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Spatial Data Infrastructure to Support Land Evaluation Applications in Egypt

El-Sayed Ewis Omran

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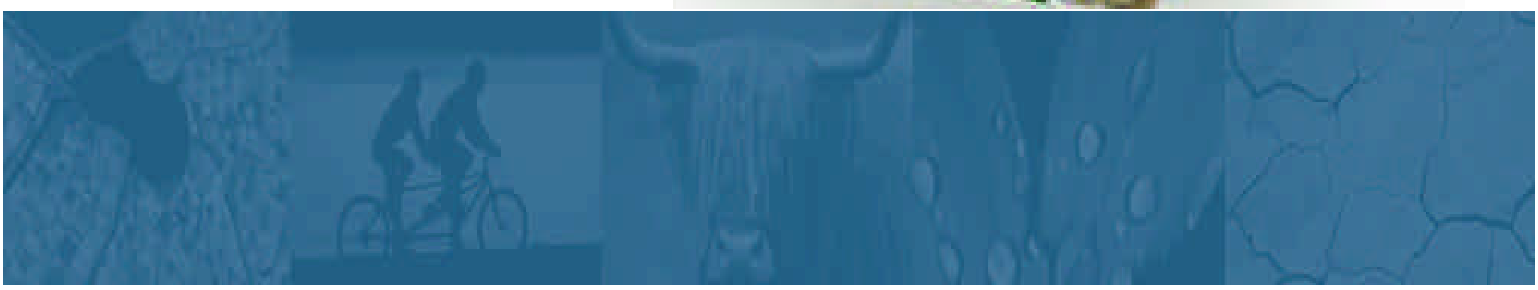

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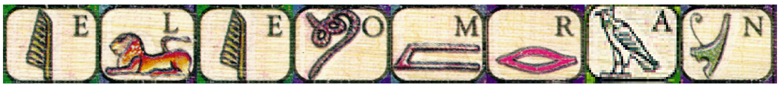

Thesis submitted in partial fulfillment of the degree of Master of Science in Geo-information Science at Wageningen University and Research Center, Wageningen, The Netherlands

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May, 2005
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Dedication

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The author indebted to Prof. Dr. **Arnold Bregt**, who gave of his fullness to lighten and rejoice the hearts of all who knew him. His insightful advice and valuable contribution have orientated my research.

Also, I wish to express my sincere gratitude to Mr. **Joep Crompvoets**, for his effort, valuable criticisms and advice.

In fact without their encouragement, continuous helps and guidance, this manuscript would not have been reality.

I dedicate this humble work.

El- Sayed Ewis Omran

Wageningen, the Netherlands.

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Report Meta- Information

If we are to understand each other, we must comprehend a common language

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Abstract:

Although there is a widespread use of GIS in different applications in Egypt, the benefit of using this technology in land evaluation (LE) is not as expected. LE processes demand an information rich environment. Many organizations involved in LE have invested heavily to address this demand but unfortunately they are not able to meet it. One reason could be that Egypt still lags behind spatial data infrastructure (SDI) development. Over 120 countries presently are at some stage along the road to the establishment of SDI. Some are at a fairly advanced stage. Others are only at the beginning of what will be a long and ongoing journey. However, realizing these purposes requires availability and accessibility of accurate, documented and up to date data. The main objective of this thesis is to assess potentiality of a SDI to support LE process in Egypt. The aim was to see the applicability of the concept of SDI to solve some of the land evaluation drawbacks in the spatial data poor environment, where poor information to support decision makers is common. SDI to support LE has not previously been explored and still new field that needs further investigation.

This thesis starts with a brief discussion highlighting the prevailing LE demand for reliable spatial information in Egypt on one hand and the potentials supplied by SDI on the other. So far efforts have been made to see what SDI means, its component as a system and how technical, financial and institutional issues are important for SDI implementation. Through the framework methodology (literature review, expert knowledge, questionnaire and interview), it was possible to study the existing situation in Egypt. Studying the existing situation helped in stressing the need to establish SDI and it could be a way to convince the decision-makers and politicians for SDI to support LE. This thesis analyzes the institutional, economical and technical aspects of the LE and GIS organizations to identify the problems that are facing Egypt. In order to gather the information needed, a questionnaire survey and interview with the key persons were done.

This study found that the spatial information field in Egypt is still immature with a broad set of issues yet to be resolved: awareness creation and political support, execution of SDI policy, establishment of SDI coordination unit, formulation of a responsible organization and partnership, creation of metadata standard, provide tools to search and access metadata and establishment of a metadata management system. The LE drawbacks will demand a lot of effort and call for some form of coordination from different organizations to solve them. These multifaceted problems justify the need for using SDI's capability. LE has greater demand for multi-source information to enhance its process which can be addressed through a well implemented SDI. In order to consider SDI as an ideal tool to improve the LE process, the data requirements must be assessed. The most relevant datasets are Topographic maps, Soil data, Geology, Morphology, Land use/ Land cover, and Meteorological data. The need for reliable data to support decision through a well informed LE makes the importance of SDI justifiable.

Spatial data infrastructure to support land evaluation applications (SDILEA) was proposed as a facility to access the data needs for LE. The whole essence of the proposed SDILEA is to forward possible way to mitigate the current land evaluation drawbacks in Egypt and fulfill the stakeholders' requirements. SDILEA includes services to explore and interact with data. An important service in SDILEA is that of discovering resources through metadata. These metadata descriptions should allow potential land evaluation users to analyze and evaluate the datasets contents and determine their fitness for use. The development of these metadata is a matter of cooperation between all Shareholders. Lack of knowledge about other organization's dataset can lead to a duplication of effort. A lack of standards makes availability of the datasets present obstacles to its access and use. Metadata standard essential for

datasets documentation are: metadata entity set, identification, data quality, reference system, and citation and responsible party. This facility links LE users seeking spatial data through electronic networks with data producers who maintain their data locally. Must be easy to discover which spatial data is available, fits the need for a particular use and under what conditions (Who will do what should be establishing for data use, and who will pay for what for data pricing) it be acquired and used.

The assessment made for the current conditions promise for improved collaboration and coordination between organizations and availability of metadata for the datasets. SDILEA with all its components (bridges the LE gap) has shown its potentiality and capability to be helpful (relevant) in the LE process (facilitates data availability and accessibility). It is effective (improve decision-making process) and efficient (reduce data duplication and save time, effort and cost of data collection and management).

Government organizations, public and private agencies and academic institutions could greatly benefits from SDILEA as a solution for easy access to spatial data to generate information that is vital to LE applications. The integration of SDI within a LE context could help users, decision-makers and stakeholders to improve LE processes. Decision-makers will gain more confidence in the data and response to emerging issues faster as the data becomes more accessible. The development of such SDILEA and the resulting GIS which can build upon it to support LE process are considered an essential requirement to improve decision-making, (positive impact).

Purpose: to assess a spatial data infrastructure to support land evaluation applications in Egypt

Themes: SDILEA

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List of Abbreviations and Acronyms

Abbreviations of Terms

ANZLIC	Australia New Zealand Land Information Council
ASDI	Australian Spatial Data Infrastructure
ASDI	Australian Spatial Data Infrastructure
CGDI	Canadian Geo-Spatial Data Infrastructure
CSF	Critical Success Factors
FGDC	Federal Geographic Data Committee
GI	Geographic Information
GIS	Geographic Information System
GPS	Global Positioning System
GSDI	Global Spatial Data Infrastructure
INGIS	Indonesian National Geographic Information Systems
ISO	International Organization of Standardization
ISO 19115	ISO Spatial Metadata Standard
IT	Information Technology
LC	Land Characteristics
LE	Land Evaluation
LUT	Land Utilization Types
NGDF	National Geographic Data Framework
NGII	National Geographic Information Infrastructure
NGIS	National Geographic Information System
NGO	Non- Governmental Organization
NILIS	National Infrastructure for Land Information Systems
NSDC	National Spatial Data Clearinghouse
NSDI	National Spatial Data Infrastructure
NSDS	National Spatial Data Strategy
NSIF	National Spatial Information Framework
OGC	Open GIS Consortium
SDI	Spatial Data Infrastructure
SDILEA	Spatial Data Infrastructure to Support Land Evaluation Applications
SNIG	National Infrastructure for Geographical Information
SOTER	Soil and Terrain Database

Abbreviations of Organizations in Egypt

ARC	Agriculture Research Center
DRC	Desert Research Center
EGSMA	Egyptian Geological Survey and Mining Authority
EMA	Egyptian Meteorological Authority
ESA	Egyptian Survey Authority
IDSC	Information and Decision Support Center
MALR	Ministry of Agriculture and Land Reclamation
MCIT	Ministry of Communication & Information Technology
NARSS	National Authority for Remote Sensing and Space Science
NRC	National Research Center

1- General Introduction

You will never be able to discover new oceans unless you have the courage to lose sight of the shore,
Hannah W. Smith.

1.1 Background

If we take a detailed look at rural areas around the world, we see a whole range of agricultural activities. Each of those activities is an alternative option to farmers. In their decision making process, they select activities that they consider to be appropriate for their specific conditions. Key question for sustainable land management is where and when we can carry out a specific activity without degrading our natural resources and fulfilling the economic and food requirements within a range of social boundary conditions. Note the spatial and temporal aspect of this question (where and when). We would like to know, for example, where we can grow a specific crop and when we can do so. With this basic question, land evaluation comes in.

In land evaluation, we assess the suitability of land for different (mainly agricultural) activities. Land evaluation is an important step in the process of land use planning where the resources are limited. Usually the land evaluation procedures show what is wrong in the land use, what and where the conflicts are, but do not give good and realistic options to the decision-makers choose from. Land evaluation is a tool to predict land performance, both in terms of the expected benefits from and constraints to productive land use, as well as the expected environmental degradation due to these uses, (Rossiter, 1996). Each scale used in land evaluation process needs a lot of data and information from various sources. Besides, each hierarchical level has its own data needs. Different processes act on different hierarchical levels. Moreover, if the same type of information is needed, there may be a difference in spatial and temporal scale at which the data have to be available. However, the decision maker(s) level depends on the scale of the project and the extent of the potential environmental effects. Therefore, a major impediment to describe these processes and to apply dynamic simulation models in land evaluation is the requirement for high quality, high frequency data and information from different sources. Much of the key information has a key spatial component and is held as digital spatial data. However, many of the data is held separately in individual organization systems, in a variety of formats and collected to a variety of standards, (Askew et al., 2005).

A well elaborated and multi directional observation on SDI is made by Groot and McLaughlin, (2000) as it encompasses the networked spatial databases and data handling facilities, the complex of institutional, organizational, human and economic resources which interact with one another and underpin the design, implementation and maintenance of mechanisms facilitating the sharing, access to and responsible use of geo-spatial data at an affordable cost for a specific application domain or enterprise. A Spatial Data Infrastructure (SDI) is an essential pre-requisite to make use of spatial information in an effective and efficient manner. The SDI can facilitate access to spatial information needed to support the land evaluation process. Such an infrastructure may be defined as a set of rules, standards, procedures, guidelines, instructions, policies and technology for creating, collecting, process, store, maintaining, exchanging, sharing, accessing and using spatial data, (Crompvoets and Bregt, 2003). Spatial information is one of the most critical elements underpinning decision making for many disciplines, (Williamson et al., 2003). Many countries around the world are developing spatial data infrastructures (SDI) as a way to better manage and utilize their spatial datasets, (Rajabifard and Williamson, 2004).

However, spatial data infrastructure to support land evaluation is not exploited and still new field that need an approach especially for Egypt. The realization of the potential of spatial information systems in supporting land evaluation depends on a number of factors. Efficient and reliable access to well-harmonized information is one of these. Efficiency of the land evaluation process in turn needs accessible, affordable, adequate, accurate and timely spatial and non-spatial information. Efficiency and optimization in use of spatial information can be achieved through sharing of the collected available information. Information sharing in turn needs an efficient route that can give possible access to the need, (Allebachew, 2000). The potential route can be achieved and accessed through implementation of a well-structured spatial data infrastructure (SDI) in the arena of land evaluation.

A solution to improve the process of land evaluation could be found by developing a spatial data infrastructure (SDI) or framework. This infrastructure supports locating, accessing, and integrating the spatial information needed for the land evaluation. The idea is to establish a mechanism by which multiple collections of geographic data could be made available for everyone's use. This mechanism is known as spatial data infrastructure, (Javier, 2004). So, how can SDI support land evaluation process is the most important issue that need investigation.

Following the previous question, this thesis presents the concept of spatial data infrastructure (SDI) as a tool to facilitate access to, and responsible use of spatial information in support of land evaluation. Because of the SDI tries to bridge the gap between the land evaluation decision-makers and the data providers, SDI seems to be a key factor in further development of land evaluation. The need to provide the land evaluation decision-makers with fast, reliable, and up-to-date information has become a requirement for land evaluation users and decision- making in Egypt in order to make the right decision. The research objective is to suggest a spatial data infrastructure to support land evaluation process in Egypt.

Consequently, the integration of SDI within land evaluation context could help users and stakeholders to improve land evaluation processes. Planners and decision makers can explore a range of possible scenarios and obtain an idea of the consequences of a course of action before mistakes are irrevocably made in the landscape itself, (Burrough, 1991). Therefore, the proposed SDI will seek to enhance the sharing of information for land evaluation decision-making. Finally, Egypt could greatly benefits from the SDI to provide solutions for easy access to spatial data to generate spatial information that is vital to land evaluation process.

1.2 Problem Statement

In Egypt, there is a high demand for information on the suitability of the land to recommend a wide range of land uses. This demand comes from decision-making to have good land evaluation. Recommendations and plans must usually be made quickly, in response to actual needs and current conditions, (FAO, 1994). However, most geo-information systems in Egypt operate on a stand alone, extreme sectoral basis where they lack inter as well as intra organizational links. With such sector jurisdiction sentiments and data secrecy culture prevailing, it is hardly possible to consider the existing systems as reliable sources that can channel information to support the land evaluation process. Consequently, land evaluation processes are often non-optimal in Egypt. This has contributed to the low acceptance of land evaluation in decision-making. The planners and decision-makers do not satisfactorily use the current land evaluation process in their decision. Groot and McLaughlin, (2000) and Ezigblike, (2002) are emphasizing the need of SDI development for sharing spatial data in order to use it effectively for different purposes, particularly for decision-making. The problems existing for land evaluation failure in decision- making process in Egypt are that:

1- lack of access mechanism. Users in Egypt complain on the difficulties in obtaining suitable spatial information from different organizations for there applications because the lack of an effective mechanism to access the various data needs, (Abdel Ghaffar, 2001). So, the land evaluation applications in Egypt are considered to be a long time consuming process (time and effort) and do not permit real time decision-making;
2- absence of GI sharing. The cooperation and coordination between different organizations that concerned with the spatial data and related applications do not exist in Egypt. Moreover, there is very little exchange of information among stakeholders in land evaluation. Most of the data are used for purposes of their own sectors. Almost every new project or study implying the use of geographic information requires the creation of new geographic information resources from scratch. So, the cultural behavior could be against co-operation and integration;
3- data duplication. Although there is a widespread use of the GIS technology in many organizations in Egypt, the benefit of using this technology is not as expected because of the lack of digital data (particularly large scale base maps), (Moustafa, 2000). Moreover, “information shortage” due to the lack of digital geographic information and the rapid demand for it in the various sectors has lead to duplicated efforts in producing digital geographic information for the same spot, (IDSC, 2000);
4- law and guidelines. No legislation for the copyright and ownership. No sharing protocol between the different organizations. Thus, the establishment of SDI cannot be easily standardized for Egypt;
5- absence of national standards. Most of the spatial data is still acquired in non-standardized, and non-normalized, format. Furthermore, the standards adopted by different organizations are often in conflict with each other. Absence of standards constraint the transparency and the necessary knowledge for decision-making, and delays the GI users to find their needs of information exactly and easily, (Moustafa, 2000); and

6- lack of information. The failure of the newly reclaimed lands such as Suez Canal region in Egypt has crumbled in to dust after having been spent huge amount of budget primarily due to the fact that their decisions were not based on reliable spatial information. Sharing this perspective is Omran, (1996) who claiming that these problems are attributed to the lack of information.

In conclusion, absence of national standards, GI sharing, and lack of an effective mechanism among land evaluation organizations to share and access the various data needed are the main research problems that need to be addressed and mitigated. So, the key problem can be stated as how can SDI support land evaluation applications in Egypt?

1.3 Research Objective

The general objective of the study is to assess a spatial data infrastructure to support land evaluation applications in Egypt.

Detailed Research Objectives:

1- To investigate the demands of land evaluation to SDI in Egypt.
2- To determine the appropriate SDI to fulfill the demands of land evaluation based on the given and existing trends in Egypt.
3- To assess if the current conditions promise for further SDI improvements.

1.4 Research Question

In order to achieve the research objectives, we have defined research question that need to be addressed for the success of the project. How can SDI support land evaluation applications in Egypt?

Detailed Research Questions:

1- Does the land evaluation process in Egypt need SDI? Why? What components does it need?
2- What is the appropriate SDI desired to fulfill the demands of the land evaluation stakeholders based on the given and existing trends in Egypt?
3- What are the current conditions support further SDI improvements?

1.7 Study Area

Egypt is one of the largest countries in northeast Africa (1,002,000 km^2) with a present population of about 74, 72 million living on 5.5% of the total area, (CIA World Factbook, 2003). Egypt presents an ideal gateway to Europe, Africa and the rest of the world. Administratively, Egypt is divided into 26 governorates. Egypt lies between latitudes 22° and 32° north of the equator and between longitudes 24° and 37° east of Greenwich line. It is bounded from the north by the Mediterranean Sea (955 km) and from the east by the Red Sea (1941 km) and Sinai Peninsula (265 km). From the south by Sudan (1280 km), and in the west by Libya (1115 km), figure (1.1). The Suez Canal links the Red Sea to the Mediterranean, a vital linkage to both Egypt and the world. This strategic location puts Egypt at the crossroads of global trade, and makes it a major commercial and transshipment destination, (Egypt: The Land of Opportunities 2003. http://www.eip.gov.eg/books/land_of_invest.asp).

The agricultural sector still represents a mainstay of Egyptian national economy, (The Year Book, 2003. http://www.sis.gov.eg/y ear2003/html/mega.htm). It contributes about 40 percent to the Gross Domestic Product (GDP), 22 percent to commodity exports, and 50 percent of overall employment. 54 percent of Egypt's population lives in rural areas, (http://www.fao.org/DOCREP/005/Y4357E/y4357e07.htm#P1_15). Egypt's agriculture is almost totally dependent upon irrigation. Agricultural development is closely linked to the water resources of the Nile River. The total agricultural land in Egypt is about 7.8 million feddans comprising about 3% of the total area, (The Year Book, 2003.http://www.sis.gov.eg/year2003/html/mega.htm).

Figure 1.1 Geographical location of the study area

Based on soil characteristics and water sources, four agro-ecological zones can be identified as follows

I Old land: Nile Valley and Delta Regions, which include and covers a total area of 5.400.000 feddans is characterized by its alluvial soils (clay too loamy) Nile water is the main source for irrigation.

II New lands: It is mainly located on both the east and west sides of the Delta and is scattered through various areas in the country and covers a total of 1.900.000 feddan. Its sand characterizes land, coarse textured, calcareous and non-calcareous soils, except in some areas of this land in the northern part of the Delta are alluvial. The majority of this land uses Nile water as the main source for Irrigation, whereas in some desert areas underground water is the only source for irrigation and new irrigation regimes as sprinkler, and drip irrigation are practiced.

III Oases: It is characterized by alluvial sandy and calcareous soils. It includes a total area of 100,000 feddans. Underground water is the main source for irrigation.

IV Rain-fed: It includes approximately 400.000 feddans located in the north coastal areas in Sinai and Matrouh where rainfall fluctuates between 100-200 mm. annually.

1.8 Covering the Thesis Landscape

The thesis will be structured as a linked set of chapters, figure (1.2). Chapter 1: General Introduction. This chapter provides an overview of the research.

Chapter 2: Review of Spatial Data Infrastructure as well as Land Evaluation Developments. Study the current theories and concepts of SDI. International review for land evaluation process and methods will be presented. Land evaluation process and methods in Egypt will be presented here. Purposes and objectives of applying SDI will also be discussed. Critical review of international SDI development is also conducted to provide specific lessons to be later integrated in the guidelines for implementation. SDI in developing countries will be review. SDI activities in Egypt will be presented.

The foreword to chapter 3 will discuss the materials and methods used. In addition, fieldwork design and the activities of field work study will discuss. A framework methodology for data collection and research methodology will be presented.

Chapter 4: Results and Discussions. Refers to analyses the current SDI versus the current land evaluation mainly focuses on the actual prevailing situations in Egypt in relation to land evaluation and GI application. In addition, the main problems that are land evaluation facing in Egypt will be identified. Data requirement and information needed for land evaluation application will be recommended. Proposed SDI structure and operational work plan to support land evaluation process will be presented. The future SDI improvements and guidelines necessary for the implementation will be discussed. Critical success factors (CSF) that are necessary to support the SDI implementation will be touched in this chapter. Overall discussion will be made in relation to the stated objectives.

Chapter 5: Conclusion and Recommendations. This chapter gives concluding remarks of all findings of the previous chapters. Moreover, important measures that need to be taken will be recommended and ends with recommendations for further research.

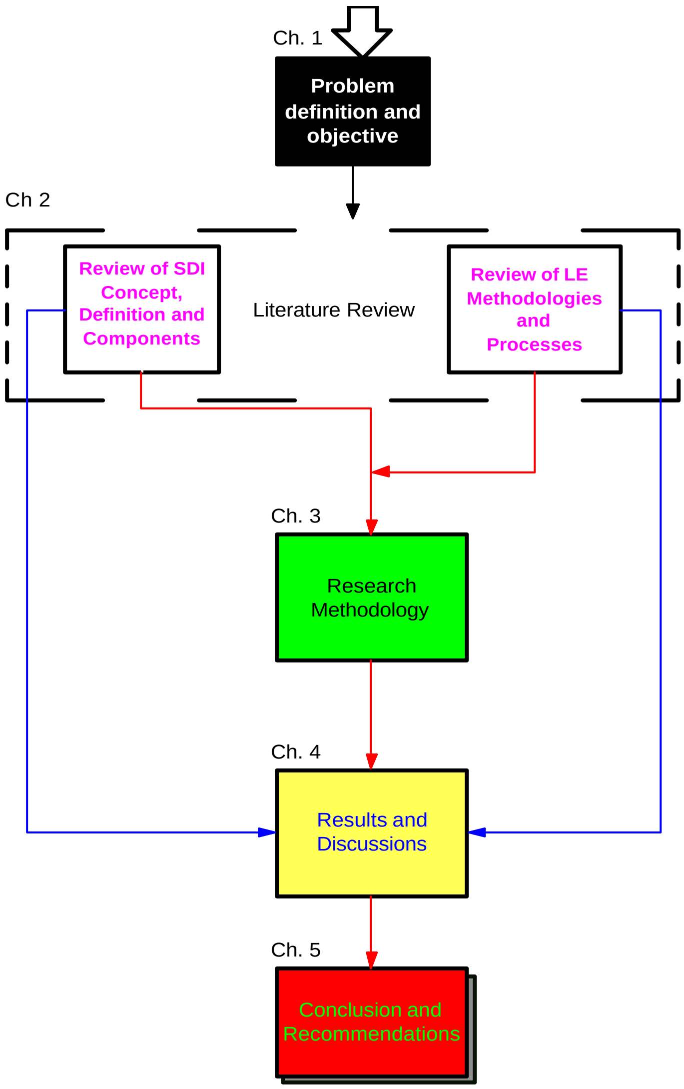

Figure 1.2 Covering the thesis landscape

2- Review of Spatial Data Infrastructure versus Land Evaluation Development

To invent something, you need a bit of imagination and a pile of junk, Thomas A. Edison.

2.1 International Land Evaluation Review

This part provides a detailed description of the definition, objectives and development of land evaluation worldwide. The purpose of this section is to evaluate briefly various methods that assist in giving alternative options for land evaluation. Following by review the land evaluation process and methods in Egypt.

2.1.1 Definition and Purpose of Land Evaluation

Land evaluation is defined as 'the process of assessment of land performance when used for specified purposes, (FAO, 1984). As such, it attempts to predict the behavior of each land unit for each actual and proposed land use. Land evaluation is a tool to predict land performance, both in terms of the expected benefits from and constraints to productive land use, as well as the expected environmental degradation due to these uses, (Rossiter, 1996). In land evaluation, we assess the suitability of land for different (mainly agricultural) activities. Land suitability defined as the fitness of a given type of land for a specified kind of land use. This matching process, which is central in land evaluation, is handled by defining land qualities and land characteristics. Land evaluation may be concerned with present land performance. However, it involves change and its effects with change in the use of land and in some cases change in the land itself.

Land evaluation consists of physical and socio-economic evaluations. Physical land evaluation involves the interpretation of data concerning the physical environment, and past and present land use in terms of its resource potential. It is thus concerned with seeking solutions to problems such as the possible long-term degradation of land quality as a result of current use, the viability of alternative land uses, the extent to which the management of existing land uses can be improved, and the impact of inputs on productivity and land quality, (http://www.fao.org/documents/show_cdr.asp?url_file=/DOCREP/004/X3810E/x3810e07.htm). Physical evaluation methods aim at assessing land qualities or suitability for a specific land-use, as conditioned by biophysical parameters, (Beek, 1978; Smit et al., 1984).

The physical resources remain reasonably stable, unlike the socio-economic resources that are affected by the social, economic, and political settings, (FAO, 1976; Dent and Young, 1981). Van Ranst et al., (1996) suggested that derivation of physical land suitability is a prime requisite for land utilization planning and development, since it guides decisions on land utilization for optimal utilization of the land resources. The evaluation process does not in itself determine the land use changes that are to be carried out, but provides data on the basis of which such decisions can be taken, (FAO, 1976).

Land evaluation is an important step in the process of land use planning where the resources are limited. Usually the land evaluation procedures show what is wrong in the land use, what and where the conflicts are, but do not give good and realistic options to the decision-makers choose from. So, Land evaluation analysis is considered an interface between land resources survey and land use planning and management, (De la Rosa et al., 2004).

Land evaluation should answer the following questions:

1- How is the land currently managed, and what will happen if present practices remain unchanged?
2- What improvements in management practices, within the present use, are possible?
3- What other uses of land are physically possible and economically and socially relevant?
4- Which of these uses offer possibilities of sustained production or other benefits?
5- What adverse effects, physical, economic or social, are associated with each use?
6- What recurrent inputs are necessary to bring about the desired production and minimize the adverse effects? What are the benefits of each form of use?

2.1.2 Land Evaluation Process

A land evaluation process can be divided into twelve steps, (Rossiter, 1996) as shown in figure (2.1).

1- Identify the decision makers, their objectives. Who are the actors in rural land use and what are their roles?
2- Define the evaluation units based on the planning needs of the decision makers. Includes scale of the final map(s) and type of map unit. May be influenced by data sources.
3- Define the Land Utilization Types (LUT) to be evaluated, both actual and potential. These are the land use options, and are specified in enough detail to support the later phases of the evaluation. Define the LUTs in terms of their Land Use Requirement s (LUR). Define the LUT by a set of more-or-less independent requirements, which are the general conditions of the land necessary for successful use according to the system specified by the LUT.
4- Define the LURs in terms of their diagnostic Land Characteristics (LC). Identify the measurable diagnostic land characteristics that will be used to determine to what degree the Land Use Requirements are satisfied.
5- Define the LURs in terms of their diagnostic land characteristics.
6- Identify data sources (survey if possible/necessary) according to how the Land Use Requirements are to be evaluation. May influence choice of evaluation units.
7- Enter tabular data and maps for the LCs
8- Build (computer) models for land evaluation
9- Compute the evaluation
10- Calibrate the results
11- Present the results to the users.
12- Assist with project implementation

Figure 2.1 land evaluation process, (after Rossiter, 1996)

2.1.3 Land Evaluation Methods

There are several approaches to land evaluation. Van Lanen, (1991) identified three general methods. The first one is qualitative evaluations based mainly on expert judgment, where physical suitability is obtained by qualitative procedures presented in discretely ranked classes (e.g. highly suitable, marginally suitable, currently and permanently not suitable). In this tradition, overall land suitability of a specific land area for a specific land use is evaluated from a set of more-or-less independent land qualities, which may each limit the land-use potential. These approaches give useful results that generalize the constraints of an area. The USDA land capability classification (Klingebiel and Montgomery, 1961) and the FAO, (1976) and suitability evaluation methods belong to this group. Land evaluation has been most widely applied as qualitative (physical) land evaluation. The basis of the approach is described in (FAO, 1976). Other accounts are given in (Dent and Young, 1981 and McRae and Burnham, 1981). The FAO concept is most commonly applied. Although it is a qualitative approach, it can be complemented and enhanced by more quantitative methods, (Yizengaw and Verheye, 1995). Other examples of qualitative approaches include Rosser et al., (1974), Hannam and Hicks, (1980); Van Lanen et al., (1989) and Van Lanen and Wopereis, (1992).

The second is a parametric-quantitative method that assesses the suitability of land on a continuous scale, instead of discrete classes of the land capability classification. The evaluation procedure generally involves deductive, inductive or simulation modeling systems, (Shields et al., 1996) to quantify the potential of land for specific uses. A deductive approach deals with the estimated yield as an index relative to a standard yield, while an inductive technique utilizes land characteristics as evaluation criteria to establish land unit indices, (Soil Survey Staff, 1951). This latter approach involves such mathematical models which are either additive, multiplicative, (Storie, 1933 and 1978; Sys, 1985), and complex. In these approaches the best land receives the maximum score, while lower scores are assigned to the less suitable land. The most limiting land quality governs the overall suitability, (Sys et al., 1991 and Van Diepen et al., 1991).

The third group is more modern based on process-orientated simulation models, where land performance is related to individual land characteristics with their net effect assessed using a model of land function. These models are able to portray many specific processes, including erosion or water movement, or may provide predictions of crop yields or financial profit, (McKenzie 1991). It is usually called 'quantified land evaluation', (Beek et al., 1987; Bouma and Bregt, 1989; Wagenet and Bouma, 1993). Land evaluation, e.g. automated physical land evaluation (APLE); automated land evaluation system (ALES) (Beek et al., 1987; van Keulen et al., 1987). And attempts to quantify some indicator of land suitability over an entire spatial field, which is usually divided into 'small' grid cells (as opposed to map units). Examples of indicators are predicted crop yield (Dumanski and Onofrei, 1989) or individual land qualities such as pesticide leaching, (Hack-ten Broeke et al., 1993). Ideally land evaluation includes assessment of both the natural resource (physical land evaluation) and socioeconomic aspects (integral land evaluation) of the use of land, (Smit et al., 1984). Simulation modeling uses a complex of multivariate factors, and makes use of a computer based analysis system such as an expert system; for example, (Johnson and Cramb, 1991). Such kinds of approaches have recently been widely used and developed with the aid of GIS-based systems. As these quantified methods usually require high data inputs, regions of the world where knowledge gaps exist require a mix of qualitative and semi-quantitative models of land performance, according to Rossiter, (1996). This approach was suggested by Van Lanen et al., (1992a, 1992b) and De la Rosa et al., (1992), whereby qualitative assessments of land quality can first identify areas that can be rejected, as opposed to those requiring more detailed investigation.

Another approach to land evaluation (biophysical) models proposed by Bouma, (1999) and adapted by Rossiter, (2003). In this approach considers the descriptive complexity, ranging from empirical to mechanistic and the degree of computation, ranging from qualitative to quantitative. Depending on the two dimensions, several levels of models are distinguished: K1 (empirical and qualitative expressions of land users' experience), K2 (qualitative expressions of expert knowledge), K3 (empirical and quantitative expressions), K4 and K5 (mechanistic expressions), (see appendix 2a for more details).

All the above approaches are based on the knowledge of land use and management experts, and use expert systems and/or other intelligent techniques to simulate this knowledge. Table (2.1) gives Summary view of current methods that can be used for land evaluation. However, not all systems integrate the same technology and therefore provide different functions to the end user, table (2.2).

Table 2.1 Summary view of current methods that can be used (partly) for land evaluation

Land evaluation method	Description
Agricultural census (AC)	A method to collect data on relatively stable agricultural structures and to provide a sampling frame for other surveys on agricultural holdings. An AC involves collecting, processing and analyzing data from a large number of agricultural holdings and provides essential structural data for small areas to prepare plans and formulate policies for rural development, (FAO, 1986)
Agro-ecosystem analysis and development (AAD)	Deals with all levels of agro-ecosystems on a multidisciplinary basis. It studies interactions between people and natural resources, often at the community level, and includes identification of trade-offs between different land uses, (Lightfoot et al., 1989).
Rapid Rural Appraisal (RRA)	A systematic activity carried out in the field by a multidisciplinary team, designed to acquire quickly new information and new hypotheses about possible interventions in the rural environment ,(Fresco et al., 1990).
Farming Systems Analysis (FSA)	FSA gives insight into the improvements that are possible and necessary, focus on the present situation, on the basis of land units, (Fresco et al., 1990). Due to the absence of relations with the landscape and with higher levels of spatial integration (agro-ecological zone), and the limited amount and accuracy of quantitative data acquired, it does not provide a basis for spatial or pattern analysis.
Land Evaluation and FSA (LEFSA)	This has been developed on the basis of LE and FSA. This method considers the regional agricultural system and cropping or livestock systems in alternation, and integrates agronomic and socio-economic aspects, (Fresco et al., 1990).
Environmental Impact Assessment (EIA)	An environmental analysis, and is merely a tool and a set of procedures to ensure that adequate environmental considerations enter into the decision-making process. EIA is an instrument for shaping policies, programs and project decisions, (World Bank, 1991).
ALES	ALES, (Johnson and Cramb, 1991) is an automated land evaluation system that allows land evaluators to build expert systems for land evaluation according to the method presented in the "Framework for Land Evaluation" (FAO 1976). However, ALES has no GIS capabilities of its own, and it uses an import/export module to access maps and geographical databases. ALES is not by itself an expert system, and does not include by itself any knowledge about land and land use. ALES is a framework within which evaluators can express their own, local, knowledge. ALES is not a GIS and does not itself display maps. It can, however, analyze geographic land characteristics if map units are appropriate defined, and it can directly reclassify IDRISI or Arc/Info maps with the same mapping unit legend as the ALES database. Since ALES has no map input or output, the data values for these LC's would have to be obtained from maps or a GIS and entered in the ALES database by hand.
Land Evaluation (LE)	A physical land suitability assessment method, including socio-economic aspects, in which properties of a given geo-referenced land unit are compared with the requirements of a specific land use. The aim is to examine the consequences of change, and guide planning decisions. LE focuses on future predicted or potential land use, for which purpose land units are classified (Fresco et al., 1990). However, translation into practice is limited because of the rather qualitative suitability classifications and the absence of formalized procedures for selecting land use systems, (Dent, 1993).
Framework for Evaluating Sustainable Land Management (FESLM)	Defined as 'a pathway to guide analysis of land use sustainability, and connect all aspects with the multitude of interacting conditions (environmental, economic and social) whether that form of land management is sustainable or will lead to sustainability'. It does not include planning or development, (Smyth et al., 1993).
Agro-Ecological Characterisation (AEC)	A comprehensive description of agro-ecosystems on the basis of physical and biotic parameters Land use is described, including its socio-economic identifiers. The degree of detail of information collected in agro-ecological characterization is strongly related to the scale of characterization, (FAO, 1978 and Andriesse et al., 1994).
Land Use Systems Analysis (LUSA)	Aims to cover the successful management of resources to satisfy changing human needs without degrading the environment or the natural resource base, and to give quantified and clear alternative land use development options on different scales, (van Duivenbooden, 1995).
LIMEX	LIMEX, (Mahmoud et al., 1997) is an integrated expert system with multimedia that has been developed to assist lime growers and extension agents in the cultivation of lime for the purpose of improving their yield. The scope of LIMEX expert system includes assessment, irrigation, fertilization, and pest control. The expert system was augmented with multimedia capabilities as enhancing an expert system by the integration of text, image, sound, video, and data, allows for a good feedback from users, assists in better understanding of the system, and allows for more flexibility in the interactive use of the system
VEGES	VEGES, (Yialouris et al., 1997) is another expert system for the diagnosis and treatment of the pests, diseases and nutrient disorders of certain vegetable species. This system is the simplest among the others and is based on forms of object-attribute-value (OAV) for the representation of symptoms. This method of representation easily fits into any rule based ES development tool, and thus is an advantage of the system.
ISLE	The final example is ISLE (Tsoumakas G. and Vlahavas); it does not allow users to build their own knowledge base and capabilities that are currently not supported by ISLE

Table 2.2 Main characteristics of current methods that can be used (partly) for land evaluation

Characteristic	AC	LE	FSA	LEFSA	AAD	EIA	RRA	FESLM	AEC	LUSA	ALES	LIMEX	VEGES	ISLE
Multi-disciplinary	2	1	1	1	1	1	1	1	1	1	ND	ND	ND	ND
Multi-scale	3	3	3	1	3	2	3	1	1	1	ND	ND	ND	ND
Systems approach	2	3	1	1	2	3	3	1	1	1	ND	ND	ND	ND
Geo -referenced	3	1	3	1	3	2	3	2	1	1	ND	ND	ND	ND
Identification of constraints	3	1	1	1	2	1	1	1	1	1	ND	ND	ND	ND
Scenario analysis	3	2	1	1	3	3	3	3	3	1	ND	ND	ND	ND
Effect analysis	3	3	3	3	3	1	3	3	3	1	ND	ND	ND	ND
Farmers' goal included	3	3	3	3	3	2	1	3	3	1	ND	ND	ND	ND
Visually clear presentation of results	1	1	3	1	2	3	3	3	1	1	ND	ND	ND	ND
Map interaction	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3	3	3	1
GIS functionally	3	1	3	3	3	3	3	3	1	1	1	3	3	1
RS	3	3	3	3	3	3	3	1	1	1				
Knowledge base	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	1	1	1
Expert system customization	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	3	3	3
User friendly graphical interface	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3	1	3	1
Fuzzy classification	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3	3	3	1
Multimedia	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3	1	3	3
Literature review	3	3	3	3	3	3	1	1	1	1	ND	ND	ND	ND
Survey and interview	1	1	1	1	1	1	1	3	1	1	ND	ND	ND	ND
Experiments	3	3	3	3	3	3	3	3	1	1	ND	ND	ND	ND
Modeling	3	1	3	3	3	3	3	3	1	1	ND	ND	ND	ND
Huge time requirements	1	1	1	1	1	1	3	1	1	2	ND	ND	ND	ND
Huge data requirements	1	1	1	1	1	2	3	1	1	1	ND	ND	ND	ND
Quantitativenature	1	2	3	2	3	2	2	1	2	1	ND	ND	ND	ND
Spatial analysis	2	1	2	2	2	1	3	2	1	1	ND	ND	ND	ND
Temporal analysis	2	3	3	3	2	1	3	3	2	1	ND	ND	ND	ND
Organizational aspects	3	1	1	1	3	3	3	1	3	3	ND	ND	ND	ND
Limited information	1	1	1	1	1	2	1	3	3	3	ND	ND	ND	ND

Analysis 1: true, 2: not always true, 3: not true and ND: no data.

2.2 Land Evaluation Process and Methods in Egypt

In Egypt the land evaluation has treated by many workers among them (Bayoumy, 1971; Reda et al., 1973; El-Kady, 1980; Harga et al., 1984; Abd El Motalb and Hussein, 1985; Bahnassy, 1987; Abdel Gaphor et al, 1990; Morsy, 1990; Abd El Rahman et al., 1991; Moawad et al., 1991; El-Shazly, 1993; and El-Shazly et al., 1994). Fathi, (1957) proposed a parametric method in evaluating Egyptian soils. He defined two principle factors in land evaluation. First, basic factors which determine the soil fertility gave it 100 degrees when computing the ideal properties of highly productive soils. Second, environmental factors which are responsible for changing the values of the first factor had a range from 0 to 1.0. The criteria for placing soils in capability classes are as follows: Soil depth, soil texture, water table depth, salinity of water table, alkalinity, salinity, and permeability. Hanna (1969) applied the numerical soil classification method on the soils of the Eastern side of the western desert on an area stretching between Fayoum governorates southwards, and the Mediterranean Sea northwards using the most important characteristics, i.e. gravel, total sulphate, $CaCO_3$ and total salts. Mansour, (1979) in his study to evaluate the soils throughout the Nile valley and delta showed that most of the soils located on the Northern delta are relatively low production owing to their heavy texture, high saline water table accompanied by the distribution of salinity and alkalinity within soil profile. In this system of evaluation six main soil factors appeared to limit the land productivity of the alluvial soils of Egypt, they are, texture, structure, salinity, alkalinity, profile depth and drainage. By rating the former six soil properties, the product is the soil index or rating index. Shendi, (1984) concluded that the most important soil properties which limit the utilization of the soils adjacent to Qarun Lake in Fayoum Governorate are the following: Soil profile depth, Soil salinity, Soil alkalinity, Soil drainage, $CaCO_3$ content, Soil texture, Soil structure, Slope, and Gravel content. Abd El Mottelib and Hussein, (1985) suggested an economic system for the evaluation of the cultivated soils of Egypt. They considered the following two groups of land characteristics:

1- Physical and chemical soil properties:

- Physical soil properties (Soil structure, ground water table, available water, soil permeability, land from, level, slope and erosion).
- Chemical soil properties (Ground water, salinity, soil salinity, soil reaction, $CaCO_3$ content, gypsum content and cation exchange capacity).

2- Environmental factors (Irrigation system, drainage condition, communication status, availability of management and its levels, mechanical grades, and type of cultivated plants). Abd El Rahman et al., (1991) introduced a computer programme based on matching soil parameters i.e., gravel content, texture, effective profile depth, salinity, lime content, gypsum content, drainage condition and slope, with the requirements of 21 common crops. This programme is focused only on soil suitability regardless of economic and climatic aspects.

However, the main activities in a land evaluation in Egypt follow the FAO, (1976). The main conceptual steps in land evaluation are (George, 2002):

Step 1: Identify the Decision Makers Objectives

The land-evaluation process begins with consultations leading up to the setting of objectives. Relevant land-use options that should be considered in the evaluation are provisionally defined at this stage[1].

Step 2: Define the Land Utilization Types

Land-use options and their requirements may be described with varying levels of detail. In reconnaissance studies, the descriptions correspond to major divisions of rural land use, e.g. irrigated agriculture or grassland. However, for detailed studies, more information on the management conditions is required. These strongly influence the attainable levels of production. Land use option is described using the following set of management-related (or "input") attributes (reflecting socio-economic setting) that together define a "land utilization type" (LUT)[2],

[1] It is recommended that preliminary selection of these options should emerge from a participatory land use planning process involving all stakeholders in the future use of the land.

[2] LUT has been defined as "a use of land defined in terms of a product, or products, the inputs and operations required to produce these products, and the socio-economic setting in which production is carried out" (FAO, 1996).

produce, including goods and services, market orientation, capital intensity, labor intensity, power sources, technology, infrastructure, size and configuration of land holdings and income level. Only LUTs that are most relevant and acceptable by stakeholders should be retained for further consideration.

Step 3: Define the Evaluation Units

The spatial unit of analysis for evaluation of suitability is the 'land mapping unit'. The delineation of this unit should be based on land qualities that have the most influence on the land uses under consideration. Thus, depending on the objectives of the evaluation, relevant 'core' data sets may include soils, landform, climate, vegetation, and surface and/or groundwater reserves.

Geographic information systems (GIS) are commonly used to overlay relevant data sets in order to derive land mapping units. Such units are now commonly referred to as 'agro-ecological units' when the original core data sets that are used in the overlay process consist of climate, soils and landform (terrain) data. The set of parameters used for assessing land quality of each land mapping (or agro-ecological) unit are the same as those retained for characterizing the requirements of each LUT.

Step 4: Interim Matching of Land-Use Requirements with Actual Land Qualities

Matching (i.e. suitability assessment) for each land-mapping unit can be made taking into consideration only the physiological requirements of a specific crop(s) and the existing biophysical land conditions (e.g. climate, soils and landform). These sets of information allow prediction of theoretical crop performance (yields). Thus, estimates are made of production performance under different operational land-management settings as specified for the LUTs. These 'adjusted' estimates form the basis for assigning land-suitability ratings for each land-mapping unit.

In earlier non-automated 'qualitative' approaches to matching, estimates of crop performance were based on previous experience or scientific knowledge. In contrast, in more recent automated approaches, estimates are based on computer modeling of crop growth. For non-automated 'qualitative' approaches to matching, land suitability was described using a hierarchic classification structure (ranging from orders, classes, sub-classes to units) that allows the incorporation of fewer or more details on specific land-use limitations. However, in automated approaches, a simplified system based on estimated productivity (% of maximum attainable yield) is often used[3]. Suitability ratings of a given land mapping unit may change over time as a consequence of improvements which modify existing land qualities[4] or as a consequence to changes in one or more of the underlying assumptions (e.g. a change in input level).

Step 5: Final Matching

The interim suitability classifications produced in the preceding step may be re-evaluated taking into consideration a range of additional factors, e.g. potential land improvements, environmental impacts, economic and social analysis.

Since a given land use could have important on-site and/or off-site environmental impacts (e.g. soil erosion, salinization, pasture degradation), such potential impacts should be assessed and subsequently considered in modifying the results of the interim matching process. Economic and social analyses help to identify problems (e.g. labor shortages, adverse tenure conditions, poor access to markets, etc) in relation to potential land uses. These analyses consequently focus on government development objectives, macro-economic tools and data, the rural economy, infrastructure, demographics, land tenure, labor availability and educational level, etc.

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[3] Very suitable: > 80% of potential maximum yields, Suitable: 60-80%; Moderately suitable: 40-60%, Marginally suitable: 20-40%; Very marginally suitable: 5-20%; Not suitable: 0-5% (FAO, 1993)

[4] A minor improvement is temporary in nature and lies within the technical capacity of an individual farmer (e.g. fertilizer application). On the other hand, a major improvement is a large, non-recurrent input which causes a permanent change in the land qualities and which lie usually outside the technical capacity of an individual farmer (e.g. a regional drainage scheme) (FAO, 1983).

2.3 International Spatial Data Infrastructure Review

This part presents an overview of state-of-the-art in the concept of spatial data infrastructure. We start by introducing the concept of spatial data infrastructure as a mechanism to discover and access geographic data, with its main components, and then we examine each of those components in detail.

2.3.1 Spatial Data Infrastructure Definition and Objectives

In order to understand an SDI, a first approximation of its term can be achieved by defining its components: (McKee, 1996) defined "geographic" data as those data describing phenomena directly or indirectly associated with a location and time relative to the surface of the earth. The term spatial data meaning data defined spatially (in location) by four dimensions (geometry and time) related to the earth, (Groot and McLaughlin, 2000). It is generally accepted that geographic information has a vital role to play in the creation of the information society, as 80 percent of all information has some form of geographic reference to it, (Masser, 1999). Throughout the world there is an ever-increasing awareness of the potential from utilizing advances in technology to bring together the many existing sets of data, which contain a geo-spatial reference, (Nanson et al., 1995).

The explanation rests on an understanding of what is meant by infrastructure. Infrastructures are things that can be used by anybody without having to pay the full price of its establishment. The price can be measured in terms of money, but also in terms of waiting time. We use transport and communication infrastructures every day, but no one could afford to found a road or a telephone network personally. Different scholars, (Groot, 1997; Masser, 1998; and Groot and McLaughlin, 2000) consider SDI as the type of any infrastructure like transport, communication, etc. As any road network is necessary for efficient transportation activity and effective economic development, information infrastructure is also very important for effective data application, which in turn can contribute for rational decision-making and subsequently to development. Sharifi and Groot, (1993) have extended their view by way of comparing its importance with road infrastructure; here it goes, a country lacking a proper public transportation infrastructure, may spend billions on cars, which jams the streets, pollute the air and environment, and can not help people with their transportation problem.

Spatial data infrastructure can be seen as an infrastructure in the same sense: just as the ability to access and use the road network is necessary for undertaking a variety of economic activities. A Spatial Data Infrastructure (SDI) is an initiative intended to create an environment which enables a wide variety of users, who require coverage of a certain area covered by the SDI, to access and retrieve complete and consistent data sets in an easy and secure way. There are numerous definitions available for SDI; see table (2.3) for a listing of some definitions which have been used.

A Spatial Data Infrastructure or framework is an essential pre-requisite to make use of spatial information in an effective and efficient way. The principal objective for developing SDI is summarized by Bishr and Radwan, (1998) as follows:

1- to achieve horizontal and vertical integration of data that leads to the promotion of data interchange and system interoperability for better decision-making;
2- to promote stimulate, encourage and support the development and use of geographic information and its associated technology;
3- to collect, organize, store, and distribute information;
4- to identify, move, and present information;
5- to provide improved data security and integrity;
6- to provide easier and more consistent access to data and information; and
7- to reduce the cost of data acquisition, storage and management.

The overall objectives of SDI can be summarized into the following two broad purposes:

1- to save time, effort and money (An estimated 90 % of all information used by government has geo-spatial characteristics or attributes and 70-80 % cost of any GIS project spend for data collection, maintenance,) in accessing spatial data and using it responsibly; and
2- to avoid unnecessary duplication (the same data sets will be collected by different agencies again and again) in the harmonization and standardization of required data sets by promoting the sharing of available data, (Groot, 1997).

Table 2.3 Spatial data infrastructure definitions

Source (reference)	SDI Definitions
McLaughlin and Nichols, (1992)	The components of a spatial data infrastructure should include sources of spatial data, databases and metadata, data networks, technology (dealing with data collection, management and representation), institutional arrangements, policies and standards and end-users
Executive Order of US President, (Executive Order, 1994)	National Spatial Data Infrastructure (NSDI) means the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geo-spatial data
Australia New Zealand Land Information Council, (ANZLIC, 1996)	A national spatial data infrastructure comprises four core components - institutional framework, technical standards, fundamental datasets, and clearing house networks
Dutch Council for Real Estate Information (Ravi), (Masser, 1998)	The National Geographic Information Infrastructure is a collection of policy, datasets, standards, technology (hardware, software and electronic communications) and knowledge providing a user with the geographic information needed to carry out a task
Victoria's Geo-spatial Information Strategic Plan of the State Government of Victoria, Australia, (Land Victoria, 1999)	The concept of a spatial data infrastructure is extended to include more than just the data itself-it now encompasses all organizations and customers involved in the entire process, from data capture to data access, including the geodetic framework
Radwan, (1999)	SDI is the processes that enhance the data/information availability and management. It is a set of institutional, technical and economical arrangements that facilitate access to and responsible use of integrated and timely geo-information at affordable cost.
Groot and McLaughlin, (2000)	The infrastructure concept has come to encompass the sources, systems, network linkages, standards and institutional issues involved in delivering spatially related data from many different sources to the widest possible group of users at affordable cots.
FGDC, (2003)	SDI is the technologies, policies, and people necessary to promote sharing of geospatial data throughout all levels of government, the private and non-profit sectors, and the academic community."
Wytzisk and Sliwinski, (2004)	A SDI can be understood as a multi-leveled, scalable, and adaptable collection of technical and human services, which are interconnected across system, organizational and administrative boundaries via standardized interfaces. Those services enable users from different application domains to participate in value chains by gaining seamless access to spatial information and geo-processing resources.

2.3.2 SDI Components

Figure (2.2) shows that what SDI component should encompass and the linkages between different elements in the components as a functioning system. All these components are parts of a system, working in an environment, where cultural, legal, financial and educational situations of the society have roles (Sharifi and Groot, 1993). Although differently expressed or a list of elements are given, most of them can be categorized in to three broad perspectives, viz. Institutional, Technical and Economical aspects.

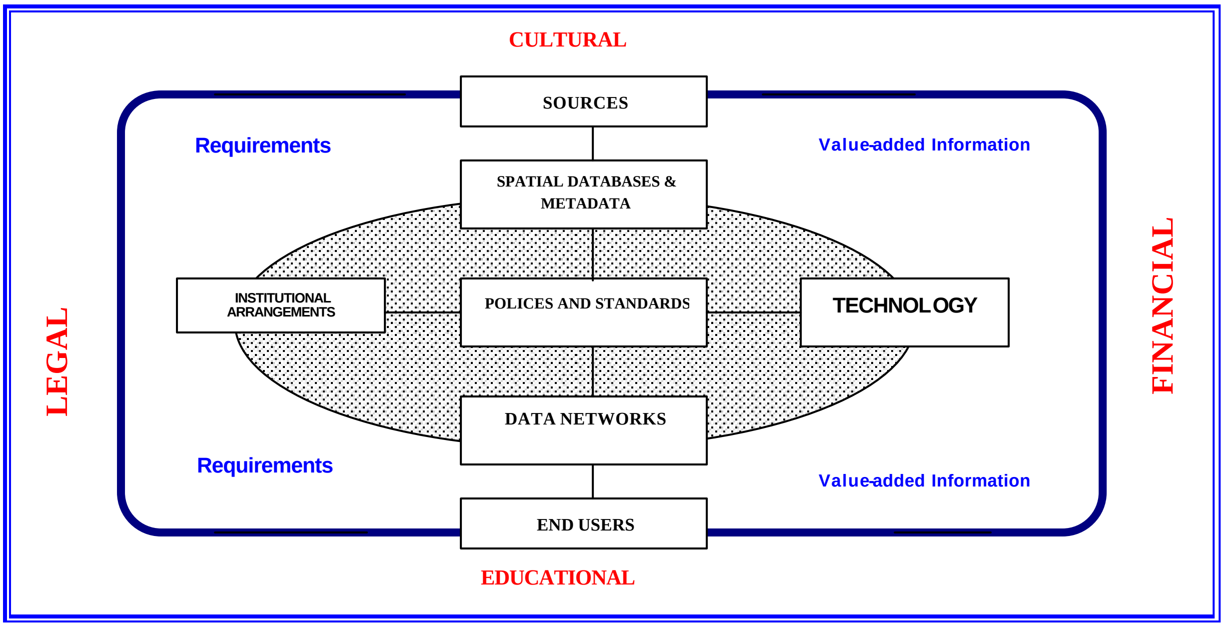

Figure 2.2 A system view of the SDI component (modified after Groot and Sharifi, 1994)

Coleman and McLaughlin, (1998) suggested that a SDI comprises not only the four basic components identified for the Australian SDI, but also an important additional component, namely, people, figure (2.3).

Although there are different view for SDI components, in this thesis viewing the core components of SDI as people (including partnerships), data, policy, technical standards and access network, figure (2.4). Rajabifard et al., 2002 suggested that different categories can be formed based on the different nature of their interactions within the SDI framework. Considering the important and fundamental role between people and data as one category, a second can be considered consisting of the main technological components: the access network, policy and standards, figure (2.4). This component includes the spatial data users and suppliers and any value-adding agents in between, who interact to drive the development of the SDI.

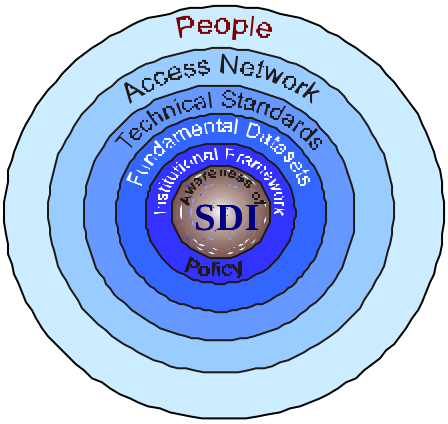

Figure 2.3 Five basic components of a SDI
(Coleman and McLaughlin, 1998)

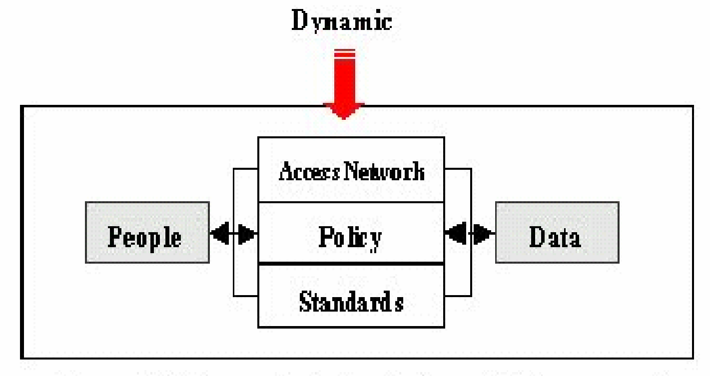

Figure 2.4 Relationship between SDI components
(adopted from Rajabifard et al., 2002)

According to figure (2.4) anyone (data users through producers) wishing to access datasets must go through the technological components. This suggests an integrated SDI cannot be composed of spatial data, value-added services and end-users alone, but instead involves other important issues regarding interoperability, policies and networks. This reflects the dynamics of the whole SDI concept, (Rajabifard et al., 2002).

Moeller (2002) presented his view of the components of Spatial Data Infrastructure, figure (2.5) as:

1- Framework provides consistent base for spatial location.
2- Metadata is explanation or textual description of data resources.
3- Clearinghouse (catalog) provides access and catalogue ability.
4- Standards are the standards for data and technology interoperability.
5- Partnerships are the relationships for collaboration, sharing and policy deliberations.

Comparing with other structure, Moeller put more emphasis on the data catalog function of SDI.

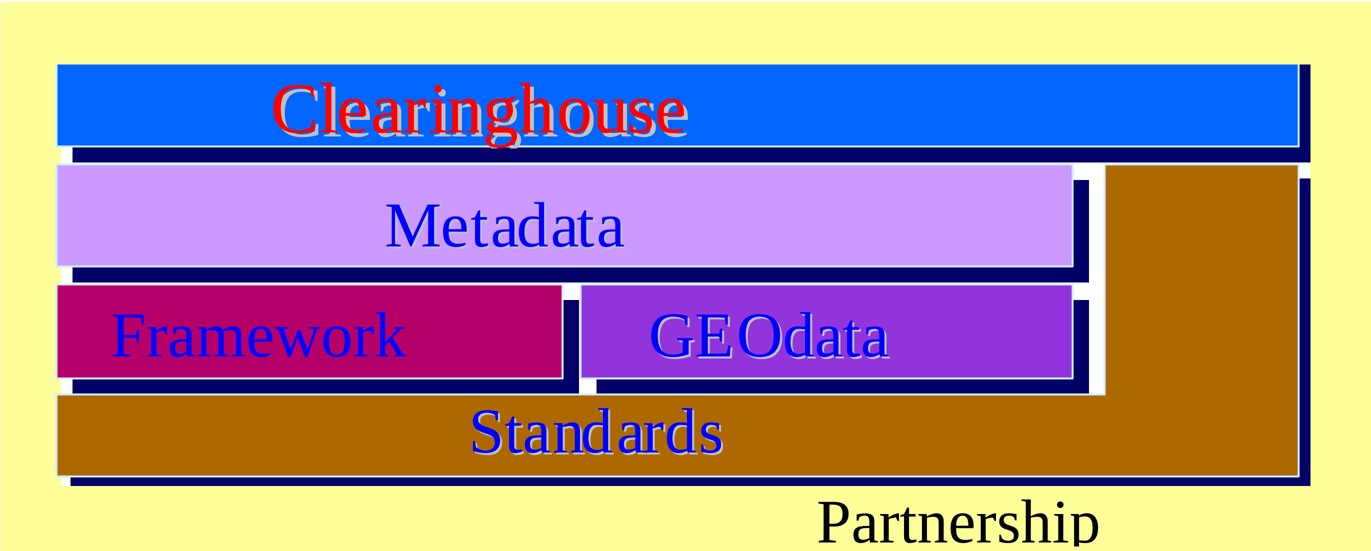

Figure 2.5 NSDI components (adopted from Moeller, 2002)

2.3.2.1 People

Different groups of people, organizations and agencies can participate in development of an SDI, (Williamson et al., 2003). Partnerships are a major achievement in the establishment of an SDI because organizations tend to feel that they are giving up their competitive edge to share, trade, sell or create data with other organizations, (FGDC, 1996). Cooperation and partnerships for spatial data activities among the central government institutions, local governments, and the private sector are essential for the development of a robust National Spatial Data Infrastructure, (GSDI cookbook, 2000).

The involvement of the politicians concerned with the SDI development is essential. SDI development needs a champion at the highest political level, (Groot, 1997). Especially in countries where almost all users and providers (potential stakeholders) are government and government related organizations, the role of the political architects forms the hub of the inter-organizational coordination efforts. The politicians' support provides legitimacy and encourages the necessary financial investment for the SDI development. "Political will, Political will, Political will. When there is a will, there is a way", (Woldai, 2002).

The lack of staff with the necessary geographic information management skills is a big problem. There is a great need for increased awareness of the benefits of spatial information by the existence of training/courses and educational resources to strengthen awareness and skills to participate involved in SDI development activities. With the proliferation of online web mapping, and navigation/direction information, an increasing number of people are using GIS. This is obviously of importance in the development of an SDI to facilitate spatial data activities, (Crompvoets et al., 2004).

2.3.2.2 Data and Mtadata

Data is the "fuel" of a GIS and the decisions made using a GIS are only as good as the data used to make them. Any project can meet its objectives only if the appropriate data is available. Different applications may need different information or data sets, but for spatial data, the same data sets may be suitable for many applications for a certain areas. Spatial data are different from other information in that the data contained can, as a spatial characteristic, refer to objects or phenomena with a specific location in space and therefore have a spatial address. For a spatial data resource to acquire an infrastructure status, it needs to develop to a stage where it is accurate, consistent, updated in one place only to avoid duplicate datasets. Prime examples of datasets that have an infrastructure status are the cadastral and topographic databases.

Groot, (1997) recognizes three datasets classes. The first class is foundation datasets. Foundation datasets as geodetic data (which determine the spatial reference system), basic topography (used by many applications as an additional geometric reference represented in the terrain), the digital elevation model, administrative boundaries and postal codes (essential to link socio-economic data to physical data), and official geographic names (still the most used reference for many applications). Sometimes digital orthophotos are part of the foundation data, (Groot, 1997). To give an analogy, the letters A to Z can be regarded as core datasets of English language, which can be combined and re-used many times to provide different words, following standard spelling rules.

The second class is the framework datasets that usually provide thematic information in a national context. This information may be surveyed directly in the field or by means of remote sensing. Or it may be derived information, such as land suitability for particular purposes. It may contain following categories: soil boundaries, hydrology, vegetation, property limits, land cover, land use, transportation and etc., (Groot, 1997). Appendix 2b shows the result of a survey in multiple countries to determine what data should be considered as framework data in the context of a national spatial data infrastructure, (Onsrud, 2002).

The application-specific data set is the last class recognized by Groot, (1997). It contains information surveyed specifically for a particular application, such as pollution measurements, water chemistry, smog indices and etc.

The need for proper documentation for the discovery, evaluation, and use of existing geospatial datasets is seen as an important first step in the creation of any SDI (McLaughlin, 1991; FGDC, 1997; Onsrud, 1998; and Crompvoets and Bregt, 2003). Effective use of GI requires easy access to documentation that describes the provenance, ownership, quality, age, fitness for purpose and other useful properties. This associated data documentation is referred to as metadata, (Maguire and Longley, 2005). Metadata is the main key to open the door of SDI. Data plus the context for its use (documentation) become information. Data without context are not as valuable as documented data.

2.3.2.3 Standards

In SDI system, it is usual for many files to have been combined in order to boost the potential for analysis of the spatial data. The potential situation exist that the data, when compatible at face view, might not warrant the conclusion drown from there analysis. To ensure interoperability amongst the datasets and access mechanisms defined by a SDI, standards are essential. By having standards, for example for data storage, encoding and transfer, data can easily be shared among a wider community of users and the best possible utilization of the data can be achieved, (Economic Commission for Africa, 2000).

A number of standardization organizations have developed standards for storing and maintaining metadata. A brief description about these initiatives is described below:

1- CSDGM: Content Standard for Digital Geospatial Metadata. Developed in 1994 by the U.S. Federal Geographic Data Committee as part of the National Spatial Data Infrastructure. It is a full metadata standard with 219 fields to describe digital datasets for all purposes. These fields are grouped into seven information categories: Identification, data quality, geospatial data organization, geospatial reference, entity and attribute, distribution, and metadata reference. It is mandatory for federal agencies, (FGDC, 1997);
2- CEN/TC 287 Env 12657: it is the European equivalent to CSDGM. It is a voluntary pre- standard (i.e. not enforceable) developed in 1997-98 for the European Committee for Standardization (CEN). It is a full metadata standard, which has provided the basis for many European initiatives;
3- ISO 19115: It should bring together both US and European standards under one umbrella. It will have two components: a “core” metadata profile for discovery, and a “comprehensive” profile for applications, (Kresse and Fadaie, 2004); and
4- Open GIS Consortium: industry based consortium to promote interoperability and develop GI market. It is developing Abstract Specifications on a range of topics including Metadata standard, some specifications have been accepted and published.

2.3.2.4 Policies

The use of spatial information as a corporate resource implies an understanding of who owns the data and what rights can and should be retained over their use, (Dale, 1991). Copyright, licensing and other rights to the use of data and information must be addressed to ensure the appropriate data and information is accessible to all. Some data are considered to be sensitive, proprietary, or require cost recovery, which raises issues of access and pricing. Who will pay and maintain the SDI is a question, which is being faced by all levels of government.

The responsibility of maintaining information should be shared between different organizations based on appropriate institutional framework for accessing and using data/information. Institutional framework (which defines the policy and administrative arrangements for building, maintaining and accessing data) encompass a wide range of issues relate to the ownership of spatial data, roles of the private and public sectors in the distribution of geographic information, the right of access to spatial data, and information privacy. The social, political, organizational arrangements and policy are the main issues in institutional framework.

2.3.2.5 Access Networks

The access network component of an SDI is critical from a technical perspective to facilitate the use of data by people. Efficient government requires that services be joined up and easy to access, and geography can provide a very effective linking mechanism, (Beaumont et al., 2005).

Over the last six years, the GIS community has become increasingly focused on the dissemination capabilities within, as well as outside of, organizations, (Tait, 2005). There is recognition within the community that the web provides a new medium for participation, (Longley and Batty, 2003), and its response has come in the form of software technologies that provide the capability to implement in a distributed environment. Clearinghouse, Website(s), and Web Map Server(s) are the means by which data and metadata are made accessible to the community. These metadata elements are stored and served through a user accessible catalogue of geospatial information, (GSDI Cookbook, 2004). Support of a discovery and access service for geospatial information is known variously as, (Maguire and Longley, 2005):

1- "Catalogue services" (Open GIS Consortium);
2- "Spatial Data Directory" (Australian Spatial data Infrastructure);

3- "Clearinghouse"; and
4- "Geospatial One-Stop Portal" (U.S. FGDC).

Although they have different names, the goals of discovering spatial data through the metadata properties they report are the same. This component seeks to facilitate access to relevant data sources and spatial information services by anyone, anywhere. The best example of an access network at national level is the national clearinghouse (Crompvoets et al., 2004). Access networks usually comprise data warehouses, data portals, one-stop shops, on-line atlases or similar. Around the world these are being set up to facilitate access to spatial data.

Further integration of these services with web mapping, live access to spatial data, in which data can be discovered, evaluated, fused, and used in problem-solving, (GSDI Cookbook, 2004). SDIs have progressed from FTP sites or web without standards to clearinghouses in the mid 1990s where standards and metadata became prevalent, to the latest trend in SDI development: geo-portals or gateways to services and applications using spatial data, or data itself, (Maguire and Longley, 2005). So, a key element of an SDI is a web portal which would be a vehicle for linking users with data providers.

Geo-portals

A technical definition of the word ''portal ''is ''a web site considered to be an entry point to other web locations '' (http://www.dictionary.com). The word Geo-portals stems from the Latin word porta and indicates an entrance point, (Annoni et al., 2004). Portals are web sites that act as door or gateway to collection of information resources, including datasets, services, cookbooks, news, tutorials, tools and an organized collection of links to many other sites usually through catalogs.

There are general portals and specialized or niche portals. Some major general portals include Yahoo, Excite, Netscape, and Lycos. Examples of niche portals include (http://www.burpee.com/) for gardeners, (http://www.Fool.com) for investors, and (http://searchnetworking.techtarget.com/) for network administrators).

There are several examples of geo-portals including the British Geological Survey (http://www.bgs.ac.uk/geo-portal/home.html) that covers geosciences resources, US Geospatial One Stop (www.geodata.gov) and EU IN-SPIRE (http://eu-geo-portal.jrc.it/) that deal with national government data, and the Geography Network (www.geographynetwork.com) and GSDI portal (http://gateway.gsdi.org/weswww/portal/index.html). The Alexandria Digital Library Project, an early online distributed, geo-referenced web archive, strongly influenced the site design process (http://alexandria.sdc.ucsb.edu/), (ADL, 2003). They provide capabilities to query metadata records for relevant data and services, and then link directly to the on-line content services themselves.

Clearinghouse web sites represent one of the earliest spatial data infrastructure (SDI) web portal initiatives. Two key technical breakthroughs distinguish the second generation geo-portals from their earlier first generation clearinghouse counterparts:
First, it is now possible to access directly both metadata records describing services and the actual services (mapping, data download, geocoding, routing, etc.) themselves. Second, services can be accessed from both conventional desktop GIS applications, as well as thin client browser. When accessed from thicker clients, usage now includes support for combining data from multiple remote services over web connection, (Maguire and Longley, 2005).

An SDI-based geo-portal is only as good as the information that is published through the site, and metadata is core to the publishing process.
Geo-portal can:

1- provide "one-stop shopping" for spatial data and services, figure (2.6);
2- search for spatial data through fields and full-text in the metadata (standardized access to spatial information);
3- links through to full data access, where available;
4- provide services that respond to user needs; and
5- identify priority areas for improvements and gaps to be filled.

A conceptual architecture design is adopted from Moeller, 2002 "One Stop Shop." One Stop Shop Model describes the NSDI network structure (figure 2.6). In this structure, the emphasized on the role of 'Geo-spatial One-stop Portal' in the relations between the data users and providers, As a tool to promote SDI development, a Geo-portal provides a measure of progress of SDI development through indicators such as the number of services and catalogues available over time and measures of user feedback. Geo-portal is important for visualization, processing and access to data. This service must be based on clear user needs and provide links to national portals. To achieve this, existing catalogues need to be extended by building software interfaces.

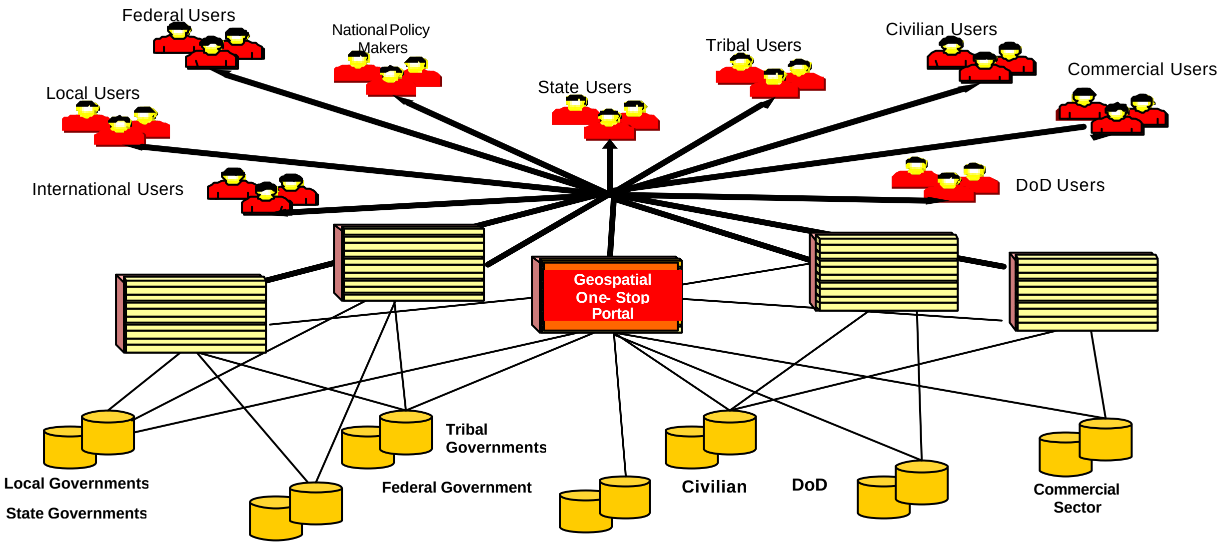

Figure 2.6 One Stop Shop conceptual design (adopted from Moeller, 2002)

2.3.3 SDI Developments

Efforts have been made to develop what are now called Spatial Data Infrastructures (SDIs), to facilitate the use of spatial data that is collected and stored in scattered digital databases to their full potential. In the evolution of the NSDI, there are two general generation. A first generation (1980s) consisting of a relatively small number of countries. Due to the differences between countries in geography, culture, levels of economic development, and government structure, the activities of implementation of the NSDI in the first generation come in all shapes and sizes, (Masser, 1998b).

The first generation can be divided into two categories with respect to their status:

- The first category that is the result of a formal mandate from government includes Portugal and the United States.
- The second category consists of countries where national spatial data infrastructure has grown out of existing coordination activities. This is the case in Australia and The Netherlands.

Most developed countries are at various stages of developing spatial data infrastructures (SDI). The factors behind their success can be linked to high levels of technology, availability of funds, trained personnel and political support.

Table 2.4 NSDI components for different countries.

Country	Name of The NSDI	Abbreviation	NSDI Components					
Australia	Australian Spatial Data Infrastructure	ASDI	Institutional Framework		Fundamental Datasets	Technical Standards	Clearinghouse Network
Canada	Canadian Geo-spatial Data Infrastructure	CGDI	Partnerships	Supporting Policies	Framework Data	Geospatial Data Standards	Geospatial Data Access
Indonesia	Indonesian National Geographic Information Systems	INGIS	Institutional Issues		Fundamental Datasets	Data Standards	National Clearinghouse
Netherlands	National Geographical Information Infrastructure	NGII	ND		Core Data	ND	National Clearinghouse
South Africa	National Spatial Information Framework	NSIF	ND		ND	Standard	Spatial data discovery facility
UK	National Geographic Data Framework	NGDF	Collaboration		Standards and best practice		Data Access
USA	National Spatial Data Infrastructure	NSDI	Partnership		Framework Data	Data Standards	Geospatial Clearinghouse

ND: No Data

In the US and Portugal, the NSDI was created by a formal mandate from government. As a result Portugal can be regarded as the first European country that has an operational national geographic information infrastructure, fully distributed, based on the most recent developments in information technology, (Masser, 1998b). In the US NSDI context, major initiatives contain four sectors, including clearinghouse, standards, data framework, and partnerships, table (2.4). And associated with freedom of information, policies in the US have led to a variety of value-added re-sellers adopting the data and selling associated functionality to the economic benefit of the country.

Approaches in Canada, Australia, Germany, and Japan are somewhat at variance with those in the United States. The activities of the NSDI in these countries have largely grown out of existing geospatial data coordination activities. Although there is not a formal mandate from top-level government, the existing coordination among all levels government are the driving force to promote the NSDI. The initiative in Canadian geospatial data infrastructure (CGDI) has five inter-related technical components, table (2.4), namely data access, framework data, standards, partnerships, and supportive policy, (Labonte et al., 1998). The Australian and New Zealand Land Information Council (ANZLIC, 1998) define a national SDI as comprising four core components: an institutional framework, technical standards, fundamental datasets, and clearinghouse networks, table (2.4).

Unlike other European countries, the concept of the NSDI both in the Netherlands and the United Kingdom has a long history. Both of them have a large amount of geospatial data held by government, but the NGDF in UK and the NGII in the Netherlands do not include spatial data (framework data), table (2.4). Most of the spatial data are copyright owned and some government agencies face the pressure of cost-recovering requirement.

In contrast the Indonesian and Malaysian National Geographic Information Systems tend to be focused on surveying and mapping activities associated with land management. In Indonesian, the SDI components were Institutional Issues, Fundamental Datasets, Data Standards and National Clearinghouse, table (2.4).

The starting point for the second generation is around the year 2000, (Rajabifard et al., 2003; and Crompvoets et al., 2004). The technological that has taken place in the second generation of NSDI is the shift has taken place from the product model that characterized most of the first generation to a process model of an NSDI. The main driving forces behind the data process model are data sharing and reusing data collected by a wide range of agencies.

SDI starts at a local level and proceeds through state national and regional levels and is completed by developing a Global Spatial Data Infrastructure, (Rajabifard et al., 2000b). The success of a spatial data infrastructure will primarily depend on the demand for geo-information products. That is why many countries around the world are developing spatial data infrastructures (SDI) as a way to better manage and utilize their spatial datasets, (Rajabifard and Williamson, 2004).

2.3.4 Spatial Data Infrastructure in Developing and Arabian Countries

Several scholars have presented efforts by developing countries to develop spatial data infrastructures, for example, Standley, (1997); Kalensky and Latham, (1998); Economic Commission for Africa (2000); and Ezigbalike et al., (2000). The scholars observe that lack of funds, professionals, spatial datasets, standards, metadata and information sharing policies are some of the factors hindering the development of SDI's.

The availability of spatial information for cities in developing countries is poor or non-existent. In many cases, the spatial data is in the form of uncalled sketches. However, in some developing countries for instance Malaysia, South Africa, Indonesia, and China, the signification and urgency of the NSDI were understood even better than some developed countries. These initiatives, at the time they were getting underway, were not referred to as SDI, but ultimately they are basis of each country's spatial data infrastructure, (Table 1). Each initiative has a slightly different origin. Many of these SDI initiatives have evolved out of specific projects. Although these nations are limited in investment and technology, the progresses of implementing the NSDI are greater and faster. In these countries the NSDI is looked more upon as a project, they tend to be focused mainly on surveying and mapping activities associated with land management or around central government surveying and mapping activities, (Masser, 1998b), but the complexity and protracted nature of establishing the NSDI are underestimated.

In Zambia, technologies such as remote sensing, aerial photography and GIS are being well utilized, but the duplication of effort in data capture is quite common at institutional level, which has called for practitioners of GIS to realize that coordination of effort is necessary. The following operational issues have been identified as needing attention to facilitate the development of a Zambian SDI, (http://www.grida.no/eis-ssa/eisnews/1-00/08.htm):

1- metadata standards;
2- human resource development (training);
3- lack of standards for capturing data; and
4- operational procedures.

At the institutional level, there is a need to focus on the following issues:

1- lack of coordination;
2- technology-driven approach;
3- bottom-up technology;
4- sharing / cost policy; and
5- duplication of effort.

The Botswana Land Information System (BLIS), table (2.5) is a computerization of the urban land records carried out in order to facilitate the allocation and sale of urban state land. The lessons to be learned from this experience by new entrants to the spatial information industry are to plan all spatial data projects from the onset for eventual integration into an SDI. To minimize this problem in Botswana, further developments in spatial data utilization should adopt SDI principles. This also applies to ongoing upgrades of BLIS, ensuring minimum problems of legacy data when the data networks and other information technologies become operational for a fully on-line, distributed SDI, (http://www.grida.no/eis-ssa/eisnews/1-00/08.htm).

The Qatarian GIS activities began in 1988. We can say that there were no major existing GIS activities to compete with Qatar's efforts to coordinate and implement GIS from top-down. This is an example of a developing country that implements a super SDI system (one of the best system in the world- The GIS City), (Tosta, 1997).

Spatial data infrastructure in Ghana started with the development of a national Environmental Information System (EIS), developed in the framework of a National Environmental Action Plan in 1989. The objectives of the system with respect to SDI were, (http://www.grida.no/eis-ssa/eisnews/1-00/08.htm):

1- provision of a readily accessible archive of homogenous datasets for reporting on environmental quality; and
2- provision of organized data and information on the state of the environment and to serve as information support for development planning.

Many useful lessons are learned through the spatial data infrastructure in Ghana which was aimed at addressing the problem of spatial data availability and establishing the necessary institutional framework to facilitate the exchange of data. It was recognized that the success of the project would depend strongly on institutions working together. The network approach built on the collective strength of partner agencies to overcome individual limitations and ensured that a large volume of compatible national level data would become available for environmental management and planning applications in a relatively short time.

Like in many other African countries, the spatial information industry in Uganda is not fully developed. Most organizations are still keeping their data as paper maps with very limited analysis. There is a lot of duplication in data collection and storage and a lot of spatial data is not documented. In Uganda, the lack of standardization is seen as a major weakness in the implementation process, (Musinguzi et al., 2004).

The National Spatial Information Framework (NSIF) spearheads SDI development in South Africa, table (2.5). This is a directorate that was established in 1997 within the South African Governments Department of Land Affairs. NSIF was essentially established to eliminate duplication with regard to the capture and maintenance of spatial information and to provide the framework for ensuring that investment in spatial information leads to an increase in the value and quality of the information available to government. NSIF strives to improve access to existing data through documenting existing datasets and creating an accessible metadata database across the country. It also strives to improve the integration of various datasets through development of standards, (http://www.grida.no/eis-ssa/eisnews/1-00/08.htm). The following components have been identified by NSIF as necessary to improve data sharing and the ability to integrate new datasets into existing information systems:

1- standards for spatial datasets, which will enable data sharing. Examples are accuracy standards for data collection, metadata standards and classification standards. These need to be developed through a process of consultation with data producers and users; and
2- a spatial data discovery facility, linking people seeking data through electronic networks with data producers who maintain their data locally.

There are initiatives to reduce the institutional problems by way of networking institutions involved in utilization of spatial data, to address environmental and socio-economic problems of the society at large.

There are few examples where SDI has become a funded activity under the central government's core budget. More common in Africa is the case of Zambia in which the central government supports an initiative in conjunction with donor funds; the Environmental Information Network and Monitoring System (EINMS) Forum which is a component of the Environment Support Programme is funded by the Government of Zambia, the World Bank, and the Nordic Development Fund. The National Spatial Information Framework (NSIF) in South Africa is funded within the budget of the Department of Land Affairs, (Lance, 2003).

Table 2.5 Partial list of SDI initiatives in developing and Arabian countries

Country	Name of the Initiative	Approximate Initiation	Abbreviation
Tunisia	Schéma national de géomatique / Programme de Géomatisation Nationale (GEONAT)	1997 initiation; 1998 launch	SNG
Algeria	National Council for Geographic Information	1996	ND
Qatar	Qatar's National Geographic Information System	1988	NGIS
Botswana	National GIS Coordination Committee	2001	BLIS
Ethiopia	Ethiopian Spatial Data Infrastructure	2002	ND
Ghana	National Framework for Geospatial Information management in Ghana	2000	NAFGIM
Kenya	National Spatial Data Infrastructure	2001	ND
Nigeria	National Geospatial Data Infrastructure; National Geospatial Information Infrastructure (NGII)	NGDI 2002; NGII 1994	NGDI
Zambia	Environmental Information Network and Monitoring System	1997	EINMS
Uganda	Uganda Spatial Data Infrastructure	2003	USDI
Namibia	Environmental Monitoring and Indicators Network	1998	EMIN
South Africa	National Spatial Information Framework (it will be known as the South African Spatial Information Infrastructure (SASII) in the future)	1997	NSIF
India	India's NSDI programme	2001	INSDI
Indonesia	Indonesia's National Geographic Information System	ND	INGIS
Malaysia	Malaysia's National Land Information System	ND	MNLIS
Chile	Chile's Sistema National de Information Territoriale	2001	ND

ND : No Data.
Source: Tosta, 1997; Lance, 2003 and Masser, 2005

The New Partnership for Africa's Development (NEPAD) is perhaps the most prominent 'hook' for SDI. NEPAD is a pledge by African leaders, based on a common vision and shared conviction, to eradicate poverty and to place their countries on a path of sustainable growth and development. This summit was in Sharm El-Sheik, Egypt in the same day for GSDI-8 conference opening in April 2005. To implement NEPAD, geographic information, across all sectors is an obvious tool for planning and monitoring - this transcends 'environmental information' or 'disaster information' or 'health information' or 'economic information' or 'demographic information', (Lance, 2003).

2.4 Review of SDI Activities in Egypt

As a result of the increasing dissemination and use of information systems (IS), decision support systems (DSS) and geographical information systems (GIS) applications in Egypt, the need for infrastructure for digital information and geospatial data become an essential issue to facilitate/ organize the data collection and flow between different data producers and users in Egypt. In the mid-1980s the Government of Egypt adopted a strategy to improve Egypt's managerial and technological infrastructure by establishing an infrastructure for informatics and decision support systems, developing a software service industry, and developing a high-technology industrial base such as communications, electronics, and computers, (IDSC, 1998).

2.4.1 GIS in Egypt

In Egypt where there are different GIS centers established at many ministries, organizations and research centers such as Ministry of water resources, Ministry of agriculture, and Ministry of Communications and Information Technology (MCIT). In fact most of the governmental agencies established their own GIS center. Those different centers do the same job, even for different applications, and all of them fall into much redundancy and duplication of efforts concerning data collection and GIS developing. It is not that easy to coordinate between those GIS centers without a strong driving force that can convince them to cooperate, and to work under the same standards that can integrate the multi-discipline applications. The following public institutions have remote sensing or geographic information system facilities. Each of these units uses the geo-information technology in specific applications, (http://www.fao.org/documents/show_cdr.asp?url_file=/DOCREP/005/Y4357E/y4357e05.htm).

- Remote Sensing Unit, Soils and Water Institute, Agriculture Research Center. Soils and agricultural applications are the main tasks of this unit.
- Desert Research Center, Ministry of Agriculture and Land Reclamation. It has a NOAA receiving station, Remote Sensing and GIS unit. The main concerns are the establishment of environmental databases of the desert areas in Egypt.
- Ministry of public works and Water Resources and its affiliated institutes. It uses geo-information technology for water resources assessment and development, irrigation and drainage planning.
- Information and Decision Support Center (IDSC). It applies GIS technology for natural resources management and development as well as land use planning.
- Egyptian Survey Authority. It applies GIS and photogrammetric techniques for producing topographic maps at Egypt of different scales (1:2 500-1:250 000).
- Egyptian Geological Survey and Mining Authority, Ministry of Public Work and Water Resources. It works mainly in mineral exploration and geologic mapping.
- Universities: Aerial photo interpretation and GIS application.
- Egyptian Meteorological Authority.

2.4.2 Existing Resources of Spatial Information in Egypt

A particular example that illustrates the existing GIS resources in Egypt is the Soil and Terrain database and soil maps for Egypt at the 1:50000 scales have provided a means to explore the necessary components for GI projects in Egypt, including training and support as well as data and hardware. The project has involved developing a GIS that draws together diverse data sources and fieldwork information to help with the management of natural resources, utilizing topographic and landform maps, base geology, terrain and soil maps and soil quality information from the SOTER database. The soil and terrain database (SOTER) and a digital soil map (1:100 000) of Sinai have been completed in 1995.As a follow-up to these activities, NARSS has completed a SOTER database for many regions in the Egyptian desert: Tushke (1:25 000), Darb Al Arbien (1:25 000), Siwa (1:25 000) in the western desert, and Halaib- Shalatien (1:100 000) in the eastern desert. In 1999, NARSS started a FAO-sponsored project to produce a digital soil and terrain database (SOTER) at a scale of (1:1 000 000), (http://www.fao.org/documents/show_cdr.asp?url_file=/DOCREP/005/Y4357E/y4357e05.htm).

There are many different types of data available. For example, soils and geology data supports broad-based agricultural activity. The following maps are available in different institutions in Egypt:

1- Soil maps for different areas at scales of 1:2,500, 1:10,000, 1:100,000 showing salinity, texture, soil and water depth and soil fertility (macro-nutrients).
2- A National Soil Association Map, scale 1:5,000,000.
3- Soil Classification Maps for certain desert areas, prepares by using remote sensing techniques and digital image analysis.
4- Computer compatible tapes, covering the whole country for 1990, 1991, and 1993 are all available at the Soil and Water Research Institute of the Ministry of Agriculture.
5- Soil Physiographic Maps at scale 1:50,000 (aerial photographs), covering areas in Upper and Lower Egypt, as well the area around the Desert Road, (Cairo-Alexandria), which comprises the reclaimed lands in the Western Desert. All these maps are available at the Soils Department, Cairo University.
6- Collection of Soil Classification Maps at scale of 1:100,000, covering 48 colored sheets for the cultivated areas. This collection is available at the Academy of Scientific Research and Technology.

The above maps have been produced using Topographic Maps of the National Survey Authority, available at scales of 1:250,000 and 1:100,000. Their compilation is done using the existing data and a great number of exploratory field studies all over the country.

The following maps are available at the National Authority for Remote Sensing and Space Sciences (NARSS):

1- Soil Maps for the Nile valley and the Delta, scale 1:100,000 (hard copy);
2- Digital Soil Map for Sinai Peninsula, scale 1:100,000;
3- Soil Maps for Siwa Oasis and Toshky, scale 1:25,000 (digital);
4- A Soil Map (hard copy) for the Eastern Desert (at scale of 1:250,000) is actually in preparation;
5- Soil Map and Land Use Map for the area of Halayib and Shalatein as well as for the Siwa Oasis, scale 1:25,000; and
6- Soil Classification and Land Productivity Maps for Bahariya Oasis, North Sinai, East Owaynat and some valleys on the Red Sea area are available at the Soils Department, Ain Shams University;
7- Soil and Land Evaluation Maps for Alexandria and surrounding areas of the North Coast are available in digitized version at the Soils and Water Department, Alexandria University.

At the Desert Research Centre (DRC), the following maps have been prepared:

1- Soil maps and Land Capability maps for the soils of Southern Egypt, Toshky, as well as Kharga and Dakhla Oases developed in GIS format at scale 1:100,000 and 1:25,000;
2- Soil maps and Productivity maps for the north coastal littoral of Egypt, scale 1:100,000 (digitized);
3- Soil maps for the soils of Lake Nasser, Korkor, Klabsha and Adendan, as well as for the Soils of Bahariya Oasis (under preparation), scale 1:100,000; and
4- Soil and Land Capability maps for desert soils of Egypt, scale 1:100,000. Digitized information maps representing gypsum requirement, sub-soiling, salinity, and water table depth for improved soils in the different Governorates, are available at the EALIP offices in Dokki, (http://ressources.ciheam.org/om/pdf/b34/01002089.pdf).

2.4.3 The Existing Information Infrastructure Available in Egypt

Egypt has seen a rapid increase in network activities through internet providers. These facilities are now more accessible than ever before, as competition has lowered prices. Several organizations have implemented networks and allow open to the internet. The accessible information infrastructure available in Egypt now is:

1- National digital maps catalogue of Arab Republic of Egypt (NGISC). One of the recent developments is the NGISC, built and hosted by IDSC in year 2000, http://www.ngisc.gov.eg/en/index.html. The NGISC is a web based clearinghouse to host the metadata of the organizations currently working in geographic information field. The main aim of NGISC is to advertise for the available digital maps and encourage sharing of data to avoid map production duplication and to save time and effort, (IDSC, 2000).
2- The Egyptian information highway. The Egyptian information highway has been built and hosted by IDSC since 1995, http://www.highway.idsc.gov.eg/. Several pilot information networks are being launched to provide the basic non-spatial information about various sectors in Egypt such as the cultural net, the tourism net, and the government net.
3- Historic Cairo, http://whc.unesco.org/pg.cfm?cid=246&id_state=50.
4- Egypt's Information Portal. Contribute in the acceleration of the economic and social development ratios via developmental studies and economic analysis needed to support the decision makers to reach the main target of the Egyptian government which is a better life to citizens, http://www.idsc.gov.eg/English/.
5- The Egyptian Government on line, http://www.misrnet.idsc.gov.eg/.
6- The Egyptian Government – Services Portal, where you will find information related to more than 700 services provided by the various ministries. You can also access services online such as retrieving and paying your phone bill online, http://www.egypt.gov.eg/english/default.asp.
7- Egypt-Nationwide Data. The GeoCommunity™ is the place for the Geographic Information Systems (GIS), CAD, Mapping, and Location-Based industry professionals, enthusiasts, and students to gather. The GeoCommunity is by far the leading GIS online portal and daily publication, http://data.geocomm.com/catalog/EG/datalist.html.
8- Quality Standards Information Technology (QSIT), http://www.qs4it.com/docs/major_clients.htm.
9- Atlas of Egypt- Egypt State Information Service, http://www.sis.gov.eg/atlas/html/map01.htm.
10- The Egyptian Geological Database web page http://ims.esrs.wmich.edu/website/Egypt/viewer.htm.
11- MSS scenes are available on http://www.esrs.wmich.edu/iarchive.htm.
12- Egyptian General Survey Authority. http://www.mwri.gov.eg/egsa/cover.htm.
13- Ministry of Agriculture and Land Reclamation. http://www.agri.gov.eg/webh.htm.
14- The new IT Industry Development Authority is set to contribute to the overall growth of the IT sector. http://www.mcit.gov.eg/.

3- Research Methodology

The significant problems we face cannot be solved at the same level of thinking we were at when we created them, Albert Einstein.
When planning future strategies for spatial information management, governments worldwide sometimes just concentrate on the technology and do not consider other influences or drivers – they do this at their peril, (Williamson, 1999).

The previous chapter presents an overview of state-of-the-art in SDI and land evaluation. It introduces the concept of spatial data infrastructure as a mechanism to discover and access spatial data. Then I examine each of SDI components in detail. In this chapter, fieldwork design for the data collection will be discussed. The research methodology used to collect and analyze the data in order to achieve the objectives (stated before) is described.

3.1 Overall Methodology

To carry out this research, the overall framework used in this study consists of the following steps (figure 3.1):
Step 1: *Literature review*. Through literature review, the general concept of land evaluation was studied and general stakeholder's requirements in terms of information demand were identified. Also the general aspects of SDI were reviewed and potential support for Land evaluation evaluated.

Step 2: *Expert knowledge*. The author has specific knowledge of the land evaluation situation in Egypt. A first assessment of the current problems was made.

Step 3: *Questionnaire and Interview*. Based on the results of step 1 and 2, a questionnaire was developed for detailed data collection on the actual land evaluation and SDI situation in Egypt. Additional interviews with key land evaluation manager were held to get in depth insight in the situation.

Step 4: *Current land evaluation situation*. Based on the questionnaire and interviews in step 3, the current land evaluation situation in Egypt is described and briefly analyzed. The spatial data requirements are indicated.

Step 5: *Current spatial data infrastructure situation*. Based on the questionnaire and interviews of step 3 the current spatial data infrastructure in Egypt is described and briefly analyzed. Attention will be paid to the technical environment, software, policy and standards used

Step 6: *Expect the future needs for land evaluation*. What land evaluation needs from SDI in the future.

Step 7: *Formulate LE Demands to SDI* (first objective). Based on the results from step 4, 5 and 6, SDI requirements for LE are specified.

Step 8: *Proposed SDI's for land evaluation* (second objective). Based on the requirements form step 7, alternative SDI scenario's for supporting LE in Egypt are formulated.

Step 9: *Analyses of the current SDI conditions*. The proposed SDI scenario in step 8 and the current situation in steps 4 and 5 are evaluated using SWOT analysis and the identification of CSF's.

Step 10: *Identification of Critical Success Factors*. The criteria (critical success factors) for the successful implementation of the proposed SDI will define based on the literature review and the interview.

Step 11: *Further SDI improvements* (third objective). Based on the analyses in step 9, the most appropriate SDI improvements are selected and implementation issues are discussed.

In the next paragraph's some more detailed information will be given on:

- The questionnaire and interview (step3);
- The Formulation of SDI scenario (step 8); and
- SWOT analysis.

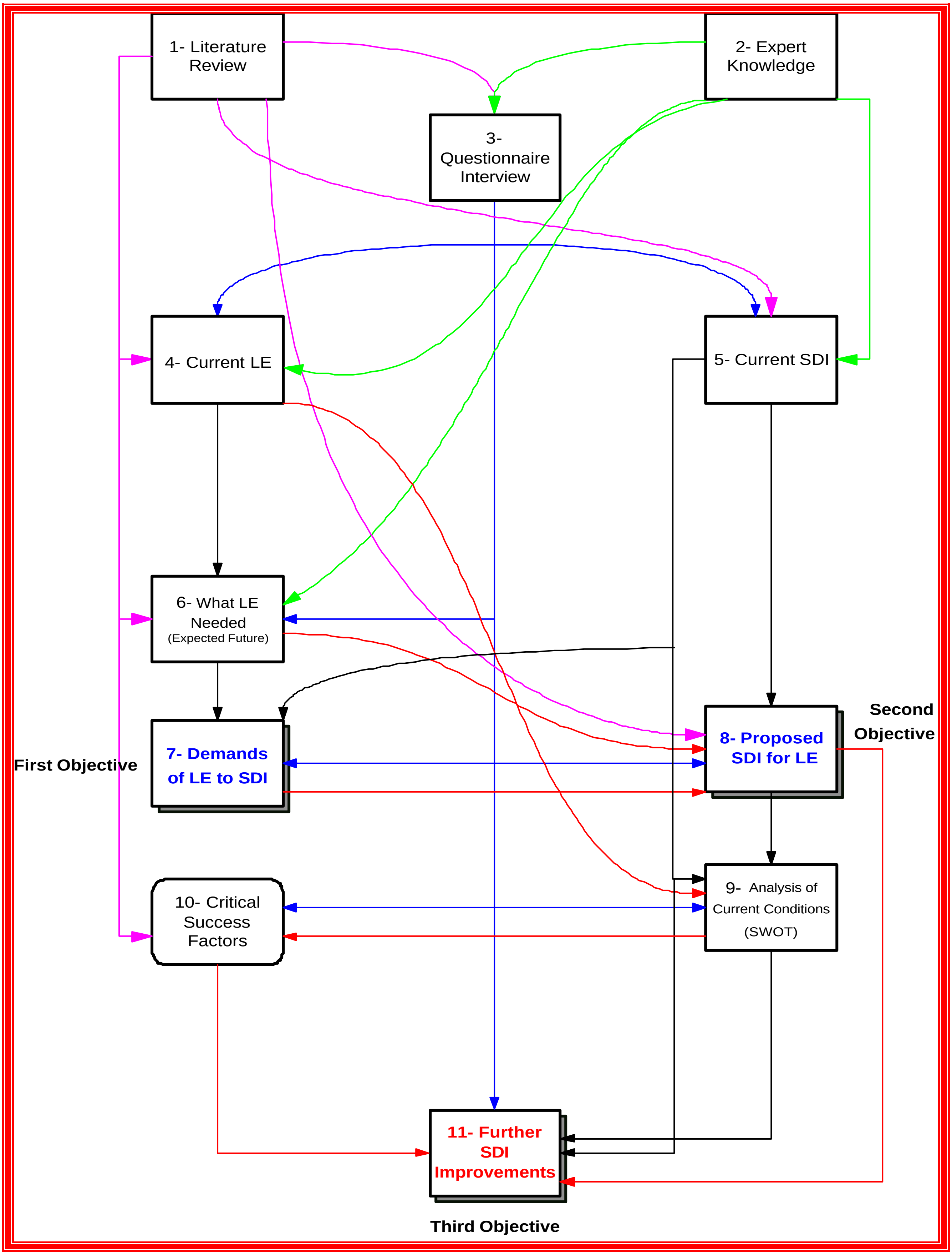

Figure 3.1 Conceptual model for the research methodology

3.2 Fieldwork Design and Implementation

Fieldwork activity was carried out (13th September-21st October, 2004) in Egypt to get insight in current SDI and land evaluation. The data was collected by a questionnaire and interviews. First the design of the questionnaire is discussed followed by the interview approach.

3.2.1 The Questionnaire

Literature review reveals that the questionnaire has some advantages over other instruments of data gathering. Surveys are suitable particularly in avoiding bias and subjectivity. It tends to be more reliable than the interview because it avoids face to face interactions, thus reducing bias. Because it is anonymous, it encourages greater honesty. Respondents have time to give thoughtful answers and to consult with others.

The primary objective of the questionnaire was to collect information and references to the current situation. The questionnaire consists of 50 questions in three parts, (See appendix 3b for questionnaire questions):

The *first* part ask questions about geospatial data within the organization, and asked some preliminary questions about how the organization's use and sharing of geospatial data. Additional questions asked about the GIS software packages used, awareness, institutional and technical, sharing, exchange and funding, data management, bottlenecks and future implementation. To examine the technical issues relating to GIS, question II-8, 11, 12 and 1-2 are very important. Through question II-8, the database management system common use will be identified. Questions II-11 and12 are important in order to recognize the mode of access to information and data transfer mode. Studying the institutional issues relating to GIS will be through question I-15 and II-5. The answer to these questions are very important to identify the current policy exist. Examine the economical issues relating to GIS through question II-9 and 10 to identify the funding source necessary to implement the proposed SDI to support land evaluation. Through answer the questions I-2, 13, 15 and II-2, the assessments of SDI awareness will be concluded. Question I-10 is very important to identify the existing SDI components. Assessment the current GIS development based on question II-3. To assess the status of geographic data exchange among the GI organizations, the answer to question I-9 is important.

The *second* part mainly for land evaluation specialists with GIS applications. Some questions ask about land evaluation model used in applications and the kind of data they needed (question I-6 and 7) to carry out land evaluation applications. The answer to these questions will determine the land evaluation requirements from SDI. In this part, there are some questions asking about the methods used for data collection, update and the data sources (question I-8). The scales and formats required plus the frequency of data acquisition and update (question I-3, 4 and 5). There are some questions related to the problem that land evaluation facing in Egypt (question I-14, 15, 16 and II-13 and 14). These questions are very important because through the answer of these questions, the demands of land evaluation to SDI will assess. Finally, determine the requirements for future implementation will be predict through question II-16.

The *third and final* part of the questionnaire (question I-19 to 26 and II-17 to 24) asks some questions about strengths, weaknesses, opportunities, and threats to scan the internal and the external environment of the organizations. Scanning the internal environment for the organizations involved in land evaluation and GIS in terms of strengths and weaknesses will help to utilize the resources they have with optimum usage. External environmental analysis will help to identify and provide detail on to the economic, technological, political/legal, socio-cultural, organizational and institutional strengths, weaknesses, opportunities and threats related to GIS use in the organizations, to establish their future strategies. Through the answer these questions, the best strategy to implement the proposed SDI will be identified.

The questions were composed such that the expected answers could be easily derived. The type of questions was mainly "multiple choice" for ease of completion. The questionnaire questions were designed to reflect the status of each organization's technological, institutional and financial capacity.

The questionnaire consisted mainly of closed questions and four open-ended questions. The open-ended questions were included in order to capture perspectives from a wide range of respondents so that the findings of the qualitative semi-structured interview with its small sample can be enriched. The inclusion of open-ended questions in a questionnaire also served credibility to the findings.

The respondents are representing 4 different groups: Government, Academic Institutions, Private Sector and Non-Government Organizing. Getting respondents were not easy task since the issue of this study is considered as a sensitive one. Because the author is a government staff, the respondents were a bit worried to give such critic statements against the government policy towards land evaluation in Egypt. For these reasons some of the key respondents eager not to mention their names or agencies' names in this research.

Distribution the questionnaire was by hand, with a cover letter from the Suez Canal University, Ismailia, Egypt. Only 29 questionnaires were returned (13 questionnaire from land evaluation users and 16 from spatial data providers) representing a 72.5 % return rate. After the responses from the questionnaires were received, all the four open ended questions were analyzed and additional questions were identified for the semi-structured interview.

3.2.2 The Semi-Structured Interview

The essence of the interview is to capture the perspectives of the respondents through verbal interaction between the interviewer and interviewee. The interview as a data-collecting instrument (see appendix 3c for interview questions) was used for this study for the following reasons:

1- a major advantage of the interview is its adaptability. A skilful interviewer can follow up ideas, probe responses and investigate motives and feelings, which a questionnaire can not do, (Bell, 1993);
2- the flexibility of interview to understand the current situation. To get more detailed perspective on some of the issues raised. However, with questionnaire, it is difficult to get questions that explore in-depth information;
3- to provide a general picture of the current situation. The telling story may be much more revealing and influential than almost any amount of words; and
4- to try to verify the validity of the information being collected. The findings derived from questionnaire can be checked against the findings derived from interview.

In this research, each individual was interviewed separately due to the strategic and confidential aspect of the information collect in each organization. Another important reason in choosing the individual interviews was that the topic is so sensitive; the respondents would be unwilling to talk openly in a group.

A series of open-ended, semi-structured questions were developed in English language with the purpose of exploring issues related to the central research questions. The interviews were conducted in Arabic language and took place in the respondent's organization in Egypt. The interviews were conducted over a period of one and half month. The average interview length was varied between seventy up to a hundred minutes.

The interviews were tape-recorded. Tape recorders increase the accuracy of data collections as they capture verbatim responses of the people being interviewed. They permit the interviewer to be more attentive to the interviewee.

3.2.3 Population and Sampling Procedures

A population in research is a discrete group of units of analysis such as organizations, institutes and so on. The target population for this study were the users of land evaluation and spatial data providers from five provinces in Egypt, namely Cairo, Gaiza, Fauoum, Alexendaria and Ismailia.

At the beginning all possible GI providers and land evaluation users have been identified for selection purpose. But 29 organizations have been found to be relevant based on expert knowledge and contact information for the perspective of the research objectives. Because of the limited time, a total of 18 different organizations, table (3.1) involved in land evaluation and GIS application in Egypt were selected based on organization rank, activities and life of time of the organizations. Eight of the selected organizations are among the several organizations which have been participated in draft a policy for IT industry and digital maps production for the country, (Information & Documentation Center, 2004). Therefore, there is a strong believe that the 18 organizations would give true image of the current situation in Egypt.

Having identified the population for this study, the sample for the survey questionnaire was all the users in the field of land evaluation and GIS for not less than 6 months. All land evaluator people who spend 6 months in the field should be subjected to the land evaluation and GIS process.

Sample size can be determined by various constraints. For example, the available funding or time plays an important role in deciding about the sample size. Because of the time limited, a total of 40 potential respondents (20 respondents from land evaluation and 20 respondents from spatial data providers) constitute a sample (that is not necessary statistically representative for all the organizations involved in the activities) were selected from 18 different organizations involved in land evaluation and GIS application in Egypt, table (3.1). This selection was according to a brain storming exercise which incorporated as many organizations based on background knowledge of the study area. This list was tabulated with contact information and later refined through confirmation with my supervisor in Egypt, (see appendix 3a for the interviewers list).

Table 3.1 Population and Sampling Procedures

Population and Sampling Types	Numbers	Remarks
Potential organizations	40	based on expert knowledge and contact information
Relevant organizations	29	According to a brain storming exercise which incorporated as many organizations based on background knowledge. This list was tabulated with contact information and later refined through confirmation with my supervisor
Selected organizations	18	Because of the limited time. Eight of the selected organizations are among the several organizations which have been participated in draft a policy for IT industry and digital maps production for the country
Potential Respondents	40	20 spatial data providers and 20 land evaluation users
Return questionnaire	29	16 from spatial data providers and 13 from land evaluation users

3.3 Data Analysis

Data analysis for the questionnaire was done using a computer package for analysis quantitative data called the MS Excel. A list of 29 answers (13 from land evaluation users and 16 from spatial data providers) to the questionnaire questions were entered in MS. Excel for analysis.

3.3.1 Demands of Land Evaluation to SDI

In order to analyze the demands of land evaluation to SDI, all the questionnaire questions grouped according to SDI components. The first stage of this analysis is the assessment of the current land evaluation drawbacks based on the questionnaire and interview results (steps 1-8 in figure, 3.1). Analysis the existing situation of the organizations should derive the problems that the land evaluation is facing. Also, identifying the problems (related to technology, financial, and institutional issues) later should be the success factors to evaluate the proposed system.

3.3.2 Proposed SDI to Fulfill the Demand of Land Evaluation

The building of the proposed SDI will be based on linkage of Spatial Data Infrastructure and Land Evaluation, (steps 1-9 in figure, 3.1). The Proposed SDI's for land evaluation (second objective) will design Based on the requirements form the first objective (LE Demands to SDI) and alternative SDI scenarios for supporting land evaluation in Egypt.

3.3.3 Further SDI Improvements

The SWOT analysis (According to the information collected during the fieldwork) is the scanning of the internal and the external environment of the organization to identify about 10-15 points for each scanning procedure, and give these points weight and rate values. The weight values of all points should be equal to (100) and divided equally between strengths and weaknesses in the internal scanning and between opportunities and threats for the external scanning. The rate values will represents the organization's response for each, which varies from (1.0 = poor response) to (5.0 = outstanding). Weight and rate of each factor based on the analysis of the information collected from questionnaire and interviews with key persons in land evaluation organization.

Developing the SWOT matrix will identify the actions and strategy to evaluate the proposed SDI, (step 9 in figure, 3.1) that can utilize the organizational resources/capabilities to avoid and overcome the challenges.

Establishing the best SDI strategy should satisfy the information needs for land evaluation decision making. So, the best strategy for SDI implementation must be responsive to the land evaluation users' interests to be successful.

Defining a critical success factors, (steps 10 in figure, 3.1) could be a useful mechanism to identify the requirements and its priorities to ensure success of the development of the proposed system. For the successful achievement of the proposed SDI as well as the organizational strategy, there are different factors, which needed to be uniquely considered. These critical success factors need to be seen in terms of various related activities that are necessary to support the achievements of the factors.

The relationship between the critical success factors and the respective activities will be presented in a critical success matrix.

3.4 Trustworthiness of the Research Findings

In scientific researches, reaching the absolute validity and reliability is almost impossible. Bell, (1993) asserts that whatever procedure for collecting data is selected, it should be examined critically to assess the extent to which it is likely to be reliable and valid. Reliability is the extent to which a test or procedure produces similar results under constant conditions on all occasions. The question of validity draws attention to how far a measure really measures the concept that it purport to measure, (Bryman and Cramer, 1996).

In this research, the reliability of the survey questionnaire was estimated by checked the questions for ambiguity, precision, type of questions and language by making several attempts at wording. Drafts were sent to the supervisors for comments.

However, for the qualitative data collected, triangulation was utilized. This view of the use of multiple data sources as a way of enhancing the validity and reliability of data is supported by Sells et al., (1997) who claim that an approach to data collection further increases the trustworthiness of the research findings.

In this research, some of the strategies employed in approximating the credibility of the research findings are: Triangulation whereby interviews were conducted with the land evaluation organizations. Field notes collected during interviews were used in conjunction with the lessons learnt from the literature review. Existing academic literature and personal experience also help in the credibility of the research findings. Moreover, the interviews were tape-recorded, a strategy which increased the credibility of the field notes. Verbatim (literally) quotations from the interview were included in the text to give more substance to the findings.

4- Results and Discussion

The people that are interested in using GIS for land evaluation applications ask all the wrong questions: They want to know what the best software is, what's the best platform, etc.
*When you ask, "What is it you want to do?" the response is usually a lot of head scratching followed by "make maps". So, it is no surprise that determining user requirements (*demand*) can be a long and painful process, (Scott Freundschuh, 1993).*

Although there is a widespread use of geographical information systems applications in many organizations in Egypt, the benefit of using this technology is not as expected. Many organizations in Egypt spend a lot of money collecting and using geographic data for the land evaluation applications. Yet they do not have the information they need to solve the critical problems of inaccessibility of land evaluation datasets. This chapter attempts to analyze the SDI components and the institutional, economical and technical issues of the land evaluation organization in Egypt. On the basis of a questionnaire and interview conducted to main land evaluation users and producers of spatial data in Egypt.

4.1 Demands of Land Evaluation to SDI

If we are going to design relevant SDIs to support land evaluation in Egypt, we have to understand the spatial needs of land evaluation society, the social system in which the SDI will operate, and the technical environment which the SDI will be required to support. The components of the SDI can be listed in several ways. The description adopted in this thesis lists them as shareholders, data and metadata, standards, institutional framework and technology. In this approach, the results will be presented according to SDI components, (see part 3.1 and 3.4.1).

4.1.1 Shareholders (users, partenerships and leadership)

Figure 4.1 illustrates that the people involved in land evaluation process come from private sector, universities as well as from government. Based on the questions (I-1 and II-1) from the questionnaire, we observed that the universities (54%) and government sector (46%) are the largest group of land evaluation users. On the other hand the government sector (50%) and private sector (38%) are the largest group of land evaluation data providers, as shown in figure (4.1).

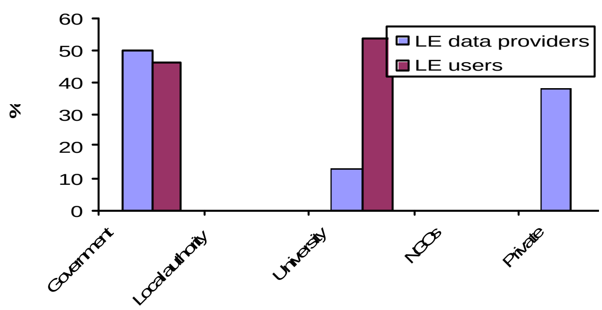

Figure 4.1 Percentage of land evaluation users and providers based on stakeholder organizations

Based on the question (I-13) from the questionnaire, we observed that more than 80 % from the land evaluation users do not use geographic information system to perform their land evaluation applications. From the figure 4.2, we can understand that the use of GIS in land evaluation application among users was less than 5 years (55%). From the results, there is a tendency to increase use of GIS in land evaluation application. However at the moment, there is inadequate-trained manpower for data collection, processing, analysis and to establish and manage the infrastructure.

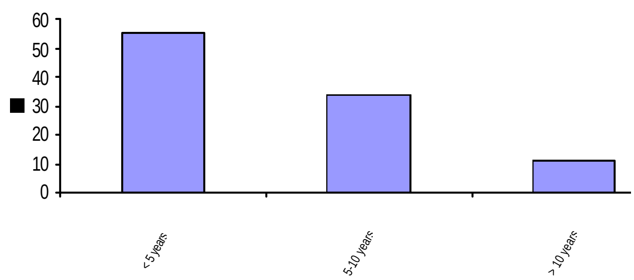

Figure 4.2 Distribution (%) of land evaluation users based on the number of years use GIS in application

For the awareness aspect of the land evaluation users in Egypt, it is often difficult to get budgets approved for the purchase of new technology, particularly, when senior administration has little experience with the technology. According to the questionnaire question II-2, we observed that the training of government staff in GIS initiative was the most known (47 %) followed by establishment of GIS center (33%) as indicated by the respondents, figure 4.3. The collaboration with GI organizations in private and public sector was the least known (20%) among the respondents, as shown in figure (4.3). However, establish GPS network and development of a clearinghouse were unknown among the respondents.

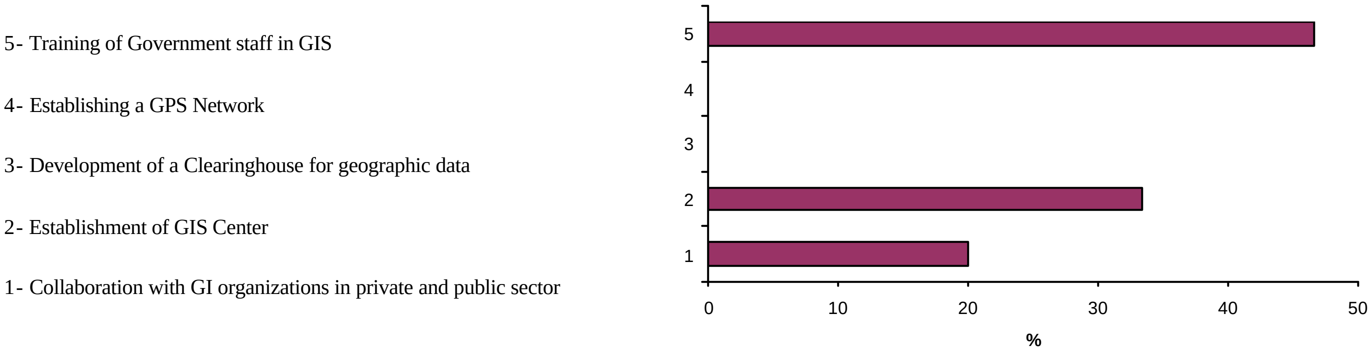

Figure 4.3 Percentage of SDI awareness generation among the land evaluation users.

There is a need for increasing the awareness of the benefits of spatial information as well as increases the capacity building by the training/courses and educational resources to strengthen awareness and skills to participate be involved in SDI development activities. So, it is important for the successful implementation of GIS in Egypt that the data and metadata used should be well known and the people using it are well educated and trained in its use.

4.1.2 Data and Metadata

Figure 4.4, shows that obtaining of spatial data by land evaluation users is very difficult (54 %), whereas 38% considers it difficult to obtain spatial data. For instance, one of the respondents who were interviewed asserts that: … the availability of spatial information is poor or non-existent in Egypt because there is no means to access data automatically.

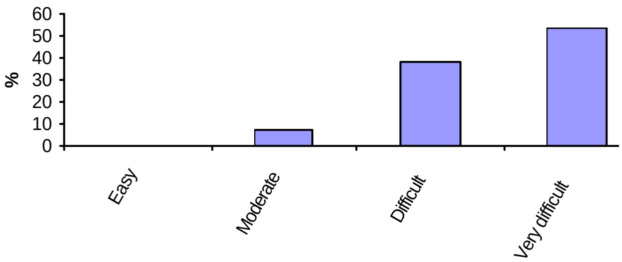

Figure 4.4 Distribution (%) of spatial data obtaining by land evaluation users based on access difficulty

The GIS format most commonly used among the users and providers are Arc View (45%), followed by ArcGIS (20%) and Arc Info (20%) as shown in figure (4.5). Erdas is the most used imaging software (more than 75%). However, Access software is the most (80%) database software used, (questionnaire results). The software selection depends on the cost and preference.

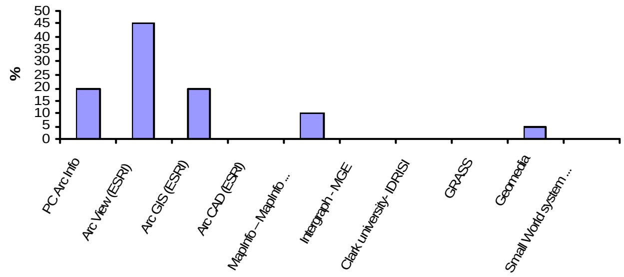

Figure 4.5 Percentage of GIS format according to types of software currently use

In the ideal situation, all data combine should be collected, identified, and measured at the same date, with the same spatial resolution. In practice however, data acquisition is far from ideal. Since, data are collected at different moments, are valid for different span of time, have different spatial resolution, and some might be collected in field and others were taken from existing maps. Based on the questions (I-8) from the questionnaire, there are two main types of data collection: in the office and in the field. Data acquisition methods in the office include scanning (44.5%), remote sensing (39%) and digitizing (17%) while in the field the use of GPS is 78 % among the respondents, as shown in figure (4.6).

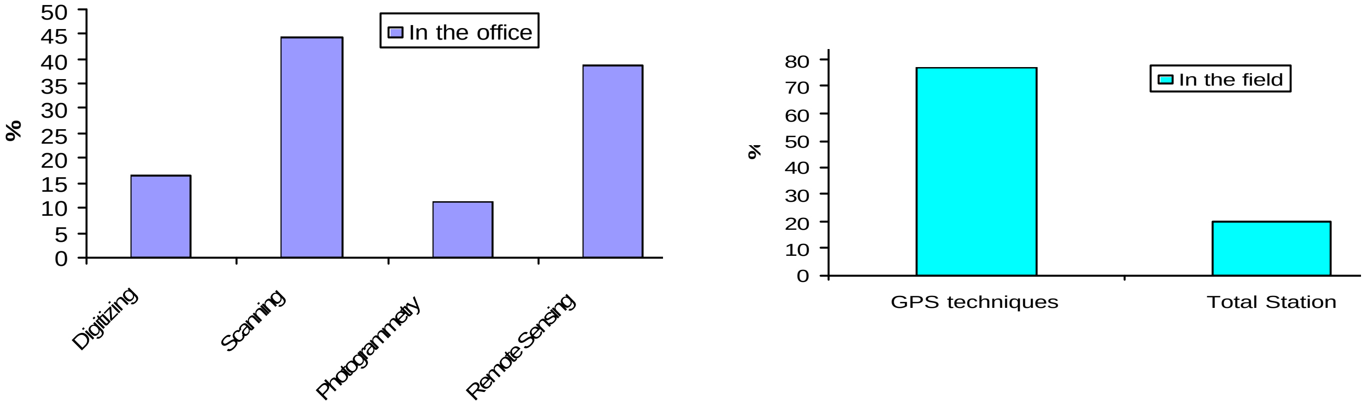

Figure 4.6 Distribution (%) of data collection methods based on data acquisition types: in the office (Left) and in the field (Right)

Good decisions are invariably based on accurate and timely information. Accurate information is only value if it has commonly understood meaning across the whole land evaluation users in Egypt. Based on the question (II-8) from the questionnaire, we observed that In Egypt most of the database managed centralized (87%), (figure 4.7). Centralized service show poor update frequency, since data and metadata are maintained in different locations by different organizations. The central organization need to run the clearinghouse is cumbersome and probably not financial sustainable in the long run, (Bregt, 2000). To store detailed metadata in one metadata base, the system would be expensive and complex to implement. Because the data managed centralized, it is not reliable (updated). One of the options is to use decentralized database to make data update easy. The goal of data management is to ensure the quality, interoperability, security and availability of data and related information. Effective data management is one enabler for interoperability.

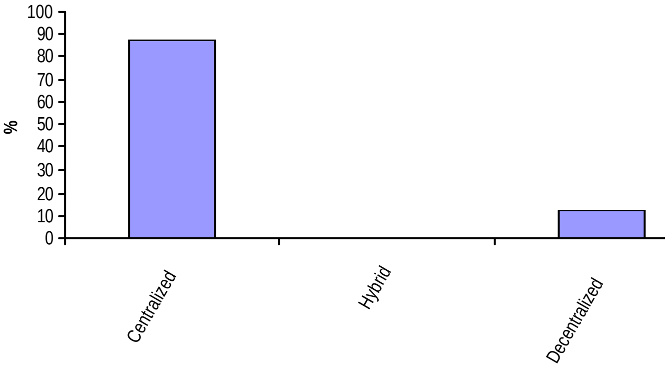

Figure 4.7 Percentage of types of database management systems

It is still difficult for potential land evaluation users in Egypt to identify the data sets that exists and if these can satisfy their requirements. So, there is a degree of duplication by agencies due to lack of knowledge about the availability and quality of datasets. There are many reasons for data duplication in land evaluation datasets in Egypt. From the interview results, we can summarize these reasons as follow:

1- concern about the security of the data;
2- reliability of available information. This information was collected without implementing standards and therefore the data quality is unknown;
3- confidentiality/sensitivity of certain national data; and
4- unclear identification of digital spatial data production in the different organizations.

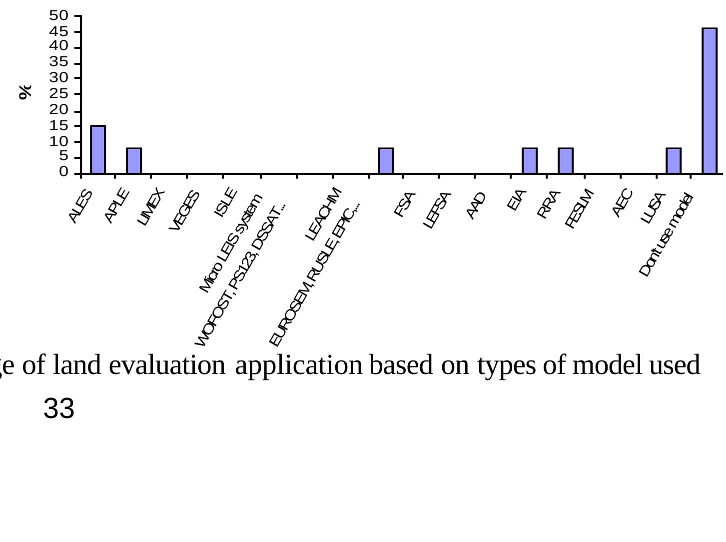

Figure 4.8 Percentage of land evaluation application based on types of model used

According to question I-6 from the questionnaire, we observed that 46.5% of the respondents that carry out land evaluation applications do not use model to perform their land eva luation applications, as shown in figure (4.8), for some reasons. One reason may be because the major impediment to applying models in land evaluation applications is the requirement for high-quality up to date data which is difficult with the centralized system to achieve. The second reason is that there is no land evaluation model suitable for Egyptian situation. The third reason is that most of users have little experience with use GIS as a tool for land evaluation.

Based on the question (I-7) from the questionnaire, we observed that the different land evaluation stakeholders in Egypt need various spatial data and information for various applications, (figure 4.9). The data needed vary depending on the land evaluation scales. It is more practical to select the minimum trigger data that are necessary for decision-making.

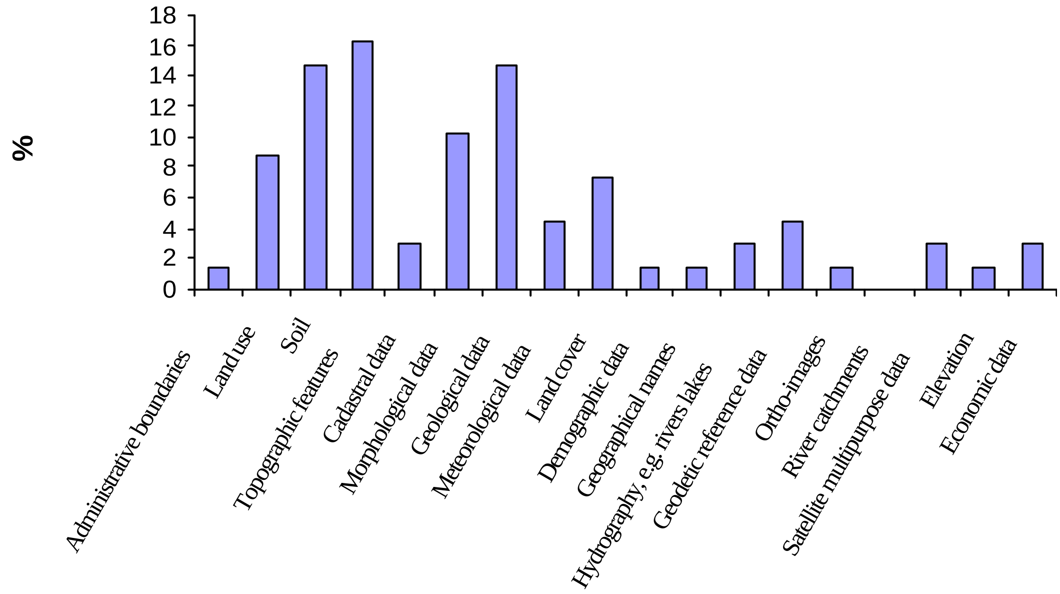

Figure 4.9 Distribution (%) of data types based on the land evaluation user requirements

Based on the literature review, summary view of representative works concerning important land criteria used in land evaluation is presented in table (4.1). The most important soil properties which limit the utilization of the soils identified based on table (4.1) are texture, soil salinity, soil depth, $CaCO_3$ content and water table.
From the table 4.1, we conclude that texture selected (12 times), soil salinity (12 times), soil depth (10 times), $CaCO_3$ content (7 times) and water table (6 times).

So, from the above results, tables (4.1) and figure (4.9), a typical minimum data set most frequently used for the land evaluation applications include:

1- Topographic maps, (16%);
2- Soil data, (14.7%) including of texture, soil salinity, soil depth, $CaCO_3$ content and water table;
3- Geology, (14.7%);
4- Morphology, (10.5%);
5- Land use, (8.5%)/ Land cover, (7.5%); and
6- Meteorological data, (4.5%).

More than 75% of the respondents (figure, 4.9) use these types of data.

Tomlinson, 1980 agree with, there is no known agreed rule what needs should be. Land evaluation is normally based on morphological, physical, and chemical data derive from the soil survey, such as soil depth, texture, water capacity, drainage class, soil reaction, and organic matter content. Other biophysical factors, mainly referred to monthly climate parameters, are also considered land characteristics, (De la Rosa et al., 2004).

Table 4.1 Summary view of representative works concerning important land criteria used in land evaluation

International

Features	Miller ,1924	Fackler, 1928	Kellogg and Albeiter, 1935	Storie, 1937	Harris, 1949	Clarke, 1950	Nelson, 1963	Searl, 1965	Klingebiel andMontgomery (1966)	Millete and Searl, 1969	Bibby and Mackney 1969	Candian Agr., 1970	Sys and Frankart 1971	Sys and Verhey 1972	Garbauchev, et al., 1974	Sys et al., 1991	Total Selected
Texture	■		■	■	■	■	■	■		■	■			■	■	■	12
Structure					■			■	■			■					4
Water table				■	■	■	■		■		■	■	■	■	■		10
Water table salinity																	0
Soil salinity				■	■		■		■	■	■	■		■		■	9
pH	■			■			■						■		■		5
$CaCO_3$ content														■	■	■	3
Gypsum content														■		■	2
Nutrient				■			■		■	■	■	■					6
CEC									■		■		■				3
Soil depth	■	■		■		■	■		■	■		■	■	■		■	11
Land form	■		■							■							3
Level	■		■							■	■						4
Slope	■		■	■	■		■		■	■	■	■				■	10
Erosion				■			■		■	■	■	■				■	7
Organic mater		■													■		2
Permeability												■					1
Moisture content									■	■	■	■			■		5
Environmental factor									■							■	2
Management																	0
Na saturation														■		■	2
Parent material													■				1
Gravel																	0
Climate					■		■		■	■	■	■		■	■		8
Total	6	2	4	8	6	3	9	2	11	10	10	10	5	8	7	9	-

Egypt

Features	Fathi, 57	Labib, 63	Nairooz, 67	Ragab,68	Hanna, 69	Omar, 70	Hamra, 72	Mansour, 79	Shendi, 84	Hussein and Abd El All, 84	Abd El Moteib and Hussein, 85	Moawad et al., 91	Abd El Rahman et. a.l , 91	Total Selected
Texture	■	■	■	■		■			■	■	■	■	■	12
Structure									■	■	■			4
Water table	■		■	■		■					■			6
Water table salinity	■										■			2
Soil salinity	■	■	■	■	■	■		■	■	■	■	■	■	12
pH		■							■	■	■			4
$CaCO_3$ content		■			■				■	■	■	■	■	7
Gypsum content					■						■	■	■	4
Nutrient						■	■				■			3
CEC		■									■			2
Soil depth	■		■	■		■		■	■	■	■	■	■	10
Land form											■			1
Level											■			1
Slope									■	■	■	■	■	5
Erosion											■			1
Organic mater		■									■			2
Permeability	■									■	■			3
Moisture content											■			1
Environmental factor								■	■	■	■	■	■	6
Management											■			1
Na saturation	■	■									■			3
Parent material											■			1
Gravel							■		■	■		■	■	5
Climate											■			1
Total	7	7	4	4	3	5	3	2	9	10	23	8	8	-

☐ Not Selected ■ Selected

4.1.3 Standards

In Egypt, there is a lack of common standards for spatial data and metadata. Most of the spatial data is still acquired in non-standardized, non-normalized, format. This view supported by one interviewee who say that "…. the standards adopted by different organizations are often in conflict with each other".

The data are in different map projections. Sometimes, the map projections are the same but some parameters such as spheroid or false easting are different. So, map transformation is hardly possible because the exact parameters for most of data sets are unknown, (El-Gamily and Bohnet, 1998). Moreover, because they have no common reference system, it is very difficult to integrate with each other. Incompatibility and integration between different data sets are very difficult, figure (4.10) (El-Gamily and Bohnet, 1998). So the existing vector data should be updated and revised. Another example, integration of LANDSAT, IKONOS, and Vector Data of scale 1:5000 & 1:50 000, (NARSS, CAPMAS, Boulaq Project & Manshiet Nasser Project).

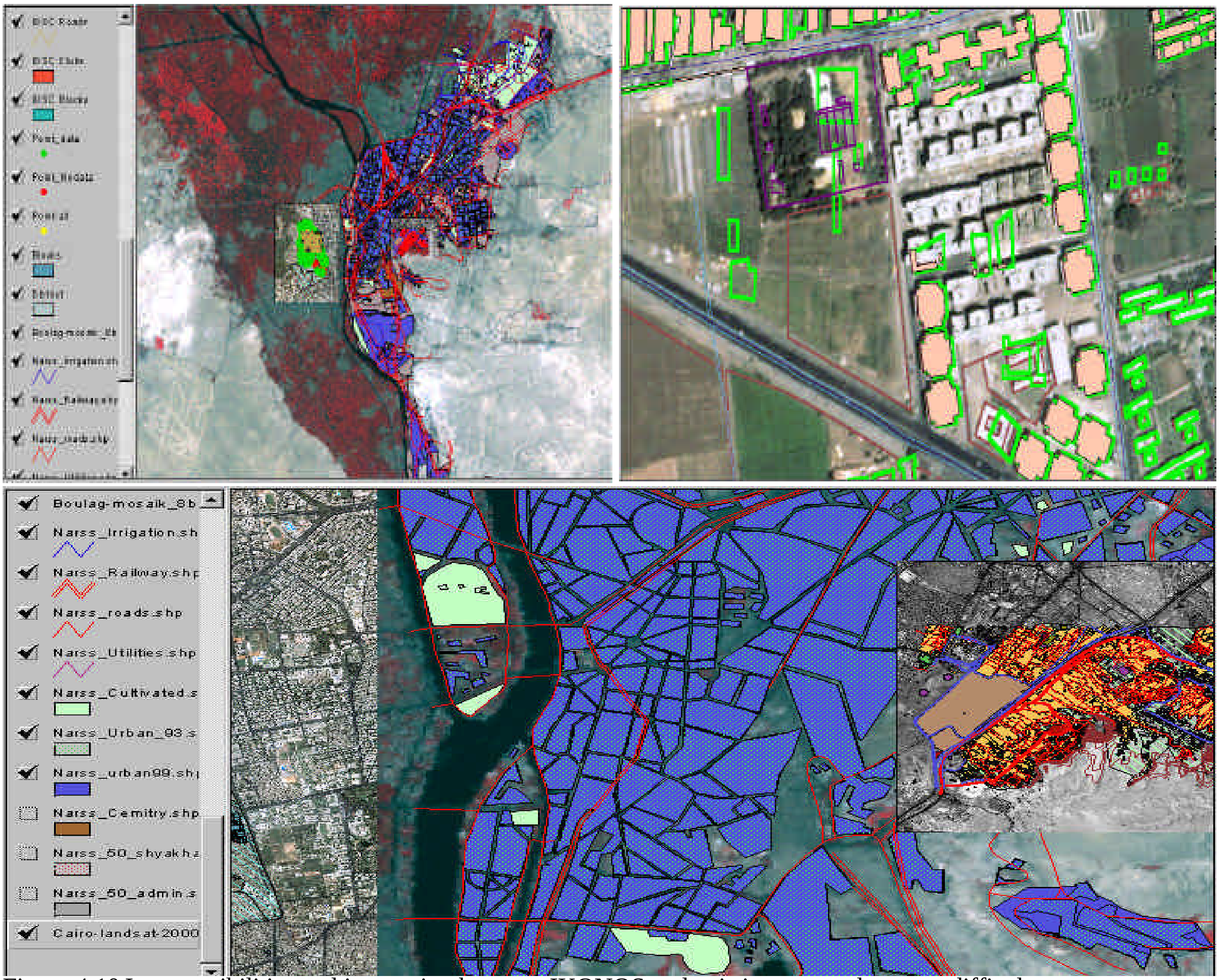

Figure 4.10 Incompatibilities and integration between IKONOS and existing vector data very difficult

Lack of standards on spatial datasets, metadata, data transfer, software and hardware has negative consequences on SDI development. Furthermore, data quality differs widely from one data set to another. Information available varies greatly in accuracy and resolution, (interview results). So, all data sets need strong data quality assurance to be applied. In order for this data exchange to occur, appropriate data standards and interoperability models need to be implemented by the land evaluation data providers so that information can be utilized within different systems.

4.1.4 Institutional Framework

To tap the potential benefits for SDI to support land evaluation in Egypt, institutional interventions in data related issues are a must. Every country and organisation has its own local policy for overall SDI development, data protection, data access, funding mechanisms, etc. We distinguish the culture, economic and legal as the most important institutional aspect in Egypt.

Culture aspect is one of the main aspects of SDI policy with potential influence on GIS technologies and organizations. The cultural behavior could be against co-operation and integration. One of my respondents strongly declares that: …. many organizations fear that they will lose their autonomy when participating in a SDI. There is no cooperation between the different organizations. Most of the data are used for purposes of their own sectors. The systems are independent from each other. Another respondent clearly stated that: … these systems are actually isolated. For more detailed on culture aspect in Egypt, (see appendix 4a).

One of the main economic aspects is the funding model of the SDI. If we take the situation in Egypt, this issue is more repelling. Preparation of the required data itself is an expensive duty. This is because the system requires a lot of money to finance it. The respondents were asked to indicate which funding and revenue models would be most suitable for the development of the SDI to support land evaluation applications. According to the questions (II-9, 10) from the questionnaire, the respondents indicated that most potential basic funding comes from the national government (69%) followed by private sector donation (31%), figure (4.11). However, the most appropriate specific revenue model was Public /private partnership together (63%) followed by the cost sharing by individual GI organizations (36.8%), (questionnaire results).

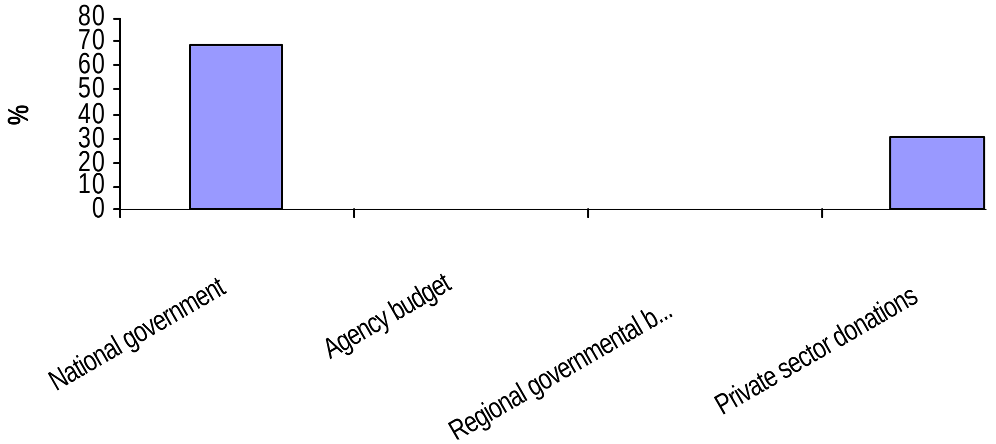

Figure 4.11 Distribution (%) of funding models for SDI to support land evaluation

Copyright, privacy, liability, and other rights to the use of data and information must be addressed to ensure the appropriate data and information is accessible to all. Copyright is a form of data protection provided by the law to the authors of "original works of authorship" to control dissemination of information. In Egypt, still no legislation for copyright and ownership, (interview results).

The transfer or exchange of data between land evaluation organizations occurs without sufficient attention to the liability issues associated with such transfers, (interview results). One of the potentially negative societal effects in Egypt is the increase in personal privacy, (interview results). So, Egyptian land evaluation organizations should:

1- Acquire, disclose and use personal information only in ways that respect an individual's privacy; and
2- Use appropriate technical and managerial controls to protect the confidentiality and integrity of personal information.

4.1.5 Technology

One of the valuable roles of GIS is to integrate information across an organization, so that it can be shared, interrelated and used in common among different organizations. Access to information is the first step in achieving this. The questionnaire question II-11 revealed that services delivery (45.5%) and office visit (36%) are the most access methods to information between land evaluation users and providers, figure (4.12).

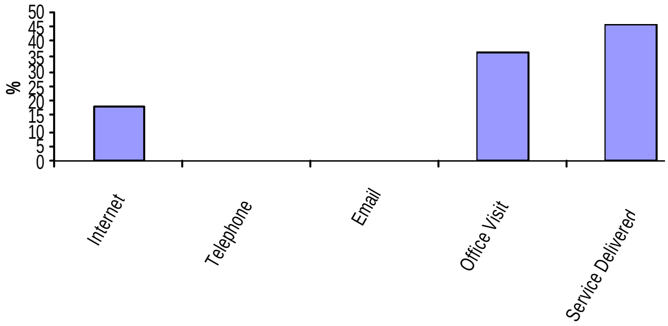

Figure 4.12 Mode of access to information based on types of services

Based on question II-12, data transfer was assessed on the 6 most common modes of transfer. These were CD Rom, diskette, Internet, hard drive, Intranet and email. From the figure 4.13, it is clear that the land evaluation users and providers respondents indicated that CD Rom is the most (50%) frequently used mode of transfer as shown in figure (4.13). A number of technical issues relating to difficulties in exchanging information were assessed among the GI providers. The highest barrier to data exchange was indicated as a lack of metadata (28.5%) and outdated information (24%) followed by inaccurate information (21.5%) and incomplete information (14%), as shown in figure (4.14).

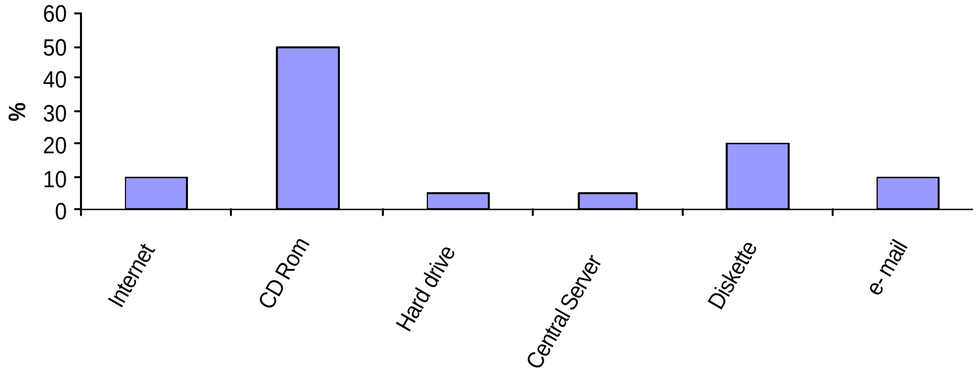

Figure 4.13 Distribution (%) of data exchange based on the mode of transfer

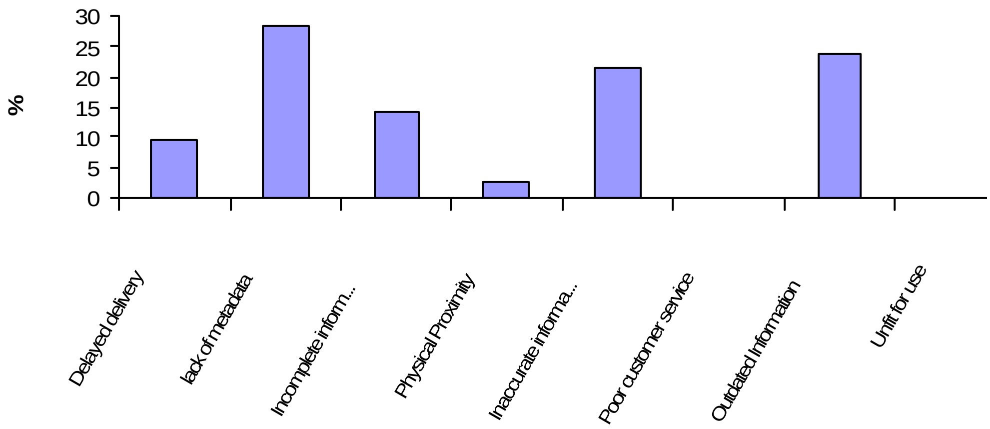

Figure 4.14 Percentage of data exchange problems according to data transfer barriers

4.2 Current Land Evaluation Drawbacks in Egypt

Based on the questions (I-14 and II-13) from the questionnaire, we observed that the main land evaluation bottlenecks in Egypt are institutional (75%), (see figure, 4.15). Technological aspect can be effective if the institutional aspects are solved. So, the successful implementation of spatial information infrastructures in Egypt is dependent on institutional aspect. Management support is necessary in understanding the limitations and providing the necessary flow of information to the system.

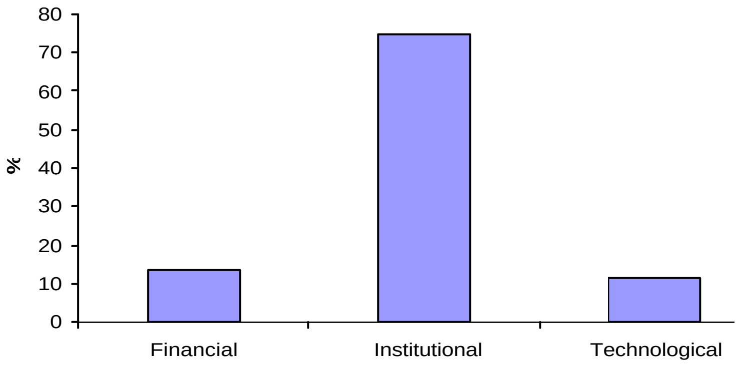

Figure 4.15 Distribution (%) of the main land evaluation bottlenecks in Egypt

According to the questions (I-12 and II-4) from the questionnaire, the respondents were asked to comment on their level of agreement with the following eight statements relating to the use of GIS for land evaluation, figure (4.16). The figure below illustrates that over 41% of the respondents agreed with the statement that there are many organizational barriers which can seriously impede use and development of GIS in Egypt. The statements that overall elicited the highest level of an agreement were 1, 6 and 7.

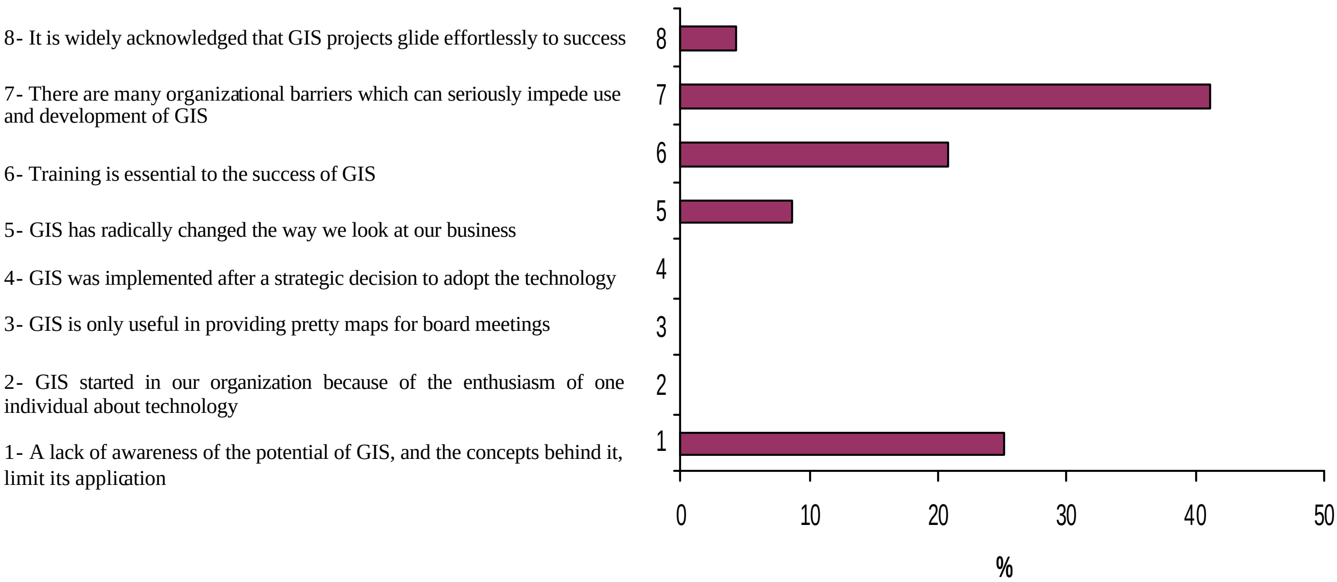

Figure 4.16 Percentage of users' agreement about the use of GIS in land evaluation applications

Question (I-15) from the questionnaire indicate that when we look in detail, the problem that the most respondents identified is the lack of metadata (22.5%) and absence of sharing mechanism (18.5%). Other important obstacles described by the respondents of land evaluation are lack of targeted polices, laws and guidelines (16.5%). About 14.5% of the respondent reported difficulties in obtaining national data due to lack of standardization, figure (4.17).

Yeh, (1999) reported that the main constraints in the use of GIS in planning today are not technical issues, but the availability of data, organizational change, and staffing. The challenges faced were more likely to be organizational than technical, (Askew et al., 2005).

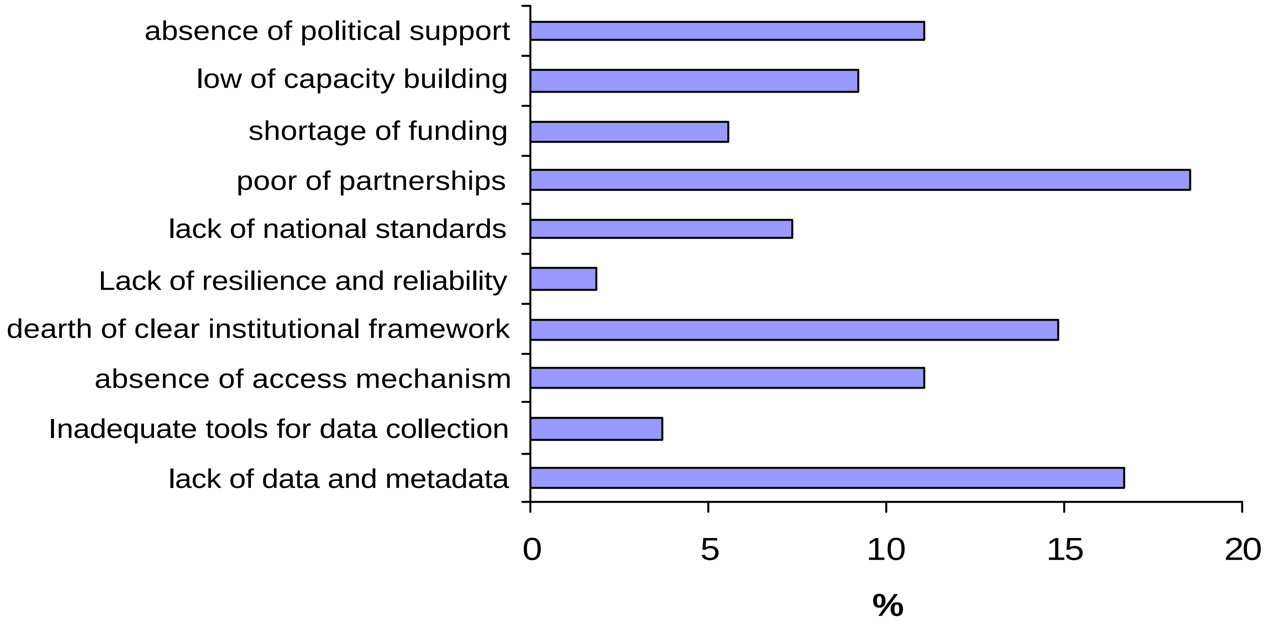

Figure 4.17 Detailed distribution (%) of land evaluation bottlenecks in Egypt

From the above results of the field work activities, there are a number of factors which stand in the way of SDI to support land evaluation and would need to be overcome or at least addressed. The problems in establishing an SDI to support land evaluation in Egypt are almost similar to those which would be faced in developing any SDI, only the degree would vary. From figures 4.15, 4.16 and 4.17, we can inferred that the technical and financial obstacles are minor compared to the institutional obstacles. Respondents who experience the problems above indicated that their main consequences are the increase in time and in costs for land evaluation application, (interview results).

So, our biggest problems in establishing SDI's to support land evaluation in Egypt can be summarized from the questionnaire results, figure 4.17 and the interview as follow:

1- lack of data and metadata;
2- absence of access mechanism;
3- dearth of clear institutional framework;
4- lack of national standards;
5- poor of partnerships;
6- shortage of funding;
7- low of capacity building; and
8- absence of political support.

4.3 Current and Expected GIS Development for Land Evaluation in Egypt

Based on the question II-3 from the questionnaire, we observed that most geo-information systems in Egypt operate on a stand alone basis where they lack inter as well as intra organizational links. As shown in figure 4.18 below, we can observe two stages of GIS development. 44.4 % of the land evaluation organizations fall in unconnected (stand-alone) and 22.2 % fall in connected (linking) category. There is a national effort undergoing to raise the system to participate (corporate) level. It is hardly possible to consider the existing systems as reliable sources that can channel information to support the land evaluation process.

Hernandez et al., (1999) have come up with four distinct GIS development stages in relation to retail GIS.

1- opt-out. Organizations are piloting GIS. They have yet to make commitment to adopting GIS in-house.
2- stand-alone. Commitment to GIS has been made, but is likely to be isolated within a specific area or department within the organization;
3- linking. Effort to extent GIS application in different departments within an organization; and
4- corporate. This is the highest stage of development. The system is used extensively in a strategic context. There is corporate information throughout the organization.

These stages can fit to any situation dealing with GIS development.

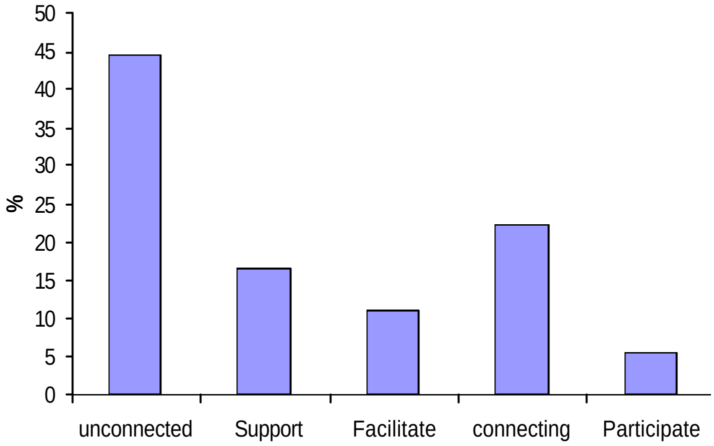

Figure 4.18 Percentage of GIS development in land evaluation organization

The respondents were asked based on question II-16 to comment on their expectations from SDI implementation to support land evaluation in Egypt, figure (4.19). Over 30% of the respondents expected that the duplication of work will decrease. More than 24% of the respondents expect that the cooperation and coordination will be more effective between land evaluation organizations. So, after building of SDI to support land evaluation, the expectations are as follows, figure (4.19):-

1- duplication of work goes down;
2- elimination of organizational "spatial data islands." Cooperation and coordination among the different disciplines will be more effective;
3- resources could be used for more development activities;
4- decision-making will be more effective; and
5- more users will benefit with good results from the development activities.

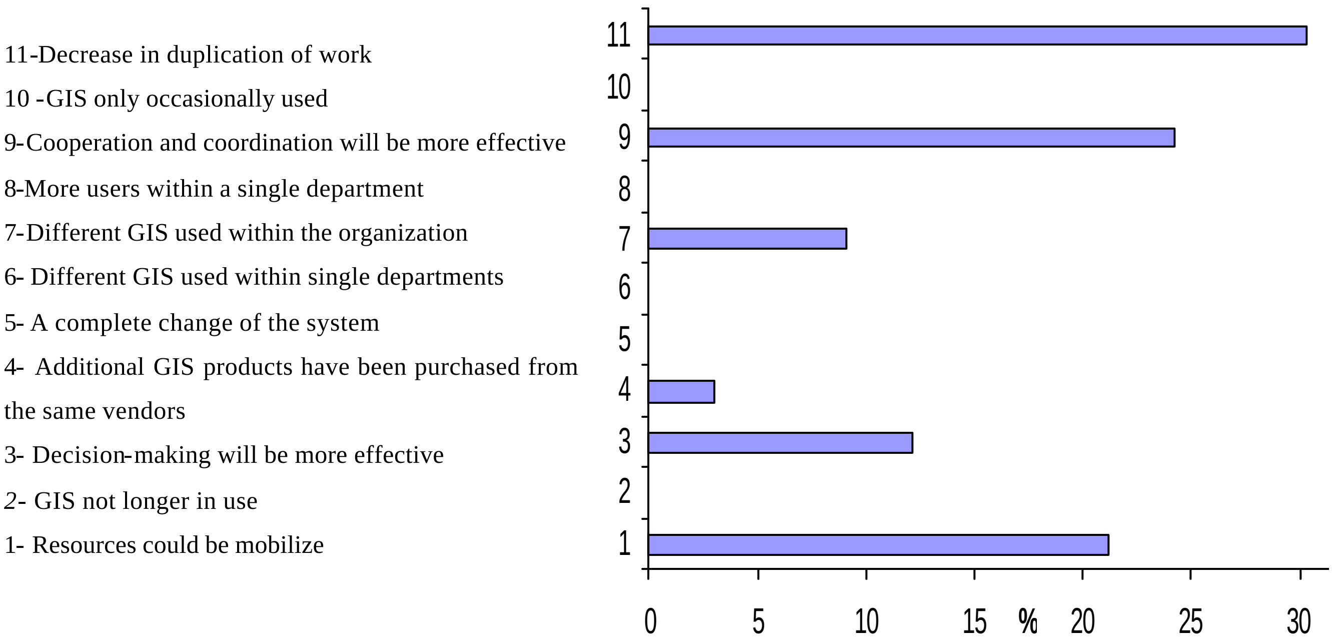

Figure 4.19 Percentage of future land evaluation users' expectations from SDI in Egypt

4.4 Proposed SDI to Fulfill the Demand of Land Evaluation

In the preceding parts, the author have tried to build the case and stressed the need for SDI. This thesis aims to address the role, concept and nature of SDI as a framework to facilitate land evaluation process. Egypt has the opportunity to learn from developed countries mistakes to start their own process avoiding those mistakes. So SDI adapted in developed countries has the potential of significantly contributing to resolving many of these urgent issues and problems in Egypt.

Here, it is possible to name the potential SDI that is going to be proposed. The infrastructure will be named as **S**patial **D**ata **I**nfrastructure to Support **L**and **E**valuation **A**pplications (**SDILEA**).

In the current case under study, aspect of land evaluation can form one side of the infrastructure while SDI forms the other.

4.4.1 Land Evaluation as a Demand

This part incorporates the findings of land evaluation data needed by users to prioritize what resource to describe. Some datasets are frequently used (have a high priority) while others may be rarely used (have a low priority) for land evaluation applications. The objective of the development of SDILEA is to make spatial data available and accessible by the land evaluation users.

4.4.1.1 Land Evaluation Process

Land evaluation is one of the areas of interest inside the Ministry of Agriculture and Land Reclamation (MALR). Given Land evaluation request, the workflow process includes very important step that need spatial data to define the Evaluation Units. The spatial unit of analysis for evaluation of suitability is the 'land mapping unit'. The description of this unit should be based on land qualities that have the most influence on the land uses under consideration. Identify the measurable land characteristics that will be used to determine to what degree the Land Use Requirements are satisfied. Identify data sources according to how the Land Use Requirements are to be evaluated. It is important to define the evaluation unit includes scale of the final maps, (table 4.2). The relationship between the land evaluation level and the scale of spatial data is given in table (4.2). However, it is quite difficult to define a boundary for detail data that can satisfy all user needs at a specific level. In general the most appropriate scales (bold in the table 4.2) indicated by the land evaluation users in table (4.2).

This process needs large amounts of data from various resources. Most of them georeferenced, that must be collected and organized in a structured way. SDI therefore consider very important infrastructure for land evaluation process.

Table 4.2 Land evaluation planning levels and recommended land evaluation map scales

Planning level	Administrative unit	Map scale	Land evaluation examples
National	Country	Small: 1: 250 000 **Medium: 1: 1 000 000** Large: 1: 5 000 000	Erosion map, Land use map and Maize growing areas, AEZ
Sub-national	Province, district	**Small: 1: 100 000** Medium: 1: 250 000 Large: 1: 1000 000	Soil maps, Suitability of various crops and Single attribute maps (p, N…)
Local	Sub-district, village	**Small: 1: 10 000** Medium: 1: 25 000 Large: 1: 50 000	Fertilizers recommended zones and Crop varieties
Farm	Farm	Small: 1: 1 000 **Medium: 1: 5 000** Large 1: 10 000	ND

ND: No Data

4.4.1.2 Identification of Stakeholders' Requirements (Demand)

Based on the field work activity, the following are the main active stakeholders involved in land evaluation process in Egypt, (see appendix 3a for the stakeholders list):

1- Agriculture Research Center (ARC);
2- Desert Research Center (DRC);
3- National Research Center (NRC);
4- National Authority for Remote Sensing and Space Science (NARSS);
5- Cairo University;
6- Alexandria University; and
7- Al -Azhar University.

The most important one is Agriculture Research Center (ARC) and Desert Research Center (DRC).

In order to consider SDI as a best tool to improve land evaluation process, the data requirements must be assessed. Be specific to be efficient. Focus on few reachable objectives. It is necessary to define what land evaluation organizations wants from the SDI. Which purpose want consider the organizations by establishing SDI. It is almost impossible to determine requirement comprehensively. To determine requirement thoroughly, it needs the involvement of all land evaluation sectors. Moreover, it needs to consider the different procedures that the land evaluation activities follow. Furthermore, it needs knowledge of the decision level that the land evaluation is going to support. The stakeholders indicate the general requirements for the future land evaluation. These requirements were collected during fieldwork, discussions during interview and questions from the survey. It is important to consider the users' needs, so that the SDI becomes user driven. Users should be considering a guiding force for new land evaluation development.

- From technological perspective, the basic requirement for land evaluation users is reliable access for the service providers, (clearinghouse or geo-portal). Access component is required to provide an efficient request-response for the service and be capable of meeting the demands of land evaluation users.
- From application perspective, the stakeholders need to land evaluation models and software as tools to perform their applications as highlighted in the results part.
- Based on data requirements, datasets are frequently used (have special consideration) should be taken on how they will be accessed. A typical minimum data set most frequently used for the land evaluation applications include:
  1- Topographic maps;
  2- Soil data, including of texture, soil salinity, soil depth, $CaCO_3$ content and water table;
  3- Geology;
  4- Morphology;
  5- Land use/ Land cover; and
  6- Meteorological data.

These data are required by many land evaluation users to perform their application. Applications in land evaluation did not vary much across the users, and therefore similar datasets were developed in many organizations. Most, if not all, projects would use these datasets.

4.4.2 Spatial Data Infrastructure as a Supply

4.4.2.1 The main SDI providers

Different governmental organizations have been established by decree to help availability of spatial information in the country. For example, to make topographical maps and aerial photographs available, etc (Foundation data), the Egyptian Survey Authority (ESA) has been established. Nevertheless, the organizations are not in a position to do so. And they have capacity problems in meeting their responsibility and making available and accessible spatial information, and more importantly up-to-date spatial information, for decision-making process. Based on the field work activity, the following are the main spatial data providers in Egypt, (see appendix 3a for the providers list): Egyptian Survey Authority (ESA); National Authority for Remote Sensing and Space Science (NARSS); The Egyptian Geological Survey and Mining Authority (EGSMA); Egyptian Meteorological Authority (EMA); and Private Sector.

4.4.2.2 Spatial Data Infrastructure Components (Supply)

Clear definition of the SDI framework is critical for facilitating land evaluation process. The five core components of SDIs are also the components that address proper land evaluation in Egypt. The building of the SDILEA should be based on five spatial data infrastructure components along with models and software. Using the same components but adapting them to suit the Egyptian situation. The interconnected nature of the five SDI components means that modifying one component will require modifications to be made for other components. These components are shareholders, spatial data and metadata, standards and protocols, institutional framework, and technology. The results relating to the land evaluation requirements from SDI have led to the representation of an augmented SDI model, figure (4.20). This model has been based on the standard SDI components and their interconnection, (Rajabifard et al., 2002). The augmentation lies in additional levels of detail for each of the components.

I Spatial data and Metadata.
The metadata required for land evaluation datasets documentation are, metadata, identification, data quality, reference system, and citation and responsible party.
II Shareholders (Land evaluation users and Providers).
III Technology (access network and access service)
IV Standards and Protocols.
Metadata standard, data transfer, data storage format, data schema, and web mapping standard.
V Institutional Framework.

- Policy issues:
  1- Legal aspect. (Copyright, liability, privacy)
  2- Culture aspect.
  3- Pricing aspect.
- Organizational arrangements.
- Social consideration.
- Political support.
- Educational issues.

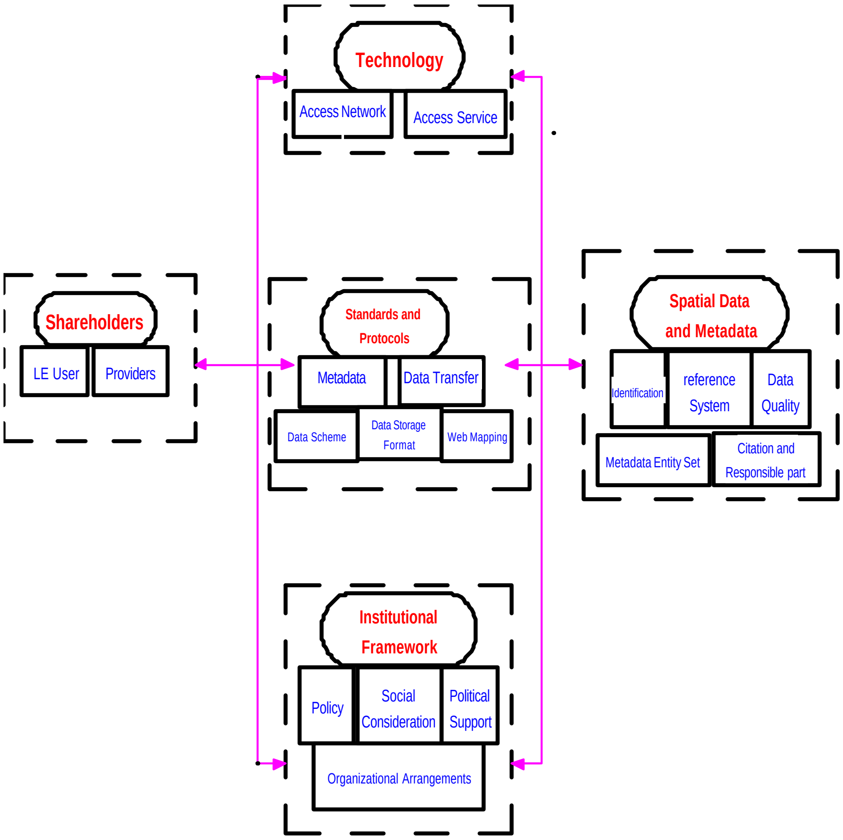

Figure 4.20 Augmented SDI model for land evaluation
(adopted from Rajabifard et al., 2002)

All these SDI components have their potential to be helpful in the land evaluation process. Limited access to data, information and services providers leads to duplicity of data by many users. To promote access to these SDI, it may be more desirable to share land evaluation data than to develop or install duplicate data. In order to overcome this type of problems, the role of standards is important. To share land evaluation data, one should follow appropriate standards for the data production. A common data standard for metadata, data transfer and data storage format accepted by all potential users will reduce duplicity of data and data redundancies. Internet is the fastest and most efficient way to distribute, find, and get the data. Here, the technology role comes. Without any automated process for its administration, the creation (or modification) of data related to land evaluation concessions had to be performed offline. This way of working created problems that were due to the work with out-of-date data. To achieve this aim, the establishment of appropriate access tools (geo-portal catalogue) for transfer and sharing information/data required for land evaluation is urgent. It is becoming clear that the establishment of a SDILEA would contribute to overcoming the previous problems. That is why SDI development is necessary for land evaluation process.

4.4.3 Linkage of Spatial Data Infrastructure and Land Evaluation Application (SDILEA)

Land evaluation process in Egypt needs for information rich environment, mainly in the Define Evaluation Unit step as a demand. So, spatial data is one of the most important infrastructures necessary for a good land evaluation. SDI (bridge the gap between the land evaluation decision-makers and the data providers) has the capability to support such a demand as a supply.

Figure 4.21 shows how land evaluation and SDI can interact in terms of demand and supply. Therefore, it is proposed that SDI as infrastructure can be an appropriate framework in bringing the components together and facilitating decision-making for land evaluation as illustrated in figure (4.21).

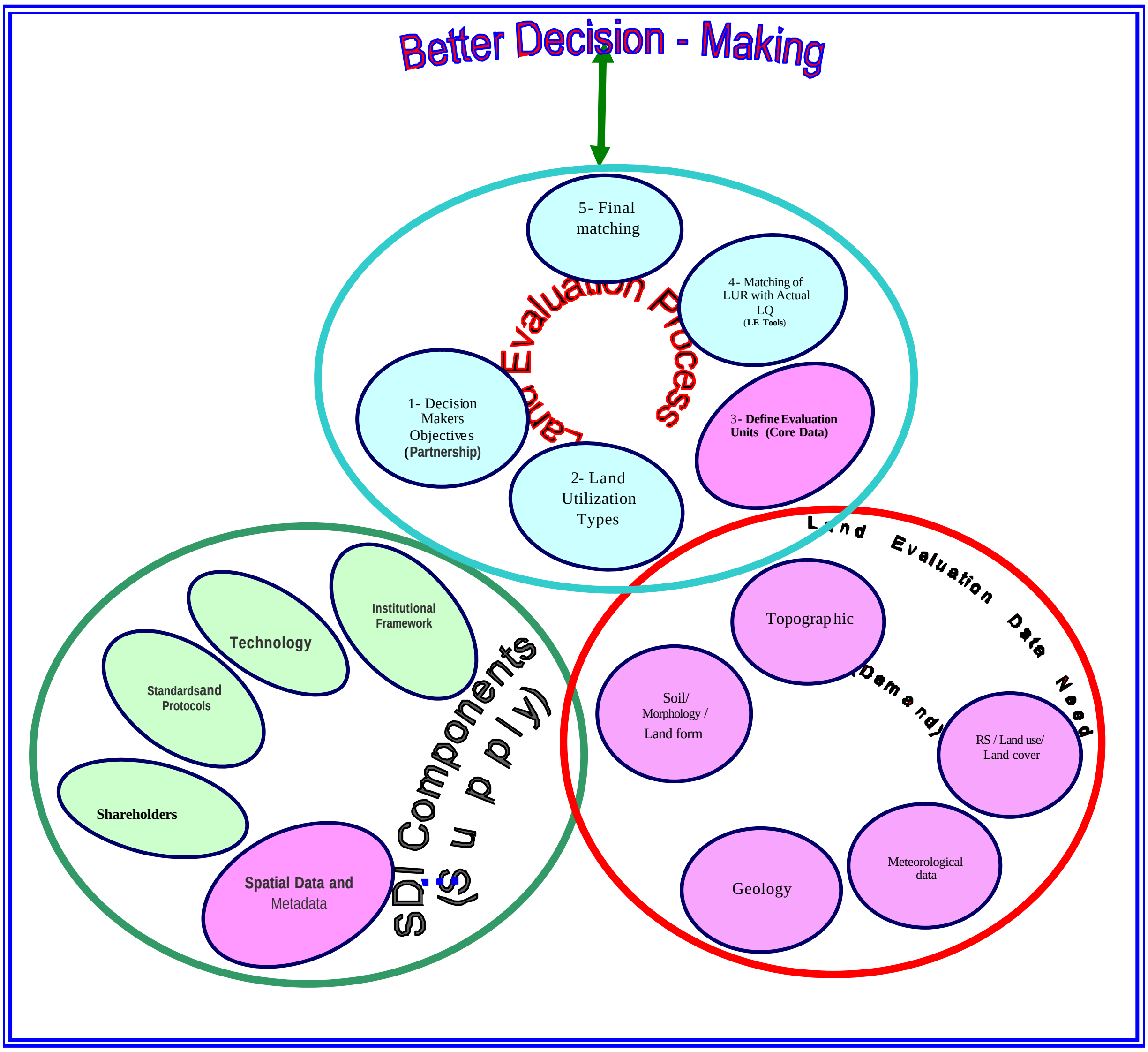

Figure 4.21 A conceptual model to facilitate the development of a SDILEA for decision – making

The proposed SDILEA will seek to enhance the sharing of data for land evaluation decision-making by providing solutions for access to spatial data to generate spatial information that is vital to land evaluation process. The main land evaluation requirements are availability of spatial data and metadata and reliable access to service providers. Based on the land evaluation stakeholders' requirements, the most SDI components that they need are:

1- spatial data and metadata availability; and
2- network technology to access to providers service.

According to these requirements, SDILEA will design as a facility to access and search spatial data. This facility includes services to help discover and interact with data. An important common service in SDI is that of discovering resources through metadata. This Discovery Service is the core function of the Geo-portal for spatial information, figure (4.22). Geo-portal is important to access directly metadata records describing services, combining data from multiple remote services over web connection and support for processing data. These services deliver 'raw' data with additional processing services on spatial information (maps). The later service enhances the delivery of data through processes applied to raw data, (Web Mapping Services, Symbolization, Coordinate Transformation and Analysis or Topologic Overlay Services).

SDILEA-based information system will have the ability to access the data supplied by other providers (e.g., Egyptian Survey Authority (ESA) and National Authority for Remote Sensing and Space Science (NARSS)), which are accessible through their spatial data infrastructures using of OGC standard interfaces. The custodian shall keep the dataset(s) it produced while making the metadata available to the SDILEA Clearinghouse. Land evaluation users can issue queries against the database providing that they have an Internet connection.

SDILEA has made contribution to simplifying access to land evaluation data. As it can be observed in figure (4.22), this allows land evaluation users discover and locates what services are available. Geo-portal catalogue facilitate spatial data sharing. Moreover, the ability to collect data once and use it many times, whilst at the same time avoiding development of duplicate data sets and reducing data management costs.

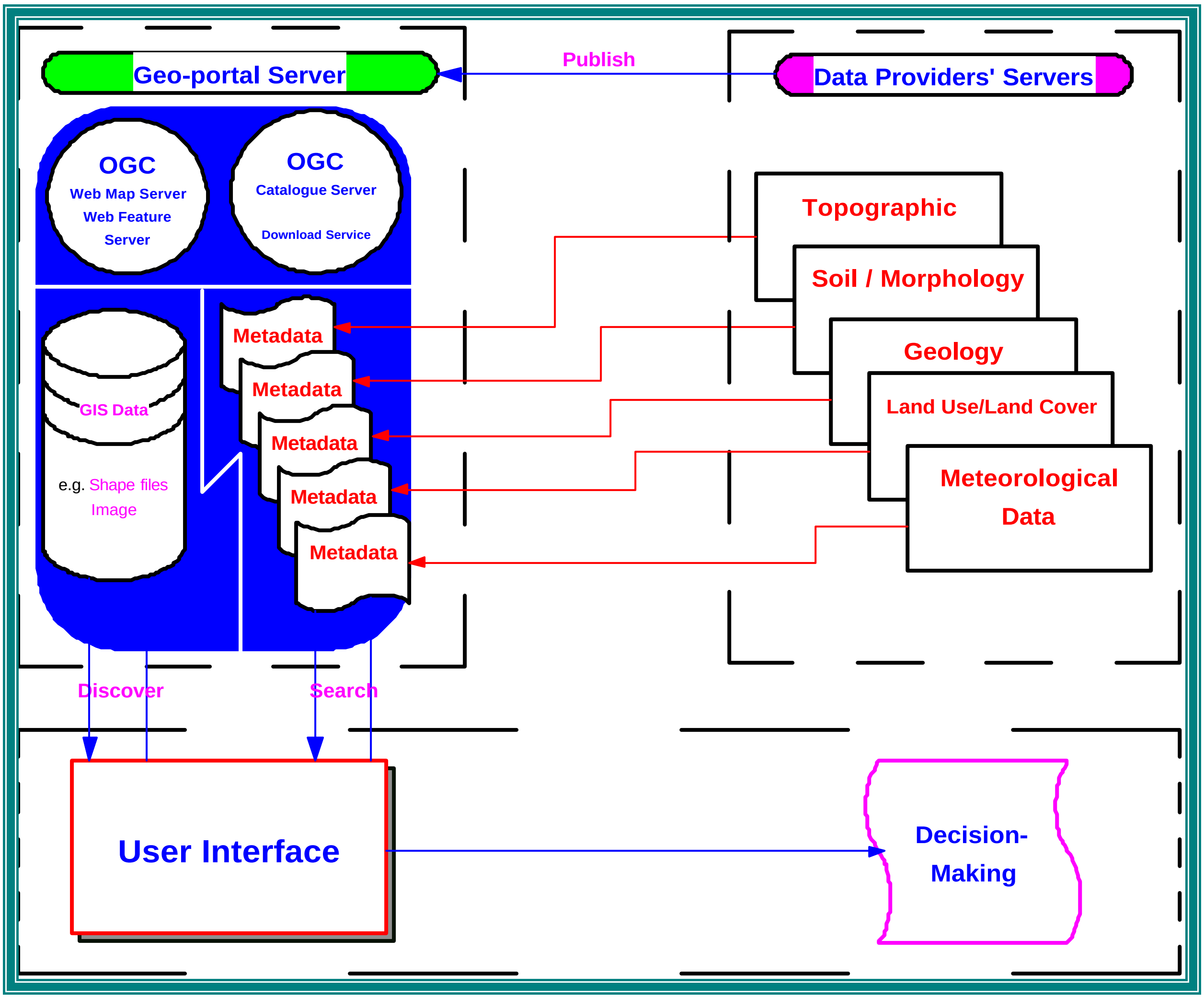

Figure 4.22 SDILEA architecture for better land evaluation decision- making

GIS applications in land evaluation organizations in Egypt are in its infancy. This gives rise to the need a careful selection of the system to be implemented than running a super SDI.

4.5 SWOT Analysis for the Proposed SDILEA in Egypt

Assessment of current status and the external environment is the first step in the strategic plan process. SWOT analysis has been used to assess the current situation and the environmental factors such as the political, economic, or technology influencing the organization. Based on the interview and questions (I- 19 to 26 and II-17 to 24) from the questionnaire, information for the SWOT analysis was obtained.

Scanning the internal environment of land evaluation organization in terms of Strengths and Weaknesses will help to utilize the resources they have with optimum usage. Scanning the external environment of the land evaluation organization in terms of Opportunities and Threats, will help to identify the political, economic, social and technological forces (PEST analysis) they deal with, to establish their future strategies, http://www.netmba.com/strategy/process/. Changes in the external environment present new opportunities and new ways to reach the objectives (goals). So we should select the opportunities that it can pursue with a higher probability of success.

Identifying the future improvements for the organization should be according to SWOT analysis. The results to establish the improvement goals for the organization, according to the internal and the external scanning for the land evaluation organization, are shown in the SWOT matrix, (table 4.3).

4.6 What Current Conditions Support Further SDI Improvements?

"Best Practice does not Equal Best Strategy"

The results of SWOT analysis proved that the land evaluation organization has a lot of resources that could utilize better future opportunities. It also faces some threats in the future that may restrain its improvement process. The future improvement actions of the organization should be identified according to this situation analysis.

The situation analysis shows the lack of data and metadata, absence of access mechanism, dearth of clear institutional framework, lack of national standards, poor of partnerships, shortage of funding, low of capacity building, and absence of political support are the main problems which all resulted from the lack of the SDI and information infrastructure. The strategies that identified based on the problem analysis part are:

- Awareness creation
- Execution of SDI policy and procedure for participation
- Establish of SDI coordination unit
- Formulation the responsibility organizations and partnership
- Creation of metadata standard for land evaluation datasets
- Provide tools to search and access the metadata

However, based on the questionnaire analysis (questions I- 19 to 26 and II-17 to 24), the strategies identified are, table (4.3):

- Establish fixed base for cooperation and coordination system supported by law to provide the information services for the governmental agencies.
- Up grade technologies
- Provides tools to access and search the metadata.
- Install organization-wide IT network.
- Focus on few reachable objectives based on the current situation.
- Make data sharing issue.
- Formulation the responsibility organizations and partnership.
- Creation of metadata standard.
- Use incomes and financial supports from the government to enhance the salaries level of the professional staff.
- Establishment of metadata management system.
- Establish of SDI coordination unit.
- Execution of SDI policy and procedure for participation.
- Establish standards on which most stakeholders can use it.
- Awareness creation.

Table 4.3 SWOT analysis matrix for SDILEA

External environment →

Internal environment ↓

strategic factors	Weight	Rate
Opportunities		
1- Availability of metadata	10	4
2- Growing number of national projects.	5	3
3-Availability of new technologies (GIS, and Internet technology)	5	4
4- Demand for data quality	5	2
5- Data can be made available at geo-portal	10	3
6- Financial support by the government	5	3
7- Improved collaboration and efficiency through department mergers	10	4
Total	100	1-5

strategic factors	Weight	Rate
Threats		
1- Continuation of adopting costly ad hoc solutions	10	4
2- Technology is changing very fast	5	3
3- Lack of awareness	10	3
4- Duplication and repetition of failed projects	10	4
5- Privatization of data provision agencies	10	3
6- Data cannot be published	5	4
Total 1-5	100	

strategic factors	Weight	Rate
Strengths		
1- Large experience in land evaluation applications and wide base of consultants from universities and international agencies.	5	3
2- Availability of geo-ICT including Internet facility	10	4
3- Existence of various organizations that have engaged in spatial data production and management	10	4
4- Improved understanding of community needs.	5	4
5- Mandate bylaw for approving any plan before implementation	10	3
6- Availability of spatial data acquisition	10	4

SO Strategy

- Use wide experience base in land evaluation applications to increase the number of national projects, (S1-O2).
- Provide data quality, (S3-O4).
- Use improved understanding of community needs to participate in the national projects, (S4-O2).
- Establish fixed base for cooperation and coordination system supported by law to provide the information services for the governmental agencies, (S5-O3).
- up grade technologies, (S2-O3).
- **Provides tools to access and search the metadata,** (S2-O5).
- Install organization-wide IT network, (S2-O3).

ST Strategy

- Participate in the national and international projects to improve its collaboration with the other organization, (S1-T5).
- Focus on few reachable objectives based on the current situation, (S2-T1).
- Make data sharing issue, (S2-T4).
- **Formulation the responsibility organizations and partnership,** (S3-T5).
- Conduct survey on what data are available, (S3-T6).

strategic factors	Weight	Rate
Weaknesses		
1- Absence of guiding SDI policy	10	4
2- Lack of digital environment in most organizations	5	3
3- Inadequate qualified staff compared to the amount of work and unqualified staff in local authorities who manage the plans and collect data	5	2
4- Data access and update are not easy and lack of information on data and metadata availability	10	4
5- Cultural behaviors play role for not sharing the data	5	3
6- Lack of standards	5	3
7- Frequent change of leadership	5	2
8- Moving of the qualified staff to the private sector	5	4
Total	100	1-5

WO Strategy

- **Creation of metadata standard**, (W4-O1).
- Use incomes and financial supports from the government to enhance the salaries level of the professional staff, (W8-O6).
- **Establishment of metadata management system**, (W4-O5).
- Identify the specific bottlenecks that hindered open partnership, (W5-O7).
- **Establish of SDI coordination unit**, (W5-O7).
- Enhance the possibilities for data collection, (W2-O7).
- Use of the national projects as well the availability of the new information technology to employ enough staff for the new projects as well to enhance the qualifications of the existing staff, and their manual way of work, (W3-O3).

WT Strategy

- **Execution of SDI policy and procedure for participation**, (S1-T5).
- Enhance behavior and routine to deal with weaknesses and to face future threats, by getting strong actions to face these problems before it makes other bad impacts.
- Establish standards on which most stakeholders can use it, (W6-T6).
- **Awareness creation**, (W3-T3).

Establishing the improvement actions will definitely impacts the external threats and the internal problems (weaknesses) of the organization. Developing these actions has to be within the available resources, so that the derived system can fit with the current situation. One of the strategies identified in SWOT matrix is Focus on few reachable objectives based on the current situation, (S2-T1). So according to this, all the 23 actions identified in SWOT matrix table (4.3) were brought down to 7 future improvement based on:

1- comparison with the results identified in the problem analysis part, (see part 4.2);
2- users requirements analysis, (see part 4.4.1.2); and
3- SWOT analysis matrix, (see table 4.3).

The future improvements can be formulated as follow: Awareness creation, Execution of SDI policy and procedure for participation, Establish of SDI coordination unit, Formulation the responsibility organizations and partnership, Creation of metadata standard for land evaluation datasets, Provide tools to search and access the metadata and Establishment of metadata management system.

4.6.1 Awareness Creation

Based on the questionnaire results (see figure 4.3), the decision makers are not yet aware of the new computer-based techniques. Some of them are aware feel intimidated by the technology and do not have the confidence to learn the new concepts and techniques, some truly do not possess the prerequisite knowledge to grasp the new concepts, not having had the opportunity to be exposed to them.

The introduction of new technology into any organization usually involves retraining of existing staff. As it is well reflected in the problem analysis part, lack of man power with the necessary background is severe. So for the future plan, they have to put this issue top on the agenda before embarking on the technology.

To upgrading staff at operational levels, this activity encompasses training programmes. Data producers need to be trained to use the metadata standard and the tools to create it. There should be a short and long term training programs for managers, system administrators, and system operators, both at the infrastructure and organizational level. However, as mentioned above, some of them do not have the necessary background knowledge to grasp the new concepts. Others may simply be unwilling to learn new things and will resist efforts to introduce the technology.

Lessons in awareness creation about SDI can be drawn upon from various countries. A list of activities includes:

1- promotion of SDI principles through presentations
2- education through workshops, training courses and material;
3- provide “train-the-trainer” technical workshops to explain the origins, purpose, and strategies for implementation of the SDI standards;
4- use pilot projects to demonstrate the value of spatial data and a SDI to improve decision making in communities; and
5- facilitate information sharing through newsletters, web pages, and publications, regularly inform interested parties of SDI-sponsored activities and initiatives.

4.6.2 Execution of SDI Policy and Procedure for Participations

Effective implementation will require a number of supporting polices to facilitate spatial information transfer. All the necessary arrangements that need to be made in order to make spatial data and associated services really available and SDI really work are called institutional framework, (Bregt and Crompvoets, unpublished data). For the use and user of SDI, it is an important component, as it regulates the conditions for data access and use. Also for the long term development and maintenance of SDIs policies are crucial.

An example of such a SDI policy questionnaire is presented in table (4.4). As an illustration of a possible SDI policy, we have presented in (column three) table (4.4) an example of such a policy for the SDI to support land evaluation applications in Egypt, (See Appendix 4c for Overall Structure and Time schedule for the implementation of a SDILEA).

Table 4.4 Issues for an SDI policy (adopted from Bregt and Crompvoets, unpublished data).

SDI Policy Issue Question	Description	Implementation
What will be the SDI coordinating organization and how will the communication and cooperation with the stakeholders be organized?	For a long term development and maintenance of the SDI it necessary to have a coordinating organization. This organization is responsible for further policy development and the coordination of the components of SDI.	A SDI coordinating unit. The activities of this unit are: 1- Overall strategy 2- Perform operational tasks
What are the core spatial data sets?	What are the core data sets relevant for a country or organization? An SDI should contain a list of the identified core datasets or procedure for its identification.	1- Topographic base data 2- Soils/ Morphology 3- Geology 4- Land use/land cover 5- Climatic data
Who is responsible for the collection and maintenance of the core datasets?	Description of the responsible organizations for the collection and maintenance of the data. Also the harmonization ambition must be formulated.	The agencies (referred to in an NSDI context as "nodes") that will initially contribute to the creation and maintenance of spatial databases. 1- Egyptian survey authority (ESA) 2- National authority for remote sensing and space science (NARSS) 3- Desert Research Center (DRC) 4- Agricultural Research Center (ARC) 5- Egyptian Meteorological Authority (EMA) 6- Private Sector
Which meta data standard will be used and how will the meta data be made available to the public?	Selection of a metadata standard and profile. The development of dissemination facility for meta data (e.g. clearinghouse).	1- Metadata entity set; 2- Identification; 3- Data quality; 4- Reference system; and 5- Citation and responsible party This metadata should be accessible via clearinghouse or geo -portal (catalogue)
What standards will adopt for the various SDI components?	The standards that will be used	1- ISO - 19115 (International) 2- Open GIS Consortium Metadata Standards, Scheme Standards and Web mapping Standards
What kind of data and meta data services need to be developed?	The kind of network services to be developed (e.g. Discovery services, download services, processing services, etc).	1- Discovery services 2- Download services 3- processing services
What are the common data policy principles and regulations?	The regulations and conditions for data and meta data access and use.	Formulate pricing, distribution, copyright, spatial data protection and access policy
What funding model will be used for the various aspects?	The funding model for the coordinating organization. The funding for the dat asets, etc	1- National government 2- Public /private partnerships funding 3- International donor organizations
What will be the procedure and schedule for policy review and update?	Decisions do not last forever. It is necessary to review the policy issues periodically and change or update the issue if needed.	The procedure and schedule for policy review are every three years in order to: 1- give an overview of the actions and activities; 2- determine problems (feedback) which have to be appear during the implementation of SDI; and 3- review the policy issues and change or update the issue if needed.

4.6.3 Establish of SDI Coordination Unit

SDI is not a duty to be accomplished by a single responsible body. SDI required for coordination at various levels calls for the establishment of different committees at higher policy and executive levels. The organizational strategy is supposed to include different levels ranging from the higher policy formulating body to the implementation level. To be exact, Executive Committee at a higher policy making level, Spatial Information Board to be formed by inter-organizational arrangements, Secretariat accountable to the Spatial Information Board and different Working Groups. For effecting improvement on the issue under consideration, the following bodies are paramount:

I Executive Committee

Experiences abroad have demonstrated that any SDI initiative can not be successful without support from the highest national level. The involvement of the politicians concerned with the SDI development is essential. SDI development needs a champion at the highest political level, (Groot, 1997). The politicians' support provides legitimacy and encourages the necessary financial investment for the SDI development. "Political will, Political will, Political will. When there is a will, there is a way", (Woldai, 2002). So it is important to involve persons with decision power and credibility. If spatial data are to be properly inventoried, catalogued, documented, standardized, updated and shared without restrictions indefinitely, it all boils to political force.

In Egypt, it is necessary to start with top-down approach. This approach has similar characteristics to the unique government framework and decision-making process in Egypt. To ensure the success of SDI, it is necessary to obtain supports from the highest level of the government and to formulate a strategy for SDI, especially at the early stage. This will give the SDI development a high level support that is basic for the success of the Egyptian SDI to support land evaluation.

II Spatial Information Board

The Spatial Information board will be composed of representatives from different ministries and agencies that currently are involved in land evaluation data production and application. Other agencies that are responsible in making national policies and related standards would also be included. This board will have a responsibility of investigating problems related to land evaluation and make proposal to the board for approval and execution as a project or activities. It also will give guidance and support to the secretariat.

III Secretariat

A group of secretariat elected by the Spatial Information board will be formed. The main duty will be to coordinate different working groups that are to be formed to address specific problem issues. It will serve as a liaison between the Spatial Information board and working groups.

IV Working Groups (WG)

The working groups are different professional groups prepared by the secretariat. Their main duty is to conduct detailed study on specific current as well as potential problems that can be of impediments to the effective land evaluation application and management. The relationship and linkage of main problems identified in the previous problem analysis and the theoretical explanation in chapter two can serve as to decide on which major aspects the focus should aim at. Based on the stated problem areas, sex different working groups need to be established to put the foundation for the desired SDI as well as to keep it active.
The proposed organizational arrangement is presented in figure (4.23).

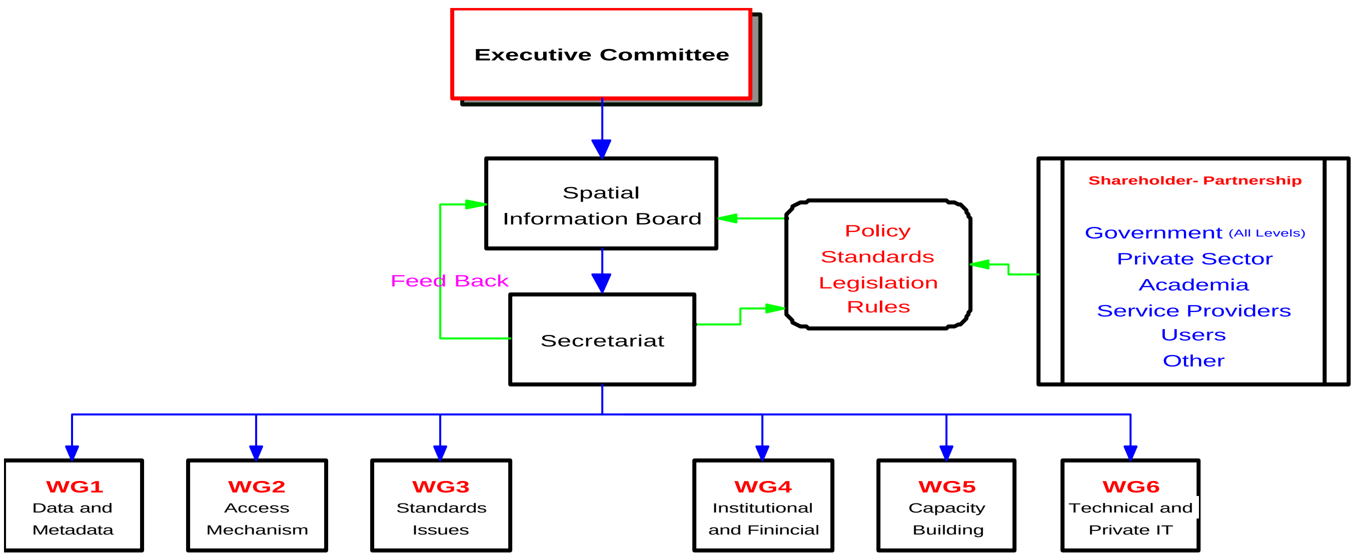

Figure 4.23 Organizational strategic arrangements to support land evaluation

4.6.4 Formulation the Responsibility Organization and Partnership

One of the most important SDI components is partnerships within and between institutions involved in spatial data for land evaluation. The responsibility for development and maintenance of the data set needs to reside with a particular agency or organization, the data custodian. It is important to identify the custodians of base data for land evaluation in Egypt, together with some basic indicators relating to data type and data access practices, as shown in table (4.5). Partnerships drive the development of SDI, allowing people to work together to achieve their respective goals. Partnership requirement are shared responsibilities, shared commitments, shared benefits and shared control.

Table 4.5 Providers of land evaluation spatial data in Egypt

Data Type	Name of Agency (ies)	Ministry of	Paper Data	Digital Data	Web Site	Use of web site for data dissemination
Topographic Maps	Egyptian survey authority (ESA)	Ministry of Public Work and Water Resources	Y	Y	Y	Y
Remote Sensing data/ Land use/Land cover	National authority for remote sensing and space science (NARSS)	Ministry of Higher Education and Scientific Research (MHESR)	Y	Y	Y	N
Geological data	The Egyptian Geological survey and mining authority (EGSMA)	Ministry of Foreign Trade and Industry	Y	N	Y	Y
Soil data/Morphology/Landforms	Agriculture Research center (ARC) and Desert Research center (DRC)	Ministry of Agriculture and Land Reclamation (MALR)	Y	N	Y	N
Meteorological data	Egyptian Meteorological Authority (EMA)	Ministry of Transport	Y	N	N	N

Identifying the agencies or organization mandated to supply land evaluation data is the core of the metadata initiative.

4.6.5 Creation of Metadata Standard for Land Evaluation Datasets

Improved SDILEA for access and sharing information for better decision-making calls for standards. Setting standards are essential in data dictionaries, reference system, metadata data quality and data transfer. The idea is not to fully adopt an exotic standards from abroad, or to come up with an exclusively own standard. The idea is to follow a selective strategy that enables most organizations to work on common ground. At least would facilitate the way to integrate the produced data sets in such a way that they can be applicable with less cost. This can be achieved by taking lessons from the already developed standards, like the International Standard Organization (ISO). Metadata standard is a formalized set of properties that describe the characteristics of the contents of a datasets. Developing proper metadata is the cornerstone of SDI to support land evaluation. Metadata is an essential requirement for locating and evaluating available data. Metadata standards will increase the value of such data by facilitating data sharing through time and space.

These information concerning spatial data including such other details as the geographical extent of the data, quality of the data, when it was last updated and who its supplier is, are described in a metadata structure and they enhance the use of GI in making appropriate decisions. Based on the minimum amount of information required, the core metadata for land evaluation datasets should contain, title and description of the data set, date of data set creation and the update cycle, data set originator or creator and supplier, the geographical extent of the data set based on lat/long Coordinates, geographical names or administrative areas, and more information about the data set how to order the data set, available formats, access constraints etc.

The following part assists in choosing a metadata element set that would describe the salient features of land evaluation datasets that responded to the user needs. Choosing a set of metadata elements based on ISO 19115, (Kresse and Fadaie, 2004), table (4.6). Followed by a decision on the content of those metadata elements, and most critically, the use of terms that represent what a resource is about, table (4.6). For example, data quality relates to the accuracy, completeness, currency, lineage, harmonization, and consistency of datasets. Users' accuracy requirements depend on their applications however they will expect to have access to positional and thematically accurate data. Nonetheless, if this is unavailable then they will need to be aware of the implications. Data completeness for graphical and tabular description is also required. Users can be given the option to utilize data at different levels of abstraction if they are willing to pay. General currency of the data will be required. The lineage of the data will be required as requests for older versions are made occasionally. Lineage has information about source materials, methods of derivations and dates. Most users will have their own datasets on which they require overlaying of other datasets. The datasets will therefore need to be compatible and well harmonized. Proper descriptions of the data (metadata) will need to be maintained according to ISO 19115 standards, (For more information about metadata see appendix 4b and 4c).

Table 4.6 Core metadata standards for land evaluation datasets

Information type	Name/Role name	Definition	Examples	Obligation condation*
Metadata entity set	MD_Metadata	Root entity which defines metadata about a resource or resources	(MD_Metadata.fileIdentifier)	(O)
			(MD_Metadata.metadataStandardName))	(O)
			(MD_Metadata.metadataStandardvVersion))	(O)
			(MD_Metadata.language))	(C)
			(MD_Metadata.characterSet))	(C)
			(MD_Metadata.contact>C1_ResponsibleParty))	(M)
			(MD_Metadata.dateStamp))	(M)
Identification MD_Identification	Basic information required to uniquely identify a resource or resources			
	MD_DataIdentification	information required to identify a dataset	(MD_Metadata>MD_Identification. pointOfContact>C1_ResponsibleParty)	(O)
			(MD_Metadata>MD_DataIdentification. geographicBox or MD_ DataIdentification. geographicIdentifier)	(C)
			(MD_Metadata>MD_DataIdentification. language)	(M)
			(MD_Metadata>MD_DataIdentification. characterSet)	(C)
			(MD_Metadata>MD_DataIdentification. topicCategory)	(M)
			(MD_Metadata>MD_Identification. abstract)	(M)
			(MD_Metadata>MD_DataIdentification. extent>EX_Extent)	(O)
			(MD_Metadata>MD_DataIdentification. spatialRepresentationType)	(O)
	MD_BrowseGraphic	Graphic that provides an illustration of the dataset (should include a legend for the graphic)	File name	(M)
	MD_ keywords	keywords, their type, and reference source		
	MD_ Resolution	Level of detail expressed as a scale factor or a ground distance	(MD_Metadata>MD_Identification.spatialResolution>MD_Resolution.equivalentScale or MD_Resolution.distance)	(O)
	MD_ Usage	Brief description of ways in which the resources are currently used	Specific usage	(M)
Data quality DQ_ DataQuality	Quality information for the data specified by a data quality scope			
	LI_ Lineage	Information about the events or source data used in constructing the data specified by the scope or lack of knowledge about lineage	(MD_Metadata>DQ_DataQual ity>LI_Lineage.statement)	(O)
	DQ_Completeness	Presence and absence of features, their attributes and their relationships		
	DQ_LogicalConsistency	Degree of adherence to logical rules of data structure, attribution and relationships (data structure can be conceptual, logical or physical)		
	DQ_PositionAccuracy	Accuracy of the position of features		
	DQ_QuantitativeAttributeAccuracy	Accuracy of quantitative attributes		
Reference system MD_ReferenceSystem	Information about the reference system			
	MD_ReferenceSystem		(MD_Metadata>MD_ReferenceSystem)	(O)
	MD_EllipsoidParameters	Set of parameters that describe the ellipsoid	semiMajorAxis, axisUnits	(M)
	MD_Identifer	Value uniquely identifying an object within a namespace	code	(M)
	MD_ProjectionParameters	Set of parameters that describe the projection	falseEasting, falseNorthing	(O)
Citation and responsible party CI_Citation	Standardized resource reference			
	CI_Address	Location of the responsible individual organization	City, postal code, country, e-mail address	(O)
	CI_Contact	Information required to enable contact with the responsible person and/o oganization	Phone, Mail address, hours of service	(O)
	CI_Date	Reference date and event used to describe it	(MD_Metadata>MD_Identification.Citation>C1_Citation.title)	(M)
			(MD_Metadata>MD_Identification.Citation>C1_Date.date and C1_Dare.dateType)	(M)

* M = mandatory, O = optional and C = mandatory under certain condations.

4.6.6 Provide Tools to Search and Access the Metadata

Promote access mechanism to share land evaluation data. Share land evaluation resources than to develop or install duplicate resources. Establish Clearinghouses or geo-portals by creating Spatial Data Catalogues in the SDI node agencies and enter the certified metadata of data producers. If land evaluation spatial data and information are shared, then the datasets are accessible to the wider land evaluation users.

The National Geospatial Data Clearinghouse provides an important means for carrying out data access responsibilities. The clearinghouse enables users to find, evaluate, and access geographic data through the Internet. By making metadata available, the clearinghouse can make the data accessible to many users who might otherwise be unaware of these resources. SDILEA is an example for such access metadata. SDILEA is serving as starting point and gateway to the Web portal for a land evaluation user.

The SDILEA shall provide facilities that link to the following functionality:

1- Publish metadata and data;
2- Find geographic information;
3- Support queries and viewing of result;
4- Delivery of geographic information; and
5- Analyze geographic information.

4.6.7 Establishment of Metadata Management System

The goal of data management is to ensure the quality, interoperability, security and availability of data and related information. Effective data management is one enabler for interoperability.

According to the number of clearinghouse servers and the detail levels of metadata, there are potentially three basic system architectures for a clearinghouse, (Radwan et al., 1997):

1- A central metadata service. A centralized system which integrates and manages data from various systems and distributes it through a single user interface.
2- A distributed metadata management. Decentralized (independent) servers but integrated accessible through a gateway.
3- Hybrid system with independent geoprocessing services.

4.6.7.1 Comparison between Different System Architectures

The central metadata service is relatively simple technical infrastructure. The national spatial data clearinghouse (NSDC) management team will be responsible primarily for coordinating the metadata development and dissemination. The team will involve members of the national coordinating body, public and private sector. The team will appoint a manger who will coordinate the adoption of standards for data content, data exchange format, metadata fields and metadata standards within the various organizations. Metadata software should be developed to quickly extract metadata from archival data and simultaneously from newly produced data. Finally, the NSDC manager will coordinate transaction processing, ordering and delivery of data products and services.

Centralized service show poor update frequency, since data and metadata are maintained by different organizations. The central organization need to run the clearinghouse is cumbersome and probably not financial sustainable in the long run, (Bregt, 2000). To store detailed metadata in one metadata base, the system would be expensive and complex to implement. Because the data managed centralized, it is not reliable (updated). A centralized system requires larger capacity servers and WAN connections however quantity of personnel and number of hardware is comparatively less. Data server will require terabyte storage, (Green and Bossomaier, 2002).

Although a centralized approach has been considered cumbersome and unsuccessful internationally, Reecce, (2004) indicated that the centralized data warehouse is suitable for Jamica because the least cost option and involved the private sector. The total start up costs for implementation in Jamica is $ 723, 657.

In a distributed metadata management update to data and metadata are done independently by each sectors' metadata Administrator but monitored by the NSDC manager who specifies standards and software. Each sector is responsible for implementing their GI services as required by users. There is no central metadata service. They can also choose to maintain services from a remote source. There is 24 hour up to date access to services and metadata.

So, there is more flexibility for data producers to update and maintain metadata. Decentralized database make data update easy.

This system does not provide a means to monitor the datasets in a national level, which might result in data duplication. A distributed independent system will have more requirements for servers and personnel as each unit would manage and operate independently however it does not require WAN connections. Users have to know the relevant metadata servers to find the suitable data. So, usually a number of servers have to be visited. Start up costs for implementation this system for Jamica is $ 990,094.6 (Reecce, 2004)

Hybrid system is a mixture of centralized and decentralized metadata service. The NSDC manger will be responsible for developing metadata content and display standards in all nodes. Each node will be located within the organization designated as the host for the sector and will have a clearinghouse coordinator who will link with the NSDC manager to implement the metadata standards and software. The organization will be responsible for the development and management of metadata and the integration of geospatial data and services. The implementation approach in this case would be a type of corporate approach. It is easy to monitor national wide datasets to avoid duplication.

There is more flexibility for data producers to update and maintain metadata. Users access all metadata via one single clearinghouse gateway.

Since two levels of metadata are required, one for the local metadata and other for the global metadata, more work has to be done. So, the hybrid system will require additional personnel to centrally manage and at the same time operate from a decentralized position. After searching the global metadata, users still have to search the local metadata again to get detailed metadata. It will also require very high speeds (possibly fiber optic) for large data transfer across a WAN. Hardware requirements will be similar to the first option.

4.6.7.2 the Most Suitable Clearinghouse Architecture for Egypt

According to the previous comparison, the most suitable architecture for Egypt from my point of view is the Hybrid system with independent geoprocessing services. The Hybrid system was recommended based on a combination of reasons:

1- Its overall costs. It was the relatively low to medium cost. Start up costs for implementation this system for Jamica as example is $ 877, 226 (Reecce, 2004).
2- One of the features of the hybrid system is the provision of a clearinghouse gateway.
3- It supports the development of a physical networked infrastructure to support collaboration among the GI sectors.
4- It is easily system to up date data and metadata.
5- The physical implementation process also has a long-term benefit for all the GI organizations because it will be a major step in establishing the information infrastructure for future emerging GI services.
6- Decrease in data duplication.
7- Facilitated the development of the national network on which other services could be easily developed and managed.
8- It is the most practical approach for Egypt since the majorities of GI providers are government and require integration of information to fulfill the mandates.

Hybrid system presents five local servers linked to a main server called “The Clearinghouse Service Center” and is a dependent distributed architectural design where metadata search and geo-processing services are conducted at each clearinghouse node. Upon entering the electronic front door of the geospatial data one-stop shop, a range of services and information is presented to the user. Upon selection of the specific service, the request processor/administrator will analyze and send the request to the appropriate sector node as described in figure (4.24). The request will be processed from the local server and the results packaged and sent to the electronic front door where a brief description of the data is presented to the user. If the user is satisfied and accepts the results a more comprehensive metadata result will be presented along with recommendations on use and information regarding distribution and delivery.

Metadata and spatial data are held in the local servers for each sector. Processes are conducted at each node but all are monitored and linked to the main server or the clearinghouse service center where the request is analyzed. Local servers also include a database for the geospatial data located in each organization.

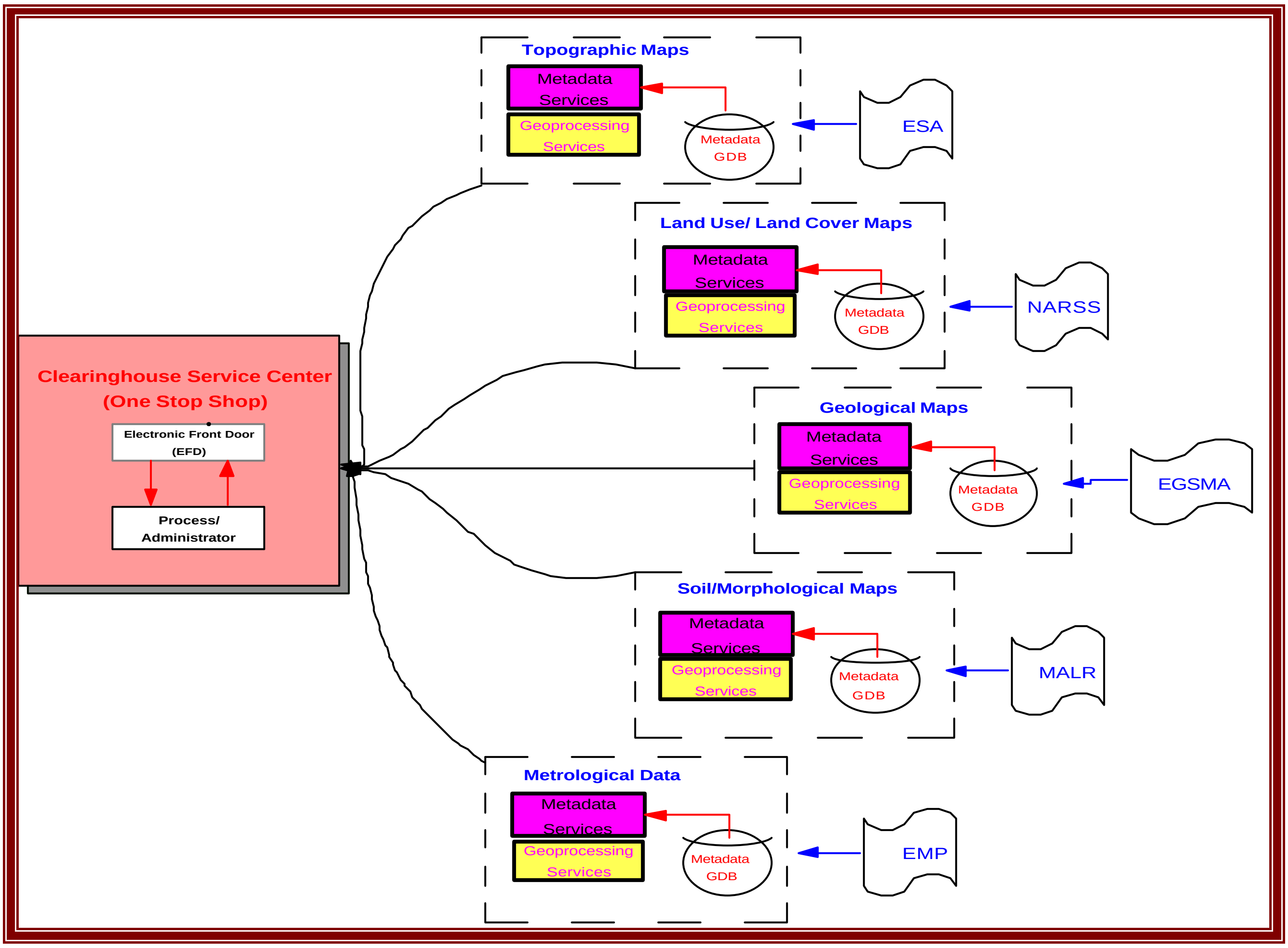

Figure 4.24 Hybrid Clearinghouse Architecture with independent geoprocessing services

To establish a clearinghouse node, organization will required among other the following activities, (Racca, 1997):

1- An understanding of the FGDC content standards for digital spatial metadata.
2- A study of Z39.50 server technology and various metadata preparation and validation tools on several computing platform.
3- Installing servers to run the suite of related software and to store data.
4- Developing a clearinghouse web page.
5- A file system strategy for how the software and data would be stored.
6- An adequate time creating metadata, checking metadata for conformance to the standard, preparing data, creating browse graphics, and establishing links so that users could immediately download the data.
7- A period of time where the clearinghouse software can be tested, and put into a production mode.

4.6.7.3 Funding Models for the System

To get a real overview of costs for implementing the system is quite difficult. The most important aspect to consider is the way of how to get that funding. An in depth analysis of the situation in Egypt is needed and drawing on the lessons learnt in the application of the models in developed countries it will be possible to modify the models to suite the right environment of Egypt.

If we take the situation in Egypt, this issue is more repelling. According to the questions (II-9, 10) from the questionnaire, the respondents indicated that most potential basic funding comes from the national government (69%) followed by private sector donation (31%), figure (4.11). However, the most appropriate specific revenue model was Public /private partnership together (63%) followed by the cost sharing by individual GI organizations (36.8%). However, based on the current economic situation in Egypt coupled with the constraints of most donor agencies, the best possible model would be the creation of a pool of funds to be access for SDI financing. Practical experiences drawn from other countries had showing that having a clearinghouse in place could be more persuasive to potential funders to give the funds needed to implement the SDI. As promotion of the clearinghouse occurs more funding will become available.

4.7 Critical Success Factors (CSF) Analysis

"You can not manage what you can not measure"

For the successful achievement of the proposed SDILEA, there are different factors which need to be considered. In order to make the required critical success factor, the logical base is the bottle necks identified in the problem analysis part. To realize the advantages of SDI to support land evaluation, the following success factors were identified important and crucial for the development of SDI based on the problems observed from the questionnaire and interview analysis:

1- institutional framework. Who will pay and maintain the SDILEA is a question which the answer in development of institutional framework;
2- capacity building. The lack of staff with the necessary geographic information management skills is a big problem in Egypt. Capacity building initiatives need to be developed in parallel to the processes of SDILEA implementation;
3- political support. Experiences abroad have demonstrated that SDI initiative cannot be successful without support from the highest National level. Therefore it is important to involve organizations and persons with decision power and credibility;
4- data and metadata availability. Data are usually the largest-living part of any SDI implementation. The essence of SDI to make data available;
5- partnerships and leadership. Cooperation and coordination are essential for the development of the SDI. Data sharing and exchange can efficiently take place only when concerned organizations accept to cooperate. Establishing strong partnership among different organizations is inescapable. Cooperation entails cost sharing of the system, sharing of ideas thus good assessment of the system;
6- same standards. Standardization is one of the most important components of the SDI. There should be standards for the data exchange, data accuracy, currency, accessibility, etc.;
7- funding support. For the success of the proposed SDILEA, sufficient funds must be made available. To establish the SDILEA, requires huge amounts of money both for its implementation and for its maintenance; and
8- access mechanism. The access network is critical SDI component to facilitate the use and sharing of data by people. SDI all about sharing.

In table 4.7 a critical success factor matrix is developed in terms of the activities (actions) that support several factors. The most three important factors necessary to achieve such activity were selected. The activities have to be designed based on the type of problems identified and SWOT analysis matrix. These activities will be most contributing to enable reaching the stated goal and have to be given high priority. The difference between the present position of land evaluation organizations and its desired future position, related to Critical Success Factors, to determine the projected deficiency in land evaluation performance. The idea is simple: in land evaluation organizations certain factors will be critical to the success of organization. If objectives associated with these factors are not achieved, the organization will fail. Based on the factors identified above, the matrix can be defined.

Based on the weight in table (4.7), the most important Critical Success Factors are: partnerships and leadership, data and metadata availability, institutional framework, political support, funding support, capacity building, same standards, and access mechanism.

Table 4.7Activities and success factors to establish SDILEA to support land evaluation

Proposed activities to support the establishment of SDILEA	Critical Success Factors: Institutional framework	Access mechanism	Capacity building	Political support	Data and metadata availability	Partnerships and leadership	Same standards	Funding support
Awareness creation	□	□	■	■	□	□	□	■
Execution of SDI policy and procedure for participation	■	□	□	□	■	■	□	□
Establish of SDI coordination unit	■	□	□	■	□	□	□	■
Formulation the responsibility organizations and partnership	■	□	□	□	■	■	□	□
Creation of metadata standard for LE datasets	□	□	□	□	■	■	■	□
Provide tools to search and access the metadata	□	■	□	□	■	■	□	□
Factor weight *	3	1	1	2	4	4	1	2

* The weight of all actions is assumed to be of equal importance as one unit (1).

■ Selected □ Not Selected

4.8 Overall Discussions

At the beginning of this research three main objectives were stated. Moreover, three research questions were identified. To support decision-makers and politicians in Egypt whether the investments in the establishment the SDILEA are necessary or not, the framework methodology was identified in methodology chapter as appropriate tool. Using the questionnaire survey and interview, it was possible to gather the information need in short time. The overall discussion focuses on the findings of the study in relation to the research objectives which aim at answering the main research question: How can SDI support land evaluation applications in Egypt?

4.8.1 To Investigate the Demands of Land Evaluation to SDI in Egypt

This part discusses the second research objective that sought to investigate the demands of land evaluation to SDI in Egypt. Before coming to any conclusion pro or against the need of land evaluation to SDI, the conceptual clarity on the demands of land evaluation to SDI has to be considered from the onset.

By looking into the current land evaluation in Egypt, there are too many things for meeting the demands for SDI. Poor decisions are frequently made because users do not know the data exist or not. If the data exist, they do not know who holds the data they require and how to get hold of it. Despite the Ministry of Agriculture and Land Reclamation (MALR) has made progress in the last twenty years in land evaluation activities, there are still problems in getting the appropriate information to help to make the right decisions. Governments are spending billions of dollars on collection of geographic information. For example, US spend more than 4 billion dollars per year on geographic data acquisition, (Srikantia, 1999). Other countries are also spending huge amount of money for data generation, acquisition, documentation and dissemination. In Egypt, More than 60% of funds for any land evaluation project are spent on data collection, (interview results).

Land evaluation in Egypt needs for information rich environment as a demand. The main land evaluation user requirements (demand) from SDI are availability of metadata and accessibility to datasets. Land evaluation organizations have invested heavily to address this challenge but unfortunately, it is not able to meet the demand. One of the reasons for that may be lack of cooperation and coordination among the organizations.

The results are clear in show that land evaluation users still find it difficult to access spatial data. Here are some of the problems encountered to these difficulties. Firstly, most spatial data produced by the organization are created in standards fitted only to their own needs. So, there is no realization to disseminate this to others. Many of the data is held separately in individual organization systems, in a variety of formats and collected to a variety of standards, (figure 4.10). The lack of standardization is seen as a major weakness in the implementation process, Musinguzi et al., (2004). Secondly, dealing with policy aspect, for any organization that has been prepared to distribute data feels inconvenience since there is no regulation or rule to protect data from any misuses. Finding data is not also easier than access it since there is no metadata available and no data directory available. Moreover, funding resources present a most constraint to make data available in Egypt. Finally, from the results of this research, most geo-information systems in Egypt operate on a stand alone (unconnected) basis where they lack inter as well as intra organizational links, (see figure 4.18). It is hardly possible to consider the existing systems as reliable sources that can channel information to support land evaluation process.

For the overall status of spatial data development in Egypt, we can compare SDI development in Egypt with other countries. This comparison has advantages as a tool to convince the decision-makers and politicians in Egypt for the need to SDI. It benchmarks the level of development for use in further strategic planning. Table (4.8) summarizes such a comparison between the Egyptian SDI development and internationally.

Table 4.8 A Comparison between the current Egyptian SDI and International development

Parameters	Egypt	International*
Mechanics of Data Access	Paper data sale through government offices	Clearinghouse nodes, websites, Geo-portals, etc.
Private Sector involvement in Data generation, dissemination	Nil	Exist in most of the countries
Digital data availability	Nil	Yes. Now vector data being also provided in addition to the raster data
Available Public domain datasets for free	No	Few in most of the countries. US is an exception.
A strategy for National Spatial Data Infrastructure	No	Yes
Metadata	Nil	Process going on in most of the countries.
Data Clearinghouse	Initiative	Yes in many of the countries
Data standards	No	Yes
Core data accessibility	No	Yes
Data dissemination and pricing policy	No	Yes
Freedom of Information	No	In some of the countries

* "International" refers here to the USA, major European countries, Canada, Australia, Japan, Qatar, Indonesia and Malaysia. (Tosta, 1997; FGDC, 1997, 2002; Onsurd, 1998; ANZLIC, 1998; Groot and McLaughlin, 2000; Bregt, 2000; Rajabifard et al., 2003; Crompvoets et al., 2004; Maguire and Longley, 2005; and Tait, 2005).

It is clear now that land evaluation process miss the SDI tools that can support/facilitate acquiring correct and up-to-date data for land evaluation development. From the above table and discussions, there is a gap in land evaluation process in Egypt. These gaps include lack of data and documentation (metadata) that limits the reuse of data, absence of access mechanism, dearth of policy, lack of standards, shortage of funding, and low of capacity building. For the future land evaluation, the user's requirements are:

- Availability of data. Datasets that are frequently used should be taken on how they will be accessed.

- Reliable access for the data providers, (clearinghouse or geo-portal). Access component is required to provide an efficient request-response for the service and be capable of meeting the demands of land evaluation users.

Based on the conceptual assessment made and the consideration of what SDI and what is it for land evaluation, it is possible to conclude that the demands of land evaluation process to SDI become urgent. As assessment for the first objective, one can conclude that the objective is well achieved.

4.8.2 To Determine the Appropriate SDI to Fulfill the Demands of Land Evaluation in Egypt

This part discuss the second research objective that sought to find out the appropriate SDI to fulfill the demands of the land evaluation stakeholders based on the given and existing trends in Egypt.
The methodology to establish the SDI differs from one country to another due to the diversity in culture, politics, government framework, etc. of each country. For the overall status of spatial data development in Egypt, we analyzed the existing land evaluation situation to help for designing the proposed system. In order to address the obstacles identified before, it should be establishing harmonized spatial data infrastructure. From the research findings, the proposed SDI to support land evaluation in Egypt are expected to be based on five SDI components: data and metadata, shareholders, standards, technology and institutional framework.

The heart of any SDI is the data. The land evaluation decisions made using a GIS are only as good as the data used to make them. Different applications may need different information or data sets, but for spatial data, the same data sets may be suitable for many applications for a certain area. From the research findings, the most important data sets need to land evaluation are Topographic maps, Soil data, Geology, Morphology, Land use/ Land cover, and Meteorological data. After the data is identified, it is essential to establish a way to connect it to the users. To identify (discovery) a dataset, the core metadata descriptions are required. These metadata descriptions should allow potential land evaluation users to analyze and evaluate the datasets contents and determine their fitness for use. Such descriptions should also include information concerning the means to access and retrieve the data stored in the datasets. This allows land evaluation users to combine easily different types of spatial data from different data sources. The metadata standard required for land evaluation datasets documentation are, metadata entity set, identification, data quality, reference system, and citation and responsible party, (table, 4.6). The development of these metadata is a matter of cooperation and partnerships between all stakeholders. This moves us from discussions of data and metadata to shareable these data by shareholders.

Shareholders involved in land evaluation process in Egypt are data providers and data users. The most important stakeholders are Agriculture Research Center (ARC) and Desert Research Center (DRC), (for more land evaluation users see appendix 3a). If spatial data and information are shared and exchanged, then the datasets are accessible to the wider land evaluation users. This brings the concept of partnerships in spatial data production and sharing to the fore. The cooperation between different stakeholders does not exist in Egypt. "… There is a difficulty to bring the stakeholders together to discuss the way forward". "… Many organizations fear that they will lose their autonomy when participating in a SDI". These organizations are actually isolated and independent from each other. As it has been put by Groot and McLauglin, (2000) "the essence of the SDI concept is that there is no master architect". The most important data providers are Egyptian Survey Authority (ESA) and National Authority for Remote Sensing and Space Science (NARSS), (see table 4.5 and appendix3a).

Through a partnership effort, it is possible to have the required spatial data for land evaluation always available and accessible for use. To achieve this aim, the establishment of a strong partnership and leadership for land evaluation is critical. So, it is important to identify the custodians for land evaluation data in Egypt. Based on the results and analysis the interview data, the author proposed Egyptian Survey Authority (ESA) as a leadership organization. The ESA with its large relationships with different organizations, its qualified human resources and the state of the art information technology resources, also its much cheaper services than the private sector can play efficiently the role of leader. The Egyptian Survey Authority (ESA) is key contributors to SDI initiatives in Egypt. However, it is not the coordinating institution. It is not uncommon for other entities to have stronger political influence or funding that can help in inducing change. For instance, the Ministry of Communication & Information Technology (MCIT) has the mandate to coordinate the national initiative.

Standards development and implementation in Egypt have been limited. Most of the spatial data is still acquired in non-standardized format. The standards adopted by different organizations are often in conflict with each other. These standards associated with analogue data concept. In most cases such standards are not documented and known by every one to control quality of the datasets. It is only in Egyptian survey authority (ESA) prepared manual documented standard. The organizations have been adopting digital technology, but not yet developed standard suitable for the digital data. Some organizations are using the analogue data standard concept for digital data standard. But digital data standard is more than that, it needs data quality and projection/reference system standard. During the field work activity, no organization is found being concerned about digital data reference system. The reference systems are rather largely understood as UTM or lat/long coordinate only. The rest projection elements like spheroid, datum, and other projection elements are neglected. Otherwise, it is impossible to integrate data from different sources, and overlay different geographical features, as shown in figure (4.10). Here the question is, how can integrate the data from different sources for land evaluation applications and apply them without going to collect the same data once again? This question has no concrete answer in the current situation in Egypt. To solve these problems and answers this question, standards are urgent. ISO 19115 for metadata standard and Open GIS Consortium are proposed. A lack of standards make availability of the data sets present obstacles to its access and use. To achieve this aim, the establishment of appropriate access tools for transfer and sharing information/data required for land evaluation is urgent.

The most important problems that identified are finding out which data is available and getting access to the existing data. Because of absence of sharing mechanism, land evaluation users do not know where the spatial data is stored and have no efficient tools to access the data. Accessing and obtaining of data from organizations is restricted by unnecessary formalities, as shown in figure (4.4). Moreover, there is a difficulty for some land evaluation data producers to get necessary information from other producers to integrate with or to update their own data bases. Thus, the data needs for land evaluation applications are often out dated and access by the users is very difficult. To solve these problems, access network is necessary. So, it proposed SDILEA as a facility to access data and metadata. This facility includes services to help discover data. An important common service in SDILEA is discovering resources through metadata. From economical and institutional perspective, we recommended to start with development the discovery service first because download service need to implement price policy first. This Discovery Service is the core function of the Geo-portal for spatial information, figure (4.22). Geo-portal is important to access directly metadata records, describing services, combining data from multiple remote services over web connection and support for processing data. In terms of data and information access, SDILEA will use Internet technology. The Internet will be used as the principle means by which producers of the information will put the directory of information sources online, setting up a geo-portal to share the information with the rest of the stakeholders. The purpose of geo-portal is to provide structured, comprehensive, coherent, accurate, and authorized information, and to facilitate access to key data and information resources for land evaluation users. This access facility requires a clear institutional framework to deal with different policy aspect.

Many of the current difficulties will only be resolved if, at the highest level in government, there is sustained interest in developing sound policy to organize the information. The policy would give a clear guideline on how spatial data has to be collected, managed, update responsibilities and distributed to the end users. It will help to reduce the duplication of efforts. Based on the field work activity, there is no legislation for the copyright and ownership. No sharing protocol between the different organizations. Spatial information producer organizations and users have faced many problems during geo-information administration (like integration of data, exchanging of data, and provision of data, etc). To solve these problems and facilitate spatial information access and transfer, a number of supporting polices will require, (table 4.6). Policy is an important SDI component that controls the conditions for data access and transfer. The responsibility of preparing such policy largely lay on the national organizations. So, it is important to establish SDI coordination unit, (figure, 4.23) first.
With the identification and building up of the proposed SDILEA the second objective was achieved.

4.8.3 To Assess if the Current Conditions Promise for Further SDI Improvements

This section discuss the third research objective, the aim is to assess if the current conditions promise for further SDI improvements. Once we have seen the problems and understand the need for SDI, the important issue at this point is to see whether the current conditions are promising for improvement or not.

There is no standard that enable to judge the current situation in terms of the desired improvement. Even in similar situation in different countries, these are not comparable to the situation in Egypt where the lack of data and metadata, absence of access mechanism, dearth of clear institutional framework, lack of national standards, poor of partnerships, shortage of funding, low of capacity building, and absence of political support are considered to be the main problems but the need is high. We take the conditions in the developed countries as the only standard scale to weigh the possibilities. The big issues behind the analysis made in table (4.3) can be summarized to the following:

Strengths

1- *Good spatial data acquisition*. The Egyptian Survey Authority (ESA), which was established in 1879, (Nasr and Radwan, 2004) is responsible for all topographical and development surveys in Egypt. Egypt with an area of 1,002,000 km^2 is covered by both topographical maps and geographical maps. The topographical maps are on scales between 1:000,000 and 1:1000 table (4.9) which are ideally suited for the professional work of geologists, geographers, agriculture, engineers, planners, etc. (see appendix 4d).

2- *Growing demand for GIS*. Development of the GI market in Egypt has contributed to the creation of a new group of companies dealing in software, value –added data, and services.

Table 4.9 Topographical maps production available in Egypt

Scale	Year of production	Total number of sheets	Hard copy	Digital	Remarks
1:1000.000	1945	7	Yes	No	ND
1:500.000	2000	15	Yes	No	ND
1:250.000	98/99	80	Yes	No	ND
1:100.000	ND	95 ?	Yes	No	ND
1:50.000	ND	1531	445	202	ND
1:25.000	67	491	Yes	No	Stop production
Less than 1:25.000	ND	ND	ND	ND	ND

ND: No Data, http://www.mwri.gov.eg/egsa/cover.htm

Weakness

Spatial information field in Egypt is still immature with broad set of issues yet to be resolved as described in table (4.10).

1- *Absence of guiding SDI policy*. The development of the SDI is not purely a technical issue, institutional, (table 4.4) or other aspects also affect its progress in different ways. There are culture and societal differences that influence the development of SDI from country to country, (Groot and McLauglin, 2000; Ezigbalike, 2002 and Radwan, 2002). In the current situation, there is no copyright law, table (4.10) and most of agencies need to market their product in order to find additional resources to maintain and update their data. Spatial information needed should be abundant and widely available. The main aspect that need to be addressed are the organizational issues (who will do what) should be establishing the conditions for data use, privacy, pricing (who will pay for what), and copyrights. The majority of the institutions are motivated by their missions and do not subscribe to national policy objectives. Must be easy to discover which spatial information is available, fits the need for a particular use and under what conditions it be acquired and used.

2- *Data access and update are not easy.* It is extremely difficult in Egypt to access any government data. Existing datasets have been collected to different specification and standards, table (4.10) making it difficult to integrate the data collected from different sources. Most of data-generating agencies do not have the mandate for data dissemination. This results in ad-hoc arrangements (table 4.10) that benefit neither the government sector as a whole nor the private sector, which functions in uncertainty environment. Very few data generation agencies have websites and even fewer of them put any worthwhile information on their sites, table (4.5). This reflects the poor appreciation of these organizations about the importance of information dissemination.

3- *Availability and accessibility of spatial data*. Coming to the status of spatial data, the situation is worse. The maps are not easily accessible, table (4.10). There does not any system for data accessibility. Digital data are not available with most of the data-producing agencies and even analogue data are not accessible. In US, government information is available at or less the cost of dissemination free of cost. In UK, government information is available at a price. Situation in other countries lies in between UK and US.

Table 4.10 Issues need to be resolved

Issue	Possible problem foreseen by the government	The ad-hoc solution foreseen by the users	Possible solution approach	Implications of government not accepting the solutions
No clear- cut policy	Assumes that no maps available	Users are getting the required maps secretly, which may be not accurate	A clear-cut policy can make life easier for map users	People lose faith in the system
No right to information	No political motivation to implement	Borrow or steal principle for data access being used	Implement regulations and rules to protect data	Government loses the revenue it would have generated by selling data
Standards in conflict with each other	No realization to disseminate the data to others	Standards fitted only their own need	Create national standards	Data held separately in variety of format and standard
Digitization of topographic maps not allowed	Loss of control of data	People forced to digitize topographic maps illegally. They do not knowledge the source name.	Digitization may be allowed at least for non restricted areas. A fee may be charged for commercial applications	Data producer loses its moral right to be known as producer of the data
Sharing and access the data very difficult	No datasets available	Digitize the data they need	Create metadata standards and data catalogue	Data duplication

Opportunities

Analysis of the SWOT results suggested the following possibilities for the future SDI development:

1- *Improved collaboration and coordination*. Land evaluation users require a wide range of spatial data includes soil maps, topographic maps, geology, morphology, land use/ land cover, and meteorological data which often come from different data providers and are not compatible. There can not be a single organization responsible for all the data needed for land evaluation, (table 4.5). That is why the need for coordination between land evaluation organizations is necessary to achieve the desired goal. The organizational arrangements should be set up as soon as possible to deal with the major issues in establishing the SDI framework, (figure 4.23). The spatial information board will be formed at the higher political level (Members from parliamentary standing committees, cabinet members) with the main duty of giving directions on the national interest pertaining to Geo-information, make amendments based on the proposals supplied by the Executive Committee. We should also formulate a strategy to develop the SDI at the top level and start to work on the standards of core data. The working group can draft paperwork for further discussion and consultation among data providers and users.

2- *Availability of metadata*. Existing data has to be organized to form datasets. It must be possible to combine spatial information from different sources and share it between many users and applications. In Egypt quite often, the users without much experience have to specify and find what they exactly need, and they have to fight their way through a maze of officers, rule and regulations which they barely understand to eventually get what they want. Quite likely, they will give up their project somewhere halfway, or find it cheaper to digitize the data they need. The contrary would be situation where the available datasets are well documented, (table 4.6). The dataset should be documented in publish data catalogues, and inexperienced users can get assistance.

Threats

1- *Reduced international competitiveness*. Although the Egyptian users are denied access to any maps, many of the maps are available freely outside Egypt. If Egypt does not make available core data sets, it will lose its competitiveness. Like air, water, and electricity information is also a vital factor for attracting investments. Thus it is very difficult for Egypt to hide geographic information. We should adopt a pro-active approach regarding spatial data availability instead of being in a reactionary mode. Now the US companies have captured 80% of the European GIS market. The European companies have just 20% market share in European market and 5% in the global GIS market, (http://www.ec-gis.org/strategic-view/). By this, can we say that nearly 100% Egyptian GIS product market is dominated by foreigners? We do not seem to be having a strategy to change this situation. So, we should try to find a number of reasons to share data instead of finding a number of reasons to hide data.

2- *Continuation of adapting costly ad-hoc solutions*. The benefits from spending on geographic data acquization are low comparable to any other developed nation. GIS activity in Egypt is at its infancy; almost no private institutions are involved. Most of GIS activities in Egypt are an ad-hoc undertaking and stand alone operational system, see part (4.3). This is related to few institutions that have included in acquired GIS. So it is not easy to convince them to accept possible change. The potential complication in the effort to change the system would certainly be low. This will continue unless we develop synergy between various stakeholders.

3- *No presence in international bodies*. This point can be illustrated by the following example. ISO/TC 211 is international body working in the field of standardization of digital spatial information. The presence of Egypt in this organization is nil. Egypt is not a participating member of the organization whereas countries not only like Australia, US, Canda, UK are the participating members, but also are countries like Iran, Jamaica, Malaysia, Saudi Arabia, South Africa, Tanzania and Thailand, (http://www.isotc211.org/welcome.html). Do we need to be satisfied with the status of observer or we need to play more active role in these organizations. So, Egypt can not afford to be an isolated entity. If we want to participate in global projects, it is essential to speak a global language.

The implementation of SDILEA in Egypt would take long time before giving the desired goal. In fact, if we wait until find financial support or focused on policy initially, we might never have advanced the national initiative. What we can do at the moment: Start with awareness creation, priorities your data documentation (start with documenting those data sets that have current use). Every organization can prepare a list on the available spatial data sets and send the document to the selected representing organization (this will enhance the access to the available data sets), and improved cooperation and coordination to take advantage from proven practices and exchange of experiences. Getting a clearinghouse up and running was a means to demonstrate the benefits of SDI, and thus ‘breed' political support. The difference between Egypt and the other countries goes to show that each country has unique conditions that are influencing the SDI implementation strategy.

Now, there are at least a good case has been to work for, lay a convenient ground to start improvement, or can see a chance to tweak the situation to make it convenient. The final selection of the best strategy has to be determined on the basis of the government and other stakeholders. This cannot be done at the moment. So, we can conclude that the objective is partially attained.

4.9 Proper Assessment of the Proposed SDILEA

The development of spatial data infrastructures (SDI) to support land evaluation in Egypt is a multi-dimensional, complex task. Many projects are initiated in an environment of political, economic and social uncertainty. In general, the current ad-hoc nature of data collection in the country is almost standing as fool proof for the occurrence of high costly surprises. With such an ad-hoc information collection, it is difficult to talk about well-informed decision making. Here, it is essential to make a proper assessment (relevant, efficiency, effective and applicable) to judge whether SDILEA is useful or not.

From relevancy perspective, all SDI components have their potential to be helpful in the land evaluation process. To promote access to land evaluation data, it may be more desirable to share data than to develop or install duplicate data. To share land evaluation data, one follows appropriate standards for the data production. A common data standard for metadata, data transfer and data storage format accepted by all potential users will reduce duplicity of data and data redundancies. So, the role of standards is important. Internet is the fastest and most efficient way to distribute, find, and get the land evaluation data. Here, the technology role comes. So, establishment of appropriate access tools (clearinghouse or geo-portal catalogue) for transfer and sharing information/data needed for land evaluation is urgent.

It is becoming clear that the SDI is relevant to land evaluation because all its components have the capability to support the land evaluation process. That is why SDI development is necessary for land evaluation process.

According to effectiveness point of view, SDI is expected to have a significant impact on decision making process. Decision-makers will gain more confidence in the data and response to emerging issues faster as the data/information becomes more readily accessible and reliable. The development of such spatial data infrastructures and the resulting GIS, which can build upon them to support land evaluation process, are considered an essential requirement to improve land evaluation decision-making, (positive impact). But only if the potential users know that the data exist and have ready access to it.

The direct beneficiaries of SDI to support land evaluation are the Government organizations, public and private agencies and academic institutions. Institutions will be strengthened and their capacity to manage land evaluation information enhanced. The land evaluation organizations could use SDI for evaluation of their plans, programmes and policies, preparation of development activities, etc. The academic institutions can make use of SDI as teaching aids as well as for research works in this sector.

Based on efficiency, SDI should be beneficial to land evaluation process because it saves time, effort and money in collecting and accessing spatial land evaluation data. Land evaluation process needs SDI because the benefits to the economy, society and the environment outweigh the costs. In Australia (period 1989–94) approximately $1 billion has been spent on investment in geographic data. This investment produced benefits within the economy in the order of $4.5 billion. This investment also has saved users approximately $5 billion, (Gupta, 2000). This implies that there is a saving of $5 on the investment of $1. Thus it is clear that governments all over the world realize that geographic information is an important infrastructure for a nation's development.

One of the objectives of the SDI is to share data and thus avoid duplication of efforts. Sharing of the land evaluation data is made possible through coordinated and structured access to a wide variety of information (metadata) about spatial data. Access to land evaluation data is made possible through the implementation of metadata catalogue and establishment of geo-portal within a legal framework.

However, the investment lack at this moment to implement proposed system (SDILEA). This is because the final decision should be based on the government funding, (lack of financial resources). As Reece, (2004) show that at least 723,657 US$ needed as a startup costs for implementation clearinghouse in Jamica. In Africa, the Africa environment information network implementation will cost a total 1,104,167 US$ for the first 2 years, (Africa Environment Outlook, 2003). In the case of the USA in 1993, the federal government spends more than $ 4 billion annually in the collection and maintenance of the geospatial data, (Tosta, 1997b). In this respect, we can make use of the Qatar experiences. It implemented a top-dawn strategy. It is a small country only 4247 square miles they start with $5 million to build there system and the system has annually a budget of $1million for maintenance not including the salaries, the result that they have one of the best system in the world, The GIS City, (Tosta, 1997) For Egypt this amount can be astronomic and prohibitive and it is not reasonable to expect that the government undertake SDI implementation for only land evaluation organizations (too small sector). So, funding resources can present a most constraint to SDILEA development when awareness of the importance of SDI is lacking via the country. It is becoming clear that the SDI is not applicable to land evaluation at the time being because the financial support.

Having this long term "think big" strategic goal in mind, would ensure that each step would contribute to its achievement even if only in small ways "start small", (Groot, 1988). Without these issues in place, the SDI initiative is doomed to fail in Egypt. In order to make SDI applicable in such an environment, the SDILEA should be practical to be successful. The system has to be made simple and manageable in one way or another. It is better to attempt to achieve modest success in a relatively short time than to attempt to install super system quickly, (Burrough, 1991). Low cost technology, enabling computing with geographic data, open source- geographic information system (GIS) software for general use, and develop "easy to see and understand" decision support aids for politicians.
The following assumptions can be made as to the system would be is concerned:

- Enhance data sharing.
- Establishment and running cost must be affordable.

To achieve the proposed SDILEA, availability of funds is important. A proportion of the initial costs have to come from the government; it is therefore high recommended to ensure participation and support of the government. Present economical situation of the organization shows that they do not have enough funds to deliver better service for the land evaluation users. Therefore, it is necessary to find other alternative for this problem. The major possible alternative as funds can be identified from the international donor organizations. As example JICA grant aid program for financial assistance to developing countries. One of the major targets of Japan's grant aid is agricultural development, (JICA, 2005). But a way to persuade government or other 'funders' to invest money, we would have something to show (for example, clearinghouse or geo-portals) rather than a concept document alone. This does not have to involve huge costs since some clearinghouse components are available free over the Internet.

5- Conclusion and Recommendations

Keep yourself visible and start it even with less involvement then others will join.

5.1 Conclusion

- Using the proposed framework methodology, the current situation in Egypt was studied. This study helped to stress the need to develop an SDI and can be used as a way to convince decision-makers and politicians to use SDI to support land evaluation. This thesis analyzed the institutional, economical and technical aspect of the land evaluation organizations to identify the problems that Egypt is facing with respect to land evaluation. In order to gather the needed information, a questionnaire survey was sent to the key persons in land evaluation, who were interviewed as well.

- Using GIS in land evaluation applications in Egypt is still immature with broad set of issues yet to be resolved.
- Many problems have been identified and the different organizations involved to solve these problems will face a heavy task. Egypt can only improve the land evaluation process if these drawbacks are overcome.
- The current status of land evaluation in Egypt is rather bad because it considered to be a long time consuming process and do not permit the real time decision-making.
- At this moment the demands for a SDI are very high and it will be difficult to keep up with the development of modern technology.
- Land evaluation process has a greater demand for multi source information. The basic requirement for land evaluation stakeholders from SDI is the availability and accessibility of spatial data and its metadata.

- The whole essence of the proposed SDILEA is to forward possible way to mitigate the current land evaluation drawbacks in Egypt and fulfill the stakeholders' requirements.
- SDILEA is appropriate access facility for discovering and sharing information/data required for land evaluation.
- Through SDILEA must be easy to discover which spatial data is available, fits the need for a particular use and under what conditions it be acquired and used.

- The land evaluation process would benefit substantially from the SDILEA, as it is relevant to land evaluation, because all its components have the capability to support land evaluation process.
- SDILEA is the most appropriate and effective SDI to fulfill the demands of the land evaluation stakeholders based on the given and existing trends in Egypt. SDILEA improves the decision-making process, data availability and accessibility to support land evaluation in Egypt.
- It is also efficient because it reduces effort in data duplication, time and cost of data collection and management.
- The assessment made for the current condition promise for improved collaboration and coordination between organizations and availability of metadata for the datasets.

5.2 Recommendations for Further Research (Where Next?)

This section as the tail end of the research looks at the possible suggestion that can be made. The main weakness of this research was the researcher limited himself to the land evaluation field. The working in SDI as a holistic concept required important field serve the whole country or at least the majority. I have 4 weeks ago the opportunity to attend GSDI-8 conference in Cairo. I felt that future research can take into consideration national spatial data infrastructure.

Many countries are now working on their national spatial data infrastructure issues. It is timely that Egyptian SDI initiatives should be supported by a compressive research on the status of spatial data in many organizations in the country. In Egypt different governmental organizations have been established by proclamation to help availability of spatial information in the country. For example, to make available or satisfy need of topographical maps, aerial photographs, etc (Foundation data), the Egyptian Mapping Authority has been established. Nevertheless, the organizations are not in a position to do so. And they have capacity problems in meeting their responsibility and making available and accessible spatial information, and more importantly up-to-date spatial information, for decision-making process.

First and foremost thing required to make SDI successful in Egypt is to make the data available and easily accessible. Up to now, no one knows the role of spatial data in the development of Egyptian landscape. Poor decisions are frequently made because we do not know who holds the information we require and how to get hold of it. Hence, it is essential to get data on the current situation to analyze the problems, and to develop guidelines that will help mitigate the problems. To this effect

1- A detailed questionnaire for the assessment of the status of spatial data in Egypt
2- Assess how spatial data is hold, processed, used and communicated.
3- Determine the benefits and bottlenecks that face spatial data in Egypt.
4- What opportunities and challenges are there?
5- Carry out user requirements survey and analysis (Data Needs Assessment)
6- Identify the specific bottlenecks that hindered open partnership in Egypt.
7- Conduct a survey on what data and metadata are available.
8- Detailed research to determine the specific bottle necks behind low of capacity building.
9- Additional study on SDI policy is required
10- Describe the technological, institutional and economical situation and their potential impacts on SDI.
11- Estimates cost involved for data production in the country.
12- Conclude the main keys for successful development of SDI in Egypt.

Information from the assessment will assist in establishing the current status of spatial data and the needs that have to be addressed in order to make spatial data more functional and efficient in Egypt. Information from the assessment will also be used to update existing Egyptian profile or where profile has not been prepared previously, prepare new ones.

Final Avowal

The old adage in Egypt that says "we need Noah age, Ayoub patience and Qaroun money for …" is equally applicable to SDIs in Egypt. The establishment of the SDI is a long and on-going process. A SDI for any application domain cannot be established over a short time as shown by experiences in developed countries. The success of the SDI relies on continuous efforts of all participants and increasing accumulation step by step (need Noah age). Moreover, the bureaucratic procedures for approval and procurement of technology are often very cumbersome. It requires a great deal of patience (need Ayoub patience) and energy to find a way through the political system to obtain support and funding, prepare and evaluate tenders, award contracts and take delivery of the system. In most cases, by the time the contract is awarded, both the technology intended for use is out dated or the persons promoting such projects are transferred (and often both!). As a consequence, the project is often delayed. Furthermore, to establish the SDI, requires huge amounts of money. Setting up a complete SDI from scratch costs a lot of money (need Qaroun money).

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Appendices

Appendix 2a- Classification of Biophysical Models

Hoosbeek and Bryant, (1992) proposed a classification of models of pedogenesis (soil formation), which was adapted by Bouma for land evaluation models, figure (2a).

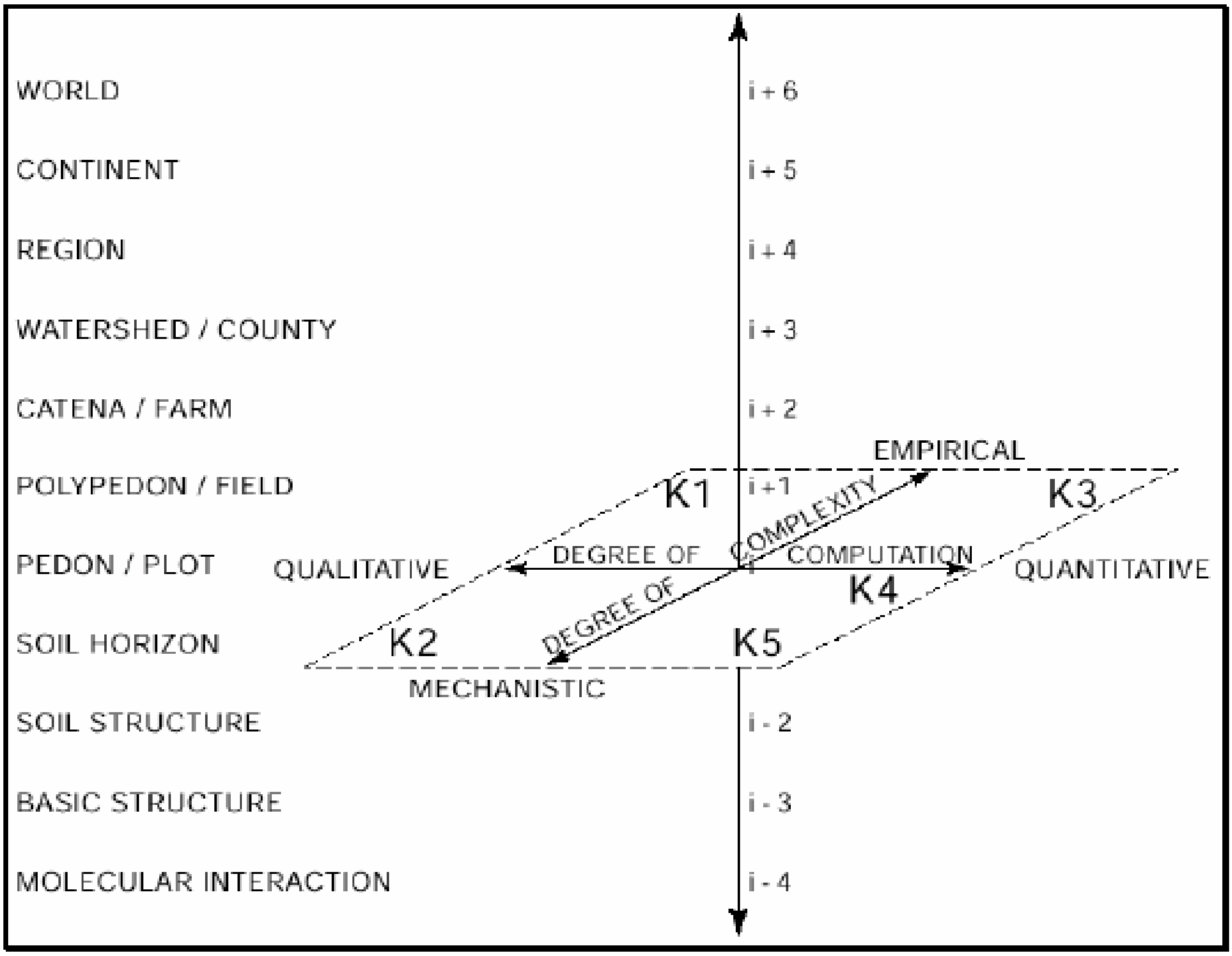

Figure 2a Conceptual framework to classify Land evaluation models, (after Bouma, 1999)

We now consider these modeling approaches, from least to most sophisticate. The first is expert knowledge models. Expert knowledge models (K2) are qualitative, but consider mechanisms. In particular, the FAO approach with its analysis of land suitability as a set of Land Qualities has the reductionism structure required for these models, which are built by specialists who are trained to search for causes. Expert knowledge was captured as a set of matching tables, one for each Land Quality, using the maximum limitation method, requiring a set of diagnostic Land Characteristics as input for each table. This was put in computable form and at the same time made more flexible by the ALES ('Automated Land Evaluation System'). ALES provide a framework with which land evaluators can build their own expert systems to evaluate land according to FAO Framework. Models are built to satisfy local needs, so that ALES does not provide a fixed list of LUT, LUR, or LC. Rather, these lists are defined by the expert to suit local conditions and objectives. ALES does not include any knowledge about land and land use; these come from the expert. A good example of an ALES model is the LEV-CET model for central Ethiopia developed by Yizengaw and Verheye, (1995).

The second is empirical-statistical models. Generalized holistic models (K3) are empirical but quantitative. These are statistical relations between output (e.g. yield) and input (e.g. precipitation, heat units, soil fertility), usually established by regression analysis on large datasets. They cannot be applied outside their area of calibration. All variables are static, and there is no attempt to simulate system behavior over time. They can only be applied to LUTs that are widely practiced, so are not useful for new crops, new technologies, or new management strategies. An attractive option in the case of well-established LUTs is to model their output as a static function of a set of Land Characteristics that are expected to influence the output (K3 models).

A typical example of this approach is the work of Olson and colleagues in New York State, and later in Illinois (USA). He begins with a conceptual model of maize yield as a function of rainfall, temperature, management, site, topography, soil chemical and physical characteristics, mineralogy, and organisms. The management level (in this case, the level of fertilization, liming, pesticide use and tillage) is fixed, while the other factors are quantified by measured values of land characteristics. For example: the 'rainfall' conceptual factor was approximated by the measured variable 'total yearly rainfall', 'temperature' by 'growing degree days, and 'topography' by 'drainage class (depth to redoximorphic mottles)'. Multiple stepwise linear regressions were used to develop increasingly complicated equations, the best of which (including rainfall, soil depth, soil available water capacity, temperature, sum of basic cations, and organic C content) explained two-thirds of the observed variance (calibration r 2 = 0.66); this is a good result for such models. This approach has been computerized, for example as the 'Albero' component of the Micro LEIS system, which predicts yields of maize, cotton and wheat from a set of soil characteristics within a fairly homogeneous climate zone (Sevilla province, Spain) using equations developed by multiple regression. As with any empirical model, these can only be applied in their original zone of calibration; extrapolation to new conditions is not justified.

The third model is dynamic simulation of crop yield. Complex holistic (K4) and complex models of system components models (K5) attempt to be mechanistic rather than empirical. This means that they are based more on scientific principles (laws such as conservation of mass and energy, diffusion, convection and dispersion, chemical kinetics and equilibrium) and less on site-specific empirical relations. These models, when applied to land evaluation, are usually driven by daily weather data. This allows the analysis of dynamic and transient phenomena that may affect land performance, so that these are commonly referred to as dynamic simulation models. Many individual modelers and collaborative groups have attempted to develop models that simulate the growth of crops, along with associated phenomena that influence crop growth such as water and solute movement in soils. WOFOST and its derivative PS123, DSSAT, APSIM, EPIC, and GAPS are examples of K4 models.

The final model is dynamic simulation of individual land qualities. If we only need to model single Land Qualities, specialized models are available that take a more detailed mechanistic approach (K5) than is possible in a holistic model. A typical application is solute transport in soils, including pesticides and pollutants such as nitrates. The LEACHM model is a good example. It uses basic physio-chemical conceptual models, such as the convection-dispersion equation for chemicals and Richard's equation for soil water redistribution.

Another important Land Quality that is addressed by many models is erosion hazard. Most prominent among these are EUROSEM, RUSLE, EPIC, AGNPS, WEPP (water) and WERS (wind). Some of these, e.g. EPIC, include a simple crop model, mainly to provide estimates of vegetative cover during the growing season and crop residues after.

We now consider these modeling approaches, from least to most sophisticate. For example, the farmer and environmentalist would require the i+1 field scale and a K4 knowledge level to get the necessary quantitative answers for their questions. The regional planner would operate at level i+4 and would need K3 knowledge level, because the K2 level would be too descriptive not allowing a quantitative analysis. He would be smart, though, to combine K2 with K3, by restricting the more detailed analyses of K3 to areas where a simpler K2 analysis could not provide answers, figure (2a).

Appendix 2b- Selection of Framework Data for NSDI

The table below shows the result of a survey in multiple countries to determine what data should be considered as framework data in the context of a national spatial data infrastructure, (Onsrud, 2002). Different countries selected from a list of Geographic data types the most relevant ones (in terms of data sharing) according to their individual needs. These are shown as empty circles in table (2b). From this list 8 types were selected as being framework data, which are shown as filled circles in table (2b).

Table 2b shows the selection of framework data for NSDI (adopted from Onsrud, 2002)

Country	Geographic Data Types																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Australia	◆	◆	◆	◆	◆	◆	◆		◇		◇	◆									
Canada	◆	◆	◆	◆	◆	◆	◆	◇		◇	◇	◆									
Colombia	◆	◆		◆	◆	◆	◆					◆	◇								
Cyprus	◆	◆		◆	◆	◆	◆			◇											
Finland	◆	◆			◆									◇	◇						
France		◆			◆											◇					
Germany	◆	◆	◆		◆																
Greece	◆	◆	◆		◆			◇			◇	◆					◇				
Hungary	◆	◆	◆		◆							◆	◇		◇			◇			
India	◆																			◇	
Indonesia	◆	◆		◆	◆				◇			◆									
Japan	◆	◆	◆	◆	◆	◆	◆		◇												
Kiribati		◆			◆																
Malaysia	◆	◆			◆																
Mexico	◆	◆	◆	◆		◆	◆		◇			◆	◇					◇			
The Netherlands		◆			◆		◆	◇		◇		◆	◇						◇		
New Zealand	◆	◆			◆		◆				◇			◇							
Northern Ireland	◆	◆		◆	◆	◆	◆			◇		◆						◇			
Russian Federation	◆	◆		◆	◆	◆	◆		◇												
South Africa		◆	◆	◆	◆	◆	◆			◇											
Sweden	◆	◆	◆		◆	◆				◇				◇		◇				◇	◇
United Kingdom	◆	◆	◆	◆	◆	◆	◆	◇		◇	◇					◇					
United States	◆	◆	◆	◆	◆	◆	◆		◇												
Total (23)	19	22	12	16	21	12	13	4	6	7	5	11	4	3	2	4	1	3	1	2	1

◆	Selected for framework data of NSDI
◇	Not selected

Geographic Data Types

1- Geodetic | **2- Land surface elevation/topographic**
1- Digital imagery | **4- Government boundaries/administrative boundaries**
4- Cadastral/land ownership | **6- Transportation/roods**
7- Hydrography/rivers and lackes planimetric | 8- Ocean coastlines
9- Bathymetry | 10- Physical features/build
11- Place names | **12- Land use/land cover/vegetation**
13- Geology | 14- Real state price register/land valuation
15- Land title register | 16- Postal address
17- Wetlands | 18- Soils
19- Register of private companies | 20- Gravity network
21- Zoning and registration

Appendix 3a- List of Interviewers and Organizations

Table 3a List of Interviewers and Organizations

Organization		Department	Interviewee	Phone	Date*	Function	Specialized	Rank** 1-5
Government	**Ministry of Agriculture and Land Reclamation (MALR)**	Agriculture Research center (ARC) - Soil, water and environment research Institute (SWERI)	Prof. Hussein Kamal Zaki	0101843277	19/9 1/10	Decision-making	LE GIS	5
		Desert Research Center (DRC) -Soils and Water Department	Prof. Mostafa El Shazly Prof. Ahmed Heraga	0102590111 0103304322	14/9 26/9	Decision-making	LE GIS	5
		Desert Research Center (DRC) - Remote sensing Department	Prof. Ibraheem Nasr Prof. Samy Solieman	0106046166	14/9 28/9	Decision-making	GIS	5
	National Research Center (NRC)	Soils and Water USE Department Dokki, Giza	Prof. Mohammed Abdel Reheem Prof. M. Wahab	4900772 4900925	27/9 1/10	Decision-making	LE	4
	Ministry of Irrigation and Water Resources	ND	ND	ND	ND	ND	ND	ND
	Ministry of Communications & Information Technology (MCIT)	GIS unit	ND	760667071	12/10 19/10	Coordinator	GIS	5
	Ministry of Higher Education and Scientific Research (MHESR)	National authority for remote sensing and space science (NARSS) - Agriculture applications, Soils and marine division	Prof. Abdallah Gaad Prof. Hamdy Gamily	0123568182	22/9 4/10	Data provider's	LE GIS	5
	Ministry of Defense and Military Production - The Military Survey Authority	ND	ND	ND	ND	ND	ND	ND
	Ministry of Public Work and Water Resources - Egyptian survey authority (ESA)	GIS unit	ND	ND	17/9 13/10	Data provider's	GIS	5
	Ministry of Foreign Trade and Industry- The Egyptian Geological survey and mining authority (EGSMA)	GIS unit	Dr. Zeinhom El Alfy	0124605854	13/10 18/10	Data provider's	GIS	4
	Ministry of Transport - Egyptian Meteorological Authority (EMA)	ND	ND	ND	ND	ND	ND	ND
Private Sector		Geomap Consultant	Dr. Mohsen Badawy	ND	3/10 16/10	Data provider's	GIS	5
		Global Geobits	ND	ND	ND	ND	GIS	
		United Information Technology (UIT)	ND	ND	25/9 16/10	Data provider's	GIS	2
		Quality Standard for Information Technology	Eng. Ahmed Abdelaal	0101001104	30/9 15/10	Data provider's	GIS	5
		Regional Observation Center(ROC)	ND	ND	ND	ND	GIS	ND
		Environmental & Remote Sensing Services Center (ERSS)	ND	0122319778	29/9 2/10	Data provider's	GIS	2
		(SALEC)52,Gameat el dewal el arabeya St. Giza 12311, EGYPT	ND	202749-3518	11/10 19/10	Data provider's	GIS	1
		Alkan Advanced Technology (AAT)	ND	ND	24/9 3/10	Data provider's	GIS	1
Universities		Suez Canal University -Faculty of Agriculture -Soils and Water Department	Prof. Mohammed Reda	026338095	20/9 4/10	Users	LE	5
		Cairo University-Fayoum Faculty of Agriculture - Soils and Water Department	Prof. Mahmoud Shendi	028350837	22/9 10/10	Users	LE	5
		Alexandria University -Soils and Water Department	Prof. Abd Rab El-Nabi Prof. Bahnassy Prof. Hassan Ismail	033587232 035447288 0101636243	15/9 9/10	Users	LE	5
		Ain Shams University –Faculty of arts, Geography Department	Prof. Mahamoud Ashour	0102591982	21/9 5/10	Users	GIS	3
		Suez Canal University-Faculty of Science Geology Department	Prof. Mohammed El Gwabe Dr. Mohammed Arnoos	3351100	20/9 6/10	Users	GIS	4
		Al -Azhar University -Soils and Water Department	Prof. Abdel Mottelb Prof. Hammad	024550427 022743157	25/9 29/9	Users	LE	4
		Zaqaziq University	ND	ND	ND	Users	LE	ND
		Assuit University	ND	ND	ND	Users	LE	ND
		Helwan University	ND	ND	ND	Users	LE	ND
		Mansoura University	ND	ND	ND	Users	LE	ND
		Menoufeya University	ND	ND	ND	Users	LE	ND
		Tanta University	ND	ND	ND	Users	LE	ND

* Date of handled the questionnaire to the respondents and the interview meetings

** 1= not imp ortant, 2 = less important, 3 = important, 4 = very important, 5 = highly important.

ND = No Data. Return rate = 29/40= 72.5 %

Appendix 3b-Questionnaire Questions

Questionnaire for Spatial Data Infrastructure (SDI) to Support Land Evaluation Applications in Egypt
I Land Evaluation Organizations

To:
From: El-Sayed Ewis Omran, Center for Geo-Information, Wageningen University
Mail address: El-Sayed Omran, Wageningen University, Center for Geo-Information
P.O. Box 47, 6700 AA, Wageningen, The Netherlands
E-mail: **El-Sayed-Ewis.Omran@wur.nl**
Phone: (+31) 317 474650
Fax: (+31) 317 419000

Dear Sir/ Madam

This survey is designed to establish of a coordinated Spatial Data Infrastructure (SDI) for finding and sharing geographic data and to make accurate and timely geographic data readily available to support sound land evaluation applications over a geographic area, and to do so with minimum duplication of effort and at a reasonable cost as a part of my MSc thesis undertaken at Wageningen University, The Netherlands.

A Spatial Data Infrastructure or framework is an essential pre-requisite to make use of spatial information in an effective and efficient way. The reasons behind such initiatives are straightforward:

1- to unlock the potential hidden in data and stimulate economic activity;
2- to reduce duplication of effort among agencies;
3- make geographic data more accessible to the public by encouraging the use of standards;
4- improve quality and reduce costs related to GI;
5- to facilitate value-added services by enabling combination of data from multiple sources; and
6- to increase the benefits of using the wealth of disintegrated data, and establish key partnership with cities, academia and the private sector to increase data availability.

So, GI stakeholders are encouraged to be more active participants in successfully implementing the technical components of this infrastructure. This questionnaire is designed to gather relevant information regarding the geo-information provision within GI related organizations by examining the institutional and technical issues relating to SDI framework. The results of this questionnaire will not only contribute to this research but will provide useful information to implementing the SDI for Egypt.

It is important that as many as possible complete this survey to provide a full and proper assessment of the current SDI and land evaluation situation in Egypt.

I would like to thank you in advance for your valuable contribution to the SDI Process in Egypt

1. Which of the following best describes your Organization?

- ❑ Government
- ❑ Local authority
- ❑ University
- ❑ Private
- ❑ Non Governmental Organizations (NGOs) and not-for profit organizations
- ❑ Other (Please specify)……………………………………………………………… ……………………………

2. Are GIS being used in your organization?

- ❑ Yes
- ❑ No

If yes, how long it has been using the system (GIS)?

- ❑ Less than 5 years
- ❑ 5-10 years
- ❑ More than 10 years

If no, do you have a plan to establish a GIS?

- ❑ Yes
- ❑ No

3. What GIS components do you currently use for land evaluation applications?
GIS Software

- ❑ PC Arc Info
- ❑ Arc View (ESRI)
- ❑ Arc GIS (ESRI)
- ❑ Arc CAD (ESRI)
- ❑ MapInfo – MapInfo professional
- ❑ Intergraph - MGE
- ❑ Clark university- IDRISI
- ❑ GRASS
- ❑ Geomedia
- ❑ Small World system - Small World GIS
- ❑ Other (Please specify)………………………………………………………………………………………

Imaging Software

- ❑ ERDAS- Imagine
- ❑ IDL-Envi
- ❑ ILWIS
- ❑ Other (Please specify)………………………………………………………………………………………

Database

- ❑ Access
- ❑ ORACLE
- ❑ Arc SDE

4. Which GIS data types have you used for your land evaluation applications?

- ❑ Raster images
- ❑ Vector data with tables
- ❑ Scanned maps
- ❑ Other (Please specify)………………………………………………………………………………………

5. What formats do you collect and maintain your datasets?

- ❑ Analogue
- ❑ Digital
- ❑ Analog and digital

6. Which of the following land evaluation models do you use for your applications?

- ❑ Automated land evaluation system (ALES)
- ❑ Automated physical land evaluation (APLE)
- ❑ LIMEX
- ❑ VEGES
- ❑ ISLE
- ❑ Micro LEIS system
- ❑ WOFOST, PS123, DSSAT, APSIM, EPIC, and GAPS.
- ❑ LEACHM
- ❑ EUROSEM, RUSLE, EPIC, AGNPS, WEPP (water) and WERS (wind).
- ❑ Farming Systems Analysis (FSA)
- ❑ Land Evaluation and FSA (LEFSA)
- ❑ Agro-ecosystem analysis and development (AAD)
- ❑ Environmental Impact Assessment (EIA)
- ❑ Rapid Rural Appraisal (RRA)
- ❑ Framework for Evaluating Sustainable Land Management (FESLM)
- ❑ Agro-Ecological Characterization (AEC)
- ❑ Land Use Systems Analysis (LUSA)
- ❑ Other (Please specify)……………………………………………………………………………………

7. Which types of spatial data sets are requested to use in your land evaluation applications?

- ❑ Administrative boundaries
- ❑ Land use
- ❑ Soil
- ❑ Topographic features
- ❑ Cadastral data
- ❑ Morphological data
- ❑ Geological data
- ❑ Meteorological data
- ❑ Land cover
- ❑ Demographic data
- ❑ Geographical names
- ❑ Hydrography, e.g. rivers lakes
- ❑ Geodetic reference data
- ❑ Ortho-images
- ❑ River catchments
- ❑ Satellite multipurpose data
- ❑ Elevation
- ❑ Economic data
- ❑ Other (Please specify)……………………………………………………………………………………

8. What techniques are adopted within your organization to collect digital spatial data to support your land evaluation applications?

In the field

- ❑ GPS techniques
- ❑ Total Station
- ❑ Other (Please specify)……………………………………………………………………………………

In the office

- ❑ Digitizing
- ❑ Photogrammetry
- ❑ RS
- ❑ Scanning
- ❑ Other (Please specify)……………………………………………………………………………………

9. Indicate the level of difficulty for obtaining geo-data, in terms of search, retrieval and acquisition for land evaluation applications.

- ❑ Easy
- ❑ Moderate
- ❑ Difficult

- ❑ Very difficult

10. Are there SDI projects at the ministry of Agriculture and Land Reclamation (MOALR)?

- ❑ Yes
- ❑ No

If yes, what are the existing components?

- ❑ Datasets
- ❑ Policy
- ❑ Access network
- ❑ Technical standards
- ❑ Other (Please specify)………………………………………………………………………………

11. Which benefits have you gained (maximum 3) from GIS with respect to your land evaluation applications?

- ❑ Improved access of information
- ❑ Better quality of information
- ❑ Better informed decision making
- ❑ Improved timeliness for decision making
- ❑ Automate existing methods of analysis
- ❑ Facilitate new forms of analysis
- ❑ Improved communication of information via maps
- ❑ More consistent information across the organization
- ❑ Other (Please specify)………………………………………………………………………………

12. Could you select (maximum) 3 from the following statements, which have been made about GIS?

- ❑ A lack of awareness of the potential of GIS, and the concepts behind it, limit its application
- ❑ GIS started in our organization because of the enthusiasm of one individual about technology
- ❑ GIS is only useful in providing pretty maps for board meetings
- ❑ GIS has radically changed the way we look at our business.
- ❑ Training is essential to the success of GIS
- ❑ There are many organizational barriers which can seriously impede use and development of GIS
- ❑ It is widely acknowledged that GIS projects glide effortlessly to success.
- ❑ GIS was implemented after a strategic decision to adopt the technology

13. What is the percentage of users using geographic information to perform land evaluation applications?

- ❑ Don't use GIS
- ❑ Use GIS

14. What would be the main bottlenecks to set up a SDI in Egypt to support land evaluation applications?

- ❑ Financial
- ❑ Technological
- ❑ Institutional
- ❑ Other (Please specify)………………………………………………………………………………

15. Could you select (maximum) 5 the main drawback to set up a SDI to support land evaluation?

- ❑ Lack of national metadata
- ❑ The requirement for high-quality, high frequency data
- ❑ Many repetitive calculations or lookup tables
- ❑ Lack of national standards
- ❑ The inadequate consideration of climate
- ❑ Lack of resilience and reliability
- ❑ Most of the data are kept in many different locations in different systems
- ❑ Most of the data are used for purposes of their own sectors
- ❑ Inadequate tools for data collection
- ❑ Poor of coordination
- ❑ Problems with data pricing
- ❑ Lack of clear policy framework
- ❑ Absence of sharing mechanism
- ❑ Other (Please specify)………………………………………………………………………………

16. Is the government aware of the importance of the spatial data infrastructure (SDI) in Egypt?

- ❑ Yes
- ❑ No

17. Which are the most important drawbacks (maximum 5) that land evaluation is facing in Egypt?

- ❑ Lack of targeted polices, laws and guidelines for land registration, planning and land management is diverse and often uncoordinated.
- ❑ Lack of national metadata.
- ❑ The requirement for high-quality, high frequency data.
- ❑ Many repetitive calculations or lookup tables, and so are tedious if many alternatives are to be compared
- ❑ The inadequate consideration of climate
- ❑ Most of the data are kept in many different locations in different systems.
- ❑ Most of the data are used for purposes of their own sectors.
- ❑ Inadequate tools for data collection.
- ❑ Problems with data pricing
- ❑ Lack of standardization
- ❑ Lack of resilience and reliability
- ❑ Poor of coordination
- ❑ Absence of sharing mechanism
- ❑ Other (Please specify)…………………………………………………………………………………

18. What could be the causes for these problems?

……
……
……

19. Could you select (maximum) 5 STRENGTHS that you consider as the most important of the current situation of your organization?

- ❑ Highly qualified, competent and experienced personnel
- ❑ Large experience in land evaluation applications and wide base of consultants from universities and international agencies.
- ❑ Mandate bylaw for approving any plan before implementation.
- ❑ Mandate bylaw to access different data sources.
- ❑ Financial support by the government
- ❑ Understand need for land evaluation applications: work to improve rural communities.
- ❑ Improved understanding of community needs.
- ❑ Organization's culture produces a positive work environment
- ❑ Other (Please specify)…………………………………………………………………………………

20. Could you select (maximum) 5 WEAKNESSES that you consider as the most important of the current situation of your organization?

- ❑ Limited financial resources: more than 75 percent of budget goes on salaries; very little left for operational costs.
- ❑ Inadequate qualified staff compared to the amount of work and unqualified staff in local authorities who manage the plans and collect data.
- ❑ Lack of monitoring/Updating system to detect changes.
- ❑ Lack of (digital) archiving system for old projects
- ❑ High staff turnover leaves some projects/programmed unfinished.
- ❑ Inadequate budgets (despite donor support).
- ❑ Lack information and technical
- ❑ Work is too localized.
- ❑ Programmed that are too short and too narrow (sector-focused) to have much impact.
- ❑ Time wasting.
- ❑ Duplication and repetition of failed projects.
- ❑ Weak national, regional and local support between line institutions
- ❑ Other (Please specify)…………………………………………………………………………………

21. Could you select (maximum) 5 OPPORTUNITIES that you consider as the most important of the current situation of your organization?

- ❑ Improved collaboration and efficiency through department mergers
- ❑ Availability of new technologies (GIS, and Internet technology).
- ❑ Growing number of national projects
- ❑ Establishing regional planning centers.
- ❑ Encourage president and the top politicians
- ❑ Empowered communities demand more services.
- ❑ Room to involve local communities in most intervention issues.
- ❑ High support to address national problems by the higher bodies of the government.
- ❑ Existence of various organizations that have engaged in geo-spatial data production and management.
- ❑ Spouting of GI related private consulting agencies.
- ❑ Other (Please specify)……………………………………………………………………………………

22. Could you select (maximum) 5 THREATS that you consider as the most important of the current situation of your organization?

- ❑ Donors are withdrawing or scaling down.
- ❑ Moving of the qualified staff to the private sector.
- ❑ Privatization of data provision agencies
- ❑ Shortage in time for projects done under politicians' directs.
- ❑ The required specifications for the organization services are changing
- ❑ Low-level infrastructure development and availability.
- ❑ Almost non-existence of GI related training institutes.
- ❑ Absence of guiding policy related to geo-information management.
- ❑ Diversified geography, difficult working situation, large area coverage.
- ❑ Lack and absence of digital environment in most organizations.
- ❑ Other (Please specify)……………………………………………………………………………………

23. Could you select (maximum) 5 STRENGTHS that you consider as the most important when a SDI would be implemented at a National level in Egypt?

- ❑ A clear strategic direction
- ❑ Public research system has a broad spectrum of researchers
- ❑ Small independent decision-making units facilitate quick decision-making and greater flexibility in project and programmed implementation
- ❑ Tend to be collaborative: desire to maximize profits.
- ❑ Availability of multidisciplinary staff
- ❑ Establishment of information units/project management sections/ planning and programming units/ GIS units in most organizations
- ❑ Existence of comprehensive medium range development plan Strong zeal to use information technology
- ❑ Other (Please specify)……………………………………………………………………………………

24. Could you select (maximum) 5 WEAKNESSES that you consider as the most important when a SDI would be implemented at a National level in Egypt?

- ❑ Unable to finance needed technology
- ❑ Funds abused or not passed to the rightful beneficiaries.
- ❑ Less focus for training in the GI related field
- ❑ Low capacity at the lower level planning structures
- ❑ Low focus of generic uses of data and information
- ❑ Absence of guiding policy regarding geo-information management
- ❑ Absence of any form of common standard related to geo-information management
- ❑ Lack of self-discipline: few can work without supervision.
- ❑ Outdated communication methods
- ❑ Poor debt or cash flow
- ❑ Self-centered institutional thinking as regards information capture, process and usage
- ❑ Data hiding and secrecy mentality
- ❑ Absence of long term strategic development plan
- ❑ Other (Please specify)……………………………………………………………………………………

25. Could you select (maximum) 5 OPPORTUNITIES that you consider as the most important when a SDI would be implemented at a National level in Egypt?

- ❑ Reduction of costs
- ❑ Less duplication of information
- ❑ Better availability of information
- ❑ Increased awareness of spatial information
- ❑ Improved economical market transparency
- ❑ Better supply of information for environmental policy
- ❑ Improved policy-making
- ❑ Better monitoring of international (environmental) policy
- ❑ Improved quality of information
- ❑ A complete change of the land evaluation process
- ❑ Different GIS used within the organization for land evaluation applications
- ❑ More users within the organization
- ❑ More use of GIS within land evaluation
- ❑ Better services and more tangible benefits for members would improve the membership base
- ❑ Great opportunities for collaboration with all stakeholders
- ❑ Increasing diffusion of GI technology at the national and regional levels.
- ❑ Increasing awareness regarding the benefit of IT for land evaluation applications among the higher political bodies.
- ❑ Other (Please specify)………………………………………………………………………………………

26. Could you select (maximum) 5 THREATS that you consider as the most important when a SDI would be implemented at a National level in Egypt?

- ❑ Inadequate budgets are declining in real terms (inflation).
- ❑ Unfavorable socio-economic environment threatens operations and survival.
- ❑ New skills may never be used because of lacking capital.
- ❑ Absence of any form of common standard related to geo-information management.
- ❑ Lack of control over financing GI related programs.
- ❑ Absence of information about the availability, quality and amount of data in different organizations.
- ❑ Unstable sociopolitical environment not conducive to normal operations
- ❑ Contradictions with other organizations.
- ❑ Lack of preventive penalties against the dissidents in the local units, NGOs, & people.
- ❑ The changing technology threatening the organization
- ❑ Other (Please specify)………………………………………………………………………………………

Other Remarks

Thank you very much for your time in completing this survey.

Questionnaire for Spatial Data Infrastructure (SDI) to Support Land Evaluation Applications in Egypt
II GIS Organizations

1. Which of the following best describes your Organization?

- ❑ Government
- ❑ Semi-government
- ❑ Local authority
- ❑ University
- ❑ Private
- ❑ Non Governmental Organizations (NGOs) and not-for profit organizations
- ❑ Other (Please specify)………………………………………………………………………………………

2. Which of the following SDI initiatives are you aware of?

- ❑ Collaboration with GI organizations in private and public sector
- ❑ Establishment of GIS Center
- ❑ Development of a Clearinghouse for geographic data
- ❑ Establishing a GPS Network
- ❑ Training of Government staff in GIS
- ❑ Other (Please specify)………………………………………………………………………………………

3. What is the role of your organization concerning the exchange and sharing of land evaluation data between the ministries?

- ❑ Unconnected
- ❑ Support
- ❑ Facilitate
- ❑ Connecting
- ❑ Participate
- ❑ Other (Please specify)………………………………………………………………………………………

4. Could you select (maximum) 3 from the following statements, which have been made about GIS?

- ❑ A lack of awareness of the potential of GIS, and the concepts behind it, limit its application
- ❑ GIS started in our organization because of the enthusiasm of one individual about technology
- ❑ GIS is only useful in providing pretty maps for board meetings
- ❑ GIS has radically changed the way we look at our business.
- ❑ GIS provide retail organizations with competitive advantage over those who do not use GIS
- ❑ Training is essential to the success of GIS
- ❑ There are many organizational barriers which can seriously impede use and development of GIS
- ❑ It is widely acknowledged that GIS projects glide effortlessly to success.
- ❑ GIS was implemented after a strategic decision to adopt the technology
- ❑ GIS is underused in many organizations
- ❑ Other (Please specify)………………………………………………………………………………………

5. Is there any duplication in data collection and processing in the different governmental organizations?

- ❑ Yes
- ❑ No

If yes, what are the reasons for this duplication?

………

………

6. Is there an initiation of SDI in any of the Egyptian ministries?

- ❑ Yes
- ❑ No

If yes, which ministry?

………………………………………………………………………………………………………..………………

…………………………………………………………….…..………………………………………………

7. Is there a potential plan for a NSDI in Egypt?

- ❑ Yes
- ❑ No

If yes, who are the terminators in that NSDI?

………………………………………………………………………………………………………..………………

……………………………………………………………….………………………………………………

8. How are the databases managed in your organization?

- ❑ Centralized
- ❑ Decentralized
- ❑ Hybrid
- ❑ Other (Please specify)…………………………………………………………………………………

9. From where does the basic funding come from?

- ❑ National government
- ❑ Agency budget
- ❑ Regional governmental budget
- ❑ Private sector donations
- ❑ Other (Please specify)…………………………………………………………………………………

10. What specific funding model would you find most suitable for future national online service provision?

- ❑ Pooling of funds among GI organizations (users and providers)
- ❑ Obtaining external funds from international sources through the government (grants)
- ❑ Cost Sharing by individual GI organizations
- ❑ International loan repayable with interest
- ❑ Revolving funds
- ❑ Public private partnerships
- ❑ Public funding
- ❑ Other (Please specify)…………………………………………………………………………………

11. How do your customers access your services?

- ❑ Internet
- ❑ Telephone
- ❑ Email
- ❑ Office Visit
- ❑ Service Delivered
- ❑ Other (Please specify)…………………………………………………………………………………

12. On what medium is the data stored?

- ❑ CD Rom
- ❑ Computer hard drive
- ❑ Central Server
- ❑ Diskette
- ❑ Internet
- ❑ E-mail
- ❑ Other (Please specify)…………………………………………………………………………………

13. What would be the bottlenecks for set up a NSDI In Egypt?

- ❑ Financial
- ❑ Technological
- ❑ Institutional
- ❑ Other (Please specify)…………………………………………………………………………………

14. Which problems do you experience regarding geo-spatial data provision?

- ❑ Delayed delivery
- ❑ Incomplete information

- ❑ Physical Proximity
- ❑ Inaccurate information
- ❑ Poor customer service
- ❑ Lack of metadata
- ❑ Outdated Information
- ❑ Unfit for use
- ❑ Other (Please specify)……………………………………………………………………………………

15. Do you support the idea of the developing the SDI to support land evaluation?

- ❑ Yes
- ❑ No

If no, why not? …………………………………………………………………………………………….

16. Which of the following do you think that are likely to take place over the next 5 years?

- ❑ Additional customization of products
- ❑ Additional GIS products have been purchased from the same vendor
- ❑ Additional GIS products have been purchased from other vendors
- ❑ A complete change of the system
- ❑ Resource could be mobilize
- ❑ Different GIS used within single departments
- ❑ Different GIS used within the organization
- ❑ Cooperation and coordination will increase
- ❑ More users within a single department
- ❑ More users within the organization
- ❑ More applications developed
- ❑ Decrease in duplication of effort
- ❑ GIS only occasionally used
- ❑ GIS not longer in use
- ❑ Other (Please specify)……………………………………………………………………………………

17. Could you select (maximum) 5 STRENGTHS that you consider as the most important of the current situation of your organization?

- ❑ Highly qualified, competent and experienced personnel
- ❑ Large experience in IT, Wide base of consultants, professionals from universities and international agencies
- ❑ Financial support by the government
- ❑ Understand need for improve rural communities.
- ❑ Improved understanding of community needs.
- ❑ Organization's culture produces a positive work environment
- ❑ Other (Please specify)……………………………………………………………………………………

18. Could you select (maximum) 5 WEAKNESSES that you consider as the most important of the current situation of your organization?

- ❑ Limited financial resources: more than 75 percent of budget goes on salaries; very little left for operational costs.
- ❑ Conflicts between line ministries and departments at the expense of rural development programmed and intended beneficiaries.
- ❑ Lack of laws to support the establishment of coordination system and to convince GI users and providers to cooperate/ integrate
- ❑ High staff turnover leaves some projects/programmed unfinished.
- ❑ Inadequate budgets (despite donor support).
- ❑ Unable to finance needed technology
- ❑ Programmed that are too short to have much impact.
- ❑ Programmed that are too narrow (sector-focused) to have much impact.
- ❑ Outdated communication methods
- ❑ Time wasting.
- ❑ Duplication and repetition of failed projects.
- ❑ Have poor debt or cash flow
- ❑ Other (Please specify)……………………………………………………………………………………

19. Could you select (maximum) 5 OPPORTUNITIES that you consider as the most important of the current situation of your organization?

- ❑ Improved collaboration and efficiency through department mergers
- ❑ Better services and more tangible benefits for members would improve the membership base
- ❑ Great opportunities for collaboration with all stakeholders
- ❑ Establishing regional planning centers.
- ❑ Dissemination of new updated Internet Technologies
- ❑ Growing number of national projects
- ❑ Encourage by the president and the top politicians
- ❑ Empowered communities demand more services.
- ❑ Room to involve local communities in most intervention issues.
- ❑ Advanced in technology
- ❑ Other (Please specify)………………………………………………………………………………………

20. Could you select (maximum) 5 THREATS that you consider as the most important of the current situation of your organization?

- ❑ Donors are withdrawing or scaling down.
- ❑ Unstable sociopolitical environment not conducive to normal operations
- ❑ Moving of the qualified staff to the private sector.
- ❑ Privatization of data provision agencies
- ❑ Shortage in time for projects done under politicians' directs.
- ❑ Competition from other organizations and private sector
- ❑ Unfavorable socio-economic environment threatens operations and survival.
- ❑ New skills may never be used because of lacking capital.
- ❑ The required specifications for your organization services are changing
- ❑ The changing technology threatening your organization
- ❑ Other (Please specify)………………………………………………………………………………………

21. Could you select (maximum) 5 STRENGTHS that you consider as the most important when a SDI would be implemented at a National level in Egypt?

- ❑ Have a clear strategic direction
- ❑ Public research system has a broad spectrum of researchers
- ❑ Wide up-to-date technological resources
- ❑ Connections with ministries, and governorates through local IDSCs
- ❑ Tend to be collaborative: desire to maximize profits.
- ❑ Small independent decision-making units facilitate quick decision-making and greater flexibility in project and programmed implementation
- ❑ Other (Please specify)………………………………………………………………………………………

22. Could you select (maximum) 5 WEAKNESSES that you consider as the most important when a SDI would be implemented at a National level in Egypt?

- ❑ Problems with data pricing
- ❑ Issues with data protection
- ❑ Liability problems
- ❑ Integrity, quality issues
- ❑ Commercialization of data
- ❑ Lack of specialized data mangers
- ❑ Lack of long term mission
- ❑ Routine and long paper work process
- ❑ Lack of self-discipline: few can work without supervision.
- ❑ Funds abused or not passed to the rightful beneficiaries.
- ❑ Work is too localized.
- ❑ Other (Please specify)………………………………………………………………………………………

23. Could you select (maximum) 5 OPPORTUNITIES that you consider as the most important when a SDI would be implemented at a National level in Egypt?

- ❑ Reduction of costs
- ❑ Less duplication of information
- ❑ Better availability of information
- ❑ Increased awareness of spatial information
- ❑ Improved economical market transparency
- ❑ Better streamline of information for environmental policy
- ❑ Improved policy-making
- ❑ Better monitoring of international (environmental) policy
- ❑ Improved quality of information
- ❑ Value added products, technical support & service provision, training and courses
- ❑ Create new markets in Arabian and African countries.
- ❑ Other (Please specify)……………………..……… …………………………………………………………

24. Could you select (maximum) 5 THREATS that you consider as the most important when a SDI would be implemented at a National level in Egypt?

- ❑ Data compatibility
- ❑ Data consistency
- ❑ No harmonized reference systems
- ❑ Institutional problems
- ❑ Lack of standardization
- ❑ Inadequate internet bandwidth
- ❑ Lack of resilience and reliability
- ❑ Extensibility problems
- ❑ Inadequate budgets are declining in real terms (inflation).
- ❑ Other (Please specify)………………………………………………………………………………

Other Remarks

Thank you very much for your time in completing this survey.

Appendix 3c-Interview Protocol

In order to answer the central questions of this research, semi-structure interviews will be conducted. A semi-structure interview is a qualitative research technique that allows person-to-person discussion. It can lead to increased insight into people's thoughts, feelings, and opinions on important issues. This type of interview is often unstructured and therefore permits the interviewer to encourage an informant (respondent) to talk at length about the topic of interest.

Introduction

- Welcome
- Self-introduction, outlining the purpose of the study and reviewing the research aims.

Interview Information

- The exact sequence and wording of the questions will vary depending on the respondents' personal opinions and characteristics.

Interview Guide

This guide consists of a list of questions to be discussed by the authors with the respondents. These questions will cover the main issues in the central questions. The following were the major focus of the interviews:

1- The activities carried out by the different organizations towards land evaluation.
2- Role of land evaluation development in Egypt.
3- The kind of data they needed for these activities.
4- The methods used for data collection, update and the data sources.
5- The objectives of SDI to support land evaluation.
6- The scales and formats required plus the frequency of data acquisition and update.
7- Recommended land evaluation map scales.
8- The methods of processing, storing, delivering and visualizing output data.
9- Problems experienced with exchanging or obtaining information.
10- Type of projects and the levels of collaboration.
11- Integration of GI and its impact on land evaluation processes.
12- Perspectives on implementing SDI for land evaluation.

Appendix 4a-Culture Aspect in Egypt

Culture is one of the most important aspects of society. It affects any development in every direction. Culture is not subject to change (on the short term), but it can tell us something about how well a SDI would fit in Egypt. Hofstede made a cultural classification for several countries, including Egypt (Figure 4a). The results will be explained below.

Dimensions of national cultures

Hofstede (1997) has studied a large body of survey data about the values of similar IBM employees in 50 different countries around the world. A statistical analysis of the answers on questions about the values of these employees revealed common problems, but with solutions differing from country to country, in the following areas:

- Social inequality, including the relationship with authority;
- The relationship between the individual and the group;
- Concepts of masculinity and femininity;
- Ways of dealing with uncertainty.

These four problem areas have been defined by the American sociologists Inkeles and Levinson 20 years before this study was done. The four problem areas defined by Inkeles and Levinson and empirically found in the IBM data represent dimensions of culture. A dimension is an aspect of culture that can be measured relative to other cultures. Hofstede named those dimensions power distance, collectivism vs. individualism, femininity vs. masculinity and uncertainty avoidance.

Power Distance (PD)

This dimension deals with the way a society handles inequality. Power Distance Index (PDI) scores say something about dependence relationships in a country. In large power distance countries the emotional distance between subordinates and their bosses is large, whereas in small power distance countries this distance is small. Power distance can therefore be defined as the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally. In the small distance countries power is usually decentralized, whereas large distance countries are more hierarchical organized. Power distance can be fairly accurate predicted from the country's geographical latitude (higher latitudes having lower PDI), its population size (large size associated with higher PDI) and its wealth (richer countries having lower PDI).

Most of the Egyptian society is of the same religion and they have the same language except few minorities. This implies a high power distance (PD = 80), figure (4a). The higher power distance culture are likely to operate on a need- to- know basis (centralized organization), rather than to see sharing. This is negative for SDI development.

Individualism vs. Collectivism (IDV)

Hofstede's study found that PD and IDV were the only dimensions that were strongly correlated. This means that large power distance countries are often collectivist and small distance countries individualist (exceptions are the Latin European countries, combining a medium to large PD with individualism). Individualism pertains to societies in which the ties between individuals are loose: everyone is expected to look after himself and his immediate family. Collectivism as its opposite pertains to societies in which people from birth onwards are integrated into strong, cohesive groups, which throughout people's lifetime continue to protect them in exchange for unquestioning loyalty, http://feweb.uvt.nl/center/hofstede/page3.htm.

In Egypt, a less individualist (IDV/C = 38) has a strong impact on leadership within the organization. The level of participation and information sharing lower in collectivism culture and this is negative because: "…SDI is all about sharing…" the more sharing the community, the better for SDI development.

Uncertainty Avoidance (UA)

Uncertainty avoidance can be defined as the extent to which the members of a culture feel threatened by uncertain or unknown situations. This feeling is, among other things, expressed in a need for predictability: a need for written and unwritten rules. Cultures with strong UA will try to avoid ambiguous situations and will look for a structure in their organizations, institutions and relationships, which makes events clearly interpretable and predictable. They are prepared to take risks, as long as they are familiar risks. This brings a conservative nature and leads to minimal innovation. Weak UA culture countries on the other hand are innovative and creative, and tolerate different views and behavior. They are also prepared to take unfamiliar risks.

Egypt has strong uncertainty avoidance (UAI = 68) because of the conservative nature. Uncertainty avoidance refers to man's search for Truth. People of high UAI are skeptic and need information for security and safety. This has a positive impact on the SDI. There is also a negative aspect to high uncertainty avoidance: Cultures with a high UA take little risks, which result in a minimum of innovations and the stakeholders may wait a long time before using newest technologies. The opposite type, uncertainty accepting cultures, is more tolerant of opinions different from what they are used to; they try to have as few rules as possible, http://feweb.uvt.nl/center/hofstede/page3.htm

Masculinity vs. Femininity (MAS)

In masculine cultures social gender roles are clearly distinct. Men are supposed to be assertive/aggressive, focused on material success and making this success visible. Women are supposed to be more modest, caring and concerned with the quality of life. In feminine cultures the gender roles have more overlap, in which men are also supposed to be modest, caring and concerned with the quality of life. Femininity refers to the distribution of roles between the genders. The women in feminine countries have the same modest, caring values as the men; in the masculine countries they are somewhat assertive and competitive, but not as much as the men, so that these countries show a gap between men's values and women's values, http://feweb.uvt.nl/center/hofstede/page3.htm. Masculine culture countries strive for a performance society; feminine culture countries for a welfare society.

The people of Egypt have a Masculinity nature (MAS = 53), figure (4a). The negative aspect for SDI is that masculinity will decrease stakeholders of the continuity of SDI. A positive aspect is that there is high assertive decision-making.

The Implications of Culture on SDI Implementation

With the above dimensions in mind, a split could be made to distinguish between active and passive societies. This will address the way societies deal with uncertainties; respectively they see them as opportunities or as threats. An active society will seek for opportunities to improve their condition and to be in charge of things (weak UA), where a passive society will want to maintain their current status and be in control of things (strong UA). These different policies will require different sets of information. However, this split will not be enough to explain why implementation of SDI is easier in some countries than others. For one, it does not explain how different ways of bureaucracy deal with information. This will relate to the way society deals with difference in power, whether management is centralized or decentralized. Decentralized countries (most western countries, low PD) will welcome the openness clearinghouses can provide, making it possible to create and make visible organization-wide accountability. In centralized countries (countries with a high PD), clearinghouses will not be so much desired, since those societies are likely to operate on a need-to-know basis and will not like too much openness and visibility. The authoritarian management of these cultures could be opposed to the implementation of clearinghouses. Also, distinctions could be made between masculine and feminine cultures, but these will primarily affect the other functions of GIS, although a masculine culture would like the visibility a clearinghouse will provide, in order to make success visible. On the other hand, it will also make failure visible, which will not be desirable.

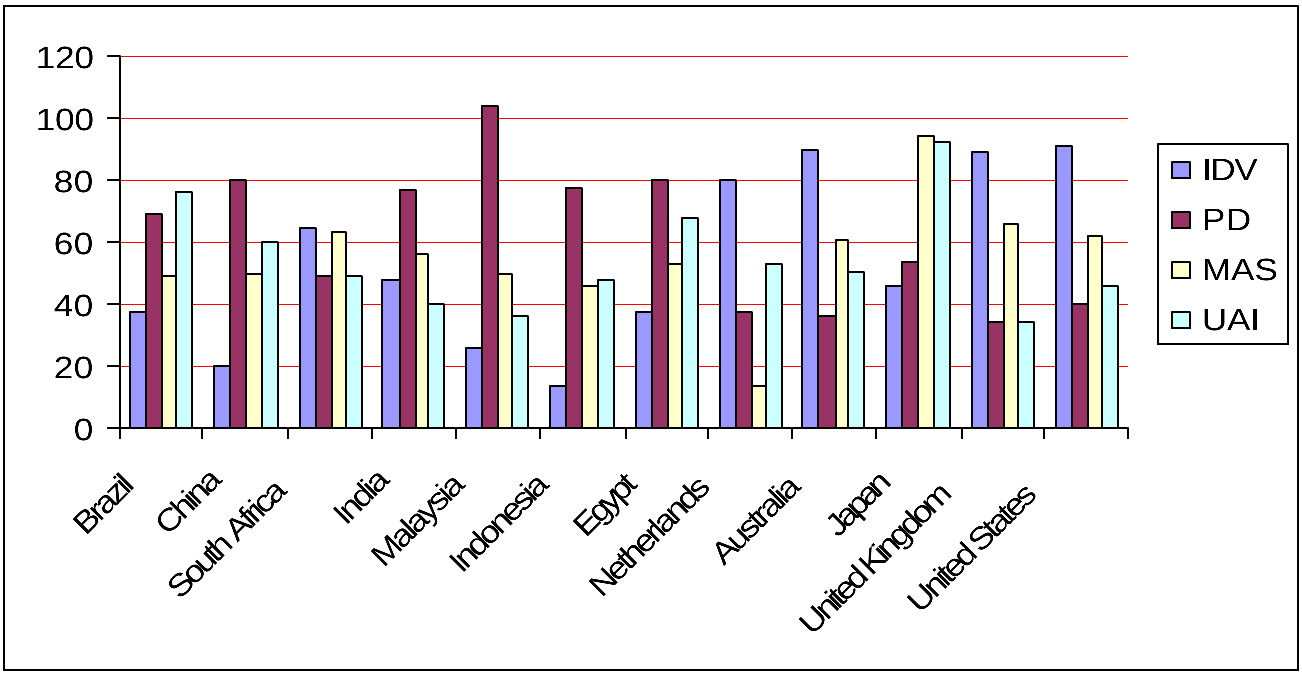

Figure 4a Shows Dimension Indicators for Egypt Comparing with other countries, (adopted from Hofstede, 2003).

Appendix 4b-Metadata Standards Creation for Land Evaluation Datasets

Effective use of GI requires easy access to documentation that describes the provenance, ownership, quality, age, fitness for purpose and other useful properties. This associated data documentation is referred to as metadata, (Maguire and Longley, 2005). Metadata is commonly defined as "data about data", (ANZLIC, 1996; Kildow, 1996; ANZLIC, 1997). They constituted the "underlying set of rules which tells a software program how to handle data", (Wilson 1998). In other words, it is a structured summary of information that describes the data. Metadata includes, but is not restricted to, characteristics such as the content, quality, currency, access and availability of the data. The concept of metadata is becoming increasingly familiar to people who deal with information and spatial information in particular. Library catalogues are a well-established example of metadata records that help with the discovery, use and management of collections of books, documents and other information. A GIS metadata catalog plays the same role as a card catalog in a library, (ESRI, March 2003). The card catalog in a library has a record for each holding. All catalog records are compiled into one comprehensive catalog and indexed by author, subject, and title (and other keywords) so that the catalog can be searched. A map legend is another common example of metadata that provides information about the publisher and publication date, scale, accuracy, datum and other characteristics of the map. The following sections provide a way to understand the utility of metadata and the challenges.

Metadata benefits

There is a real need to document the data for future use to be as accessible as possible to as wide a "public" as possible. Data, plus the context for its use (documentation, metadata) become information. Data without context are not as valuable as documented data. It also benefits the data producing agencies as well, because as personnel changes in an organization, undocumented data may lose their value due to little understanding of the contents and uses by the new staff. There are significant benefits to such asset management:

1- Metadata helps organize and maintain an organization's investment in data and provides information about an organization's data holdings in catalogue form;
2- Coordinated metadata development avoids duplication of effort by ensuring the organization is aware of the existence of data sets;
3- Users can locate all available geospatial and associated data relevant to an area of interest;
4- Collection of metadata builds upon and enhances the data management procedures of the geospatial community; and
5- Data providers are able to advertise and promote the availability of their data and potentially link to on line services (e.g. text reports, images, web mapping and e-commerce) that relate to their specific data sets, (GSDI Cookbook, 2004).

Metadata classification

Metadata needs to be collected at different levels to satisfy different purposes. These purposes can be broadly grouped into five distinct but complementary categories, each of which requires a different level of information: Data discovery, data assessment to determine fitness for use, data access, data use, data transfer and data management. In general, the amount of information and the degree of detail that is required increases from the "data discovery" level through to the "data management" level. In a heterogeneous computring environment that has a variety of available data sources as well as a great number of different applications for the data, the metadata provide guidance to find the most appropriate dataset for a certain application, (Kresse and Fadaie, 2004). There are different levels that metadata may be used for, (GSDI Cookbook, 2004):

I Discovery Metadata. Metadata for data discovery purposes represents the minimum amount of information required to convey to the enquirer the nature and content of the data resource. The metadata elements in ISO 19115 are grouped in two levels: the core metadata elements and the full list (comprehensive metadata elements). The core metadata falls into broad categories that answer the following questions:

1- What – title and description of the data set;
2- When –the data set was created and the update cycle, if any;
3- Who – data set originator or creator and supplier;
4- Where – the geographical extent of the data set based on lat / long coordinates geographical names or administrative areas; and
5- How –to obtain more information about the data set, how to order the data set, available formats, access constraints etc.

The core metadata elements are required to identify (discovery) a dataset that is typically used for catalogue purposes, (Kresse and Fadaie, 2004). Resource discovery is a process through which searchers use various tools to discover the existence, location, and characteristics of resources that might be useful to them. Resource discovery is optimized through the use of metadata records that provide structured representations of resources. Metadata schemes that intend to support the discovery of resources will include elements that characterize the resources for that purpose.

The library catalog record focuses on resource discovery. For example, Title, Author, Subject, Date, and Place. These few characteristics (metadata) are used traditionally for the citations of books. These are the same characteristics now found in metadata on the World Wide Web, and they provide a foundation for common searching of the metadata no matter the types and formats of information being described. This moves us from discussions of resource discovery to information search and retrieval.

II Exploration metadata. Exploration metadata Provides sufficient information enable an inquirer to ascertain that data fit for a given purpose exists, to evaluate its properties, and to reference some point of contact for more information. Thus, after discovery, more detail is needed about individual data sets, and more comprehensive and more specific metadata is required. Exploration metadata include those properties required to allow the prospective end user know whether the data will meet general requirements of a given problem.

III Exploitation metadata include those properties required to access, transfer, load, interpret, and apply the data in the end application where it is exploited. This class of metadata often includes the details of a data dictionary, the data organization or schema, projection and geometric characteristics, and other parameters that are useful to human and machine in the proper use of the geospatial data.

Metadata standards

The consistency in metadata content and style is recommended to ensure that comparisons can be made quickly by data users as to the suitability of data from different sources. This means for example when comparing metadata about different map sources the relevant scales are shown. Without standardization, meaningful comparisons are more difficult to derive without reading and learning many metadata management styles. However the problem has been that there are a number of "standards" in use or development, (GSDI Cookbook, 2004).

The ISO series is a multi-part international standard for Geographic information that is being developed by Technical Committee 211 Geographic information/Geomatics of the International Organization for Standardization (ISO). ISO 19115, Geographic information–Metadata is part of ISO 19100 series. This standard provides a procedure for describing digital geographic datasets using a comprehensive set of metadata elements. These elements support four major uses: discovery of data, determining data fitness for use, data access and use of data. Standards (and standardization, as the process to produce standards) are used for all type of agreements between users for mutual data transfer, (Aalders, 1998). This standard can be used for cataloguing datasets, clearinghouse activities and the full description of datasets. From the previous it may become clear that at least the use of a metadata standard for a SDI is inevitable. See table (4b) for websites for standards.

Table 4b some related websites for spatial data standards

Organization	**Acronym**	**Type**	**URL**
American National Standards Institute	ANSI	Standards	www.ansi.org
British Standards Institute	BSI	Standards	www.bsi.org.uk
International Organization for Standardization	ISO	Standards	www.iso.org
OpenGIS Consortium	OGC	Specifications	www.opengis.org
Federal Geographic Data Committee	FGDC	Standards	www.fgdc.gov
ESRI and standards	ESRI	Standards	www.esri.com/standards
Gigateway	GI	Standards	www.gigateway.co.uk
Open Mobile Alliance	W3C	Specifications	www.openmobilealliance.org
Web Services Interoperability Organization	WS-1	Interoperability	www.ws-i.org
MapInfo	-	Standards	www.mapinfo.com
Intergraph	-	Standards	www.intergraph.com
Cadcorp	-	Standards	www.cadcorp.com

Appendix 4c Overall Structure and Time Schedule for the Implementation of a SDILEA

Set out below are some preliminary ideas regarding the proposed SDILEA. They are produced with the view to indicating, albeit in outline form, how the SDILEA could be structured. Clearly all the points need to be tested and no doubt many or all will be altered to a greater extent. Instead they should be seen as a collection of ideas across a wide variety of SDILEA matters.

Mission Statement

The mission of the SDI to support land evaluation is to:

1- Generate spatial databases, which are vital for land evaluation development in Egypt by facilitating cooperation and collaboration among stakeholders.
2- Establish institutional frameworks for:
   - a consistent and harmonized mechanism for spatial data distribution
   - easy access to vital spatial datasets and their efficient sharing and exchange
   - integration of datasets through the application of common standards

3- Promote research, training, education and capacity building related to spatial data production, management and usage.
4- Eliminate duplication in the acquisition and maintenance of spatial data.

Policy Statement

The policy statement to guide the operations of SDI covers the following items:

1- Standardization of data production, transfer and exchange, hardware and software.
2- Provision, standardization and maintenance of metadata for spatial data holding in the SDI
3- Legal issues pertaining to ownership/custodianship of datasets, copyright/intellectual property, privacy and liability.
4- Organizational arrangement. There shall be composed of five Ministers and leaded by ESA. Other GI producers shall be SDI node agencies.
5- Funding of the SDI.
6- Capacity building in terms of manpower and technology transfer. Making it mandatory to include training component in GI projects.

Portal (Catalogue)

•SDILEA catalogue to be according to ISO standards.
•Levels of catalogue to facilitate discovery.
•Dictionary, translation and thesaurus services linked to the catalogue.
•Basic structure of the portal to be developed as a first phase and then added to incrementally over time.
•Core data (see below) form the basis of the portal.
• Web sites of all land evaluation organizations to be hyper-linked to the SDILEA portal.

Standards

•Overall standards framework would be those set by ISO Technical Committee 211 [5] and by the Open GIS Consortium[6].

Languages

•Initially in Arabic.

Metadata

•ISO 19115 standard.
•Levels of metadata which facilitate data discovery as follows:

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[5] This Committee (see www.isotc211.org/) has produced almost 40 standards.
[6] This Consortium has 6 agreed standards and another 12 ‘candidate’ standards (see www.opengis.org/)

1- metadata entity set;
2- identification;
3- data quality;
4- reference system; and
5- citation and responsible party.

Software
•Open source software where possible and appropriate.

Visualization
•Incorporate state of the art web GIS functionality on an ongoing basis as the technology evolves.

Geo-reference System
- Using a common referencing system for coordinate positions
- Use the datum’s recommended, particularly when collecting new data.
- Think about coordinate systems. Use of latitude and longitude coordinates is encouraged for the framework. If you use a different referencing system for local purposes, use one that can be easily converted to latitude and longitude, and record the parameters for the coordinate system in metadata.

Data Transfer Languages
•XML – for text/data.
•GML - for spatial information.

Core Spatial Data
Each type of core data would have relational data bases containing more specific information.
Issues to be considered in relation to core data include user needs, cost of acquisition, data sizes, frequency of update, responsibility for keeping the authoritative version, scale, accuracy, metadata etc.
Possible core data includes:-
• Topographic maps.
• Soil data.
• Geology.
• Morphology.
• Land use/ Land cover.
• Meteorological data.

Access
•Core data free over the Internet for access and viewing.
•Copyright and data privacy issues to be dealt with.
•Portal directly accessible on the browser of every land evaluation organizations.
•Hyperlinks on the SDILEA portal site to other sites which meet certain agreed standards.

Funding SDILEA
Acknowledgement that the SDILEA will require an ongoing funding commitment. Clear annual funding commitment for the next five years need to identify. Main funding needs in the short term may include:-
•SDILEA Unit for overall co-ordination.
•Portal development and hosting.
•Data purchases.
•Research and specialist investigations.
•Education and training.
•Hardware and software.
•Selective data acquisition.
•Certain data management.

The time schedule gives an overview of the activities, which have to be undertaken during the implementation phase of the next 5 years. To make the SDI ready and running after these five years, there is a time schedule needed.

Year 1-2 (awareness of people)

Letting the public know what exactly an SDI is and what is its benefits.

1- Create different forums to awareness activities among different organizations.
2- Create an overall technical network between the different LE institutions to establish a fast and efficient communication.
3- Create a direct contact with the government.
4- Create an overall spatial board which controls, evaluates and assigns the different sub-offices for the creation of a Geo-portal or Clearinghouse.
5- Start with assigning head managers in the ministries to create subdivisions with specific timetables for every ministries to upgrade efficiency and communication.
6- Create an institutional framework for the SDI, concerning the availability, storage and transfer the data.
7- There has to be made a start for finding different companies and organizations that will participate in the SDI.
8- Build contacts with private data acquisition organizations and make contracts.
9- Forward common standards for data collection.
10- Upgrade (including analog to digital conversion and metadata production) and update the datasets (by the recognized custodian) in adherence to the SDI standards.
11- Acquiring the core data sets that still have not been acquired.
12- Realize a good and sustainable relationship with foreign SDI- organizations.
13- Provide an evaluation report for the government regarding the progress of the SDI.

Year 3-4 (implementation phase)

1- In the beginning of year 3 the overall Geo-portal or Clearinghouse with the available data should be up and running.
2- Make an internal program and policy for each organization.
3- Acquiring the data for the core data sets that still has not been acquired.
4- Make a fixed policy with foreign organizations.
5- Evaluation at the end of year (3) for the overall organization.
6- Complete the Geo-portal with data and provide also payable data through the clearinghouse gateway by an automated system.
7- Updating of data, software and hardware if necessary.

(At the end of this year, all organizations and companies have implemented the standards and policies)

Year 5 (Feedback)

The last year is for determining problems (feedback) to improve the SDI where necessary.

1- Yearly evaluation on quality of the Geo-portal or Clearinghouse, based on feedback of the users and the evaluation office and efficiency of the SDI-structure.
2- Acquiring the data for the core data sets that still has not been acquired.
3- Maintain the contacts with other organizations and clearinghouses abroad to ensure a proper standardization of the metadata.
4- At the end of year five there is an overall evaluation of every aspect of the organization.

After this year, the SDI should be up and running.

Appendix 4d Topographic Maps Production Available in Egypt

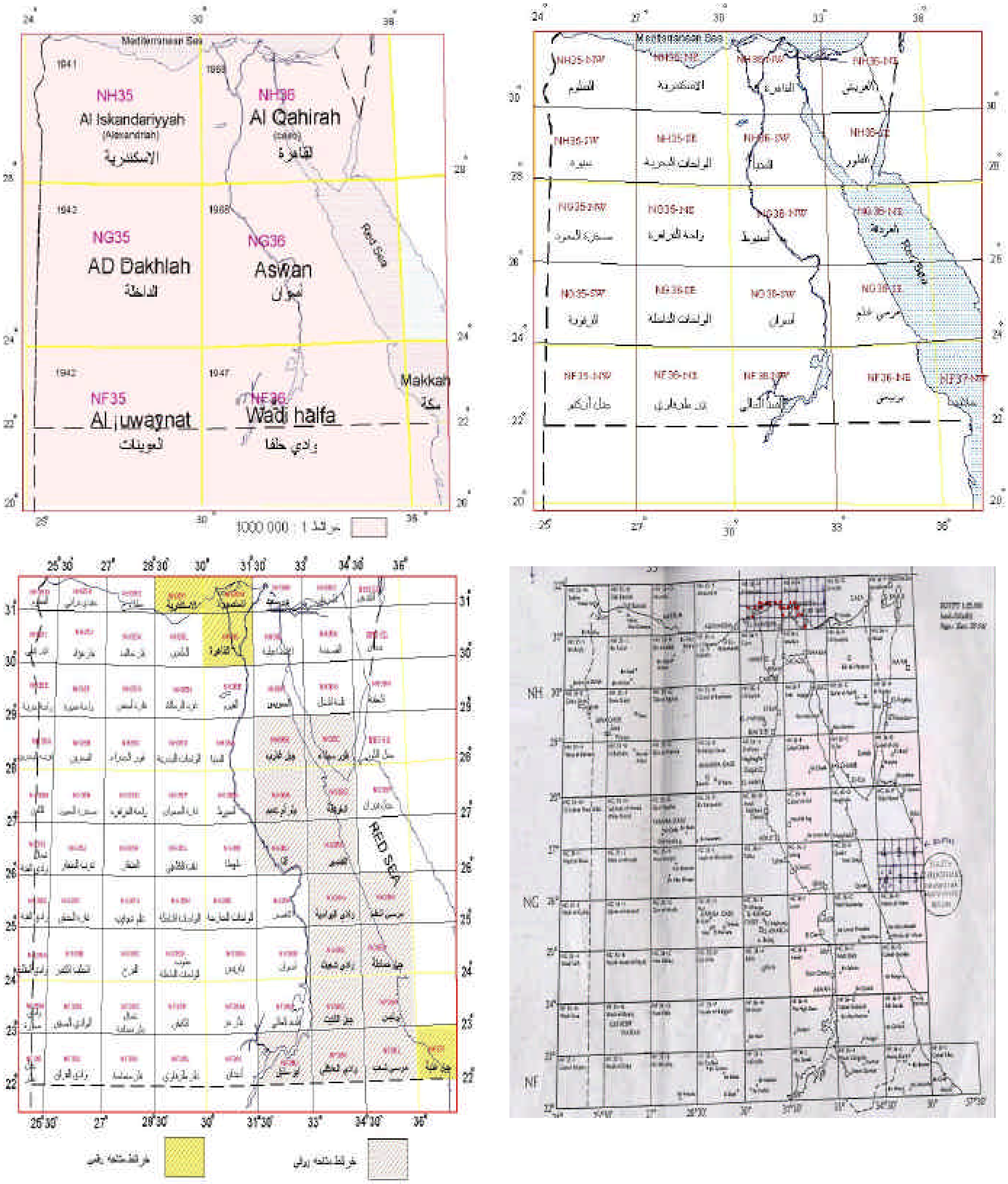

Figure 4d Topographic maps scales 1:1000.000 (Upper left), 1:500.000 (Upper right), 1:250.000 (Lower left) and 1: 25.000 (Lower right).