

AUSTRIA NATIONAL REPORT

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PREFACE:

In Austria, several institutions are working within the ISPRS scope. According to their objectives they may be classified into federal offices, administrations of federal provinces, municipal authorities, research institutes, universities and private enterprises. In order to give a clear picture of their activities the following report is primarily structured with respect to the institutions and, if necessary, subdivided with regard to the classification of ISPRS commissions. Of course, federal offices are of major importance because of their responsibility for the whole state. Sometimes however, the work of smaller institutions is of more interest because they perform typical applications according to their special tasks. Both aims, overall map production dedicated to various problems based on photogrammetry and remote sensing, and special applications in the various fields of far- to close-range techniques, will be mentioned in the following report.

A. FEDERAL OFFICES

Federal Office of Metrology and Surveying

1 Aerial surveying flight operations (Com. I)

1.1 Flights with infrared colour positive film

Each year, some 8,000 to 10,000 aerial images with infrared colour material are taken to deal with two clearly-defined problems:

1. Compilation of the digital cadastral map and consolidation of the digital terrain model of Austria. The images have an average scale of 1:15,000 and were obtained with an end lap of 80 %. The individual flight blocks have an area of approx. 600 km². The individual flight strips have an average length of 30 km. After the flight these are separated into two sets, the first being used for photogrammetric compilation and the second for the interpretation of land use and land cover on site.

2. The Austrian forest inventory status. The images have a mean scale of 1:7,000 and are obtained with 60 % end lap. They are used for the interpretation and mapping of the forest status.

1.2 Flights with colour positive film

These images serve mainly for cadastral compilations at a scale of 1:10,000. The annual production is some 1,000 aerial photos.

1.3 Flights with PAN film

Aerial photos with a mean scale of 1:30,000 are produced in pin point flight for the updating of the 1:50,000 topographic map based on 1:25,000 ortho-photos. The flight pattern corresponds to the sheet line system of the Austrian 1:10,000 aerial photo map with a strip spacing of 5 km and a base length of 2.5 km. Some 1,600 to 2,000 photos are taken annually for this purpose. These aerial photos also serve as the basis for the production of ortho-photos at a scale of 1:10,000 for the Austrian aerial photo map.

1.4 Equipment

The office manages two aircrafts equipped for surveying flights (Beechcraft Super King Air 200 and Pilatus Turbo Porter PC6) with a total of three aerial camera systems (1 RC30 and 2 RC10 of Wild). They may be equipped with lenses of 15 cm, 21 cm and 30 cm focal lengths. The cameras type RC30 or RC10 are installed alternately in the King Air 200, while one type RC10 aerial camera is installed in the second aircraft.

Between 1995 and 1996 the King Air 200 was fitted with a GPS-supported navigation system coupled with the autopilot, as well as the Leica ASCOT flight management system. Both systems will be in operation in the 1996 flying season. Differential GPS methods will be used for the determination of the projection centres in aerotriangulation. This should ensure a considerable reduction in the necessary control points. In addition, GPS-supported approaching procedures to the photo area should reduce navigation times to a minimum. A GPS receiver has been in use in the Pilatus Porter surveying aircraft since 1992, thus considerably increasing the daily flight capacity of this aircraft due to the reduced approach times to flight lines.

2 Data recording and processing (Com. II/IV)

2.1 Aerotriangulation and block adjustment

Annually, some 30 flight blocks with an average of 200 models at scales ranging from 1:7,000 to 1:15,000 are aerotriangulated. The preliminary work (control point identification, selection of new points) is carried out on Wild PUGx point transfer devices. The PAT-MR program has been used for block adjustment since 1990. From 1996 the PAT-B/GPS program will be used in connection with GPS measurements of the projection centres.

2.2 Data capture for the digital terrain model

The national DTM with an average point density of 50 m has been continuously updated since 1988 and upgraded with structural information. *Scale:* 1:15,000. *Sampling method:* grid of 50 m and supplementation of relief structures (break lines, form lines, singular points).

For revision purposes and in support of the data correction, the contour lines are calculated by means of the SCOP program after compilation, and the images are superimposed on the stereo model. At present, the compilation status according to the current method amounts to approx. 30 % of the Austrian territory.

2.3 Data capture for the topographic model

The topographic model (TM) is a digital landscape model. It represents the earth's surface according to topographic aspects and consists of primary data in vector form which have not been changed by cartographic procedures such as generalization and symbolic feature codes. The structure of the landscape is defined in an object type catalogue according to object ranges, object groups and object types. A more detailed description of the objects is provided by means of integration with attributes.

Apart from manual digitizing of 1:10,000 orthophotos, digital compilation of aerial images (approx. 1:15,000 or 1:30,000) is also used for continuous updating and user-oriented supplementation, especially in the object range "traffic".

2.4 Maintenance and application of the digital elevation model - data base (DEM-DB)

At present, a total of approx. 10^8 individual points from photogrammetric compilation are maintained in a data base together with structural information. Besides the original data, fully interpolated grids (25 m) are also maintained and recalculated automatically on every update of the original data. Thus, grids with any randomly-selected grid size can be derived at any time for the data output.

The most important application of the digital elevation model is the production of orthophotos which are primarily used for the further updating of the topographic map 1:50,000 and the continuous updating of the topographic model. These orthophotos have been produced *digitally* since 1994. A total of some 1,500 orthophotos are produced annually with scales ranging from 1:5,000 to 1:25,000. Further applications of the DEM-DB include the derivation and output of contour line plans, perspective views and hill shading.

2.5 Technical hardware:

5 Wild PUGx point transfer devices; 1 Leica BC3 analytical workstation (aerotriangulation); 8 Leica BC3 analytical workstations with RISIS image superimposition systems (DEM sampling and topographic model); 1 HP 715/50 workstation (Digital Elevation Model Data Base); 1 PS/1 photo scanner (used jointly with University of Technology and

University of Agriculture, Vienna); 1 Digital photogrammetric workstation (Image Station of Intergraph) for orthophoto production; 8 Graphic workstations (PC 486, PC Pentium)

3 Cadastral Photogrammetry (Com. IV)

The division of cadastral photogrammetry carries out the applications for cadastral purposes on a national level. Depending on the posed problem the method of aerial photogrammetric compilation supports the

- ⇒ determination and demarcation of types of soil exploitation
- ⇒ determination of feature lines and feature points
- ⇒ quality control and quality improvement of the digital cadastral map.

Its tasks also include photogrammetric restitutions from historical flight missions for the documentation of historical topographic facts and photogrammetric compilations of topographic cadastre feature lines for administrative boundaries.

The following basic information is applied to perform these tasks:

- ⇒ Scale 1:10,000 colour photographs for the photogrammetric compilation of buildings and feature lines.
- ⇒ Scale 1:15,000 colour infrared photographs for the photogrammetric compilation of land-use boundaries and feature lines.
- ⇒ Scale 1:30,000 B/W photographs for the photogrammetric compilation of those areas which are not yet included in the project of the digital cadastral map. In this case the cadastral map is updated for the valuation of farm land: i.e. updating of boundaries for the demarcation of agriculturally cultivated areas from uncultivated areas.

For preparation of the photogrammetric compilation, enlargements and transparencies are delivered to the respective local surveying offices in order to establish an interpretation key for the various types of cultivation. The areas to be updated are interpreted and depicted in the aerial photograph enlargements. The aerial photographs are classified in a stereo model according to given object classes and digitally analyzed. The digital results are transferred to the local surveying offices after the appropriate processing and serve for the evaluation of the digital cadastral map.

The technical equipment of the division is:

10 Leica BC3 analytical workstations with RISIS image superimposition systems; 4 Graphic workstations (PC 386, PC 486, PC Pentium); 1 PC 386 linked to the real estate data base

4 Remote sensing (Com. IV)

Combined with a geographic information system, three remote sensing systems were put into operation at the end of 1995. *Fields of activities:* use of remote sensing data for topographic mapping as well as the interpretation of land use and land cover

for cadastral purposes. *Equipment:* 3 SGI Indigo workstations with ERDAS and ARC/Info.

Federal Environment Agency (FEA)

1 Programs

During the period 1992-1996, the FEA realized the following projects with respect to the topics of ISPRS:

⇒ CORINE-Landcover (Com. VII)

⇒ March (river) water meadows (Com. VII)

Other projects referring to water quality, soil contamination by radioactivity, dangers caused by waste deposits and other environmental inquiries were carried out by means of geographical information systems. They will not be explained in more detail.

2 Descriptions

2.1 CORINE (= Coordinated Information on the Environment)

This is a project dealing with "the compilation, coordination and adjustment of information about the situation of the environment and the natural resources in the European Community (EC)" by means of a geographical information system. The program comprises all members of the EC and is the basis for a future European environmental information system. It will be realized in a European environmental agency, its goal being to support the respective activities of the Community. One of the tasks is the land-cover project, which will be performed by means of Landsat-TM (channels 4,5,3)-images. The classification distinguishes 44 classes regarding areas > 500 m x 500 m. The results will be integrated in a database with a period of renewal every ten years.

2.2 March river

The very delicate areas of water meadows in the March-Thaya region are monitored periodically by means of infrared colour flights (Federal Office of Surveying). From these images the state of the biotops is classified in a very detailed manner and the results are inserted into a GIS of the FEA. The diagnosis from the images is completed by terrestrial investigations. The whole work is dedicated to the preservation of the March-Thaya water meadows.

Federal Center of Research and Standardization "Arsenal"

This institute works in the fields of hydrogeology, applied geophysics and geotechniques (waste deposits) by means of the GIS/ARC/INFO in order to provide administrative authorities with all informations required for decision-making processes. Apart from these projects the Arsenal participates in a new remote sensing project called

"MOMS-MISSION", which is aimed at mapping neotectonique zones of intrusion. The test area will be a special region of Lower Austria where remote sensing data will be compared with terrestrial explorations. As a subproject, a remote sensing infrastructure is installed at the institute. These activities belong entirely to Com. VII.

Federal Forest Research Office

The activities of this institution may be summarized under the topics of Com. I, Com. IV and Com. VII. Because of insufficient ground resolution, space-borne remote sensing data cannot be used for its purposes. Hence, the investigation is entirely based on infrared aerial images taken periodically of selected forest areas during the growth period in order to get information about damage by immission. The scale of images is about 1:7,500. The models are triangulated, coordinates and parameters of orientation are stored, and the interpretation referring to the biological state of single trees, their topographic surrounding (exposition, inclination of terrain, elevation etc.) and other indicators are transmitted from the analytical stereoplotter (Zeiss Planicomp P1) to an information system. This approach offers various possibilities of visualization and mapping. The system is in operation since 1992 and provides continuously annual informations about Austrian forests.

B. FEDERAL PROVINCES

Photogrammetry and remote sensing are used in a very typical way by the administrations of the Austrian federal provinces. As the responsibilities of those administrations cover all kinds of planning, the applications refer to the production of basic maps for several purposes and - because of the mountainous surface - to DTM production. The most important fields are:

- ⇒ Environmental planning by means of maps at scales ranging from 1:5,000 to 1:10,000 depending on the economic significance of the regions in question. They are prepared in the traditional way of graphical maps or by means of orthophotos.
- ⇒ Road planning using scales of 1:10,000 and larger. The applications cover detailed technical drafts (1:1,000 or 1:2,000), checking of variants, general studies and, last but not least, maps on noise pollution.
- ⇒ Forestry planning and inspection by means of infrared aerial photos.
- ⇒ Land use classification based on Landsat and Spot multispectral images.

In general, traditional photogrammetric evaluation is performed by private photogrammetric enterprises. Special applications, for example satellite remote sensing or infrared image interpretation, are carried

out in collaboration with universities or special research institutions. Depending on the relief, different percentages of coverage were attained during the last period: Carinthia for example shows a coverage by *orthophoto maps* of 85%, while 40% of the settlement region of the Tyrol is already covered by traditional *line maps* at a scale of 1:5,000.

C. MUNICIPAL AUTHORITIES

The special goal of city administrations must be the support of all kinds of planning in structural and civil engineering, architecture, traffic, cable lines, pipelines, sewage systems, etc. Because of continuous changes of the settlements periodical flights are performed, their scale in general being larger than 1:5,000.

The Austrian capital **Vienna**, the venue of this congress, is the dominating example of urban application of photogrammetry and remote sensing. Besides being a city, Vienna is also a federal province and has to satisfy both tasks.

Its area of 415 km² is surveyed completely every three years at a scale of approx. 1:6,000. In the years between these flights, one third of this area is covered by aerial images which are used for the production of the digital city map on the one hand, and for real land-use mapping on the other. Apart from these regional applications, photogrammetry is used for surveying the second Vienna water pipeline, the Danube river, the roof landscape and other projects. The administration of Vienna manages its own photogrammetric department, connected to a large information system with all possibilities of visualization, established at the central computing office of Vienna.

The smaller provincial capitals also apply photogrammetry periodically for the above-mentioned purposes. Two interesting examples may be shown referring to Graz (capital of Styria) and Salzburg.

In 1992 **Graz** performed a complete colour image flight (730 images) at a scale of approx. 1:3,700 and in 1993 a flight along its main river, the Mur. By means of these images a complete aero-triangulation was carried out, and the results (coordinates and parameters of orientation) were stored in a respective data base. Using these data, the evaluation of stereoscopic models is performed by an analytical plotter with reference to actual planning activities. Recently, the instrumentation for digital photogrammetry was installed, and corresponding procedures are in development.

In good time (1972), the administration of **Salzburg** started a project referring to a utility register. In order to complete this basic information for a digital city map, several flights (scale appr. 1:4,000) providing a complete coverage of the Salzburg area were carried out since 1992. The evaluation is performed by private photogrammetric offices under

the supervision of the municipal authority. The project should be finished in 1996.

The capitals of all the other Austrian provinces are working more or less in the same way.

D. RESEARCH INSTITUTIONS

In Austria there exist two important independent institutions of general research. They are:

⇒ Joanneum Research in Graz

⇒ Austrian Research Center Seibersdorf near Vienna

Besides other topics both are also working in the fields of digital image processing and remote sensing.

1 Joanneum Research

Joanneum Research consists of 21 institutes. One of them is the institute of Digital Image Processing with the two departments of "Industrial Image Processing" and "Remote Sensing". Both are working in the fields of ISPRS related to Com. V and Com. VII respectively.

1.1 Industrial Image Processing

This department works on the development of novel vision systems for automating industrial production control. Emphasis is put on drafting algorithms and software systems which solve two-dimensional inspection tasks in real time. Apart from these 2D developments, 3D measuring techniques (light sectioning) are investigated. In this topic several special projects were performed, as for example: Planetary body high-resolution terrain models, 3D navigation and reconstruction based on multiple views, surface inspection by color recognition algorithms, tunnel measuring using CCD cameras, geometrical measuring with high-resolution area cameras and track measuring. The department serves as a "partner in innovation" for business enterprises focused on applied research in key technologies.

1.2 Remote Sensing

The department processes all kinds of remote sensing (active and passive) data. The high-precision geometrical rectification of remote sensing images based DTM's is its special forte. Developments also have been related to the stereoscopic extraction of 3D terrain information from SAR image pairs and stereo-MOMS-data using automated image matching techniques. Moreover, investigations referring to SAR interferometry have been carried out recently. Another research area is the development of new methods and technologies to identify natural resources, vegetation damage and natural risks. In this context the following special topics were treated: Analysis of land use, such as settlement zones, agricultural land and forest types; classification of forest damage and assessment of environmental risks,

such as avalanche and desertification; GIS applications in classification of remote sensing data; participation in the "MOMS-Mission" project. In all these cases, the department represents a supporting partner of all political decision-makers in favour of a healthy environment.

2 Austrian Research Center Seibersdorf

Referring to Remote Sensing Activities, the institute carried out the following projects (Com. VII):

a) Land Use Map of Pannonian Area

aim: mapping the spatial distribution of agricultural crops

data: Landsat TM quarter-scenes (May, July, September 1991)

area: eastern part of Lower Austria, northern part of Burgenland

method: hierarchical classification approach using multitemporal index images

result: digital land-use raster map (30x30m cell size), 8 crop classes, 15 classes in all

application: modelling local impact of agricultural land-use on natural areas.

duration: 1993 - 1994

partners: international research project

b) Change Detection in urban areas

aim: developing a fast method for detecting new built-up areas in urban environments

data: Landsat TM quarter-scenes (1986, 1991)

area: metropolitan area of Vienna (Austria)

method: linear mixture modelling

result: change detection map of Vienna (1986/91)

application: basis for updating the land use vector-coverage of Vienna.

duration: 1994 - 1995

partners: municipal council Vienna, Austria

c) Land use/land cover map of Austria

aim: establishment of a land-use/land-cover map of Austria

data: Landsat TM mosaic of Austria (1991)

area: entire area of Austria

method: multispectral classification/spatial post-classification / integration of GIS layers

result: digital raster map of Austria (100x100m cell size), 15 land-use/land-cover maps (related to CORINE land-cover nomenclature)

applications: input to a number of environmental modelling approaches

duration: 1994 - 1995

partners: Institute of Photogrammetry and Remote Sensing, Technical University, Vienna, Austria; Federal Environment Agency, Vienna, Austria

d) Pan European Land Cover Monitoring

aim: Development of a consistent methodology to derive land cover information from remote sensing for environmental monitoring on a European scale

data: multitemporal NOAA/AVHRR imagery

area: Europe

method: testing and validation of different classification algorithms

applications: applying the best suitable classification method to derive a small scale land cover map of Europe

duration: 1996 - 1999

partners: Winard Staring Centre (the Netherlands); Institute of Remote Sensing Applications of the Joint Research Centre (Italy); Geodan (the Netherlands); Centre Nationale de Recherche Meteorologique (France); National Institute for Public Health and the Environment (the Netherlands); Swedisch Space Co-operation (Sweden); University of Venice (Italy); (this project is funded by the EU within the 4th framework programme)

e) Participation in the "MOMS-MISSION"-project

E. UNIVERSITIES

In Austria four universities provide full or partial ISPRS-relevant education (Com. VI). At the two universities with full education (TU Graz and TU Vienna) between 20 and 30 students take up their respective studies each year. The whole study comprises five years and leads to the degree of a "Dipl.-Ing.". This title corresponds with the MSc. of English speaking universities. Apart from education a lot of research work is done at the respective institutes. In the following, a brief representation should give an appropriate impression of this matter:

1 Technical University Graz (TUG)

1.1 Institute for Applied Geodesy and Photogrammetry, Department of Remote Sensing, Image Processing and Cartography

Theoretical research (Com. III): Algebroprojective Photogrammetry (= projective evaluation of complete non-metric mono- and stereo images); Digital stereo correlation by means of local descriptors.

Applied investigations (Com. II / V / VII): Implementation of a digital photogrammetric workstation; Morphometric observations at block glaciers in the "Hohe Tauern" national park; Mapping in the "Franz Josef Land" archipelago from photogrammetric spaceborne imagery; Reconstruction of sacral objects from non-metric stereo images.

2.1 Institute of Computer Graphics and Geometry
Theoretical research (Com. II / III / V): Image understanding; Parallel computing algorithms; Radargrammetry.

Applied investigations (Com. II / IV / V): Implementation of a digital photogrammetric workstation; 3D-restitution/rendering; Multiple-image-data-sets; Data-networks.

Special project (Com. I, Com. VII): Supervision and central data administration of the "MOMS-MISSION" project.

2 Technical University of Vienna (TUW)

Institute of Photogrammetry and Remote Sensing

Theoretical research (Com. I, Com. III): Integration of lines, curves and surfaces into image orientation; Automatic robust estimation, singularity control and analysis of variance components in 3D bundle adjustment; Integration of GPS results into absolute orientation.

Applied investigations (Com. II, Com. IV): Completion of the software package "ORIENT" with respect to the above-mentioned theoretical results and improvement of its handling; Completion of the software package "SCOP" (DTM) with respect to orthophoto production, 3D visualization and contour maps.

Special projects (Com. I, Com. IV, Com. V, Com. III): Implementation of an international network for industrial engineering and architectural photogrammetry (CIPA etc.); International CIPA-experiment "Karlsplatz" in order to verify the possibilities of terrestrial photogrammetry; 3D image processing in application to face and orthodontic surgery; Derivation of a land-use model of Austria from DTM and Landsat data for use in mobile telecommunication; High-precision 3D-reconstruction from digital multiple stereo images; Participation in the MOMS-MISSION project.

Additional activities: The well-known book on photogrammetry has already been translated into nine languages; Implementation of a central homepage referring to geodesy, photogrammetry, cartography and geoinformation; Management of the XVI ISPRS congress in Vienna.

3 University of Agriculture (Vienna)

Institute of Surveying, Remote Sensing and Geoinformation

Theoretical research (Com. IV): Topology of line elements avoiding fragmental polygons.

Applied investigations (Com. IV, Com. VII): Methods of evaluating airborne and spaceborne images for purposes of agriculture and forest monitoring; Knowledge-based analysis of remote sensing images; Investigations on GIS for forest planning.

Special projects (Com. II, Com. IV, Com. VII): Development of monoplottting systems; Methods of interpretation of forest damage; Forest maps from airborne and spaceborne imagery; Knowledge-based analysis of remote sensing data using physical models; GIS application in forest planning; Algorithms for digital cadastres; Participation in the project "Theory and Applications of Image Processing and Pattern Recognition" and in the MOMS-MISSION project.

4 University of Innsbruck

Institute of Geodesy

Applied investigations (Com. I, Com. V): Stability of digital images from photo CDs; Application of digital photogrammetry to architectural documentation; Documentation of the well-known glacier mummy "Ötzi".

F. PRIVATE SECTOR

In Austria photogrammetric production is performed to a large extent by private enterprises belonging to so-called "Ingenieurkonsulenten für Vermessungswesen" (= consultant engineers of surveying). Regarding the high basic expense for photogrammetric instrumentation, it is obvious that only few consultant engineers will be able to install an office of photogrammetric production. Hence, only one or two of such offices exist in each province. Remote sensing is not applied in this connection, but there exists a special private enterprise in the province of Salzburg, where remote sensing data are handled.

In general, the application of photogrammetry occurs in collaboration with official authorities (federal provinces and cities) and refers to the production of large scale maps ($\geq 1:10,000$), orthophotomaps, precise situation maps for several utilities (postcables, pipelines, noise pollution, etc.) and the use for architectural and archaeological purposes. It is not possible to explain all applications in detail, but everybody who is familiar with photogrammetry, image processing and mapping will be able to imagine the large variety of possibilities Austrian photogrammetry can offer in practice.

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