# DEVELOPMENT AND STATE OF PHOTOGRAMMETRY IN BULGARIA

**Dr Ivan Katzarsky**
**Head of Main Department of Cadastre and Geodesy**
**at the Ministry of Regional Development and Construction, Bulgaria**

Commission VI, Working Group 6

**KEY WORDS:** Photogrammetry, History, Mapping, Management, Revision, Aerial Photogrammetry, Close-Range Photogrammetry

**ABSTRACT**

The paper provides a brief review of the development and state of photogrammetry in Bulgaria which made its initial steps during the first decade of this century to reach its present state corresponding to the requirements of national economy of this type of activity as well as to up-to-date trends in science and technology. Nowadays over 20 institutes companies and offices in Bulgaria develop and apply photogrammetry in various fields of human endeavor. Although the principal photogrammetric activity concerns the making and revision of maps at scales from 1:25 000 up to 1:500, photogrammetry is also applied for various special purposes. In line with the large volume of production,research of a predominantly applied character is carried out. Photogrammetry is taught in 4 technical universities and 6 technical high schools. There are textbooks, instructions, manuals, technologies, etc. while the theoretical and applied publications on photogrammetry in year-books and magazines exceed 1000.
The public activity of Bulgarian phogrammetrists is organized by the Photogrammetry and Remote Sensing Section at the Union of Surveyors and Land Managers in Bulgaria, through which they are affiliated to ISPRS.

## 1. INTRODUCTION

Having made its first steps only 30 years following the liberation of the country from Ottoman domination, photogrammetry in Bulgaria has been making steady progress to reach its present state, which corresponds both to the needs of national economy from such an activity and to modern trends of science and technology.

## 2. HISTORICAL DEVELOPMENT

### 2.1. Initial Steps (1907-1928)

Bulgaria was probably the first country on the Balkan peninsula to begin to apply photogrammetry. The first known photogrammetric surveys in the country were made near city of Sofia in 1907 and 1908. These were plotted in the Vienna Institute of Cartography by Eduard von Orel, using a Stereoauthograph of his own make, which, as it is known, is the first photogrammetric analog instrument. During the 1912 Balkan War aerial photographs were taken for military reconnaissance, while during World War I (1914-1918) terrestrial photogrammetric pictures were taken of Belasitsa mountain and the Southern front-line for military purposes as well as between the towns of Skopje and Bitola for design of a railway line. Meanwhile an aerial photo was taken of the city of Gabrovo from a Zeppelin in 1917. Later on, in 1920 and 1921 terrestrial photogrammetric pictures were taken around Sofia and of the Rhodope mountain, and in 1926 an aerial photo was taken of Gabrovo from an aircraft.

### 2.2. Medium-Scale Mapping (1928-1944)

A more noteworthy attempt of introducing terrestrial photogrammetry in Bulgaria was made in 1928 when an area of about 2.5 sq. km in the vicinity of Sofia was surveyed by means of the newly-designed Wild Phototheodolite. The area was mapped at the scale of 1:10 000 at the Wild factory, using also the newly-designed A-2 Autograph. Following that successful step preparations got underway for the use of terrestrial photogrammetry in making of a topographic map at 1:25 000 scale. Three Wild phototheodolites and one A-2 Autograph were imported in 1930. At the same time a Wild aerial survey camera and a Hugershoff-Heide rectifier were purchased so that the use of terrestrial photogrammetry for mapping of the mountainous regions of the country began simultaneously with aerial photography of the plain regions. Later on, Zeiss-Jena Multiplex and C-5 Stereoplanigraph and a A-5 Wild Autograph were bought and ever since 1940 aerial photogrammetry has been almost exclusively in use.

In 1930 the geodesists V. Peevsky and G. Grozdanov (students of Prof. Doležal of Vienna) and A. Raikov (a student of Prof. Hugershoff of Dresden) published "A Course in Photogrammetry" which until late 1945 was the standard textbook for all practicing photoprammetrists in the country.

### 2.3. Large-Scale Mapping (after 1944)

Application of photogrammetry for large-scale mapping and for non topographic use made its headway after 1944, aimed at the post-war restoration and intensive development of the country's economy. Single-frame

photogrammetry of that period was linked with making 1:5000 and 1:2000 scale photomaps of several residential areas and irrigation basins of water dams.

Aerial stereophotogrammetry was introduced for making the Large-scale topographic map of the country (1:5000 and 1:10 000) in the end of 1954 when a C-8 Zeiss Stereoplanigraph was imported. During the next couple of years deliveries were effected of Zeiss C-5 stereoplanigraphs, Drobishev (Russia) stereometers, Zeiss stereometrographs and other photogrammetric apparatus.

## 3. PRESENT STATE

Nowadays numerous companies and offices in Bulgaria are developing and using photogrammetry in various fields of human endeavor in the country and abroad. Presently we have at our disposal the necessary number and types of photogrammetric apparatus and systems as well as qualified specialists capable of coping with any type and volume of tasks in the field of photogrammetry.

### 3.1. Production Enterprises

Intensive photogrammetric production is carried out by Geoplanproekt Co. for Surveying and Mapping, Geodesia Co. for Surveying and Mapping (city of Plovdiv) and National Centre of Cadastre Ltd., belonging to the system of the Main Department of Cadastre and Geodesy.

Besides, photogrammetry is applied also by Patproekt Ltd., a road designing enterprise; Transproekt Ltd., an enterprise for design of railways and other transport projects; Agrolesproekt, an enterprise for research and design of forestry and land management; Niproruda, a national research and design enterprise for mining projects; the National Institute for Monuments of Culture, and elsewhere.

### 3.2. Education and Research

Training in photogrammetry is the concern mainly of the Faculty of Geodesy at the University of Civil Engineering, Architecture and Geodesy in Sofia, as well as of the respective chairs at the Mining and Geology University and the Forest University, both in Sofia. Photogrammetry is also taught in other six technical high schools in the country.

Research is carried out by the Research in Geodesy and Photogrammetry Ltd. at the Main Department of Cadastre and Geodesy as well as by the respective chairs of the above mentioned technical universities and by some other research and design institutes. Particular attention is being paid to automated data processing systems, aerial triangulation, orthophotoscopy, remote sensing methods for Earth study and to architectural photogrammetry.

The 1930 photogrammetry textbook has long been replaced by other textbooks, instructions, manuals and technologies while the number of theoretical and applied publications on photogrammetry in year books, collections and magazines exceeds 1000.

### 3.3. Public Activity

Public activity of Bulgarian photogrammetrists is organized by the Scientific and Technical Section of Photogrammetry and Remote Sensing at the Union of Surveyors and Land Managers in Bulgaria, through which they are affiliated to the International Society for Photogrammetry and Remote Sensing. The section annually organizes conferences, symposia and consultations, some of them with international participation.

## 4. PRODUCTION

### 4.1. Aerial Photography

Various parts of the country's territory are periodically covered by aerial photographs at scales ranging from 1:40 000 to 1:3000, used for a variety of purposes. The instruments applied are mainly wide-angle and normal-angle aerial cameras (of focal lengths respectively 15 and 30 cm and 23x23 cm format), made by Zeiss and Wild. Aerial photos are taken by specially equipped AN-30 (Russia) and L-410 (Czech) aircraft. Agfa-Gevaert and Kodak aerial films and diapositives are used. Photolaboratory equipment used is Zeiss, Pentacon, etc.

Pictures taken of the territory of the country by satelites are used for economic purposes as complex space information.

### 4.2. Topographic Mapping

Principal photogrammetric activity in Bulgaria consists of making and revision of topographic maps at 1:25 000, 1:10 000, 1:5000 and 1:2000 scales with contour interval ranging from 10 m to 1 m; urban maps and such of out-of-town and industrial zones at 1:1000 and 1:500 scales with 1 m contour interval, as well as maps serving the special needs of study and design at scales from 1:10 000 to 1:500 and orthophoto maps at 1:10 000, 1:5000 and 1:2000 scales to serve as a basis for rural cadastre.

The 1:25 000 scale map is revised on the basis of aerial photographs at scales ranging from 1:25 000 to 1:40 000. The 1:10 000, 1:5000 and 1:2000 scales maps are made and revised on the basis of aerial photographs at respective scales from 1:16 000 to 1:30 000 from 1:12 000 to 1:18 000 and from 1:6000 to 1:8000. Making and revision of urban maps at scales of 1:1000 and 1:500 is effected from aerial pictures at scales from 1:6000 to 1:3000. Orthophotomaps at scales of 1:5000 and 1:10 000 are made of aerial pictures at respective scales of 1:16 000 and 1:30 000 to serve as a basis for rural cadastre.

### 4.3. Special Mapping

Maps at scales ranging from 1:500 to 1:10 000 are made to meet the special needs of investigation and design of

various projects and structures such as motor-ways, railways and other linear projects, bridges, tunnels and other engineering structures, industrial and out-of-town zones, etc. One should also mention photogrammetric measuring of terrain profiles for automated design of motor-ways and reconstruction of railway lines, as well as photogrammetric inventory of existing road and railway networks. Besides photomosaics at various scales are made for the needs of townplanning. Revision is made of geographic subject and small-scale topographic maps, based on space photographs.

### 4.4. Aerial Triangulation

Analytical block aerial triangulation is widely used in photogrammetric identification of the geodetic network. The necessary measurement for this purpose are made by means of the precise stereocomparators Stecometer and Dicometer of Zeiss. Zeiss Transmark and Wild PUG-4 devices are used for marking image points on the diapositives. Computation is effected by means of different computers, using Bulgarian or adapted programs.

### 4.5. Apparatus

Stereoplotting is effected mainly by means of analog instruments of the Zeiss Stereometrograph type, while differential rectification is carried out by Topocart-Orthophot and Topomat Zeiss systems. When rectification is required it is most frequently carried out by means of Zeiss SEG-5 and SEG-6 and Wild E-4 rectifiers.

Bulgarian made devices forming a system for graphic data acquisition and processing are: Isot 9115E for analog-digital data transformation, EC9002 and EC9004 data recording devices, Isot 230 alpha-numeric printer, Isot 310 mini-computer and the Wild TA-2 Aviotab automated plotter. The modules of this system are used in different combinations for recording of photo-grammetric measurements, digitalization of existing urban maps, and for making digital models for various purposes. Technologies for making and revision of urban maps as well as for setting up cadastral information system have been developed on the basis of the above system. Scaners are in use also.

## 5.CLOSE-RANGE PHOTOGRAMMETRY

Terrestrial photogrammetry rendered measuring processes in certain fields far more efficient. Among these are construction, industry, mining, architecture, archeology and road accidents.

For the purposes of architecture maps and photomaps of street areas, building facades, monuments and interior design elements (iconostases, profiles and vaults of churches, fragments, bas relief, murals, etc.)are made at scales from 1:20 to 1:100. Terrestrial photogrammetry is applied in industry to calculate volumes of bulk materials, and for the needs of power generation construction to plot underground areas intended for power stations. For the needs of the hydrotechnical construction it is used for digitalization of contours for estimation of changes in water volumes of dams.

Terrestrial photogrammetry has been successfully applied in tests of buildings and engineering structures as well as in monitoring landslide areas. Photogrammetric measurements are often used for determining areas and volumes in open cast mining as well as terrestrial multi-spectral photographs used for determining quality parameters of coal. Terrestrial photogrammetric pictures are taken by means of Zeiss and Wild universal metric and stereometric cameras. Measurements are carried out most frequently by Zeiss Technocart and other suitable analog apparatus. When analytical methods are applied measurements are carried out by precise stereo-comparators.

## 6. THE PHOTOGRAMMETRY IN LAND REFORM AND CADASTRE

The place of photogrammetry in the land reform and cadastre in Bulgaria is determined mainly by six of its multiple potentials:

(i) Use of retrospective aerial photographs taken over the territory of Bulgaria for compilation of the topographic map at 1:25 000 scale before pooling of private farms into large collective farms. These aerial photographs are taken by normal-angle aerial survey camera (focal length 21 cm, format 18x18 cm) and are at approximate scale of 1:20 000. In the prevailing cases real boundaries of ownership at that time in mountain and hilly regions can be distinguished on them, i.e. where presumably these boundaries have been preserved up to now.

(ii) Production of large scale orthophotomaps without contours as basis of the rural cadastre. The orthophotomap is cheaper and is produced considerably faster than the conventional topographic map which make it more up-to-date. The semantic information contained on it is of the same quality and quantity as that on the aerial photographs from which it is made.

(iii) Production and revision of very large-scale topographic maps in graphical and digital forms as basis of urban cadastre. This is a slower and more expensive process but it is inevitable in view of its high precision necessary for the compilation and updating of the respective graphical and digital maps.

(iv) Production of photomosaics and other intermediate photogrammetric products for the purposes of the land reform. The photogrammetry has the advantage that from the instant of taking the aerial photography up to the production of the final product for which it is intended, several intermediate products can be made with different accuracy, serving some intermediate phases of the land reform.

(v) Determination of terrain points by aerial triangulation for the needs of land reform and cadastre.

Photogrammetry disposes of powerful means for high precision determination of points on the terrain.

(vi) Numerical mapping of aerial photographs for compilation of land maps at scale of 1:5000 and larger, necessary for the restitution of ownership of agricultural lands in the existing real boundaries mainly in mountain and hilly regions of the country.

Here one should add also the topographic map at scale of 1:5000 which is produced and periodically updated by aerial photogrammetry.

## 7. CONCLUSION

In conclusion it should be noted that a brief account such as this one could hardly be conducive to an adequate idea of the scope of development, achieved by photogrammetry in Bulgaria during the past ninety year period. Its particularly intensive and wide upsurge took place during the last 5 decades. The future of photogrammetry in the country is in the application of automated photogrammetric systems for acquisition and processing of space, aerial and terrestrial data alike.

To attain this objective Bulgarian photogrammetrists rely both on their own capabilities and cooperation with their colleagues from abroad.

## REFERENCES


Haidoushki, I.T., 1978. Photogrammetry (in Bulgarian), 3rd edition, Technika, Sofia.

Haidoushki, I. and Katzarsky, I.,1983. Le development et l'etat de la photogrammetrie en Bulgarie /Development and state of photogrammetry in Bulgaria / Entwicklung und Stand der Photogrammetrie in Bulgarien. Geodezia, Kartografia, Zemeustroistvo, 3, pp.51-56, Sofia.

Katzarsky, I., 1988. Fotogrammetria Bulgarissa. Maankäyttö, 3, pp. 42-44, Helsinki.

Katzarsky, I. et al., 1989. Photogramphy and photogrammetry, Technika, Sofia.

Kristev, I. and Tzankov, I., 1991. Development of topographic and photogrammetric activity in the Military Topographic Service (in Bulgarian), Technical Bulletin, Military Topographic Service, Vol. XXX (1), pp. 17-28, Sofia.

Member Report of the Scientific and Technical Union of Geodesy and Land Management, Bulgaria. ISPRS XV Conress, Rio de Janeiro, 1984. International Archives of Photogrammetry and Remote Sensing, Vol.XXV, Part A8, Supplement, pp. 238-242.

National Report of the People's Republic of Bulgaria for the period from 1972 to 1976. XIII International Congress for Photogrammetry, Helsinki, 1976.

National report of the People's Republic of Bulgaria. 14th Congress of the International Society for Photogram metry, Hamburg, 1980.

Peevsky, V., 1988. My duty in the State Geographical Institute - The beginning of application of photogram metry in Bulgaria (in Bulgarian). Annual of the National Polytechnic Museum, Sofia, Vol. 16, pp. 87-110.

Raikov, A.N., 1964. Photogrammetry (in Bulgarian), 3rd edition, Technika, Sofia.


## AUTHOR'S ADDRESS


Dr Ivan Katzarsky
Ministry of Regional Development and Construction
Main Department of Cadastre and Geodesy
17-19, Kiril i Methodi Street
BG-1202 Sofia, Bulgaria
Tel: (+3592)876 260 and 813 785
Fax: (+3592)872 517 and 874 888