LIBYAN NATIONAL MAPPING PROJECT

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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.**
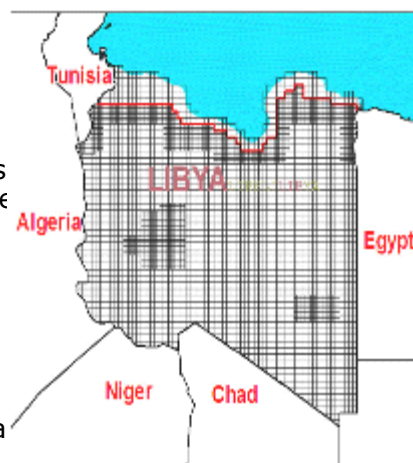
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Like many other countries, Libya also having maps, but most of them in analogue format and not up to date as desirable.

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)"**.

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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.

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NO	TASKS	DESCRIPTION
1	**SDL & MSD Institutional Development and Capacity Building**	- Assessment of SDL & MSD - Study of International best praxis and success cases - Assessment of partnership with local institutions - Reviewing LSDI SDL assessment and upgrade SDL&MSD - Preparation of Strategic plans for SDL & MSD - Development of policies and procedures for data dissemination - Development of organizational chart - Development an institutional capacity building program - Preparation of implementation plan - Supervise implementation plan - Preparation of Technical training program
2	**Map Production, Geodatabase and Portal GIS**	- **Work Package-1**: CORS Establishment - **Work Package-2**: Geodetic Network and Geoid - **Work Package-3**: Ground Control Points - **Work Package-4**: Aerial photography and AT - **Work Package-5**: Orthophoto - **Work Package-6**: Digital, thematic and LBS mapping - 1/25,000 mapping - 1/50,000 mapping - 1/100,000 to 1/2,000,000 mapping - **Work Package-7**: Geodatabase and portal GIS - **Work Package-8**: HW/SE and Equipment - **Work Package-9**: Training

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TASKS	DESCRIPTION
Work Package-1: Establishment of CORS-LIBYA	Establish CORS along coast line of Libya (50 stations)
Work Package-2: Upgrading Geodetic Control Network and Geoid Determination	a) Establish additional stations (200) b) Survey existing stations (61 +) b) Determine national dm-level geoid
Work Package-3: Establishment of Ground Control Points	Establish ground control points for mapping
Work Package-4: Aerial Photography and Aerial Triangulation	a) Acquire aerial images in two seasons (1,660,000 km2) b) Carry out Aerial Triangulation (if required) or c) Carry out georeferencing

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Work Package-5: Orthophoto Mapping	a) Compile DEMs at 5 m grid spacing b) Compile orthophoto maps (1/10K) / 1,660,000 km2
Work Package-6: Production of 1/25K, 1/50K, and 1/100K-2000K Digital Topographic Mapping, Color Land Use Thematic Mapping and Navigational / LBS Mapping	a) Compile 1/25K map sheet (280,000 km2) b) QA/QC 1/25K existing maps (95,000 km2) c) Derive 1/50K map sheets from 1/25K sheet (375,000 km2) d) Compile 1/50K map sheets (1,285,000 km2) e) Derive 1/100K map sheet (1,660,000 km2) f) Derive 1/250K – 1/2000K map sheet (1,660,000 km2) g) Compile color land use mapping for all scales above h) Compile 1/25K navigational / LBS maps (10,000 km2) i) Compile 1/100K navigational / LBS maps (1,660,000 km2)
Work Package-7: Establishment of Geodatabase	Establish geodatabase and metadata consisting of: - Geodetic network points and CORS - Aerial photographs - DEMS and orthophotos - Topographic maps (1/25K -1/2000K) - Landuse thematic maps - Navigational / LBS maps - Other spatial data available in SDL

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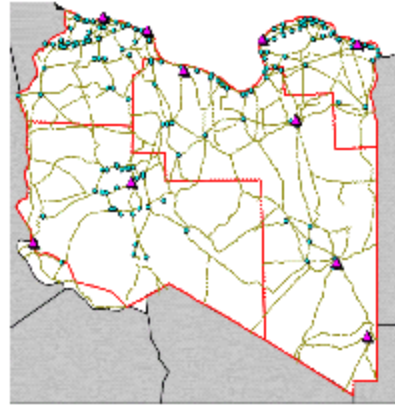| **Work Package-8: Provision of HW / SW and Equipment**	a) Provide servers & workstations &PCs, tablet PCs b) Provide Softcopy Photogrammetric Systems c) Provide GNSS sets d) Provide 4WD Vehicles e) Provide Scanners, plotters, printers, archival drawers f) Provide Geodatabase, GIS and portal software f) Others …
Work Package-9: Training	a) Assist capacity building of SDL b) Conduct training of staff in-house c) Conduct training of staff for B.Sc. degree d) Conduct training of staff for M.Sc. degree

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PHASE I - ESTABLISHMENT OF LGFN POINTS

Phase-1 consists of:

- The design of the LGFN comprising 10 stations tied to at least ten well distributed ITRF stations ;
- simulation analysis of the LGFN as to the precision achievable eventually.
- Reconnaissance for the LGFN stations and monumentation
- GNSS surveys of the LGFN stations
- Baseline computations, least-squares adjustment and analysis
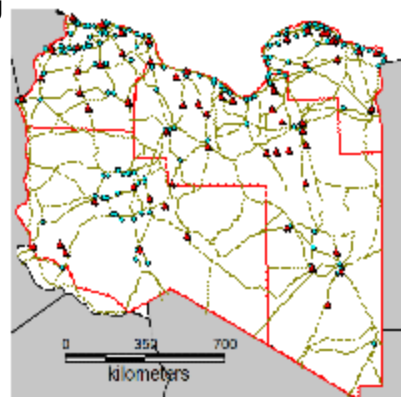- Final report

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PHASE II – ESTABLISHMENT OF LGMN POINTS

Phase-2 consists of:

1. The design of LGMN comprising about 200 stations with an average spacing of 100 km and properly tied to the LGFN stations
2. Reconnaissance for the LGMN stations and monumentation
3. GNSS surveys of the LGMN stations
4. Baseline computations, least-squares adjustment and analysis
5. Final report on all the activities above and results including final coordinates.

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PHASE III GEOID DETERMINATION

Libya Geoid 2009 to **dm-precision** through the present project using the techniques of GNSS leveling as we do not have gravity data available to SDL. The objective here is to GNSS survey levelling points, whose orthometric heights are known, and determine the geoid using analytical techniques such as kriging, minimum curvature surface fitting, etc. For this purpose, levelling points will be GNSS surveyed and computed to the national accuracy and standards of 2nd order control or better

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CORS LIBYA

▸ CORS-LIBYA consists of a network of multi-functional RTK and DGNSS reference stations providing signals that could be used for geodetic point positioning, land, marine and air navigation.

▸ CORS-LIBYA will fulfill all accuracy requirements of geodesy and navigation: **centimeter and sub-centimeter levels of accuracy** in the post-processing mode, and centimeter, decimeter and meter levels of accuracy in the real-time mode.

▸ It will guarantee availability and quality of service continuity. CORS-LIBYA network will include **45 reference stations** to be installed and five reference stations to be used for monitoring and replacement purposes in emergency cases.

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CORS LIBYA OBJECTIVES

The main goals of this project are the establishment of
CORS stations functioning 24 hours / day and the
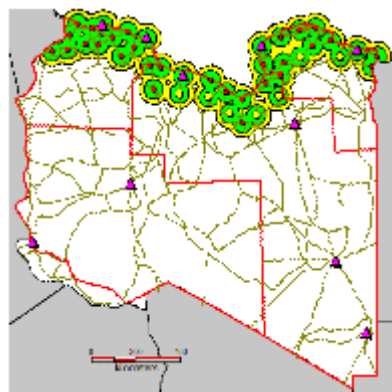determination of datum transformation parameters
as presented below:

Goal-1: Providing continuous real-time cm-level
precise geodetic positioning along the northern part
of Libya (i.e. 24 hours / day, 7 days / week) for
collecting geographic data, including data for
terrestrial mapping and cadastre, by much faster,
more economical and reliable means.

Goal-2: Providing dm- and m-level positioning for
navigation and vehicle tracking in air, land and sea.

Goal-3: Modeling the atmosphere (troposphere
and ionosphere) over the area and contributing to
atmospheric studies and weather predictions, as well
as studies on signals and communication.

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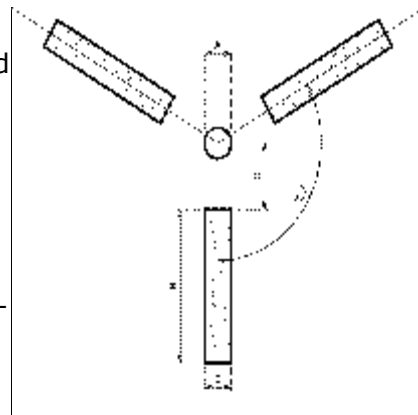## The scope of CORS-LIBYA

Project consists of four
major tasks:

•the site preparation and
monumentation of CORS
sites,
•provision of CORS receivers
and peripherals,
•establishment of CORS
control center, and finally
•the installation and making
the entire system fully
operational.

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ESTABLISHMENT OF GROUND CONTROL POINTS

▸ Design the most optimum number and locations of ground control points required for aerial triangulation.
▸ Monument and presignalize ground control points
▸ Carry out GNSS surveys, baseline computations and adjustment, all based on LGFN, LGMN and Existing SDL Network control points.
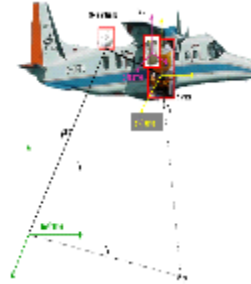
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AERIAL PHOTOGRAPHY

The aerial photography shall cover the entire country at 60 cm GSD resolution using digital aerial photography, amounting to 1,660,000 km2

The scope of work here includes:
▸ Pre-signalization of ground control points
▸ Preparation of flight plans
▸ Flight by digital aerial camera and acquisition of digital images
▸ Processing of airborne GPS and IMU data
▸ Postprocessing of raw images
▸ Preparation of prints
▸ Aerial triangulation (tie points, mensuration, image coordinate refinement, adjustment computations)

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- The Digital Aerial Imagery will **cover the entire area of Libya.** The aerial imagery will be undertaken so as to provide **complete stereoscopic coverage** over the specified area. SDL will provide assistance in connections with the Foreign ministries in Libya and in neighbouring countries in order to get permissions to fly over the border areas.
- All project area must be covered with digital aerial imagery of **60 cm GSD**. The SDL may divide the total area into sub-blocks , with the condition that such division is shown in flight plans and approved by SDL prior the flights.

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- A minimum margin of 1 km around the coastline must be included.
- A minimum overlap of 5 km between all the AT sub blocks is required, to be included in the blocks layout.
- The following overlap percentages at a minimum:
  - **in case of 60cm GSD**:
  - **Forward overlap:**   **60% ± 5%**
  - **Side overlap:**   **30% ± 5%**
- The flight direction of strips should alternate as much as possible, in order to prevent accumulation of systematic errors.

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AERIAL TRIANGULATION

‣ The ground control for the required (Orthophoto) mapping scales will be extended by aerial triangulation using the digital imagery together with direct sensor orientation

‣ Using the post-processed digital aerial images, the geodetic control data for the pre-signalised ground control points and the airborne GPS and IMU observations, aerial triangulation and its adjustment shall be carried out, separately for each block. **Each block shall have an overlap to adjacent blocks of at least 1 flight line or 3 images.** Measurement of all photogrammetric data for aerial triangulation shall take place at Digital Photogrammetric Workstations (DPW) using the post processed aerial digital images.

‣ The block(s) to be triangulated shall be planned in such a way that enough redundant observations can be taken to ensure a high geometric stability of the block(s) resulting in well defined, numerically stable unknown parameters during the adjustment process.

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‣ To obtain absolute accuracies, **the geodetic control established through ground surveys** shall be supplemented by the spatial co-ordinates of the camera projection centres derived from the **airborne GPS observations**, and the camera orientation angles derived from the **airborne IMU** data blended with GPS data with appropriate weight.

‣ The final output from aerial triangulation will be the coordinates of all the tie points in the mapping datum of UTM based on the LIBYA DATUM

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- Measuring accuracy of the DPW should be **better than 0.5 pixel**. DPW's from well established brands such as Inpho/DATEM, Intergraph, SocketSet and Leica are accepted. Other brands must be approved by SDL before image measurements are carried out.

- Image mensuration will normally **be carried out using an automated image correlation method** based on least square measurement approach to provide a precision in x- and y-coordinate of tie points **at 1/10 pixel level**.
- Automated image measurements should be supplemented with manual measurements, where necessary, to ensure acceptable distribution of tie points in the model.

▸ To ensure high reliability and accuracy, only bundle block adjustment with robust estimators, additional parameters and the ability to process **GPS and IMU observations** will be allowed. For the purpose of aerial triangulation adjustment, computer programs such as **MATCH-AT and comparable software** packages shall be used.
▸ After simultaneous least squares adjustment, an overall standard deviation of unit weight **(sigma-naught)** smaller than **+/- 0.5 pixel** shall be met.
▸ AT procedure which adjusts all observations in the image block simultaneously. The adjustment shall be conducted according to a rigorous application of the principle of least squares with complete error analysis.

ORTHOPHOTO MAPPING

Orthophoto maps shall cover the entire country at **1/10K** scale, amounting to 1,660,000 km2

The scope of work here includes:

▸ Compilation of Digital Elevation Models **(DEMs) at 5 m grid interval**
▸ Compilation of **contours at 5 m** interval
▸ Processing of images and compilation of orthophoto maps

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DTM

▸ *Ground Sampling Distance* is the nominal ground resolution of the aerial image
▸ *Grid Distance* is the distance between successive points of the interpolated grid of the DEM in Northing and Easting
▸ *Contour Interval* is the interval at which contours should be generated and recorded in a separate layer
▸ *Road Spot Interval* is the interval at which spot heights should be measured at all major street intersections and on all asphalted or non–asphalted roads
▸ *Sigma Spot Height* is the required measurement accuracy of manual spot height measurements relative to the given photogrammetric control for each stereo model
▸ *Sigma Roof Top* is the required measurement accuracy of manual spot height measurements of roof tops relative to the given photogrammetric control for each stereo model
▸ *Sigma Grid Height* is the required accuracy of the interpolated height grid of the DEM

Ground Sampling Distance (m)	0.60
Grid Distance (meter)	40
Contour Interval (meter)	5
Road Spot Interval (meter)	200
Sigma Spot Height (meter)	1.0
Sigma Roof Top (meter)	1.0
Sigma Grid Height (meter)	1.5

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REQUIREMENTS OF ORTHOPHOTO MAPS

- *Orthophoto Ground Resolution* is the pixel size of the orthophoto in the terrain
- *Interval Intermediate Contours* is the normal interval of the contour lines
- *Interval Index Contours* is the interval of the contour lines that should be labelled
- *Interval Supplementary Contours* is the interval of the contour lines in case the terrain is very flat and intermediate contours do not satisfactorily represent the terrain
- *Map Size* is the dimension of the orthophoto map in the terrain. The dimension is stated as Easting x Northing

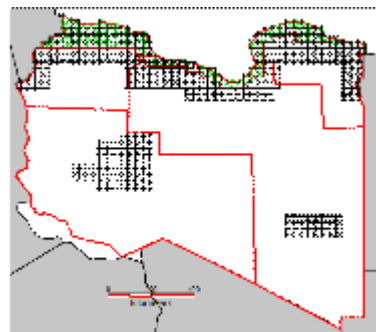| Orthophoto	
Orthophoto Ground Resolution (meter)	0.80
Interval Intermediate Contours (meter)	20
Interval Index Contours (meter)	100
Interval Supplementary Contours (meter)	10
Map Size (kilometer; East x North)	

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COMPILATION OF DIGITAL TOPOGRAPHIC MAPS

OBJECTIVES

The objective is to produce 1/25K covering selected areas and 1/50K and 1/100K – 1/2000K digital topographic maps covering the entire Libya.

STATEMENT OF WORK

The following tasks will be completed in this package:
- Compilation of **1/25K** scale topographic maps
- QA / QC of existing 1/25K maps produced through a previous project
- Compilation of 1/50K scale topographic maps
- Derivation of **1/100K, 1/250K, 1/500K, 1/1000K and 1/2000K** digital topographic maps

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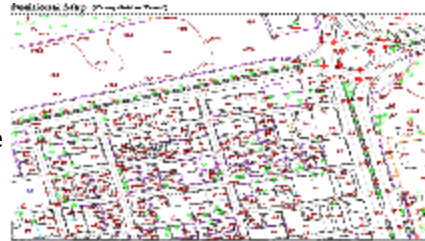## COMPILATION OF COLOR LAND USE THEMATIC MAPS

OBJECTIVES

The objective is to produce 1/25K covering selected areas and 1/50K and 1/100K – 1/2000K digital thematic maps covering the entire Libya. These maps will serve all the users of geoinformation in Libya.

STATEMENT OF WORK

The following tasks will be completed in this package:

▸ Production of 1/25K scale thematic maps
▸ Production of 1/50K scale thematic maps
▸ Derivation of 1/100K, 1/250K, 1/500K, 1/1000K and 1/2000K digital thematic maps

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COMPILATION OF NAVIGATIONAL / LBS MAPS

OBJECTIVES

The objective is to produce 1/25K navigational / LBS maps covering selected areas and 1/50K and 1/100K – 1/2000K digital navigational / LBS maps covering the entire Libya. These maps will serve all the users of geoinformation in Libya.

STATEMENT OF WORK

▸ The following tasks will be completed in this package:
▸ Production of 1/25K scale navigational / LBS maps in urban areas
▸ Production of 1/100K scale navigational / LBS maps in entire Libya

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ESTABLISHMENT OF GEODATABASE

OBJECTIVES
The objective is to establish a comprehensive geodatabase for SDL and use digital / Internet technology for data storage, query, analysis and applications.

STATEMENT OF WORK
The following tasks will be completed in this package:
▸ The design of geodatabase
▸ The establishment of metadata
▸ The establishment of geodatabase

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TRAINING

▸ 2 year education as MSc for staff members with BSc,
▸ 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.

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CONCLUSIONS

▸ 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 by GeoTech Consulting.

▸ The project is shortly before signature by a contract company, so several steps of the consultancy have been finished always.

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THANKS
FOR YOUR ATTENTION

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