

**PROJECT FOR THE PRODUCTION OF 1/1000
SCALE BASE MAPS FROM COLOUR IMAGES
USING DIGITAL CAMERAS IN BURSA
METROPOLITAN AREA (BMA) IN TURKEY**

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1.AIM OF PRESENTATION

The aim of this presentation is to share the experiences gained from the Project commissioned to produce vector and orthophoto base maps in the National Standards of 1/1000 and 1/5000 using 10 cm Ground Sampling Distance (GSD) digital aerial photographs in Bursa Metropolitan Area (BMA) which is the 4th largest metropol in Turkey with a population of nearly 3 million and 3.500 km² area.

**2. GEOGRAPHICAL LOCATION OF THE PROJECT AREA
AND SOME CHARACTERISTICS**

Bursa Metropolitan Area (BMA) is

- situated on the South Coast of Marmara Sea in Turkey and influenced by Istanbul Metropolitan**

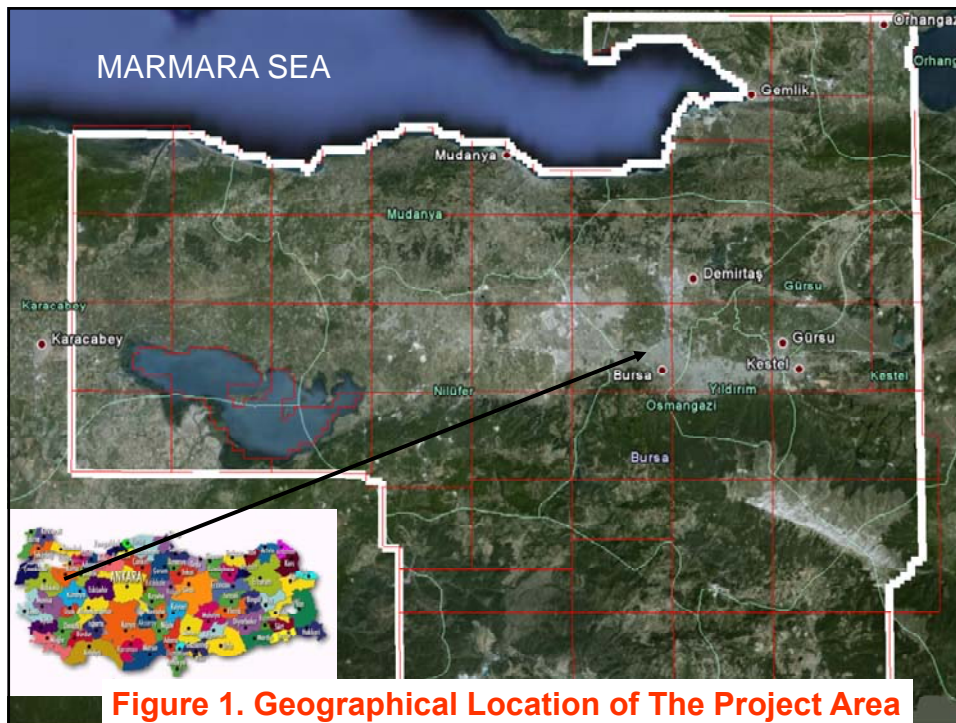


Figure 1. Geographical Location of The Project Area

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- between the latitudes of 39^o.09' – 40^o.50' North
- and longitudes of 28^o.35' – 29^o.45' East

The project area;

- has a rugged topography varying between Bursa Plain with a average height of 100m and the Uludağ Mountain with 2,540m.,
- is under the influence of the west section of North Anatolian Fault zone constituting the most active seismic belt of Turkey, and is considered in the 1st degree seismic zone,
- has an approximately 5% population increase per year
- ranks the 4th in terms of economic contribution national inland revenue.



3. IMPORTANCE OF GEOGRAPHICAL DATA FOR BMA

Due to the aforementioned natural and cultural characteristics of BMA;

- Its natural and manmade characteristics of the surface changes are occurring very rapidly
- Due to these changes, it is necessary to update the existing geographical information, documentation and to produce up-to-date geographical data for appropriate expanding areas.

3.(CONTINUE)

- In parallel to population increase, economical and social developments of the area, the need for planning about surface; infrastructure projects production and implementation activities is more urgent than ever.
- Up-to-date and reliable geographical data and information are basic necessities for these planning, projecting and implementations.
- So it is decided to “UPDATE AND RENEW EXISTING LARGE SCALE VECTOR AND ORTHO-PHOTO BASE MAPS OF BMA” which is the first of basic requirements of expanding and developing BMA.

4. BASIC PROPERTIES AND PURPOSE OF THE BASE MAP PROJECT

The project ;

- was contracted in November 2008 to the “Mescioglu Eng. And Consultant Company” with the about \$5 million project budget
- is planed to complete in 24 monthes and aimed to produce vector and colorful orthophoto base maps of BMA
- The base maps and geographical data to be produced are proposed to:
 - .Be on GRS 80 Ellipsoid and in ITRF–96 Datum,
 - .Have ± 10 cm positional and height accuracy,
 - .Be coherent with existing topographic and the other thematic maps (integrated),
 - .Be consistent with national geographical data infrastructure and all kinds of geographical information systems, forming a base for all sorts of local and general administrative planning purposes, projects and land use implementations

5. STAGE OF CONDUCTING THE PROJECT

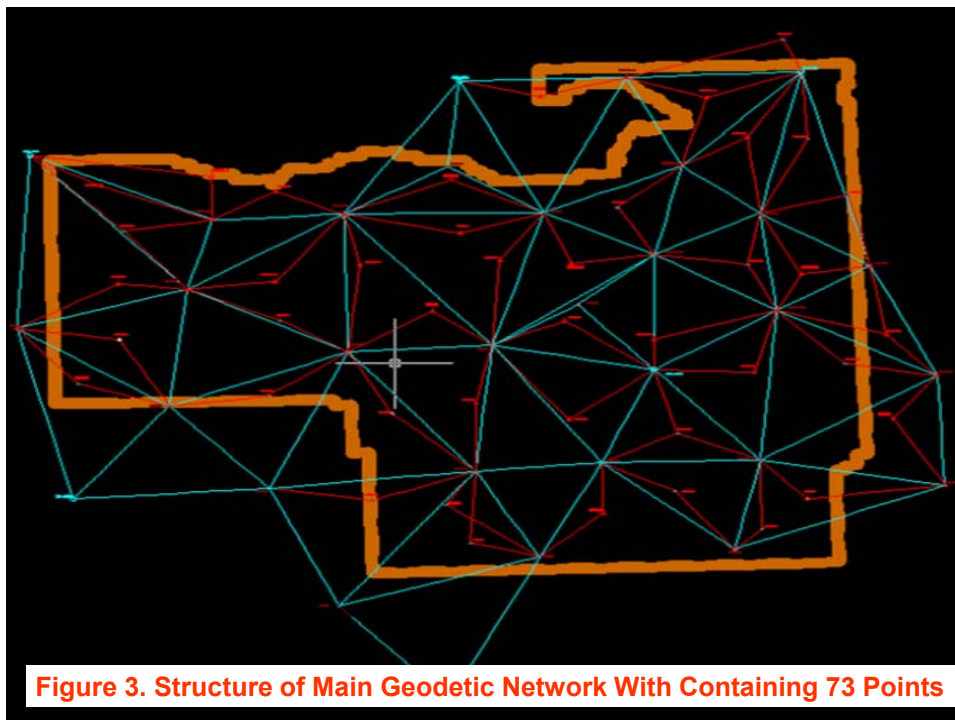
The project has the following task steps:

- Formation of geodetic infrastructure,
- Recording flight and imagery,
- Image process
- Photogrammetric triangulation and adjustment
- Stereo compilation
- Orthophoto and vector map sheet production
- Field checks and quality control.

6. GEODETIC STUDIES

In the project area, the main geodetic GPS network is established:

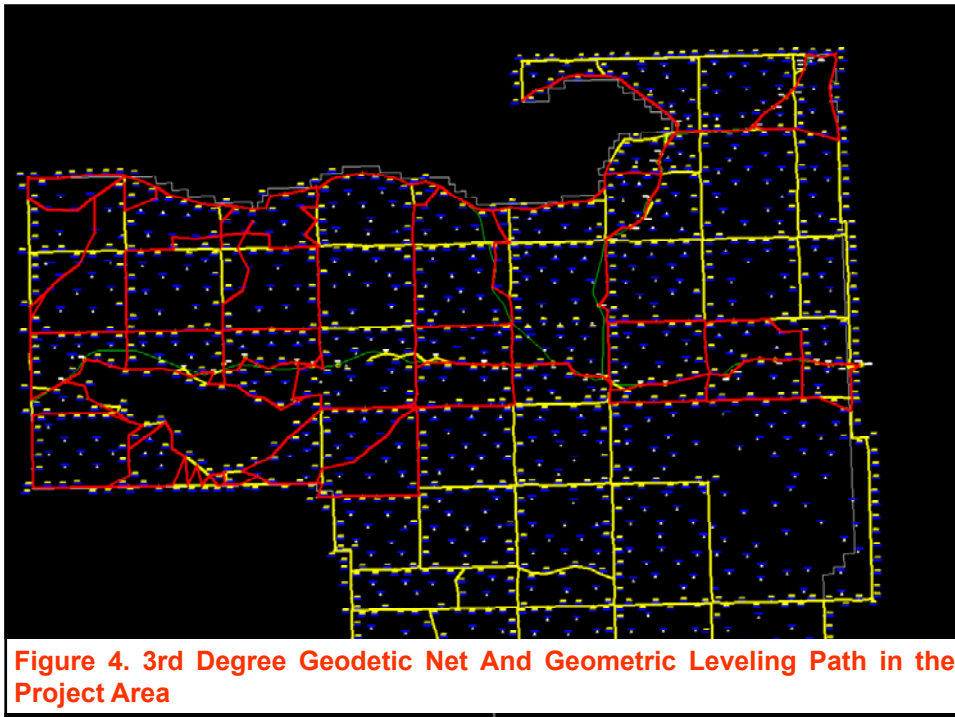
- to comply with the technical specifications of the project for all kinds of photogrammetric planning and geographical implementation purposes,
- to connect to the National Basic Geodetic Network of the country,
- to have 73 control points of the first and second degree with 5-15 km spacing. (Figure 3)



- Accuracy of the network: $\sigma\Delta X, \sigma\Delta Y, \sigma\Delta Z \leq \pm (10\text{mm} + 1\text{ppm})$,
 $\sigma\delta, \sigma\lambda \leq \pm 3 \text{ cm}$ $\sigma h \leq \pm 5 \text{ cm}$
 - For the traditional photogrammetric necessity 1200 GPS points of 3rd degree with 0.8-2.0 km spacing are established also. (Figure 4)
- These points are:
- Connected to the main geodetic network of the project
 - Suitable for photogrammetric flight patterns and operations supported by both static and kinematic GPS observations
 - A leveling network of 460 benchmarks is established using precise leveling with a total path of 1.740 km. (Root mean square from free adjustment: $m_0 = \pm 3.83 \text{ mm}$).
 - Furthermore, GPS leveling is conducted on 7 benchmarks whose heights could not determined using geometric leveling ($m_0 = \pm 4.37 \text{ mm}$)
 - Result information produced which based on the above measures for local geoid are given in table 1

Table 1 Brief Value About Calculation of Local Geoid

Used number of points	433
Degrees of freedom	414
Test limit value	3.8278
Polynomial degree	5th degree 19polynomial
Root mean square	$\pm 0.054\text{m}$
Minimum correction	-0.159
Maximum correction	0.185
Nmin	37.30m
Nmax	39.03m



7. PHOTOGRAMMETRIC FLIGHT AND STUDIES FOR TAKING DIGITAL PHOTOGRAPHS

- In the country, in National Technical Specification, concerned with large scale photogrammetric base map production, it is foreseen that photographs should be taken using film-based (analog) cameras and the digital camera usage can be possible with a special permission in project basis.
- At the BMA Bursa Project, the benefits of using digital air camera which is supported by GPS/IMU have been evaluated in terms of being technical economical and the digital camera usage of the contractor has been allowed. By this usage, an economical gain circa 15% (500.000 \$) was recorded in comparison to the usage of analog camera and technique.

(7 Continue)

- Also in National Technical Specification, the relations and the criteria between the technical qualifications of the air cameras and images which will be used in large scale map production and the scales of produced maps (the GSDs, photogrammetric project parameters, accuracies of the positioning etc.) have not been identified. In this project, the ambiguities about these subjects were solved by the Project administration.

8. THE FLIGHT AND IMAGING EQUIPMENTS, USED IN THE PROJECT AND THE PROJECT PARAMETERS

- Aircraft : Cessna T207
- Camera : UltraCam-XP (Large Format Digital Camera)
- Technique : Direct sensor orientation (GPS /IMU supported)
- Camera and photogrammetric project parameters are as blow:
 - . Camera focus length (f) : 100.5 mm
 - . Image format : 11310 pixel x 17310 pixel
 - . Pixel size (Ps) : 6 μ m
 - . Distance between the columns : 1100 m
 - . Base length : 340 m
 - . Flight height (h) : ~ 57000 ft = 1733 m
 - . Photograph scale : ~ 1/17300 (100.5/1733000)
 - . Ground Sampling Distance (GSD) : (Ps/f) X h = 0.1034 m
 - . Frontlap : %70, Sidelap:%30

9.PHOTOGRAMMETRIC TRIANGULATION AND ADJUSTMENT

- The Project area has been divided into 49 photogrammetric blocks which are consisted between 200 and 800 models and has 7000 hectares average area.
- Photogrammetric triangulation measurement and adjustment processes were performed using with Z/I software, ISAT (Image Station Automatic Triangulation).
- “Block adjustment by bundle of rays” technique was used.
- The mean square errors of the photogrammetric points are between $\pm 1-3$ cm after the adjustment.

10. STEREO COMPILATION, ORTHOPHOTO AND GRAPHIC BASE MAP PRODUCTION

- At the digital work stations, models are consisted by Photogrammetric Manager 5.1, third dimensional (3D) vectorizations on these models are performed using Microstation V8 together with Image Station Stereo Display 5.1 softwares at the same time. At the end of these processes, the outcome design (.dgn) files are achieved which consist 1/1000 scale vector maps. Additionally, using the generated digital elevation model (DEM), orthophotos are acquired. These outcomes are titled as the first output sheets.
- After those productions, required edits, completion processes on the terrain and quality controls of the first output sheets are performed and they are submitted to the project control unit (Consultant University). These submitted outcomes are titled as the second output sheets.

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- Similar with the other processing steps, the project control unit, checks the 10-20% of the second output sheets by office and terrain controls and gives back them to the contractor for the edition of assigned local and general lacks and mistakes.
- After removing these lacks and mistakes, the 1/1000 and 1/5000 scale sheets are submitted to the employer for the approval.(Figure 5)

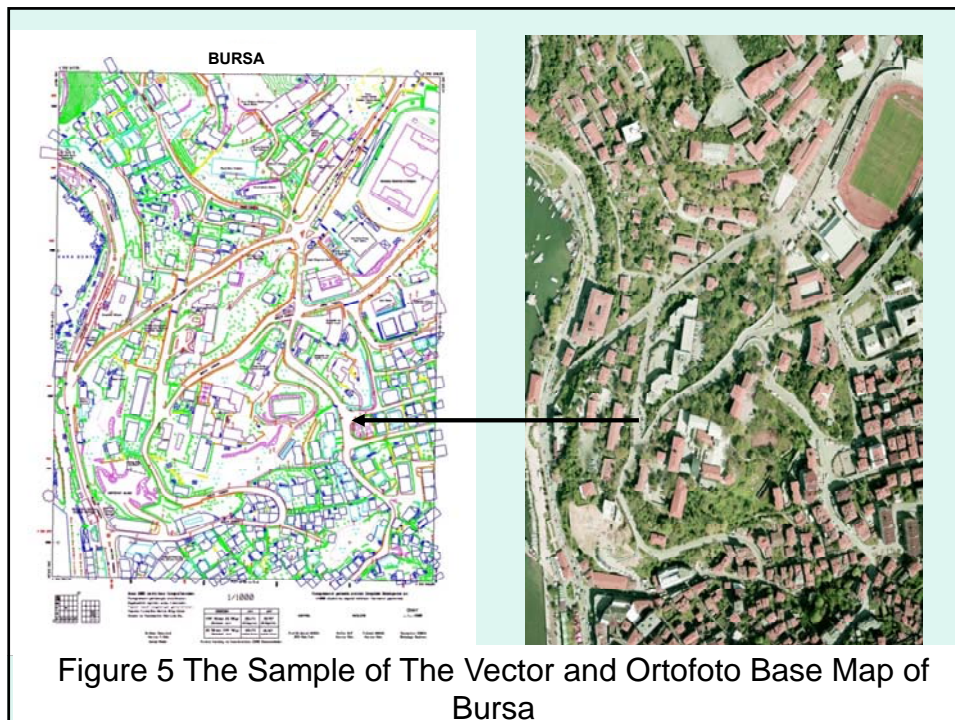


Figure 5 The Sample of The Vector and Ortofoto Base Map of Bursa

11. Results

- **Geographic based planning projects and services are more needed to where the topography and the surface are rapidly changes due to natural, cultural and economical reasons such as BMA**
- **For this reason, current and accurate geographic information is needed**
- **Large scale base maps come, at the beginning of this information**
- **Vector and orthophoto base maps which are produced from colorful aerial photographs with 10cm GSD value obtained from the BMA using a digital aerial camera and GPS/IMU supported are first major project that is implemented to meet needs of BMA. Therefore the results are observed across the country and gained more knowledge and experience**

11.(CONTINUE)

- Project is continued 60 percent of the area that field completion and map sheet producing stage
- Produced the Vector and Orthophoto base maps are provided to national technical specifications
- Zonguldak Karaelmas University (ZKU) Department of Geomatics Engineering is consultant and controls of the project which have got sufficient academic staff and practice for realization of this major project
- It is planned by the ZKU Geomatic Engineering Department that these photogrammetric and geodetic data and experiences gained from the project will be the source for the master/doctorate studies and the scientific publications also.

THANK YOU FOR YOUR ATTENTION