

# **Libyan National Mapping Project**

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**Keywords:** Institutional development, CORS, digital basemapping, geodatabase, portal GIS

## **SUMMARY**

Libya, like all nations, requires accurate maps depicting its geography, natural resources, population centers, transportation network; and many other types of information that can be presented visually to support decision making and daily government business.

Surveying Department of Libya (SDL) has decided to acquire CORS, Digital Elevation Models (DEMs), medium scale orthophoto images, small and medium scale digital topographic maps of the country, to upgrade the national geodetic network, to establish continuously operating reference stations (CORS) in the coastal zone of the country, to establish comprehensive geodatabase and portal GIS, the organizational structure of SDL and strengthen the Department.

In this paper, the scope of the project and its implementation phases will be discussed.

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## 1. INTRODUCTION

Digital base map is one of the most vital information required for most of activities to be performed by a government presently. For example, infrastructure development and planning, natural resource management, security, emergency services, utility management and services, etc. can be most effectively planned and managed, if the appropriate maps are used.

Furthermore, accurate maps; illustrating the topography and terrain, natural resources, villages and towns, transportations, land use and land cover, and many similar other information; supports the decision making process and day to day government business. Such kind of digital base maps are required by most of the countries including Libya.

Like many other countries, Libya also having maps, but most of them in analogue format and not up to date as desirable. Libya needs a seamless digital base maps those will be the fundamental products, which will serve as the foundation for spatial based information. Accordingly, the Libyan government has decided to realize a mapping project, named as “1/25K, 1/50K and 1/100k-1/2000K National Mapping and Geodatabase Project” with the assignment name as “Libya National Mapping Project (LNMP)”.

As name indicates, the primary output of this project will be the digital topographic base maps that cover whole country. Usually, information in the base maps is in the spatial frame of reference for all geographic data, which include horizontal and vertical control, aerial topography, terrestrial topographic contour, spot heights, planimetric features; in the form of line, point and area; such as roads, buildings, agricultural land area, and similar other information.

The objectives and description of the assignment, as stated in RFP, are:

- Digital Elevation Models (DEMs),
- Medium scale orthophoto images,
- Small and medium scale digital topographic maps of the country,
- Establishment of continuously operating reference stations in coastal zone of the country,
- upgrading geodetic network of Libya,
- Establishment of a comprehensive geodatabase and portal GIS, and
- Strengthen the department.

## **2. SURVEYING DEPARTMENT OF LIBYA (SDL)**

Surveying Department of Libya (SDL) is the national mapping agency, which is responsible for civilian surveying and mapping in Libya.

SDL mandate includes all ground-based, aerial and satellite surveying activities in Libya, such as aerial photography, remote sensing from space, geographical information systems, cartographic activities and the acquisition and production of country maps of all types and at various scales. It also has jurisdiction in all matters relating to the formulation of the State's general policy in the survey field in all its branches, and it is the body responsible for elaborating general principles, standards and technical specifications and providing technical and scientific advice on all survey-related activities in the areas of survey data, aerial and satellite photography, remote sensing, cartography and map-making for the government agencies and institutes in Libya. The SDL has well defined organizational setup with necessary bureaus, divisions and sections to carry out its activities and implement the policy in the survey and cartographic field established by its committee of administration.

However, it is still lacking several modern surveying equipments and systems.

SDL has completed many aerial photography, field survey and cartographic projects in the past since it was established. Notably, SDL has produced a National Atlas and wall maps of the country. SDL has also supervised the preparation of maps of the other Arab countries. In the past SDL had several mapping projects and produced topographic and other maps at various scales starting from 1:1,000 to 1:1,000,000 with several scales in between such as 1:2,000; 1:10,000; 1:25,000, 1:50,000; 1:250,000; 1:400,000 and so on. However, in most of the cases these maps were covering only partial area of the country. In many cases, the mapping activities were concentrated of costal area of the country.

SDL has also conducted several aerial photography of the country along with geodetic survey, since early days. For example, with regard to ground control surveys, at the end of the 1950s the coastal area was covered by a triangulation network calculated on the based on the Hayford 1924 International Ellipsoid as well as some triangulation surveys in the southern regions and about 7,000 kilometers of traverses in the northern half of the country. Regarding aerial photography, the territory of Libya was covered during the 1970s by aerial photography at various scales for agricultural purposes, for the preparation of urban plans or for the establishment of manufacturing projects.

## **3. OVERALL SCOPE OF LNMP AND WORK PACKAGES**

The project is based on international best-practice standards for all aspects of National Basemapping, including : national basemapping data, process standards, communication channels and cooperative partnership, design and development of a GIS portal, training and professional development, technology infrastructure development, data and metadata standards, institutional framework, technology standards.

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The project is mainly separated into two work packages as listed Table-1. These are;

1. SDL & MSD Institutional Development and Capacity Building
2. Map Production, Geodatabase and Portal GIS

Table – 1: Scope of Work of the project and work packages

NO	TASKS	DESCRIPTION
1	<b>SDL &amp; MSD Institutional Development and Capacity Building</b>	<ul style="list-style-type: none"> <li>- Assessment of SDL &amp; MSD</li> <li>- Study of International best praxis and success cases</li> <li>- Assessment of partnership with local institutions</li> <li>- Reviewing LSDI SDL assessment and upgrade SDL&amp;MSD</li> <li>- Preparation of Strategic plans for SDL &amp; MSD</li> <li>- Development of policies and procedures for data dissemination</li> <li>- Development of organizational chart</li> <li>- Development an institutional capacity building program</li> <li>- Preparation of implementation plan</li> <li>- Supervise implementation plan</li> <li>- Preparation of Technical training program</li> </ul>
2	<b>Map Production, Geodatabase and Portal GIS</b>	<ul style="list-style-type: none"> <li>- <b>Work Package-1:</b> CORS Establishment</li> <li>- <b>Work Package-2:</b> Geodetic Network and Geoid</li> <li>- <b>Work Package-3:</b> Ground Control Points</li> <li>- <b>Work Package-4:</b> Aerial photography and AT</li> <li>- <b>Work Package-5:</b> Orthophoto</li> <li>- <b>Work Package-6:</b> Digital, thematic and LBS mapping               <ul style="list-style-type: none"> <li>- 1/25,000 mapping</li> <li>- 1/50,000 mapping</li> <li>- 1/100,000 to 1/2,000,000 mapping</li> </ul> </li> <li>- <b>Work Package-7:</b> Geodatabase and portal GIS</li> <li>- <b>Work Package-8:</b> HW/SE and Equipment</li> <li>- <b>Work Package-9:</b> Training</li> </ul>

### 3.1 Institution Development and Capacity Building

Institutional development is evaluated together with capacity building and a new organization structure has been proposed. This proposal consists of a national mapping organization which produces maps and map information internationally and serves these data digitally over a portal.

The prospect of implementing the Libyan digital base map system offers an opportunity to develop a strategic approach for developing and maintaining new, digital base maps and

associated mapping and analysis functions. To assist in developing such a strategy, the core functions that National Mapping/Survey organizations around the globe currently employ as a set of “good practices” are being documented. These business functions are summarized below.

The business functions of the organization will be,

- Adopt and promote the use of standards
- Manage national geodesy with the main functions of CORS.
- Provide leadership for base mapping and conduct data collection.
- Conduct data compilation and integration (photogrammetry, geodesy and field surveying) and prepare the survey maps in different scales;
- Manage information systems- geodatabase/ portal GIS
- Conduct GIS analysis
- Provide products and services
- Qualify offices, companies and authorities that are specialized in survey activities for providing their services based on the conditions and technical specifications that are prepared by the authority
- Strategic planning and development
- Partnership development
- Administrative and financial issues
- Procurement and contract management
- Education and training

One important role of SDL will be to adapt and promote the use of relevant technical standards for example the expanding use of GIS, GPS and related technology throughout Libya. Many of the good business practice standards for geospatial information are developed and published by voluntary national or international standards organizations.

A second critical role for the Agency is to adopt policies that describe how the agency will address issues such as data sharing, distribution, information ownership, and information security.

SDL is responsible for the seamless national base mapping. In future several governmental and private organizations will collect location related information. The Libyan digital base map system must be the base for such information which can be integrated at the other governmental and private organizations. This requires a simple access to the data base. It should be avoided, that other or private organizations build up their own geodatabase. The build-up of private organized geodatabase systems will be provoked by organizational or financial problems in the access of the geodatabase as it happened in several countries. SDL

should have the leadership for the base mapping and data collection in Libya; that means it has to cooperate with and has to support other organizations by data sharing, support of data acquisition and by consulting services given by SDL.

It also requires:

- Metadata documentation
- Development of data sharing policies
- Marketing
- Dissemination strategies (Internet, Portal, DVD, etc.)

Handling the digital base maps offers possibilities for new products and services that SDL can provide for customers as it can offer to meet special map requests from other agencies. Once technical expertise is in place, it will be possible to offer consulting services for new projects, and e-services taking advantage of Internet mapping.

Activities included in this function are:

- Consulting on survey and mapping issues
- Standard products
- Special projects
- E-services
- Map requests from other agencies

National mapping agencies in many countries are recognizing the need to modernize work forces and maintain flexibility in their ability to adapt to new technology. The resulting outcome is a combination of in-house staffs with expertise focused on core business functions coupled with assistance from outside contractors. This requires maintaining government skill sets that enable efficient procurement of goods and professional services, as well as capability to effectively manage contracts. Activities included in this function are:

- Development of technical requirements/specifications
- Quality assurance/quality control of deliverables
- Development of contract policies
- Implementation of contract management “best practices”

SDL has to maintain the quality of the geodatabase in the field of accuracy and actuality. A geodatabase is a living system which always has to be updated. By updating the geometrical quality should not be worsened, this only can be guaranteed by SDL itself. The integration of update information reported by others, as there are new roads or railways, reported by department of transportation, has to be made by SDL. In general a system of upgrade has to be established with permanent changes based on reports from other organizations and by periodical check of the completeness of the geodatabase.

In addition to the geodatabase maps have to be printed in the designed scales. This requires as before the printing operations, cataloguing and distributing.

The primary goal for SDL should be:

- To be the primary provider of base geographic maps and services
- To recruit recognized experts in surveying and digital mapping
- To serve current, accurate base geographic data delivered via the Internet to decision makers and citizens,

Based on the established geodatabase and the CORS, SDL will be able to get a return on the investment by fees for the use of the geodatabase and CORS, by consultancy services and applied projects. At least a mayor part of this should be available directly for SDL to reduce the required financial support by the government and for investing it into required technology to stay with the hardware and software on the up-to-date development.

Up to date the following work have been done, in scope of Institutional Development works

- Organization have been reviewed and a new Organizational Chart have been proposed
- Capacity Building program
- Technical Training program
- Strategic Plan
- Data Policy
- Project Management approach and proposal
- Map projection and datum
- 1/1K,1/5K,1/10K base maps technical specifications
- QA/QC for field surveying
- Geographical names
- Mapping Index
- Building Construction Technical Specification

### **3.2 Map Production, Geodatabase and Portal GIS**

Libya National Mapping Project (LNMP) has to achieve the digital topographical mapping that covers 1660000 sq. km. of the country. Practically, LNMP will be resulted into the 1:50,000 scale topographic map covering almost all of the country area, thus comfortably termed as the based map. Realizing the geophysical and natural environment of the country, it has been decided that there will be different scale of mapping. The most detailed mapping will be at the scale of 1:25,000 covering populated areas, while the most detailed scale that covers almost the whole nation will be at 1:50,000.

The project is separated into six technical work packages which have to be delivered by a contractor. The work packages and descriptions are given in Table-2.

Table-2: The work packages and descriptions

TASKS	DESCRIPTION
<b>Establishment of CORS-LIBYA</b>	Establish CORS along coast line of Libya (50 stations)
<b>Upgrading Geodetic Control Network and Geoid Determination</b>	<ul style="list-style-type: none"> <li>a) Establish additional stations (200)</li> <li>b) Survey existing stations (61 +)</li> <li>c) Determine national dm-level geoid</li> </ul>
<b>Aerial Photography and Aerial Triangulation</b>	<ul style="list-style-type: none"> <li>a) Acquire aerial images in two seasons (1,660,000km<sup>2</sup>)</li> <li>b) Carry out Aerial Triangulation (if required) or</li> <li>c) Carry out georeferencing</li> </ul>
<b>Orthophoto Mapping</b>	<ul style="list-style-type: none"> <li>a) Compile DEMs at 5 m grid spacing</li> <li>b) Compile orthophoto maps (1/10K) / 1,660,000 km<sup>2</sup></li> </ul>
<b>Production of 1/25K, 1/50K, and 1/100K-2000K Digital Topographic Mapping, Color Land Use Thematic Mapping and Navigational / LBS Mapping</b>	<ul style="list-style-type: none"> <li>a) Compile 1/25K map sheet (280,000 km<sup>2</sup>)</li> <li>b) QA/QC 1/25K existing maps (95,000 km<sup>2</sup>)</li> <li>c) Derive 1/50K map sheets from 1/25K sheet (375,000 km<sup>2</sup>)</li> <li>d) Compile 1/50K map sheets (1,285,000 km<sup>2</sup>)</li> <li>e) Derive 1/100K map sheet (1,660,000 km<sup>2</sup>)</li> <li>f) Derive 1/250K – 1/2000K map sheet (1,660,000 km<sup>2</sup>)</li> <li>g) Compile color land use mapping for all scales above</li> <li>h) Compile 1/25K navigational / LBS maps (10,000km<sup>2</sup>)</li> <li>i) Compile 1/100K navigational / LBS maps (1,660,000 km<sup>2</sup>)</li> </ul>
<b>Establishment of Geodatabase</b>	<p>Establish geodatabase and metadata consisting of:</p> <ul style="list-style-type: none"> <li>- Geodetic network points and CORS</li> <li>- Aerial photographs</li> <li>- DEMS and orthophotos</li> <li>- Topographic maps (1/25K -1/2000K)</li> <li>- Landuse thematic maps</li> <li>- Navigational / LBS maps</li> <li>- Other spatial data available in SDL</li> </ul>

### 3.2.1 Geodetic Network and CORS



The current geodetic network of Libya is out of date, doesn't have the today required accuracy and connection to the international reference frame. So based on 10 new fundamental points, which will be determined in relation to ITRF stations, the Libya Geodetic Main Network with approximately 200 stations will be generated having an accuracy of better than 5cm CE90. In the more dense populated coastal area a system of approximately 50 continuous operating reference stations (CORS) shall make precise GNSS-positioning easy. In addition the leveling network shall be reestablished and Libyan national dm-level Geoid shall be determined by GPS leveling.

### 3.2.2 Aerial Imaging and Aerial Triangulation

The whole project area shall be flown by digital aerial cameras with 60% end lap, 30% side lap and 60cm ground sampling distance (GSD). With relative kinematic GPS-positioning and inertial measurement units (IMU) an integrated bundle block adjustment shall be enabled to solve the image orientation problem with a minimal number of control points.

### 3.2.3 DEM generation and Ortho-Image Mapping

By automatic image matching a digital elevation model with a standard deviation of +/-1.5m and a point spacing of 40m shall fulfill all requirements. It shall be the base for ortho-images covering the whole project area with 60cm GSD.

### 3.2.4 Digital Mapping

Digital maps with 0.3mm CE90 in the map scale (15m / 7.5m), including contour lines with 5m contour interval and spot heights, shall be the core for the Libyan National Geodatabase. All elements relevant to the presentation scales of the topographic maps have to be included. It shall be based on UTM coordinate system using the GRS80-ellipsoid and ITRF-datum to simplify GNSS-positioning and the overlay of other data as satellite imagery. All geographical settlement names on map shall be written in Arabic and English. Compilation check plot for all map sheets, cartographic proof plot for all map sheets, ortho-image check plots for all map sheets, thematic check plots for all map sheets and digital map data sets and associated statistical listings are required and have to be validated.

Furthermore, there will be derived maps as well, such as Color Land Use Thematic Maps (LU); sometimes also termed as Land Use/Land Cover map; and Navigational and Location Based Service (LBS). Once features are extracted at detailed level fresh mapping, they can be generalized for preparing small scale maps. Thus, scope of work includes preparation of various scales derived maps as well.

### 3.2.5 Geodatabase and portal GIS

The Geodatabase shall be the core for all geodata in Libya. All other governmental organizations have to use it for any location related information. Also private organizations shall have the possibility of use. The access will be enabled by portal GIS.

### 3.2.6 Training

The Libyan National Geodatabase will be established and controlled by a company. Nevertheless the staff members of SDL must be able to handle, support and update it and support the integration of other data as from road construction, utility systems, planning department and others. This is only possible with required soft- and hardware, but more important with well trained staff members. By this reason a sequence of educational steps is required, it includes a 2 year education as MSc for staff members with BSc, a 4 year education as BSc for staff members with High School degree, a sequence of 2 month courses outside Libya, some 2 – 4 week general training, 8 week software training, 8 week project specific training and on-the-job training for all technical staff members. The successful use of the Libyan digital base map system, not only by SDL, requires permanently educated SDL staff and also educated staff members of other organizations which will use the geodatabase. Because of missing education possibilities in Libya at SDL an application oriented School for Surveying and Geoinformation shall be established to fulfill the request.

## **4. CONCLUSION**

The very large project size the ambitious plan to finish the whole project four years after signature and the complete contents from fundamental points for the geodetic net up to the portal GIS raises several problems to be solved with the support of GTC (GeoTech Group is the consultant of LNMP). The project is shortly before signature by a contract company, so several steps of the consultancy have been finished always.

## **BIOGRAPHICAL NOTES**

### **Dr. Jamal Gledan**

He was born in Libya at 1963. He had Civil Engineering BSc degree at 1986 and MSc Degree in Remote Sensing at 1994. He finished his PhD at Newcastle University at 2004. He had worked as lecturer at Al Fatah University in between 1994-2006. He is a member of `Space in Civilian Purposes Commission` for North African Countries Union and `Regional Center of Remote Sensing` Commission. He is the Director General of Surveying Department of Libya since 2006. He is the chair of the executive board of `Libyan National Mapping Project`.

### **Dr. Orhan Ercan**

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He was born in Turkey at 1959. He had his BSc at 1983, MSc at 1988 and PhD at 1997. He had worked at the Geodesy, Photogrammetry, Cadastre departments of General Directorate of Land Registry and Cadastre. He executed the World Bank's MEER/MERLIS and ARIP/Cadastre projects. He worked as executive staff at 'Turkish National Spatial Data Infrastructure Project phase I and II' and Land Registry and Cadastre Information System. He worked at CORS-TR project group. He had published more than 30 papers for various academic publications. He works for GeoTech Group as Vice President and executes Libyan National Mapping Project.

**Eng. Mahmoud Ejweli**

He was born in Libya at 1968. He had Civil Engineering BSc degree at 1989 from Al-Fatih University, Tripoli, Libya and MSc Degree in Geodesy at 1994 from Middle East Technical University (METU), Ankara, Turkey. He worked as a Technical Manager in Great Man Made River Company. He is the Director Manager of Geo Tech Group in Libya since 2006.

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