

SWEDISH NATIONAL REPORT
FOR
PHOTOGRAMMETRY AND REMOTE SENSING
1992-1996

Prepared for the Swedish Society for Photogrammetry and Remote Sensing by
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Commission VI

ABSTRACT

A short description of some aspects of the development of photogrammetry and remote sensing in Sweden during the period 1992-1996 is given. Within photogrammetry, research on digital methods has been followed by an introduction of digital photogrammetry in education as well as in some production areas. A depression in public economy has led to a structural rationalization within private photogrammetry consultants. In remote sensing, Sweden holds a strong international position through the Kiruna satellite receiving stations and the engagement in the SPOT and CORINE programs. Sweden is involved in international cooperation through ISPRS Council and working groups, and through OEEPE and ESA.

KEY WORDS: National_Report, Sweden, Photogrammetry, Remote_Sensing, Research, Production, Organization

**1. SWEDISH SOCIETY FOR
PHOTOGRAMMETRY AND REMOTE SENSING**

The Swedish Society for Photogrammetry and Remote Sensing (SSFF) was founded in 1929 with the aim "to promote research and development within photogrammetry and remote sensing". The society has over 500 members and works by promotion of national and international cooperation, by offering travel grants, by the publication of a journal, *Bildteknik/Image Science* and by organizing yearly "Map Days together with the Cartographic Society. One yearly issue of the journal presents an account of the latest year's development in Sweden.

The society has been actively involved in international development and activities. Prof Kennert Torlegård acts first vice president of ISPRS. Sweden hosts three TC working groups, viz.

WG I/1 "Image Data Quality Control and Standardization" (Chairman Prof Hartmut Ziemann, Dessau, former at KTH, Stockholm, secretary Mr Anders Boberg, KTH, Stockholm)

WG I/6 "Preprocessing and Archiving of Satellite Data for Remote Sensing" (Chairman Dr Dan Rosenholm, secretary Mr Dan Klang, both Swedish Space Corporation)

WG III/2 "Geometric-Radiometric Models and Object Reconstruction" (Chairman Prof Kennert Torlegård, secretary Dr Eberhard Gülch, both KTH, Stockholm)

WGs I/1 and III/2 arranged workshops in Dessau and Stockholm, respectively.

In the autumn of 1994, the society hosted a national conference on Digital Image Analysis (together with the Swedish Society for Automated Image Analysis). The society has been preparing for the participation in ISPRS'

Vienna Congress and for hosting the 1997 CIPA Symposium in Göteborg (together with the Institute of Conservation, Göteborg University). The theme for the CIPA Symposium has been chosen as "Photogrammetry for Architecture, Archaeology and Urban Conservation".

The society has supported the publication of a new textbook on photogrammetry and remote sensing, published by the National Swedish Board for Forestry, Commission for Remote Sensing in Forestry.

**2. DEPARTMENT OF GEODESY AND
PHOTOGRAMMETRY, KTH, STOCKHOLM**

2.1 Organization

The departments of Photogrammetry and of Geodesy, and the section for Photography and Sensor Physics at KTH were merged into one department in 1993. The new department is called Department of Geodesy and Photogrammetry. Except photogrammetry, geodesy and photography, the department is active in geoinformatics in large, s.a. GIS and remote sensing. The WWW address is:

<http://www.geomatics.kth.se>

The department hosts the Centre for Geoinformatics (CGI). CGI consists of 7 institutions in Sweden. It was founded in 1995 to promote interdisciplinary and international research related to geoinformatics and to establish a graduate school in geoinformatics. The WWW address of CGI is:

<http://www.ce.kth.se/GEOFOTO/CGI>

2.2 Equipment

For the CGI and for the department, 14 Silicon Graphics Indy computers and a file server were bought. The disk storage comprises 35 Gb. The work stations, which replace Apollo work stations from 1986, are used for education as well as for research.

In 1995, a commercial software for digital photogrammetry, the Desktop Mapping System (DMS) of R-Wel, Inc., Georgia, was bought and installed on 15 Pentium PC's. The DMS is used mainly for introduction of digital photogrammetry to students in surveying and mapping.

The Kern DSR-11 analytical plotter has been upgraded with a PC server and MicroStation software from Intergraph.

2.3 Education

The department gives some 15 undergraduate courses in the disciplines geodesy, photogrammetry, photography, remote sensing and geoinformatics, and contributes to yet 5 courses. The courses are taken by classes of 10 up to more than 100 students. The department also gives external courses for professionals outside KTH. A successful example of the latter is a course in Digital Photogrammetry, which has been given repeatedly since 1992, e.g. to the National Land Survey of Sweden and to the National Swedish Road Administration.

2.4 Postgraduate Degrees

The following postgraduate degrees in Photogrammetry or Geoinformatics have been passed during the period 1992-1996:

- Lars Schylberg, PhD (in digital cartography)
- Holger Zielinski, PhD (in photogrammetry)
- Katarina Johnsson, PhD (in remote sensing)
- Eberhard Gülch, Dr-Ing (in photogrammetry, defended in Germany)
- Peter Axelsson, Licentiate (in photogrammetry)

2.5 Research Activities

The following main research activities have been undertaken during the period 1992-96 in photogrammetry, photography, remote sensing and geoinformatics.

- Automated object description
- Photographic image quality
- Orientation procedures without need for provisional values
- Precision and reliability in strip triangulation
- GPS in block triangulation
- Line photogrammetry
- Design of a photogrammetric workstation for close-range line photogrammetry
- Mobile mapping system
- Software for basic analytical photogrammetry
- Resampling using segmentation
- Aerotriangulation using digitized images

- Raster operators for map generalization
- Integration of GIS and Remote Sensing data
- Morphometric studies using geophysical and digital elevation data
- Land elevation, bathymetry, and seismic data analysis using GIS

3. THE NATIONAL LAND SURVEY OF SWEDEN

3.1 Organization

The National Land Survey of Sweden (NLS) was totally reorganized in 1995, including the National Board for Real Estate Data. The result is an organization that includes authority departments for real estate administration, for provision with basic geographic information in computerized and map form, and for research and development, as well as a production department called METRIA.

NLS / METRIA performs the major part of aerial photographic services in Sweden, produces national geodetic networks, maps and databases and acts as a consultant in mainly large scale photogrammetric production.

3.2 GPS in Aerial Photography and for Block Triangulation

Yearly some 20 000 aerial photographs are produced and stored. The NLS has since 1992 routinely used real-time GPS in aerial photography for navigation and automatic exposure at preselected points. The system for this, called Computer-Assisted Aerial Photography (CAAP), was developed in-house. The CAAP system consists of four parts: Planning, Navigation and automatic exposure, Post processing and Archiving.

Post-processed GPS is to an increasing extent used in aerial block triangulation to reduce the amount of ground control points. Block adjustment is performed as bundle block adjustment with PAT B-RS GPS, using corrected image coordinates, ground control point coordinates, antenna coordinates for each exposure, determined by differential GPS, and eccentricity data between antenna and camera. Unknown drift parameters for stripwise linear GPS drift corrections are introduced.

The photographic archives contain more than one million aerial photographs from 1929 until today. In order to improve archive services a computer-based information system for aerial photographs, FBIS, has been developed, based on a digital background map, manual digitization of existing index maps and storage of GPS coordinates and digitized attribute data for new photo missions. Information will be distributed via Internet.

3.3 Analytical Photogrammetry for Small-scale Map Production

Since 1937, the Economic Map of Sweden at a scale of 1:10 000 has been produced using a combination of in-

house aerial photo interpretation and extensive field work. Later, the map was printed at a scale of 1:20 000, and for the moment printing has ceased in favour of a "Forced Database Edifice". In order to render the production more effective and to minimize field work, analytical photogrammetric instruments of the type Zeiss Planicomp P3 or Casco-modified Wild B8 are used for data collection.

3.4 Digital Photogrammetry

In 1994 the NLS decided to accomplish a study of digital photogrammetric workstations. The main objective was to enable production and mosaicing of digital orthophotos. Other objectives were automatic production of digital elevation models, acquisition of vector data for mapping and map revision, especially updating of the Economic Map database, and good basic orientation, measurement and triangulation capabilities.

The decision was made to purchase a complete digital photogrammetric system from Leica/Helava, consisting of a DSW200 Digital Scanning Workstation and five digital photogrammetric workstations – one DPW670 monoscopic station and four DPW770 stereoscopic stations. The system is used mainly for production of digital orthophotos. Special products including digital orthophotos, elevation models and image map plots for road design have been produced for the National Swedish Road Administration. Tests have been made of the automated triangulation software module HATS (Helava Automated Triangulation System), which is approaching sufficient stability to be used in production.

For data collection and updating of the Economic Map database, two Zeiss PHODIS ST with PHOCUS software were purchased. Stereoscopic superimposition of map data and use of PHOCUS mapping software has shown great potential for its purpose.

4. THE NATIONAL SWEDISH ROAD ADMINISTRATION

After an inventory phase the first digital photogrammetric workstation in Sweden was delivered by Intergraph to the National Swedish Road Administration in January 1994. It is of the type ImageStation. The main purpose was to provide road designers with orthophoto maps and digital elevation models as a base for early design phases.

The workstation is connected to a network including analytical photogrammetric instruments of the type System 9. In 1995 the system has been completed with another ImageStation.

Plans are to develop products for visual presentation of road design projects.

5. PRIVATE PHOTOGRAMMETRY CONSULTANTS

5.1 Structure of Companies

Swedish private photogrammetric consultancy has faced a radical structural rationalization due to increased competition in the period 1992 - 1996. Today there are five relatively large consulting firms in Sweden, as well as a number of minor firms. The larger firms together employ some 100 persons in photogrammetric production.

5.2 Resources

There are no Swedish private companies offering aerial photography for mapping purposes, but Swedish companies co-operate with Danish and Finnish companies with aerial photography resources.

Swedish photogrammetric companies have approximately 35 stereo instruments in total. Among these there are 15 analytical instruments. Almost all mapping today is digital. The analog instruments are in general modified to accommodate digital mapping. Most of the instruments are connected a CAD- or GIS- system for data capture and editing of map data. Datafiles are delivered in a common Swedish data format (KF85) for exchange of digital map data.

Digital photogrammetry has not yet been introduced on a permanent basis among Swedish consulting firms for photogrammetric production.

5.3 Customers and Products

Sweden has been facing a difficult economic situation during the last years. This has caused major cut downs in public expenses, especially within municipalities, resulting in reduced planning and building activities. Therefore, local map production has slowed down, and investments in GIS systems have dropped. The conversion of analog maps into digital map data, as well as production of new digital map data is far less than in earlier years.

On the other hand public investments for infrastructure have increased considerably. The National Swedish Road Administration and The National Swedish Railway Administration are performing major projects in road and railway design and construction. The need for photogrammetric products have consequently adjusted to that situation. Photogrammetric digital map data and digital terrain models for infrastructural project design are today the main products.

There is also an increased interest in orthophotos for preliminary design of infrastructural projects. This is expected to promote the introduction of digital photogrammetry.

Non-topographic photogrammetric applications are found mainly within the car industry, for documentation of industrial environments and for cultural preservation.

6. REMOTE SENSING ACTIVITIES

6.1 Remote Sensing Facilities

Research and development in remote sensing is performed mainly at departments of physical geography in Stockholm and Lund Universities, at the University of Agriculture and Forestry, at the Royal Institute of Technology, at Chalmers Institute of Technology, at the Swedish Space Corporation and at the Swedish Meteorological and Hydrological Institute.

Sweden has a 5% share of the SPOT programme, and runs satellite receiving stations for SPOT, Landsat, ERS and Resurs-01 image data in Esrange and Salmijärvi, Kiruna. Through the National Swedish Space Board and the Swedish Space Corporation, Sweden actively takes part in ESA's space programs. As a result of development at SSC Satellitbild and at the Royal Institute of Technology, satellite imagery is produced in precision corrected form and is used for derivation of digital elevation models as a basis for international topographic or thematic mapping.

6.2 SAR Activities

In 1993, a national seminar on basic technology and applications of synthetic aperture radar (SAR) was arranged. At Chalmers University of Technology, satellite radar interferometry has been developed for topographic mapping, using SAR data from repeated overpasses by the ERS-1 satellite. Especially the possibility to map forested surface topography was studied.

6.3 Remote Sensing courses

Since 1990, the Department of Physical Geography at Stockholm University has, together with SSC Satellitbild, hosted a yearly recurring international course in remote sensing, mainly directed at experienced tertiary-level teachers from developing countries. The courses are the result of a co-operation between the United Nations and the Swedish authority SIDA.

The International Space University 1995 Summer Session took place at the Royal Institute of Technology in Stockholm, with Prof Kennert Torlegård as representative of the host organization. As design projects for the course were chosen

- Earth Observation Scenario for the Polar Regions
- Vision 2020 (Space activities 25 years into the future).

6.4 National Remote Sensing Programmes

The CORINE (Coordination of Information on the Environment) program was initiated by the European

Union in 1985, with the aim to acquire an overview of environmental status and changes in Europe. CORINE Land Cover is one of the projects within the programme. A pilot project on Land Cover was carried through by the Swedish Space Corporation in cooperation with several Swedish research groups. The project aimed at development of a method for Land Cover mapping of Sweden using satellite data as well as existing topographic and vegetation maps. Also methods for digital generalization of Land Cover map data was studied.

In 1995 a national remote sensing programme was initiated by the National Swedish Space Board in cooperation with research institutes and authorities. Within the programme, four long-time program areas have been defined:

- Environmental monitoring
- Topographic mapping
- Forestry
- Meteorology

The program areas are to be completed in 1998 in cooperation between research groups and the Swedish Space Corporation.

In Kiruna an Environmental Data Center (MDC) is under completion, coordinated by the National Swedish Space Board. The task will be to research on and to perform operational environmental monitoring with the help of remote sensing technology. MDC has been appointed "European Topic Centre for Land Cover" by the European Environment Agency.

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