PHOTOGRAMMETRIC MAP PRODUCTION FOR COASTAL BELT WATER PROJECT IN LIBYA

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INTRODUCTION

In the frame of the Libiyan development plan the Coastal Belt Water Project /C.B.W.P./ has one of the essential roles. The main purpose of the project is to convey the oasis water /Tazerbo/ to the Coastal line Benghazi - Ajdabija - Sirt. /See Figure 1/.

Water will be conveyed by 4 m diameter pipe line mostly gravitationaly. Therefore, the map /produced photogrammetricaly/ for planning purposes of corresponding accuracy was needed.

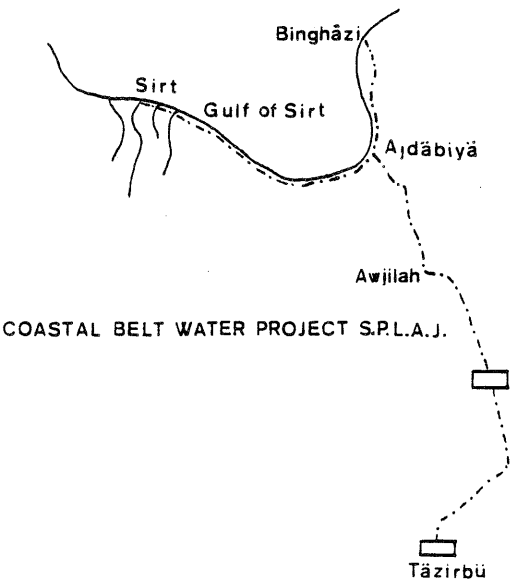


Figure 1. Location of the C.B.W.P. in Libya

The necessary terrain measurements for ground control contained the ordinary traverse observations. In order to densify existing trigonometric net the satelite and astronomic measurements took place. This paper concentrates on photogrammetric part of the map production which was entirely realised by Geodetski zavod SRS.

EVALUATION OF THE PROJECT

Figure 2 shows the planned subsequent phases of the map production.

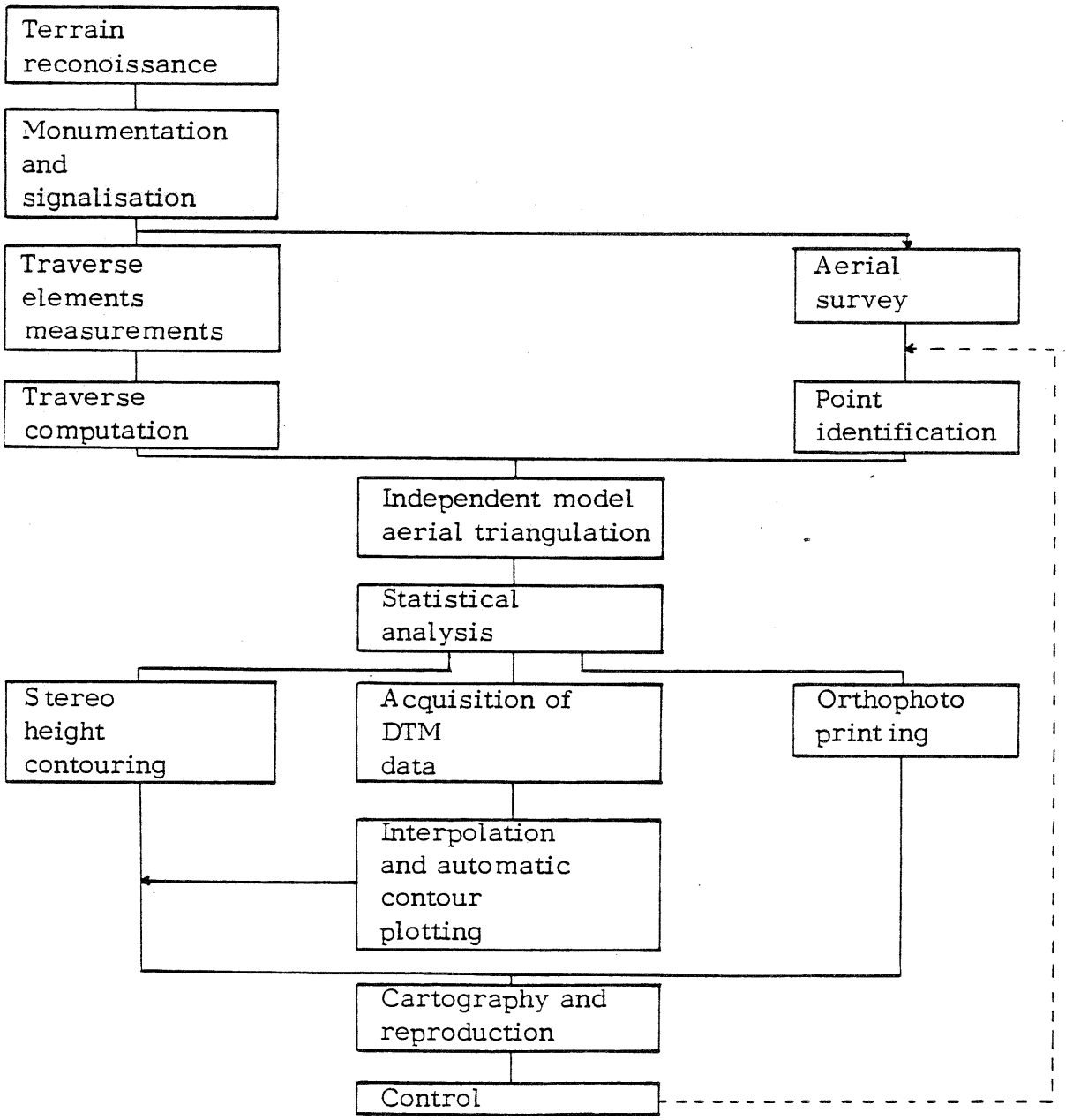


Figure 2. Subsequent phases of map production

Technical specifications for the map:

Map scale: 1:10 000
Technique: Orthophoto
Planimetric accuracy: $\sigma_{xy} = \pm 2$ m
Height accuracy: $\sigma_z = \pm 0,5$ m
Contour interval: 1 m
Coorridor width mapping: 3,5 km

Photogrammetric realisation:

Aerial survey

Camera: Wild RC 10 /150 mm/
Air craft: Piper Navajo Chieftain
Photoscale: 1:32 000 orthophoto printing, 1:16 000 height contouring
Overlap, sidelap: 60 %, 20 %

Ground control

Central traverse sides: 4 - 5 km
Wing points: 2 - 3 km apart from central traverse points

Photogrammetric plotting

4 WILD A 7 stereoplotters for height contour plotting
WILD PP08 Orthophoto Printer

Aerial triangulation

Wild A 10 Precission Stereoplotter
Computer PDP 11/45
Point transfer PUG 4

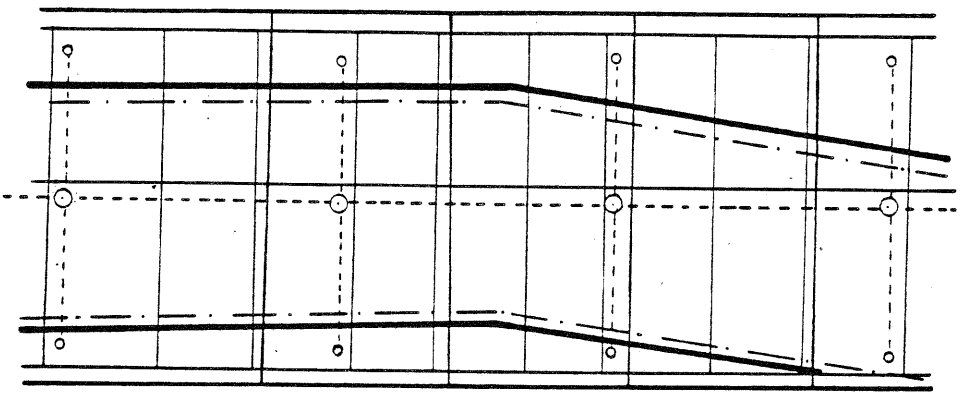
Automatic plotting

Coradomat 21 Automatic drafting machine

Aerial survey

At the availability of camera with lens cone /c 150 mm/ it was decided to obtain the required photographs with two level aerial survey /at 2400 m for 1:16 000 for height contouring and at 4 800 m for scale 1:32 000 for orthophoto production/. For the scale 1:16 000 the side lap was 20 % and for both scales the longitudinal overlap of 65 % was applied.

Due to the frequent changes in the direction of the proposed conveyance route the total lengths of the project /1 300 kms/ was photographed in 154 aerial survey runs overlaping each other by necessary number of photographs. Figure 3 shows the location of photogrammetric models and ground control in the proposed conveyance route.



— models 1:16 000
— models 1:32000
⊙ central travers point
o wing point
—·· mapping corridor
▬ map boundary

Figure 3. Photogrammetric models and ground control in the conveyance route

Aerial triangulation

The independent models block adjustment of aerial triangulation was used to provide the control points for plotting /height contouring, orthophoto mapping/. The procedures of preparation, point transfer, instrumental observations and computer adjustment with accuracy analisys were standard. The entire procedure was carried out using photographs in scale 1:16 000. Due to considerable changes in the mapping corridor directions it was not possible to adjust greater blocks simultaneously. Therefore the entire conveyance route was divided to 154 sections coinciding with aerial survey runs. These sections were then adjusted separately.

The aerial triangulation blocks have as an average appr. 20 models /2 x 10/.

Each block was then statisticaly processed /with different control point pattern/. The best values of coordinates were selected as definitive.

Height contouring

The models constructed from photographs in scale 1:16 000 with aerial triangulation points as control were used as the base for height contouring. In the areas with the ondulated terrain relief the height contouring was standard

i.e. continously.

In flat areas with poor stereoscopy the continous contouring was not reliable. Therefore the descrete heighting was adopted in the form of Digital Terrain Model /DTM/. Grid was 100 x 100 m or 50 x 50 m according to the height variations. The automatic plotting machine was used to linearly interpolate and plott the contours out of DTM grid. DTM data are stored in the computer in order to have data base for later mass computation. Certain amount of stereoscopic models were not complete due to non existence of stereomodel crossections /salt lakes, restricted areas/. Therefore same special orientation procedures were applied in order to obtain the optimal values for orientation parameters.

Orthophoto restitution

The orthophoto restitution was carried out using photographs in scale 1:32 000. The corresponding aerial triangulation points were transfered from photographs in scale 1:16 000 serving as control for orientation. As an average the largest slit width and slowest speed of profiling was used in dependance of terrain type. Due to the non-contrast terrain the profiling has left considerable stripes which were sreened photographicaly.

Cartography and reproduction

The height contouring and orthophoto originals were mounted together. The screened copy was printed on reproducible plastic material.

Accuracy analysis and control

In order continuously control the accuracy of final maps and also the accuracy of subsequent production phases the system of relative and absolute accuracy was established.

The relative accuracy of each individual map is determined by aerial triangulation control points. These points were during triangulation proces transfered to the photographs in scale 1:32 000 and their adjusted coordinates were compared with interpolated coordinates from the final map. Standard deviations od differences of compared coordinates are the following:

$$\sigma_{xy} = \pm\ 0{,}20\ \text{m}, \quad \sigma_z = \pm\ 0{,}17\ \text{m}$$

The absolute accuracy of the maps was determined by comparison of the coordinates of the natural points. Terrain coordinates were compared with the interpolated ones. The following standard deviations of the differences were obtained:

$$\sigma_{xy} = \pm\ 0{,}25\ \text{m}, \quad \sigma_z = \pm\ 0{,}21\ \text{m}$$

The described comparison showed that the elaborated maps fulfill the required accuracy.

Time analysis

The entire project /excluding terrain measurement and aerial survey/ was completed in one year. All office phases /point identification, aerial triangulation, height contouring and orthophotoprocessing, cartography and reproduction/ were elaborated according to the network plan. Photogrammetric mapping includes about 5000 sq km out of which 3/4 represents extremly monotonous, flat, /negligibile small height variations/ photographicaly contrast-less sand desert. Such terrain type has dictated discrete heighting /in the form of DTM/ which demanded additional production time. The same problems have occured also at the orthophoto processing, where slowest operational speed was chosen. Due to the unexpected lack of stereoscopic vision it was sometimes immposible to realise the parts of succesive production phases in time. Such circumstances caused sometimes considerable time delays.

CONCLUSION

Although some unexpected technical difficulties have occured during the map production /poor stereoscopy/ the mapping was realised in time. The accuracy analysis confirms that the planning parameters were correctly determined.