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APPLICATION OF ANALYTICAL AND DIGITAL PHOTOGRAMMETRY METHODS FOR FORECASTING VISTULA RIVER FLOODS.

Abstract

Modern flood forecasting methods are based on the use of detailed and up-to-date numerical maps and Digital Elevation Models (DEM). The largest Polish River, Vistula, floods its valley almost every year. The existing traditional maps in scale 1:10000 are outdated and not suitable for the purpose of flood forecasting.

The described mapping project, initiated in Spring 1999, deals with the elaboration of DEM and numerical maps for the 400 km long stretch of upper and middle Vistula river with required accuracy.

Black and white aerial photography of the area has been acquired in two scales: 1:17 000 for generation of DEM and numerical maps, and in and in scale 1:25 000 for generation of orthophoto maps in two periods: April and September, when the level of water was at its lowest. Signalized GCP's have been measured in field with GPS methods. Aerial triangulation has been performed on analytical plotter Planicomp P-1 Zeiss. Block adjustment has been done with the use PAT-MR- GPS Inpho and BINGO-F softwares with Sigma naught 6 μm.

Numerical topographic maps in scale 1:10 000 have been elaborated according to map standards and recorded in DXF format in MicroStation environment. The same aerial photos in scale 1:17 000 were used for production of DEM with 25 meters grid and with accuracy in elevation mh = +/- 0.5 m.

Aerial photographs in scale 1:25 000 have been scanned with pixel size 22.5 μm with compression by JPEG. Digital aerial triangulation has been performed on ImageStation INTERGRAPH with Sigma naught 8 μm. Scanned photos and highly accurate DEM have been used for generation of ortophoto - maps in scale 1:10 000, with pixel size in field 1 x 1 m. Additionally, the enlarged aerial photographs have been used for the elaboration of land cover and land use maps in MicroStation environment. All these digital data will be incorporated into GIS, to be used by flood forecasting specialists in Regional Water Management Office in Warsaw.

This project have been accomplished by the Institute of Geodesy and Cartography and PPKG in Warsaw.

MSWiA has awarded this project with 2nd price this year.

1. Acquisition of aerial photographs and geodetic measurement.

Aerial photographs have been acquired by the German Company BSF in two different scales, during two campaigns. Photographs in the scale 1:17 000 have been acquired on 18 May 1999; in scale 1:25 000 during the second mission on 5 September 1999. Carl Zeiss camera LC with focal length ck=152.23 mm was used in both cases. All ground control points (GCP's) have been marked in the field using 1.5 m by 1.5 m black crest 0.35 m wide signals. Coordinates X,Y, Z, of signalized GCP's have been measured in field with GPS techniques and transferred to 1942 coordinates system with accuracy RMS x,y,z = +/- 5 cm.

2. Aerial triangulation.

Measurements of points in the block of aerial photographs in scale 1:17 000 have been performed on analytical plotter Planicomp P-1 Zeiss. Block adjustment was done with the use of PAT-MR-GPS software produced by Inpho and new version of BINGO -F. Sigma naught 8 μm has been achieved. Accuracy of the block adjustment have been as follows: RMS x,y = +/- 9 cm and RMS z = +/- 13 cm in the models. RMS x,y = +/- 7 cm and RMS z = +/- 4 cm for GCP's.

Digital aerial triangulation of the aerial photographs in scale 1:25 000 has been performed on the ImageStation 6487 INTRGRAPH. The photographs have been scanned with accuracy +/- 1-2 μm on precise PhotoScan PS-1 Zeiss with INTERGRAPH software with pixel size 22.5 μm. Scanned data were compressed by JPEG with Q factor 15.

Digital aerial triangulation has been done on the ImageStation by semi-automatic methods. Sigma naught 8 μm has been achieved after block adjustment with Photo-T software. RMS xy = +/- 30 cm and RMS z = +/- 19 cm. Accuracy of correlation was below 0.2 of pixel size.

3. DEM

As the accuracy of DEM is high and area of Vistula Valley is covered by vegetation, automatic DEM generation by correlation methods cannot be used. Therefore

DEM has been measured on aerial photos in scale 1:17 000 on analytical plotter Planicomp P-1 Zeiss with grid 25 m x 25 m. Breaklines, escarpments and other morphological lines have also been recorded in ASCII format. Contour lines and perspective view have been generated following the edition of raw DEM. Vertical accuracy of elaborated DEM is about +/- 0.5 m.

Contour lines with 1 m contour intervals have been generated from DEM.

4. Orthophotomaps

Orthophotomaps in scale 1:10 000 have been generated from aerial photos in scale 1:17 000 with pixel size 1 m x 1 meter on the Image Z INTERGRAPH using exterior orientation parameters obtained from digital aerial triangulation and DEM elaborated

by analytical method. All photographs have been used for orthophoto generation and mosaicking which was performed with contrast enhancement. The accuracy of generated orthophotomaps is RMS x,y <+/- 2 pixels, which corresponds to M x,y <+/- 2 m in the terrain. Softcopies of ortophotomaps have been recorded in TIFF format on CD-ROMs; hardcopies have been plotted on precise ink-jet plotter IRIS with 1800 dpi.

Another soft and hardcopy products have been produced by merging orthophotomaps and digital vector maps.

Part of orthophoto map of the center of Warsaw is shown on Fig.1.

5. Digital maps

Digital maps in scale 1:10 000 have been elaborated on analogue plotters supported by computers in MicroStation environment, and recorded on CD-ROM. Contour lines have been incorporated into vector maps. Hardcopies in scale 1:10 000 have been plotted on HP vector plotter.

Part of vector map of Warsaw center area is shown on Fig.2. Perspective view of DEM for the same region is shown on Fig.3.

6. Land use and land cover maps

Visual interpretation of enlarged aerial photographs has been performed for elaboration of digital land use/land cover maps. Classification results have been scanned, merged with topomaps and implemented into the MicroStation environment.

Altogether 19 land use classes have been recognized. The produced digital land use/cover maps will be incorporated into GIS for Vistula River Valley.

7. GIS for the Vistula River Valley

This comprehensive Geographic Information System will consist of the following layers elaborated by photogrammetric methods:

- orthophotomaps with pixel size 1 by 1 meter;
- DEM with grid 25 by 25 meters;
- digital topographic map in scale 1:10 000;
- land use and land cover map in scale 1:10 000.

All these data will be used for Urban Planning of Warsaw area, Environmental Planning and Risk prevention for the 400 km of the Vistula River.

It was first time in Poland when 400 km long aerial photographs strips of Vistula river (with different orientation) have been adjusted as one block. Bellow some examples of elaborated maps are shown.

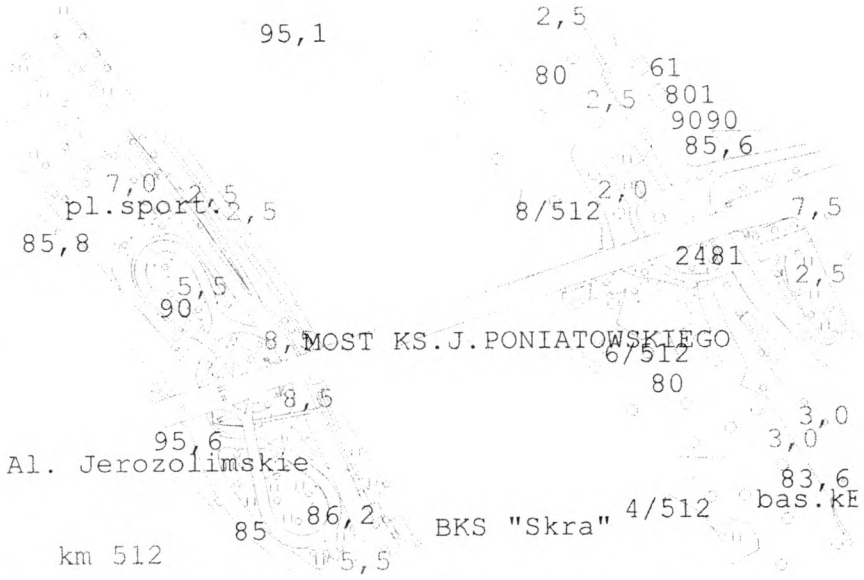

Fig.1.: Topographic map (original in scale 1:10000) of the center of Warsaw.

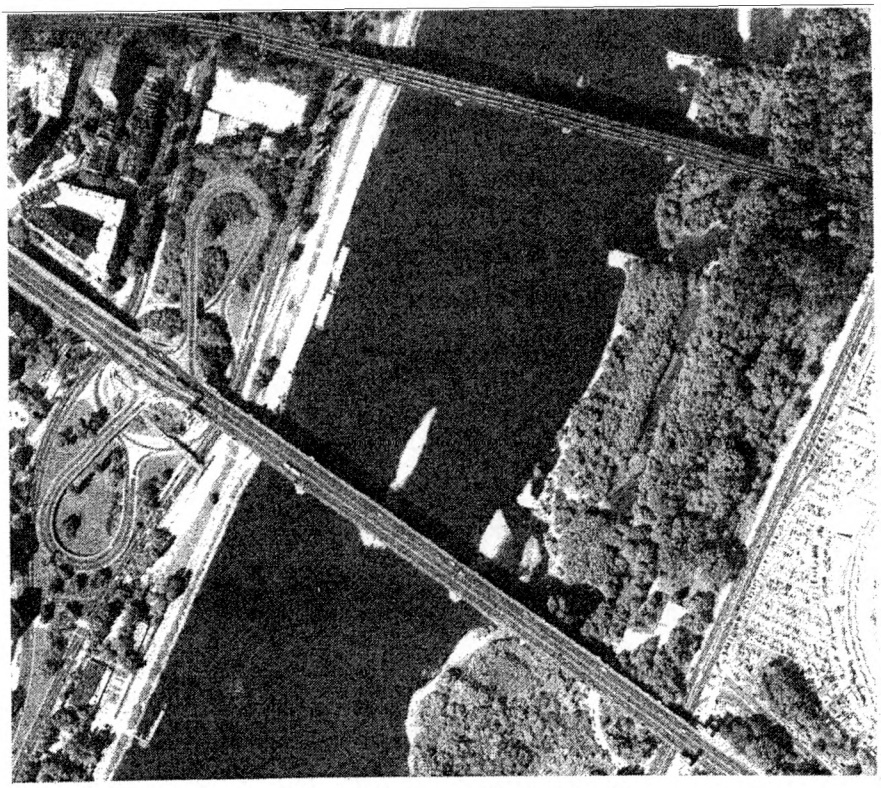

Fig.2.: Orthophotomap of Vistula River in the center of Warsaw area.

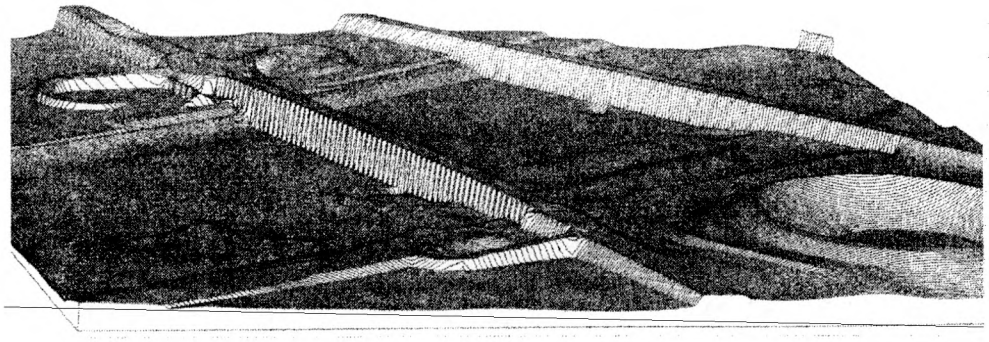

Fig.3.: Perspective view of DEM of the Vistula River in the center of Warsaw area elaborated with HIFI.

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