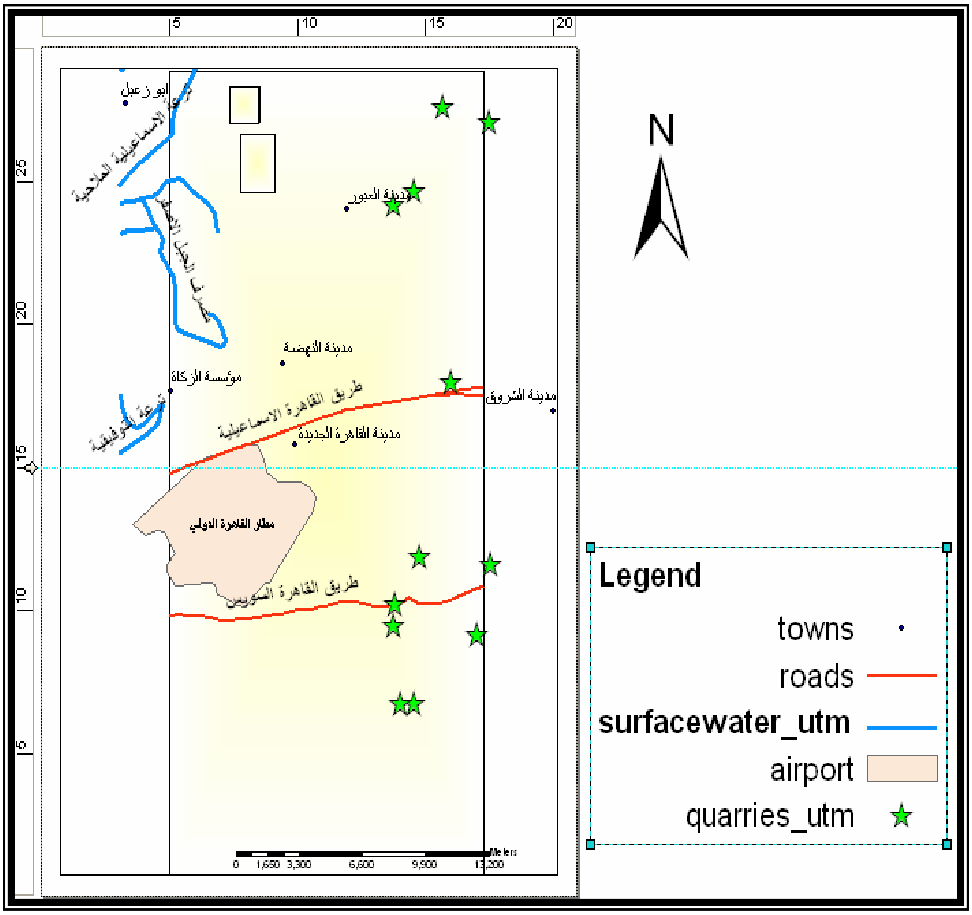


Figure 3.21: Quarries map of case study area, integrated from enhanced satellite images

3.3.4.4 Main Roads

Roads were traced from the topographic map, and the satellite images. There are four main roads in NORTH EAST OF CAIRO which are Cairo-Ismailia road, Cairo-Suez road, Cairo-Belbeis road and El-Daery road (figure 3.22). In Urban development, the areas around main roads take the highest score and as we go far from main roads the score is reduced. Then it will be done by using multi-ring buffers around main roads with different scores and reclassify the main roads map to four classes of urban development.

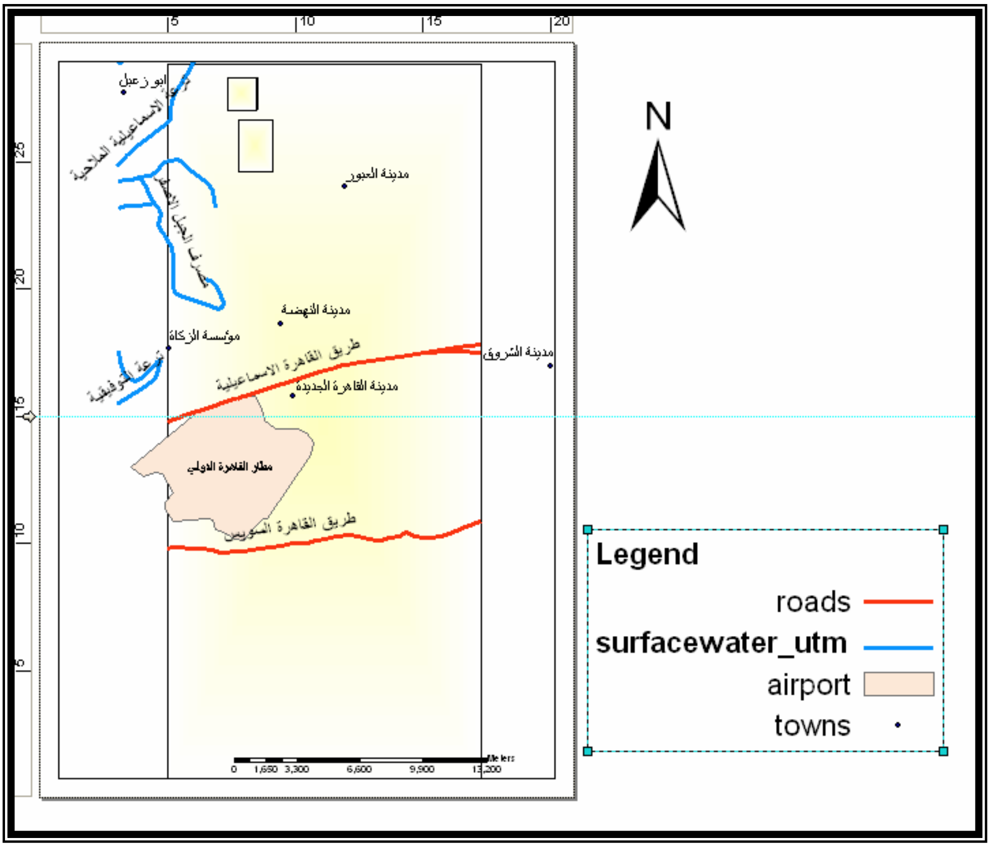


Figure 3.22: Main roads map of case study area, integrated from enhanced satellite images

3.3.4.4 Secondary roads and Streets map of NORTH EAST OF CAIRO

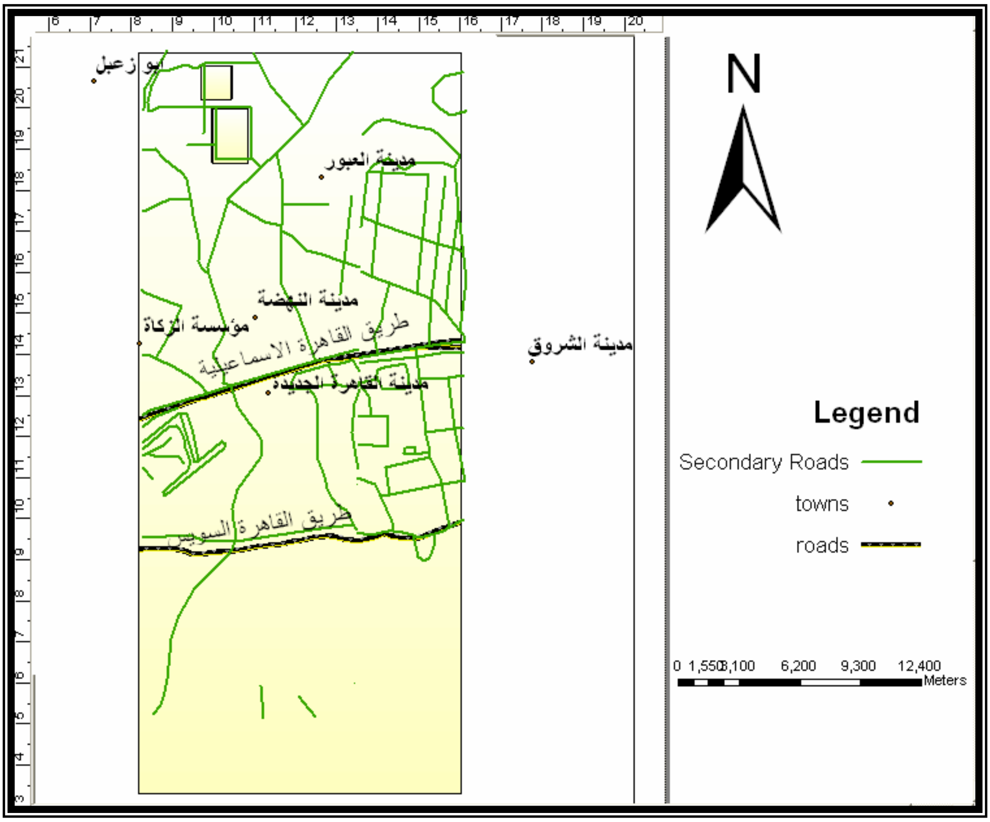


Figure 3.23: Secondary roads and Streets map of case study area, integrated from enhanced satellite images

The following map is the map of the secondary roads that exist in North East of Cairo. As these secondary roads are potentials in urban suitability analysis. So, multi-ring buffer will de done and as we go far from them, the score will de decreased (figure 3.23).

3.4 Natural resources and environmental hazards in NORTH EAST OF CAIRO

Nowadays, the environmental problem is considered as of the most serious one that faces mankind in the 21st century. It is also one of the hot issues that will require great efforts at all levels; individual, group, national and international. The Egyptian government has recently become increasingly aware of the importance of environmental risk management and socio-economic development impacts on public health and quality of life.

The success of urban development plan of an area depends on:

- ❖ Inventory of natural resources and centers and axes of development.
- ❖ Reconnaissance of enough reliable environmental data on the natural hazards and the expected hazards produced by the human activities.

3.4.1 Natural Resources

3.4.1.1 Water Resources

Water resources in the case study area are of two types:

- ❖ Surface Fresh Water (figure 3.24)

The surface fresh water is represented in NORTH EAST OF CAIRO by Ismailia fresh water canal that is taking its water from the Nile course at Shoubra district. This canal water is running eastward upon the low relief of the old buried Pelsium and El-Tumilate branches of the old Nile Delta.

Ismailia fresh water canal salinity increases eastwards where it varies between 240 ppm to 470 ppm [Arnous, M. O. (2004): Geo-environmental Assessment of Cairo-Ismailia Road Area, Egypt Using Remote Sensing and Geographic Information Systems (GIS), PhD. Thesis, Faculty of Science, Suez Canal Univ., Ismailia, Egypt]. The high salinity may be attributed due to the municipal, agricultural and industrial draining wastes that are charged into the canal itself.

- Ground or Subsurface water (figure 3.25)

The ground water of NORTH EAST OF CAIRO comprises two main hydrographic environs; Old and relatively recent environs. The old one comprises mostly deep Eocene, Miocene and Oligocene aquifers. The relatively recent one involves the Quaternary environs [Hussein, S. M. (2001): Hydrogeological and geophysical studies for evaluation of groundwater potentialities at Cairo-Belbeis district, Egypt rocks in Northern Sinai, Egypt. Ph.D. thesis, Suez Canal Univ., Fac. Of Sci., Geol. Dept., Ismailia, Egypt, 235]

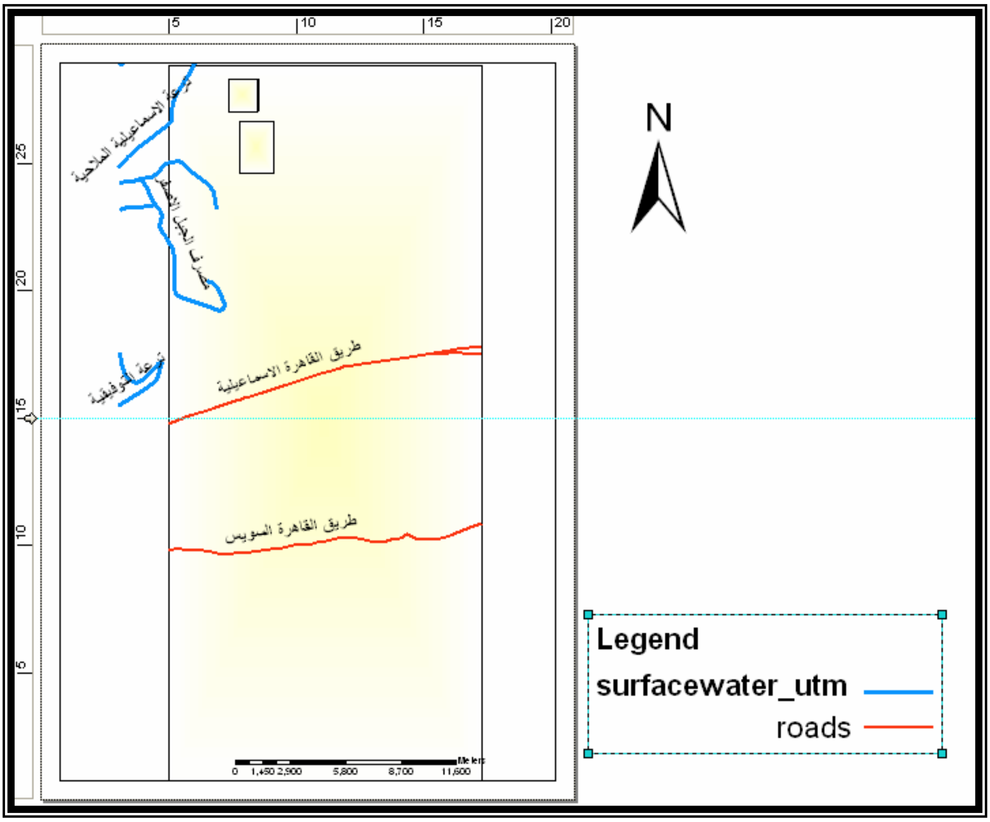


Figure 3.24: The surface water canals and drains network in case study area

The Quaternary aquifers are commonly composed of graded sand, rock fragments and gravels with clay intercalations [RIGW (1988): Hydrogeological map of Egypt scale (1:2,000,000), 1st edition, Res. Inst. For Groundwater, Water Research Center, Ministry of Pub. Work and Water Reso., Egypt]. The deep faults in the area of study may have facilitated upward leakage of the Miocene saline water into the lower parts of the Quaternary aquifer.

3.4.1.2 Industrial Minerals and Rocks

Based on the lithological map (figure 3.16) and metallogenic map of Egypt, the study area encompasses numerous quarries that comprise building and construction raw materials such as limestone, clays, gravels, sands, basalts, decorative stones such as hard limestone and industrial raw materials such as clays, limestone and quartz (figure 3.21).

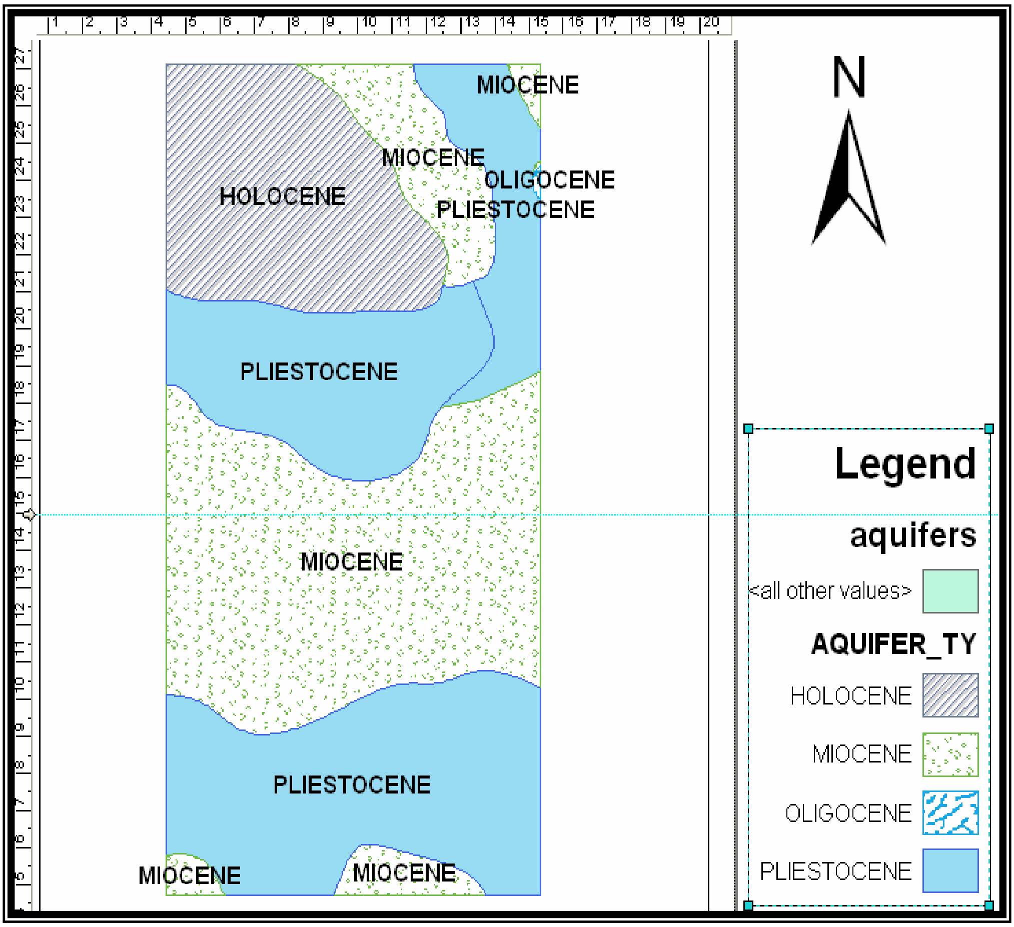


Figure 3.25: Aquifer types map of case study area modified after (RIGW, 1988, Geriesh, 1989 & 1994)

The most important rocks for dimension stones in the study area are hard limestone and basalts at Umm Gamar Mountain, Abou Zaabal and El-Hamza mountain. Some of these deposits have been exploited for constructing roads and buildings and for producing dimension stones and slabs.

Moreover, the extensive distribution of sands, gravels and basalts are used as aggregates for concrete and paving materials especially at Belbeis, Cairo-Suez road and south Cairo-Ismailia roads. Deposits of limestone, clays and sands suitable for cement industry are exploited from Umm Raqam mountain.

Specific clay stones are required for manufacturing brick, floor and roofing tiles, clay pipes, sanitary ware and filter materials (figure3.26).

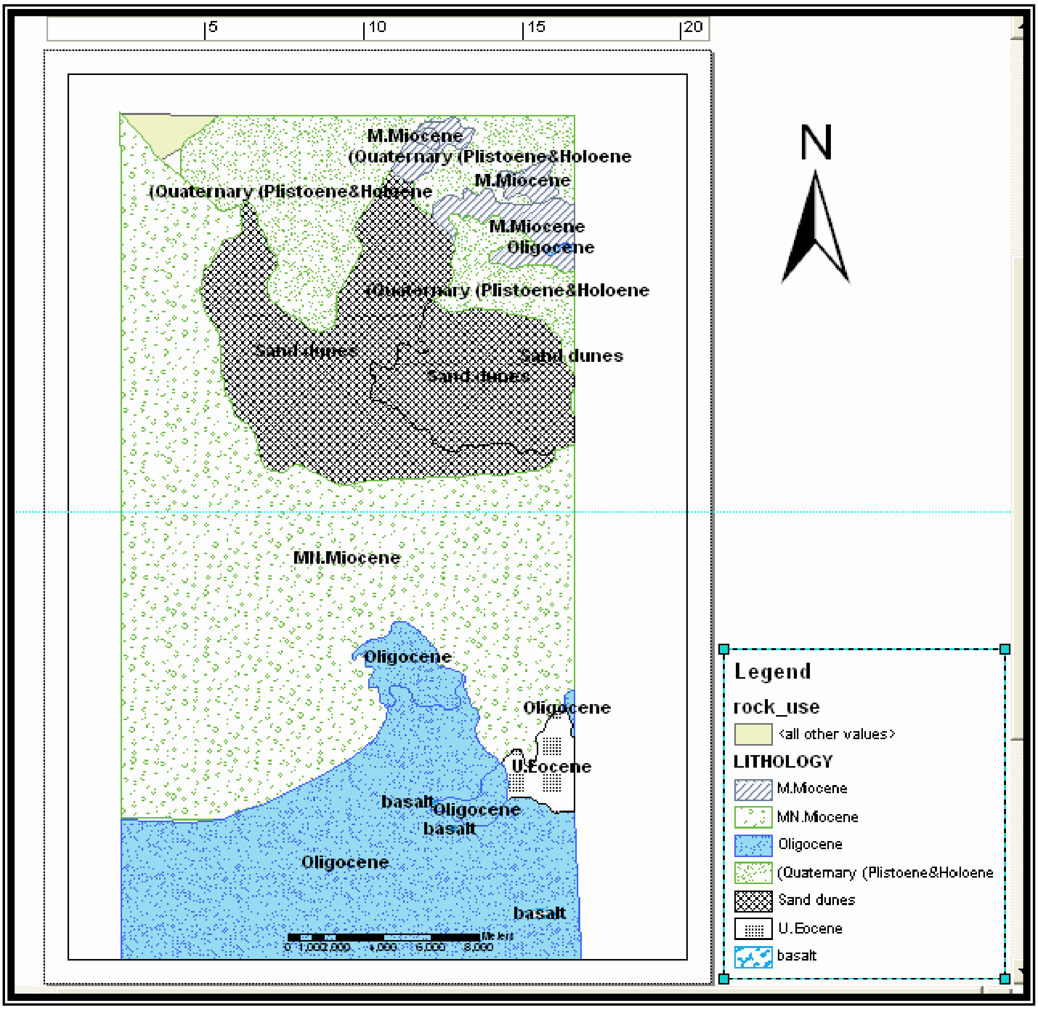


Figure 3.26: Rock-use map showing the distribution of raw materials in NORTH EAST OF CAIRO

3.4.2 Environmental Hazards

The area comprises several environs with probable different human activities and natural hazards. The land-use / land-cover map (figure 3.18) might express precisely such environs. The natural and human expected hazards in the area have to be known to understand mitigation of their expected influences, and then to avoid their risk and prepare their measures.

3.4.2.1 Natural Hazards

There are several expected natural hazards in the present study area such as earthquake activity, rainfall flash flooding, soil degradation, sand dune movement, land sinking and rock fall. The environmental natural hazards in the study area can be summarized in the following paragraphs.

- **Seismo-tectonic activity (figure 3.27 and figure 3.28)**

Earthquakes are the most typical phenomenon of natural hazard. They have effects on nature, human life and man made structures. Assessment of earthquake sequential occurrence in an area plays an important role in proposing measures to minimize damage and to anticipate the future save development for the strategic projects.

The seismological data are collected and then integrated with the available geological and geophysical information to develop a seismo-tectonic model for the area of study.

Seismological data from 1900 to 2001 has been collected and analyzed to conduct seismic hazard assessment at the study area. The seismic intensity map of the area of study has been integrated with the geological structural lineament map to propose the expected high risk zones of seismic activities.

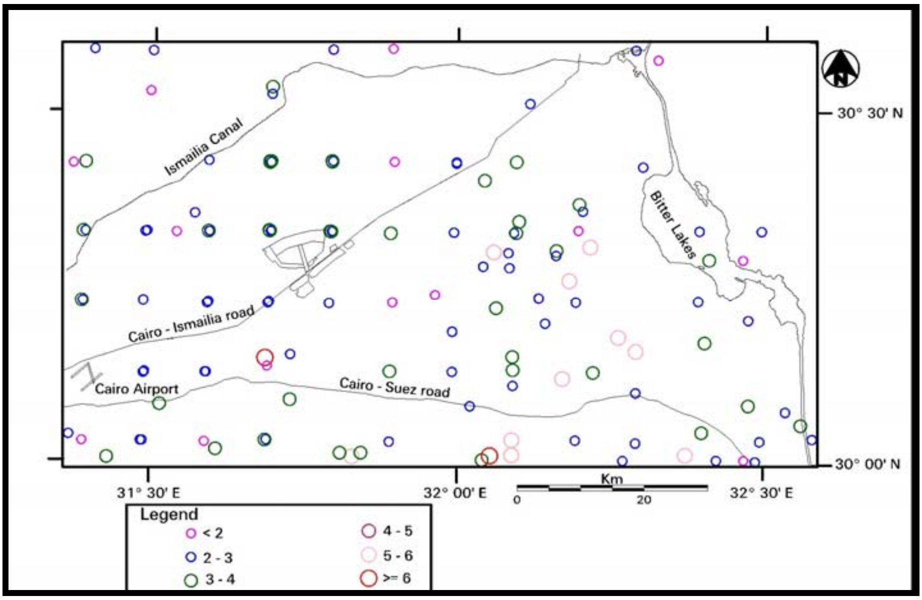


Figure 3.27: Epicenters distribution of earthquake events recording during (1900-2001) for Cairo – Ismailia road area (After Arnous, 2004)

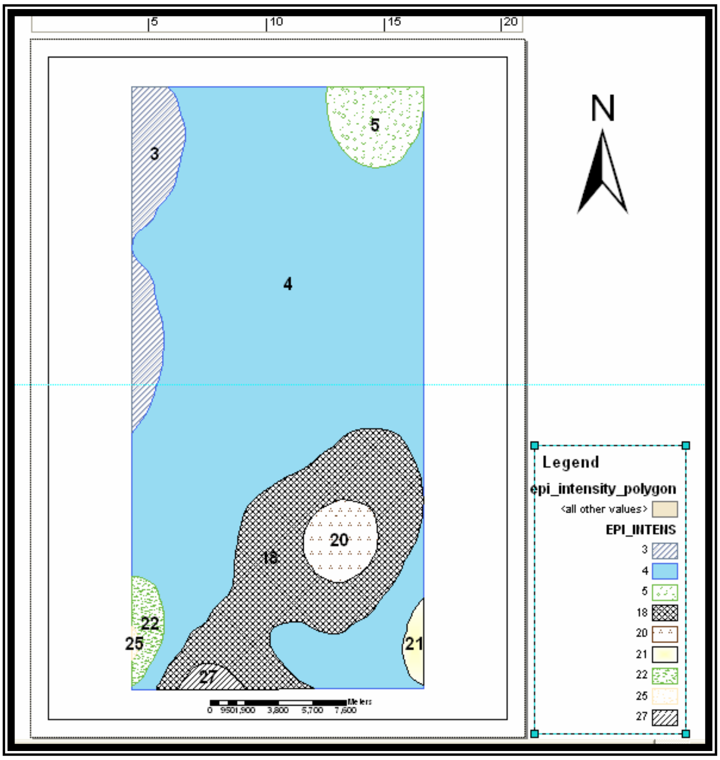


Figure 3.28: Epi-intensity distribution for case study area

❖ Rainfall Flooding (figure 3.29)

Flash flood is defined by WMO-UNESCO, 1974 glossary of hydrology as short flood duration with relatively high peak discharge. The magnitude of flash floods depends upon different factors, among of them, the morpho-metric parameters of drainage basins and the geological and meteorological conditions.

On the bases of previously recorded climatic conditions, the area may face strong cloudbursts in the next few years. The meteorological readings were statistically analyzed and it was found that as the interval of years increases the amount of rain increases. Therefore, the recurrence of cloudbursts in the study area is expected to take place every 100 years with a daily rainfall up to 46 mm. So, the few years between 2006 and 2015 may witness strong storms [Hamdan, A. H. (1999): Potential of flash flooding of the drainage basins of the east Cairo area and risk evaluation. Egypt J. Remote Sensing and Space Sci., v. 2, PP.15-33].

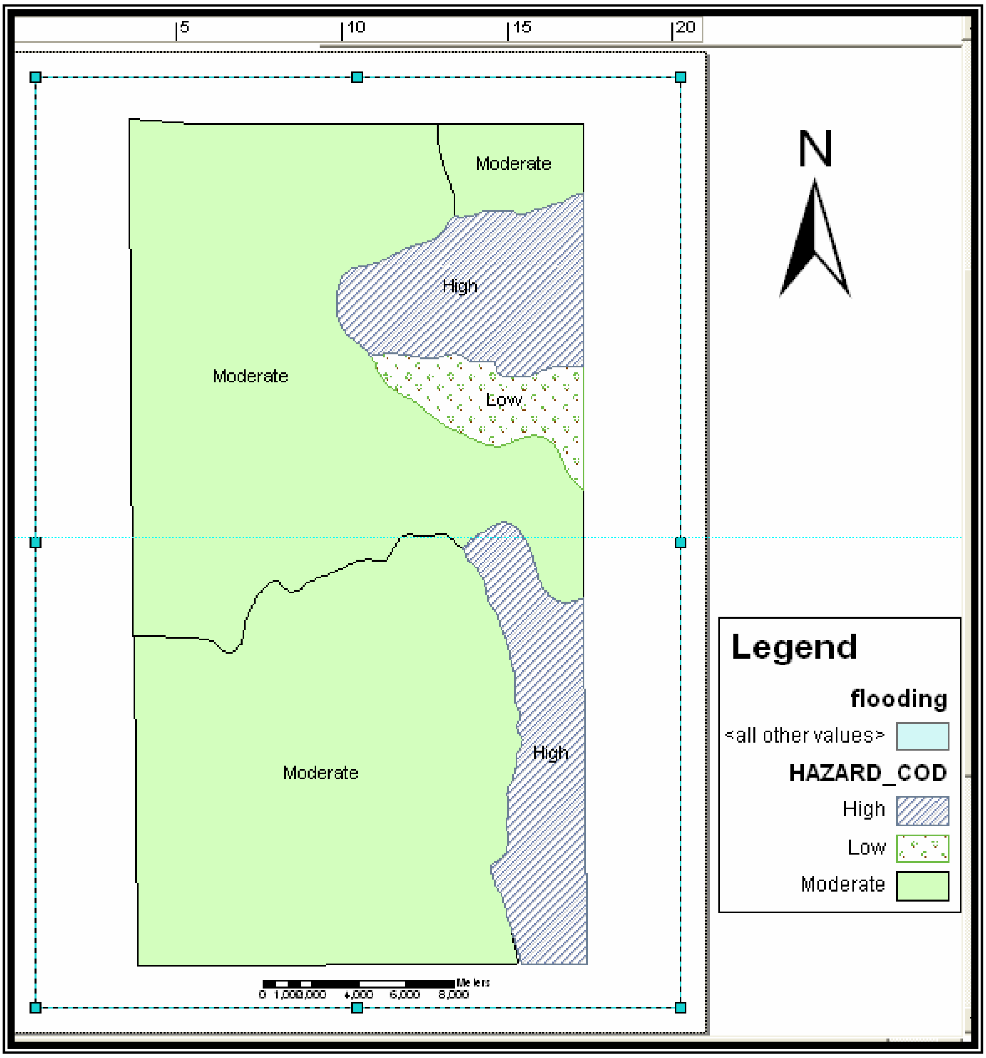


Figure 3.29: Flash flood hazard map of case study area

The flood vulnerable sites have been identified and relatively categorized, risk-wise, into three orders, namely: high, moderate and low (figure 3.29). This assortment is based on the integration of several parameters including slope gradient, basin shape, relative drainage density, overland flow, catchments area, frequency, average annual rainfall, soil infiltration capacity and rock type exposed. Based on the computed weight and mean values of the important morph-metric parameters, basins of the area under investigation could be classified into their relative amount of surface runoff such as flood hazard.

❖ **Soil degradation**

Soil degradation is defined as deterioration in the physical, chemical and biological properties of the soil due to environmental change that cause soil erosion, loss of fertility and salinization. The low elevation relief of the northern part and in Heliopolis depression helps soil degradation to occur.

The salinization, as one of main problems encountered in the area, is caused by high water table resulting from the water seepage from the nearest fresh or saline water bodies. Productive land in some cases becomes completely

unproductive within three months if the water table reaches levels of 60 to 75 cm from the surface [Arnous, M. O. (2004): Geo-environmental Assessment of Cairo-Ismailia Road Area, Egypt Using Remote Sensing and Geographic Information Systems (GIS), PhD. Thesis, Faculty of Science, Suez Canal Univ., Ismailia, Egypt].

❖ **Sand Dunes Encroachment (figure 3.30, figure 3.31, figure 3.32)**

Desertification in the study area is recognized by increase in mobile sand activities. Sand accumulations around and beneath such man-made constructions have resulted in an acute environmental problem in El Salam, El-Khanka and El Obour residential and industrial communities. Recently, at El-Asfer mountain, El-Khanka and El Obour dunes are fixed by covering their front face with limestone blocks to prevent their movement. In the previously mentioned urbanized locations, land sliding most probably occurs due to heavy weight constructions that were built over the sand dunes.

Figure 3.30: Residential buildings at El-Salam district been constructed over sand dunes (looking, NW) (After Arnous M. O.,2004)

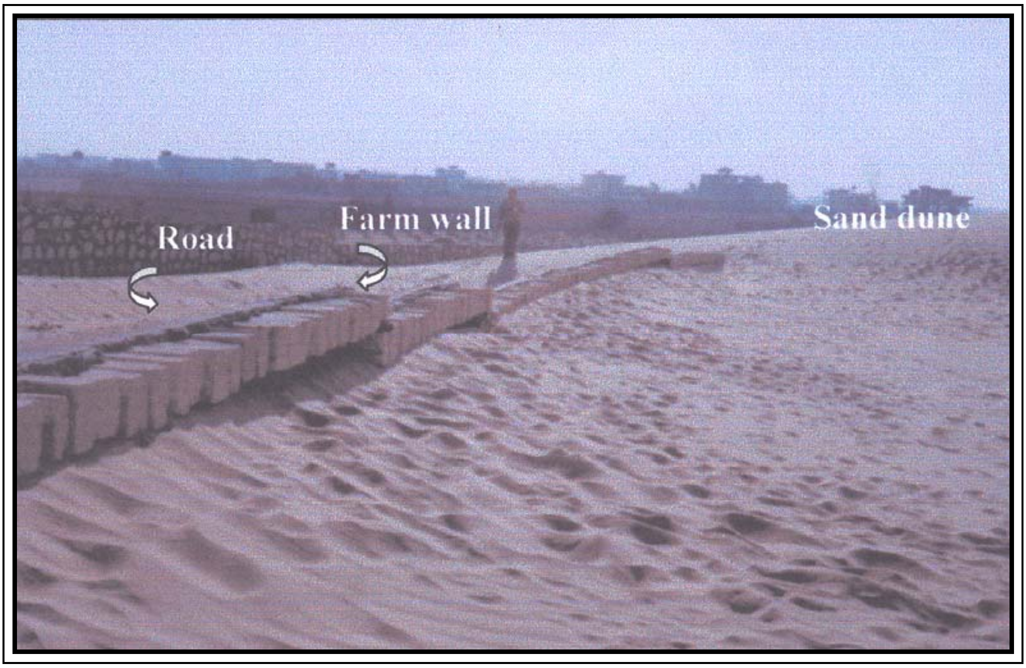


Figure 3.31: A road and farm locates in active sand movement at El-Khanka area, as example of bad site selection (looking, NW) (After Arnous M. O.,2004).

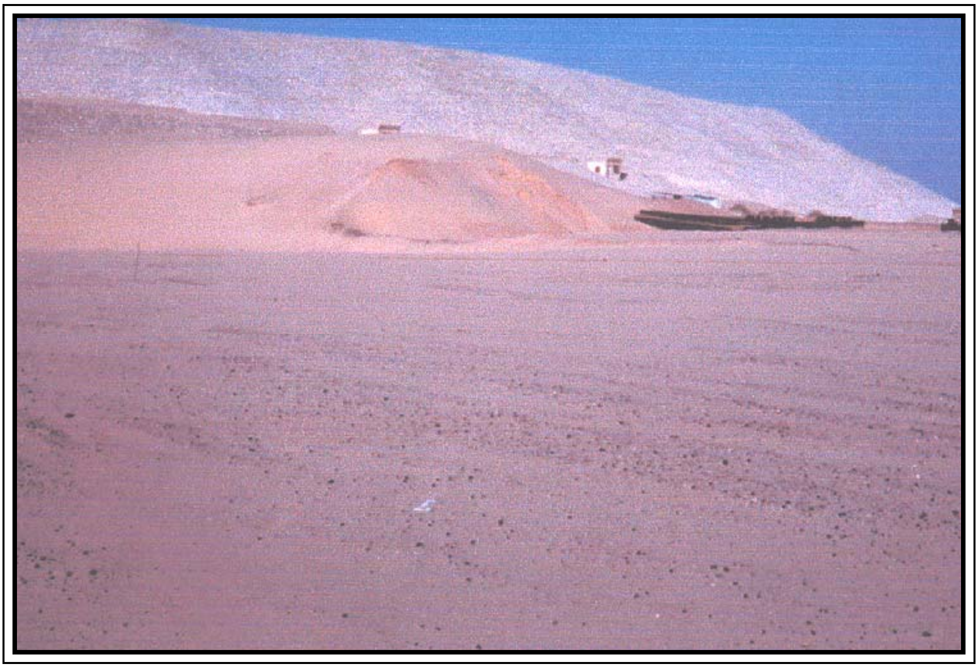


Figure 3.32: Fixing and covering the front side of El-Asfer mountain dunes with limestone blocks to prevent their movement (Looking, NW) (After Arnous M. O.,2004).

❖ **Hydration, swelling and differential land subsidence**

Clays such as bentonite, have the capacity to absorb water during the wetting discharge. If the source of wetting stops, the expansion of clays will loose part or most of the absorbed water, initiating an alteration swelling and shrinking sequence with periods of wetting and drying.

Hydration of carbonate salts within pore spaces and fissures in limestone that forms most of the plateau and ridges in NORTH EAST OF CAIRO dissolute these salts and develop cavities and caverns (figure 3.33).

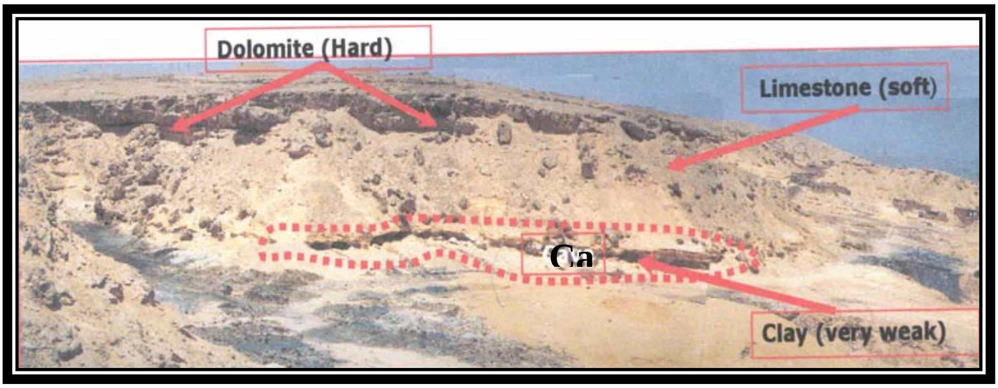


Figure 3.33: Kind of forming caves and rock failure (after Amasha A. A. I., 2009)

The terrain, where bentonite clays and/or limestone caverns exist under shallow depths of the surface, becomes one of the most serious problems over where building heavy constructions, (figure 3.34 and figure 3.35) exist (occur).

Figure 3.34: Swelling of shale (mudstone) formation due to saturation with infiltrated groundwater through jointed limestone (after Amasha A. A. I., 2009)

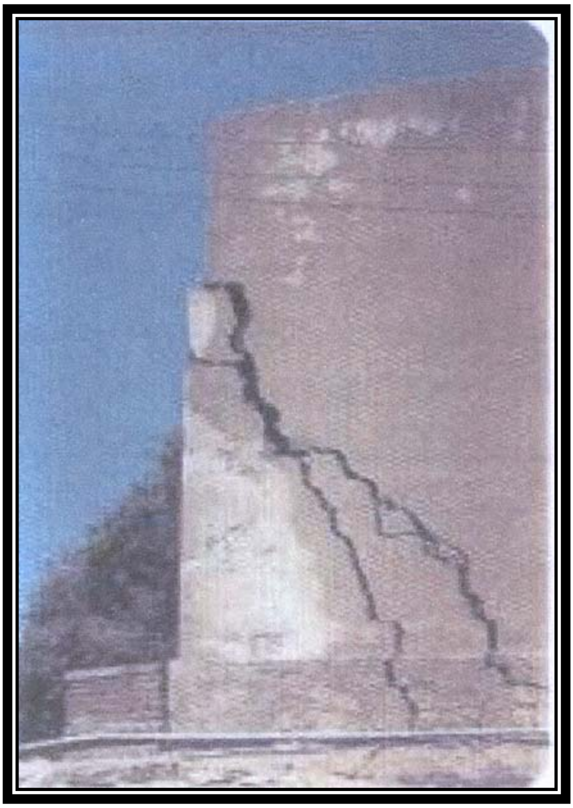
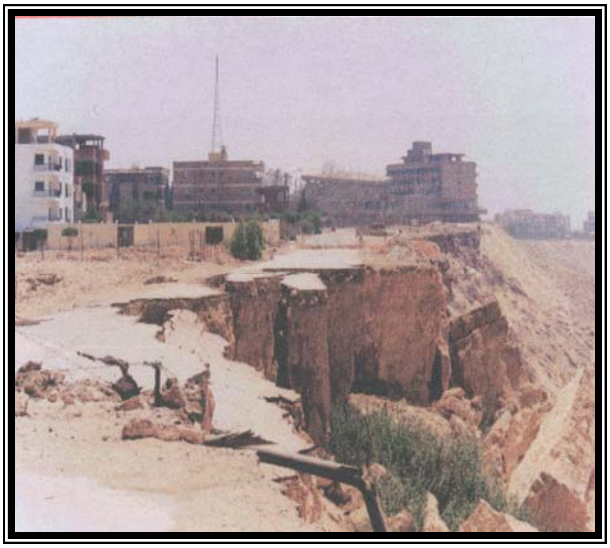


Figure 3.35: Damage in building due to slumping and differential subsidence (after Amasha A. A. I., 2009)

❖ **Rock fall (figure 3.36)**

A large number of houses in Medinet Nasr just to the west of the case study area were subject to destruction due to rock falls on the slopes of the Mokattam plateau. Many of these houses lie directly under loose rocks that may easily fall and cause damages and death.



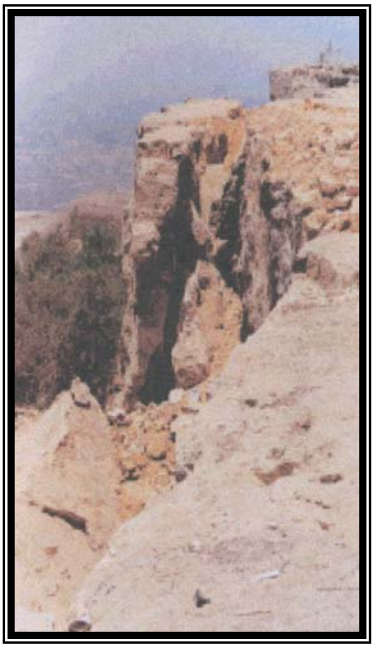


Figure 3.36: (Left) urban communities close to the steep cliffs of the southern Upper Plateau (Right) rock cracks and failure along the cliff (after Amasha A. A. I., 2009)

3.4.2.1 Hazards caused by human activities

❖ **Air Pollution (figure 3-37)**

The sources of air pollution of the study area are represented in the industrial activities at industrial cities. Also, seasonal air pollution often happens due to burning thousands of tons of crop ash and peel in the cultivated areas located to the north and west of the study area. These types of air pollution affect directly and indirectly the public health, soil quality and ground water quality.

❖ **Water pollution (figure 3.38 a & 3.38b)**

Any change of physical, chemical and biological properties of water, preventing its use in various applications, is considered water pollution. Water pollution in the study area is represented in the groundwater and the surface water as well.

As regard to groundwater pollution, caused by agricultural irrigation water with dissolved pesticides, cause dangerous health problems. The uncovered drains are receptacles for untreated and partially treated municipal and industrial waste water in addition to agricultural draining water. The problem exists here, due to the re-use of these drained waters for direct irrigation or after blending with the Ismailia fresh waters.

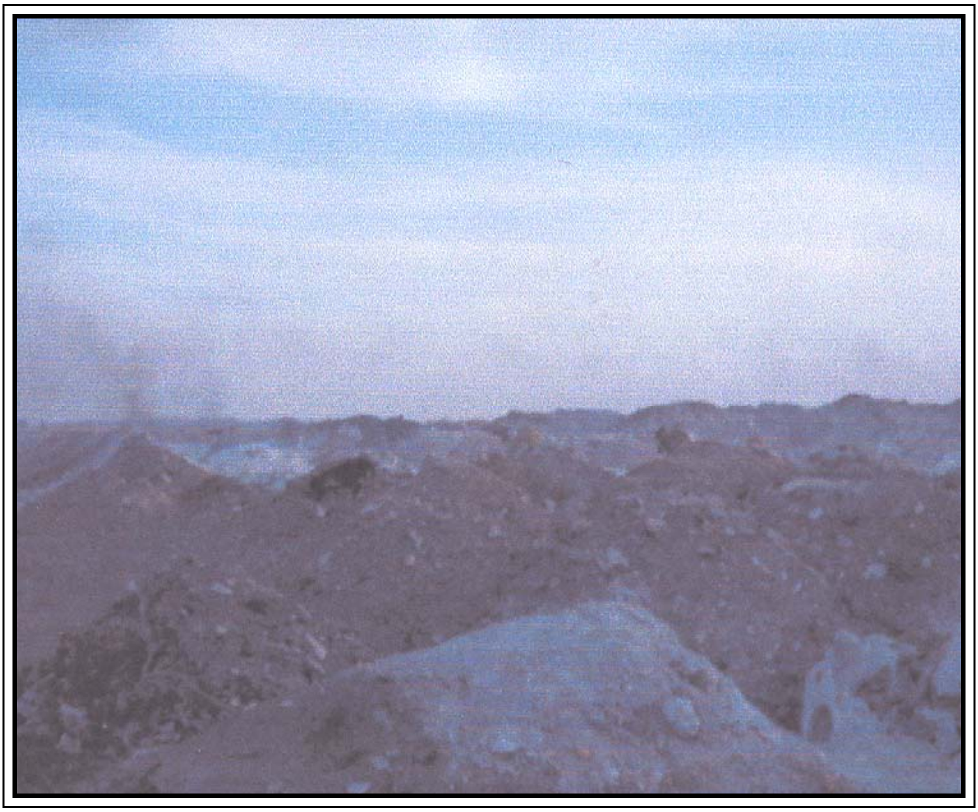


Figure 3.37: Air pollution results from industrial activities and burning of the industrial waste in the study area (Looking, NW) (After Arnous M. O.,2004).

Figure 3.38: Domestic wastes pollution in surface canal water of the study area, (A) solid wastes disposed and (B) municipal wastes in Ismailia canal (Looking NW) (After Arnous M. O.,2004).

❖ Soil pollution (figure 3.39)

There are several sources of soil pollution in the study area such as:

- The increased concentration of heavy metals in soils irrigated with sewage effluents.

- Soil salinization due to irrigation by highly saline water either from surface or groundwater under high rate of evaporation
- Huge tailings amounts of quarrying activities cause a serious soil pollution
- The industrial waste, either in solid or liquid form, cause contribution of various poisonous pollutants and heavy metals substances, to the fertile soil.

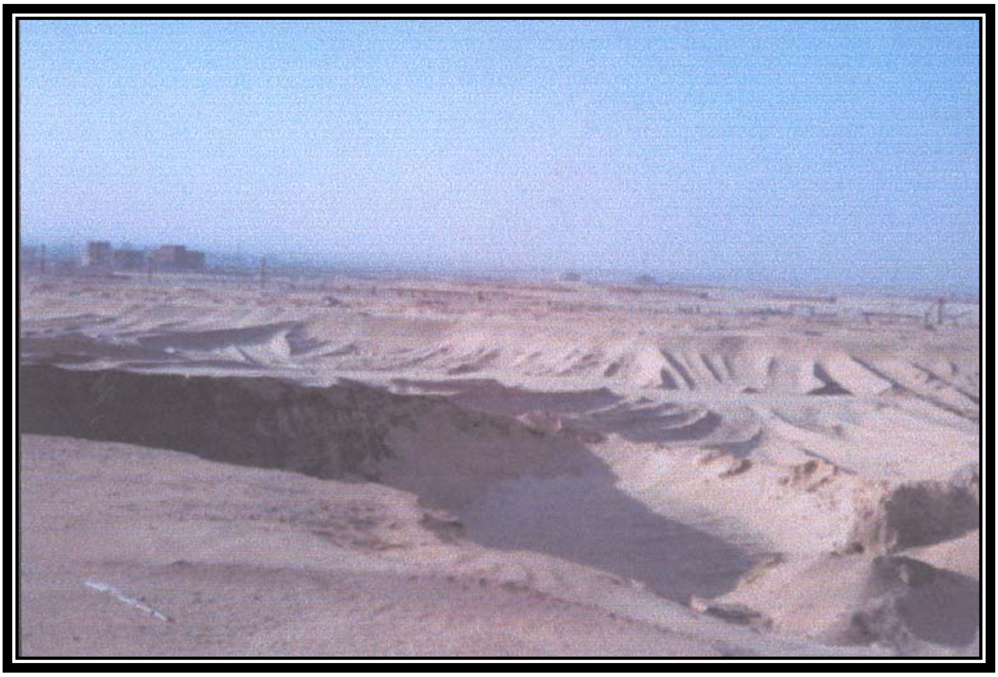


Figure 3.39: Active quarrying at Heliopolis depression that causes environmental impacts (Looking, SW) (After Arnous M. O.,2004).

3.5 Summary

Case study area is located to the east and north east of Heliopolis and Madinet Nasr districts. It extended from the north parts of El-Moqatam-

Ataqa plateau to the south, into the fresh water Ismailia Canal to the north. It is limited from the west by the urbanized districts of Cairo city, and from the east by the boundaries of Tenth of Ramadan town.

Case study area characteristics have been discussed in this chapter included physiography, climate, soil cover, surface geology and land uses in it. That is to present a model that might be followed up to provide a supportive urban planning to the decision makers with the best alternative solutions that minimize the unexpected problems and maximize the positive benefits socially, economically and environmentally. That is done through building a geo-database for NORTH EAST OF CAIRO.

Natural resources and environmental hazards in NORTH EAST OF CAIRO have been considered. Natural resources like water resources and Industrial minerals and rocks. Natural hazards such as earthquake activity, rainfall flash flooding, soil degradation, sand dune movement, land sinking and rock fall. Hazards caused by human activities such as air pollution, water pollution and soil pollution.

CHAPTER FOUR

URBAN SUITABILITY ANALYSIS METHODOLOGY

CHAPTER FOUR

URBAN SUITABILITY ANALYSIS METHODOLOGY

4.1 Introductory statement

The analysis we use in this study is a process for determining a planning area's supply of land that is suitable for Urban-type development. It includes consideration of a number of factors, natural system constraints, compatibility with existing land uses and development patterns, existing land use policies, and the availability of community facilities. As the influencing parameters on site selection for urban development are essential for proper analysis.

To overcome difficulties or discrepancies of qualitative data irregularities met with, each parameter has to be relatively ranked depending on either the expert knowledge with direct observation of the terrain or by comparison with key factors and information in similar well-known case studies in the world.

To calculate the impact percentage of each parameter, the statistical analysis procedure proposed by Harman [Harman, H.H.; (1960): Modern factor analysis, Chicago Press], Comry [Cormey, A.L. (1973): A first course in factor analysis. Academic Press; New York; 316 pp] and Press etal [Press, W.H., B.P. Flannery, S.A. Teukolsky and W.T. Vetterling; (1986): Numerical recipes, The Art of Scientific Computing. Cambridge Univ. Press ; 817] have to be adopted [El-Ghawaby, M. (2006): A Standard Procedure to Weigh Controlling Factors On Land Use Planning

Of Arid Regions through Spatial Modeling; 2nd International Conference on Water Resources and Arid Environments "ICWRAE"].

Two elements are essential in estimating parameter weights; they are:

1- The relative impact of various parameters on the target activity planned to achieve.

2- The rank of every influencing parameter in a unified normalized scheme.

By algebraic multiplication and addition in parameter impact and parameter rank, a parameter weighted absolute value is obtained.

4.2 Methodology

To make the work of the urban development strategy and programs, the study followed the next methodologies:-

4.2.1 Land Suitability Analysis (LSA)

Without computer application, a planner could generate a series of maps on transparent media and overlay the maps so that each one fits over or under each other and all the shading and labeling on each map is visible.

A planner may be able to make an effective presentation of land suitability using the paper map overlays. However, this method has several drawbacks [Department of Environment and Natural Resources Division of Coastal Management (2005): Land Suitability Analysis user guide; North Carolina Center for Geographic Information and Analysis, NC-USA]:

1. The method has practical limits on the number of layers that the eye can interpret at once;

2. All data on the maps are discrete, where some of the variables (e.g., distance from a water line) are continuous;

3. The relative importance of each layer is not explicit or quantifiable; and

4. The results cannot be easily summarized or applied to other planning tasks.

The GIS capabilities for spatial analysis overcome the drawbacks of the paper map overlay approach. It helps to understand and better discover spatial relationships in our data, from viewing and querying the data to help the user determine what locations are most/least suitable for any type of development. In this way, the results of GIS analysis can provide support for decision-making.

The criteria for urban development are defined based on the environmental baseline information as followed:

Constraints	**Potentials**
Water bodies	Elevation
Sand dunes	Slope
Road & Railways	Proximity to roads
Cultivated lands	Existing urban centers
Ports and Airports	Proximity to ports
Earthquakes epicenters	Industrial zones
High voltage network	Proximity to electric network
Flood risk zones	Proximity to water pipes
Reactors	Proximity to sewer pipes

The most applicable procedure for multi-criteria evaluation is the weighted linear combination [Voogd, H. (1983): Muticriteria Evaluation for urban and regional planning. Planologisch, studiecentrum TNO, Delft, The Netherlands]. In a weighted linear combination, factors are combined by applying a weight to each, followed by a summation of the results to yield a map of suitability [Eastman J.R., W. Jin, P.A.K. Kyem and J. Toledano (1995): Raster procedures for multi-criteria/multi-objective decisions, Photogramm. Eng. Rem. S. 61 (5) (1995), pp. 539–547. View Record in Scopus | Cited By in Scopus (72)]. An underlying assumption, in this study, has been that agricultural land must be preserved; thus, agricultural areas were excluded from the analysis. This step was accomplished by creating a Boolean map with constraints areas coded zero and potentials areas coded one. In cases where Boolean constraints apply, the previous procedure is modified by multiplying the suitability calculated from the factors by the product of the constraints.

Once the factor maps were developed and relative weights were computed, each factor map (each raster cell within each map) was multiplied by its weight. The site suitability map was produced as the sum of these weighted factor maps. Because the factor weights sum to unity, the range of values in the urban suitability map matches those in the standardized input factor maps. The constraints Boolean map is generated for the urban suitability; consequently, the produced suitability map had to be multiplied by the constraint map to eliminate constraints areas.

4.2.2 GIS spatial analyst

Spatial data analysis is the process of looking at the characteristic features of every site, from a number of layers to solve a problem. The Spatial Analyst Module imposes a square grid networks, because of their ease of computer implementation and computational efficiency [Collins, S.H. and G.C. Moons (1981): Algorithms for dense digital terrain models Photogramm. And Remote Sensing; 47, pp.71-76].

Spatial Analyst cannot solve problems on its own. It can tell, for instance, how far apart things are, but to get an answer like "This is the best location" one have to ask the right kinds of questions. To do this, we have to conceptualize spatial problems, data, and operations, break down the problem into parts to solve it and create a model to find good locations.

Cell-based raster maps are created, queried and analyzed to derive new information from existing data; query information across multiple data layers; fully integrate cell-based raster data with traditional vector data sources; and create sophisticated spatial models to rate areas according to several factors with varying weights and values, and derive new information from existing data to determine land suitability.

The major output of the LSA is a land suitability map that shows the relative suitability of land in the study area for urban-type development, (figure 4-1).

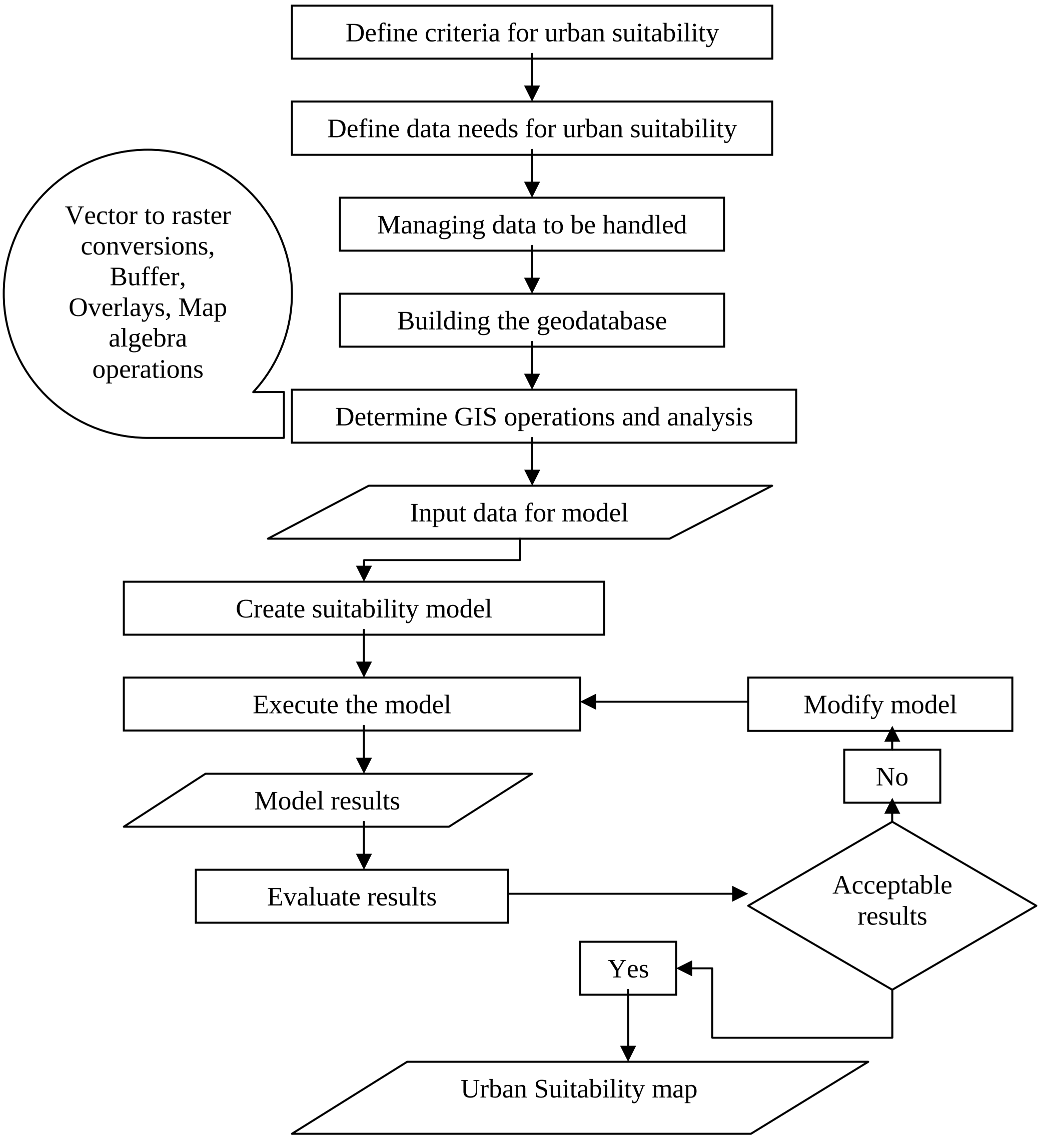


Figure 4.1: The steps necessary for performing a land suitability analysis

4.3 Land Suitability Categories for Factor selections

Only one item of information is available for each location within a single layer. So, multiple items of any information require multiple layers.

The layers of the study area are classified into six categories, each category has some factors in it, and each factor will be translated into a layer or some integrated layers as follows:

1- Infrastructure determinants

The accepted land for urban development from the infrastructural point of view contains factors like:

a. Primary roads and high ways
b. Secondary roads and streets
c. Airports
d. High voltage network
e. Electric network
f. Water pipes network
g. Sewer pipes network
h. Railways
i. Telephone network

2- Socio-Economic determinants

The accepted land for urban development from the socio-economical point of view contains factors like:

a. Agricultural area
b. Industrial zones
c. Mining resources (Quarries)

3- Land characteristics determinants

The accepted land for urban development from the land characteristics point of view contains factors like:

a. Drainage system
b. Relief (Slope)
c. Lithology
d. Subsurface
e. Aquifers
f. Geomorphology
g. Basins
h. Lineaments

4- Urban determinants

The accepted land for urban development from the urban point of view contains factors like:

a. Existing urban centers
b. Soil types
c. Rockuse

5- High sensitive areas determinants

The accepted land for urban development from the high sensitive areas point of view contains factors like:

a. Surface water sources

b. Ground water sources

c. Radiation (from Reactors)

d. Depth of water table

e. Wells

f. Mountains

6- Environmental hazards determinants

The accepted land for urban development from the environmental hazards point of view contains factors like:

a. Earth quakes

b. Flood risk zones

c. Rain falls

Table 4.1 Criteria table for factor selection and standardization

	Layer Name	Not Suitable	Least Suitable	Moderately Suitable	High Suitable	Most Suitable
	Suitability score	**0**	**1**	**2**	**3**	**4**
Infrastructure	**Primary Roads**	0-50m	>7.5 km	5 - 7.5 km	2.5 – 5 km	50-2500m
	Streets	--------	>5000m	------	1.5 – 5 km	0-1.5 km
	Airport	0-100m	>7 km	4 -7 km	2 – 4 km	100-2000m
	High Voltage network	0-100m	100-200m	200-300m	300-400m	>400m
	Electric Network	---------	>3 km	2 -3 km	1 – 2 km	0-1 km
	Water Pipes	---------	>3km	2-3km	1-2km	0-1km
	Sewer Pipes	---------	>3km	2-3km	1-2km	0-1km
	Railways	0-50m	>7500m	5000-7500m	2500-5000m	50-2500m
	Telephone Network	---------	>3000m	2000-3000m	1000-2000m	0-1000m
Economic	**Agricultural Area**	Inside	>20km	10-20km	5-10km	0-5km
	Industrial Zones		>40km	---------	0-40km	Inside
	Mining Resources (Quarries)	---------	>5km	4-5km	2-4km	0-2km
Urban	**Existing urban areas**	----------	>5km	2.5-5km	1-2.5km	Inside + 0-1km
	Soil Types	Aeolian Soils	Nile delta flood plain	Alluvial soils of the old	Alluvial fan soils	Rocky terrain
	Rock use	Sand dunes	M-Miocene MN-Miocene Basalt	Quaternary oligocene	U eocene	-------
High Sensitive Areas	**Wells**	---------	>=3 km	----------	1-3 km	0 – 1 km
	Surface Water	Inside+ 100m	100 – 1000 m	>5 km	3000-5000m	1 – 3 km
	Ground Water up to 100m from surface	---------	>1000mm/l	1500-2000mm/l	1000-1500mm/l	<1000mm/l
	Depth of Water Table	0-2m	2-5m	5-10m	10-15m	>15m
	Radiation (Reactors)	Inside + 1 km	1 – 5 km	5 – 10 km	10 – 30 km	> 30 km
Land Characteristics	**Relief (Slope)**	>13	10-13	7-10	3-7	0-3
	Lithology	Sand Dunes	Nile flood Basalt	Quaternary MiddleMiocene	Upper Eocene	Oligocene
	Physiographic Drains	--------------	0-1km	>1km	---------------	------------
	Basins	---------	High	----------	Moderate	Low
	Geomorphology	Sand dunes	Depressions	Structural ridges	Um Gidam gravelly	Nile flood plain
	Lineaments	0 – 100 m	100 – 500 m	500 - 3000 m	3 – 5 km	>5 km
Env. Hazards	**Earth Quakes (Seismic epi centers)**	---------	0-50m	50 – 100 m	100 – 150 m	>150 m
	Flooding Risk Zones		High	-------	Moderate	Low

The distinction between proper and incomplete land-use plans often depends on how well the planner can define all the influencing parameters on the target activity to develop in the investigated terrain. If some influencing factors are neglected, or if the analyst is not aware of the right ranking of every influencing factor or not aware of the suitable weighting of each factor, the final land-use plan will face many unpredictable obstacles and unexpected problems during implementation.

Two modeling approaches; statistical and experience-driven ones, were used to combine input influential parameter layers, for producing integrated potential map of certain land use capability. In the first, rating of the influential parameters is mostly based on direct measurements or statistically derived values [El-Ghawaby, M. (2006): A Standard Procedure to Weigh Controlling Factors On Land Use Planning Of Arid Regions through Spatial Modeling; 2nd International Conference on Water Resources and Arid Environments "ICWRAE"].

4.4 Operations used in the analysis

4.4.1 Geo-referencing

Data we had input cannot be used directly, so its criteria have to be changed to fit within the system. The geographical data could be on different projections so we have to rectify the entire maps on one base.

4.4.2 Vector to Raster Conversion:

Vector layers are converted to raster to be used in the analysis. Some layers are converted within the model itself. Others have already been converted outside of the model.

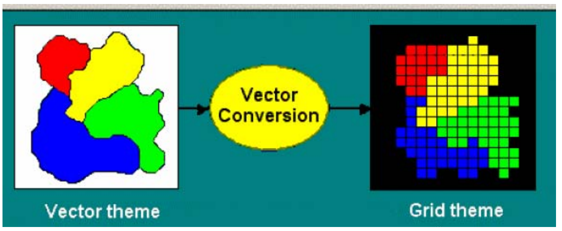


Figure 4.2: Vector to Raster conversion

4.4.3 Buffering

Buffers are zones of specified distance from a given feature and are useful in proximity.

Buffering was done on many layers to determine what values should be assigned inside/outside the extent of the feature and its buffer.

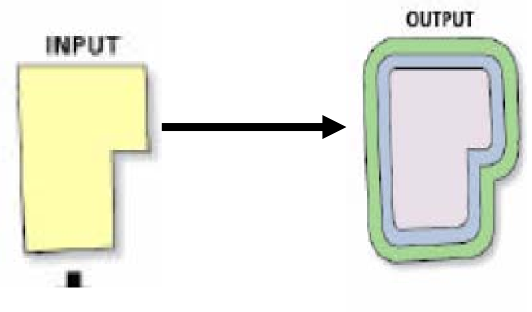


Figure 4.3: Buffering analysis

4.4.4 Ranking using reclassification:

The thematic coverage of the terrain under investigation represents map layers of variable parameters. Each map shows polygons with absolute or relative values, based on the adopted modeling approach. These polygonal areas might have scores according to their urban suitability degree to realize the target activity. Rank values of every parameter is selected according to numerical measurements or quantitative evaluation to make sure that unsuitable areas remain zero, while the suitable areas are rated according to the degree of suitability.

The data are rated according to their respective suitability for urban development as 1, 2, 3 or 4, with 4 being assigned to the conditions most suitable for urban development. This rating scheme results is a reasonable comparison of less and more suitable areas.

The defined criteria for the Land Suitability Analysis (LSA) according to available datasets are most suitable, suitable, moderately suitable, and least suitable. Values are assigned 4, 3, 2 and 1 respectively and zero is assigned for areas not suitable at all in urban development.

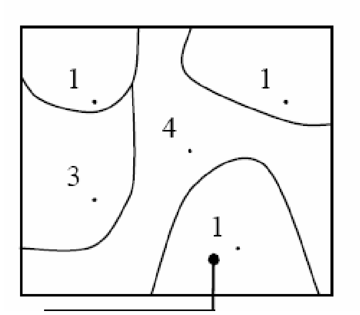


Figure 4.4: Ranking (Reclassification)

They were identified like this (table 4.1):

- ❖ Within 50 to 2500 meter to Primary Roads have highest suitability; within 2500 to 5000 meter have suitable score; within 5000 to 7500 meter have moderately suitable; areas greater than 7500 meter outside of primary roads have least suitability
- ❖ Within 1km of Existing urban centers have highest suitability; areas within 1km to 2.5km have suitable score; areas within

- An area that is close to existing infrastructure, water pipes and sewer pipes networks up to 1km have highest suitability; areas within 1km to 2km of water pipes and sewer pipes have suitable score; areas within 2km to 3km of water pipes have moderate suitability; areas further than 3km away from water pipes and sewer pipes have least suitability
- Within flood risk zones, have least urban-development suitability
- Within 100m of an Airport is not suitable for urban development, areas within 100m to 2km of airport have highest suitability score; areas within 2km to 4km of airport have moderate suitability; areas within 4km to 7km of airport have low suitability; areas further than 7km away from airport have least suitability.
- An area that is inside earth quake epicenters has a least suitability. These areas receive a score of 1.
- The areas not suitable for urban development (surface water, Agricultural areas, Sand dunes...) are treated somewhat differently. They are given scores of 0.

According to these criteria and many others that are listed in Table 4-1, values for layers are quantitatively scored according to suitability for urban-type development.

Each layer is reclassified into polygons that are ranked from 1 to 4

4.4.5 Weighting using map algebra – multiplication by a constant:

In addition to the ranking (reclassification), the specialist assigns variable weights to each layer to represent greater or lesser importance in urban development, according to how important they are to the overall analysis. In the criteria table developed (Table 4.1), planner may weight a layer as 1, 2 or 3, with 3 being very important (Table 4.2).

Each layer gets a weight from 1 to 3 depending on its importance in urban development.

4.4.6 Assigning relative weights

Once rankings and weightings is agreed upon, the analysis requires that the specialist quantify the ranked layers from an ordinal scale (ranked 1 thru 3) to a percentage of the total (percent weight) to assign relative weights. The relative weight for a layer is equal to 100 (percent) divided by the product of the sum of all weights times the weight for that layer. In other words, it is the whole pie divided by the number of pieces (yielding the size of a piece), times the number of pieces for that layer. Taking into considerations, these numbers change for each county depending on the number of layers that apply and the weight of each layer in it.

Our criteria are now defined in the form of a table (table 4.2) and if you add or delete layers or if you change assigned weights (1, 2, or 3) these data have to be updated into the analysis.

Layers may be added and weights to the layers may be changed as the specialist see fit. The values entered for classes for the various themes and overlays included the weighted overlays.

Total number of weights in this analysis = W = 46

Relative Weight of a layer = (100/W) * weight of this layer

In our analysis RW = (100/46) * weight of this layer

4.4.7 Map Algebra – Addition of Layers:

After multiplying all layers by their respective weights, they will be added together to get a suitability ranking. Each grid cell represents a location and has a value in every map layer. A specific cell from various layers stack on top of each other, describing attributes of such location. The value assigned to this specified cell that was simply obtained by algebraic addition of various influencing parameters scores of superimposing layers, points to its potential for urban land use activity.

The integrated addition map

Total number of weights in this analysis = W = 46

When all layers are added;

The minimum number in the integrated addition map can not be less than = W * least ranking score = 46*1 = 46

The maximum number in the integrated addition map can not be more than = W * highest ranking score = 46*4 = 256

4.4.8 Map Algebra – Multiplication of Layers:

To do this analysis, the Boolean algebra was used. A Boolean choice can only assume one of two values (true/false and yes/no), therefore depending on the acceptance or rejection of criteria, the cell value in the raster data layer should consist of either (0) or (1), which corresponds to 1 = accepted and 0 = rejected.

Layers that have features to be scored not suitable are multiplied together then the layers are classified with 0's and 1's. The resulting layer shows all areas not suitable for urban development as shown in the figure below.

1	1	1	1	1
1	0	0	1	1
1	0	0	1	1
1	0	0	1	1
1	1	1	1	1
1	1	1	1	1

X

1	1	0	0	1
1	1	0	0	1
1	1	1	0	1
1	1	1	1	1
1	0	0	0	1
1	0	0	1	1

=

1	1	0	0	1
1	0	0	0	1
1	0	0	0	1
1	0	0	1	1
1	0	0	0	1
1	0	0	1	1

Figure 4.5: Multiplication of layers using Map algebra to get all areas not suitable for urban development to be excluded.

<u>The integrated multiplication map</u>

Multiplying all layers to get an integrated multiplication map with scores 1's and 0's

(Excluded all constraints areas that have score = 0 from the analysis)

<u>The final integrated map</u>

The final integration map = the integrated addition map * the integrated multiplication map

(Multiplication process is used here to get out all the zero pixels from the integrated addition map)

The final reclassified urban suitability map

The final integrated map will be reclassified into four classes of suitability; most suitable, moderately suitable, less suitable and not suitable

Table 4.2: Establishment of factor weights

	Layer Name	Not Suitable	Least Suitable	Moderately Suitable	High Suitable	Most Suitable	Assigned Weight	Percent Weight %
		0	**1**	**2**	**3**	**4**		
Infrastructure	**Primary Roads**	0-50m	>7.5 km	5 – 7.5 km	2.5 – 5 km	50-2500m	3	6.52
	Secondary roads & Streets	--------	>5000m	------	1.5 – 5 km	0-1.5 km	2	4.35
	Airport	0-100m	>7 km	4 -7 km	2 – 4 km	100-2000m	2	4.35
	High Voltage network	0-100m	100-200m	200-300m	300-400m	>400m	1	2.17
	Electric Network	---------	>3 km	2 -3 km	1 – 2 km	0-1 km	2	4.35
	Water Pipes	---------	>3km	2-3km	1-2km	0-1km	1	2.17
	Sewer Pipes	---------	>3km	2-3km	1-2km	0-1km	1	2.17
	Railways	0-50m	>7500m	5000-7500m	2500-5000m	50-2500m	1	2.17
	Telephone Network	---------	>3000m	2000-3000m	1000-2000m	0-1000m	1	2.17
Economic	**Agricultural Area**	Inside	>20km	10-20km	5-10km	0-5km	2	4.35
	Industrial Zones		>40km	---------	0-40km	Inside	2	4.35
	Mining Resources (Quarries)	---------	>5km	4-5km	2-4km	0-2km	1	2.17
Urban	**Existing urban areas**	----------	>5km	2.5-5km	1-2.5km	Inside + 0-1km	3	6.52
	Soil Types	Aeolian Soils	Nile delta flood plain	Alluvial soils of the old	Alluvial fan soils	Rocky terrain	2	4.35
	Rock use	Sand dunes	M-Miocene MNMiocene Basalt	Quaternary oligocene	U eocene	-------	1	2.17
[illegible]	**Wells**	---------	>=3 km	----------	1-3 km	0 – 1 km	1	2.17
	Surface Water	Inside+ 100m	100 – 1000 m	>5 km	3000-5000m	1 – 3 km	2	4.35
	Ground Water up to 100m from surface	---------	>1000mm/l	1500-2000mm/l	1000-1500mm/l	<1000mm/l	1	2.17
	Depth of Water Table	0-2m	2-5m	5-10m	10-15m	>15m	1	2.17
	Radiation (Reactors)	Inside + 1 km	1 – 5 km	5 – 10 km	10 – 30 km	> 30 km	2	4.35
Land characteristics	**Relief (Slope)**	>13	10-13	7-10	3-7	0-3	2	4.35
	Lithology	Sand Dunes	Nile flood Basalt	Quaternary MiddleMiocene	Upper Eocene	Oligocene	1	2.17
	Physiographic Drains	--------------	0-1km	>1km	---------------	------------	2	4.35
	Basins	---------	High	----------	Moderate	Low	1	2.17
	Geomorphology	Sand dunes	Depressions	Structural ridges	Um Gidam gravelly	Nile flood plain	2	4.35
	Lineaments	0 – 100 m	100 – 500 m	500 - 3000 m	3 – 5 km	>5 km	1	2.17
Envi. Hazar.	**Earth Quakes (Seismic epi centers)**	---------	0-50m	50 – 100 m	100 – 150 m	>150 m	3	6.52
	Flooding Risk Zones		High	-------	Moderate	Low	2	4.35
Total							**46**	**100%**

4.5 Summary

Before applying GIS, the data has to be changed to a format that the GIS-software can handle. Most probably the spatial data are provided either in imagery or mapable coverage hard copies with tabulated or descriptive attributes. As mentioned previously, GIS can handle two formats; the Vector and the Raster.

In order to design a GIS database useful for urban development purposes, one must define the essential requirements for development and management. These requirements involve, physical, environmental, economical and social parameters that control or influence urban development in the target area.

Describing factors associated with urban land use, and understanding their interrelationships and roles, is a basic and necessary requirement to forecast urban land use suitability. Criteria of land suitability for urban development were divided into two types: factors and constraints. A factor is a criterion that enhances or detracts from the suitability of the specific alternative under consideration. A constraint is a land type or use that restricts or makes it impossible to urban development.

To assess land use planning for urban development of an area, the controlling factors should be quantified through spatial data analysis. In GIS, the different types of spatial data are stored and organized by layers. These diverse, yet complementary, spatial data sets represent the actual world model: from geological layers to demographic layers, passing by satellite imagery layers, road layers, etc... [Malheiro B. and Oliveira E. (1995): An Intelligent Distributed System for Environmental Management, Kluwer Academic Publishers].

CHAPTER FIVE

GEO-DATABASE BUILDING OF NORTH EAST OF CAIRO

CHAPTER FIVE

GEO-DATABASE BUILDING OF NORTH EAST OF CAIRO

5.1 Introductory statement

A geodatabase (short for geographic database) is a physical store of geographic information (spatial, attribute, metadata, and relationships) inside a Relational DataBase Management System (RDBMS). RDBMS is a type of database in which the data can be spread across several tables that are related together. Data in related tables is associated by shared attributes. Any data element can be found in the database through the name of the table, the attribute (column) name, and the attribute values that uniquely identify each row. In contrast to other database structures, a RDBMS requires few assumptions about how data is related or how it will be extracted from the database. As a result, the data can be arranged in different combinations.

A geo-database is an object-oriented geographic database that provides services for managing geographic data. In the present study, the geo-database includes several layers. The data catalog is the detailed index of the study case layers and their attributes, their documentations and storing. The spatial data might be in a readable map format.

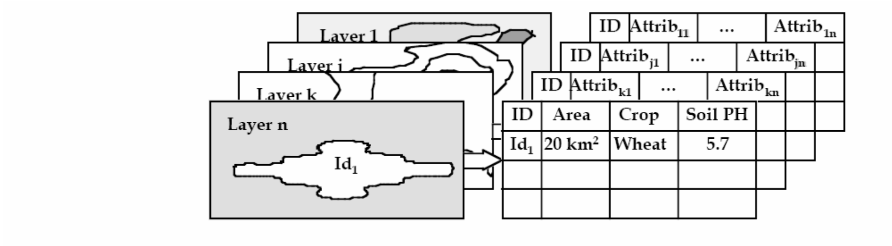


Figure 5.1:The data catalog

5.2 Data sources for NORTH EAST OF CAIRO

It is to get the data which include acquiring existing data from both internal and external sources, evaluating and checking the source materials for completeness and quality, and/or creating new data by planning and conducting aerial or field surveys.

Current GIS schemes attempt to rely on existing, rather than new data due to the high cost of original data collection. However, existing data (maps and other forms) were usually created for some other purposes and thus have constraints for use in GIS. This situates much greater importance on evaluating and checking the suitability of source data for use in a GIS.

Data on the case study area are purchased from ESA, CAPMAS, EEAA, Remote Sensing and Geological Authorities, Ministry of Agriculture and other private consultants and projects. Most of the spatial data are extracted from Arnous Ph. D. Thesis [Arnous, M. O. (2004): "Geo-environmental Assessment of Cairo-Ismailia Road Area, Egypt Using Remote Sensing and Geographic Information Systems (GIS)", PhD. Thesis, Faculty of Science, Suez Canal Univ., Ismailia, Egypt].

5.3 Data management capabilities

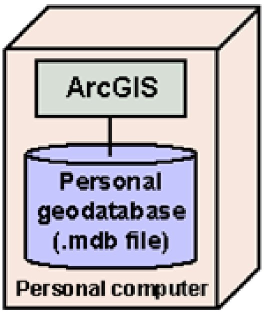


Figure 5.2 :Personal Geodatabase

Establishing one uniform geo-database involves entering all attribute and feature data into a common database with an established workable file structure. Once the database is designed, it then becomes important to maintain data accuracy and currency. If changes are made within the borders of the data layers, these changes must be defined and updates made to keep the integrity of the database.

The GIS enhances data management capabilities by providing tools for organizing, reclassifying, combining and overlaying the collected data, through the following steps:

a) Data Input:

Converting data to digital form is the physical process of digitizing or scanning to produce digital files in the required format.
Data from national, international and local sources were combined with field surveys and experts maps to form the first GIS digital database of the area. The main geo-database includes both graphical and attributes databases. The graphical database contains the spatial features such as

road network, area boundaries, and various facilities, while the attribute database contains data about the textural and numeric characteristics of the corresponding features, and graphics of the features.

The GIS can handle only two formats; the vector and the raster. The first can be getting through a process called "digitization", while the second is obtained from the satellite images directly or by scanning the images and maps.

b) Geo-referencing the Spatial Data:

The spatial data can't be used directly, due to their variation in scale and projection. Therefore, the maps criteria have to be corrected and unified in scale and projection to facilitate their geo-referencing by geographic coordinates on one base map.

The used GIS data is projected to UTM projection system, Zone 36, spheroid and datum WGS 84 and unit's meters.

Projected Coordinate System: WGS_1984_UTM_Zone_36N

Projection: Transverse_Mercator

Linear Unit: Meter

Geographic Coordinate System: GCS_WGS_1984

Datum: D_WGS_1984

Prime Meridian: Greenwich

Angular Unit: Degree

c) Data encoding:

This is a raster image compression technique. If a raster contains groups of cells with identical values, run length encoding can compress storage.

The longer and more frequent the consecutive values are, the greater the compression that will be achieved. This technique is particularly useful for encoding monochrome images or binary images [Arnous, M. O. (2004): "Geo-environmental Assessment of Cairo-Ismailia Road Area, Egypt Using Remote Sensing and Geographic Information Systems (GIS)", PhD. Thesis, Faculty of Science, Suez Canal Univ., Ismailia, Egypt].

The earth surface features, whether natural such as drainage basins, or artificial such as road network are generally expressed as polygons, linear or points. All of them might be subdivided into small polygonal units by tracing their boundaries, if they are originally polygons, or being presented by buffer zoning in case they are lines or points. Such polygonal units are tailored to fit the earth surface features.

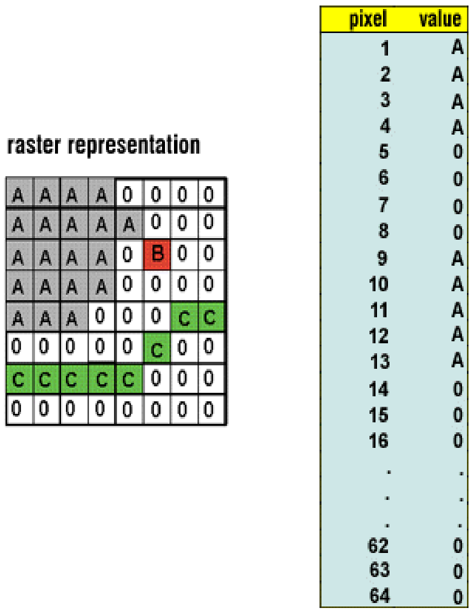


Figure 5.3: Exhaustive representation

d) Data transformation:

Data transformation is the process of converting data from one coordinate system to another through translation, projection, rotation and scaling.

This process embraces removal of errors, updating or matching with other data sets. Transformations can occur both on spatial and non-spatial data, either separately or in combination. They include scale changing, data fitting to new projections, logical retrieve of data, calculation of areas, perimeters and volumes, as well as other domain specific transformations [Burrough, P. A. (1992) "Principles of Geographical Information Systems for Land Resources Assesment", Monographs on soil and resources survey n¼ 12, Oxford Science].

e) Data representation:

Geographical data has specific data structure requisites since it includes information about position, possible topological connections and attributes of the represented objects. In these systems, real world entities are represented by their position in a coordinate system with a set of attributes and the topological relations with other elements.

The two different ways of representing spatial data in a computer are: either the spatial entities which are described in terms of a grid, where the grid elements that include the object are assigned by a numeric value, or they are represented as a set of vectors that describe the form of the object [Burrough, P. A. (1992) "Principles of Geographical Information Systems for Land Resources Assesment", Monographs on soil and resources survey n¼ 12, Oxford Science].

The first spatial representation is called raster while the second is called vector. The two fundamental ways of representing topological data can be summarized as follows:

- ❖ Raster representation is a set of cells (pixels) located by coordinates; each cell is independently addressed and contains a value that represents an attribute.
- ❖

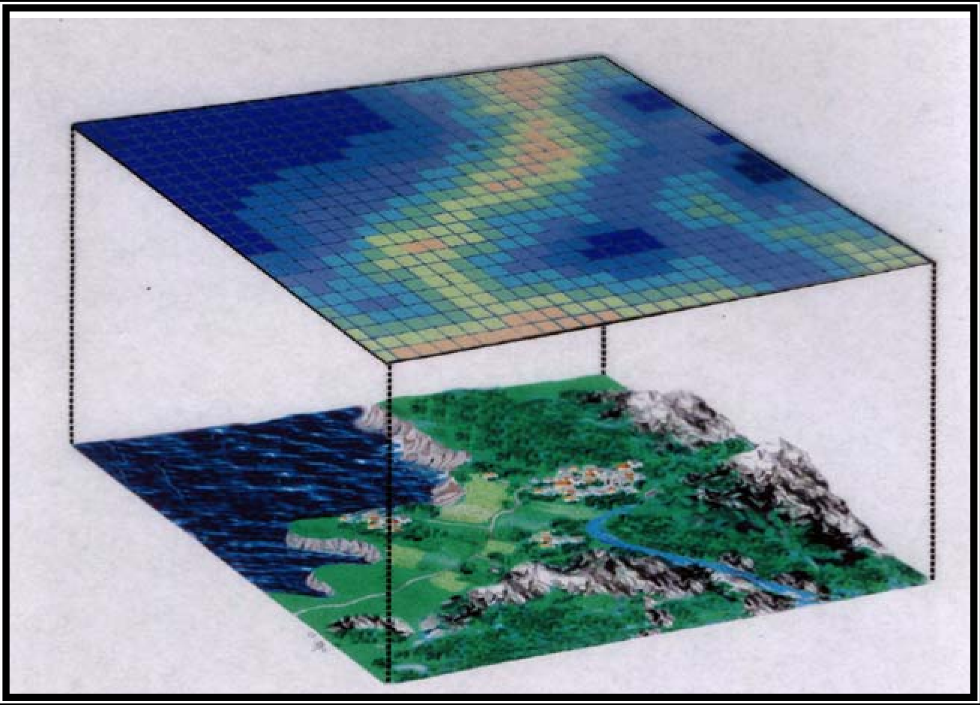


Figure 5.4: This is a raster model representation of the real world picturing gradual changes in topography (a continuous surface) with no distinct boarder lines

- ❖ Vector representation contains three main geographical entities; points, lines and areas. Points are similar to cells, except they do not cover areas; lines and areas are sets of interconnected coordinates that can be linked to given attributes.

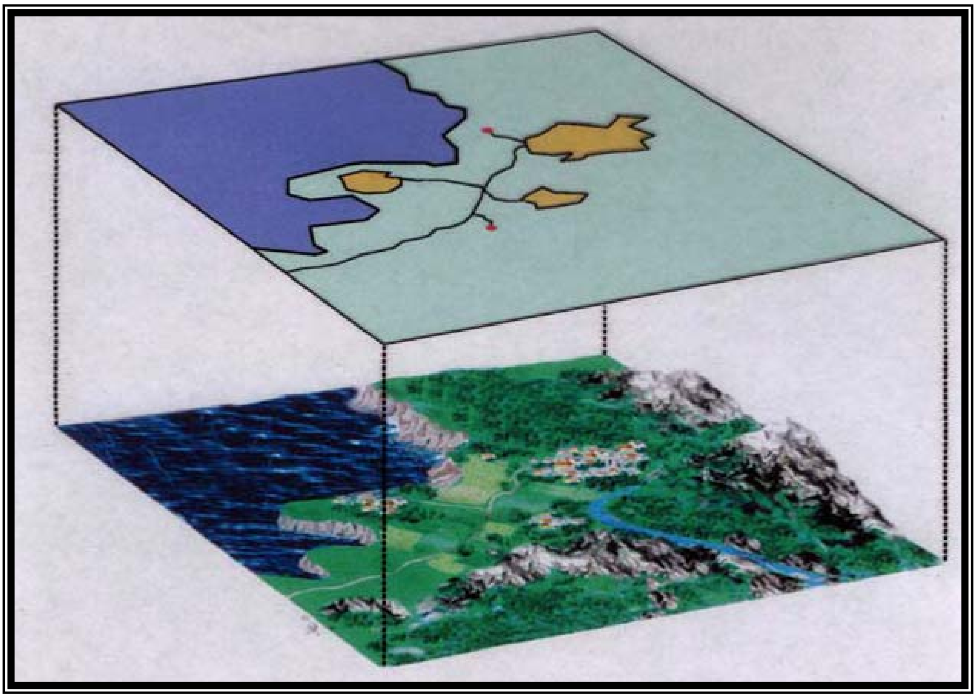


Figure 5.5: Vector model representation of the real world, picturing a lake, some roads, villages and some smaller properties, all separated from each other by defined borderlines

f) Data Output: A variety of maps, charts and tables ranging from CRT visualization to plotter or printer outputs are available to specialist to take his decision.

5.4 Geodatabase Construction

A geodatabase construction process is divided into two major activities

- Creation of digital files from maps, air photos, tables and other source documents;
- Organization of the digital files into a GIS database.

The structural elements of a geodatabase, are some of the elements used to develop a rich GIS, such as

- Attribute data
- Geographic features
- Satellite and aerial images (raster data)
- CAD data
- Surface modeling or 3D data
- GPS coordinates
- Survey measurements

5.5 Geodatabase planning and design

A geographical database is often very long-lived and should therefore be planed to sustain for a longer period of time. The approach was in making the database design, generating database tables, editing the datasets to be adapted for database linkage, and finally generating links between spatial datasets and monitoring tables.

The design of case study geo-database has started by defining the basic themes that should be presented in the geo-database. Every theme represents its geographical features; i.e. the projection, datum and coordinate systems, characteristic features, as well as its land-use and land-cover characteristic features. Every theme is composed of a set of layers; every layer represents a specific geographical feature with a specific geometrical representation (Table 5.1).

This involves:

- The geographic features are to be represented for each theme (for example, as points, lines, polygons, or rasters) along with their tabular attributes.

forth.

- Spatial database elements that are needed for integrity rules are to be added, for implementing rich GIS behavior (such as topologies, networks, and raster catalogs), to define spatial and attribute relationships between datasets.

5.6 Creating the Geodatabase

Geodatabase is created and managed easily using the standard tools in ArcCatalog. This geodatabase is a "container" used to hold a collection of datasets. Each feature dataset holds a collection of feature classes. Geodatabases can represent these types of data as the following data objects:

Basic objects:

- feature classes,

- feature datasets,

- nonspatial tables.

Table 5.1: Themes with its geographic features used in urban planning for study area

No	Physical name	Type
1	Agriculture areas	Polygon
2	Existing Urban areas	Polygon
3	Airport	Polygon

4	Aquifers	Polygon
5	Basins	Polygon
6	Flood_risk_zones	Polygon
7	Geomorphology	Polygon
8	Landuse	Polygon
9	Lineaments	Line
10	Lithology	Polygon
11	Rainfall	Polygon
12	Reactors	Polygon
13	Rockuse	Polygon
١٤	Seismic_epi_centers	Polygon
١٥	Soil_types	Polygon
١٦	Depth of water table	Polygon
17	Electric_network	Line
18	Mountains	Point
19	Physiographic_drains	Line
20	Qu_miocene	Line
21	Quarries	Point
22	Roads	Line
23	Secondary roads	Line
24	Subsurface	Line
25	Surface water	Line

26	Telephone network	Line
27	Railways	Line
28	Drains	Line
29	Drains flood	Line
30	Wells	Point
31	Slope	Raster
32	Elevation	Raster

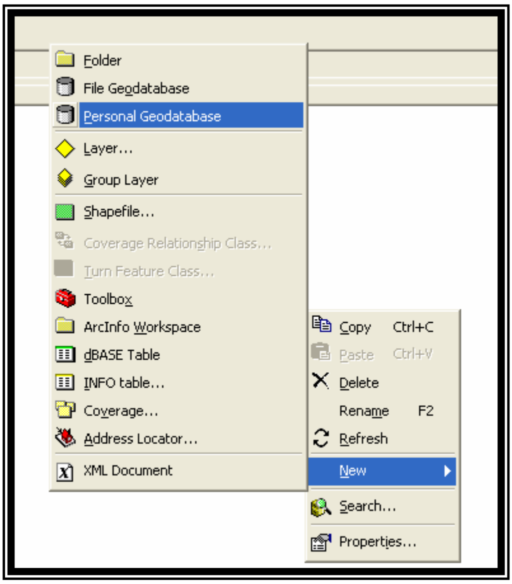


Figure 5.6: Building a Geodatabase named "Suitability" using ArcCatalog 9.2

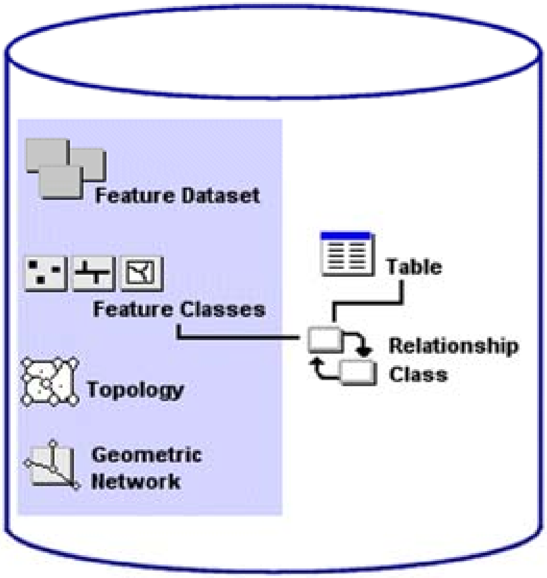
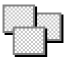


Figure 5.7: Personal Geodatabase basic objects



Feature dataset

It is composed of feature classes that have been grouped together so they can participate in topological relationships with each other. All the feature classes in a feature dataset must share the same spatial reference (or coordinate system).

Edits made to one feature class may result in edits being made automatically to some or all of the other feature classes in the feature dataset.

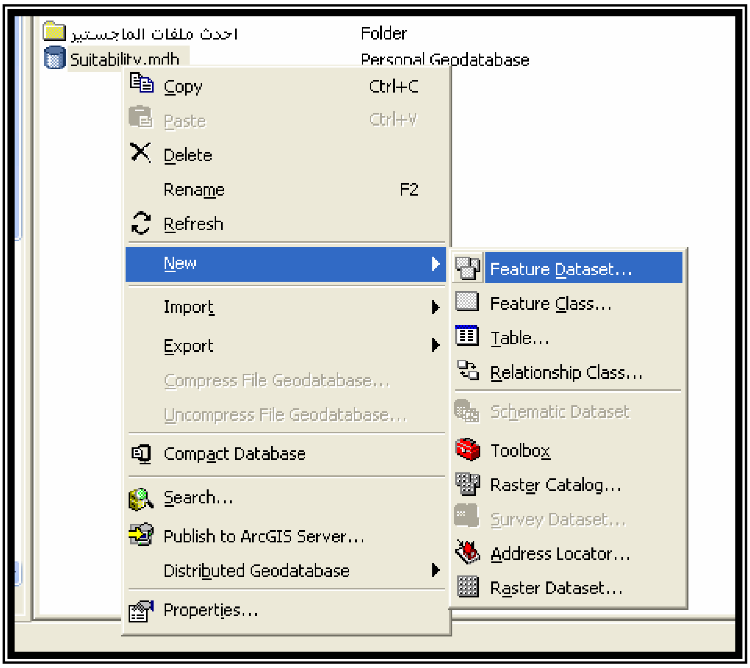


Figure 5.8: Building Feature dataset inside the geodatabase using ArcCatalog 9.2

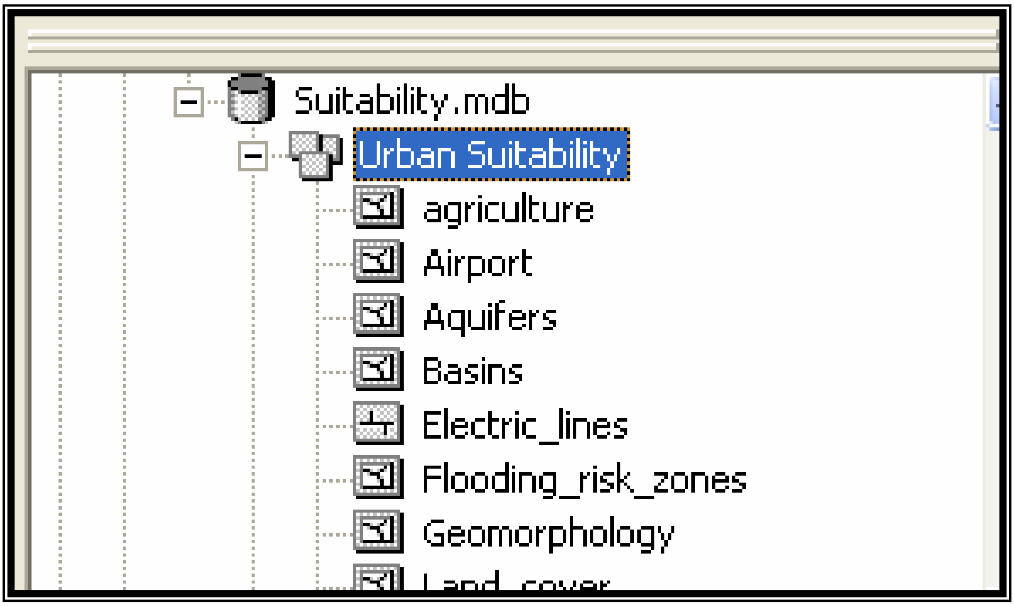
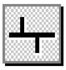


Figure 5.9: Building Feature classes inside the dataset using ArcCatalog 9.2

 **Feature class**

It is a geographic feature includes points, lines, polygons, and annotation feature class. Feature classes may exist independently in a geodatabase as stand-alone feature classes or can be grouped into feature datasets.

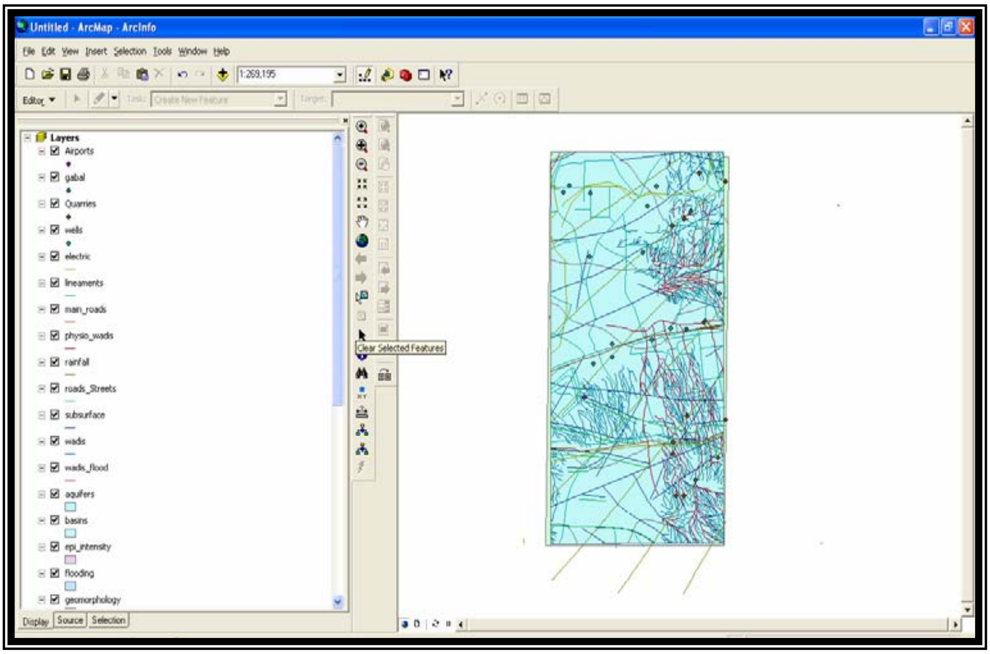


Figure 5.10: Geo-database layers of the study area presented in ArcMap 9.2 to be analyzed

5.7 Entry of attribute data

Additional attribute data is added to the geodatabase by joining tables which contain the new attributes to existing tables already in the GIS. To join these tables together, a common field must be present. Then ArcGIS 9.2 software use the resulting table to display the new attributes linked to the entities.

In the case of paper files related to case study area , and attribute data existing on paper maps, this data have been manually entered into GIS attribute data files in the form of tables. Before this information is entered into a database, it was first reviewed and edited. It was also important to have a procedural plan designed for the entry of this data in order to coordinate the flow of these source documents.

5.8 Acquisition of External Digital Data

The availability of existing digital data had an effect upon the design of the database. Integrating existing databases with the primary GIS required the establishment of common data keys and other unique identifiers. Issues of data location, data format, record match rates, and the overall value of integrating the external data should all be considered before deciding to purchase or acquire existing datasets.

5.9 Quality Control Procedures

Geodatabase allows the specialist to specify the type of field for each data element, whether it is numeric, alphanumeric date, etc.; whether it has decimal places, and so on. This feature can help prevent mistakes as the system will not allow entries other than those specified in advance.

There are number of automated and manual procedures which can be performed to check the quality of attribute data. Some customized programs may be required for the testing of some quality control criteria. Some attribute value validity checks which may be performed include: verifying that each record represents a graphic feature in the database, verifying that each feature has a tabular record with attributes associated with it, determining if all attribute records are correct, and determining that all attributes calculated from certain applications must be correct based upon the input values and the corresponding formulas. The translation of obsolete record symbology into a GIS usable format, according to conversion specifications, is one procedure which will have to be conducted manually [Montgomery, G.E. and H.C. Schuch, (1993): GIS Data Conversion Handbook (GIS World Books, Fort Collins, CO)].

5.10 Data catalog

The data catalog is the detailed index of the used maps and the tabulated data linked to it. It is also considered the documentation of the used database. The attribute data of case study area are also linked and input to the spatial data in the geo-database (Figure 5.1).

5.11 Data themes

Many themes are represented by a single collection of homogeneous features such as a feature class of soil types and a point feature class of well locations. Other themes, such as a transportation framework, are represented by multiple datasets (such as a set of spatially related feature classes for streets, intersections, bridges, and highway ramps, and so on).

Raster datasets are used to represent continuous surfaces, such as elevation, slope, and aspect, as well as to hold satellite imagery, aerial photography, and other grid datasets (such as land cover).

The database themes or layers that are built through ArcGIS 9.2 are the following:

5.11.1 Soil Types map of the study area

Soil type is a very important factor for urban development in any selected site. Dr. Harry Williams [Williams H., (2003) Urbanization Pressure Increases Potential for Soils-Related Hazards, Denton County, Texas"

Source: University of North Texas News Release. Available at http://web2.unt.edu/news/print.cfm?story=8636, published in the international journal Environmental Geology in the fall 2003 issue] is exploring how urbanization pressures have resulted in housing construction on soils poorly suited for urban development. Williams' research is described in his article that there's a lot of housing being developed on poorly-suited soils. Unfortunately, many people will probably have foundation problems in the future. Williams says 90 percent of soils in some places are rated low to very low for urban suitability, because of expansive soils -- soils that swell.

"Expansive soils can damage foundations, pavements and pipelines, because hundreds of tons of pressure can develop in these soils as they absorb moisture." Williams said.

According to a 1982 Federal Emergency Management Agency (FEMA) report, expansive soils have caused billions of dollars of damage in the United States. Today, damage from expansive soils is more costly than damage caused by earthquakes, floods, tornadoes and hurricanes combined.

Soil type suitability is based on propensity to flood, high water table, wetness, shrink-swell potential, soil strength, soil texture and soil corrosively to uncoated steel and concrete

In this study, soil suitability layer is mapped, into GIS. The GIS map shows suitability of soils for urban development with its attribute table (figure 5.11) and the results of analysis show the following:

The soil cover type map of case study area is ranked according to soil type suitability in urban development (figure 5.12) and then it is weighted according to its importance in urban development as a factor and its weight equals 2 in this analysis study.

Attributes of Morph_soils

OBJECTI	Shape	AREA	PERIMETER	MORPH_SOI	_MORPH	SOIL_CO	SOIL_TYPES	Shape_Length	Shape_Area
1	Polygon	9221670	25003.9	8	0	5	Aeolian soils	25004.542214	9221812.80784
2	Polygon	96033104	58514.398	3	0	2	Alluvial soils of the old	30458.899014	33846637.95457
3	Polygon	10591600	16773.6	4	0	6	Rocky terrain	15785.338429	9884757.172726
4	Polygon	92408800	58868.301	7	0	6	Rocky terrain	36500.44942	40327257.233179
5	Polygon	39580300	28388.1	9	0	5	Aeolian soils	28003.186605	39186152.14749
6	Polygon	24019600	33372.801	10	0	5	Aeolian soils	295.21995	2672.192944
7	Polygon	9834380	13036.7	2	0	1	Nile Delta flood plain	5413.950631	1106422.349934
8	Polygon	6948020	12596.1	6	0	6	Rocky terrain	2482.403089	141077.882619
9	Polygon	459572990	251506	5	0	4	Alluvial fan soils(basin	168011.023824	285425972.816492
10	Polygon	296800990	104800	11	0	6	Rocky terrain	66068.563019	134928991.191956

Record: 1 Show: All Selected Records (0 out of 10 Selected) Options

Figure 5.11: Attribute table of Soil types layer

Soil type	Ranking
Aeolian soils	0
Nile Delta flood plain	1
Alluvial soils of the old	2
Alluvial fan soils`(basin)	3
Rocky terrain	4

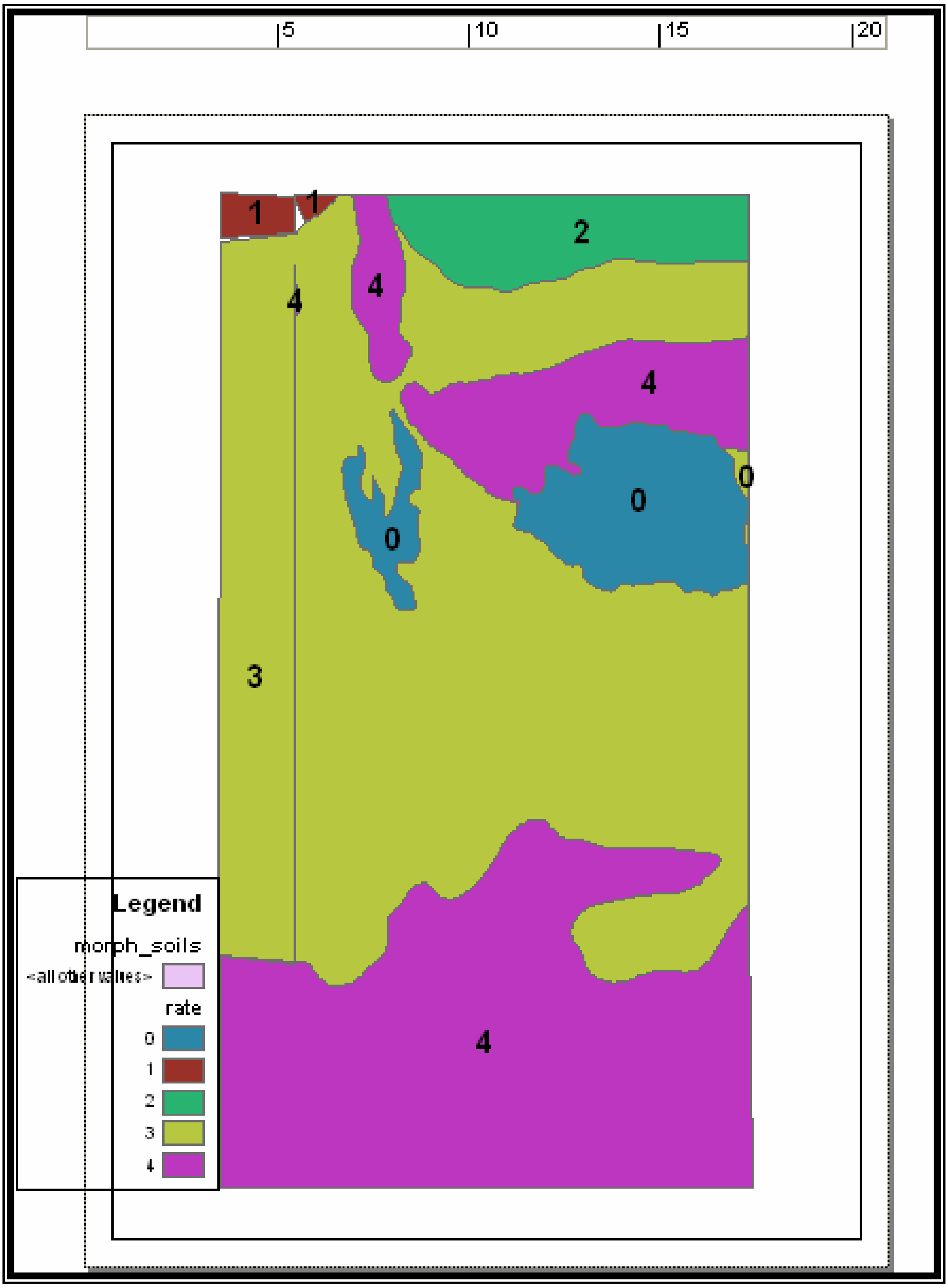


Figure 5.12: Reclassified Soil types layer of the study area

5.11.2 Lithological map of the study area

The land cover of rocky terrain has an important influence on the suitability of the case study area land sectors for urban development.

Attributes of lihology_ff

FID	Shape	AREA	PERIMETER	_LITHOLOGY	LITHOLOGY1	CODE_LITHO	LITHOLOGY
0	Polygon	82390400	65472.801	10	58	0	Sand c
1	Polygon	39578700	28383.699	19	120	0	Sand c
2	Polygon	24019400	33371.5	20	133	0	Sand c
3	Polygon	9834220	13036.5	2	1	0	Nile Flood (Re
4	Polygon	63584500	40731.5	3	33	0	Quaternary (Plistoene&Hol
5	Polygon	72365104	59638.5	4	314	0	Quaternary (Plistoene&Hol

Record: 1 Show: All Selected Records (0 out of 21 Selected) Options

Figure 5.13: Attribute table of Lithological layer of case study area

In this study, lithological suitability layer is mapped, into a geographical information system (GIS) and its attribute table is built (figure 5.13). So, the lithological map of the area has been reclassified and weighted according to its importance in urban development as a factor and its weight equals 1 in this analysis study.

The GIS map shows suitability grades of lithological types for urban development and the results of analysis show the classified map in figure 5.14.

Lithology	**Ranking**
Sand dunes	0
Nile Flood (Recent)	1
Basalt	1
Quaternary (Plistoene&Holoene)	2
Middle Miocene	2
Non marine Miocene	3
Upper Eocene	3
Oligocene	4

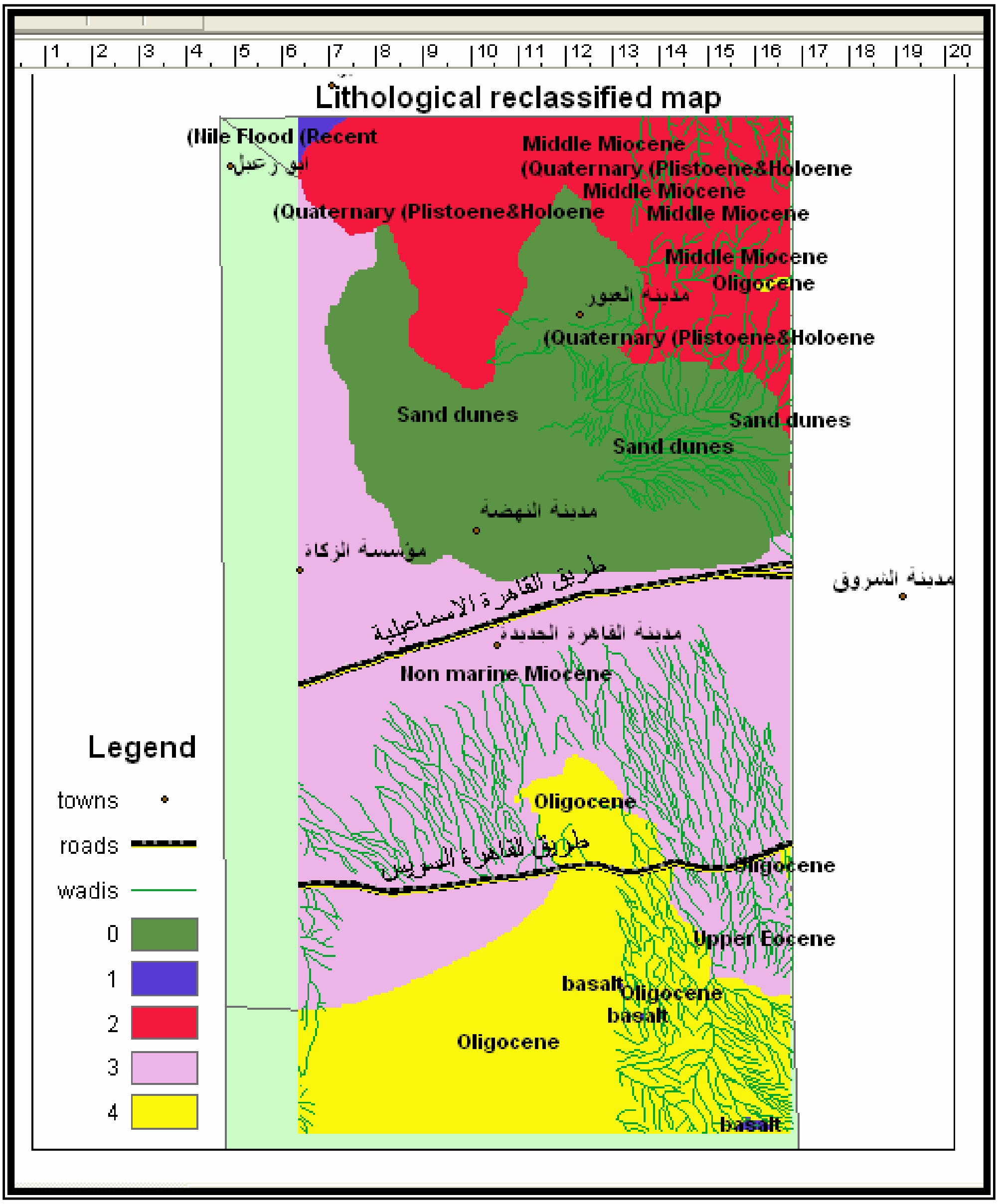
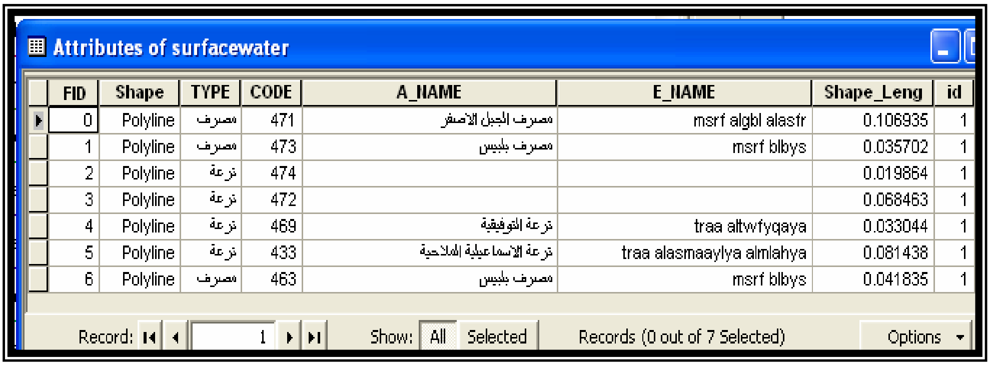


Figure 5.14: Reclassified Lithological layer

5.11.3 The surface water canals and drains in the study area

The surface water is considered one of the environmental factors that form the environmental sensitivity index. The distance from the surface water canals is an important criterion to define suitability for urban development. We produced a reclassified map that gives buffer zones from the surface water.

To do this analysis in the study area, a 5km were taken as a multi-ring buffer zone from surface water and then the layer is reclassified to five levels of suitability for urban development.


Attributes of surfacewater

FID	Shape	TYPE	CODE	A_NAME	E_NAME	Shape_Leng	id
0	Polyline	مصرف	471	مصرف الجبل الاصفر	msrf algbl alasfr	0.106935	1
1	Polyline	مصرف	473	مصرف بلبيس	msrf blbys	0.035702	1
2	Polyline	ترعة	474			0.019864	1
3	Polyline	ترعة	472			0.068463	1
4	Polyline	ترعة	469	ترعة التوفيقية	traa altwfyqaya	0.033044	1
5	Polyline	ترعة	433	ترعة الاسماعيلية الملاحية	traa alasmaaylya almlahya	0.081438	1
6	Polyline	مصرف	463	مصرف بلبيس	msrf blbys	0.041835	1

Record: 1 Show: All Selected Records (0 out of 7 Selected) Options

Figure 5.15: Attribute table of Surface Water Canals and Drains in case study area

Closer areas to surface water are better in urban development and the more far areas is less good (figure 5.16). Finally the reclassified map of surface water is weighted with score equals 2 in this analysis.

Distance from surface water	**Ranking**
From 0-100m	0
From 100m-1km	1
From 1-3km	2
From 3-5km	3
>5km	4

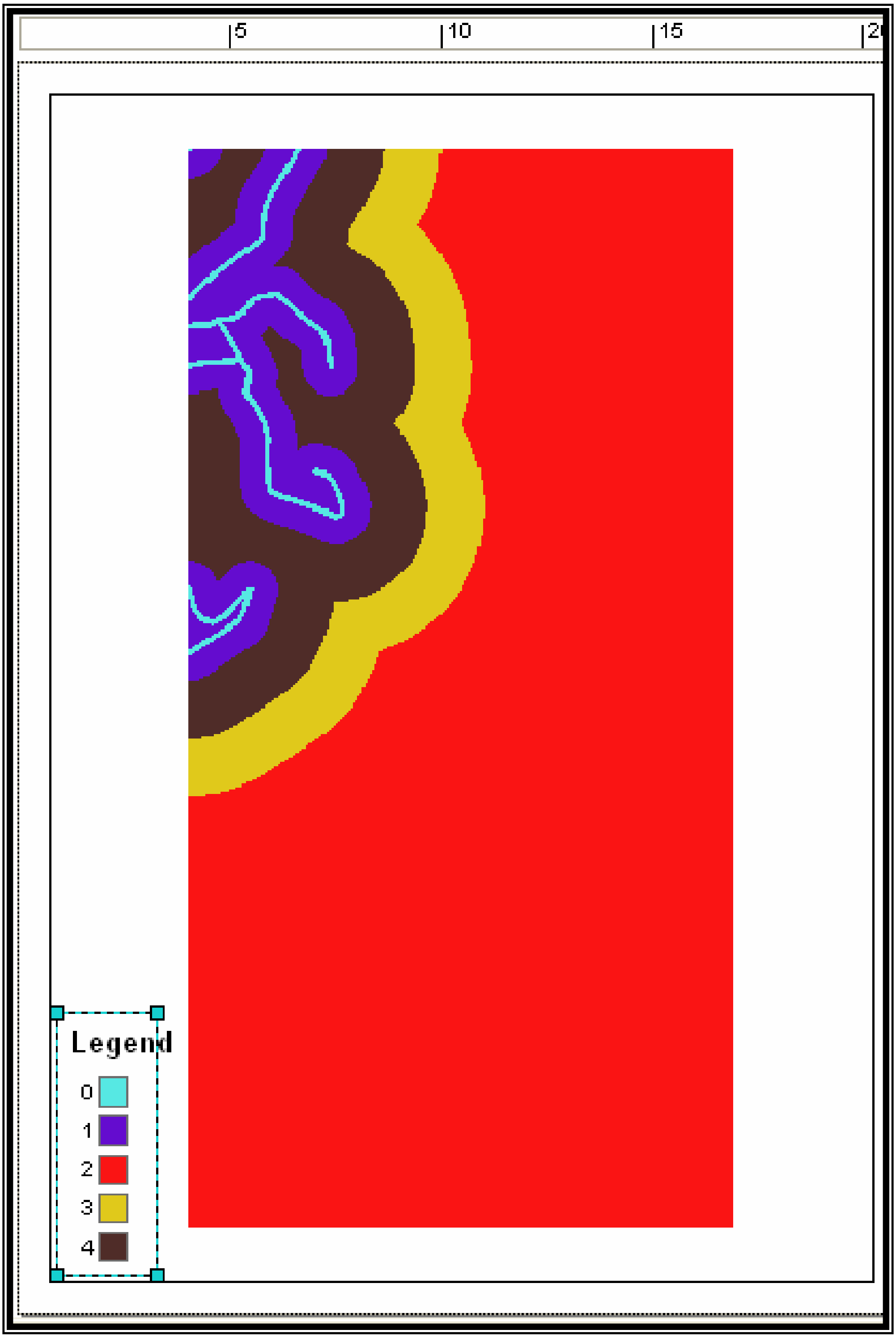
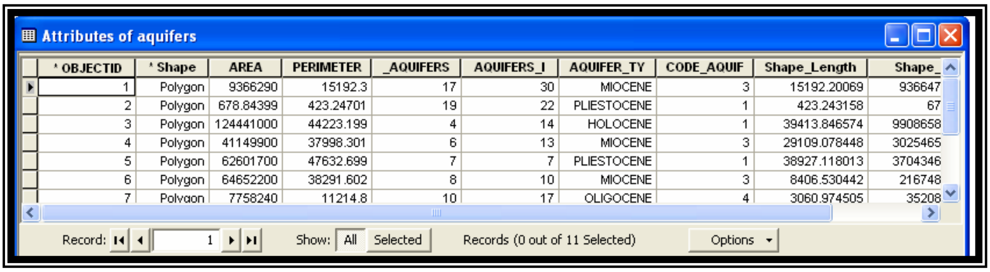


Figure 5.16: The reclassified Surface Water Canals and Drains layer

5.11.4 Aquifers types map of the study area, (Fig. 5.18)

In this study, Aquifer layer is mapped, into a Geographical Information System (GIS) The GIS map shows suitability of Aquifers for urban development with its attribute table (figure 5.17).



Attributes of aquifers

* OBJECTID	* Shape	AREA	PERIMETER	_AQUIFERS	AQUIFERS_I	AQUIFER_TY	CODE_AQUIF	Shape_Length	Shape_
1	Polygon	9366290	15192.3	17	30	MIOCENE	3	15192.20069	936647
2	Polygon	678.84399	423.24701	19	22	PLIESTOCENE	1	423.243158	67
3	Polygon	124441000	44223.199	4	14	HOLOCENE	1	39413.846574	9908658
4	Polygon	41149900	37998.301	6	13	MIOCENE	3	29109.078448	3025465
5	Polygon	62601700	47632.699	7	7	PLIESTOCENE	1	38927.118013	3704346
6	Polygon	64652200	38291.602	8	10	MIOCENE	3	8406.530442	216748
7	Polygon	7758240	11214.8	10	17	OLIGOCENE	4	3060.974505	35208

Record: 1 Show: All Selected Records (0 out of 11 Selected) Options

Figure 5.17: Attribute table of Aquifers types' map of case study area

This map is reclassified due to its suitability grade to high, moderate and low due to the aquifer types and the results of analysis shown in figure 5.18 and finally, a reclassified map is produced and weighted according to its importance in urban development and is weighted 1 in this analysis study.

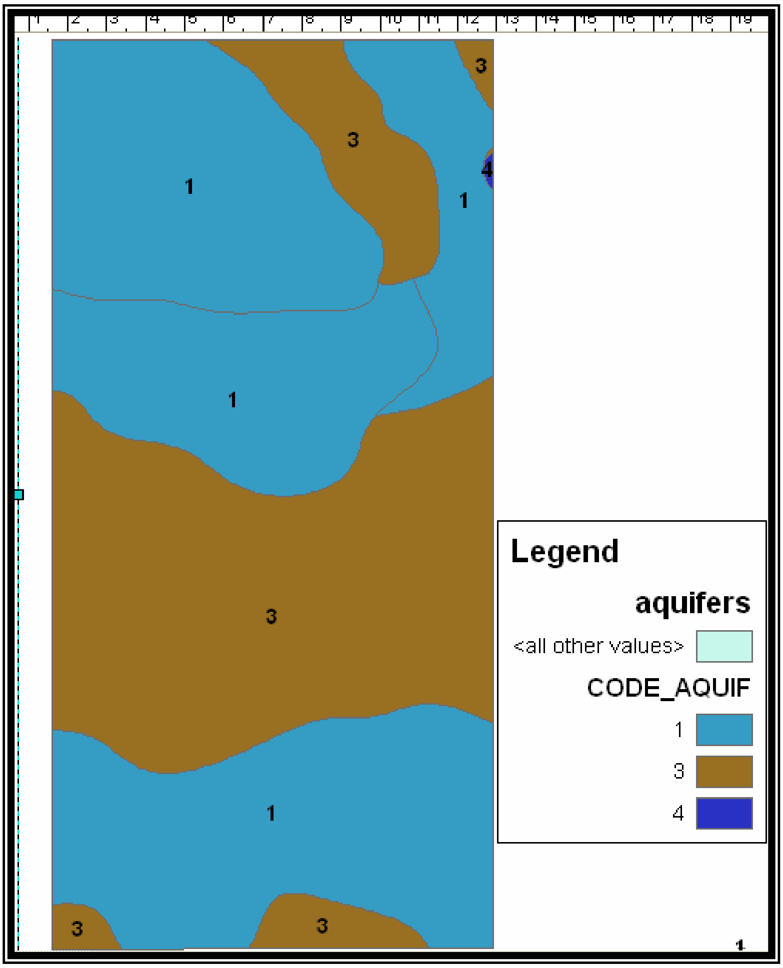


Figure 5.18: the reclassified Aquifers types' layer

Aquifer type	Ranking
PLIESTOCENE	1
MIOCENE	3
OLIGOCENE	4

5.11.5 Main roads map layers of the study area (figure 5.20)

In our study, main roads layer is mapped, into a GIS and reclassified due to its suitability. The GIS map shows suitability from main roads to urban development with its attribute table (figure 5.19). Distance from the main roads lines has a variable degree of suitability for urban development (figure 5.20). Closer areas to main roads are better in urban development and more far is less good.

Attributes of roads

_FNODE	_TNODE	_LPOLY	_RPOLY	LENGTH	_ROADS_2	ROADS_2_ID	Shape_Leng	road_name
16	15	2	2	1213.67	11	1	1213.637427	
16	13	2	2	11479	12	1	2901.953104	
17	16	2	2	9911.04	13	1	9910.872452	طريق القاهرة الاسماعيلية
18	17	2	2	288.92599	14	1	288.932193	
19	18	2	2	163.23199	15	1	163.217188	
20	19	2	2	6433.29	17	1	3708.535264	
24	15	2	2	12705.3	21	1	1659.900708	
25	24	2	2	22592	22	1	16809.543953	طريق القاهرة السويس

Record: 1 Show: All Selected Records (0 out of 8 Selected) Options

Figure 5.19: Attribute table of Main roads of case study area

Finally, a reclassified map was produced and weighted with score 3 which is highest weight due to its importance.

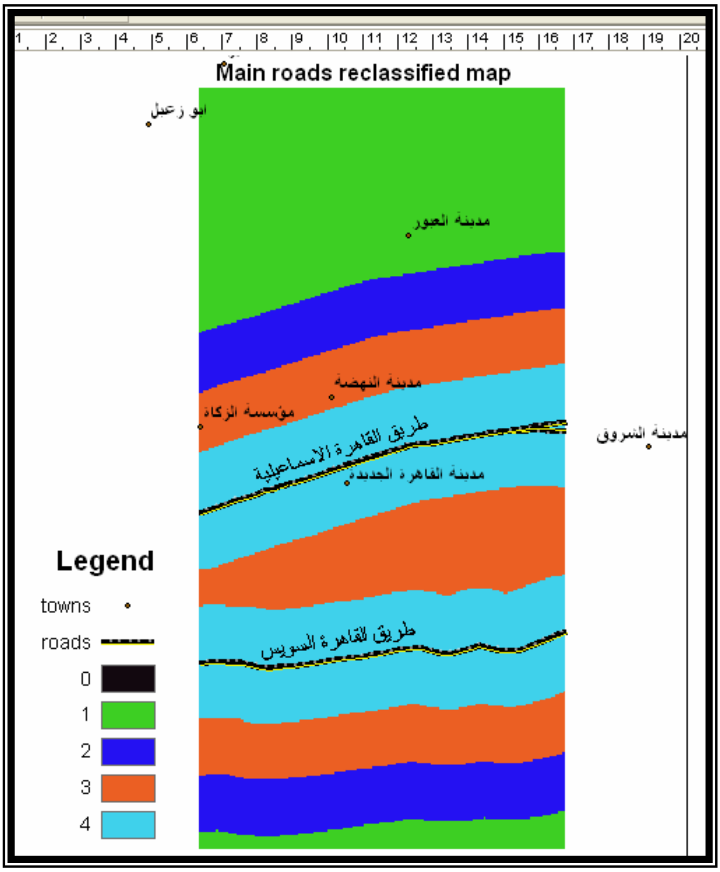


Figure 5.20: the reclassified main road layer

Distance from roads	Ranking
0 – 50 meter	0
50 m – 2.5 km	4
2.5 - 5 km	3
5 – 7.5 km	2
> 7.5 km	1

5.11.6 Secondary roads map layers of the study area (figure 5.22)

The GIS map shows suitability from secondary roads to urban development with its attribute table (figure 5.21).

Attributes of Roads_Streets

FID	Shape	TYPE	CODE	A_Name	E_Name	Shape_Leng
0	Polyline		1			0.036896
1	Polyline		1			0.000372
2	Polyline		1			0.007122
3	Polyline		1			0.016691
4	Polyline		1			0.024117
5	Polyline		1			0.038535
6	Polyline		1			0.006625
7	Polyline		1			0
8	Polyline		1			0.050304
9	Polyline		1			0.006243
10	Polyline		1			0.058328
11	Polyline		1			0.012146
12	Polyline		1			0.016675
13	Polyline		1			0.017557
14	Polyline		1			0.03078
15	Polyline		1			0.01079
16	Polyline		1			0.010329
17	Polyline		1			0.000211
18	Polyline		1			0.024993
19	Polyline		1			0.003726
20	Polyline		1			0.04614
21	Polyline		1			0.0347
22	Polyline		1			0
23	Polyline		1			0.017762
24	Polyline		1			0.004817

Figure 5.21: attribute table of Secondary roads map of case study area

Distance from secondary roads has a variable degree of suitability for urban development (figure 5.22). In this study, a 5km were taken as a buffer zone from these roads. The ranked criteria are defined. Closer areas to these roads are better in urban development and more far is less good.

With the help of Imagine Erdas 9.2 spatial analyst, a distance map around secondary roads was done. Finally, this reclassified map is weighted with score 2 in our analysis.

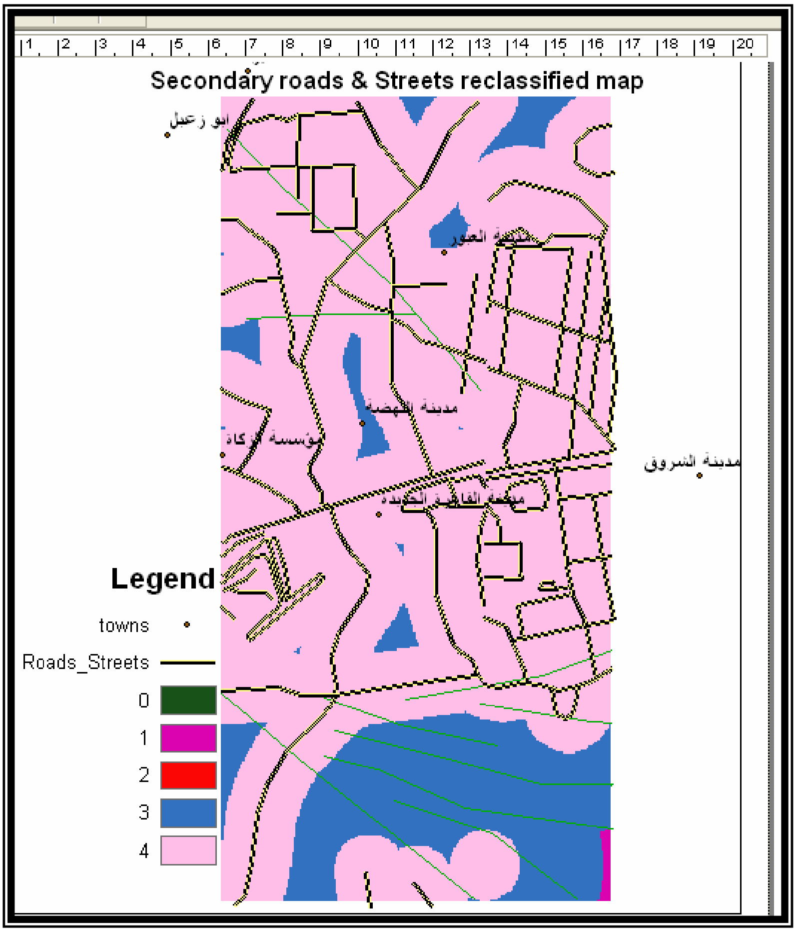


Figure 5.22: the reclassified secondary roads layer

Distance from streets	Ranking
0 – 1.5 km	4
1.5 – 5 km	3
> 5 km	1

5.11.7 Land.cover / Land-use map layer of case study area, (figure 5.23)

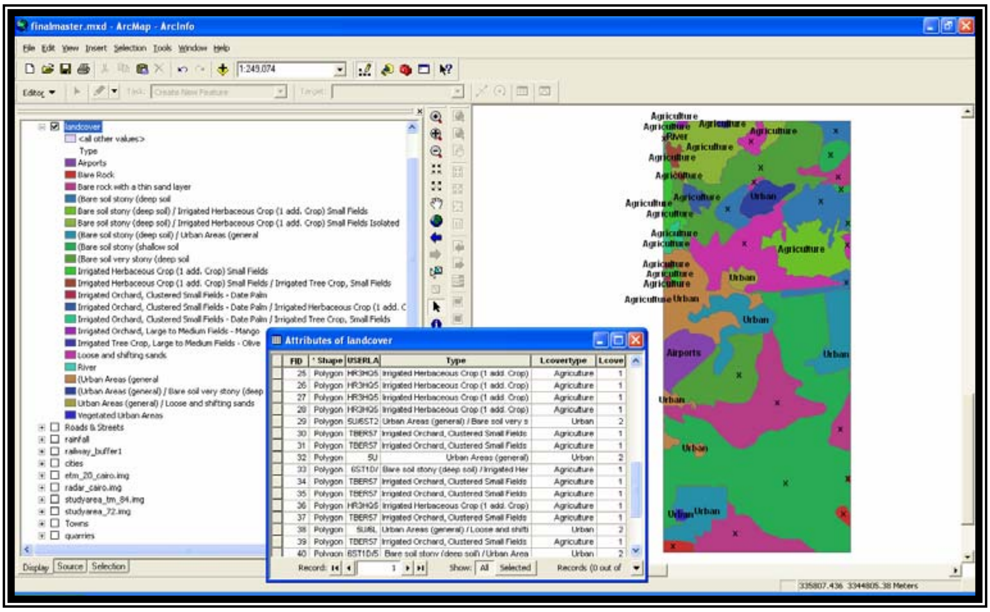


Figure 5.23: Land-use map of case study area with Attribute table

The land-use map is important in this analysis as it is used to get the agricultural areas, urban areas, industrial areas and any other type of land-cover/ land-use.

5.11.8 Mining resources map layer of case study area

The mining resources factor comes in a very important level, especially in case study area. So the mining resources give the surrounding areas a very high opportunity for urban development than other areas. The study area is rich with mining resources in both metallic and non-metallic minerals.

To do this analysis, it is not important to define the type of the material as metallic or non-metallic, so both will be joined in one map. In the study area a 5km were taken as a buffer zone from the location of the mining resources.

The GIS map shows suitability from mining resources to urban development with its attribute table (figure 5.24).

Attributes of quarries...

FID	* Shape	CODE	id
0	Point	297	1
1	Point	298	1
2	Point	299	1
3	Point	300	1
4	Point	366	1
5	Point	367	1
6	Point	368	1
7	Point	403	1
8	Point	411	1
9	Point	412	1
10	Point	413	1
11	Point	414	1

Record: 1

Figure 5.24: Attribute table of Quarries map of case study area

First we define the ranked criteria depending on the distance to the mineral resources, closer areas to the mining resources is better to urban development and more far is less good.

With the help of Erdas Imagine 9.2 spatial analyst, a distance map around mineral resources was done.

Finally, a reclassified map was produced and zones will be given a weight value that matches (figure 5.25).

Distance from Quarries	Ranking
From 0 – 2 km	4
From 2 – 4 km	3
From 4 – 5 km	2
Rest of the study area	1

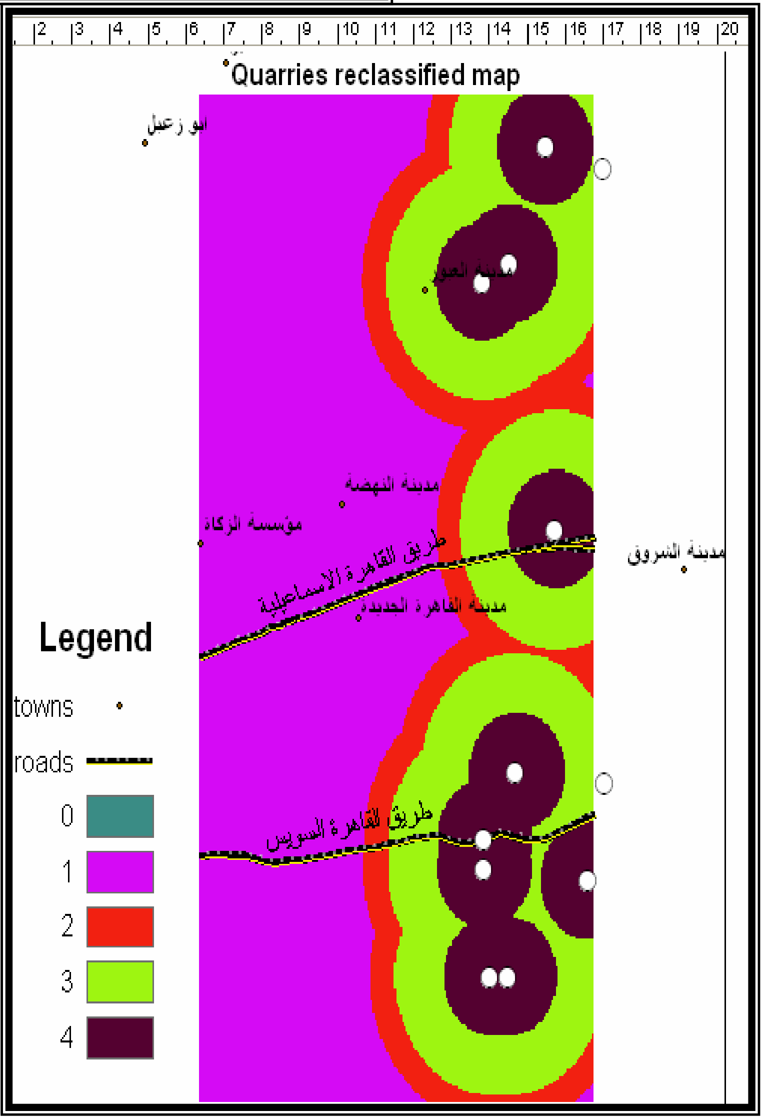


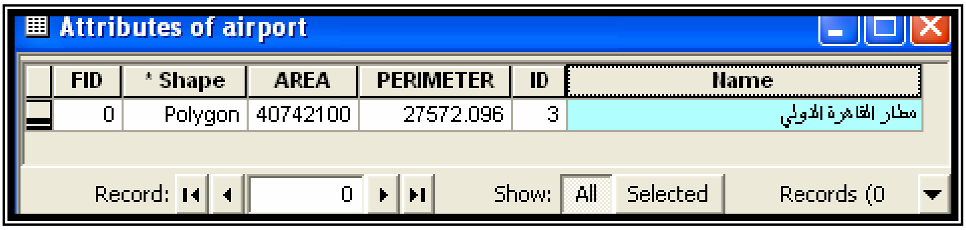
Figure 5.25: the reclassified Quarries layer

5.11.9 Airport map layer of case study area

It is important here to mention that the airport existence is a great support for the development process and subsequently for urban extension or suitable land for urban extension.

The GIS map shows suitability from airport to urban development with its attribute table (figure 5.26)

A distance map was created from the existing airport location in the study area, with multi-ring buffer zones as follows:


Attributes of airport

FID	Shape	AREA	PERIMETER	ID	Name
0	Polygon	40742100	27572.096	3	مطار القاهرة الدولي

Record: 0 Show: All Selected Records (0

Figure 5.26: Attribute table of Airport map of case study area

Distance from Airport	Ranking
0 – 100 meter	0
100 meter – 2km	4
2 – 4 km	3
4 -7 km	2
>7 km	1

The distance map is reclassified (figure 5.27) with closer areas to Airports are better in urban development. In this study a 7 km were taken as a buffer zone from Airport and the ranked criteria is defined. Finally, this reclassified map is weighted with score 2 in this analysis.

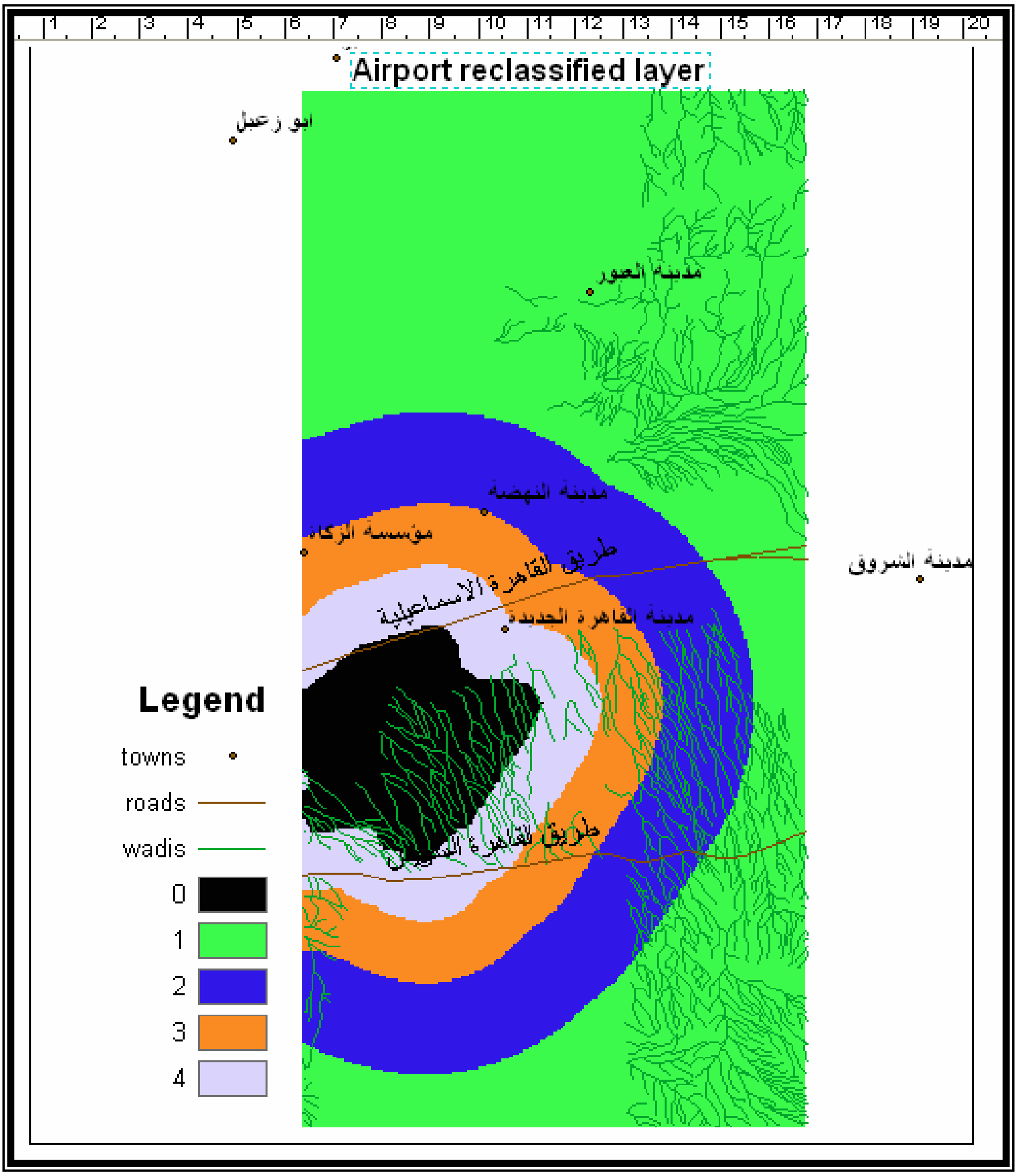


Figure 5.27: the reclassified Airport layer

5.11.10 Wells map layer of case study area

Wells are important source of water for drinking and agriculture, so it has sensitivity in the ecosystem for the study area. First we defined the wells in the study area with its attribute table (figure 5.28) and derived a distance map from the wells. Then we reclassified the distance map and take the buffer distance of 3km around it. This zone is divided into multi-ring buffer zones. With the help of IMAGINE Erdas 9.2 Spatial Analyst, a distance map around Wells was done. The reclassified map is weighted with score equals one due to its importance level in urban development.

Attributes of wells

FID	* Shape	AREA	PERIMETER	_WELLS3	WELLS3_ID	POLYGONID	SCALE	ANGLE
0	Point	0	0	6	13	6	1	0
1	Point	0	0	7	132	7	1	0
2	Point	0	0	9	42	9	1	0
3	Point	0	0	10	41	10	1	0
4	Point	0	0	11	40	11	1	0
5	Point	0	0	16	39	16	1	0
6	Point	0	0	17	38	17	1	0
7	Point	0	0	19	122	19	1	0
8	Point	0	0	26	10	26	1	0
9	Point	0	0	28	181	28	1	0
10	Point	0	0	30	25	30	1	0
11	Point	0	0	31	180	31	1	0
12	Point	0	0	32	9	32	1	0
13	Point	0	0	33	8	33	1	0

Record: 1 Show: All Selected Records (0 out of 14 Selected)

Figure 5.28: Attribute table of Wells map of case study area

Distance from Well	Ranking
0 – 1 km	4
1 – 3 km	2
>3 km	1

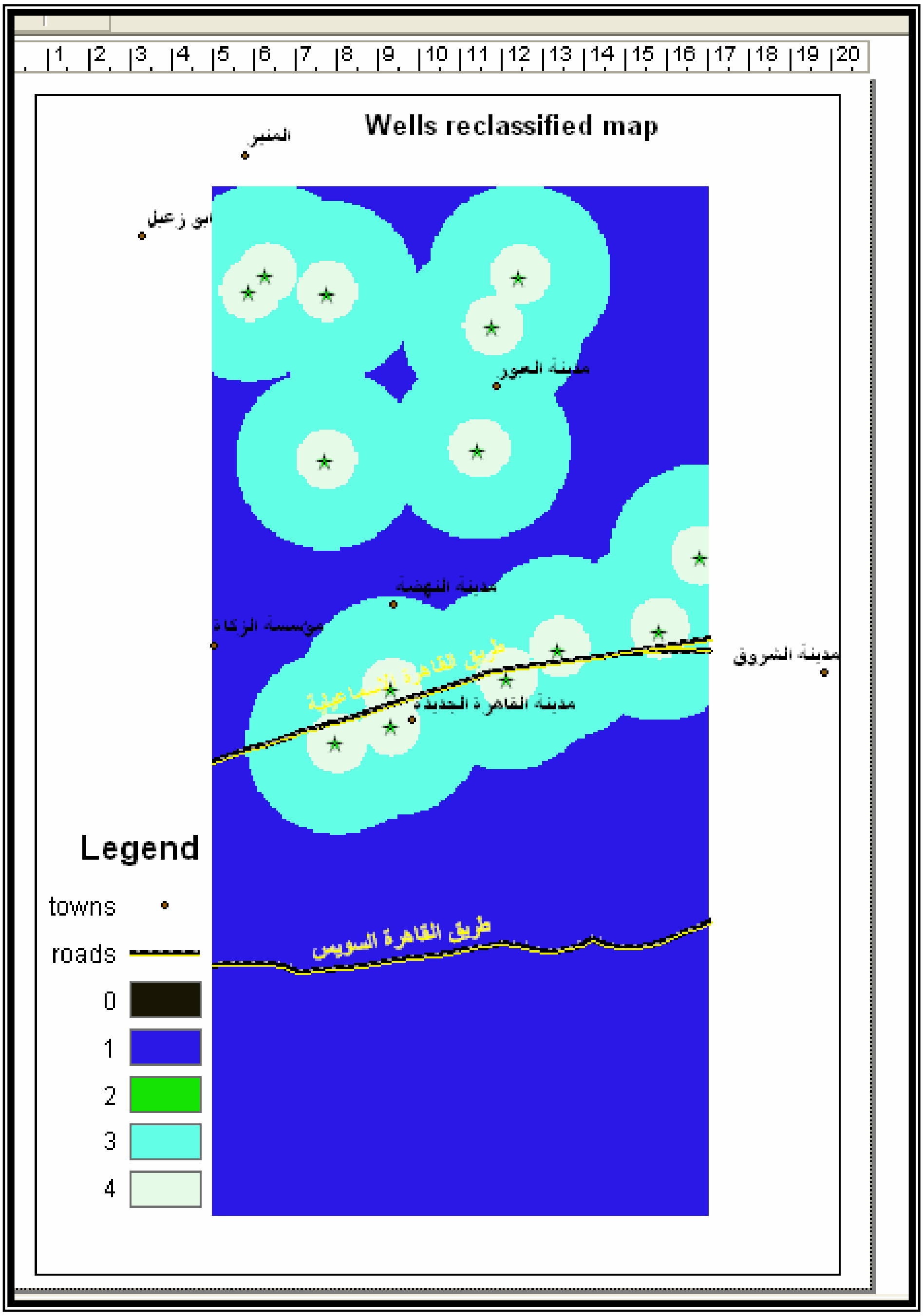


Figure 5.29: the reclassified Wells layer

5.11.11 Electric lines Network map layer of case study area

The electricity parameter is influencing the urban development of the study area and is summarized in the distance from the main transition lines and power stations.

Attributes of electric_lines

FID	Shape	_FNODE	_TNODE	_LPOLY	_RPOLY	LENGTH	_ELECTRIC	ELECTRIC_I	Shape_Leng
0	Polyline	1	8	2	2	5615.0298	3	1	2294.181796
1	Polyline	9	2	2	2	8038.8398	4	1	6610.658691
2	Polyline	10	11	2	2	11160.3	5	1	11160.249091
3	Polyline	7	12	2	2	4032.74	6	1	3278.575488
4	Polyline	13	9	2	2	12543.6	7	1	12543.552245
5	Polyline	12	14	2	2	15374.7	8	1	11202.32891
6	Polyline	16	17	2	2	14167.4	10	1	10651.404526
7	Polyline	19	18	2	2	492.50101	11	1	492.505854
8	Polyline	16	15	2	2	17752	9	1	6014.522379

Record: 1 Show: All Selected Records (0 out of 9 Selected) Options

Figure 5.30: Attribute table of Electric lines network map of case study area

The service area of electricity transition lines was taken from previous study (Arnous M., 2004) with its attribute table (figure 5.30).

Electric Lines are buffered, ranked and weighted due to its importance in urban development. Using Erdas Imagine 9.2, we buffered the lines of electricity, then we defined the ranked areas and a reclassified map was produced (figure 5.31) given a weighted value equals 2 due to its importance level in urban development.

A distance map was created from the existing transition lines locations in the study area, the buffer distance were taken as follows:

Distance from Electric lines	Ranking
0-1 km	4
1 – 2 km	3
2 – 3 km	2
> 3 km	1

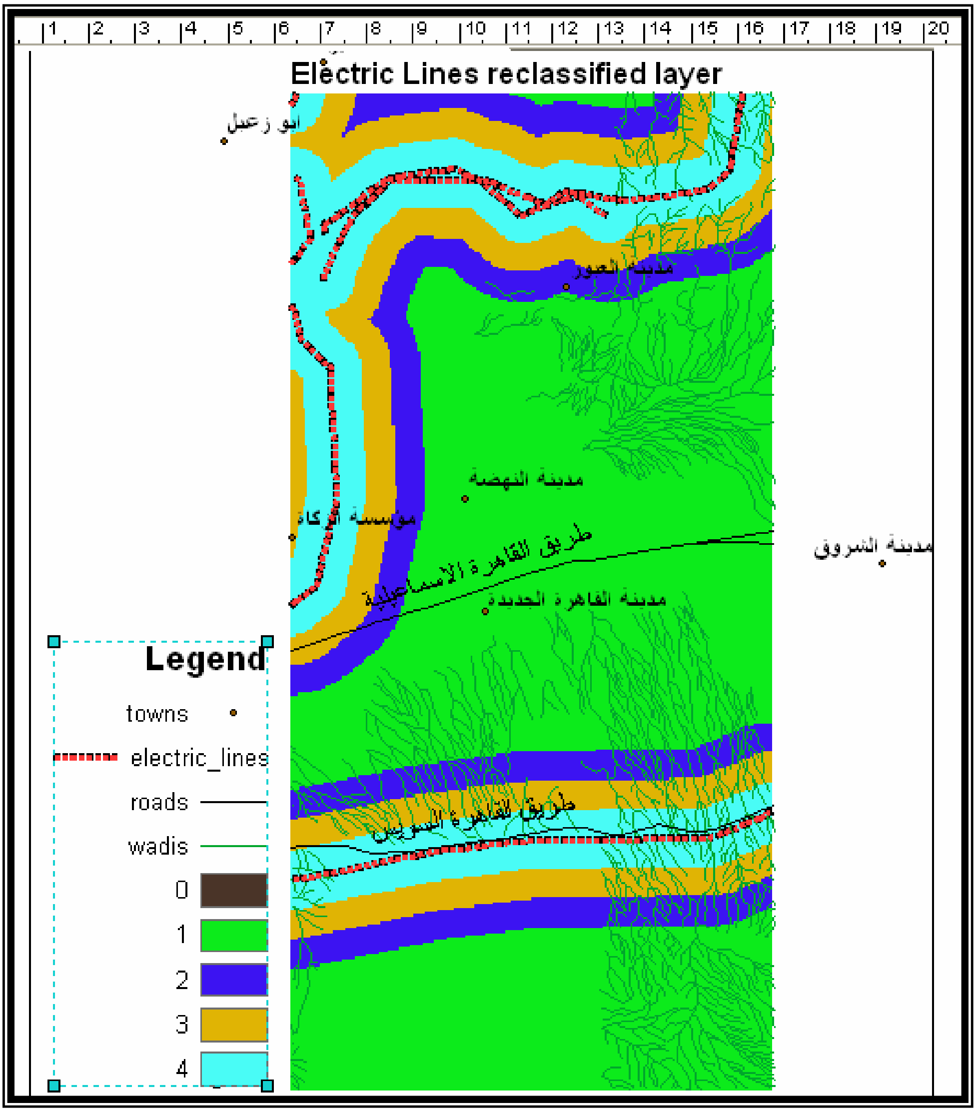


Figure 5.31: the reclassified Electric lines network layer

5.11.12 Lineaments map layer of case study area

This layer represents the geological structures of major faults and fractures. They are weak zones that refer to possibility of high seismic activity. These fault lineaments are buffered and weighted.

Attributes of Lineaments

FID	Shape	_FNODE	_TNODE	_LPOLY	_RPOLY	LENGTH	LINEAMENTS	LINEAMEN_1	Shape_Leng	code
0	Polyline	1	5	2	2	2314.47	1	1353	563.149422	1
1	Polyline	6	4	2	2	1703.72	2	1351	337.589661	1
2	Polyline	6	2	2	2	2745.8701	3	1350	1317.612617	1
3	Polyline	8	6	2	2	851.02899	5	1349	851.059776	1
4	Polyline	5	9	2	2	3302.6499	6	1354	3302.73663	1
5	Polyline	15	14	2	2	1140.22	10	1356	1140.206868	1
6	Polyline	36	19	2	2	2642.55	22	1393	2642.56847	1

Record: 1 Show: All Selected Records (0 out of 22 Selected) Options

Figure 5.32: Attribute table of Structural lineaments map of case study area

To generate the fractures hazard risk zones, first we draw the fractures by digitization, according to the published data and lineaments maps in the study area with its attribute table (figure 5.32). Then buffer zones were done for hazardous fracture with multi-ring buffer in fractures and the surrounding distance within 10m, 50m, 300m and 500m.

By using the GIS spatial analyst reclassification command; the rejected highly hazardous areas will take the value (0) and the rest of the study area will take values from (1) to (4) from which the closer zones to these lineaments are worse in urban development and more far are better. Finally, the map is reclassified to 5 rankings and weighted 1 due to its importance level in urban development.

Distance from fracture	Ranking
0 to 10 meter	0
10 to 50 meter	1
50 to 300 meter	2
300 to 500 meter	3
>500 meter	4

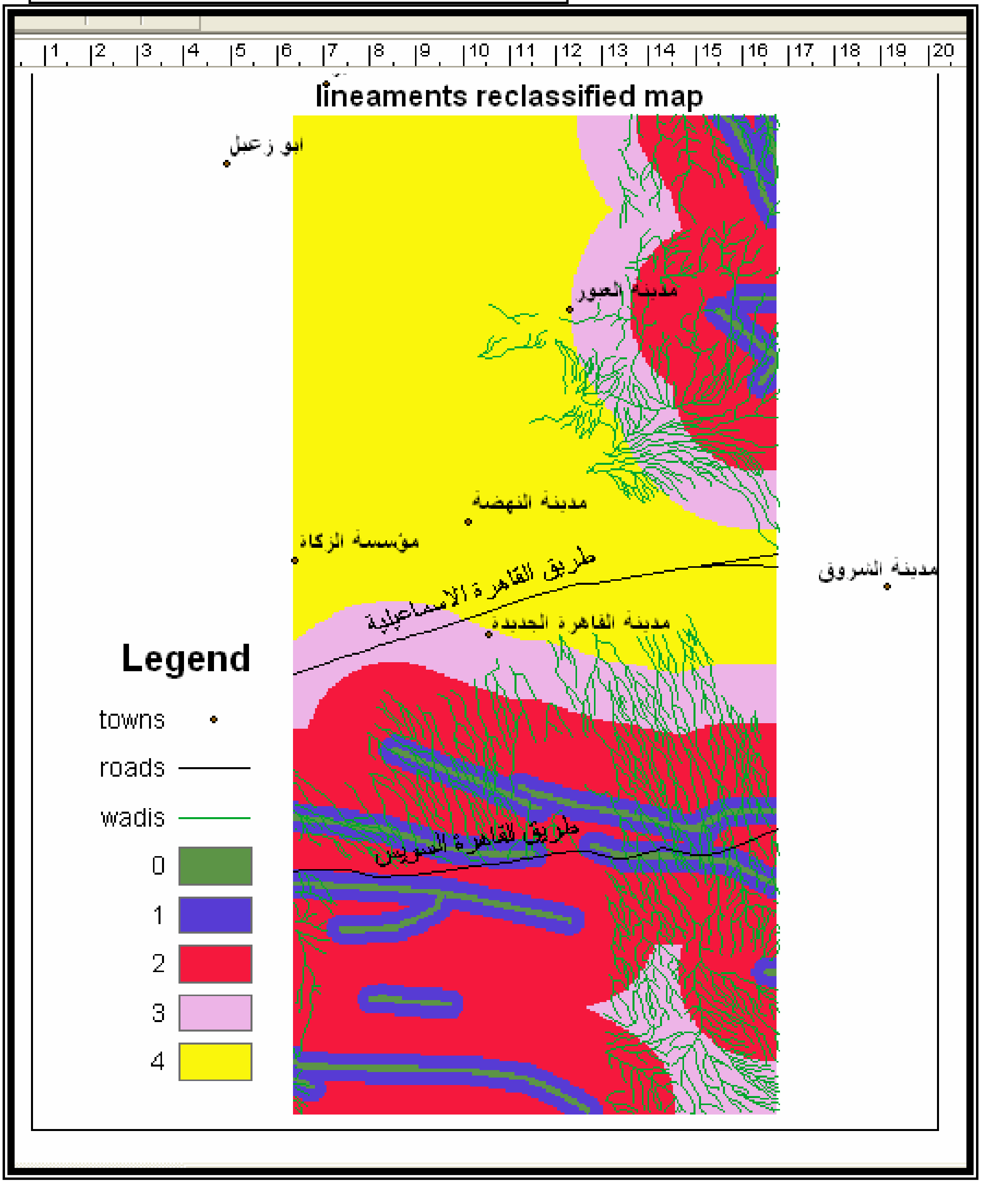


Figure 5.33: the reclassified Structural lineaments layer

5.11.13 Physiographic drains map layer of case study area

Physiographic drains are weak zones for urban development. These drains are shown in the GIS map with its attribute table (figure 5.34) and are buffered with multi-ring buffer zones with surrounding distance 2km around.

Attributes of physio_wadis

FID	Shape	_FNODE	_TNODE	_LPOLY	_RPOLY	LENGTH	PHYSIO_WAD	PHYSIO_W_1	WADIES_ORD	Shape_Leng
0	Polyline	5	8	2	2	224.573	4	10177	2	224.586282
1	Polyline	6	9	2	2	191.519	5	10241	2	191.520584
2	Polyline	8	16	2	2	308.664	9	10177	2	308.675964
3	Polyline	18	15	2	2	165.254	11	9740	2	165.265268
4	Polyline	9	19	2	2	481.556	12	10241	2	481.555166
5	Polyline	19	25	2	2	261.13699	19	10241	2	261.164502
6	Polyline	14	26	2	2	439.38199	20	10219	2	439.396065
7	Polyline	16	30	2	2	664.08002	21	10177	2	664.089295
8	Polyline	25	33	2	2	373.629	23	10241	2	373.62745
9	Polyline	30	36	2	2	146.08501	26	10177	2	146.081397
10	Polyline	26	37	2	2	328.603	27	10219	2	328.608539
11	Polyline	42	40	2	2	257.20999	29	10224	2	257.207553
12	Polyline	38	44	2	2	132.388	30	10237	2	132.391984
13	Polyline	44	42	2	2	406.47101	31	10223	2	406.457229
14	Polyline	46	44	2	2	147.024	33	10223	2	147.020793
15	Polyline	27	47	2	2	428.625	34	10178	2	428.624645
16	Polyline	36	49	2	2	241.55499	35	10177	2	241.561816
17	Polyline	50	46	2	2	312.17499	36	10223	2	312.165505
18	Polyline	33	50	2	2	218.136	37	10241	2	218.147132
19	Polyline	47	58	2	2	216.79201	43	10179	2	216.791239
20	Polyline	49	58	2	2	181.89999	44	10177	2	181.899244
21	Polyline	37	60	2	2	368.66699	47	10219	2	368.688101
22	Polyline	50	66	2	2	658.48401	53	10233	3	658.484062
23	Polyline	58	92	2	2	878.55603	81	10185	3	878.601352
24	Polyline	103	105	2	2	253.40601	90	13929	2	253.398391
25	Polyline	105	101	2	2	350.909	91	13929	2	350.903783
26	Polyline	115	92	2	2	1000.79	99	13914	3	1000.825461
27	Polyline	116	93	2	2	939.13702	100	13974	2	939.160389
28	Polyline	118	108	2	2	362.94101	102	13951	2	362.956989

Record: 1 Show: All Selected Records (0 out of 385 Selected) Options

Figure 5.34: Attribute table of Physiographic drains map of case study area

Using IMAGINE Erdas 9.2 Spatial Analyst reclassification command, the areas took 2 values, one and two from which the closer zones are worst and the more far are better in this analysis. This layer is finally weighted with score 2 due to its importance level in urban development.

Distance from drains	Ranking
0 – 1 km	1
1 – 2 km	2

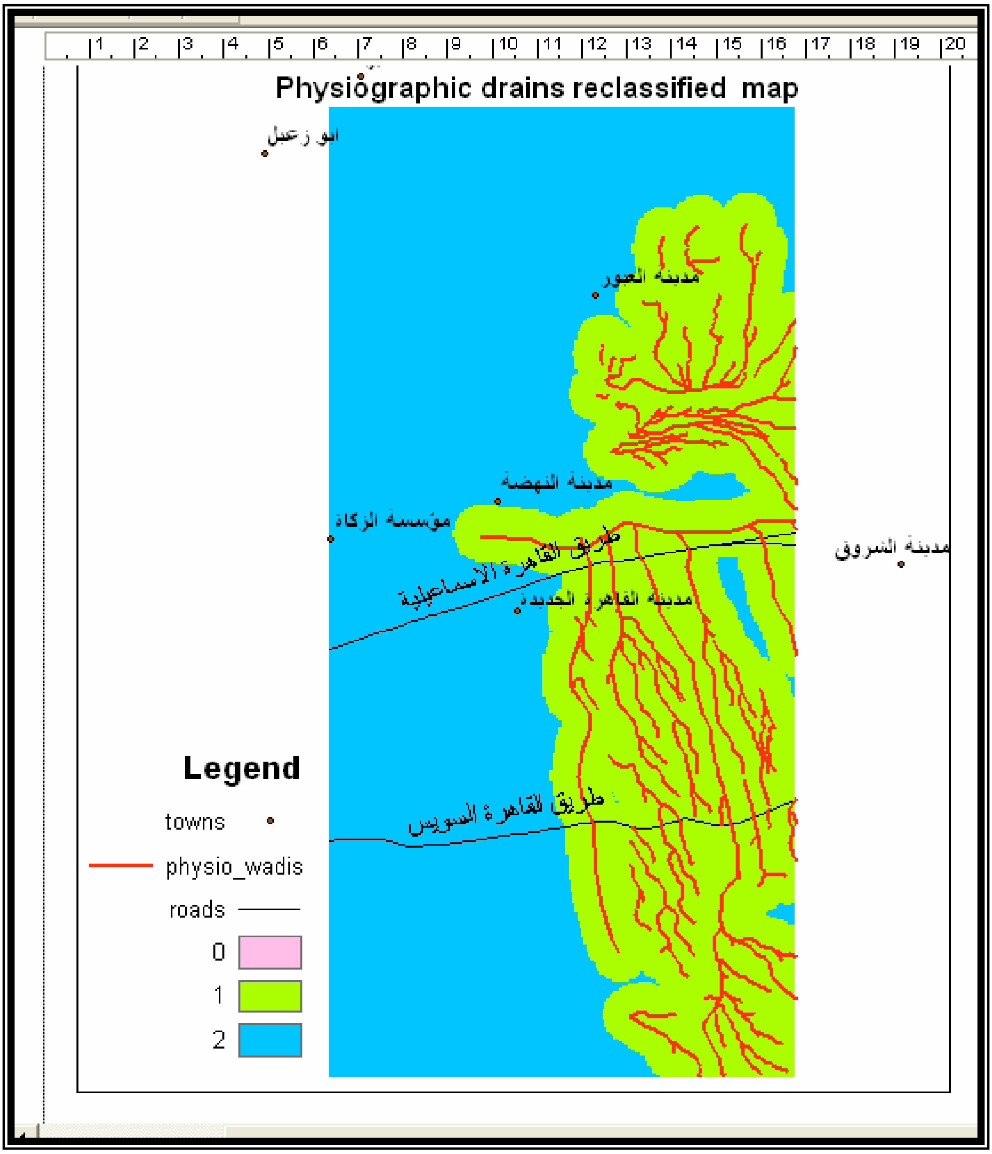
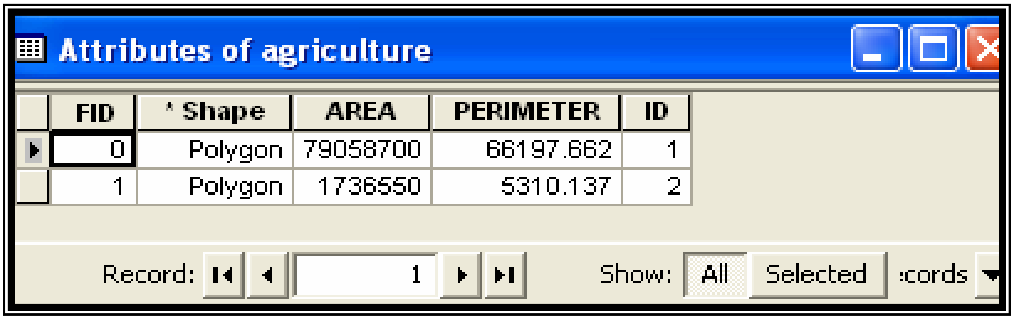


Figure 5.35: the reclassified Physiographic drains map layer

5.11.14 Agriculture map layer of case study area

The agriculture factor is an important factor as it gives the surrounding areas very high capabilities for urban development. These agriculture areas are shown in the GIS map with its attribute table (figure 5.36).



Attributes of agriculture

FID	Shape	AREA	PERIMETER	ID
0	Polygon	79058700	66197.662	1
1	Polygon	1736550	5310.137	2

Figure 5.36 Attribute table of Agriculture map of case study area

Using Erdas Imagine 9.2, the buffer zone areas around the agriculture zones were drawn, and then we defined these ranked zones around the agricultural areas depending on the distance to these areas. Closer areas to agricultural areas are better in urban development and more far are less good. The areas of agriculture itself are taking zero score in urban development analysis as they are excluded from analysis to be preserved. Finally, a ranked (reclassified) map was produced with given weighted value 2 due to its importance level in urban development.

Distance to Agricultural areas	Ranking
Inside	0
0 – 5km	4
5 – 10 km	3
10 – 20 km	2
>20 km	1

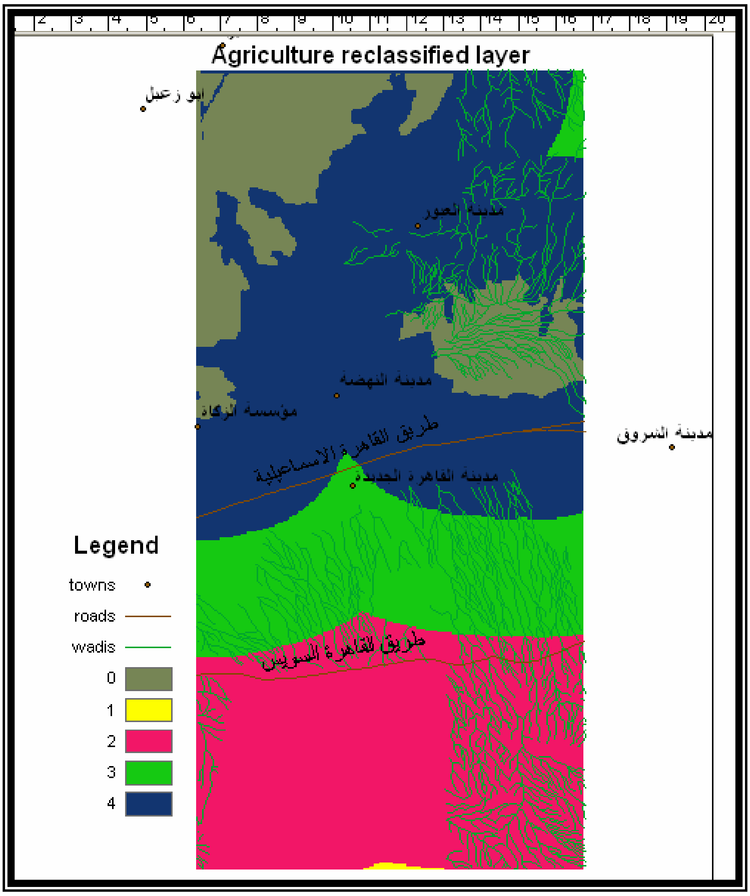


Figure 5.37: the reclassified Agriculture map layer

5.11.15 Urban areas map layer of case study area

The existing and neighborhood areas to well planned urbanized locations are considered attracted to urbanized extensions, while the slum non planned settlements have a negative influence to close urban development.

Attributes of urban

FID	Shape	AREA	PERIMETER	ID
0	Polygon	3283200	8914.609	9
1	Polygon	6666750	17749.02	10
2	Polygon	5856300	12917.126	12
3	Polygon	1876050	6052.018	13
4	Polygon	0	0	0
5	Polygon	0	0	0
6	Polygon	0	0	0
7	Polygon	0	0	0
8	Polygon	0	0	0
9	Polygon	0	0	0
10	Polygon	0	0	0
11	Polygon	0	0	0

Record: 1 Show:

Attributes of towns

FID	Shape	CODE	A_NAME	E_NAME
0	Point	3	مؤسسة الزكاة	Moasasat Al Zakah
1	Point	4	ابو زعبل	Abou Zaabal
2	Point	400	المنير	Almounir
3	Point	549	مدينة الشروق	Madinet Al Shorouk
4	Point	1113	مدينة النهضة	Madinet Al Nahda
5	Point	1114	مدينة القاهرة الجديدة	Madinet Al Kahira Al Gadida
6	Point	1115	مدينة العبور	Madinet Al Oubour

Record: 1 Show: All Selected Records (0 out of 7

Figure 5.38: Attribute table of urban areas and Towns map of case study area

The main point here is that areas inside and close to the existing settlements will be considered more suitable for urban development than other areas.

At the end of this analysis, a map was made showing the suitability grades for urban development from the urban point of view.

The already urbanized locations have to be buffered, reclassified and weighted. Depending on the ranking, a distance map was created for the existing urban areas (Figure 5.39) and this distance map was reclassified as follows:

This layer is finally weighted with score 3 due to its importance level in urban development.

Distance from Urban	Ranking
[Inside] + [0 – 1 km]	4
1 – 2.5 km	3
2.5 – 5 km	2
>5 km	1

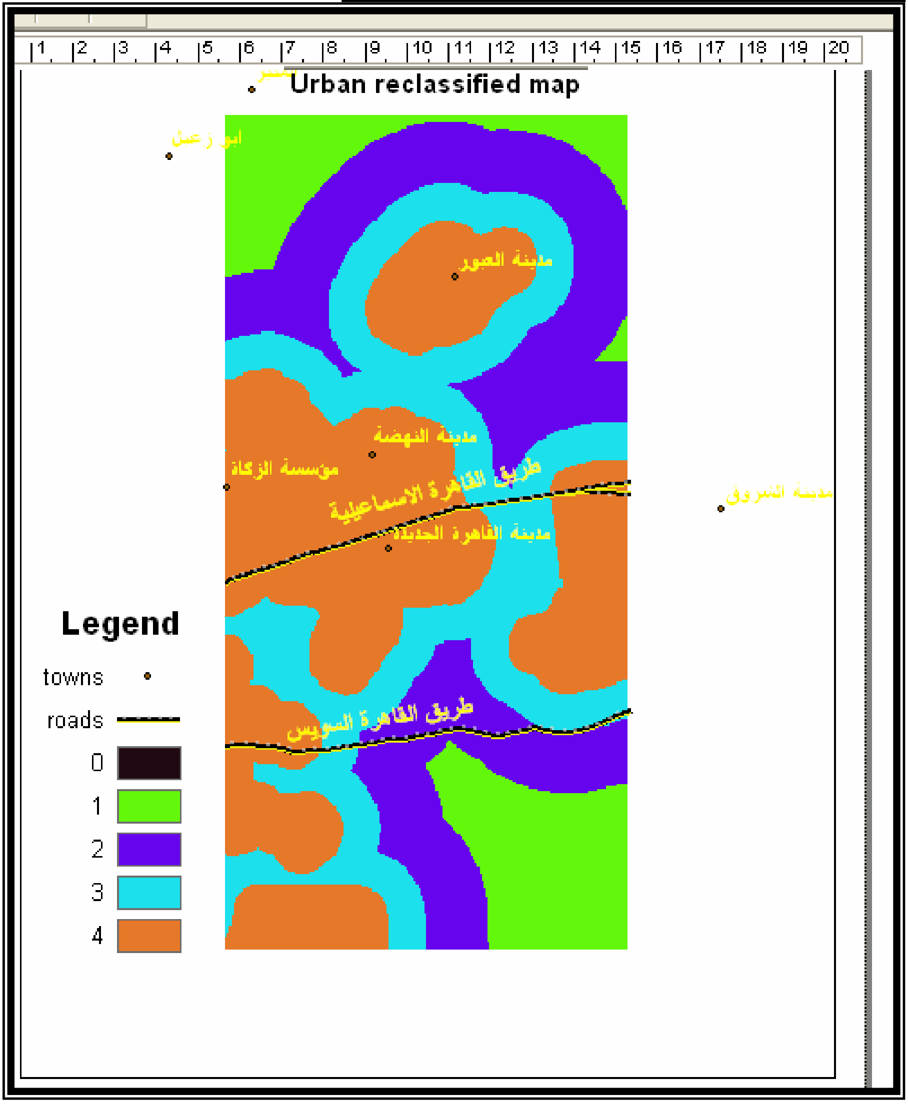


Figure 5.39: the reclassified urban areas map layer

5.11.16 Basins map layer of case study area

In this study, basins layer is mapped into GIS. The GIS map shows suitability of basins for urban development and reclassified into high, moderate and low, which had scores 1, 3 and 4 respectively as a suitability ranking for urban development.

Using Erdas Imagine 9.2, we defined the ranked polygons in the basins layer to produce map that is given a weighted value equals 2 due to its importance level in urban development.

Attributes of basins

OBJECTID	Shape	AREA	PERIMETER	_BASINS	BASINS_ID	HAZARD_COD	Shape_Length	Shape_Area
1	Polygon	281279010	95451.398	2	4	MODERATE	83568.479689	207500645.106366
2	Polygon	87434000	45144.602	3	17	MODERATE	18707.36175	20775696.857531
3	Polygon	86391104	40423.801	5	15	MODERATE	32023.670523	56933048.822496
4	Polygon	106881000	58721.801	8	23	MODERATE	26452.455066	25000540.448822
5	Polygon	158200000	60635.898	9	25	HIGH	41497.294626	51373891.163166
6	Polygon	221758000	61853.301	11	29	LOW	57361.485172	192533553.807909

Record: 1 Show: All Selected Records (0 out of 6 Selected) Options

Figure 5.40: Attribute table of Basins map of case study area

BasinType	Ranking
High	1
Moderate	3
Low	4

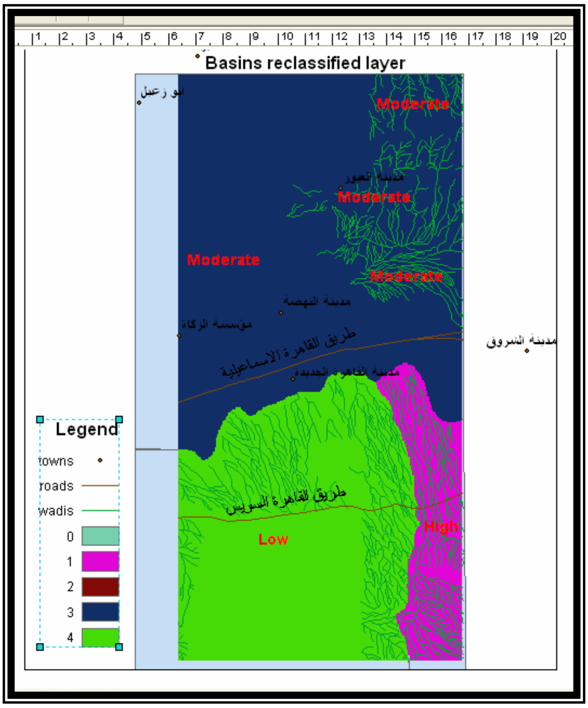


Figure 5.41: the reclassified map of Basins layer

5.11.17 Flash Flood map layer of case study area

To generate the flood risk zoning, several steps had been done because it is very important to have accurate map for flood risk areas. The shape of a surface determines how water will flow across it. The hydrologic modeling function is one of the GIS functions that provide methods for describing the physical components of surface. Using elevation grid or the DEM (Digital Elevation Model) we had delineated a drainage system and quantified the characteristics of that system.

To calculate a watershed and stream network of the study area, we used the DEM as input into the flow directions operations to which water will flow out of each cell.

To create a stream network; flow accumulation request was used to calculate the number of upslope cells flowing to a location. The output of the flow direction request from the previous step was used as input.

The flow accumulation is divided into three categories from the flow accumulation map, highly hazards streams, moderately hazards streams and slightly hazards streams, depending on the number of the flow accumulation into each cell of the study area.

The highly hazards streams had been identified and buffered 1km from each side and defined as flood risk zones.

Attributes of flooding

PERIMETER	_FLOODING2	FLOODING21	HAZARD_COD	CODE_FLOOD	Shape_Leng	Shape_Area	rating
95451.398	2	1	Moderate	2	83568.479689	207500645.106	3
45144.602	3	13	Moderate	2	18707.36175	20775696.8575	3
61853.301	11	28	Moderate	2	57361.485172	192533553.808	3
58721.801	8	22	Low	1	26452.455066	25000540.4488	4
40423.801	5	17	High	3	32023.670523	56933048.8225	1
60635.898	9	27	High	3	41497.294626	51373891.1632	1

Record: 1 Show: All Selected Records (0 out of 6 Selected) Options

Figure 5.42: Attribute table of Flash Flood map layer of case study area

The map is reclassified due to its suitability grade into high, moderate and low. Finally, a reclassified map is produced and weighted according to its importance level in urban development which equals 2 in this analysis study.

Basin type	Ranking
High	1
Moderate	2
Low	3

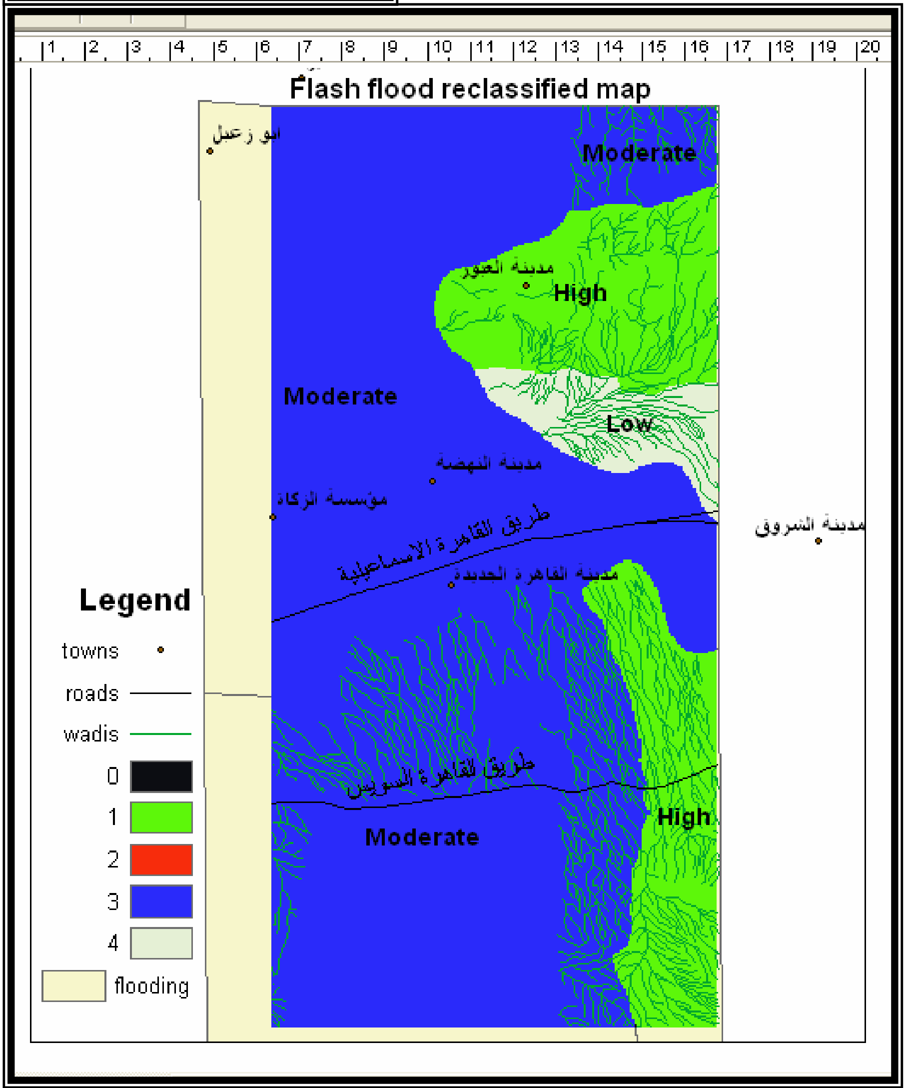


Figure 5.43: the reclassified map of Flash Flood layer

5.11.18 Earthquakes epi centers-intensity map layer of case study area

To generate the earthquakes hazard risk zones several steps has been done. The distribution shape of earthquakes epicenters can give indicator about the hazard areas that can be affected with earthquakes; Earthquake epicenters that occurred in the study area have been digitized by giving the epicenters its value "magnitude" by Richter scale and through using the spatial analyst contour generating, a seismic contour map for the study area can be produced.

By using the GIS spatial analyst and interpolating values of earthquakes epicenters to create the surface of the study area, using cell size of 100m "to be covalent with the rest of the study" a figure of the seismic activity in the area can be produced showing which areas are more threatened by earthquakes more than others.

So the areas with seismic value less than 5^o by Richter scale were accepted as highly suitable and the areas with the value over 5^o by Richter scale had less suitability scores as special precautions should be done in these areas.

Attributes of epi_intensity_polygon

EPI_INTENS	EPI_INTE_1	CODE_EPINO	EPI_INT_CO	Shape_Leng	Shape_Area	code
20	59	0.045	2	13932.205007	15201115.458	1
27	78	0.045	2	8858.461566	3758834.22703	1
3	15	0.04	2	43122.906491	32090279.8085	3
4	1	0.035	1	141415.597461	377038354.668	3
5	22	0.03	1	17214.090386	20235394.8775	3
21	62	0.03	1	10688.378627	4130195.06459	1
22	63	0.03	1	14257.814826	7731593.24703	1
25	71	0.025	1	4097.478168	633457.716008	1
18	53	0.04	2	67591.974529	93252370.3869	1

Record: 4 Show: All Selected Records (1 out of 9 Selected)

Figure 5.44: Attribute table of Earthquakes epi centers-intensity map layer of case study area

Depending on the acceptance or rejection of criteria, the cell value should consist of either a (1) for low areas in suitability or a (3) for suitable areas. So the development at the areas low in suitability will need to follow the earthquakes codes. Also special precautions should be followed.

Epi intensity (Reclassification)	Ranking
0-5	1
>5	3

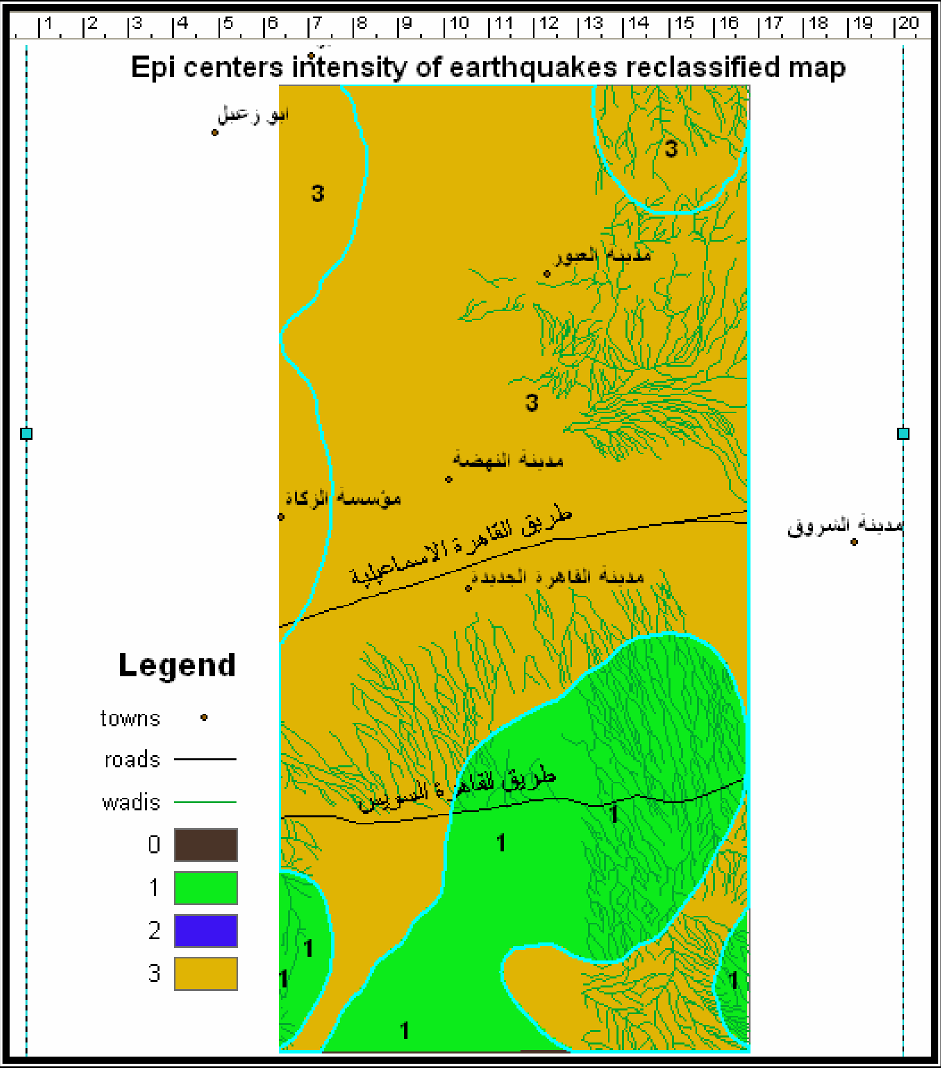


Figure 5.45: the reclassified map of Earthquakes epi centers-intensity layer

5.11.19 Geomorphological map layer of case study area

Geomorphology layer is mapped into GIS and its attribute table is shown in figure 5.46. So the Geomorphological layer is ranked (reclassified) due to the type of land (figure 5.47) and this layer is weighted "2" due to its importance level in urban development.

Attributes of Geomorphology

PERIMETER	GEOMORPHOL	GEOMORPH_1	GEOMORPH_U	CODE_GEOMO	Shape_Leng	Shape_Area	rate
28388.1	6	70	SAND DUNES	5	28005.600518	39188190.0304	0
33372.801	7	71	SAND DUNES	5	300.765242	2891.003709	0
13036.7	2	1	NILE FLOOD PLAIN	9	5414.027579	1106435.91102	4
124677	3	17	UM GIDAM GRAVELLY S	4	89956.678558	127436202.064	3
73548.898	4	69	STRUCTURAL RIDGES	7	23960.554284	10883983.5047	2
266749	5	84	DEPRESSIONS	3	157014.06122	363551971.343	1

Record: 1 Show: All Selected Records (0 out of 7 Selected) Options

Figure 5.46: Attribute table of Geomorphological map layer of case study area

Geomorphology	Ranking
Sand dunes	0
Depressions	1
Structural ridges	2
UM Gidam gravelly	3
Nile flood plain	4

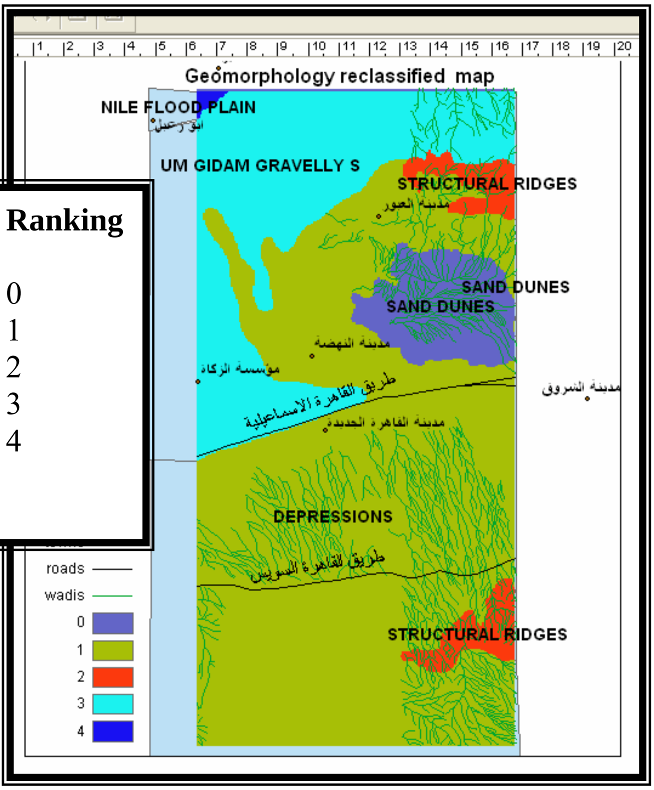
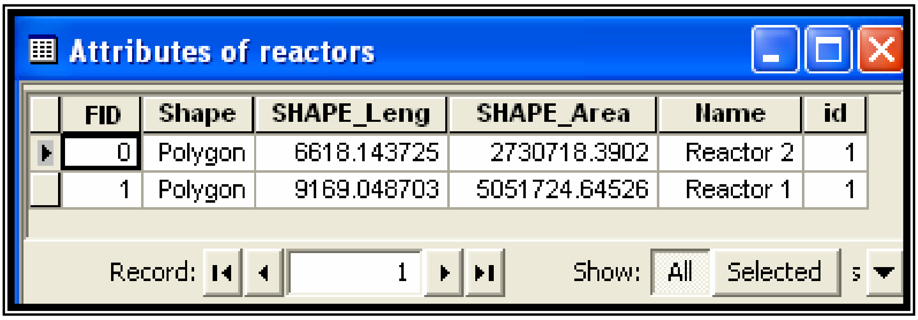


Figure 5.47: the reclassified map of Geomorphological layer

5.11.20 Reactors of EAEA map layer of case study area

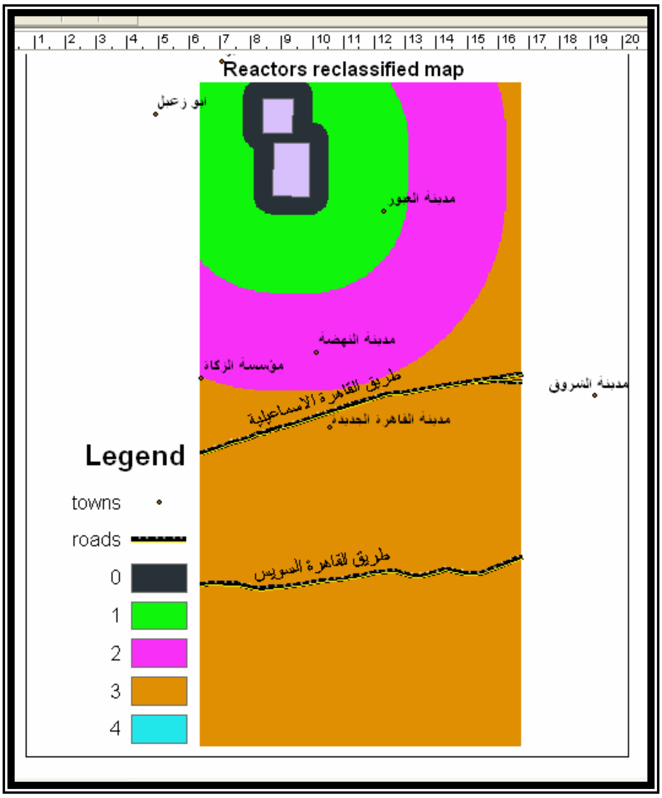
Layer of Reactors of EAEA is mapped into GIS and its attribute table is shown in figure 5.48. The main point here is that areas inside and close to the Reactors of EAEA will be considered not suitable for urban development. A map is made showing the suitability grades for urban development from the urban point of view.



FID	Shape	SHAPE_Leng	SHAPE_Area	Name	id
0	Polygon	6618.143725	2730718.3902	Reactor 2	1
1	Polygon	9169.048703	5051724.64526	Reactor 1	1

Figure 5.48: Attribute table of Reactors of EAEA layer

Reactors of EAEA are weak zones for urban development. These Reactors are buffered with multi-ring buffer zones with surrounding distance 10km around, reclassified and weighted. Depending on the ranking, a distance map was created for the existing urban areas (Figure 5.49).



Distance from Reactors	Ranking
0 – 100 meter	0
100m – 2km	1
2 – 5 km	2
5 – 10 km	3
>10 km	4

Figure 5.49: the reclassified map of Reactors of EAEA layer

5.11.21 Rock-use map layer of case study area

Some of the rock types existed in case study area is economically feasible to be extracted.

Attributes of rock_use2

OBJECTI	* Shape	AREA	PERIMETER	_ROCK	_ROCK	_CODE	LITHOLOGY	Shape_Length	Shape_Area
1	Polygon	9834220	13036.5	2	323	1		5413.950631	1106422.34993
2	Polygon	63584500	40731.5	3	33	2	Quaternary (Plistoene&Holoene)	34337.942818	49245442.03508
3	Polygon	72365104	59638.5	4	314	2	Quaternary (Plistoene&Holoene)	31923.037077	17316048.03683
4	Polygon	3886220	12558.9	5	41	6	M.Miocene	12558.945111	3886277.13441
5	Polygon	299776000	112776	6	300	2	MN.Miocene	99732.489554	208411797.8627
6	Polygon	742175	3381.8899	7	42	6	M.Miocene	3381.895423	742188.29078
7	Polygon	2960750	8118.8799	9	54	3	M.Miocene	8118.87713	2960787.65743
8	Polygon	82390400	65472.801	10	58	2	Sand dunes	65473.320607	82391620.4280
9	Polygon	54085500	101719	11	59	3	M.Miocene	26489.359978	10585442.91268
10	Polygon	46389100	81903.102	13	316	2	Quaternary (Plistoene&Holoene)	29389.152599	16664190.03169
11	Polygon	2338850	12428.2	14	80	4	Oligocene	3043.682233	293259.63492
12	Polygon	39578700	28383.699	19	120	2	Sand dunes	27999.964333	39184517.14203
13	Polygon	24019400	33371.5	20	133	2	Sand dunes	297.344011	2459.64766
14	Polygon	9432680	16148.5	25	192	4	Oligocene	16148.638897	9432826.05761
15	Polygon	131476000	101378	33	317	4	Oligocene	58222.209985	98878044.89992
16	Polygon	2264710	6175.3999	36	219	4	Oligocene	4485.593494	510380.12485
17	Polygon	21928900	31864.699	38	231	3	U.Eocene	14443.197728	7997076.46580
18	Polygon	3922110	10423	42	248	4	Oligocene	10423.005012	3922179.0368
19	Polygon	17055.9	562.08002	43	318	4	basalt	562.058229	17054.82551
20	Polygon	22536.6	623.96698	46	316	4	basalt	623.973226	22537.0295
21	Polygon	337378	2747.3701	52	287	4	basalt	2747.33514	337383.29044

Record: 1 Show: All Selected Records (0 out of 21 Selected) Options

Figure 5.50: Attribute table of Rock-use map layer

These sites favorably used as rock extraction quarries. Therefore the rock use map is designed and ranked as follow:

Rockuse type	**Ranking**
Sand dunes	0
M.Miocene	1
MN.Miocene	1
Basalt	1
Oligocene	2
Quaternary (Plistoene&Holoene)	2
U.Eocene	3

The Rock-use map layer is reclassified due to its types (figure 5.51) and this layer is weighted "1" due to its importance level in urban development.

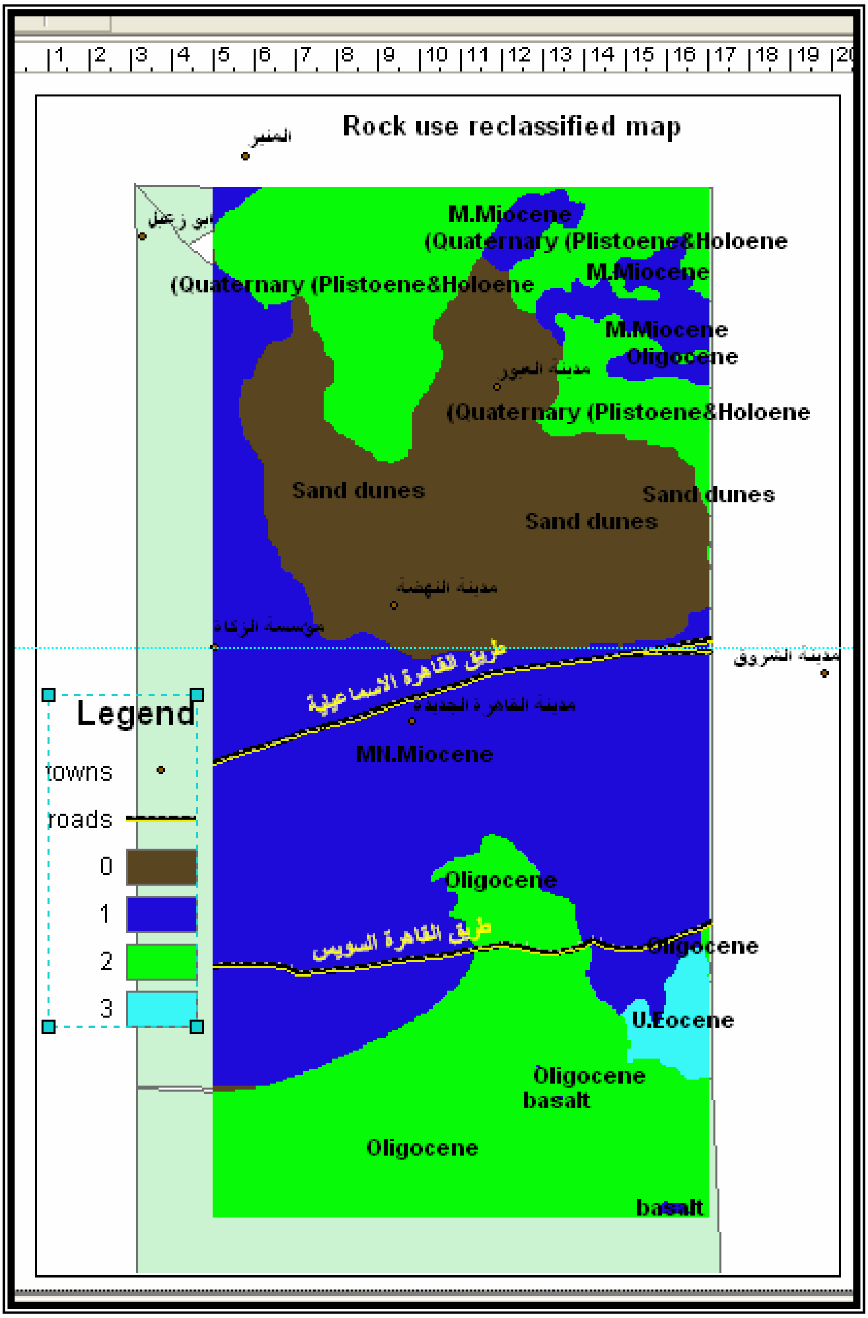


Figure 5.51: The reclassified map of Rock-use layer

5.11.22 Water-depth map layer of case study area

The Water-depth of underground water is an important factor in urban development, as it has its sensitivity in the ecosystem.

Attributes of water_depth

FID	Shape	AREA	PERIMETER	WATER_DEPT	WATER_DE_1	WA_DEPTH	Shape_Leng	Shape_Area
0	Polygon	10148800	23390.6	18	31	101	23390.742794	10148996.7521
1	Polygon	6031420	10601.8	19	32	111	10601.846502	6031491.21763
2	Polygon	194114	1683.16	21	33	121	1683.170263	194119.131795
3	Polygon	3313020	7725.48	28	40	21	7725.425545	3313077.01457
4	Polygon	12478500	21272.6	3	3	11	3229.096762	420615.033252
5	Polygon	109351000	77453	4	5	21	54740.974355	57496388.9895
6	Polygon	70281504	83305.398	5	16	31	70320.229447	56619112.3699
7	Polygon	72228096	105594	6	17	41	77300.443583	55760809.8515
8	Polygon	79476600	111611	9	18	51	93950.116523	65410367.5991
9	Polygon	88512600	118643	10	19	61	109713.898099	81680816.345
10	Polygon	76008200	125550	11	0	71	105256.10941	62816915.5952
11	Polygon	83809104	133679	12	20	81	99563.535082	58678667.7728
12	Polygon	68421696	97738.797	13	22	91	41938.907022	26602614.2454
13	Polygon	55058000	97519.398	14	26	101	36552.325186	23967553.9746
14	Polygon	52114200	94812.898	15	27	111	32668.849171	21880784.6455
15	Polygon	19320900	38406.801	16	30	91	38391.299265	19320785.2204
16	Polygon	33418200	57494.898	24	28	121	23532.640379	3774327.48894

Record: 1 Show: All Selected Records (0 out of 17 Selected) Options

Figure 5.52: Attribute table of Water-depth map layer

The water depth was studied and reclassified into 5 categories 4, 3, 2, 1 & 0 as follows:

Water depth	Ranking
0 – 200	4
200 – 600	3
600 – 800	2

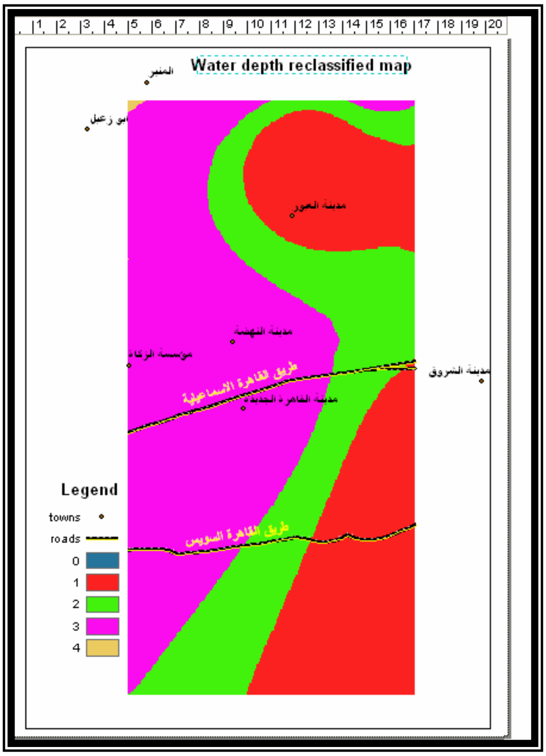


Figure 5.53: the reclassified map of Water-depth layer

5.11.23 Slope map layer of case study area

If the slope here is less than 13 degree, it considered suitable for urban development, and more than this degree, it is rejected for urban development. The spatial analyst extension is used to calculate the slope. Attribute table of the slope map layer for case study area is shown in figure 5.

The values of the slope are reclassified into five classes (From 0-3 degree, 3-7 degree, 7-10 degree, 10-13 degree and 15+ degrees).

A map of the accepted areas and the rejected areas from the slope point of view was built. It became able to reclassify slope classes into suitability classes and then recalculate the areas of the suitable land. Last step is to change the suitability to classes depending on: the slope degree from 0-3 is suitability 4, 3-7 is suitability 3, 7-10 is suitability 2, 10-13 is suitability 1 and >13 is suitability 0 (rejected).

Attributes of slope.img

OID	Value	Count
0	0	31967
1	1	40259
2	2	14703
3	3	4366
4	4	1525
5	5	678
6	6	323
7	7	150
8	8	93
9	9	55
10	10	49
11	11	29
12	12	28
13	13	17
14	14	18
15	15	12
16	16	7
17	17	4
18	18	1
19	19	5
20	20	9
21	21	9
22	22	9
23	23	30
24	24	13
25	25	16

Figure 5.54: Attribute table of Slope map layer

Slope	Ranking
0 – 3	4
3 – 7	3
7 – 10	2
10 – 13	1
> 13	0

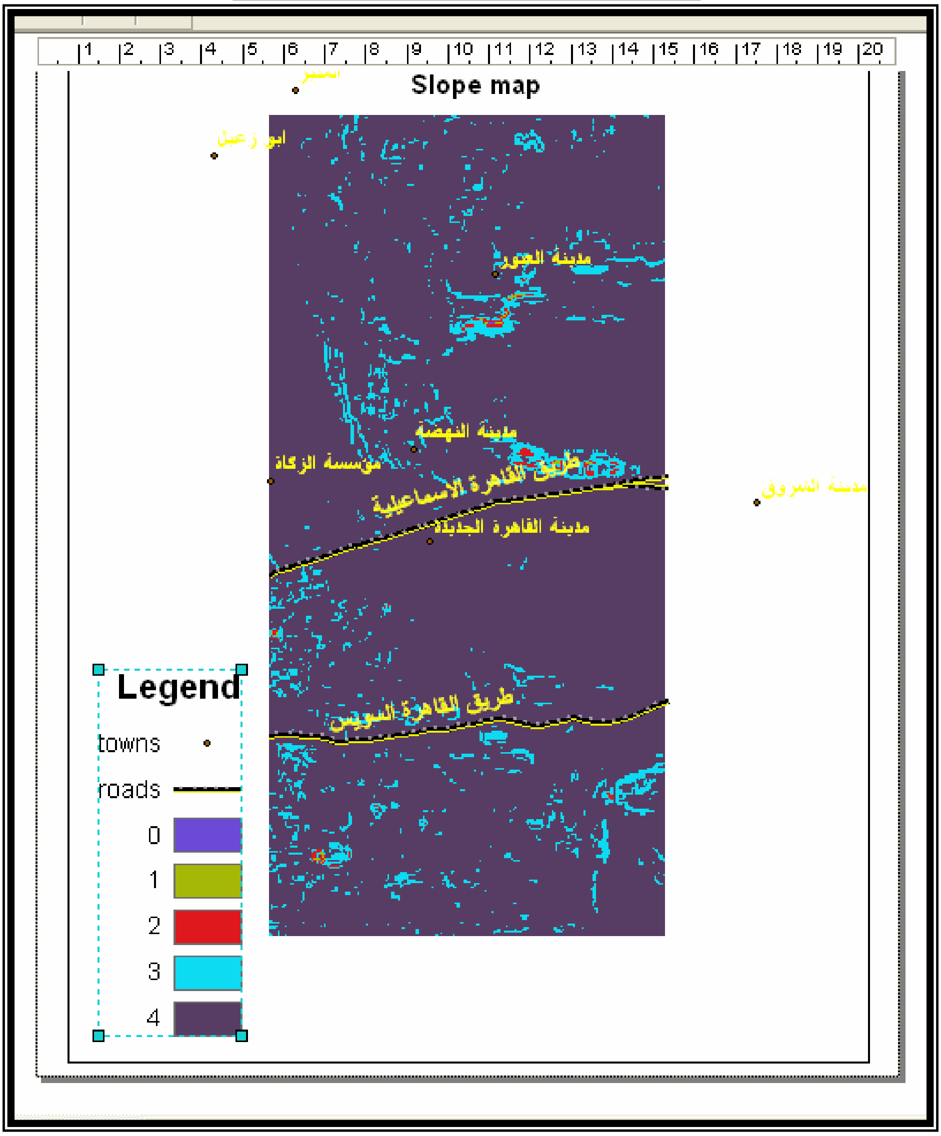


Figure 5.55: the reclassified map of Slope layer

5.12 Summary

The presence of a good geographic database is the first step to build the urban suitability model. The geographic database created in this study was used to derive the land suitability for urban development in the study area.

Geodatabase storage area enables all stakeholders, such as planners and researchers, to access spatial data relative to urban, environmental, socioeconomic, transportation, utility services, flood control, and public safety issues.

All data (vector, raster, address, measures, CAD, etc.) is stored together in a commercial off-the-shelf RDBMS. This means that organizations can have an integrated data management policy covering all data, which can significantly simplify support and maintenance, and reduce costs.

This chapter demonstrates the potential of GIS-based assessment for site suitability in an urban area. The reliability of the assessment depends on a multitude of factors ranging from the quality of the established database to the potential errors that may be associated with data input and analysis. Thus, the resulting database included only reliable information related to specifically selected factors that were considered most important in determining site suitability within North East of Cairo. In addition, input data, analysis procedures, and outputs were checked.

CHAPTER SIX

SUITABILITY MODEL AND USER INTERFACE APPLICATION FOR CASE STUDY AREA

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SUITABILITY MODEL AND USER INTERFACE APPLICATION FOR CASE STUDY AREA

6.1 Urban Suitability Model

6.1.1 Significance of developing model

Modeling is a way of describing something that can not be experiential in reality. Because all phenomena in our environment can not be observed at one time, models are used to create simplified representation of reality. This is done by simulating reality as a set of variables in map layers format. Relationships of such layers are modeled with spatial analysis tools.

A GIS model is a set of rules and procedures for representing a phenomenon or predicting an outcome [ESRI Inc., 2005 ArcGIS 9.1 software help by ESRI Inc.]. In geo-processing, a model consists of one process or a sequence of processes connected together. Building a model helps manage and automate geo-processing work flow, as managing processes and their supporting data can be difficult without the aid of a model.

Urban Suitability Model is established to provide final map for the study area, showing information as guidance for urban planning and development as well as early-warning regarding problematic areas. This model is a GIS-based process for evaluating the suitability of land for urban development which makes it easier for decision makers to address the requirements to make decision about urban land-use development. It looks at the characteristics of land from different points of views through number of layers that sometimes buffered, then all layers were ranked (reclassified) and weighted due to its importance level in urban development. Then cells from various layers stacked on top of each other, describing many attributes to find optimum locations.

6.1.2 Developing the urban suitability model

Urban suitability is being determined upon certain criteria whereas certain land-uses are more conductive than others for urban development. For example, it is desired to locate the urban development on flat or gently sloping lands, near infrastructures, and far from earthquake epicenters, sand dunes and flash flood zones.

Criteria for urban development were based on the potentials and the constraints. Potentials include natural and human resources, while constraints include natural hazards and unsuitable lands. Both criteria were ranked and weighted according to their influence in the process of urban suitability and were used in a Geographic Information System (GIS) model. This suitability model (figure 6.1) is used to produce the land suitability map for urban development.

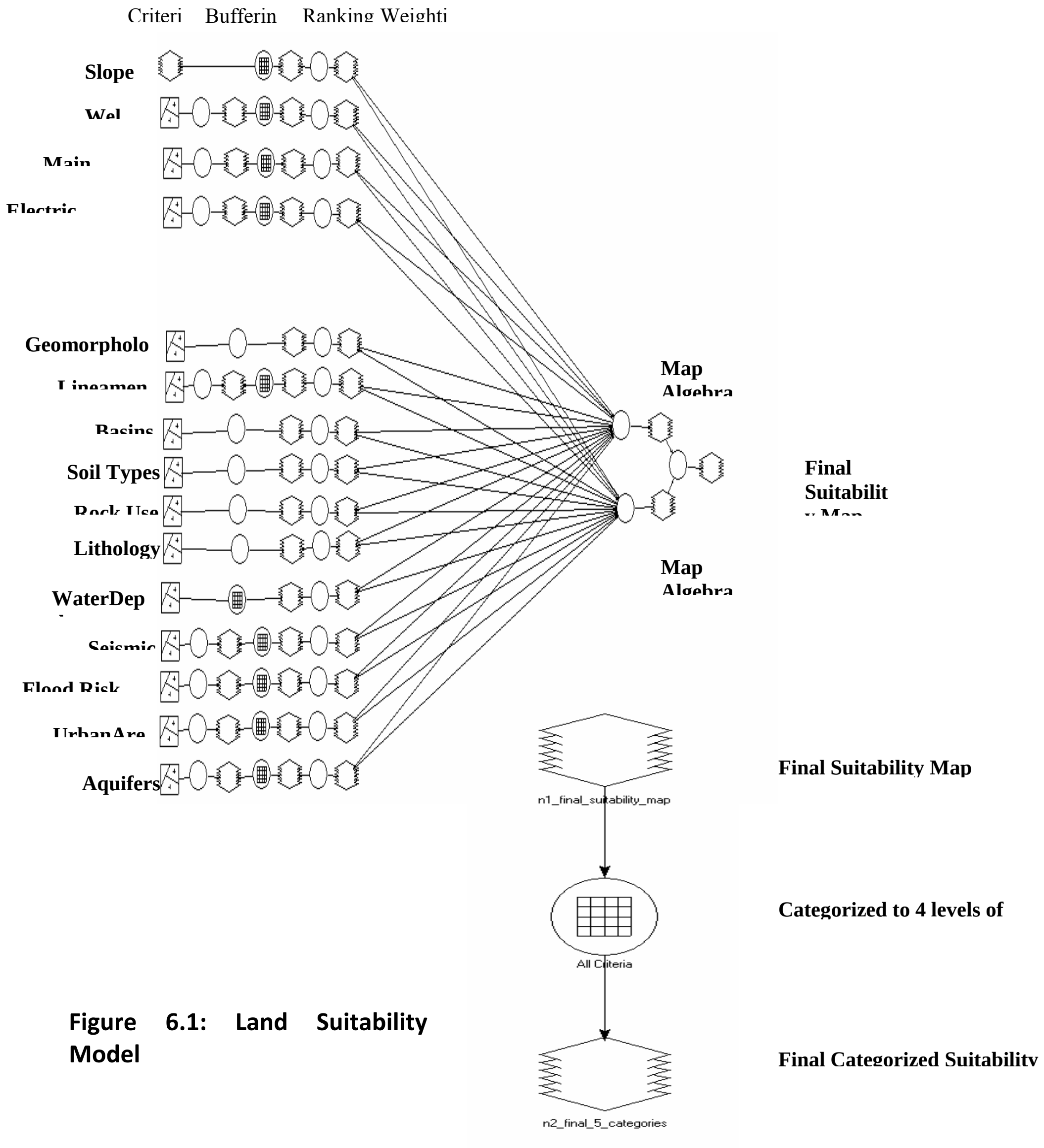

Figure 6.1: Land Suitability Model

6.1.3 Urban suitability model mechanism

6.1.3.1 Acquisition of layers

Using ERDAS Imagine 9.2 software, the data layers prepared are to be entered into the model. This includes clipping the data to the correct boundary, and the model includes most of the data preparation steps, so the decision to run some processes outside of the model was based on the amount of time those processes took to run.

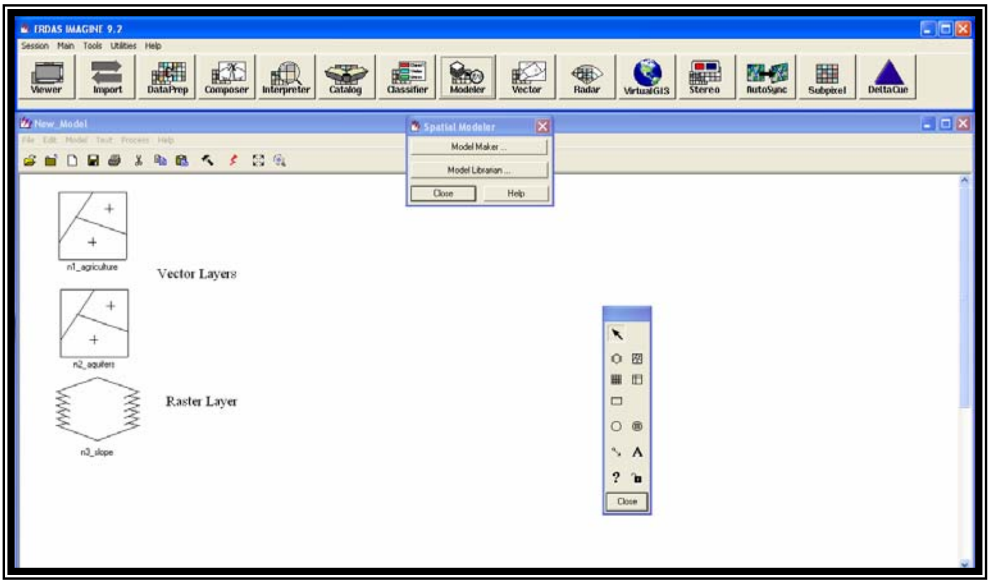

Figure 6.2: Using Erdas Imagine 9.2 Model Maker to create a model and start adding vector and raster layers into it

6.1.3.2 Converting layers to raster

In this analysis, all the layers should be in raster format, therefore the vector layers (e.g. maps including polygons, lines or points) should be converted to raster layers, and should be extrapolated to cover the whole area of interest. Polygons should be converted to grid (e.g. soil, land cover…). In case of lines and points data (e.g. faults and earthquakes), the software calculates the distance to closest source, this process is called Euclidean distance.

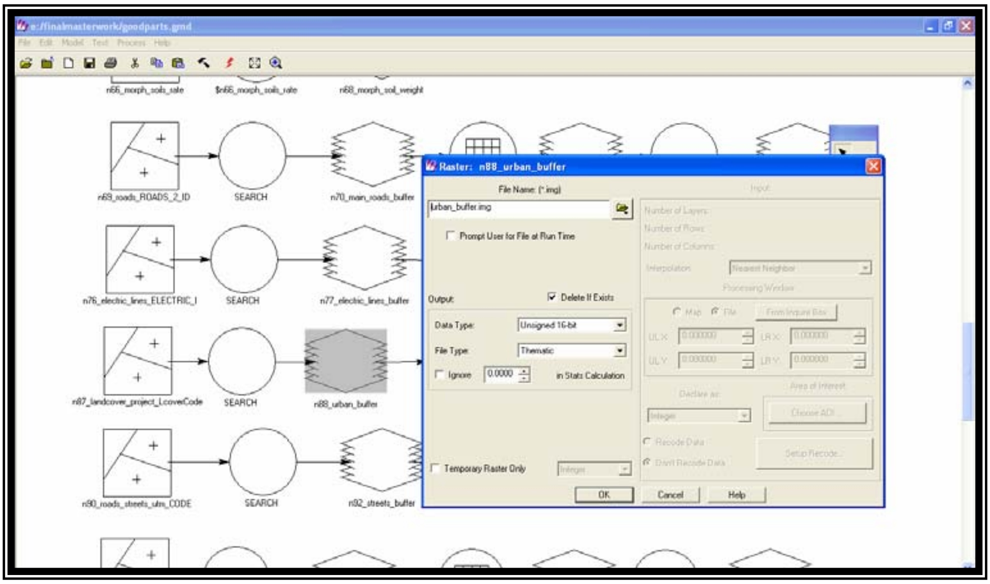

Figure 6.3: Raster conversion analysis using Erdas Imagine 9.2 model maker module

6.1.3.3 Ranking in each layer

For each input raster layer, zones of priorities should be assigned. The capability to reclassify ranges of values becomes even more critical when reclassifying continuous data. Reclassifying range of values is usually done when the input values are continuous (for example, elevation or distance). Each layer is reclassified due to its suitability in urban development as 4, 3, 2, 1 and 0 with 4 is assigned for the most suitable degree in urban development, 3 is assigned for the areas suitable, 2 is assigned for the areas moderately suitable, 1 is assigned for the areas least suitable and zero is assigned for the areas not suitable at all in urban development (Figure 4.4).

6.1.3.4 Buffering some layers

A buffering technique was applied for the urban suitability model to determine values that should be assigned inside / outside the extent of the feature and its buffering zones around it that has an effect in urban development (Fig. 6.4).

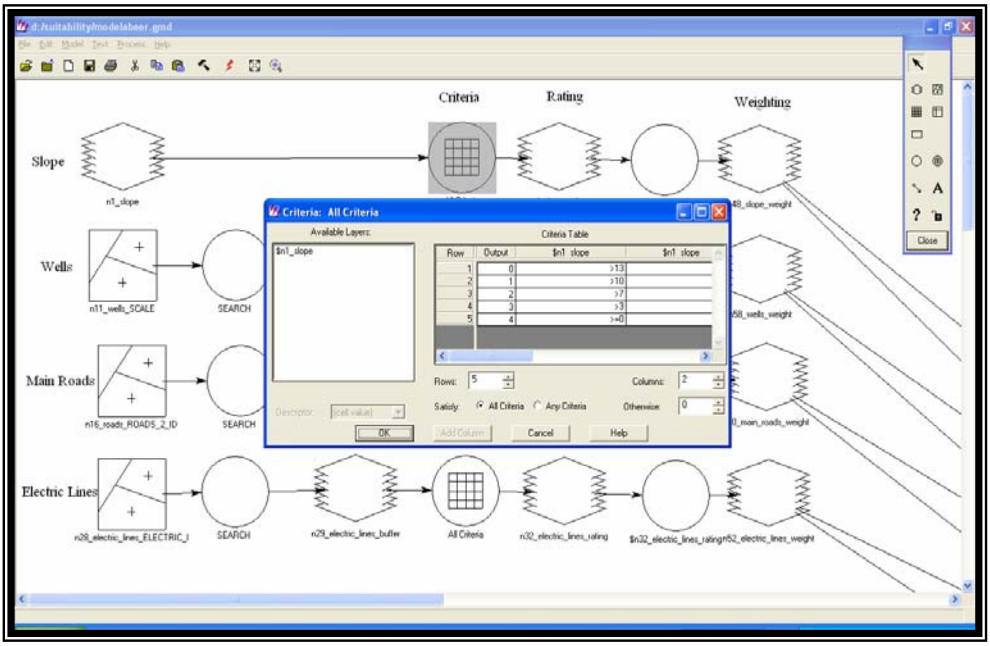

Figure 6.4: Buffering technique

6.1.3.5 Weighting

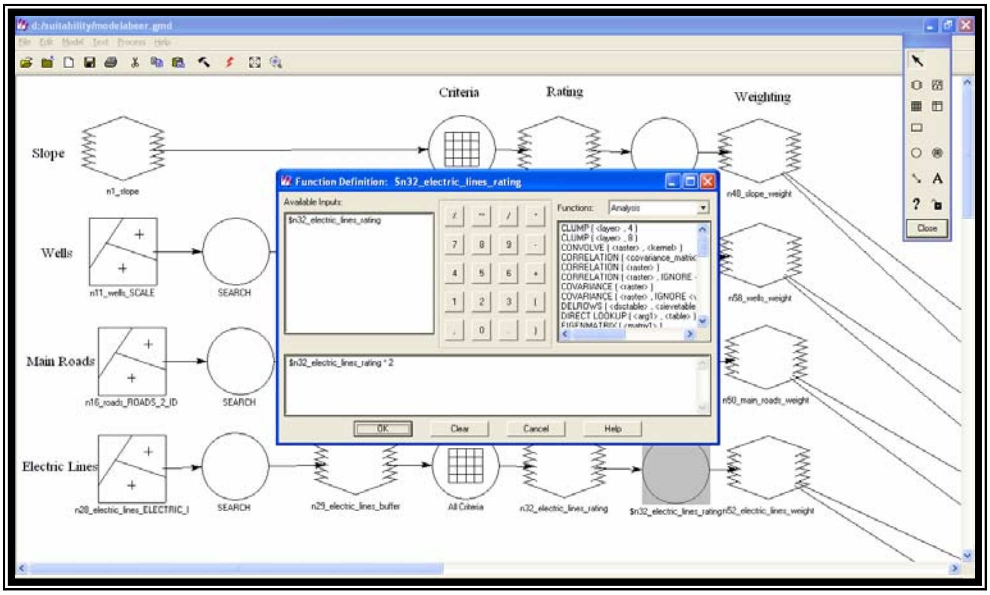

Figure 6.5: Weighting technique

Ranked layers then weighted using a common measurement scale of 1 to 3 each according to its importance or its percent influence. As an explanation, each raster layer is assigned a percentage influence. The cell values are multiplied by their percentage influence, and then added to create the output raster layer, (Fig. 6.5).

The percent weight is a relative percentage, and the sum of the percent influence weights must equal 100 percent. Changing the remap assignment evaluation scale value or the percentage influences may change the results of the weighted overlay analysis.

6.1.3.6 Integration techniques

Two categories of data — exclusive and weighted — are present in the model. The not suitable areas are represented by the exclusive data sets:

these are assigned values of 0 and are differentiated from the other data within the model logic. These areas are not able to be developed for reasons of environmental resource value or conservation ownership.

We apply Boolean logic in the urban suitability model (by multiplying the ranked layers), so we can differentiate the areas not suitable from the rest. This is done through using the Erdas Imagine 9.2 software, map algebra multiplication of layers which is applied in the model to perform the areas which have the value (1), and exclude the areas which have the value (0), (Figure 6.6).

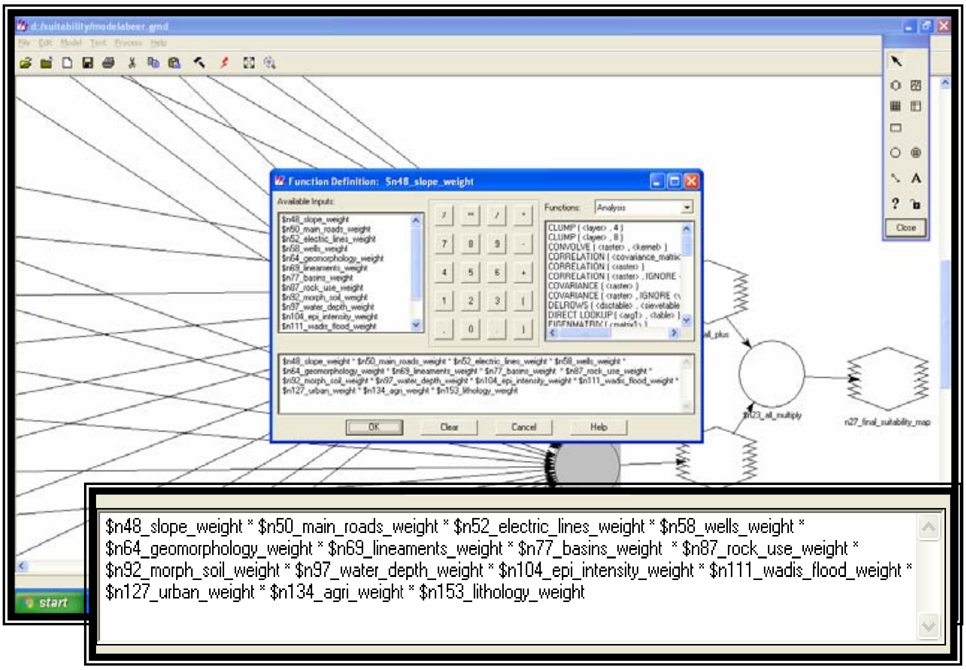

Figure 6.6: Using Map Algebra to multiply all layers to get the zero areas

From the integrated map of multiplying all layers, we get a map having a score 1 or 0 in it.

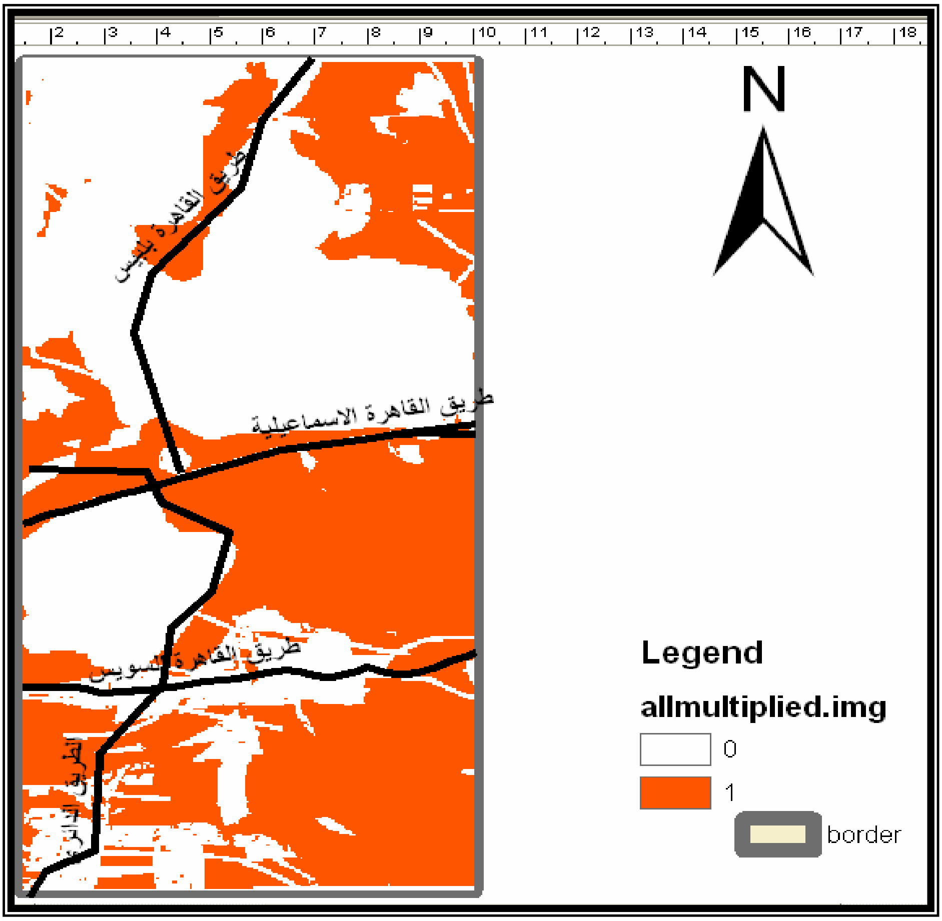

Figure 6.7: Integrated map that is resulted from multiplication of layers

Also, by using the Erdas Imagine 9.2 software, map algebra through addition of the reclassified layers is applied in the model to perform the integrated ranked layer, (Fig. 5-4).

That is to get a reclassified map. Each cell in it, has a value up to the maximum number which is (4 * total weight of layers) where 4 is the maximum ranked number in a cell which means that this cell has the most suitable ranking in urban development. And the total weight of layers in this study analysis = 46.

Max. Number = 4*46 = 184

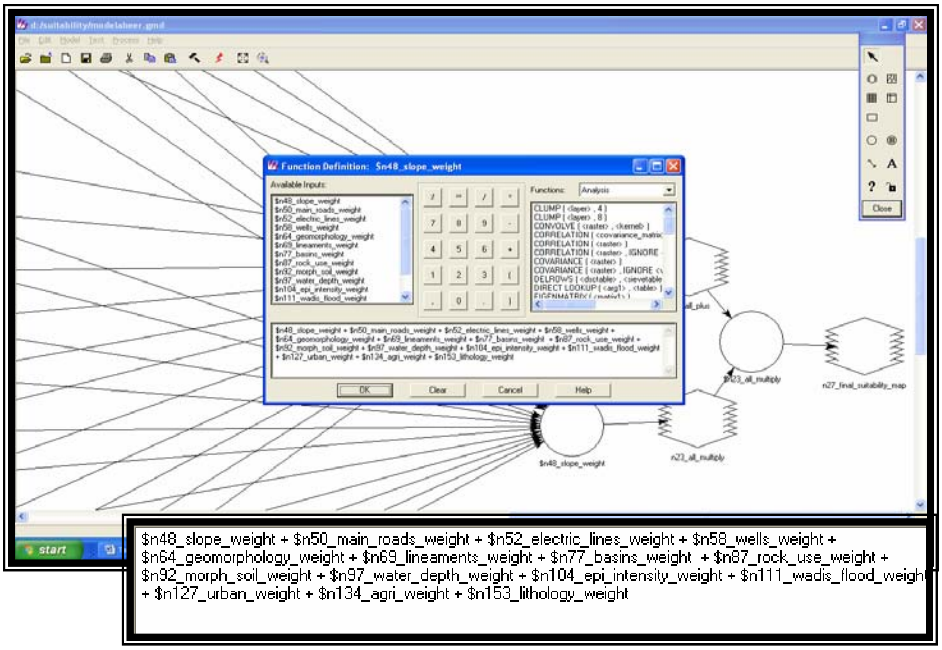

Figure 6.8: using map algebra to add all layers to get the integrated ranking map

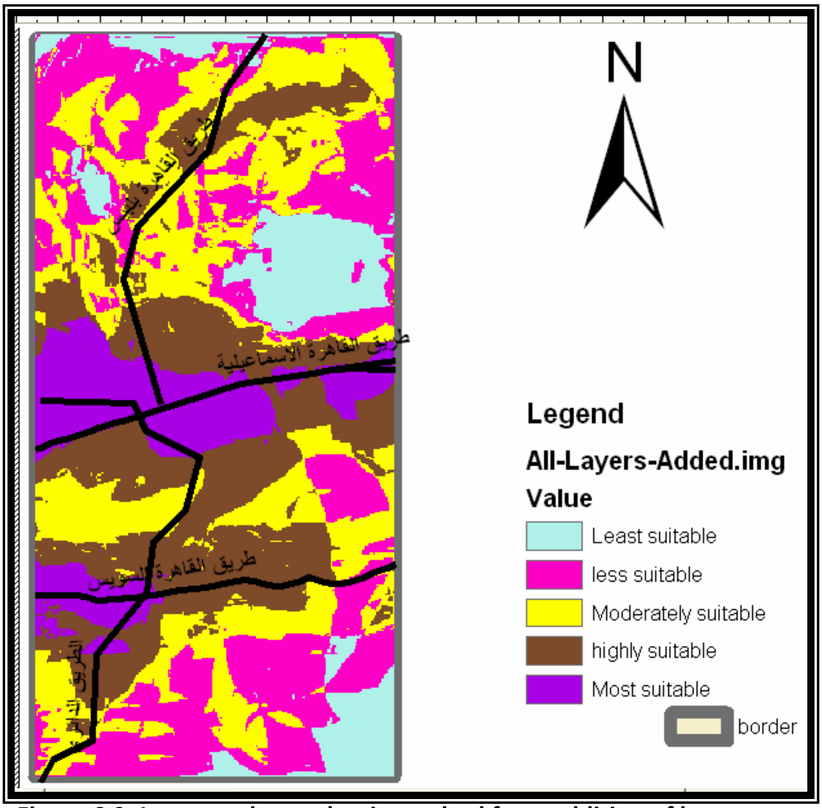

Figure 6.9: Integrated map that is resulted from addition of layers

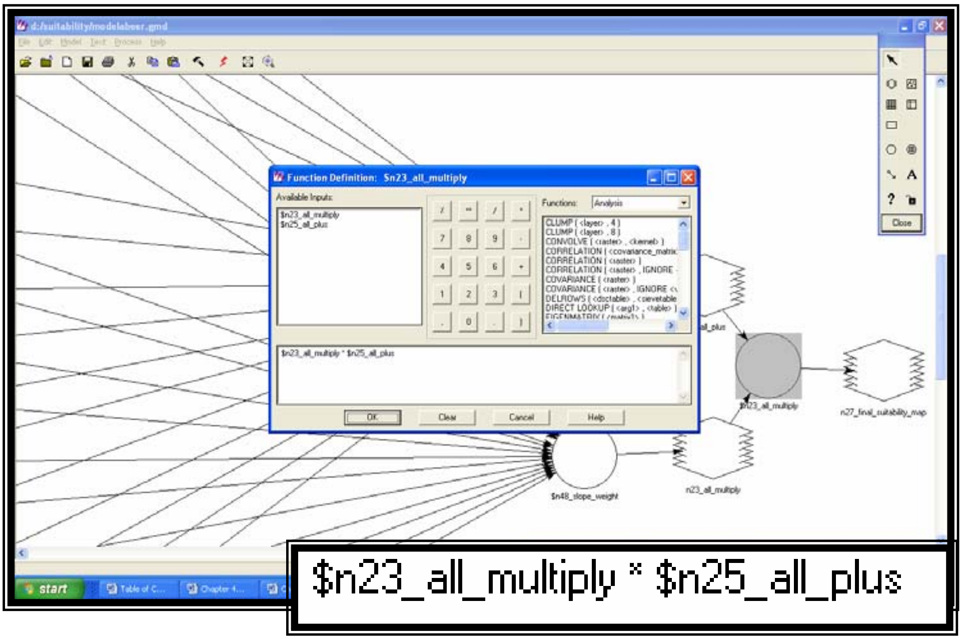

Figure 6.10: using map algebra to multiply the two final integrated maps to get the suitability map for urban development

The final urban suitability map was developed from multiplying the two integrated maps, to identify the ranked locations from best to worst as potential areas for urban development excluding the areas not suitable for urban development (Figure 6.10). Then this map is reclassified into four grades of suitability; most suitable, moderately suitability, less suitable and not suitable.

6.1.4 Urban Suitability model characteristics

Urban suitability model contains a number of interrelated processes. At any time, it is possible to add new processes, delete existing processes, or change the relationships between processes. It is also possible to change assumptions or parameter values; for example, replace old datasets with newer ones, or consider alternative scenarios in which input factors are prioritized differently. Also it is possible to add data layers not included in the original model that add value to the analysis, update data inputs and modify the influence of each data set on the model. The layer weights can also be easily changed to better reflect land use planning priorities and perspectives in a particular field.

Specialists can run a model with a variety of parameters to assess data sensitivity or to evaluate geographically different but structurally similar data sets. They can copy portions of their models within a model and smaller models can be combined to build larger model. It is also possible to perform complex analysis functions, and generate maps that illustrate the results of analysis.

Any theme can be excluded from the model (for “what if” purposes or if data for that theme are not reliable) by deleting the link from the theme to the next process and leaving the theme in the model for reconnection later if desired, (Fig. 6.1).

6.1.5 Suitability Integration Results

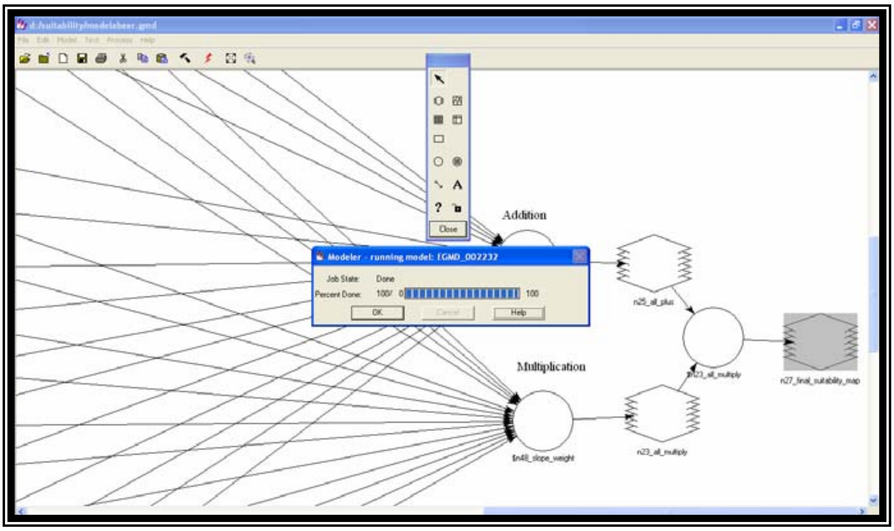

Figure 6.11: Running the Model

Running the suitability model of the study area (figure 6.11) has produced a suitability map which is reclassified into four categories of urban development from highest suitable to unsuitable, (Figure 6.20).

6.2 Land Suitability User Interface Application

The development of GIS application will not only ensure the database duplication is removed, but also that database updating and reporting will become more accurate. The User Interface is ready for the specialist to modify the assigned weights.

Output is the procedure by which data is presented in a form suitable to the specialist. Data are output in one of three formats, namely: Hard copy, soft copy, and electronic format [El-Maghraby and Zobarei, (2005): Uses of Recent Techniques for Establishing a Good and Up-to-date Base for a Modern Cadastre System]. The program developed here is designed to output the results, on the computer screen (Soft copy output), as explicit tables, that can display the attribute data of the layers in optimum way. In addition, for printing purposes, all output results (resulted maps, graphs and tables) of the program that displayed on the computer screen, are automatically saved in the database, so the specialist can print it anytime (hard copy output). On the other hand, the package output can be saved in electronic format, as a computer compatible file stored on fixed or removable discs. The outputs are the urban suitability map with tabular attribute data, which contains the attribute data for each layer.

The interface is to be written in Visual Basic for Applications (VBA) programming language, which is COM (Component Object Model) compliant and also supports the ArcObjects technology of ArcGIS developed by ESRI. This is also embedded in ArcGIS 9.2 tool comprising of ArcMap, ArcToolbox and ArcCatalog modules. The VBA programming language is one of the best technologies developed in recent years and ArcGIS with COM can integrate with VBA [1 Razavi, S.N. (2002). "Quantitative analysis of urban traffic using image processing and time delayed neural network." M.Sc. Thesis, Department of computer engineering, Iran university of Science and Technology, Supervisor: Prof. Mahmood Fathy, Other committee members: Dr. Jahed Motlagh, Dr. Mozayeni]. The applications developed using VBA are often called macros, which automate repetitive tasks or create complete applications. The following figures represent some examples of the user interface application screens for urban development.

In the following figures (6.12, 6.13, 6.14, 6.15, 6.16 and 6.17), the screens done for specialists to choose the layers that have influence on urban development and check them on, and in addition they insert the weighting of each layer in a combo box due to its importance in urban development from 1 to 3.

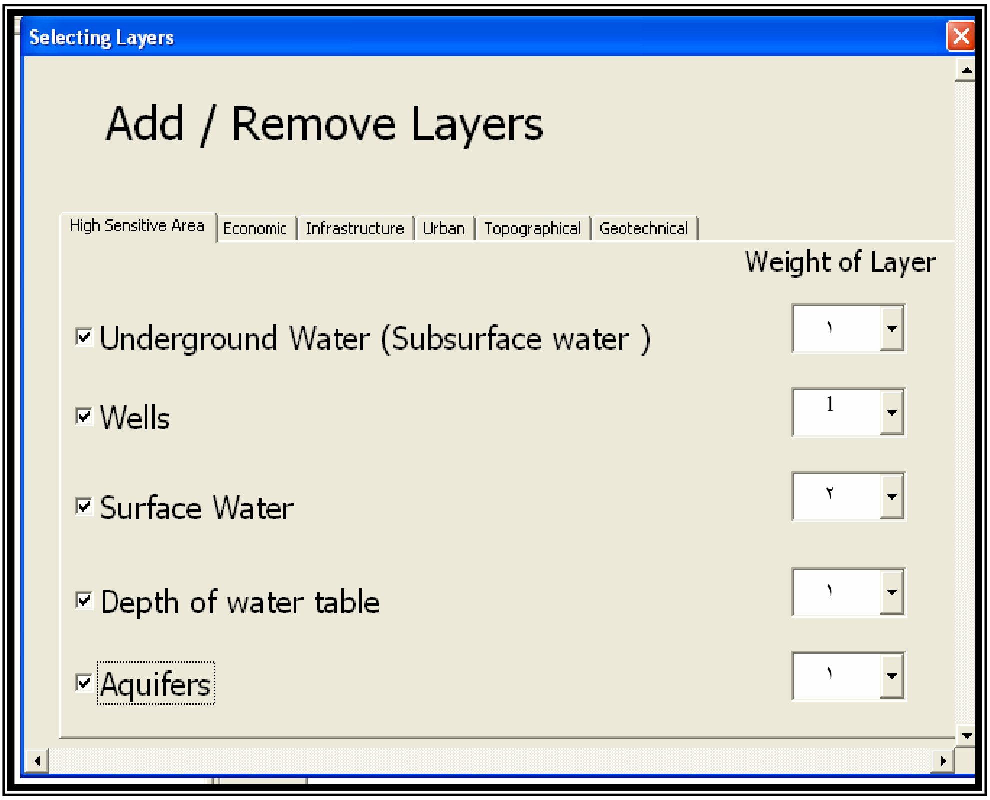

Figure 6.12: Form used to select High Sensitive Area category layers that is used in the analysis and select their weights

The layers are grouped into six categories; High sensitive areas, Economic, Infrastructure, Urban, Topographical and Geotechnical. Each has some layers in it and we can move between categories through clicking their tabs.

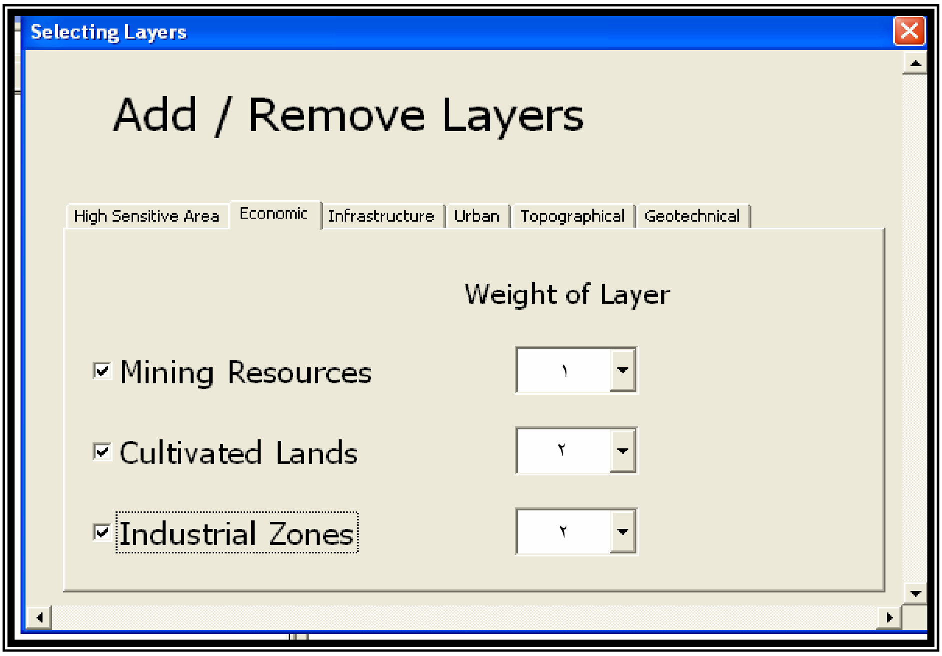

Figure 6.13: Form used to select Economic category layers that is used in the analysis and select their weights

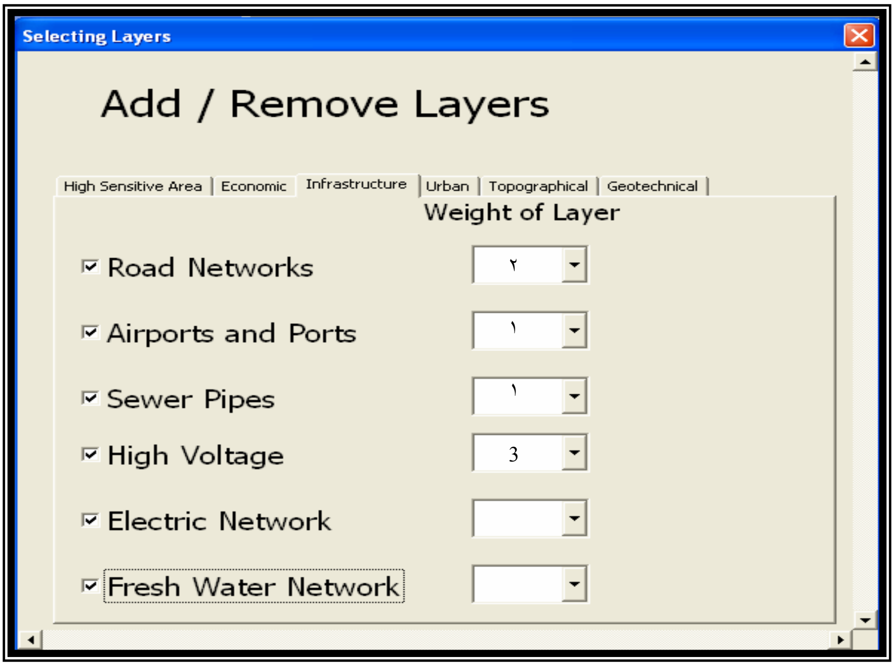

Figure 6.14: Form used to select Infrastructure category layers that is used in the analysis and select their weights

Through the User Interface Application, specialists can easily change the data sets used by the model, modify the influence of each data set, perform complex analysis functions, and generate maps that illustrate the results of analysis.

Figure 6.15: Form used to select urban category layers that is used in the analysis and select their weights

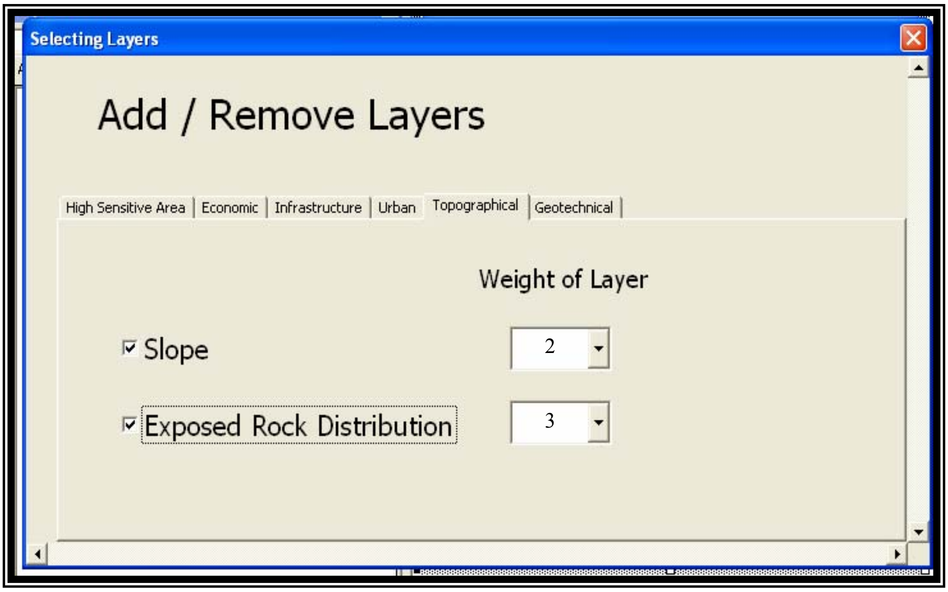

Figure 6-16: Form used to select Topographical category layers that is used in the analysis and select their weights

The layer weights can be easily changed, and the models may be re-run to evaluate the new results through the User Interface Application. As it is ideal for this task because it allows specialists to overlay multiple layers, rank order categories within each layer, include a weight for each layer, and sum using map algebra.

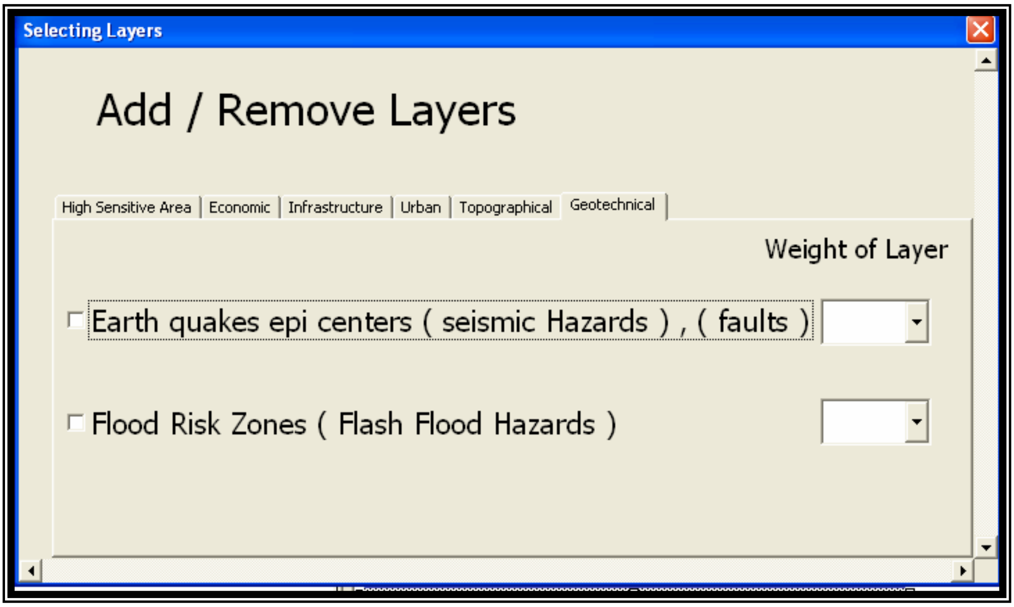

Figure 6.17: Form used to select Geotechnical category layers that is used in the analysis and select their weights

In the following screen (figure 6.18), specialists can put the ranking degree of polygons or buffered zones in each layer, due to its influence on urban development, into the attribute table, through creating new field. This field is to be used in the overlaying technique of all layers.

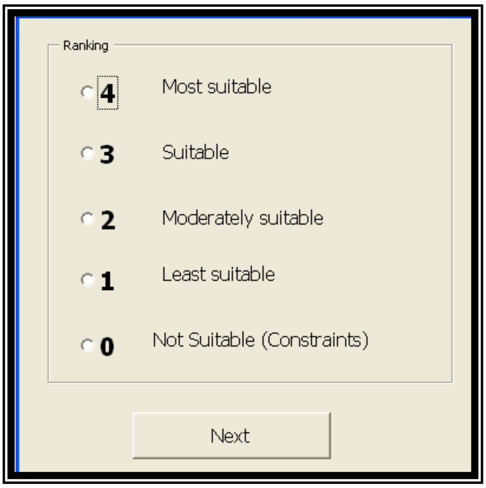

Figure 6.18: Form used to rank polygons in each layer due to its influence on urban development

The following screen (figure 6.19) is designed to represent the Final Suitability Map that is to be used by the specialists to plan for urban extensions and also re-evaluate the urban areas already exist. In this screen we can deal with the map such as zooming in and out, getting information in each point in it, fully extending maps and measuring lengths in it.

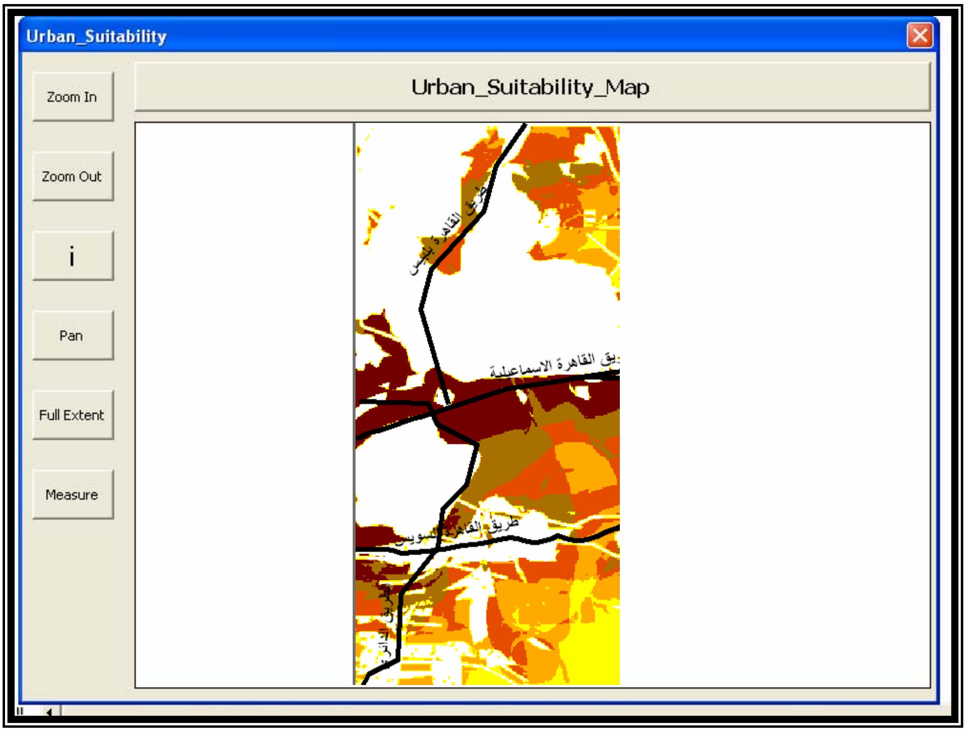

Figure 6.19: Form used to represent the final suitability map

6.3 Results and discussions

The analysis and interpretation of NORTH EAST OF CAIRO images revealed that there was considerable growth in urban settlement from 1984 to 2002. The results of the study regarding urban areas show that there are sufficient qualitative inputs for planners and managers to make decisions about urban planning and development.

For the final map of suitability, an interval classification was used in which urban suitability was assigned to one of four classes (Not suitable, less suitable, moderately suitable, and highly suitable). The resulting ratings of suitability were indexed to produce the final map of suitability (Figure 6.20).

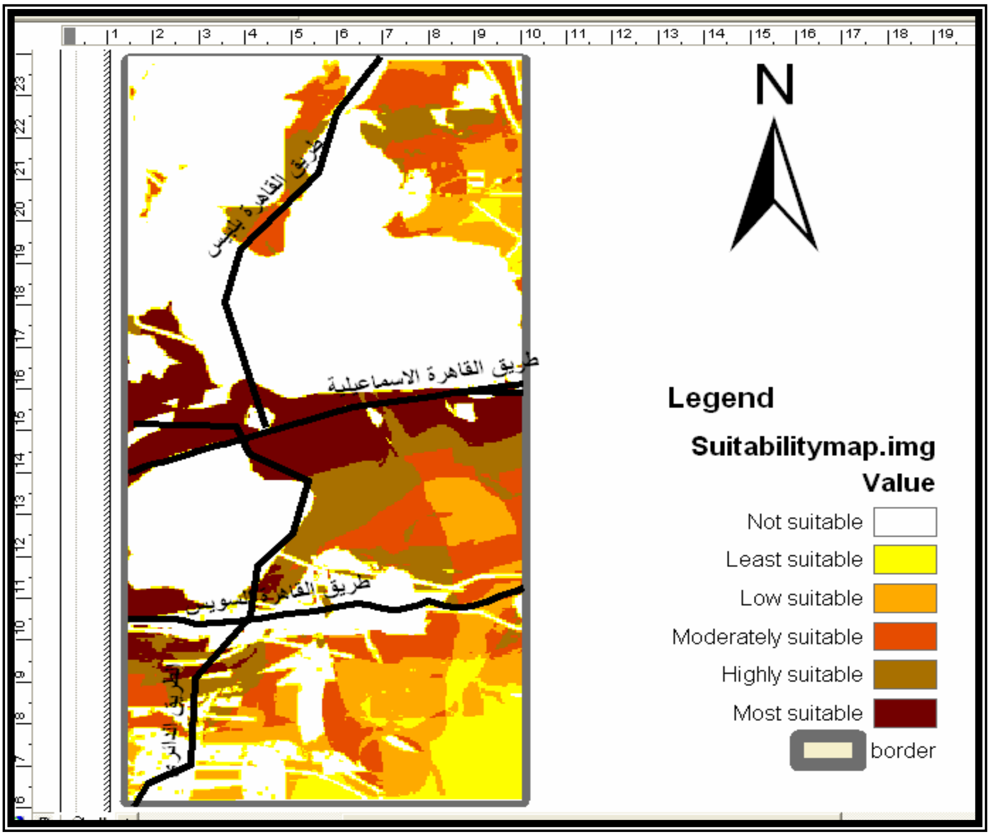

Figure 6.20: Final Suitability map

These four classes provide decision makers and planners with an integrated approach and essential needs to rational land-use sustainability for urban development.

Although the development of case study area is already underway, the developed areas were also investigated. If this investigation identifies urban development over unsuitable areas, the obtained maps from this study can raise awareness of potential hazards in such areas. Thus, we restate the question: Is urban development occurring over suitable areas? To address this question, an urban land use map was created. Current urban land use (Figure 6.21) within case study area falls into four suitability classes. Approximately 20% of all areas urbanized are in not suitable class, due to sand dunes, which suggests that the map of urban suitability can serve as a good base for planning sustainable development in case study area.

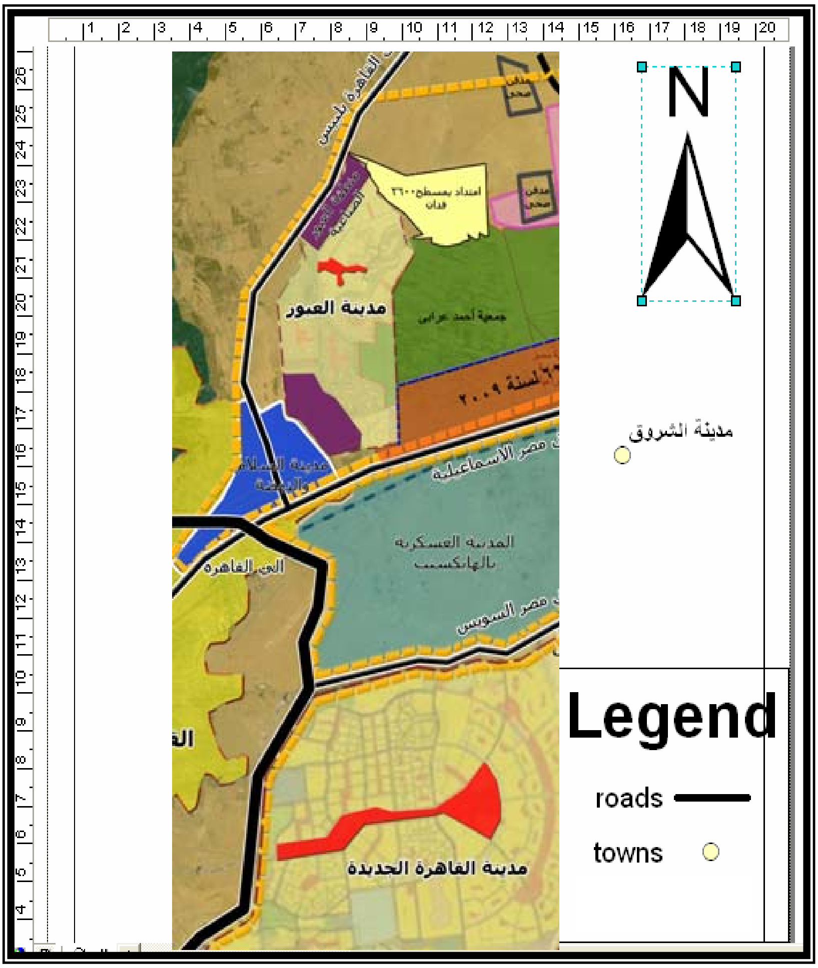

Figure 6.21: Land use already exits in NORTH EAST OF CAIRO

In this study, suitability of the area for urban development was evaluated using GIS-based approach. Urban suitability model that incorporated land use/cover, types of soil, fractures, slopes, distances to major faults and streams, road network, and city boundaries was established to create a map of site suitability for NORTH EAST OF CAIRO. Model weights were developed using the multi-criteria evaluation approach. The final suitability map within NORTH EAST OF CAIRO falls into four classes of suitability. These four classes provide decision makers and planners with an integrated approach and essential needs to rational land-use sustainability for urban development.

The output map of urban suitability for NORTH EAST OF CAIRO tells differences in suitability range across the area. The suitability ratings appear to be primarily controlled by the factors related to urban suitability. Analysis of the map for urban suitability suggests that most of the land of NORTH EAST OF CAIRO is suitable for urban development. As can be seen in figure 6.20, about 15% of the area is highly suitable for urban development. If one extends the boundary to moderately suitable areas, the total area of NORTH EAST OF CAIRO suitable for urban development increases the fraction to >70% of the total area. Thus, it appears that NORTH EAST OF CAIRO location is suitable for urban development. Areas not suitable are concentrated in the northeastern portion of the area due to agricultural areas around Ismailia channel and also in the upper central part due to sand dunes. These areas represent about 30% of the total area of NORTH EAST OF CAIRO. Based on examination of the map of suitability, we suggest that the central part of the region, below the sand dunes area, should be given the first priority for urban development in NORTH EAST OF CAIRO. This region is in between the Cairo-Ismailia road and Cairo-Suez road.

6.4 Conclusions

Accurate information and perfect data are rarely available, which lead to a kind of uncertainty in building a geo-database. This, in turn, affects the accuracy of the criteria assessment. To accommodate the propagation of uncertainty through the established geo-database, input data should be of suitable spatial resolution for the analysis, factors should be selected carefully, and the manner in which the selected factors are combined and analyzed should be suitable for the desired objectives.

A GIS-based assessment of site suitability can help identify optimal areas for urban development while promoting preservation of environmentally sensitive or hazardous areas. The map of site suitability obtained from this study can provide decision-makers with useful information to determine the general trends and spatial distribution of classes of suitability for urban development in NORTH EAST OF CAIRO. For assessment of urban suitability, GIS can manage a large number of spatially related data and integrate multiple layers of surface and subsurface information to extract new, useful information.

The GIS technique is a powerful tool for performing the urban development analysis, managing data, and transforming data into visual information in map form. Supervised classification is usually appropriate when analyst wants to identify relatively few classes or when he has selected training sites that can be verified with ground truth data.

GIS model provides a basis for informed decision making to support integrated sustainable development. However, the developed approach integrating GIS and multi-criteria technique can be adapted and used to assess suitability of any other site wherever multi-criteria decision making is needed.

One of the best promising approaches to solve the challenging task of thematic mapping in urban environments is the integration of multiple data sources to benefit from the complementary types of available information. The multi-criteria approach was used to create appropriate weights for the different factors affecting the suitability of the site for urban development. Spatial analysis is the only known method to understand the complexity of the environment.

6.5 Recommendations

- ❖ The monitoring of urban expansion and planning the future development of metropolitan area needs a regularly or periodically updated land-use \ land-cover maps.
- ❖ The urban development planning has to use computer model and information analytical techniques such as GIS and Remote Sensing, which are powerful tools for performing updated information and urban development changes through time and space.
- ❖ In the context of extreme data limitations and methodological constraints, the accuracy and reliability of the technique needs to be checked with experienced human knowledge of the area. In

- ❖ The application could be extended to different land-use development activities.
- ❖ Participation of all Egyptian governmental authorities in all possible phases. It is highly recommended that all the concerned government agencies should have an image interpretation and analysis facilities so that they can do time to time monitoring and get the required information quickly without being dependent on others.

6.6 Deficiency aspects

- ❖ The study is concerned with the possibility of potentials, land capabilities and constraints while some factors do not have the same attention and this will reflect on the resulting final suitability map.
- ❖ Using old topographic maps due to the lack of data.

6.7 Summary

This study presents an approach using a Geographic Information System (GIS) in integration with multi-criteria evaluation technique using weighted linear combination to achieve a site suitability assessment for urban development in NORTH EAST OF CAIRO. This assessment will mark out areas unsuitable to urban development.

Integration analysis allowed us to develop an urban suitability GIS model to assess urban suitability for NORTH EAST OF CAIRO. The GIS modeling procedure incorporated field investigations, information derived from photographic mosaics, and satellite digital data including Landsat Thematic Mapper and ASTER scenes. Surface and subsurface information obtained from previous studies were also analyzed and employed in this assessment of suitability. The approach is effectively employed in this study to develop rational weights for factors that affect suitability according to the respective importance for suitability of the area for urban development.

Urban suitability model is established to provide final map for urban planning for NORTH EAST OF CAIRO. This model is used for evaluating the suitability of land for urban development to make it easier for decision makers to take their decisions.

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إعداد قاعدة بيانات مكانية لإدارة استخدامات الأراضي
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رسالة مقدمة من

عبير محمد الغوابي

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(١٩٩١)

لإستكمال متطلبات الحصول على درجة الماجستير
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قسم العلوم الهندسية البيئية
معهد الدراسات والبحوث البيئية
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٢٠١٢

صفحة الموافقة على الرسالة

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٢٠١٢

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ختم الإجازة

أجيزت الرسالة بتاريخ   /   / ٢٠١٢

موافقة مجلس المعهد	موافقة الجامعة
/ / ٢٠١٢	/ / ٢٠١٢

المستخلص

يتطلب لتصميم نموذج صلاحية استخدام الأرض للتخطيط العمراني بمنطقة صحراوية مثل شرق مدينة القاهرة تطبيق نظم المعلومات الجغرافية وتوافر بيانات دقيقة وحديثة ومحددة الإحداثيات عن مكونات غطاء الأرض وطبيعة تضاريسها ومناخها السائد والمخاطر البيئية المتوقع تعرض منطقة الدراسة لها.

باستخدام برامج تحليل البيانات بأنواعها المتداولة (المصورة والمرسومة كخرائط والوصفية والمجدولة) قد تم بناء قاعدة بيانات جغرافية لمنطقة الدراسة وتصميم برنامج تفاعلي للمستخدم لتطبيق النموذج المناسب لاستنباط درجات صلاحية الأراضي المتاحة للتنمية العمرانية، مما يمكن تطبيقه على أي من الأنشطة البشرية الأخرى وذلك بتجميع البيانات الأساسية التي لها علاقة بالنشاط المطلوب تنميته، سواء كانت هذه البيانات هي مصادر الثروات المختلفة بالمنطقة أو المخاطر البيئية المحتمل تعرض المنطقة لها أو النشاط الإنساني الذي يمارس على سطح الأرض بالمنطقة المراد تنميتها.

يتم تجميع البيانات في قاعدة بيانات جغرافية سواء كانت عن طريق خرائط أو صور فضائية أو معلومات وصفية ويتم تقسيمها وتسجيلها ثم عمل معالجات مختلفة لها واستخدامها للمساعدة في وضع تخطيط أمثل لاستخدامات الأرض في المنطقة.

وبناءا على هذه المعلومات، يتم تصميم نمذجة للوصول الى انسب المناطق للتنمية العمرانية بالاضافة لواجهة تطبيق للمستخدم لتسهيل عملية الاستخدام والوصول للنتائج سريعا وبشكل اوتوماتيكي.

الملخص

الباب الأول:

يحتوي هذا الباب على مقدمة تفصيلية لظهور تقنيات حديثة لجمع واستقراء البيانات مثل نظم المعلومات الجغرافية وقد تم اختيار منطقة شمال شرق القاهرة لوضع نموذج لتحديد صلاحيتها للتوسع العمراني ومقارنة نتائج تحليل درجة الصلاحية مع الواقع الراهن في الامتدادات العمرانية ثم تحدثنا عن هدف الرسالة هو وضع نموذج لمعالجة البيانات وتحليلها وتفسير دلائلها لاستخدام الأرض بواحد من الأنشطة البشرية من خلال بناء قاعدة بيانات جغرافية للمنطقة المستهدف تنميتها ومن ثم نمذجة صلاحية استخدام الأراضي للتخطيط العمراني بتطبيقات نظم المعلومات الجغرافية

الباب الثاني:

يحتوي هذا الباب على الدراسات السابقة في هذا المجال ابتداءا من مصادر ايجاد البيانات وأنواعها وطرق وأساليب تجميعها بما في ذلك البيانات الرقمية لصور الأقمار الصناعية والخرائط الغير رقمية وكذلك البيانات المجدولة والوصفية ثم البحث في الدراسات السابقة لقواعد البيانات الجغرافية وإمكاناتها وعناصرها التركيبية وخطوات تصميمها وأهمية وجود واجهة للمستخدم ثم توجهت الدراسات السابقة الى التطبيقات الخاصة بالبيانات المكانية وكيفية معالجتها للتعامل معها بعد ذلك ومن ثم اتجهت الدراسات السابقة الى توضيح الاساليب المختلفة للتحاليل التي يتم استخدامها لتقييم مدى صلاحية الأراضي لأى نشاط او استخدام متمثلا في استخدامها عمرانيا كنموذج لإستخدامات الأرض.

الباب الثالث:

يحتوي هذا الباب على دراسة شاملة لمنطقة الدراسة وهي منطقة شمال شرق القاهرة بما في ذلك من الخصائص المختلفة لهذه المنطقة وذلك للوصول لنتائج عن تفاصيل منطقة الدراسة في هذه العناصر:

الأولى: مصادر الثروات بالمنطقة مثل:-

- تضاريس الأرض

- ❖ غطاء الأرض من تربة وصخور ونباتات
- ❖ موارد المياه
- ❖ المناخ السائد من أمطار وسطوع شمس ودرجة رطوبة وبخر وغيرها
- ❖ الثروات الاستخراجية التعدينية صخرية كانت أم معدنية

الثانية: المخاطر البيئية المحتمل تعرض المنطقة لها

- ❖ مخاطر طبيعية مثل الزلازل والسيول والانهيارات الصخرية والهبوط الأرضي وخلافه
- ❖ مخاطر بيئية ناجمة من اساءة استخدام الأرض كتلوث هواء أو ماء أو تربة

الثالثة: النشاط الانساني الذي يمارس على سطح الأرض بالمنطقة المراد تنميتها سواء كان

- ❖ نشاط زراعي
- ❖ نشاط استخراجي
- ❖ نشاط عمراني
- ❖ نشاط صناعي

<u>الباب الرابع:</u>

يحتوي هذا الباب على التحاليل اللازمة للوصول الى أنسب المناطق للتنمية العمرانية واستخدام انسب أنواع هذه التحاليل واستخراج المحددات والإمكانات المؤثرة عمرانيا المتواجدة في منطقة الدراسة وطرق حساب صلاحة المناطق بعد تحديد كل عامل وتجزيئه على مستوى كل شريحة الى خمس مستويات من الصلاحية ابتداء من صفر للمناطق التي لا تصلح مطلقا وانتهاءا برقم ٤ الذي يمثل المناطق الأعلى صلاحية للتنمية العمرانية بناءا على مواصفات كل عامل ومن ثم يتم تحديد وزن كل عامل على أساس درجة أهميته في تقييم صلاحية التنمية العمرانية لهذه المنطقة وكيفية تنفيذ خطوات هذا الأسلوب من التحليل من خلال نظم المعلومات الجغرافية.

<u>الباب الخامس:</u>

يحتوي هذا الباب على كيفية انشاء قاعدة بيانات مكانية تحتوي على العوامل المؤثرة في التنمية العمرانية التي تم استنباطها والتعامل معها وذلك بعمل تخطيط وتصميم لقاعدة البيانات وانشائها وادخال البيانات بها وربط جداول البيانات الخارجية بها ومن ثم عمل اعادة تقسيم للطبقات

المختلفة المعبرة عن اجزاء قاعدة البيانات بناء على درجة صلاحياتها في التنمية العمرانية وكذلك تحديد وزن لكل منها في درجة اهميته بالنسبة للتنمية العمرانية.

فمن الضروري كخطوة أولى قبل معالجة هذه البيانات أن يتم تخزينها في قاعدة بيانات جغرافية على هيئة:-

- ❖ خرائط ذات إحداثيات مساحية جغرافية رقمية
- ❖ ملاحق (Attributes) محددة الإحداثيات الجغرافية

وأنماط البيانات يمكن تقسيمها إلى بيانات أولية وهي البيانات التي تقاس وتسجل قيمتها مباشرة مثل الخرائط الطبوغرافية والمساحية وبيانات ثانوية أو مستنبطة مثل البيانات المستخرجة من الصور الفضائية والتي يتم استنتاجها بعمليات تحليلية ومعالجة إحصائية.

وفي كلا الحالتين فإن البيانات الأولية والثانوية تتعرضان لمعالجات مختلفة فالبيانات المأخوذة من الصور الفضائية تتعرض لمعالجة البيانات المصورة في مجالات طيفية متعددة وإظهارها والبيانات المستخرجة من الخرائط والملحقات تخضع لمعالجات الضبط المساحي والتحويل الرقمي.

<u>الباب السادس:</u>

يحتوي هذا الباب على النمذجة والتطبيقات المستخدمة في التطبيق العملي والذي تم تصميمهم للوصول الى أنسب المناطق للتنمية العمرانية شاملا النتائج التي تم الوصول اليها و الاستنتاجات والتوصيات المقترحة التي يمكن أخذها في الإعتبار

النتائج

التحاليل المتبعة في منطقة الدراسة أثبتت أن النمو العمراني سريع جدا في منطقة الدراسة ومن خلال الخريطة النهائية الناتجة من النموذج المستخدم والتي تم تقسيمها الي أربع تصنيفات ابتداء من غير صالح للتنمية الى أنسب المناطق للتنمية مما تبين أن معظم أراضي المنطقة صالح للتنمية العمرانية وأن المناطق الغير صالحة للتنمية العمرانية تتركز في الشمال الشرقي من المنطقة وذلك لكثرة النشاط الزراعي بها لتواجدها حول ترعة الإسماعيلية وكذلك منطقة في الوسط الشمالي لتواجد الكثبان الرملية التي تعيق التنمية العمرانية. وهذه المناطق تمثل أقل من ٣٠% من مساحة منطقة الدراسة. ومن خلال النظر للمناطق المصنفة أعلى مستوى للصلاحية للتنمية العمرانية

يتبين أن المنطقة الوسطى تناسب وجود تنمية عمرانية بالإضافة الى بعض المناطق الأخرى المنتشرة في منطقة الدراسة والتي تظهر باللون الأحمر في الخريطة النهائية.

الإستنتاجات

١- كي نبدأ في وضع تخطيط أمثل لاستخدامات الأرض في منطقة ما بعد تجميع البيانات الأساسية وتخزينها في قاعدة بيانات جغرافية فإن هناك العديد من البرامج التي تسهل تحليل البيانات ونمذجتها لتحديد الاستخدام الأمثل لكل نشاط من النشاطات الإنسانية.

وتمر طرق تحليل البيانات ووضع نماذج لتحديد صلاحية الاستخدام لكل قطعة بعدة خطوات

- ❖ تحديد مواصفات كل قطعة أرض وصلاحيتها للنشاط المستهدف
- ❖ تحديد العوامل والمعايير المتحكمة في صلاحية كل قطعة أرض وترتيبها بقيم تحدد درجة تأثير كل عامل على كل نشاط مستهدف
- ❖ إعطاء أوزان لكل قطعة أرض تحدد درجة صلاحيتها للنشاط المستهدف

٢- تطبيقات نظم المعلومات الجغرافية أداة قوية في التخطيط العمراني والتحليل المكاني لمنطقة ما هو الحل الأمثل لفهم التعقيدات البيئية لكل عامل مؤثر في التحليل.

التوصيـــــات:

- ❖ يتطلب تخطيط المدن الى استخدام تقنيات حديثة مثل نظم المعلومات الجغرافية والإستشعار عن بعد
- ❖ لابد من تكامل المعلومات لدى الجهات والهيئات الحكومية المختصة بالتخطيط العمراني واستخدامات الأراضي حتى لا يحدث اعادة للمجهود المبذول في كل جهة
- ❖ لابد من تسهيل الحصول على البيانات في الجهات المختصة بذلك وتكاملها ودقتها