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BUILDING GEOGRAPHIC INFORMATION SYSTEM FOR THE SOUTHERN VALLY PROJECT IN TOSHKHA AREA I- A PILOT PLANNING AND DEVELOPMENT STRATEGIES

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ABSTRACT

The present paper describes a proposed Geographic Information System (GIS) that can aid in the development of the south Egypt project in TOSHKHA area. The studies provide guidelines for the design issues concerning the manipulation of geographic and environmental data and mapping of such areas. These guidelines include technical requirements of the system, equipment, design strategies, natural resources and limitations, conceptual structure of the geographic soil database, georeferencing issues, regional planning strategies as well as development requirements. Analysis of satellite images and the available data of the study area were undertaken. A proposed GIS that can aid in the planning and development of the area was introduced. The proposed system was designed to provide natural hazard maps related to high flooding and sand encroachment.

INTRODUCTION

Development of the southern valley in TOSHKHA area is considered very essential for Egypt especially that the Nile valley represents only 5% of the area of the whole country. The development of the TOSHKHA area was started on 1996 upon the occurrence of good floods and the initial operation of the TOSHKHA spillway. The spillway was constructed in 1981 to accommodate high floods that may affect the body of the High Dam. The TOSHKHA Project area is located about 240 km southwest of the Aswan Dam. The area encompasses approximately 540000 feddans as shown in Fig. (1). The terrain is somewhat flat where the lowest-level 102m above MSL recorded in Toshka depression, (Altorkomani, 1999), whereas

the highest-level 393m above MSL recorded in Jabal Masmias 7.6 km north of the pumps station, (The present study).

The development stage of the region was initiated by digging a new canal (named later Sheikh Zayed Canal). The objectives of the development project can be summarized as adding new areas for agriculture in the region of Toshka Depression, establishing of Agricultural, Industrial and Commercial new communities along with the essential Road and Communications networks. The development plan of the area was based on digging of a 70-km main Canal that supported by elevating water from Nasser Lake. The lifting process of the water need establishment of an enormous pumps station, which is designed to have a maximum static lift of water of about 52.5 m. The proposed location of the pump station is 31° 50" longitude and 22° 40" latitude. A road connecting the pump station and Abu Simbl-Aswan road is planned to be constructed with 47 km length. The main canal delivers water to four branches, which their lengths vary between 29 km and 70 km. The estimated cost of the project including the digging of the main and branch canals, pump station and social structures is 6807 million L.E. (NERC, 1998).

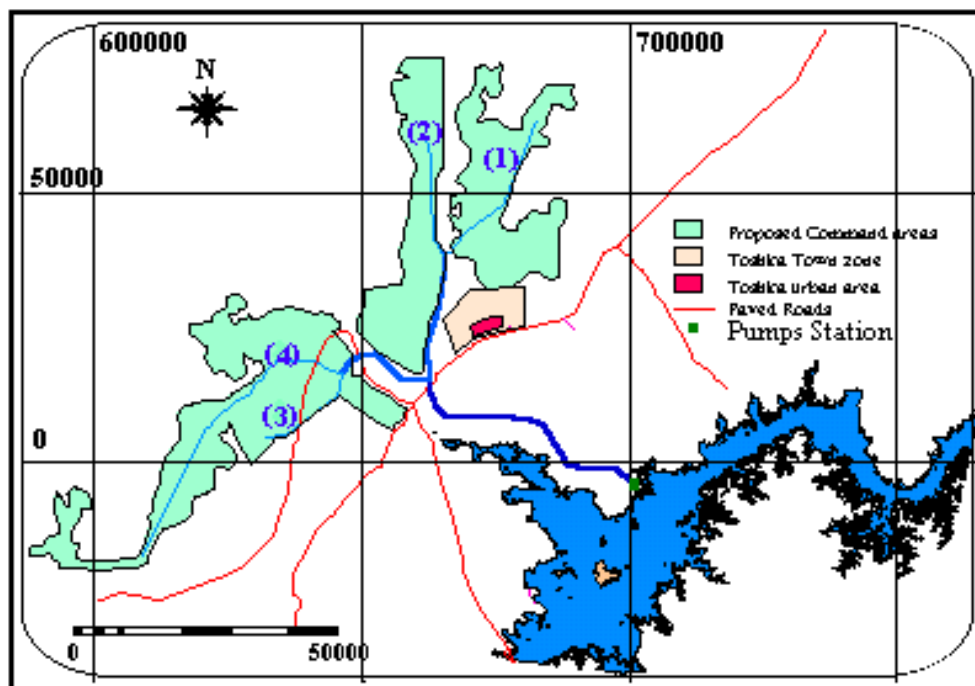


Fig. 1: Location Map of TOSHKA Project Area, (NWRC, 1998).

POTENTIALITIES AND LIMITATIONS

1-Soils: the primary technical studies of Desert Research Institute, Soil, Water and Environment Research Institute, General Authority for Rehabilitation Projects and Agricultural Development and National Water Research Center revealed that the

total land area suitable for agriculture development reached to 0.87 million feddans. A sum of 540000 feddans were primary selected around the designed four canals branches. The final locations and areas of the project are still under modification according to the results of the detailed soil survey studies.

Some severe soil limitations were recorded in some localities in the area such as:

a- The occurrence of rock out crops (limestone, gneiss, basalt and sandstone).

b- Shallow soil depth.

c- Clayey texture with low permeability.

e- Gypsum, lime and salts contents.

f- Contents of gravels and rock fragments.

g- Mechanical and chemical weathering.

2- Topography: the project area is characterized generally by moderate dissected relief. Some intercalation of rocky hillocks and uplifting scarps were also recorded.

3- Climate: the area is characterized by a very dry climate, (Hyperthermic and Torric temperature and moisture regime), with long very hot summer and short warm winter. The maximum temperature values, (Aswan climatological station 1985-1996), reaches up to 41.8 °C in June whereas the minimum temperature 8.1 °C in January. The evaporation rate is very high and ranges between 27.3 – 10.4 mm/day. Solar energy is very promising and should be considered for the development of the area.

4- Labors: is very limited and usually from Aswan Governorate. Highly mechanized farms should be considered for agricultural development.

SYSTEM DESIGN AND CONSIDERATIONS

1- System design: Planning issues for a huge project such as the south Egypt project require a very large amount of environmental and geographical data.

Management of the spatial data should be undertaken using a Geographic Information System (GIS). The building of GIS for the TOSHKHA area should be utilized and optimized during the data collection stage based on the compatibility and acceptability of the data. The GIS system should be designed to produce information concerning both topographic and thematic maps for the area. It should also capable to perform different quarries and modeling processes on spatial and tabular data. The development of spatial data for the region can be enhanced using remote sensing (RS) and digital photogrammetry (Enbner et al., 1991). The interpretative usage of remote sensing data to produce thematic maps can be used for building GIS thematic layers. Many Types of satellite images can be used for gathering thematic and topographic data for the area. TM landsat image (shown in Fig. 2) and Spot images can be used to gather the geographic data. Spot images can be used to capture topographic details in scale of 1:50,000. Maps on this scale or smaller are required for development planning. Radar images are particularly useful for mapping structural features and subsurface fluvial features in such desert environments (Robinson, 1999).

The coarse data captured by Remote Sensing can be updated later using photogrammetric techniques. Maps at scale of 1:25,000 or larger that developed by photogrammetric means is needed for development project design (Acharya, 1990). The quality of data can be evaluated and traced through GIS procedures. For

Remote Sensing data, image parameters and rectification results should be traced for assessment of data analysis results. The GIS system should be able to manipulate both raster and vector spatial data and also comprise map digitizing, scanned maps and GPS data.

The GIS should be aimed to provide decision-makers with the suitable data, statistics and its indices. The system should also provide tools for interpolation and visualizing spatial data in 3D. Another important aspect of the GIS is the data gathering, exchange and updating.

Modern PC computers can be used to handle many of GIS and Remote sensing tasks. It is preferable to use workstations with UNIX operating system as a platform for RS, GIS, and digital photogrammetry software packages (Enbner et al., 1991). X1 windowing system can be used to provide stereoscopic display (Ahac et al., 1992). The present research was done on PC platform using ILWIS software (ITC, 1998), GIS and image processing software, which used to integrate satellite and other data sources in order to manage natural resources and development tracking.

2- System considerations: The digital data for the TOSHKA area is needed by many organizations to promote development. Regional planning organizations, agricultural and industrial developers, water resources managers, transportation planners, electricity authority and tourism and archeological representatives are some examples of such organizations. The building process of the system may be accompanied by data infrastructure build up. For example, building a data infrastructure can save efforts by exchanging the data between system makers, researchers, and organizations with the preservation of all rights. The institutional capabilities and mechanics of development should be evaluated at this stage. Some examples of institutional issues are data sharing, data standardization and data updating. The proposed generic system calls for sending information to centralized server with the modified data. The GIS of the area should be capable to manipulate data of each command branch area individually.

3- System problems: The desert very hot and arid environment characterizes the TOSHKA area, which restricts field survey activities especially during summer. The development of such area requires recent maps. While there is a severe demand for available recent maps with scale 1:50000 to cover the area. Therefore, extensive efforts related to aerial photography and satellite mapping are required until covering the area with large-scale maps.

Also the development problems related to administrative boundaries of the area should be touched. Aswan is the closest Governorate and all of the services (utilities, services, education, etc.) should be linked to Aswan Governorate in the beginning. Later on it may be recommended to treat the project area as an independent administrative area.

In accordance with the pre-described activities, this study focuses on the design strategies of the system, engineering techniques and development issues for such these areas. The study concentrates on building a conceptual soil database structure that can be suitable for Toshka Project area, adapted from (Zinck, 1989) and (Zinck and Valenzuela, 1990) .

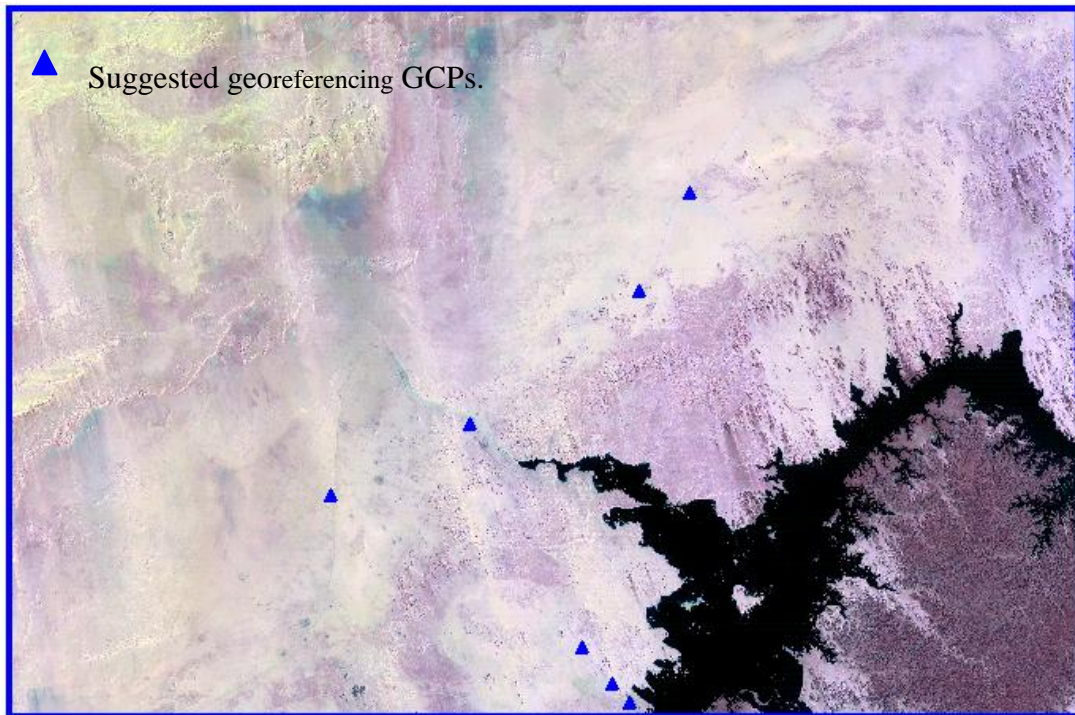


Fig. (2) TM landsat color image of TOSHKKA area recorded in April 1995.
(Color composite of bands 7,4,3/1)

Mathematical and Functional Model

Development of the southern valley needs the cooperation of many studies and fields. The full integration of GIS and Remote Sensing require geocoding of specific features to be included in a GIS using reference data. Reference data is the data collected about objects, areas or phenomena.

Remotely sensed data is suspected to sources of errors, which need both radiometric and geometric corrections. This data can be resampled to suit other Data sets (Kraak, M. and Ormling, F., 1996).

The delineation of various features based on its spectral reflectance using various wavelengths can be undertaken using satellite images. For example, soil-mapping units can be delineated on the enhanced satellite images. A good informative color composite for the study area found to be (Principal component of bands 5&7, 4, 3/1) RGB respectively. Digitizing on screen was found to be more efficient and accurate. The delineated mapping units can be checked in the field and represented by modal soil profiles with the help of GPS. Different soil characteristics can be stored as attributes for the different mapping units in the GIS where various quarries and models can be done. Previous work for Ministry of Irrigation (Fig. 1) shows the expected zoning of the area

The conceptual building of the soil database require many attributes such as landscape, relief, land form, terrain slope, lithology, drainage and permeability condition, soil depth, stones or gravel content, erosion condition, soil texture, soil salinity, pH, calcium carbonate content, bulk density, available water capacity,

nutrients contents and soil classification. Using of these data, different models can be calculated such as; soil capability, suitability for different crops, flooding, etc. The soil layer with the DTM data is very essential for planning irrigation networks and water requirements. They also aid in preservation of misuse of land. Vulnerability to natural hazards such as flooding, erosion and rock fall can easily be performed. Drainage networks of different basin catchments can also be extracted from the DTM layer. The soil and geology maps can help also for determining suitability for different land use of various development activities.

The validation of both thematic and topographic data from RS can be undertaken using conventional data and GPS receivers. Leveling and total station instruments can undertake the validation of DTM data captured by spot images. More data and research in Egypt is required to integrate GPS leveling into GIS databases based on modeling of the geoid in the region. The integration process of the gathered spatial and attribute data can be undertaken as prescribed schematically in Fig. (3).

The structure of the suitable base map should be flexible enough to accommodate the broad usage of the GIS system. If the agriculture development is the main objective, the rectified soil-map should be considered the base map in the GIS system. For land resources assessment, the geological layer can be considered the base theme as in mineral exploration applications. For engineering planning, the topographic layer integrated with geological layer can be considered the base map. Management of image data is very essential during the data gathering and processing to automate data transformation, The existing of DTM can be used for geocoding of image using parametric mapping equations (Enbner et al., 1991).

Development strategies of the region should be based on data concerning potentiality of the area and environmental limitations. The resources of the area should be investigated carefully using Remote Sensing data integrated with conventional field survey.

Referencing of Satellite images

Utilization of GPS in such these projects is very essential for many tasks such as georeferencing, mapping of features, ground truth to locate observation points and validation of mapping unit boundaries. In addition, it can be used to navigate the dessert.

Georeferencing of the satellite images can be done using GPS ground control points. Collecting both locational and attribute data using GPS receivers can be undertaken for mapping certain features. GPS hand held receivers could be used to produce position data with accuracy 1 to 3 m. Modern GPS/GIS grade receivers can produce differentially sub-meter accuracy while occupying a point for a short time in a dynamic mode. These receivers is based on recording both code and carrier phase data.

Primary control networks needed as a framework for GIS can be undertaken using static different GPS. These networks, sometimes called HARN (High Accuracy Reference Networks), usually established to –B- order (8mm+ 1:1,000,000). The spacing between stations is 50 km according to the existing topographic features. Densification of secondary GPS stations can suggested to be with lag distance 20 km as shown in Fig. (4). The specifications for such surveys claim for accuracy

within (1 to 5 cm + 10 – 100 ppm) according to the order of the survey (FGCC, 1988). This accuracy is needed to meet mapping, planning, land information and engineering requirements. Connection with existing control points outside the area should be less than 50 km for order (2c).

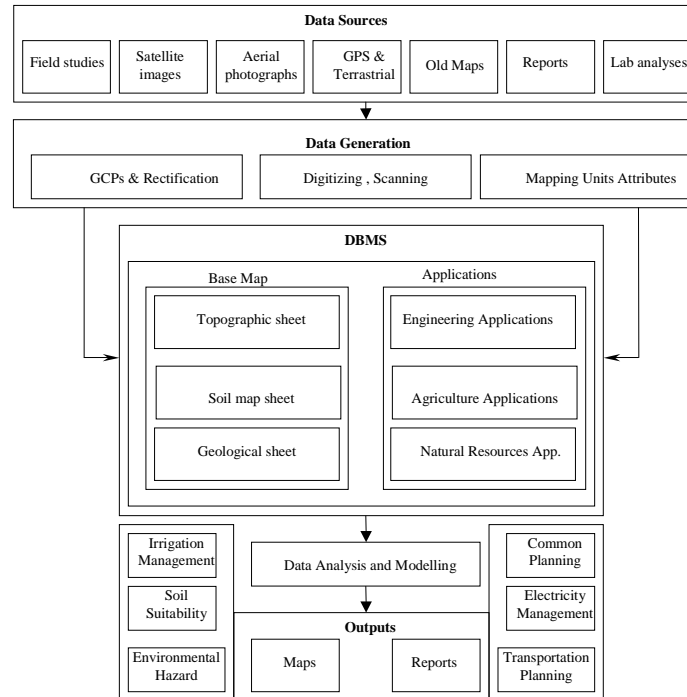


Fig. 3 Schematic Diagram of GIS system for the TOSHKHA area

The rectification process of digital image needs at least four to six ground control points (GCPs) per scene to correct image distortions provided that special techniques is to be used (Ahac et al., 1992). The GCPs establishment for the TOSHKHA region was very difficult due to lack of mapped, well-defined features. The beneficial of using of 1:50,000 topographic maps in referencing of satellite data was also restricted due to the lack of the data that covered the project area. Fig. (2) represents some GCPs that found to be very helpful for the image rectification of the area.

EXPERIMENTAL ISSUES

Building a GIS for the area is investigated using a pilot study. Thematic Mapper (TM) image dated 3/4/1995, with 30m ground resolution, was used for the present study. It is proved that such images can be used to support planimetric mapping at a scale 1:50000 (Kennie and Petrie, 1990). An enhanced color composite, (PC1 5&7,4,3/1), was used for visual interpretation on screen. Geopedologic soil map was established following the geopedologic approach adapted after (Zinck, 1989). Four topographic maps scale 1:50,000 were digitized to construct the topographic layer as shown in Fig. (5).

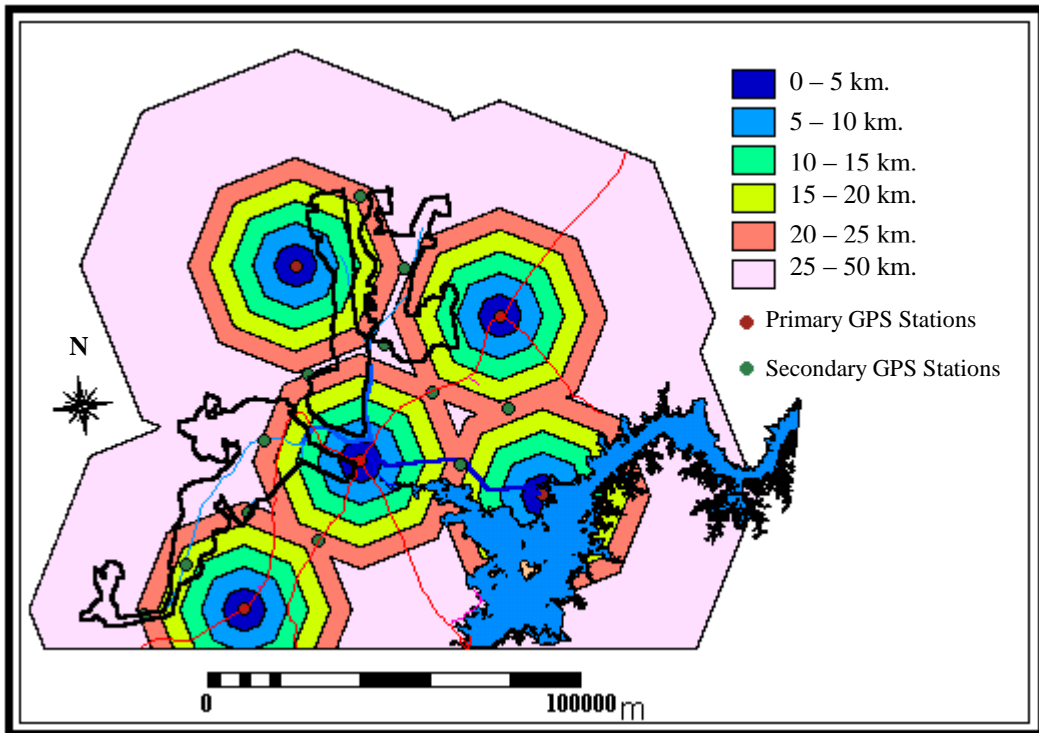


Fig. 4. Suggested locations of GPS Stations.

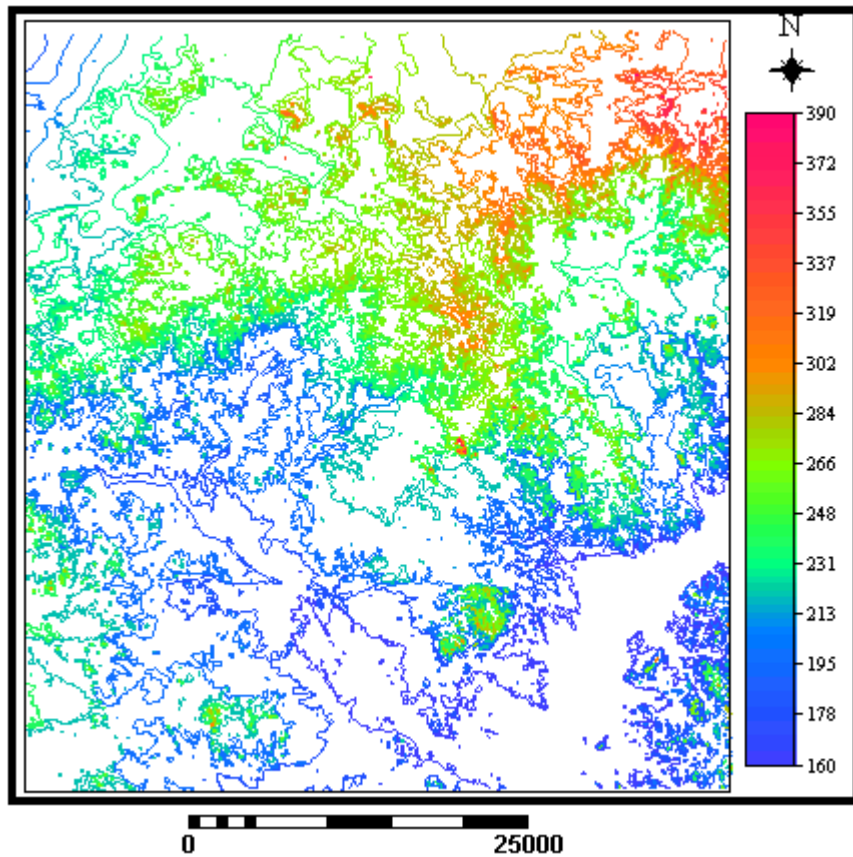


Fig. (5) The digitized topographic layer of the eastern part of Toshka area. (31° 30" - 32° E and 22° 30" - 23° N).

Referencing of satellite image using topographic map was undertaken. The image data can be rectified using GCP that have been measured in a topographic map and in the image. The referencing process using 12 points was undertaken and enhanced by using digitized roads from the topographic map. The rectification process needs at least three points while eight well-distributed points is a common practice .The resulting pixel size is equal to 29.96 m while the registration error is about 0.5 of the pixel size.

A hypothesis study to monitor the useful of the main canal and its branches in preserving the land that may suspect to submerging by high flooding was undertaken. To calculate the area that may expose to a certain flooding level, the hypothesis uses the spread GIS function started from the lake over the DTM layer which created through the interpolation contour layer.

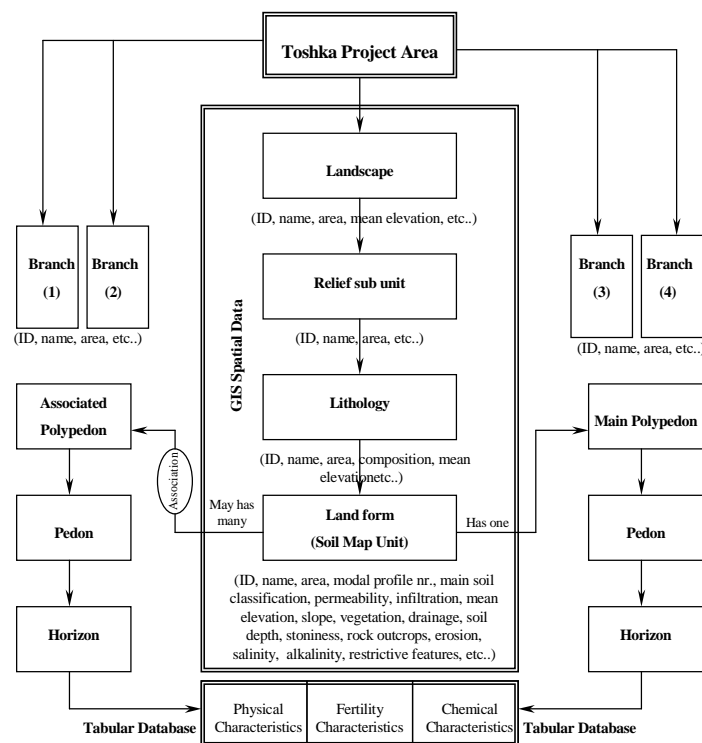


Fig. 6. Conceptual geopedologic model of soil data structure for Toshka Project.

ANALYSIS AND RESULTS

The analysis of the TM satellite image was undertaken to investigate of better utilization of the image in producing enhanced image. The Optimum Index Factor OIF results found to be as the following :

Band combination	Sum of standard deviations
1,3,7	71.17
3,5,7	70.97
3,4,5	69.05

A geopedologic soil map of the area was derived from the satellite image after referencing of the data using the topographic map data and geometric correction of the image. Different color composite with different band ratios was also investigated for better representation of the area. The study reveals that different results of the soil capability map for agriculture production may be encountered between similar studies. So, data available for such these studies should be standardized and characterized by various attributes such as modeling techniques, date of capturing the data, accuracy indices.

The details of the soil studies will be treated in another work. The conceptual geopedologic soil data structure is presented in Fig. 6.

CONCLUDING REMARKS

- The study of the area reveals that the methodology of capturing and analyzing geographical data should be clearly indicated with the estimated level of accuracy.
- GIS can undertake successfully the study of soil and ground water resources with the aid of soil, geological and hydrological data.
- For seek of standardized results manipulated by different authorities, capability model or other GIS models should clarify the used attributes, their rating and the used equations.
- The suggested GIS can be used to evaluate the potentiality of soil mapping units and hydrological units.
- The environmental impact of Toshka Project area should be accurately studied to define the impact of the project on the possible changes in the sediment distribution through the Nile Valley and the new valley.
- The final boundaries of the branches command areas should be undertaken after clear analysis of the detailed survey results. Some dynamic changes may be considered after the comparison with the surrounding soils.
- Very urgent efforts should be paid to complete the coverage of the area with recent 1: 50000 topographic maps.

REFERENCES

Acharya, B. (1990) - Optimizing surveying and Mapping Systems, Ph. D. Dissertation, Purdue University, IN, USA.

Ahac, A., Defoe, R. and Van Wijk, M. (1992) - Considerations in the Design of a System for the Rapid Acquisition of Geographic Information. J. of Photogrammetric Engineering and Remote Sensing, ol. 8, No. 1, Jan., pp. 95-100.

Altorkomani, G.F. (1999) - The Geomorphology of TUSHKA and development potentialities. Geographical Research Series 1999, No.4

Enbner, H., Fritch, D. and Heipk, C. (eds), (1991) - Digital Photogrammetric Systems. Organized by International Society for Photogrammetry and Remote Sensing, Herbert Wichmann erleg GmbH, Karlsruhe.

FGCC, (1988) - Geometric Geodetic Accuracy Standards and specifications for

using GPS Relative Positioning Techniques. MD, USA

Findorff, D. (1994) - "A Proposed GPS Geodetic High Accuracy Reference Network for the State of Indiana". GPS workshop of the 4th Indiana GIS Conference, IN, USA.

ITC (1998) - ILWIS 2.23. ITC, 7500 AA Enschede, The Netherlands.

Kennie, T. J. M. and Petrie, G. (editors), (1990) - Engineering Surveying Technology. First Publications, John Wiley & Sons, Inc., NY.

Kraak, M., Ormling, F. (1996) - Cartography: Visualizing of Spatial Data. A. W. Longman Ltd, First Publications, England.

Robinson, C.A. (1999) - Potential and application of RADAR data in Egypt. Egypt. Jour. Remote Sensing & Space Sciences, V.I, pp. 25-56.

National Water Research Center (NWRC). (1998) - Southern Egypt Development Project. Ministry of Public Works & water Resources, Egypt.

Zinck, J.A. (1989) - Physiography and soils, Internal publ., ITC, Enschede, The Netherlands.

Zinck, J.A. and C.R. Valenzuela (1990) - Soil geographic database: structure and application examples. ITC Journal 1990-3. pp 270-293.