ACCURACY AND QUALITY CONTROL OF THE PHOTOGRAMMETRIC DIGITAL MAP PRODUCTION OF ISTANBUL

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ABSTRACT :

In this paper, the accuracy and the quality control of Photogrametric Digital Map Productuon of Istanbul will be explained. The scales of the produced maps are, 1/500 and 1/1000. During the control period, modern analytical plotters, workstations, total stations and other related instruments had been used. From the beginning till the end, control process succeded each production step. No source of error was found to be a bottleneck in the production lines. Results which are very satisfactory can be seen as follows.

1. INTRODUCTION

Istanbul is a unique city located on two continents, Europe and Asia, with a population of 10 millions and covering an area of 940 sq. km. In July 1987, Metropolitan Municipality of Istanbul decided to have uniform (base) maps of Istanbul with scales of 1/500 and 1/1000 produced, /3/. Control process had started from the beginning of the project.

2. CONTROL PROCESS

The supervision of this project had been carried out by the staff members of Geodetic and Photogrammetric Engineering Department of Engineering Faculty of Yıldız University-İSTANBUL. Control Process was initiated with the establishment of ground control points. For convenience in block adjusment of aerial triangulation, whole area was divided into 21 blocks as in figure 1., below:

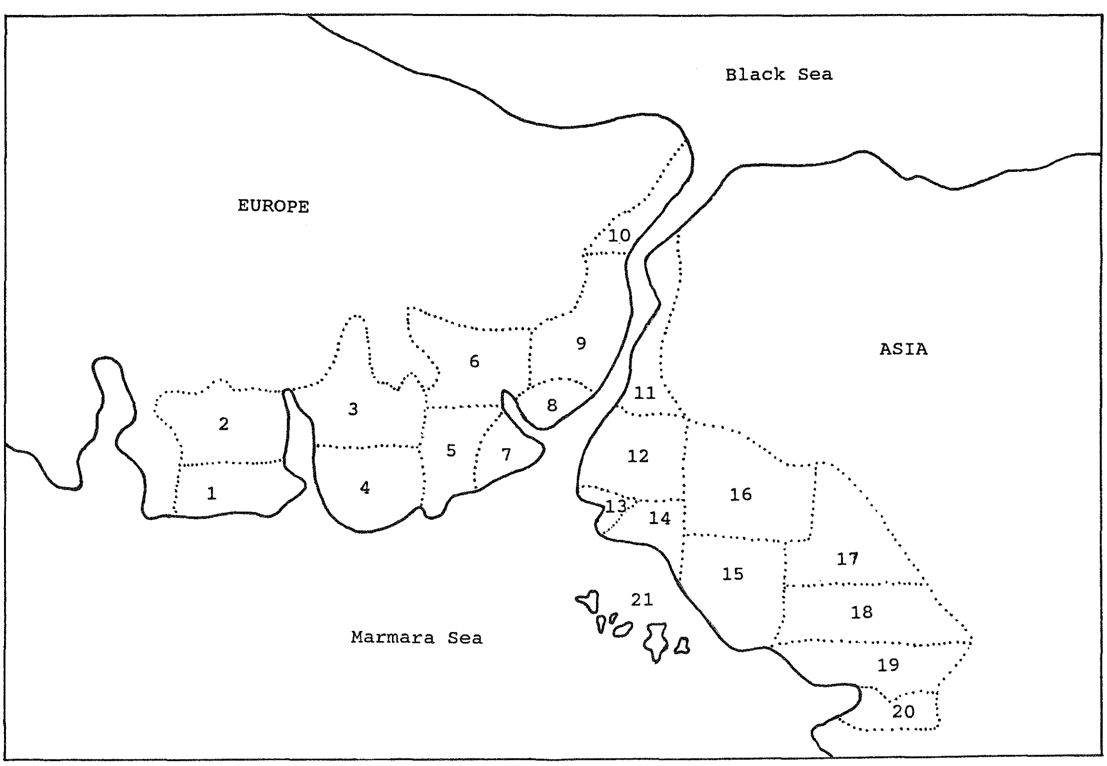

Figure 1: Project Area and Blocks for Istanbul Photogrammetric Digital Maps.

2.1 Ground Control

2.1.1. The Control of Distribution, Signalization and Shapes of Ground Points.

Before taking aerial photographs, we have checked first, the distribution, signalization and the shapes of ground points, whether they were suitable to the technical specifications or not. The contractor was informed of the missing or the corrupted points.

2.1.2. The Control of Geometric Accuarcy of Ground Control Points (GCP) and Height Control Points.

There were 1500 GCP and 1200 Height Control Points in the Whole area, /3/. In order to check the triangulation chain network and levelling network, electronic theodolites, Wild T.2000 with D15-GRE 3, data recorder and Zeiss Ni-2 levelling instruments had been used. Checking has been done by sampling method in which 10 % of the GCP had been verified. At the end of calculations, position error of full ground control was found as $m_p = \pm 5.7$ cm. and max. position error was found as $m_{p(max)} = \pm 8.7$ cm. For the height control, according to the test measurements, mean square error was $m_h = \pm 1,2$ cm. and max. height error was $m_{h(max)} = \pm 3$ cm. As a result, it is easily said that, all ground control measurements and calculations were suitable to the technical specifications, and we confirmed them.

2.2. Control of Aerial Photographs

Aerial photographs were taken using a Zeiss RMK camera with a Forward Motion Compensation system, /3/. After developing the films paper prints of these photographs had been taken. From these prints and also from original films, following points have been taken into account in order to the detect whether they are suitable to the technical specifition or not.

. Forword and lateral overlap percentages,
. Quality of aerial photographs,
. And other conditions on the technical specification.

2.3. Control of Aerial Triangulation

Before starting aerial triangulation, we have controlled the calibrations of Inter Map Analytic (IMA) Instruments as well. Since these instruments as a comparator for aerial triangulation mesurements. For aerial triangulation adjusment, the PAT-MR (PC-Version), "Block Adjustment with Independent Models" program has been used, /3/. Each block was adjusted separately. International tests have been applied to each block. Sigma naught values which are very important because of block stability were found to be approximately 5 micrometers for planimetry and 9 micrometers for altimetry for each block. On the other hand we also made some tests, such as, decreasing the number of GCP, namely i=4b for planimetry and i=8b for altimetry. We found that, there was no significant change on the sigma naught values either for planimetry or for altimetry. This shows that, aerial trangulation measurements and calculations were good enough. According to us, these results were sufficiently accurate for large scale digital map production.

3. CONTROL OF DIGITAL PHOTOGRAMMETRIC MAPS (SHEETS)

In the Figure-2,sheet control flow-chart is shown:

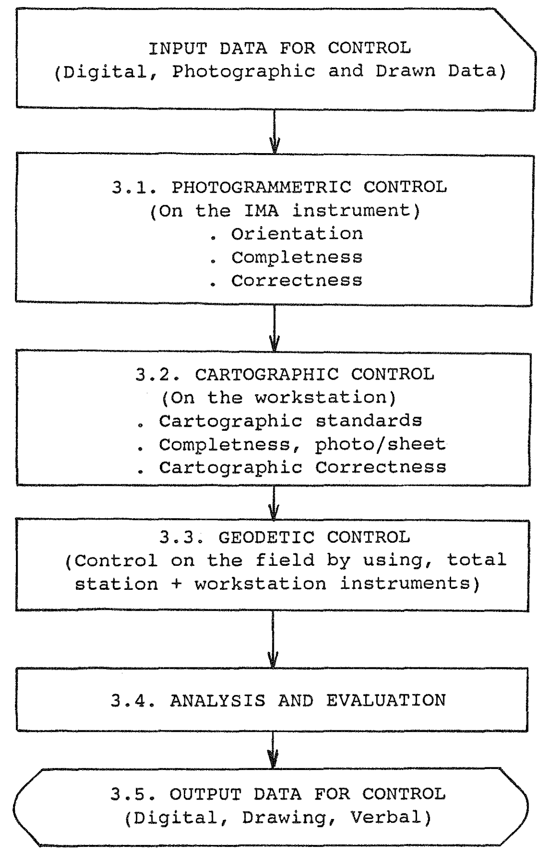

Figure 2: Sheet Control Flow-Chart

3.1. Photogrammetric Control

Photogrammetric control was performed on the 10 % of the models (sheets), choosen by sampling method on the IMA instrument. For this purpose diapositives of these models have been oriented on the IMA. After making inner orientation, results of relative orientation and absolute orientation have been checked. By means of superimposition, PLN-file, TOP-file DTM-file, and beside these, completness and correctness of the photogrammetric evaluation have been verified. If there were some missing points, they were pointed out and the contractor was asked to complete them.

3.2. Cartographic Control

For cartographic control, 2 Intergraph 32 C Workstation and Vax tarminals and a drum plotter have been used. As software, IGDS and ICS have been used. The completness, correctness and the quality of cartographic data have been verified by PLN-TOP-DTM files. By means of MFC.TBL attiributes of graphic data have been checked. Such as:

. Symbology
. Coincidence
. Pattern error

- Verbal data
- Position error of tie points
- Grid lines

If there were some errors or some missing items among these subjects or anything beyond the technical specification limits, they were pointed out on the sheets and sent back to the contractor.

After they were corrected and completed by the contractor these sheets were also certified.

3.3. Geodetic Control

Geodetic control was performed on the 10 % of the sheets choosen by sampling method. We have used total station (electronic tacheometer), Zeiss Elta-3 and REC-500 recorder, on the field. Later, Intergraph 32-C workstation was also used. By using IGDS graphical software package, field data had been compared with the design file.

In order to check the application quality of these maps, optical plump ZLN is utilised. It was a very handy tool, to point out the projection point of the roof corners on the ground.

3.4. Analysis and Evaluation

The analysis and the evaluation of the control measurements carried out in this five phases are as fallows:

- Planimetry
- Neighbourhood
- Point height
- Contour height
- Application and updating

3.4.1. Planimetric error of arbitrary point which can be well defined was computed by this formula, /4/.

$$m_p = \sqrt{m^2_x + m^2_y}$$

where,

$$m_x = \sqrt{\frac{(\mathcal{E}_x - a_x)^2}{n_x - 1}} \qquad m_y = \sqrt{\frac{(\mathcal{E}_y - a_y)^2}{n_y - 1}}$$

$$\mathcal{E}_x = x_{photogrammetric} - x_{geodetic}$$

$$\mathcal{E}_y = y_{photogrammetric} - y_{geodetic}$$

$$a_x = \frac{\sum \mathcal{E}_x}{n_x} \qquad a_y = \frac{\sum \mathcal{E}_y}{n_y}$$

In the first check after having measured 652 points, position error $m_p = \pm$ 13.8 cm. had been found. On the other hand, differences which were explained above are shown, in table 1:

Differnces	Measured point Number	Percentage	
0 - 10 cm	234	36	76
11 - 20	259	40	
21 - 31	117	18	24
31 - 40	42	6	
	652	100	

Table 1: Differences for position

As it is shown in table 1, 76 % of the measurements were suitable to technical specifications. However the rest 24 % of the measurements needed to be corrected. These sheets were sent to the contractor back. In the second (or third) check, they were also found to be suitable. Therefore we confirmed them.

3.4.2. The differences for neighbourhood were also computed, by the formula:

$$m_n = \sqrt{\frac{\mathcal{E}^2}{n}}$$

$$\mathcal{E} = \text{Distance}_{(map)} - \text{Distance}_{(control)}$$

Where $\mathcal{E}$ is the difference between distance in map (digital photogrammetric data) and the distance measured by the control team on the ground. And from the first check neighbourhood error $m_n = \pm$ 10.9 cm has been found.

Differences	Measued distance Number	Percentage	
0 - 10 cm	314	57	85
11 - 20	154	28	
21 - 31	61	12	15
31 - 40	19	3	
	548	100	

Table 2: Differences for neighbourhood.

By the way, as it is shown in table 2, 85 % of the differences on measured distances were suitable to technical specification. Other 15 % of the differences needed to be corrected. These sheets were sent to the contractor back. And later on, second (or third) check was done. Then it has been seen that they were all corrected.

3.4.3. For the point height control, according to the test results, avarage height error of well identified points had been found as $m_h = \pm$ 11 cm.

3.4.4. For the control of height error of contour lines 5 crossections were measured and compared with the design file. In each crossection there were 15 points. As a result the mean height error of contour lines was found to be $\pm$ 20 cm. So, at the end of Geodetic control, all measurements were found to be acceptable and they were confirmed.

3.4.5. Meanwhile for applications purposes, resection method also had been made use of. Since the digital map coordinates of wall corners, roof corners or other sharp points were already known, the coordinate of resection points were found easly by using electronic tacheometer. According to the tests results position error, $m_p = \pm$ 6 cm. has been found on these resection points.

By means of these resection points, application of some new points which are known on the map, were also made easily on the terrain.

On the other hand for updating purposes some new points on the terrain were also measured with the help of these resection points and maps were completed very quickly.

So it has been seen that, the application quality and map completion (updating) capability of these maps were very high. And they were very suitable for the thecnical specification which is compatible with international standarts.

4. CONCLUSIONS

The accuracy and the quality of these maps largely fulfill the standard requiremets of the technical specification.

These digital maps can give graphical and verbal data easily. So, they can be used as a"base-map" for land information system.

It is easily possible to transfer old maps data and cadastral data to these digital maps.

It can be said that these digital maps may easily be updated and used for application purposes.

REFERENCES

1/ ALKIŞ,A., SAGAY,Z., KOYUNCU,D., Photogrammetric Digital Mapping for İstanbul Land Information System. ISPRS 16. International Congress, 1-10 July, 1988 Kyoto-Japan.

2/ ALKIŞ,A.,EVRANUZ,C.,ÖRÜKLÜ,H.E., İstanbul Land Information System. ISPRS 16. International Congress, 1-10 July, 1988 Kyoto-Japan.

3/ ALKIŞ,A., ÖRÜKLÜ,H.E., BATUK,G., BAYRAM,B., Experiences on the Photogrammetric Digital Mapping for Istanbul Land Information System ISPRS 17. International Congress, 2-14 August 1992, Washington-USA.

4/ JOHANSEN, I.M., Digital Mapping in Norway- Experiences from An Accuracy Test. Norwegian Institute of Technology, Division of Geodesy- Photogrammetry