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Current Status of GIS in the Sudan^{*}

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Introduction

Local government authorities and urban organizations are involved in a variety of activities undertaken at different levels to manage and provide services to the urban society. To do so, they need information related to many different phenomena, subjects and objects, such as population density, distribution of utilities (telephone, electricity, water, and sewage), availability of transportation, health facilities, etc., for their daily operations. On the other hand, geographic information systems (GIS) are the systematic introduction of numerous different interdisciplinary spatial and statistical data that can be used in inventorying the environment and other settings. The system strength is in storing, manipulating and retrieving large data sets. GIS's are described as being "intelligent mapping" systems, since they can integrate graphic data maps with tabular attribute data using different matching methods. This ability to integrate information through spatial links makes GIS useful for a wide range of applications. GIS's technology is now mature. However, in developing countries adaptation of such technology in full scale in the daily life is still suffering. Sudan is not an exception. The slowness in utilizing the technology is due to issues associated with public awareness, lack of geospatial data, scant funds, lack of trained personnel, data sharing, etc.

Who Own's GIS DATA?

This report focusses on study and assessment of mapping and GIS status in the Sudan. The report is part of an academic Ph.D. research to design and develop an enterprise geo-spatial system for Khartoum State. Government agencies and private companies that provided information relating to GIS to compile this report are:

- Sudan National Survey Authority (SNSA); the main governmental mapping agency of the country.
- Khartoum State (Engineering Issues Department);
- Khartoum State - Ministry of Health;
- Khartoum State – Water Corporation;
- Sudan Engineering and Digital Information Centre (SEDIC);
- Sudan National Remote Sensing Authority;
- Khartoum University, Faculty of Engineering (Department of Surveying);
- El-Neelain University;
- Red Sea State – Ministry of Physical Planning and Public Utilities;
- North Kordofan State – Ministry of Physical Planning and Public Utilities;
- Ministry of Health;
- Central Bureau of Statistics;
- Dams Implementation Unit.
- Ministry of Defense -Topography and Aerial Photography Department;
- Greater Nile Petroleum;
- SudaPet Petroleum;
- Roads and Bridges Public Corporation;
- National Authority of Electricity;
- Ministry of Energy and Mining;
- Ministry of Agriculture;
- Forest National Corporation;

- Mierag Company for Space Technologies; and
- Ministry of Investment.

Collection of GIS Data

The optimum way to view and assess available GIS in terms of hardware, software, data, applications, regulations, location and human resources is to visit each authority, conduct personal interview with administrators, engineers and technicians and review existing maps, attributes and output. This is in addition to:

- Interview key persons by telephone or direct meeting;
- Collection of information from active people in the field such as consultants and professors; and
- Local media, workshops, seminars and conferences, etc.

Survey of the Departments and Organizations

To have a clear picture of digital mapping status the key organizations mentioned above were visited in order to have an insight into the GIS development process within government agencies and problems hampering implementation. Problem identification was put up through understanding all relevant details, such as data type, status, flow, documents, communications between processes, staff and internal and external activities. Four arguments were identified and used to define the GIS status and development in Sudan in general and in the Khartoum State in particular. These are:

1. Availability of GIS data in an organization e.g:
 - Description of the GIS data;
 - Content;
 - Format;

- Quantity;
 - Accuracy; and
 - Completeness and currentness.
2. GIS data sources.

 3. How GIS data/functions are used in terms of:
 - Tasks and products;
 - Decision making;
 - How data are managed and maintained;
 - Descriptions of current methods;
 - Qualifications of key personnel;
 - Professionals who know the tasks; and
 - System specialists and/or external consultants;
 4. Current computer systems (hardware/software).

Table 1 shows the results of the survey.

Table (1): Summary of Status as Collected by the Author

No.	Organization/Department	Availability of Functional GIS System	Availability of Recent Digital Topographic Maps	Availability of Recent Aerial Photography/ Satellite Imagery	Availability of GPS Equipment	Availability of GIS Development Plan	Year
1	Sudan National Survey Authority.	There are several photogrammetric systems: - Analog Photogrammetric stereo plotters. - Aerial Cameras, none of them is working	No	The most recent aerial photography was taken in 1996 for Khartoum State. Plus some satellite images(Landsat and Quickbird)	There are some	Starting	2008
2	Khartoum State (Engineering Issues Department).	There is good hardware setup and some GIS/ Image processing software such as (ArcGIS and ERDAS Imagine)	No	Digital aerial photography/ recent satellite imageries are: - SPOT 2001 - IKONOS 1999 - Raw Aerial Photos 2008	There is a good set of Trimble GPS and at least one base station	Getting better rapidly	2008
3	Sudan Engineering and Digital Information Centre (SEDIC).	A good photogrammetric system and some workstations exist	No	There are color unprocessed aerial photographs taken in 2000.	Use and sell GPS devices	Not clear	2008
4	Sudan National Remote Sensing Authority.	- Analog Photogrammetric lab but not functioning. - There are some PCs and some GIS and Image processing software such as (ArcGIS and ERDAS Imagine) mainly for training and research.	No	Some Landsat imageries (MSS, TM, and ETM+) available	No	Not clear	2008
5	University of Khartoum Faculty of Engineering (Department of Surveying).	- Some PCs and software available for training and research - Photogrammetry equipment: old long-outdated optical and mechanical projection instruments	No	Few stereo Model for teaching purpose	No	Not clear	2008
6	Sudan Central Bureau of Statistics.	None	No	Available maps were prepared for census; and generally they show administrative boundaries. The most recent maps were prepared in 2002 and currently under update	Some handheld GPS receivers which are used by surveyors to collect general locations of settlements	map available for census purpose from satellite imagery	2008
7	Khartoum State Water Corporation	There are several workstations /PCs used for data conversion and collection	There is a project for water network paper map conversion	No	No	Have a GIS project to convert as built CAD data to GIS	2008

Table (1): (Continued)

No.	Organization/Department	Availability of Functional GIS System	Availability of Recent Digital Topographic Maps	Availability of Recent Aerial Photography/Satellite Imagery	Availability of GPS Equipment	Availability of GIS Development Plan	Year
8	Dams Implementation Unit	A large Apple Server, workstations, plotter and some GIS software available	Production of topographic maps is going on	Aerial photos (2008-2009)	Yes	Line maps are captured in CAD format and then converted	2008
9	North Kordofan State (Ministry of Physical Planning and Public						2008

	Utilities)					
10	Khartoum State (Ministry of Health)	There are some PCs and copies of ArcGIS Desktop	No	No	Yes	There is a plan to acquire recent maps for the state and turn all the health data collection using digital maps and adopt GIS in service distribution 2008
11	Ministry of Defense - Topography and Aerial Photography department	The department is quite established some hardware and GIS software are exist many paper maps were converted to digital and utilized in a daily business	There are some	No	Yes	Starting 2008

Availability of Topographic Maps in the Country:

Mapping, and/or spatial data collection for GIS databases, can generally be categorized into either planimetric or topographic methods. Planimetric maps show only the horizontal positions of features (x,y coordinates). On the other hand, topographic maps contain planimetric details and elevation information (digital contour lines or columns).

Topographic maps are very important for GIS implementations. Modern topographic maps are invariably produced by photogrammetry and high resolution satellite data such as IKONOS, Quickbird or GeoEye. Production of topographic maps is a very expensive and time-consuming work. It requires: (1) costly aerial photos or satellite imagery, (2) photogrammetric image stations and software, and (3) qualified personal.

Full and accurate topographic coverage is unavailable outside Sudan National Survey Authority. Most available maps are in hard-copy which are now being converted into digital form. There are three categories of maps:

1. 1:100,000 map series; (cover selected areas of the country). Only 220 sheets were produced in 1967, 1980 and 1983, each map including about 30 layers (see Fig1).

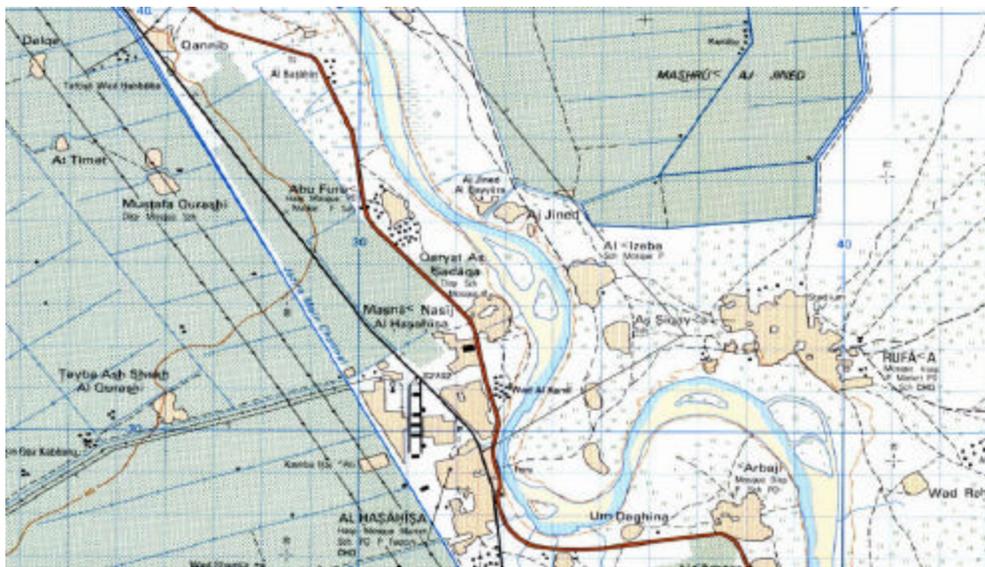


Fig1: sample map of 1:100,000 (Rufaa)

2. 1:250,000 map series; cover the whole country. Each sheet is about 110x160 km². The map sheets were produced in 1936 through 1976 (see Fig2).

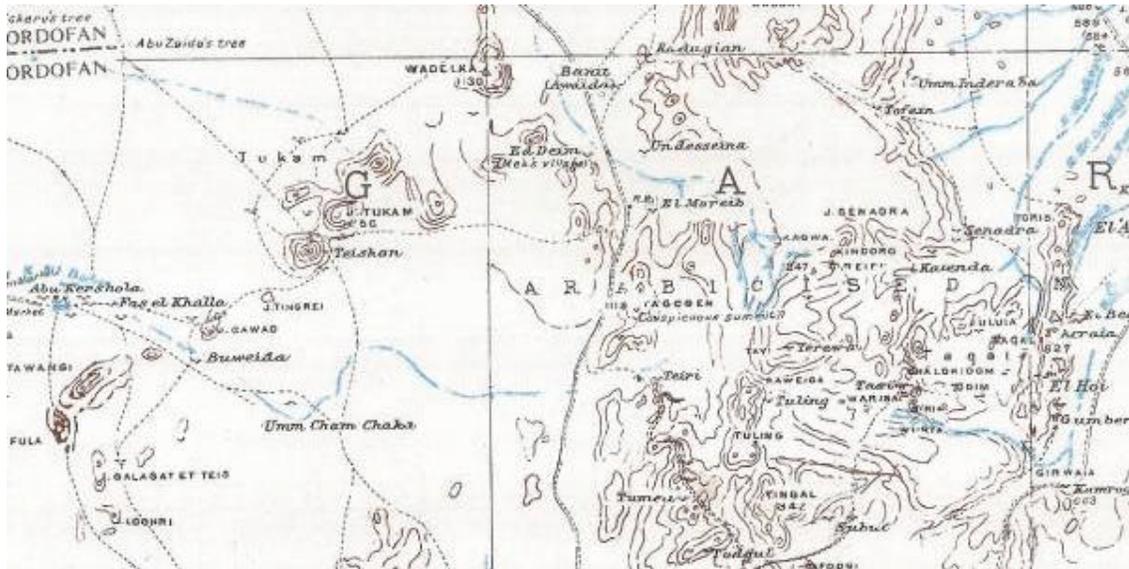


Fig2: Sample of map of 1:250,000 (South Kordofan)

3. 1:1000,000 map series. There are about 16 map sheets covering the whole country. Sheets were produced in 1944 through 1975(see Fig3).

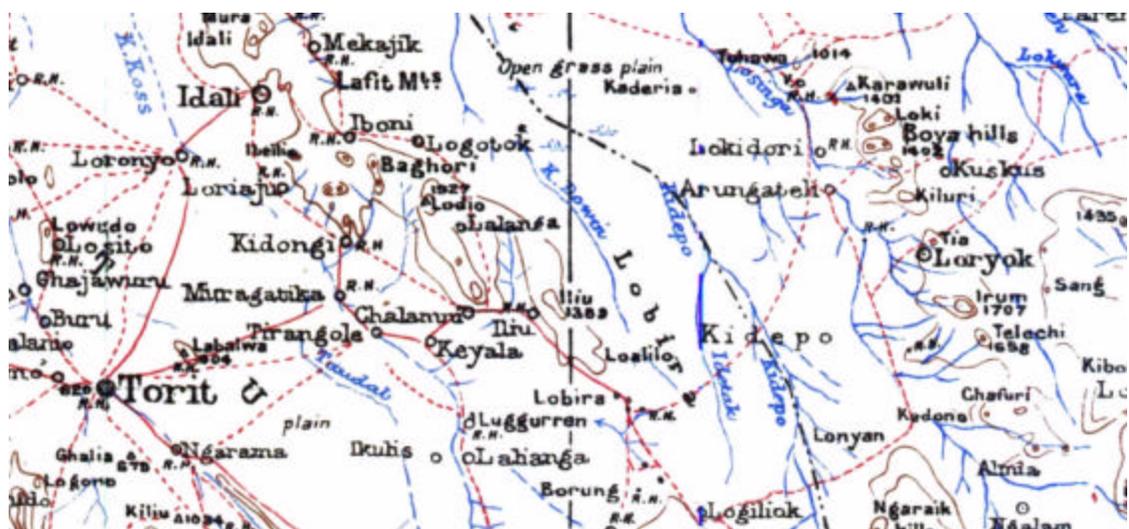


Fig3 : Sample of 1:1,000,000 maps (Torit area)

Conclusion:

- GIS status in Sudan is far from satisfactory.
- As a recommendation, a development of approach and standards can help the various departments create their GIS's. A GIS data model can be developed and adopted as a multi-agency system to accomplish the following objectives:
 - Assure attribute and positional accuracy.
 - Pool and optimize available resources for the needed tasks.
 - Reduce or eliminate redundancy.
 - Permit re-use of available data.
 - Help users to communicate with each other and work together.
 - Permit agencies to share costs, staffing and responsibilities.

An important part of the issue is the base map. This can be produced with different scales so as to be used as reference for other GIS layers.