

NORWAY
NATIONAL REPORT

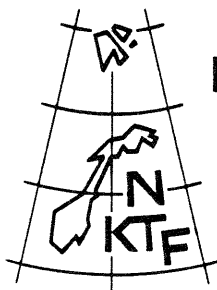
XV CONGRESS OF THE INTERNATIONAL SOCIETY FOR PHOTOGRAMMETRY
AND REMOTE SENSING

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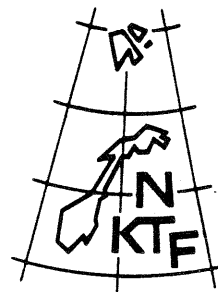
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**Norges
Karttekniske
Forbund**

**The Norwegian Association
for Cartography, Geodesy,
Hydrography and
Photogrammetry**

NORWAY - NATIONAL REPORT
 Issued by Norges Karttekniske Forbund
 (The Norwegian Association for Carto-
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 Editor: Øystein Andersen
 Norway



1. INTRODUCTION

This report is produced by Norges Karttekniske Forbund, NKTF, The Norwegian Association for Cartography, Geodesy and Photogrammetry. NKTF is the Norwegian member of ISPRS.

The report gives a short introduction to the most important developments and changes during the 4 year period 1980-1984. The most obvious changes can be seen in computer assisted photogrammetry and remote sensing.

2. A NORWEGIAN RESEARCH PROGRAMME ON MAPPING AND SPATIAL DATA MANAGEMENT

The Royal Norwegian Society for Technical and Industrial Research and the Ministry of Environment have in cooperation taken the necessary steps to the organize a research programme specifically dedicated to mapping and handling of spatial data. The programme runs for 5 years starting in 1982.

The research programme has three major aims:

1. To contribute to the development of more efficient systems in mapping and spatial data handling. The productivity within the Norwegian mapping and spatial data community must be increased significantly.
2. To support the Norwegian industry in their development and marketing of advanced production systems on the international market.
3. To supply the spatial data users with more and up to date information, as well as better tools to utilize this information.

The programme is led by a special steering committee of 5 persons. The secretary of the programme is allocated to the Norwegian Computing Centre, which is a part of the Research Council.

The steering committee is responsible for allocating the resources made available for the programme from the Research Council and the Ministry. Internal funds from industry and user organizations, carrying out the different projects, add up to the total resources in the programme.

Project proposals are presented to the steering committee by research institutions, industrial companies or user organizations. Industrial projects should normally be financed on a 50/50 basis. Projects carried out by research institutions may apply for 100 percent funding from the programme.

The research programme is supposed to build its future activity upon the expertise which has been accumulated in a variety of Norwegian organizations during the past years. In addition it is of great interest to the programme to sponsor cooperative projects between Norwegian and foreign research organizations.

The steering committee has worked out a detailed scientific plan for the research programme. In this plan 7 larger research fields are identified and described:

1. Development of new equipment.
2. General methods in mapping and spatial data handling.
3. Methods for terrestrial resource mapping.
4. Methods for hydrographic mapping and mapping of the coastal areas.
5. Methods for mapping of communication networks, utility networks, building, etc.
6. Navigation and positioning.
7. Utilization of digital maps and spatial data.

This year (1984) the programme is responsible for a total of 17 projects and a budget totalling 21 mill. NOK of which 9,3 mill. NOK are governmental funds.

Secretary:

Truls Kjølbjerg/Lise Tchudi, Norwegian Computing Centre,
Postbox 335-Blindern, Oslo 3, Norway.

3. PUBLIC STUDIES 1980-1984

An official publication "Satellittfjernmåling" ("Satellite Remote Sensing") was presented to the Ministry of Environment in June 1983. It points out how satellite remote sensing data can be used in map production, especially for updating of maps and producing various thematic maps.

An other official publication "Tematiske kart og geodata" ("Thematic maps and geodata") was published in November 1983. It contains a survey on the use and production of thematic maps and data, and gives guidelines for the future work in this field.

The benefits of mapping is treated in the report "Samfunnsmessig nytteverdi av kart og geodata" ("Benefits for the society from mapping and collection of geodata"), published in June 1983. It mainly concentrate on the Economic Map series in 1:5000 and 1:10 000. The main conclusion is that the benefits have a value which is 8 times the investments!

4. MAP-PRODUCTION IN NORWAY 1980-1983

Only the main map series are included in the following.

4.1 Topographic map of Norway - scale 1:50 000

The topographic map of Norway in the scale 1:50 000 is produced by the Geographical Survey of Norway (Norges geografiske oppmåling-NGO). The table below gives a summary of the maps produced in the period:

<u>Year</u>	<u>Maps produced</u>	
1980	12	(NGO moved from Oslo to Hønefoss)
1981	43	
1982	40	
1983	20	

Each full size sheet covers between 550 - 726 km².

By 1. January 1984 585 sheets have been issued of this series. The remaining 142 sheets are planned to be remapped within 1987-88.

A project has been initiated for rationalization of the revision procedure. The project, subsidized by Royal Norwegian Council for Scientific and

and Industrial Research, is a joint project between NGO and Lantmäteriverket in Sweden (LMV).

After a preliminary start in 1983 the study is planned to continue for 3 years. The following main objects will be examined:

- a. The use of small scale aerial photographs.
- b. Report routines about revision details from public institutions.
- c. Registration of revision objects.
- d. Cycle of revision.
- e. Simultaneous viewing of map and stereomodel.
- f. Map automation.
- g. Satellite data.
- h. The use of orthophoto for revision.

By 1.1.84 NGO has (since 1982) digitized approx. 120 mapsheets in the scale 1:50 000 - hydrographic and contour details - using SYSSCAN-system. The plan is to establish a base for digital height models to cover the whole country within the end of 1987.

4.2 Economic map of Norway - scales 1:5 000 and 1:10 000. Orthophoto

The economic Map of Norway is planned to cover 185 000 km², 57% of the total land area. 163 500 km² will be mapped in scale 1:5 000 and 21 500 km² in scale 1:10 000. During the years 1980 through 1983, the area mapped amounted to 27 392 km². By 1st January 1984, 147 633 km² had been mapped. According to the present plans, the whole series will be completed around 1990.

Revision of the oldest maps started some years ago, and in 1983 2432 km² was revised, bringing the revised area up to a total of 6 288 km².

Research on digitizing the content of Economic Map is going on. Revising the map by data from different registers is in focus.

Orthophotos are produced for forestry purposes and in combination with the Economic Map. The scales are 1:5 000 and 1:10 000. To provide height information for orthophoto production, the contour lines on the Economic Map are digitized. Different film-qualities for orthophoto is tested.

4.3 Municipal maps - scale 1:500 - 1:2 000

Municipal maps are produced for local needs. The annual production within a community varies. The average annual production for Norway has been approximately:

<u>Scale</u>	<u>Area mapped</u>
1:500	50 km ²
1:1 000	700 "
1:2 000/2 500	250 "

4.4 Base maps for Thematic Mapping. National Atlas of Norway

Geographical Survey of Norway has produced a series of small scale base maps for thematic mapping. All base maps are produced from the same source material by use of digital techniques. The scales are in the range from 1:1 mill. to 1:25 mill. The base maps has been edited by an IGS system. This system is also used to combine thematic information from statistical sources with base map information to produce thematic maps in the National Atlas series.

The work on the National Atlas of Norway started in the last part of 1979. The Atlas will be published as a series of small scale thematic maps accompanied by booklets in folders. It provides an official source of information about the physical and human geography of the country. The Atlas is divided into 21 sections. January 1984 the first complete folder was issued, containing 11 base maps. Additional 15 single maps of different themes were issued.

4.5 Norwegian polar mapping

Norwegian Polar Research Institute is responsible for mapping in the Norwegian Arctic and Antarctic areas.

Svalbard. The topographic main map series of Svalbard in scale 1:100 000 is planned to cover the whole island group. By late March 1984 37 of 61 sheets have been constructed.

Jan Mayen. The island is covered by two sheets in scale 1:50 000.

Bouvetøya. The island is covered by one sheet in scale 1:20 000.

Dronning Maud Land. Parts of this area are covered by maps in scale 1:250 000. 23 sheets have been issued.

In 1981-82 Norwegian Polar Research Institute and IBM used the ERMAN system to make maps from LANDSAT data. The result is a new coastline of Austfonna, Svalbard, and one satellite map of Filchnerfjella Nord, Dronning Maud Land, in scale 1:250 000.

5. DEVELOPMENT AND RESEARCH

During the period considerable efforts have been made on development and research, largely computeroriented.

5.1 Software for mapping

Geographical Survey of Norway (Norges geografiske oppmåling) has contributed to a number of projects carried out by the Norwegian Computing Centre. The most important projects are:

- MAPRES - A system for production of large and medium scale topographic and cadastral maps. A new data base concept for cartographic data has been developed (BASE 85).
- IGS/ALK - An interactive graphic and utility information system. The system has also been developed in cooperation with national/regional organisations for utilities (telecommunications, electricity and VA). The system has been successfully implemented in different applications and will be further maintained and distributed by a private organisation.

Beside being a tool for map production, IGS/ALK is as a general information system useful for different applications in the geodata field. In addition to geographic information, it is possible to store and use technical information about the different objects, as well as network information, polygons etc. The system is equipped with automatic procedures for generation of networks, polygons and other types of information processing.

Automated Name Placement - A pilot project for testing of algorithms for automated name and text placement.

DKK The interactive use of digital maps and geodata in administration of municipalities

The project started in 1982 and was organized as a joint effort by the private company Fjellanger Widerøe A/S and the survey department at the municipality in Trondheim. The development and testing of procedures were carried out at the data processing service-centre at Fjellanger Widerøe A/S and thereafter installed and tested in regular production at the survey department in Trondheim.

Main activity in 1982: Evaluation and selection of a suitable database for digital maps (BASE 85, a database developed at the Norwegian Computing Centre, was selected). Adaption of existing software for property survey certificates and cadastral mapping, and development of programs for interactive drawing and editing.

Main activities in 1983: Regular production test of cadastral mapping and survey certificate-programs. Developing of interactive methods for updating large scale maps and computerassisted area development planning in combination with digital maps.

To-day the programs are able to:

Draw and edit property survey certificates/cadastral maps. Calculate areas and setting-out data. Carry out some calculations in road planning.

Combine topographic maps, cadastral maps and other thematic maps and give them a cartographic presentation.

Geometric modelling of an area development plan.

Edit map-database.

MINGU

MINGU is the digital image processing system of the Geological Survey of Norway. MINGU is a software system and the project was carried out from 1982 to 1983, based on a system already used at the Survey.

Implementation of modules for statistical analysis and classification and geometric correction of remote sensing data was the main aim of the project.

MINGU runs on a NORD-100 16 bits computer and uses a simple colour raster screen for displaying data. Data from the new earth resources satellites LANDSAT-4 and SPOT will be the main aim of the system.

5.2 New company established - SysScan a.s.

In December 1982 A/S Kongsberg Våpenfabrikk, Norway, and Messerschmitt-Bölkow-Blom GmbH, West Germany, joined their efforts within automated mapping in establishing a new company - SysScan a.s.

SysScan specializes within the development and marketing of computerbased map information systems for the application fields of Topography, Utility and Geophysics. SysScan a.s., of which Kongsberg is the major shareholder, has its headquarters in Kongsberg, Norway.

5.3 Aerial photography

All Wild RC 8 cameras are now withdrawn from operation in Norway. All aerial photography for mapping purposes are carried out with Wild RC 10 cameras. Nearly all photography is carried out with black and white film,

Kodak Double-X being the standard. However, the new Agfa Aviphot PAN 200 has been tested and the experiments will continue. Recordings in colour and false colour infrared only amounts to a few percent of the about 25 000 negatives yearly added to the National Archive.

The quality of aerial photography has been a big issue during the period. Continuous efforts are made to strengthen the communication between picture users and producers, to increase the general understanding of picture quality and the possibilities and limitations of aerial photography, to implement new and improved routines in the aircraft and in the laboratory and make use of the best possible machine-chemistry-film/paper combinations. These efforts have been greatly helped by the keen interest and help of ITC and Dr. Rudolf Lorenz, co-chairman of W.G. 5, Commission I on "Acquisition and Processing of Aerial Photography".

5.4 Remote sensing project

A SPOT simulation campaign has been carried out in Norway. Based on several processed simulation scenes from different parts of the country it deals with a variety of topics. Evaluation of SPOT data for production of statistics on land use and land cover, and for production of different types of maps at scales 1:50 000 and smaller, is now being conducted at various research- and map-institutions in Norway.

The programme is a joint undertaking with three participants: The Royal Norwegian Council for Scientific and Industrial Research, Space Activity Division; Centre National d'Etudes Spatiales, The French National Space Agency and Elf Aquitaine Norge A/S. The programme is coordinated by the Central Bureau of Statistics in Norway.

5.5 Remote sensing equipment

On behalf on the State Pollution Control Authority, Fjellanger Widerøe A/S is now flying and operating an L M Ericsson SLAR for oil pollution control. The SLAR is operated regularly in the Skagerak in cooperation with the Swedish Coastguard, and it is operated on missions to oilproducing fields in the North Sea as well as during acute pollution accidents. It has also turned out that it is possible to detect internal ocean waves with the radar which opens up a new area of application. It is likely that the SLAR will be supplemented with scanner equipment and radiometers for oil thickness measurements in the near future.

Fjellanger Widerøe A/S has also acquired a DIPIX ARIES-II interactive digital image processing system. The system is used for production of satellite maps and thematic maps in developing countries as well as in Norway. This work is mainly based on LANDSAT imagery. For work in Norway, Fjellanger Widerøe A/S has acquired a complete LANDSAT coverage, geometrically corrected to the UTM grid with 50 m accuracy. The 35 scenes covering Norway has also been corrected radiometrically and merged in the computer to a digital mosaic with 300 m resolution. Other tasks so far have been i.e. processing of LANDSAT scenes and CZCS data in the Barents Sea to look for chlorophyll concentrations (Norwegian Polar Institute), processing for geological structure analysis in connection with a feasibility study for an underwater tunnel between two islands, processing of NOAA data for estimation of snow cover (The Norwegian Water and Electricity Board), mineral exploration, area statistics based on simulated SPOT data for the Central Bureau of Statistics and processing and analysis of airborne digital multispectral scanner recordings from an exercise for fighting of oil pollution.

5.6 Research in remote sensing

Norwegian Computing Centre

Activity at the Norwegian Computing Centre within the field of Remote Sensing is concentrated on the problem of classifying remotely sensed data, and draws upon the Institute's competence in statistical methods and computing techniques.

In the classical approach, the classification of a given pixel is based upon data (i.e. the radiometric intensities in several spectral bands), taken exclusively from that pixel. In contrast, in the approach being developed and implemented at NCC, the so-called contextual approach, the classification of a given pixel takes into account data from that pixel and from neighbouring pixels. This approach is based on the fact that there is in nature a high correlation between what is found at neighbouring points on the ground. It is hoped that the contextual approach will yield considerably better classification results than the classical approach.

University of Bergen/Chr Michelsen Institute

A research programme "Norwegian Maritime Remote Sensing Programme" has been initiated for development of new methods and algorithms in order to evaluate and use data from infrared radiometer and microwave instruments. Data from NIMBUS-7 and NOAA has been analysed, for making ice-concentration maps and seasurface wind maps. Future data from ESA's remote sensing satellite ERS-1 will be of particular interest, and the Bergen-group is taking part in an international datacollecting and simulation campaign 1983 and 1984 (MIZEX - Marginal Ice Zone Experiment).

An image processing system has been developed to produce seasurface temperature images, which are geometrically corrected to the UTM-system.

University of Tromsø/Tromsø Telemetry Station

A cooperation between the University of Tromsø, Institute of Mathematical and Physical Sciences and Tromsø Telemetry Station has been established. The programme includes both education at university level, and development of methods in digital image processing and satellite remote sensing. Image data from the NOAA and LANDSAT series of satellites, as well as SPOT-simulated data have been applied. The main point is to develop techniques, based upon physical and statistical models, to extract multispectral and spatial information from images. Recently, marine applications have been introduced in the activities.

Central Bureau of Statistics

Evaluation of SPOT data for production of statistics on land use and land cover is one of the main topics. Maps on land cover are, however, also a product generating from this work. Satisfactory statistical results are obtained for the main land use classes by interpreting simulated SPOT images using the experience from interpretation of aerial photogrammetry taken at the same time as control data set. Different classification algorithms are being tested to find optimal classification routines for a chosen number of land use classes. Statistics from classified simulation data are compared with statistics generated from "ground truth" registrations.

5.7 Photogrammetric equipment and methods

During several years it has been a clear trend to connect the plotters to digitizing equipment. But the need for digital data, the requests from customers, has not been especially high. However, this is now changing. From 1983 on there has been a steady increase in the orders for digital data.

Four analytical plotters are in use, two Wild Aviolyt BC 1, one Zeiss Plani-comp C100, and one Zeiss Jena Stereodicomat. Three of them are equipped with digital tables. The instruments are used for aerial triangulation, for digital mapping and for graphic mapping.

5-10 analog plotters have been acquired during the period, mainly Wild (and Santoni plotters for forestry purposes). On several older plotters the mechanic drawing tables have been replaced by digital tables, mainly Wild TA1.

Several stereoplotters have been connected to computers for aerotriangulation and for digital mapping. In some cases the plotters are connected to one microcomputer each, and in other cases more plotters are connected to one minicomputer, often a NORD-computer. For the counting of pulses and the interfacing Norwegian-made hard- and software is used (MAPDAT-system by VIAK A/S, Ødegaard), but also registration units like Wild EK 20.

Three methods for mapping with graphic or/and digital output are in use:

- Conventional mapping with only graphic output on mechanic or digital drawing table.
- Digital mapping on EDP-medium and graphic control plot. Then data-processing with MAPRES-programs, and finally off-line fair-drawing on Kongsberg drawing machine.
- On-line computer-aided mapping on a digital table, with direct scribing. For large scales the map from the stereoplotter are delivered to the customer without any further fair-drawing. System: Wild RAP and Wild Aviolyt BC 1.

Some advanced software has been developed for map digitizing and for computer-assisted triangulation. As for instance in the Geographical Survey of Norway: The package have programs for projection center determination, analytical relative orientation, absolute orientation (3-dimensional transformation), and digitizing. The programs can be activated by the stereo-operator while he is measuring. He can go to a point with given terrain coordinates for identifying the signal, or for measuring the height if the point is not signalized. The programs provides for thorough, stepwise checks of the measurements both during relative orientation, strip formation and absolute orientation. Datasnooping is included.

The MAPDAT-system by VIAK A/S consists of both hardware and software. The hardware registration box can be coupled to any encoder-equipped plotter, and then coupled to any CP/M microcomputer. The software allows for easy digitizing, both for aerotriangulation and for mapping. A block adjustment program for a micro-computer has been developed.

An analytical orthophotoinstrument, Zeiss Orthocomp Z2, has been installed. It is now fully occupied, mainly with jobs from public mapping authorities. The need for digital height data to the Z2 is one of the reasons for increased digitizing on the stereoplotters. A stereo-orthophoto-plotter, a Stereograph from company Rost, has been acquired.

5.8 Photogrammetric research

Technical University of Norway, The Department of Photogrammetry and Geodesy. A test field $10 \times 10 \text{ km}^2$ is established in mountainous terrain for complete camera calibration and other purposes. About 100 control points have been permanently signalized and measured in this field. A project to adapt analytical photogrammetry for making measurements of off-shore platforms during construction is completed.

Agricultural University of Norway

The main research topics during the last four years:

- Coastal mapping in shallow waters with aerial photogrammetry.
- The usability of orthophotos and stereo-orthophotos.
Updating of maps with stereo-orthophotos. Geometrical quality of orthophotos and stereopartners.
- Resolution in aerial photographs under operational conditions.
- Use of microcomputer on stereo-plotters for computer-aided aerial triangulation and for block adjustment.

5.9 Remote sensing in forestry

Due to raising cost of traditional fieldwork, the use of aerial photographs in forest inventory is still more important. Research work is done to develop methods of photo-interpretation and volume tables based on photomeasurements, to meet the needs of planning.

Improvement of the aerial volume tables is under way at the Agricultural University. At the Forest Research Institute it is tried to make use of wing-tip-mounted 70 mm cameras for photographing sample plots. This method is now adapted for practical surveys. The institute also take part in an internordic project on investigation of new remote sensing techniques, including the simulation tests previous to the SPOT-satellite.

To make full use of the informations inherent in the photos, suitable instrumentation is important. In this connection the present construction of a new low-cost analytical instrument for photogrammetry in Norway, is paid great attention to by forestry users.

6. EDUCATION

Education at technician level (photogrammetric operators), is given at the "Rud vocational school". This school offers the opportunity for up to two years training in survey subjects, including some 120 hours of theory and 200-400 hours of practical training in photogrammetry. Four students complete this course every year. In addition, there exists some institutional training schemes at the map production organizations.

At engineer level, no courses in photogrammetry exist.

At university level, photogrammetry is taught at two universities, The Technical University of Norway (NTH, Trondheim) and the Agricultural University of Norway (NLH, Ås). The courses last for 4-5 years. Each year, 7-9 students take their Master's Degree in photogrammetry, cartography or geodesy.

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