

DANISH SOCIETY FOR PHOTOGRAMMETRY AND SURVEYING



MEMBER REPORT of DENMARK

XVII CONGRESS

International Society for Photogrammetry and Remote Sensing

Washington 1992

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ABSTRACT

As many different organizations are working on establishment of Information Systems, the demand for digital maps has been important during the last congress period. This has resulted in a total coverage of the country with digital maps, and it has been a heavy task for the private photogrammetric sector who made the maps.

The governmental mapping institutions have been through a strong structural change, and are fighting with reductions. In the period traditional topographic mapping has been finished, and photogrammetry has also been used in renovation of cadastral maps.

Remote sensing is not intensively used for mapping purposes in a small place like Denmark, but some activities are going on. The Danish member report will have chapters from the various actors in photogrammetry and remote sensing.

THE NATIONAL SURVEY AND CADASTRE

Introduction

In January 1989 Geodætisk Institut (the Geodetic Institute of Denmark), Matrikeldirektoratet (the Danish Cadastral Department) and Søkortarkivet (the Nautical Chart Administration) were merged into one institution under the name of Kort- og Matrikel Styrelsen, KMS (the National Survey and Cadastre, Denmark). From the beginning of April 1991 a process of bringing together the new institution in one address in Copenhagen was started. At the moment the number of addresses in Copenhagen has been reduced from 8 to 2.

It is the policy of the Danish government to reduce production within the public framework and to force the work to be done as much as possible by using private companies. In order to facilitate this a new law defines KMS to be responsible for the coordination of the public map production and the authorization of map standards.

This forces KMS to prepare standards which enable the private companies to produce or to bring up-to-date any of the national map series. A consequence of the privatization is a reduction of employees by 20 per cent which is taking place at the moment.

At the same time a shift is in progress from manual/analogue to automatic/digital production. When successfully implemented, it is expected to reduce manual work considerably.

TOPOGRAPHIC MAPPING

Denmark

The production of photogrammetric manuscripts, which began in 1966 and was estimated to end in 1990, was cancelled in 1990 leaving about 10 per cent of maps in scale 1:25 000 and 1:50 000 still to be based on table measurements produced in the period 1920 to 1935. The cancellation was caused by a new digital photogrammetric production initiated by utility owners in Jutland (see T0-project under The Private Photogrammetric Companies). KMS was participating in the project at the beginning but failed to obtain a satisfying agreement with the utility owners. In the rest of the country KMS obtained satisfactory agreements. This means that all rural areas have been digitally mapped during the last 4 years and that all urban areas also have been or will be mapped within the nearest future. The scale of photography used for these digital mapping projects ranges from 1:18 000 to 1:30 000, and the number of features from 18 to 56. One important aspect of this mapping

is that street names connected to the centre lines of roads and house numbers are part of the mapping and open up for connection to existing administrative databases.

The map in 1:200 000 which covers Denmark in 4 sheets has been converted to digital form. The next edition will be updated purely digitally. The road centre lines of this map are at the moment being transformed into a road database by establishing connections between the centre lines and all town names, CIP codes and information from the Danish Road Administration.

Greenland

All mapping activities in Greenland have been suspended due to lack of resources. Looking at the Northern Greenland Mapping Project, all data capture is finished, and 34 sheets are published.

The Faroe Islands

The mapping project of the Faroe Islands is continued and at the moment 23 sheets have been plotted and 16 sheets have been published.

The future

At present a lot of test exercises are taking place in order to establish cooperation between the National Survey and local communities which are responsible for the large-scale technical mapping of Denmark. The idea is that the National Survey shall utilize information from the local communities in order to minimize production costs.

Lars Tyge Jørgensen

THE CADASTRE

Introduction

Registration of land, titles, interests, mortgages, easements, etc. is divided between the National Survey and Cadastre and the offices of the Land Registry.

In accordance with the Development Act, all alterations of boundaries are to be registered in the Cadastre. Alterations are registered on the basis of documents worked out by licensed land surveyors in private practice who also do the surveying required. In the National Survey and Cadastre the areas, etc. are entered in the register, and the new boundaries are drawn on the cadastral maps. When alterations of property have been registered, the keeper of the Land Registry and the tax assessment authorities are notified.

The cadastral register has been on edp for six years.

A conversion of the maps to digital form is going on. 10-15 per cent is on a digital form today.

Cadastral maps

In Denmark the entire country is covered by cadastral maps. The maps have been kept up-to-date with registered alterations of property since the start of the Cadastre in 1844. The scale of the maps is 1:4000 or larger.

The majority of the maps are "island maps", i.e. every village is on a separate map. The maps were originally measured by plane table survey, and they have all been redrawn one or more times. The towns were registered for cadastral purposes for the first time 1865-1875. The maps are in scale 1:800 and are based on traverse survey.

Since the turn of the century new plans have been produced on the basis of terrestrial surveys and since 1960 on the basis of photogrammetric surveys. Surveys carried out after 1934 are normally linked to the Danish national grid.

The cadastral maps are mainly intended for the public registration of land, but they are also used for administrative purposes, planning, etc. by authorities, public institutions and by private persons.

Reference network

Control points for cadastral measurements have been coordinated using bundle adjustment with added parameters.

The result of the coordination is a densification of the existing 2 km net of triangulated points down to a density of approx. 400 m. The photo scale is preferably 1:8000 - 1:10000 and the overlap 60/30.

The accuracy is tested in the field by measuring distances between coordinated points using edm. The standard error on a photogrammetrically coordinated point is less than 5 cm.

In connection with the conversion of the maps to digital form it was agreed that an accuracy of 10 cm on the control points was sufficient for that purpose. This was obtained using a photo scale of 1:18 000.

An edp-based register of the coordinates for control points - about 360 000 points - has been established. The observations are being converted in connection with the conversion of the cadastral maps.

Present activities

A conversion of the cadastral maps to digital form is going on. The conversion is not just a matter of digitizing the existing maps.

The "island maps" were not measured on a common reference system. In order to relate the contents of the maps to the reference system of today, you have to partly reconstruct the maps. Information from the field, in the form of orthophotos or photogrammetrically produced line maps, and existing measurements from the updating procedure are used in this connection.

The accuracy of the new map depends very much on the accuracy of the control points and the amount of measurements used.

As the accuracy is also expensive, you will have to watch out for a balance.

Today we have given up the aerotriangulations for the renovation of the control points. We have found that a recalculation of the points from the existing observations, supplemented with a few new, will give us an accuracy sufficient for this purpose. We also use less measurements and more digitizing of the old maps today than we intended when we started in 1986.

These changes mean that covering the whole country with digital cadastral maps is today calculated to cost less than half the price that we anticipated 6 years ago.

The conversion is partly financed by user-payment. Therefore the speed of the conversion is very much depending on user

interest. Our main users are the municipalities and other official bodies.

The guess today is that it will take 5 - 6 years to finish the conversion of the cadastral maps for the rest of the country. In order to meet this time limit it is planned to give private companies the contract for more than half of the conversion job.

Jonna Hvidegaard

THE PRIVATE PHOTOGRAMMETRIC COMPANIES

Introduction

The period 1988-1992 was for Danish photogrammetric map-makers the years, when digital mapping for the natural gas net was completed.

As this project was of great importance for development of digital mapping and the investments in new technique, the private companies are now looking for new large projects in Denmark and abroad.

The bridge/tunnel between the islands of Fyn and Sjælland (the Great Belt) is important for development of new methods in surveying and mapping. Here photogrammetry has only served to a minor extent.

New trends in digital mapping

In the month of May 1988 new specifications for digital mapping were published by a committee under the Association of Chief Engineers in the municipalities. This meant a breakthrough for the standardization of digital mapping. These standards have been used by all mapmakers since then.

The maps have been defined by 3 different standard types, T1, T2 and T3, from simple to more differentiated mapping. However, a very important standard type was established in 1989, T0 (called T Zero) (see illustration). The idea of T0 was that it should cover the open country of Denmark to a degree of 100 per cent, thus being a very economic mapping using photo scales 1:18 000 -1:30 000. In 1993 Denmark is totally covered by digital maps.

A new edition of the specifications is soon ready for publishing.



T0 map

The digital T0 coverage has been the most important mapping project in Denmark in this congress period. An important feature is that roads are being mapped by the centre lines, and that addresses are added. The map is better presented in colour.

Technical performance of the companies

Another trend in Denmark has been the change from analogue to analytical instruments. By February 1992 the last WILD A8 in the private sector was dismantled so that the change to ZEISS Planicomps and WILD BCs is now 100 per cent.

In the private sector there are now 14 Planicomps, 7 BC 1-3 and 1 Leica SD 2000.

The Danish work station **DanGraf** is still popular among the photogrammetric companies, although the competition is hard, especially from Intergraph.

Orthophotography

In 1986 the the National Cadastral Survey decided to produce digital cadastral maps, using orthophotography to rectify older surveys.

The private companies established DORPAS (Danish Orthophoto Production) and bought a ZEISS Orthocomp Z2 system. During the period 1986-1989 the island of Funen (3500 km²) was mapped with orthophotos in scale 1:4000.

Unfortunately the programme was stopped for political reasons.

Who are the photogrammetric companies?

Since 1990 there has been important changes in the configuration of photogrammetric companies in Denmark.

Today the old companies are split up in two major blocks. **Kampsax Geoplan** which also includes **Aerokort** and **Geomasters** is one. The **Scankort-LLO** group is the other important group.

In 1992 two new companies have appeared in the field of aerial photography and digital mapping: **Infokort** and **Jysk Digital Kort Center**.

Anders Foghsgaard

THE TECHNICAL UNIVERSITY AND THE ENGINEERING ACADEMY

Institute of Surveying and Photogrammetry

The institute is responsible for education and research on surveying, photogrammetry, digital cartography, geographical information systems and basic computer science for BSc and MSc students in engineering.

Staff

The staff comprises 1 full professor, 6 associate professors, 1 secretary, 1 technician, a varying number of temporarily employed personnel and PhD students.

Education

The basic courses in surveying include introduction to photogrammetry and are given to about 200 students a year. Specialized courses in photogrammetry, remote sensing, digital cartography and geographical information systems are given to 25-40 students a year. 2-5 students graduate in photogrammetry, remote sensing or GIS every year.

Research

Photogrammetry

A method of multi-model stereo restitution (Dueholm, PERS 56(2)) was developed in cooperation with the geologic division of the U.S. Geological Survey in Denver, Colorado. Multi-model photogrammetry includes the advantage of free movement between stereo models at widely different scales in an analytical plotter, and thus facilitates the use in photogrammetry of small-format photographs (colour-slides) taken with ordinary 35 or 70 mm cameras. Over the past two years the method has been employed in scientific analysis and mapping within diverse fields: geological and geomorphological mapping in Greenland, Utah, and India; mapping of steep coastal cliffs in Denmark and the Faroe Islands; architectural measurements in Japan; and archaeological survey of Newport Tower in Rhode Island.

Image processing

Mosaicking scanned images using least squares adjustment for radiometric correction of orthophotos has been studied and a PC program system developed (Ph.D. thesis). Together with the University of Copenhagen an image processing system for automatic extraction of DEM from SPOT images has been developed. The system is based on correlation, organized in pyramids. The project included extensive control measurements from hardcopies of SPOT images and aerial photographs.

Digital Elevation Models

The institute was in charge of the construction of a national elevation database based on digitized 5-metre contours. The database was primarily developed for radio communication and completed in 1989. A DEM program package has been developed for the Danish geographical information system, **Dangraf**. The DEM is an integrated part of the GIS, giving a 3D database for projecting and analysis.

Updating digital maps and databases

Development of methods for least squares adjustment to combine new and old data. Design of a user interface that can display the varying accuracies and the variation in details of the database.

GIS

An on-going Ph.D. study develops a framework for geographical data modelling for GIS. Systematization and documentation of aims and goals is seen as essential for the successful and cost efficient implementation.

Development of methods for automatic creation of links between attribute and map databases applies principles of artificial intelligence. The implementation of an analytical application on an ARC/INFO platform will demonstrate the potentials of generalized cartographic representation of attribute data. Research on the feasibility of using existing map data in GIS has been carried out.

A staff member participates in a work group on developing new standards for digital mapping in Denmark.

Instrumentation

Several electronic theodolites, EDM, and total stations.

A KERN DSR15 analytical plotter, a stereo comparator and a few analogue instruments.

Computers comprise UNIX workstations, MicroVAXes, Prime, and IBM and MacIntosh PCs. Standard GIS, image processing, and database software are running on the computers together with in-house developed software for calibration, adjustment, and analysis.

Keld Dueholm

AALBORG UNIVERSITY

Laboratory for Photogrammetry and Surveying

Education

As part of the 5-year education of the chartered Danish land surveyor, standard courses in photogrammetry and mapping are given to about 45 survey student each year, including practicals like control point determination, stereoscopy, photomap production, and analogue and digital restitution.

After the common first 3 years, the students can specialize. Courses in remote sensing, digital mapping, image processing, terrestrial photogrammetry, raster photogrammetry, GIS and other are given.

As all teaching is organized in projects, photogrammetry is highly integrated with neighbouring subjects like surveying, deformation measurements, cartography, remote sensing, digital image processing, GIS and similar. About half of the students specialize (MSc) in these areas.

Staff

The teaching staff consists of 11 academic persons, 3 of these specialized in photogrammetry.

Equipment

As all mapping projects are carried out in a digital way, the students have access to total stations and various workstations, equipped with AutoCad, Microstation, GeoCAD, MapInfo and other software systems. A smaller PC-based image processing system is also available. For photogrammetry we still have analogue instruments for the first exercises: rectifier, orthoprojector and B8, G6 plotters. A stereocomparator is not in use any more, replaced by a Zeiss Planicomp. After this congress we plan to procure two smaller analytical instruments to supplement/replace the B8s.

During the congress period we procured an Intergraph Tigris system. We hope to be able to extend this system to a full digital stereo workstation.

Research

Digital orthophotos and object-oriented height models in GIS
Experiments with generation of digital orthophotos on the background of an object-oriented height model is performed on the Tigris system.

The combination of digital orthophotos and an object-oriented and topologically structured maps and height models forms a powerful GIS tool.

Experiences, also some negative, are obtained, using the Intergraph Tigris software, combining raster and vector data.

The GeoCAD software system

Many student projects are performed using the GeoCAD software system, developed at the laboratory in cooperation with private land surveyors.

The system uses data collected from total stations as well as photogrammetric instruments. It has from the beginning been an object-oriented system.

During the last congress period the mapping system has been developed into a GIS system, being able to create areas coupled to registers.

The software is UNIX based, and is implemented on a large number of different hardware systems. It is also available commercially, sold to municipalities and utility companies.

Computer-assisted learning for GIS

The increasing use of computers in the information society gives new training and educational problems. The computer can, however, be used as a means of coping with these new tasks.

A program package for Land Information Systems called LIS-demo is developed, having sections for cadastral map construction and updating, choropleth map, orthophoto production, databases, concepts and queries. Extension for Digital Height Models and Exchange of GIS data is planned.

Digital image processing

The main area of interest within the field of image processing is the development of a change detection model. An existing map is updated by a process of low-level control routines in order to verify the presence of existing features. The processed results are then used as basis for acquiring high-level knowledge for detection of new elements. The result of the last process is then used as reference in a precise stereo registration, analytical or digital.

The precise extraction of map-relevant elements requires high-level knowledge and intelligent behaviour. This is usually acquired by experience and training which requires great computer capacity. The project is concentrated on advancing this process in order to improve the completeness of the map.

Brande-Lavridsen

UNIVERSITY OF COPENHAGEN

Institute of Geography

The Institute of Geography has for several years been working on remote sensing, digital image processing and GIS in relation to case studies of physical environment.

Staff

The remote sensing/image processing/GIS-group encompasses 11 scientist.

Research

Remote sensing and image processing

- 1 Methodologies for application of NOAA AVHRR data for monitoring of agro climatological parameters, vegetation, crops and bush fires.

- 2 Mapping of vegetation and land-use on the basis of SPOT and LANDSAT multispectral and multitemporal data sets.
- 3 Development of a correlation-based algorithm for extraction of elevation information from stereo pairs of panchromatic, digital SPOT images.
- 4 Use of expert systems for urban land use classification on the basis of SPOT/LANDSAT.
- 5 Development of a software package, CHIPS, for PC-based satellite image processing.

Project activities are ongoing in Greenland, Denmark, Portugal, Senegal, Burkina Faso, Niger, Ghana and Tanzania.

GIS application

Major projects have focused on estimation of sediment load in coastal areas and river basins, land evaluations, change detection of agricultural systems and studies of urban growth. Until 1990 the institute used self made software designed for individual projects, but in 1990 the institute procured the PC Arc/Info GIS for future research and training of students. Raster-based systems such as OSU-Map-for-the-PC and IDRISI are used in spatial analyses especially when it comes to integration of digital satellite images and GIS.

Cooperation

The institute has been responsible for establishing facilities for satellite image processing and GIS at three African institutions as part of partnership arrangements.

Courses offered

Educational activities include introductory courses in *Remote sensing and digital image processing* and *GIS* as well as advanced courses within specific application fields, supervision of MSc and PhD students and training of scientists from other institutions.

Thomas Balstrøm and Kjeld Rasmussen

SOCIETY ACTIVITIES

The Danish Society for Photogrammetry and Surveying, DSFL, represents Denmark in the ISPRS.

The society has in its statutes that it works with photogrammetry, remote sensing mapping aspects and land surveying. During the later years many activities have of course to do with digital mapping and GIS.

The society has now approximately 450 members, covering a wide range of professionals and institutions.

The activities are in different fields. We arrange 10 to 15 evening lectures a year, usually attended by 40 to 100 members. We arrange one day seminars every 2 to 3 years, and cooperate with other organizations like AM/FM for other conferences.

An important activity is our work on the "Standard Format for Exchange of Digital Map Data", the "DSFL Format". New editions are appearing approximately every second year, now also giving possibilities of exchange for other types of information than the map itself. Just now we work on a format for exchange of the public registers (buildings, real estate and similar). DSFL has representatives in working groups on European exchange formats.

The society also sends representatives to working groups of other organizations. This spring a revision of the Specification for digital maps to the municipalities is taking place. This concerns production, content and accuracy of these technical maps. In the new version it is tried to make it possible to produce topologically better maps (clean geometry) than the existing spaghetti types. There was some opposition from as well producers as users, because many smaller systems are not able to handle these things, and because of threats of rising prices. It was only possible to include these improvements as an optional delivery.

Brande-Lavridsen

ADDRESSES

Society

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Government Institution

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Photogrammetric companies

Infokort, Frøslevvej 34, DK 2610 Rødovre

Jysk Digital Kort Center, Burvej 1, Idom, DK 7500 Holstebro

Kampsax Geoplan, Stamholmen 112, DK 2650 Hvidovre

Landinspektøernes Luftfotoopmåling, LLO, Selsmosevej 2, DK 2630 Tåstrup

Sankort, Kirkevej 8, DK 2630 Tåstrup

Education and research

Elektromagnetisk Institut, Bygning 349 Danmarks Tekniske Højskole, DK 2800 Lyngby

Geografisk Centralinstitut, Københavns Universitet, Øster Voldgade 10, DK 1350 Copenhagen K

Instituttet for Landmåling og Fotogrammetri, Danmarks Tekniske Højskole, Landmålervej 7, DK 2800 Lyngby

Laboratoriet for Fotogrammetri og Landmåling, Aalborg Universitetscenter, Fibigerstræde 11, DK 9220 Aalborg Øst

Sister societies

Dansk Kartografisk Selskab (ICA), KMS, Rentemestervej 8, DK 2400 Copenhagen NV

Dansk Selskab for Telemåling (Remote Sensing), Elektromagnetisk Institut, Bygning 349, DTH, 2800 Lyngby

Den Danske Landinspektørforening (FIG), Lindevangs Allé 4, DK 2000 Frederiksberg C