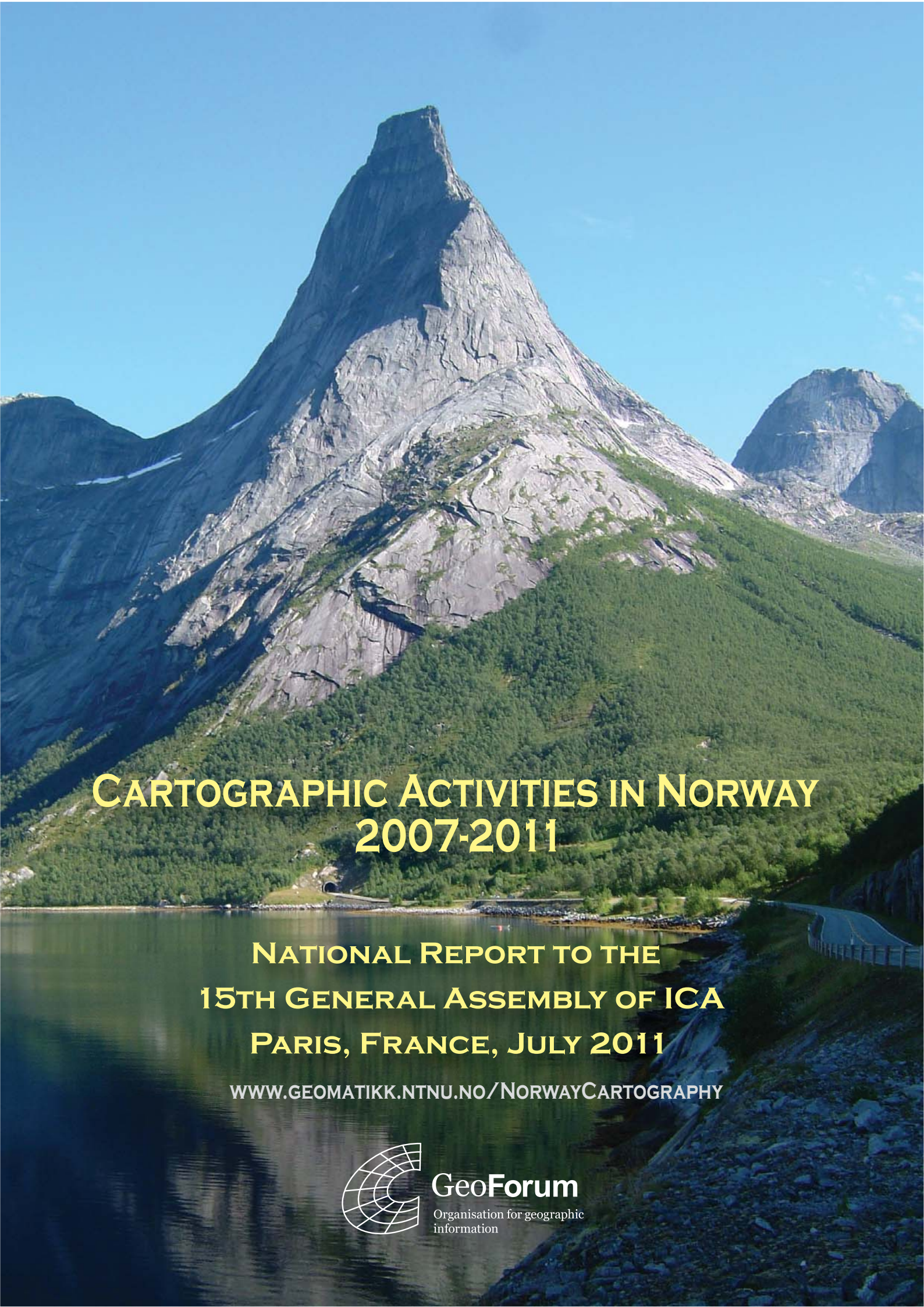

Cartographic Activities in Norway 2007-2011

National Report to the 15th General Assembly of ICA Paris, France, July 2011

www.geomatikk.ntnu.no/NorwayCartography

GeoForum
Organisation for geographic information

Trondheim/Hønefoss

June 22nd, 2011



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Cartographic Activities in Norway 2007-2011

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Introduction

This is the Norwegian report describing Cartographic activities in Norway over the last years. The contents of the report is based on contribution from invited governmental institutions, private companies and educational/research institutions. The call for contribution resulted in positive answers from more than half of the invited partners. Hence, the activities presented in this report have to be considered as an insight in the Cartographic activities in Norway rather than a full overview. The most central institutions/companies are however represented in the report.

Each institution/company is introduced together with a couple of examples of Cartographic products.

The material in this report is also presented on the Web-site:
www.geomatikk.ntnu.no/NorwayCartography

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Cartographic Societies

GeoForum

GeoForum was founded in 1969 and is the Norwegian membership organization of ICA. This is the national association for people who work within Geomatics. The mission of GeoForum is to promote the use of geographic information, share information and knowledge, contribute to recruitment, build networks etc. GeoForum is an association consisting of a central secretariat and 15 local organizations. In addition 5 centrally organized discipline-oriented groups are included in GeoForum.

Courses and conferences are main activities in GeoForum. Yearly many meetings are arranged within different fields of interests. GeoForum also organizes an annual conference (GeoForum 2oXX) where various Cartographic works are presented. Contributions to the ICC exhibition are selected from this national "competition". In many years Jan Terje Bjørke and Kristoffer Kristiansen have evaluated the map exhibition. We are sorry to say that Jan Terje Bjørke, Professor and a central person in Norwegian Cartography, passed away at an age of 63 this spring.



Figure 1: The Norwegian map jury for many years - Jan Terje Bjørke and Kristoffer J. Kristiansen.

A national exhibition of map drawings made by school children is also hosted by this conference. The best contributions are sent to the Barbara Petchenik Children's World Map Competition at ICC.

In addition to the central conference many of the local GeoForum organizations arrange local conferences annually or every second year.

In 2009 GeoForum hosted a Nordic course in Cartography. This was a successor of the earlier "Nordic summer school in Cartography" which was organized annually alternating between the Nordic countries. The arrangement in Stavanger 2009 gathered about 60 participants from the Nordic countries.

ICA Commissions with Norwegian representation:

Education and Training: *Terje Midtbø*
Geovisualization: *Terje Midtbø*
Maps and the Internet: *Sverre Iversen*
Mountain Cartography: *Kristoffer J. Kristiansen*

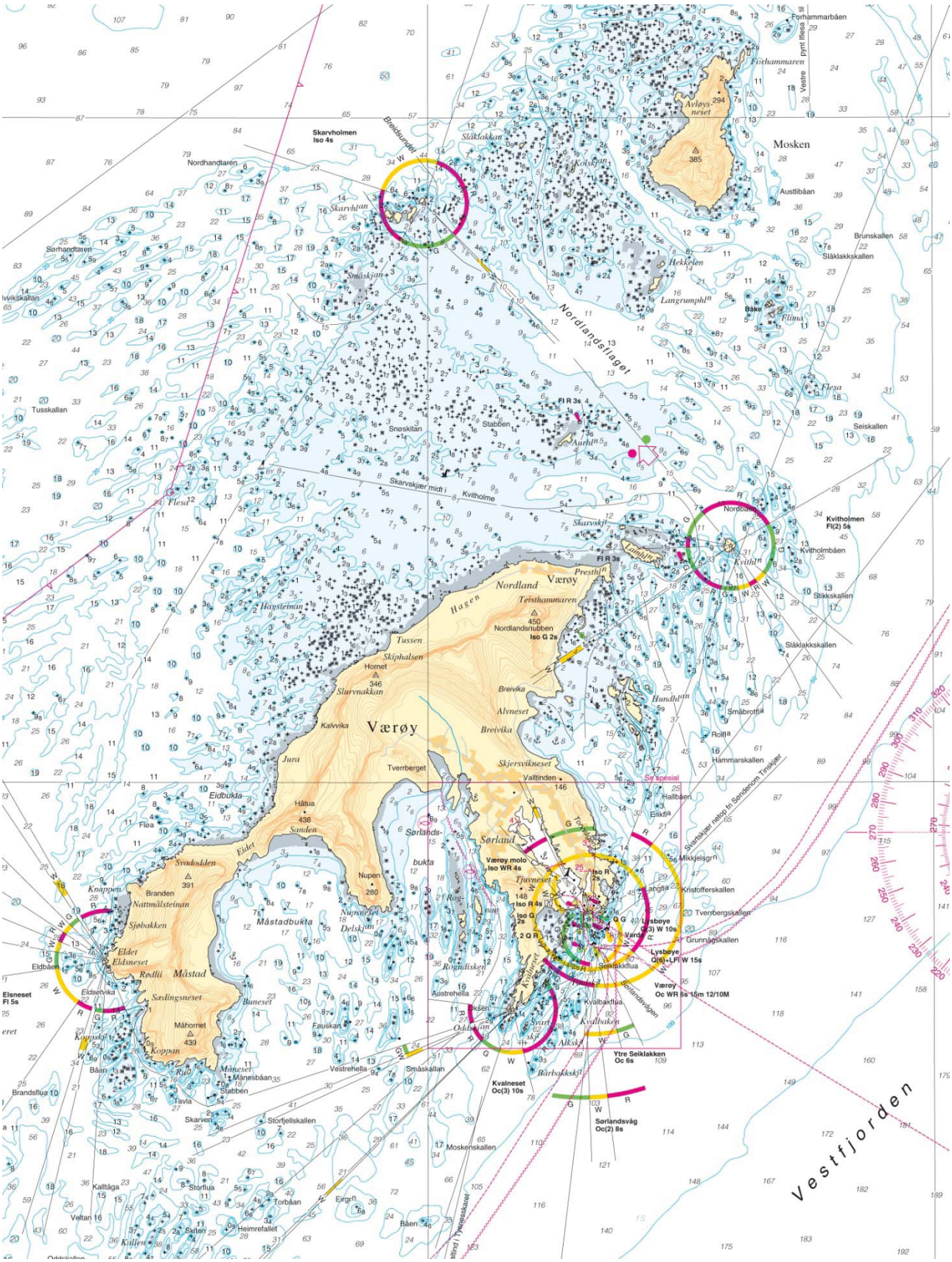


Figure 2: Section of the Norwegian winner of the Map exhibition on the 24th International Cartographic Conference, Chile 2009 (Hydrographical maps). The map is made by the Hydrographic Division at the Norwegian Mapping Authority.

Governmental Institutions

As in most countries Norway has different governmental institutions which manage digital geographical information for different sectors and purposes. As a part of this responsibility these institutions also make topological and thematic maps in both analogue and digital formats. Below some of the most central institutions are presented together with some examples on cartographic development over the last years.

Norwegian Mapping Authority

http://www.statkart.no/eng/Norwegian_Mapping_Authority/

The Norwegian Mapping Authority collects, systematises, manages and disseminates public spatial information at a high level of precision, to the benefit of our users and society as a whole. As the national Land Registry authority, we secure rights in real property and housing cooperative shares through effective registration services.

The Mapping Authority leads and manages the work on the national infrastructure for spatial information. The regions we are responsible for include the Norwegian land areas, coastal regions and seas.

As the national expert authority in our disciplinary areas, we are responsible for the national development in these areas, and must also contribute to the international development in the field. The Mapping Authority is a public agency under the Ministry of the Environment.

A national infrastructure

The Mapping Authority's most important task is to establish and manage a national infrastructure of geographic information and public property information. This work takes place through Norway Digital, a public sector collaboration, and includes close cooperation with local municipalities and large public producers and users of geographic information. The Norwegian Mapping Authority organises and manages this collaboration.

Our responsibilities include:

- a national geodetic reference frame
- services for accurate remote sensing of coordinates
- the production and management of national digital map series (land and nautical)
- the production of national printed map series (land and nautical) and publications (nautical)
- registration of real property and shares in housing cooperatives
- the operation of the national registries for public property information (The New Cadastre and the Land Registry)
- national standards for maps and geographic information
- the coordination and management of the work on the national infrastructure for geographic information through the public sector collaboration Norway Digital
- the dissemination of data and services
- the operation of the international electronic navigational chart centre, Primar

Finances

The Mapping Authority's operation is financed through the state commission that is included in the budget of the Ministry of the Environment. Until 2010, the Land Registry was financed through the budget of the Ministry of Justice and the Police, but as of 2011 the Ministry of the Environment has been given the budgetary responsibility for the Land Registry. In addition, the Mapping Authority's collaborator contributes significant resources to joint mapping projects through joint financing.

The Mapping Authority also receives income from the sale of maps, mapping data and property information.

Areas of responsibility

The Norwegian Mapping Authority has two main roles that are closely intertwined

Norway Digital
We lead and manage the work on the national geographic infrastructure through the public sector collaboration Norway Digital.

National authority and production
We carry out tasks related to our roles as a national authority, a national expert agency and a national producer of geographic information. We also disseminate data sets and services, and promote increased use of spatial data.

Norway Digital
Norway Digital is the Norwegian government's initiative to build the national geographical infrastructure. Norway Digital is since 2005 a working co-operation and infrastructure with reference data and thematic data available, more than 100 operational web map services, geoportal and other services. Thus Norway Digital is an existing implementation of the infrastructure described by the European Inspire-directive."

Norway Digital is a broad collaboration between public sector agencies and businesses that are responsible for the production of spatial information and/or are large consumers of such information. The collaboration mainly includes public agencies such as municipalities, counties, energy companies and national agencies. There are more than 600 partners participating in the collaboration.

Through Norway Digital, all public spatial information that the parties are responsible for, are made available to the parties themselves and to the general public. All parties make an annual financial contribution to the collaboration.

The Norwegian Mapping Authority coordinates and leads the national and regional collaborations. We are responsible for the organisational agreements as well as the technical agreements that the collaboration is based on, and we ensure that these agreements are observed.

We must ensure that there are guidelines, systems and routines for the collection of data and for entering the data in the data bases. We are responsible for the development and facilitation of national standards and for ensuring that the partners comply with these.

The Norwegian Mapping Authority also develops and operates services that make both data and metadata (information about data) within Norway easily accessible digitally on the internet and to the users.

Norway Digital will continue to be an important superstructure for large parts of the Mapping Authority's activities.

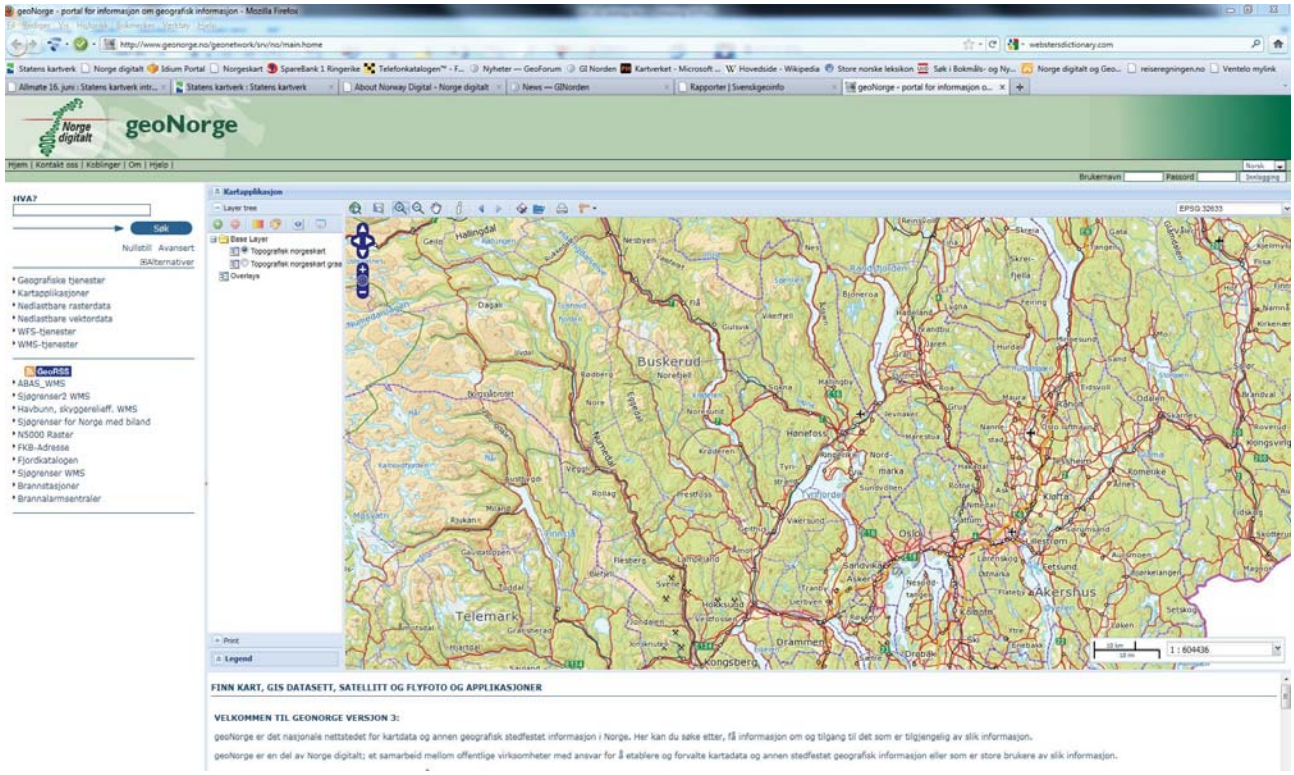


Figure 3: The Web portal for maps in "Norway Digital".

State commission and joint financing
The Mapping Authority's governance and production tasks are defined by the Ministry of the Environment through the state commission in the annual Budget Propositions.

The geodetic task, nautical charting and management tasks are fully financed through the National Budget (state commission). The work on establishing and managing basic spatial data for the land areas largely takes place in collaboration with municipalities and other large public users of maps through joint financing schemes within the Geovekst collaboration. This collaboration includes 430 municipalities, the Norwegian Public Roads Administration, Telenor, energy companies, agricultural producers and the Mapping Authority. The Geovekst collaboration is a very important supplier of data to Norway Digital. In 2010, NOK 135m were invested in Geovekst projects.

Organisation

The Norwegian Mapping Authority is organised in four divisions: The Geodetic Institute, Mapping and Cadastre and the Land Registry are located in our Hønefoss headquarters, while the Hydrographic Service is located in Stavanger. In addition, we have 12 county mapping offices, as well as a regional office of the Land Registry in Ullensvang in Hardanger. Our customer service centre is also located in Ullensvang. We have a geodetic earth observatory in Ny-Ålesund on Svalbard.

The Geodetic Institute
The Institute is responsible for the national geodetic reference frame. This is the basis for all determinations of coordinates, surveying and mapping. The Institute operates the national services for remote sensing of coordinates, Dpos and Cpos. It also provides surveys and determinations of national reference frames, geoid and height reference surfaces, orthometric

height and land uplift.



Figure 4: The Norwegian Mapping Authority's Geodetic observatory in Ny-Ålesund. Photo: Bjørn-Owe Holmberg.

The Mapping and Cadastre Division
This division is responsible for producing and managing mapping data and other geographic information about the land areas. The Division collaborates with municipalities and other public agencies. The County Mapping Offices maintain a collaborative relationship with the respective counties. The Division is responsible for the new national registry of public property information, The New Cadastre (matrikkelen). The Division also manages the tasks related to the Act on Place Names (Lov om stedsnavn), the National Registry of Aviation Hazards and administrative boundaries, and protects historic maps and aerial photographs. The Division heads the public sector collaboration Norway Digital on behalf of the entire Norwegian Mapping Authority.

The Land Registry
This division is responsible for the registry of real property and shares in housing cooperatives, and is thus also responsible for the management of the the National Land Registry. The registry of real property takes place at the Mapping Authority's headquarters in Hønefoss. The registry of shares in housing cooperatives takes place in Ullensvang, which is also the location of our customer centre.

The Hydrographic Service
This Service is responsible for surveying the Norwegian coastline, including polar waters, and for preparing and updating nautical charts and descriptions of these waters. The activities also include studies of tides and currents and publishing tide tables. The Hydrographic Service has the operational responsibility for the international electronic navigational chart centre Primar.

Norwegian Polar Institute

http://npweb.npolar.no/english

The Norwegian Polar Institute is dedicated to scientific research, mapping and environmental monitoring in the Arctic and the Antarctic regions. The institute advises Norwegian authority on

matters concerning polar issues, and is Norway's competent environmental authority in Antarctica.

Of NPI's 160 employees, there are 8 people in the Mapping section working with maps and visualization of geographical information. Products are topographical maps, geological maps, books, reports and papers. TopoSvalbard is an example of a map portal on the Internet

Topographical maps of Svalbard in 1:100.000 scale are our main map series. It is published both digitally and as paper maps. We also publish maps in smaller scales and various tourist maps. We handle the entire mapping process from fieldwork until the digital files are sent to the printers.

Examples from our production:

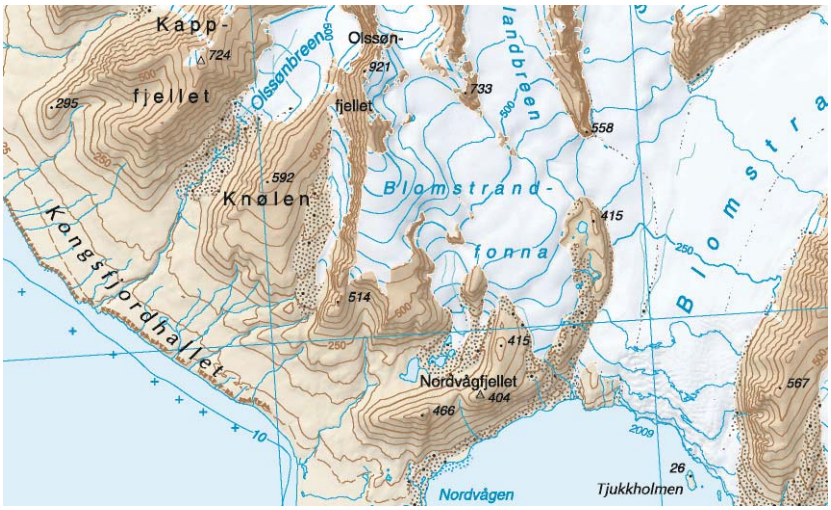


Figure 5: S100 - A6 Krossfjorden, Svalbard



Figure 6: S250 - Sheet2 Nort West, Svalbard



Figure 7: TOPOSVALBARD (www.npolar.no).

Geological Survey of Norway (NGU)

http://www.ngu.no/en-gb/

The Geological Survey of Norway is the country's central organisation for the collection, processing and distribution of information on the bedrock geology, superficial deposits, mineral resources and groundwater of Norway.

NGU is a government agency under the administration of the Ministry of Trade and Industry. NGU currently has 225 employees. An increasing number - currently over 100 - are using GIS in their work covering the whole cartographic process from collecting information to delivering user

oriented maps, often as Internet map services in addition to some sort of printed product. NGU makes at this moment 22 datasets and 15 WMS-services accessible through the national SDI "Norway Digital". The data management group in NGU has 17 employees, organized in an Information Division. The group works on all cartographic activities, with a special focus on developing and managing the geographic databases and map services. The Map services are available at www.ngu.no. In recent years the use of Open Source Geospatial Software for map services and web maps has increased. There has been work on connecting textual information to the maps through "fact sheets" (image) and developing more user oriented maps to be directly used in planning through classifications based on estimated values of geological resources (local, regional and nationally important resources). Two examples of such map services are shown below.

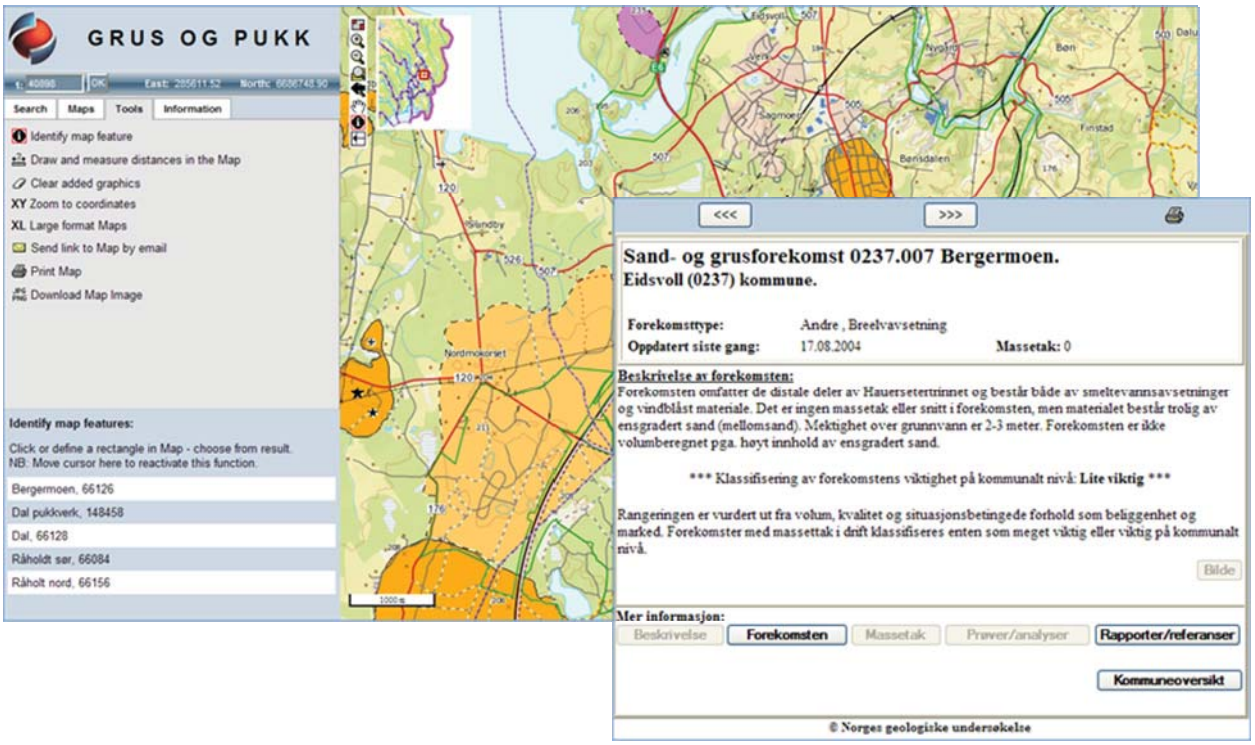


Figure 8: Sand & Gravel database and map service.

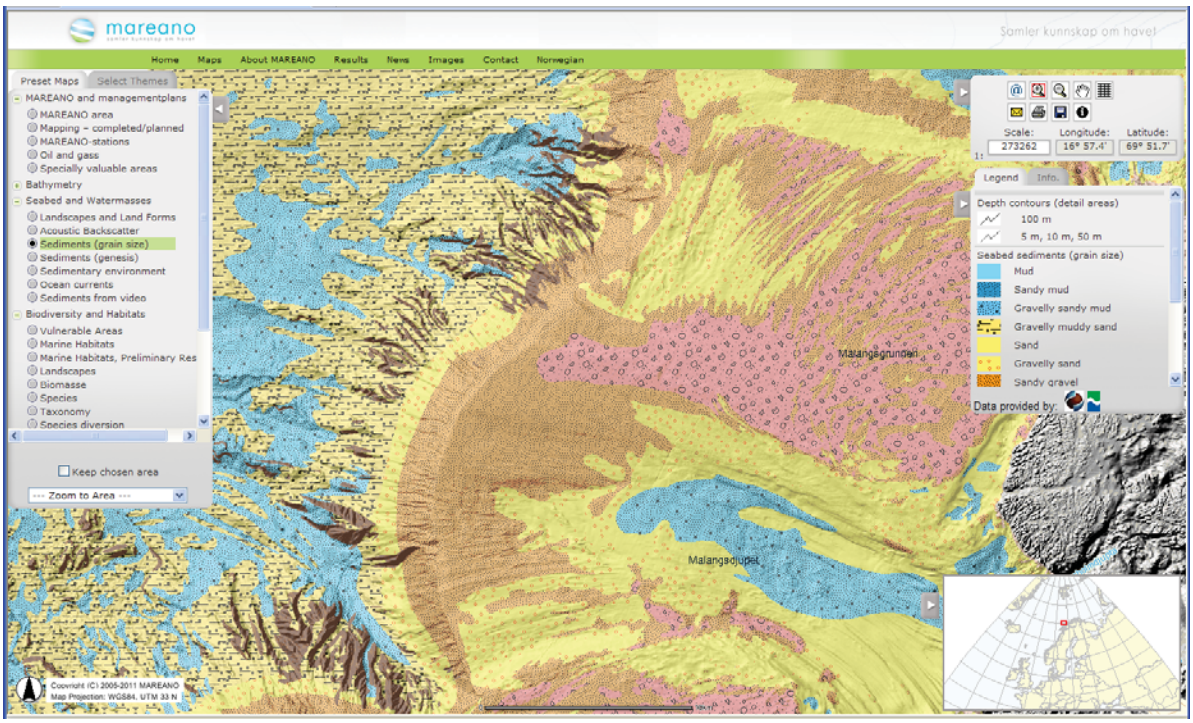


Figure 9: MAREANO service (www.mareano.no) contains topography, sediment composition, contaminants, biotopes and habitats in Norwegian waters. The figure shows grain size distribution of seabed sediments.

Norwegian Directorate for Nature Management

http://english.dirnat.no/

The Norwegian Directorate for Nature Management is one of five government agencies under the Ministry of the Environment. We serve as an executive and advisory body for the Ministry, and our main areas of responsibility are outdoor recreation and the conservation and sustainable use of biodiversity.

We have a staff of about 300, the majority based in Trondheim. Most of us have university qualifications, and in many cases a scientific background, but we also offer expertise in law, the social sciences, economics and the humanities.

We assist the Government in its environmental protection work at national and international level. We are responsible for implementing the Government's environmental policy, and for identifying, preventing and dealing with environmental problems.

Three people are involved in producing maps and visualizations. Two have master's degrees in Geography from the Department of Geography, and one did a master's degree in Photogrammetry / Remote Sensing at the Department of Geodesy and Photogrammetry. Both departments are with NTNU in Trondheim.

These are some of our products:

- Nature base is a data base which is used for production of web based map, paper maps and distribution of spatial data to stakeholders and the general public
- Visualizations of alien species
- Preparation of maps for development of policies

- Maps for action plans related to focus species
- Caribou maps
- Wilderness maps
- Ramsar area reporting

We are currently working on upgrading our core spatial data base system, Nature base, from version 3 to version 4. This will streamline the import system from municipalities through county levels and up to national level. It will hopefully also shorten the time from field surveys to data is available for management purposes on the same levels.

In 2009 the Directorate concluded the analysis of changes in wilderness status for Norway in the period 2003 to 2008. Updated versions of wilderness maps back to 1988 were also made.

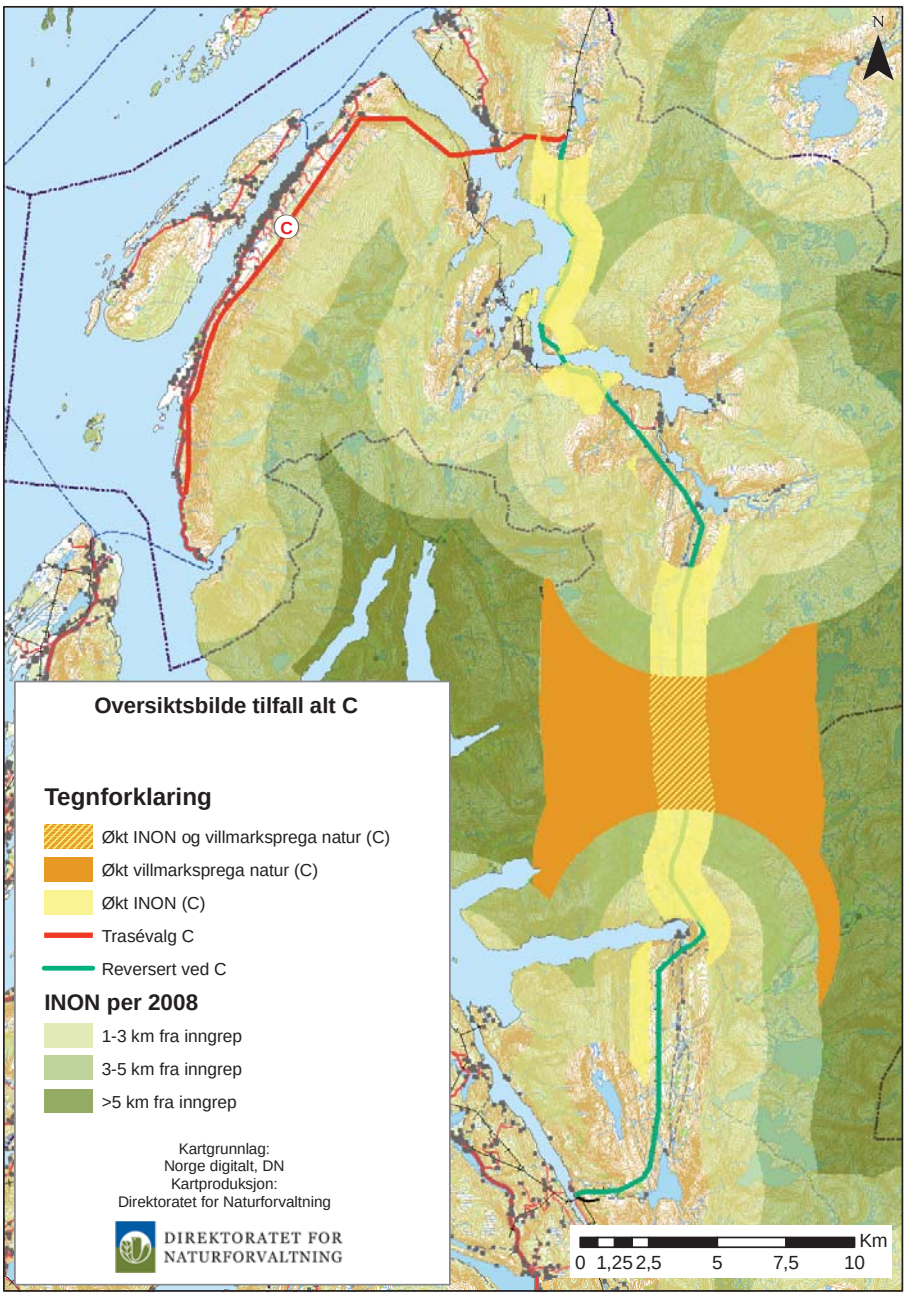


Figure 10: The removal of power lines leads to an increase of wilderness like areas. The map is from an evaluation of total three alternatives where this alternative was chosen.

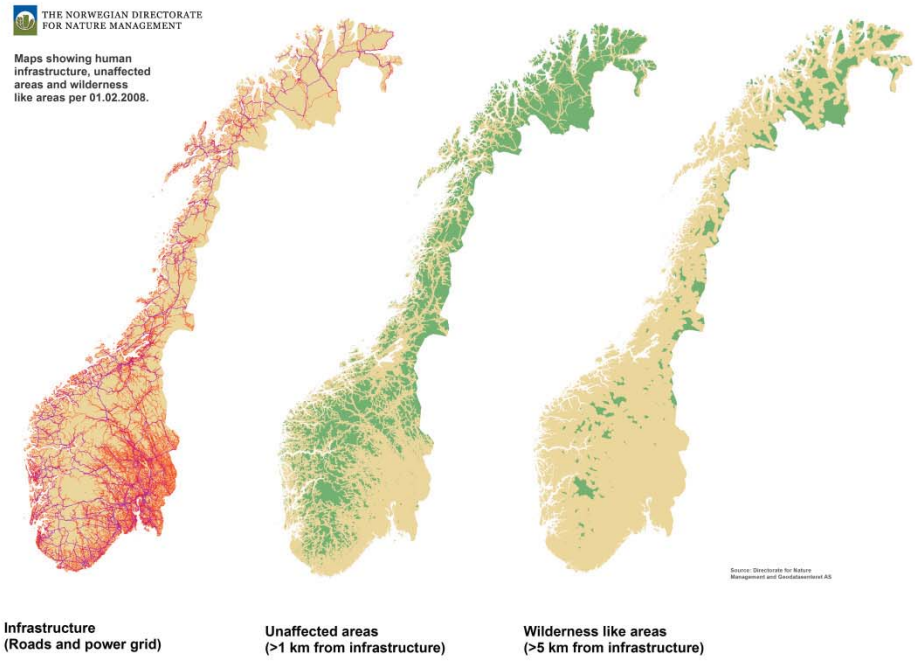


Figure 11: Overview of infrastructure (roads and power grids) with a map of unaffected areas and a map of wilderness like areas.

The Norwegian Forest and Landscape Institute

http://www.skogoglandskap.no/en/

The Norwegian Forest and Landscape Institute (Skog og landskap) is conducting research and providing information about the land resources; including land cover, forest, soil, vegetation and landscape.

Skog og landskap is a leading Norwegian scientific institution regarding use of forest resources, forest ecology, landscape and land monitoring. The institute is also responsible for a range of national mapping programmes and resource inventories related to land cover, forestry, agriculture, landscape and the environment – including the Norwegian part of the pan-European CORINE Land Cover map.

The institute is a national institute under the Ministry of Agriculture and Food. Skog og landskap provides knowledge to the authorities, industry, commerce and the public in order to contribute to the sustainable management and formation of values of land resources through research and data collecting.

The institute has approximately 220 employees in total. The main office is in Ås, just south of Oslo, and regional offices are in Northern Norway, Mid-Norway and Western Norway.

The data are collected through field surveys, by image interpretation or automatically retrieved by computer assisted image processing. The collected data are presented in different ways; as

reports, statistics and maps. The institute produces a large number of various thematic maps, both on paper and on the web. Several departments and skilled employees are involved in the map designing. A great effort is being put into cartography to ensure that the products are readable maps of high quality that is easy to understand. Examples of thematic maps are e.g. land resource map in scale 1:50 000 for all 430 municipalities and in scale 1:250 000 for all counties in Norway, grazing land for sheep and cattle in scale 1:20 000 and risk for erosion in arable land in scale 1:10 000.

The majority of the software used by the institute is proprietary; the data are stored in Oracle object-relational database, and ESRI's ArcSDE and ArcGIS are used for the production of paper maps. However, the use of open source software is expanding, and more and more data are stored in PostgreSQL object-relational database using PostGIS and GeoTools for different GIS tasks. Paper maps are still made using ArcMap. Our internet application for viewing and downloading maps is entirely based on open source software like GeoServer, MapServer, OpenLayers and GeoExt.

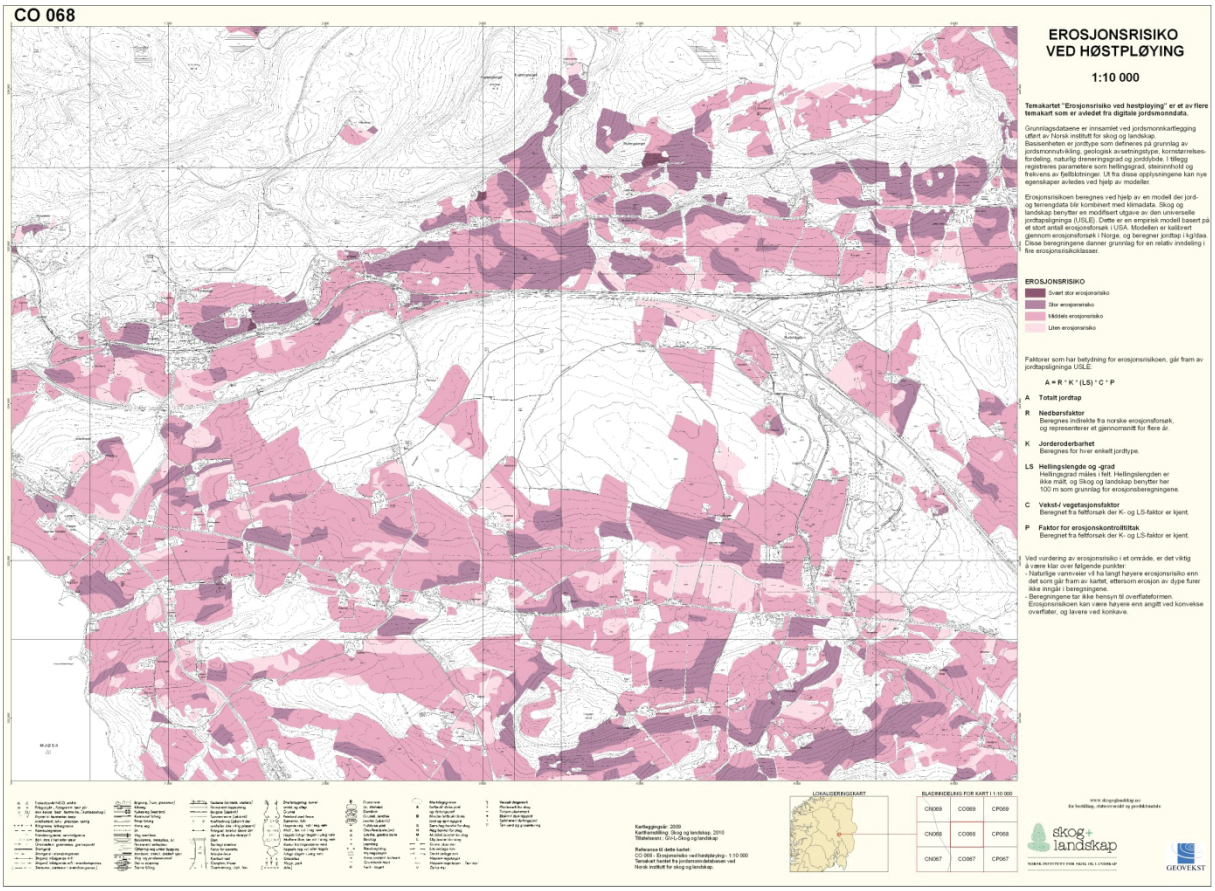


Figure 12: Paper map - Risk for erosion 1:10 000, 2010.

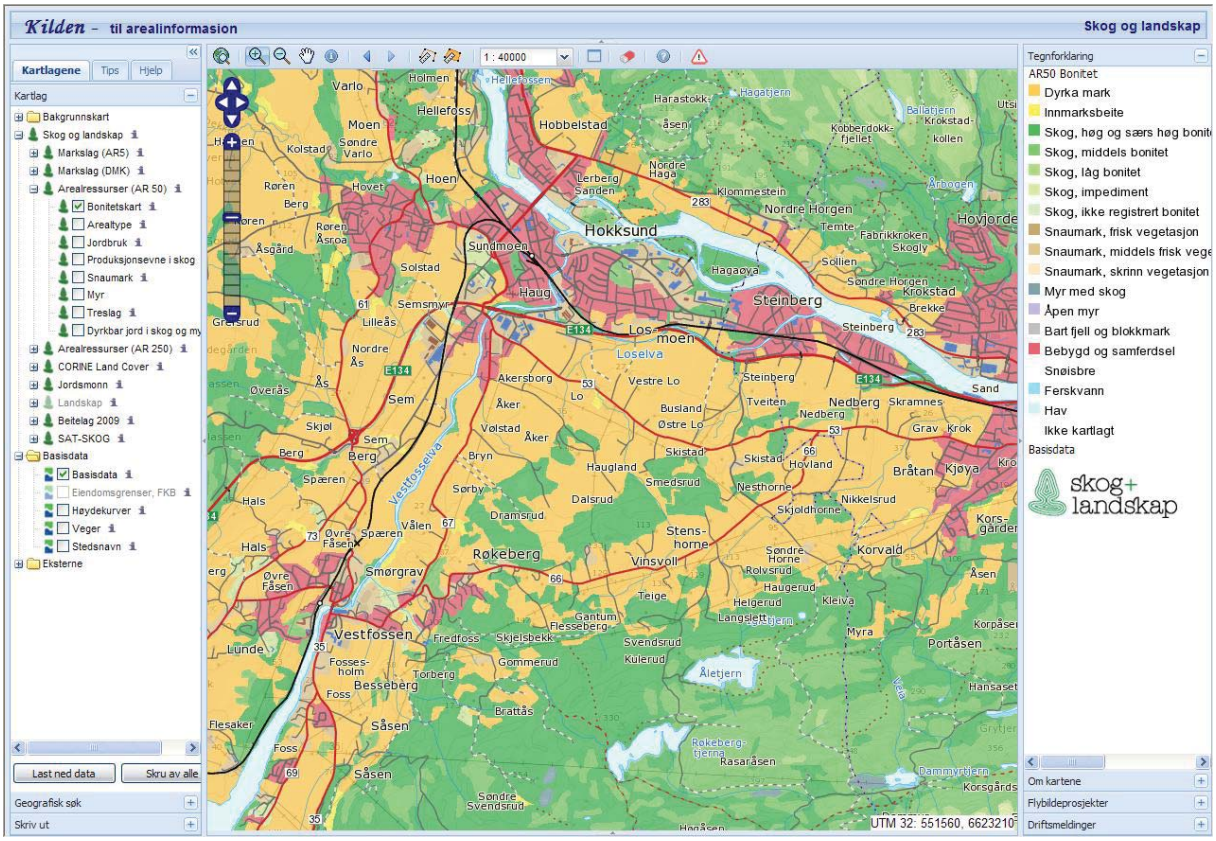


Figure 13: Internet application - Land resources 1:50 000 (kilden.skogoglandskap.no), 2011.

Directorate for Cultural Heritage

http://www.riksantikvaren.no/English/

The Directorate for Cultural Heritage is responsible for the management of all archaeological and architectural monuments and sites and cultural environments in accordance with relevant legislation.

We ensure that cultural heritage considerations are taken into account in all planning processes, and that the interests of cultural heritage are safeguarded at all levels in the same way as the interests of society as a whole.

Through education and information we are responsible for increasing awareness among the general public about the value of cultural heritage. We are also the appeals body for decisions made by cultural heritage authorities at county and regional level.

Of the ca. 150 employees at the directorate, approximately 10 are involved in cartography. Our main effort is in ensuring that geographic data for cultural heritage monuments are readily available for regional and local management authorities, where the most important map production takes place.

Three of our most important projects are the Norwegian National Cultural Heritage Database, Cultural Heritage Search and MedievalGIS.

The Norwegian National Cultural Heritage Database.

In 2003 the Norwegian Directorate for Cultural Heritage launched a new database over legally protected Cultural Heritage objects in Norway. The database includes information on archaeological sites and monuments, Sami cultural heritage, maritime heritage, as well as

protected buildings and churches. One of the most important features of the database is the use of GIS in searching and maintaining data. The database is available over the internet to management authorities and researchers. The database currently contains information on 135,000 localities containing 280,000 single objects.

While the database is centralized, the addition of new records, and updating of existing data is decentralized. Regional cultural heritage management authorities are responsible for updating the content of the database. This provides accurate and updated information to all management levels simultaneously. WMS services from the database have greatly contributed to better contact between cultural heritage managers and planners and developers. The easy availability of this data has also increased the visibility of cultural heritage within plan processes.

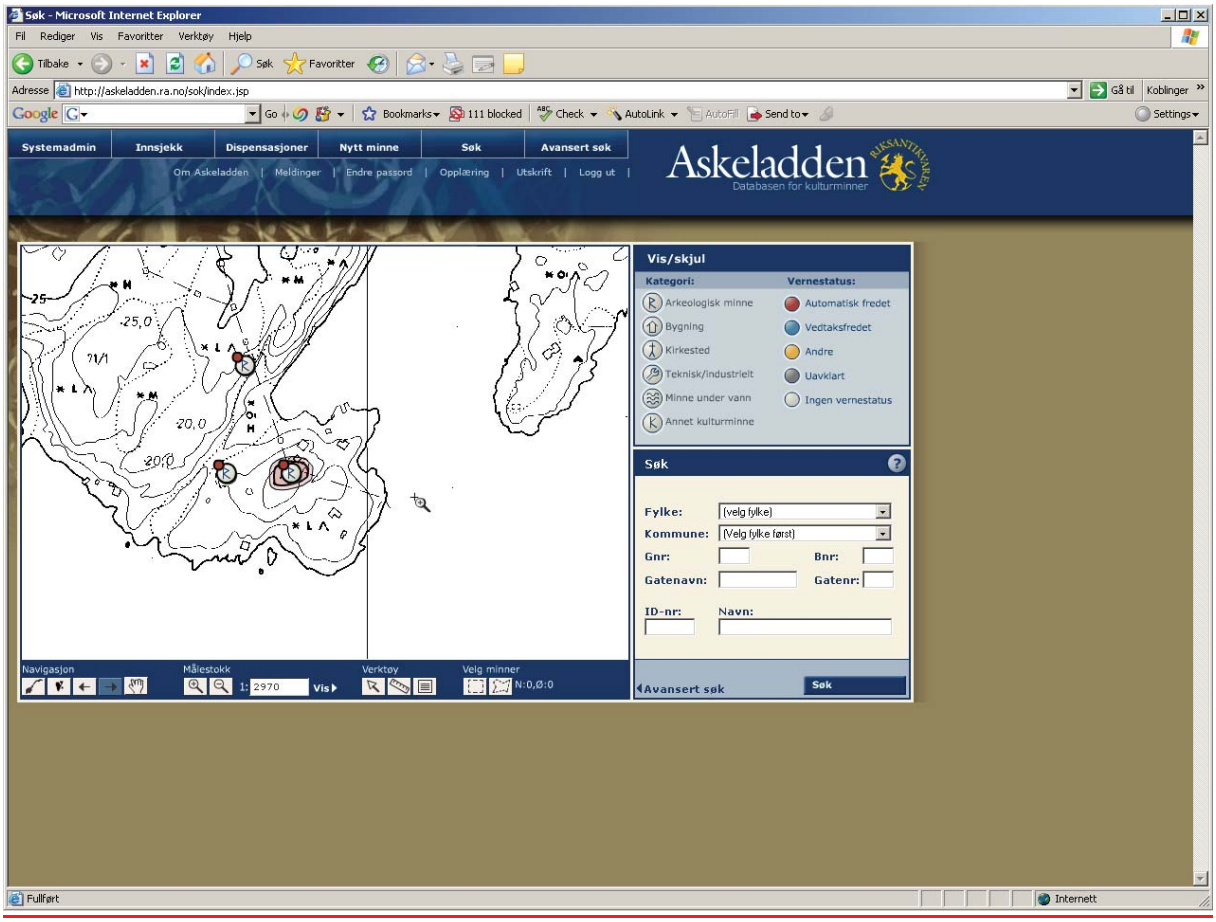


Figure 14: The Norwegian National Cultural Heritage Database.

Cultural Heritage Search (Kulturminnesøk)

Cultural Heritage Search is an edited version of the data found in the National Heritage database, and the presentation and data that is available is directed towards the public. The database uses cached maps and aerial photographs as the primary entrance to the large database. The individual heritage objects are presented with pictures, movies and description written for the public. The public is also encouraged to include their own comments about heritage monuments, as well as ask questions about the monuments.

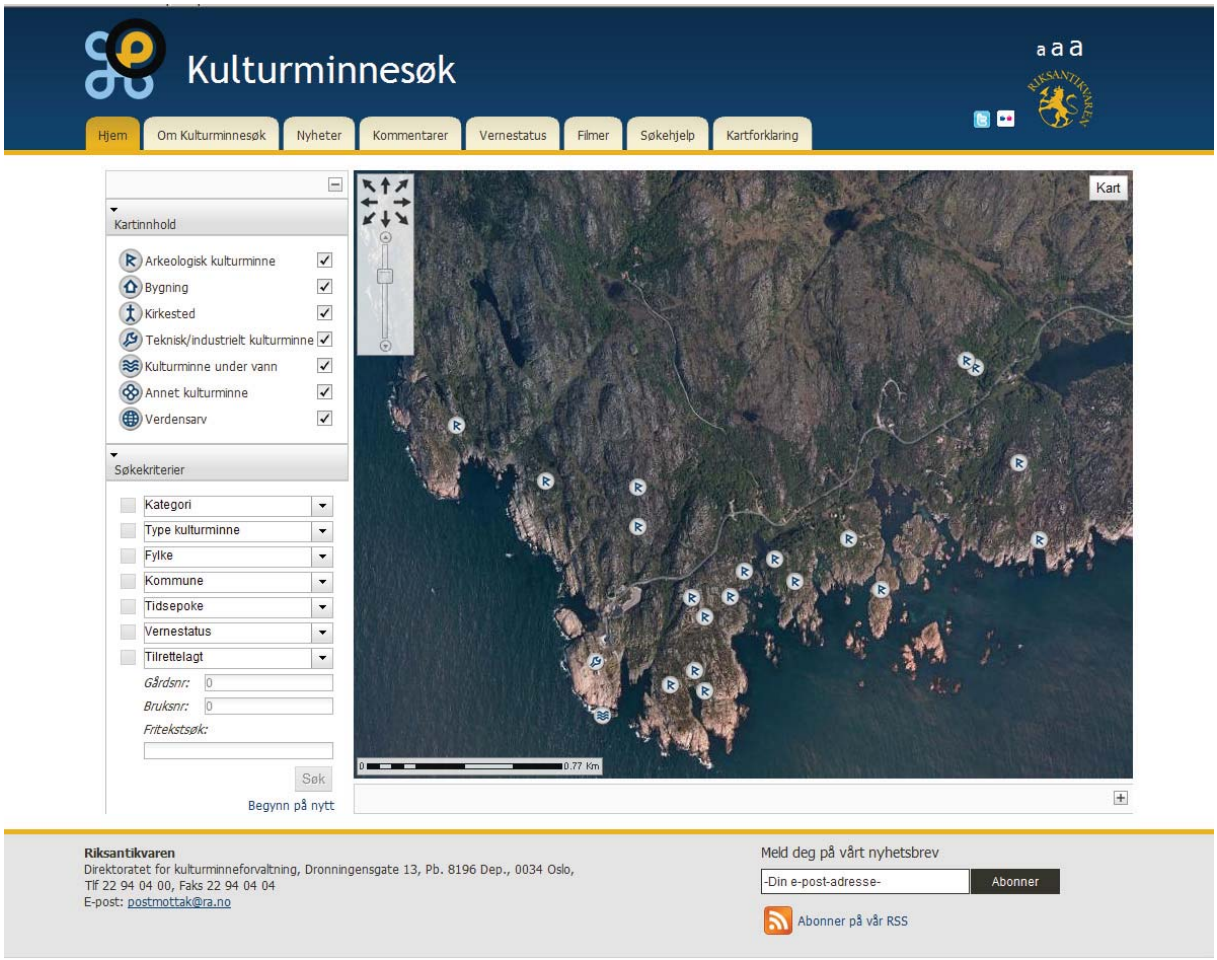


Figure 15: Interactive maps showing cultural heritage

MedievalGIS (MabyGIS)

The management needs in urban areas where development often comes in conflict with sub-surface medieval cultural layers are more complex than can be accommodated within the National Cultural Heritage Database. MedievalGIS is an application that provides the detailed information necessary for planning in urban areas with extensive medieval cultural heritage.

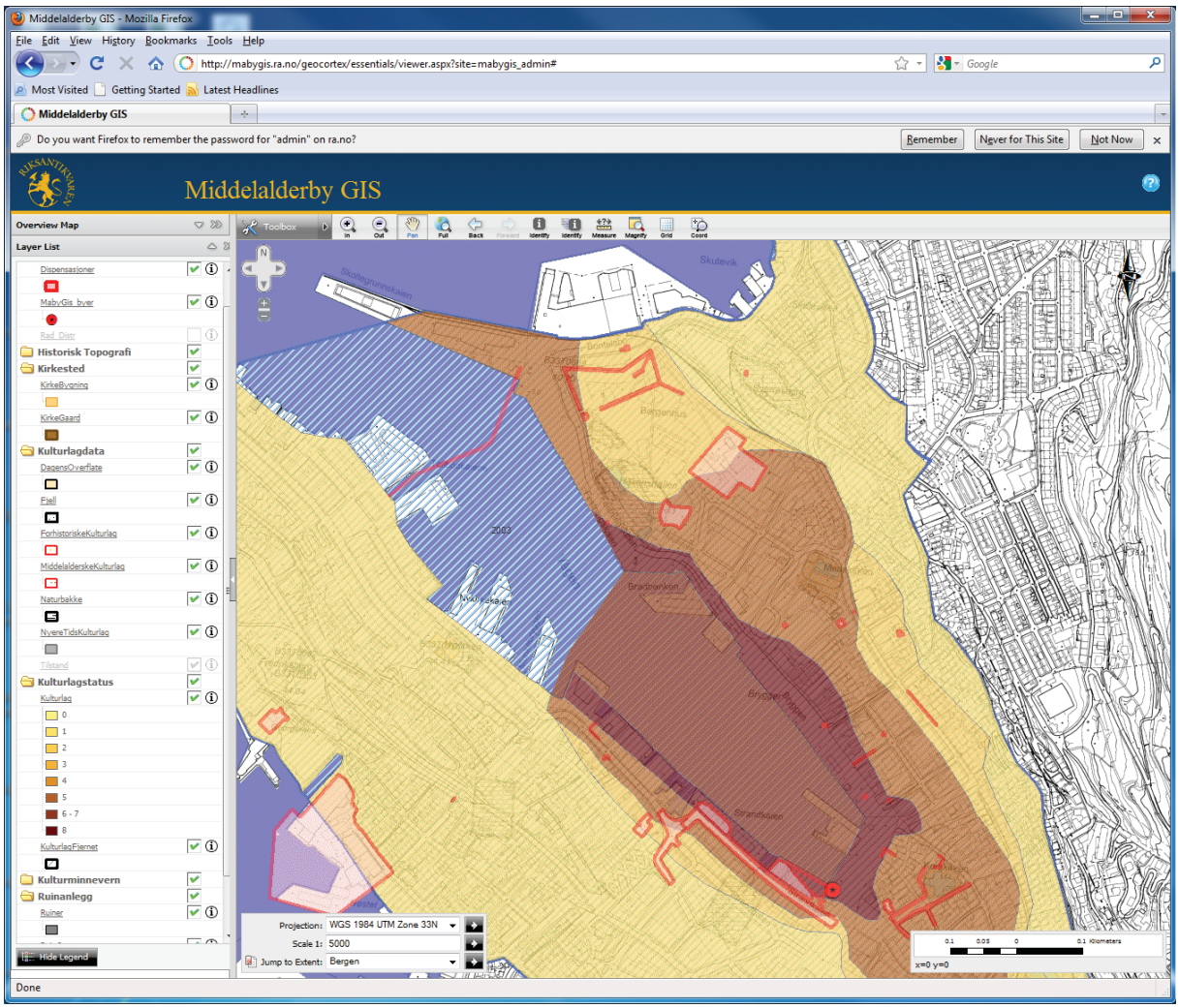


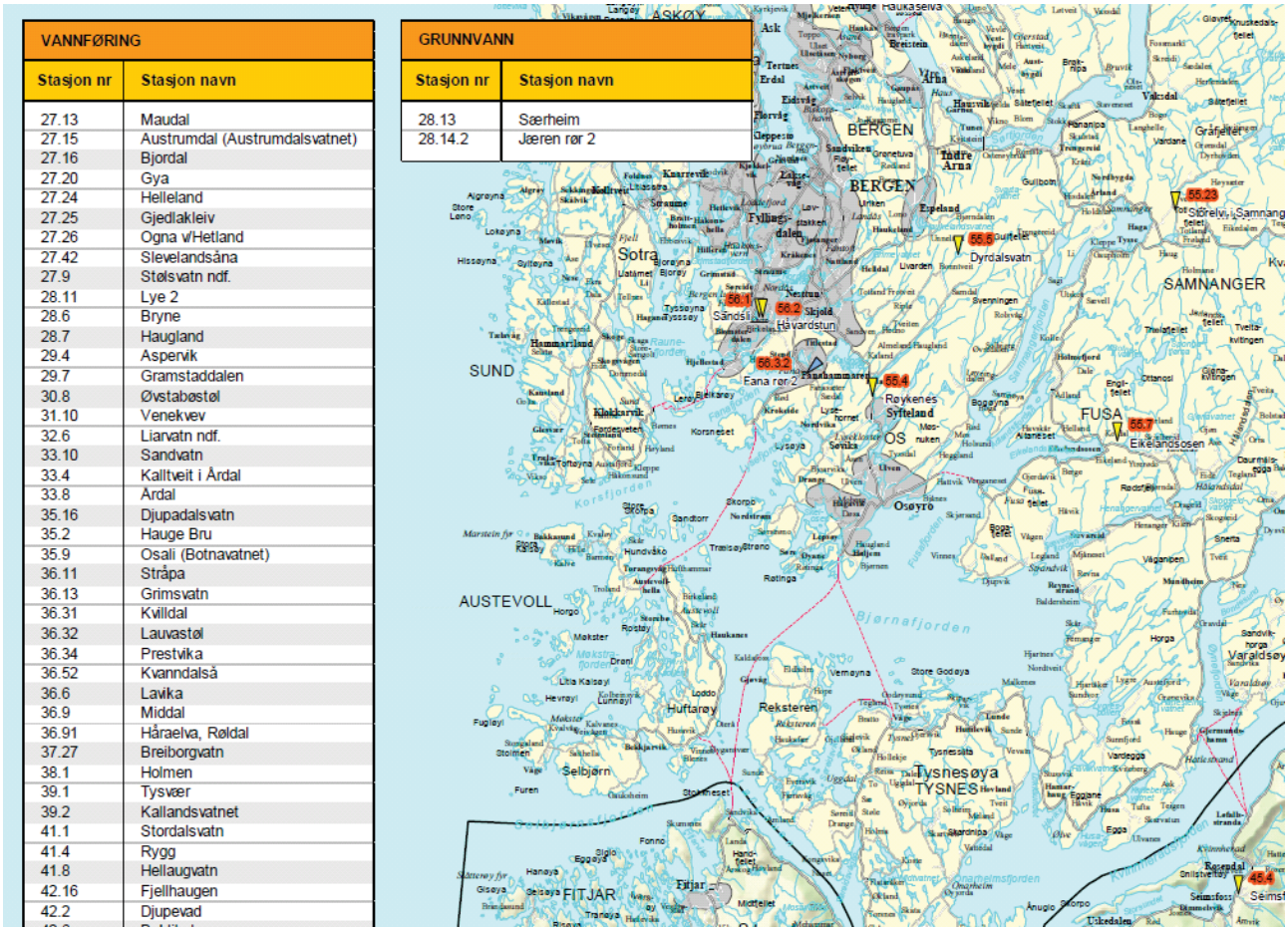
Figure 16: Application showing detailed information about urban areas in the middle ages.

Norwegian Water Resources and Energy Directorate (NVE)

http://www.nve.no/en/

The Norwegian Water Resources and Energy Directorate (NVE) is a directorate under the Ministry of Petroleum and Energy and is responsible for the management of Norway's water and energy resources. NVE is Norway's national centre of expertise for hydrology, and has a central role in the national flood and landslide contingency planning. NVE also has the overall responsibility for maintaining national power supplies. NVE is based in Oslo and has 5 regional offices and has approximately 550 employees.

About 5- 10 persons are involved in cartography related work. The main cartographical products are made for NVE's map applications on the web, like NVE Atlas (http://atlas.nve.no). In addition a range of thematic maps are produced to be used in reports, books and posters. Such maps may present water resource analysis results, the hydrological station network within a catchment or areas prone to flooding.



VANNFØRING	
Stasjon nr	Stasjon navn
27.13	Maudal
27.15	Austrumdal (Austrumdalsvatnet)
27.16	Bjordal
27.20	Gya
27.24	Helleland
27.25	Gjedlakleiv
27.26	Ogna v/Hetland
27.42	Slevelandsåna
27.9	Stølsvatn ndf.
28.11	Lye 2
28.6	Bryne
28.7	Haugland
29.4	Aspervik
29.7	Gramstaddalen
30.8	Øvstabøstøl
31.10	Venekvev
32.6	Liarvatn ndf.
33.10	Sandvatn
33.4	Kalltveit i Årdal
33.8	Årdal
35.16	Djupadalsvatn
35.2	Hauge Bru
35.9	Osali (Botnavatnet)
36.11	Stråpa
36.13	Grimsvatn
36.31	Kvildal
36.32	Lauvastøl
36.34	Prestvika
36.52	Kvanndalså
36.6	Lavika
36.9	Middal
36.91	Håraelva, Røldal
37.27	Breiborgvatn
38.1	Holmen
39.1	Tysvær
39.2	Kallandsvatnet
41.1	Stordalsvatn
41.4	Rygg
41.8	Hellaugvatn
42.16	Fjellhaugen
42.2	Djupevad

GRUNNVANN	
Stasjon nr	Stasjon navn
28.13	Særheim
28.14.2	Jæren rør 2

Figure 17: Flow of water.



Dammer:
Fjellåsvatn hoveddam (I) og sekundærdam (II)
Eier:
Alstahaug kommune – Teknisk etat
Fylke:
Nordland
Kommune:
Alstahaug
Opprinnelig byggeår:
1918 (I og II)
Oppdemt magasinvolum:
0,025 mill. m^3 (I)
0,015 mill. m^3 (II)
Maksimal høyde:
7,5 m (I) og 3,5 m (II)
Kronelengde:
16 m (I) og ca. 50 m (II)
Formål:
Vannforsyning

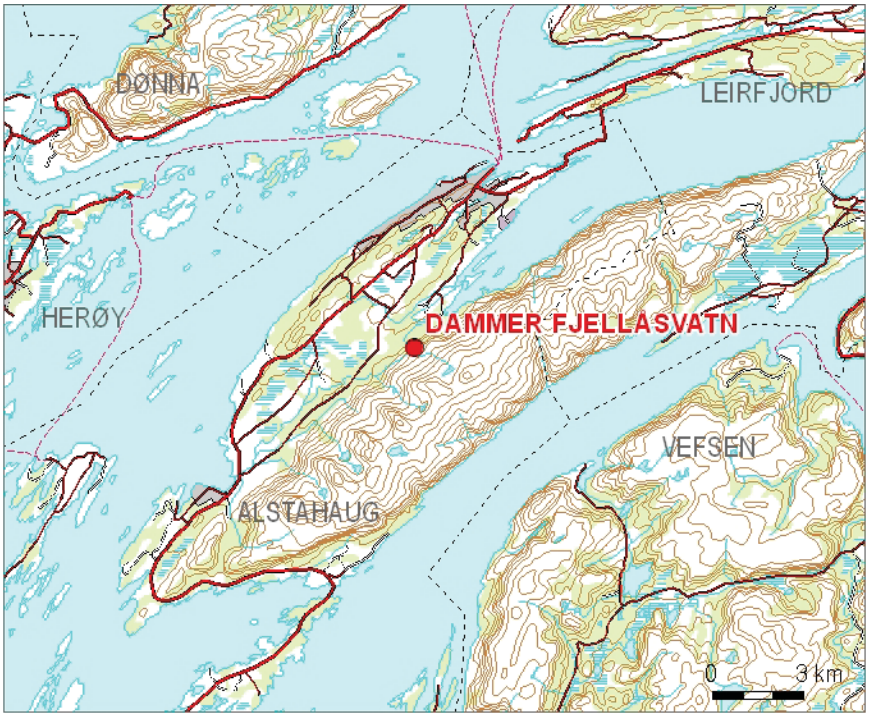


Figure 18: Information about Fjellaasvatna hydroelectric power reservoir.

Avinor

http://www.avinor.no

Avinor is responsible for planning, developing and operating the Norwegian airport network.

Avinor operates 46 airports in Norway, thereof 12 in cooperation with the armed forces. Operations also include air traffic control towers, control centres and technical infrastructure for aircraft navigation.

Avinor has approx. 3000 employees, around 300 at the head office in central Oslo and the remaining employees located at the 46 airports. Avinor has a department for technical and aeronautical information which is responsible for most of Avinor's cartographic production. In this department, around 7 employees work with map and chart production, whereas another 6 work with geographic information systems and geographical data management.

Avinor's cartographic production consists of the following mapping and charting products:

- Charts for AIP (Aeronautical information publication): Aerodrome charts, docking charts, aeronautical obstacle charts, en-route charts, arrival and departure charts. These charts are available at: https://www.ippc.no/norway_aip/current/main_eng.html.
- Building restriction area maps for each airport. These maps are available at www.avinor.no.
- Charts showing signs and markings
- Airport maps: security, airside safety, emergency planning, noise pollution, utilities, etc.

Norwegian National Rail Administration

http://www.jernbaneverket.no/en/Startpage/About-Us/

Jernbaneverket (the Norwegian National Rail Administration) is the national railway authority. Jernbaneverket is responsible for the management of the national railway network, on behalf of the Ministry of Transport and Communication.

Through public funding and with a socio-economic perspective, our objective is to operate, maintain and develop the national railway network.

The Norwegian Parliament determines the annual funding through the national budget. Long-term planning is dealt with through Norsk Transportplan (the Norwegian Transport Plan), in which the Parliament draws up the economic framework for the four year period.

Jernbaneverket is responsible for:

- Developing and operating a rail network that meets the requirements of society and the market
- Railway stations and terminals
- Timetabling
- Traffic management
- Regulation of the public rail network
- Studies and planning in the rail sector

Jernbaneverket employs 3000 people in the entire country while 20 of these are working with map

production and visualisation.

Map products include schematic maps, statistics, plans for new lines (Figure 20), location and condition of infrastructure objects, environmental maps including noise, water and weather issues, population maps (Figure 19) and traffic volumes.

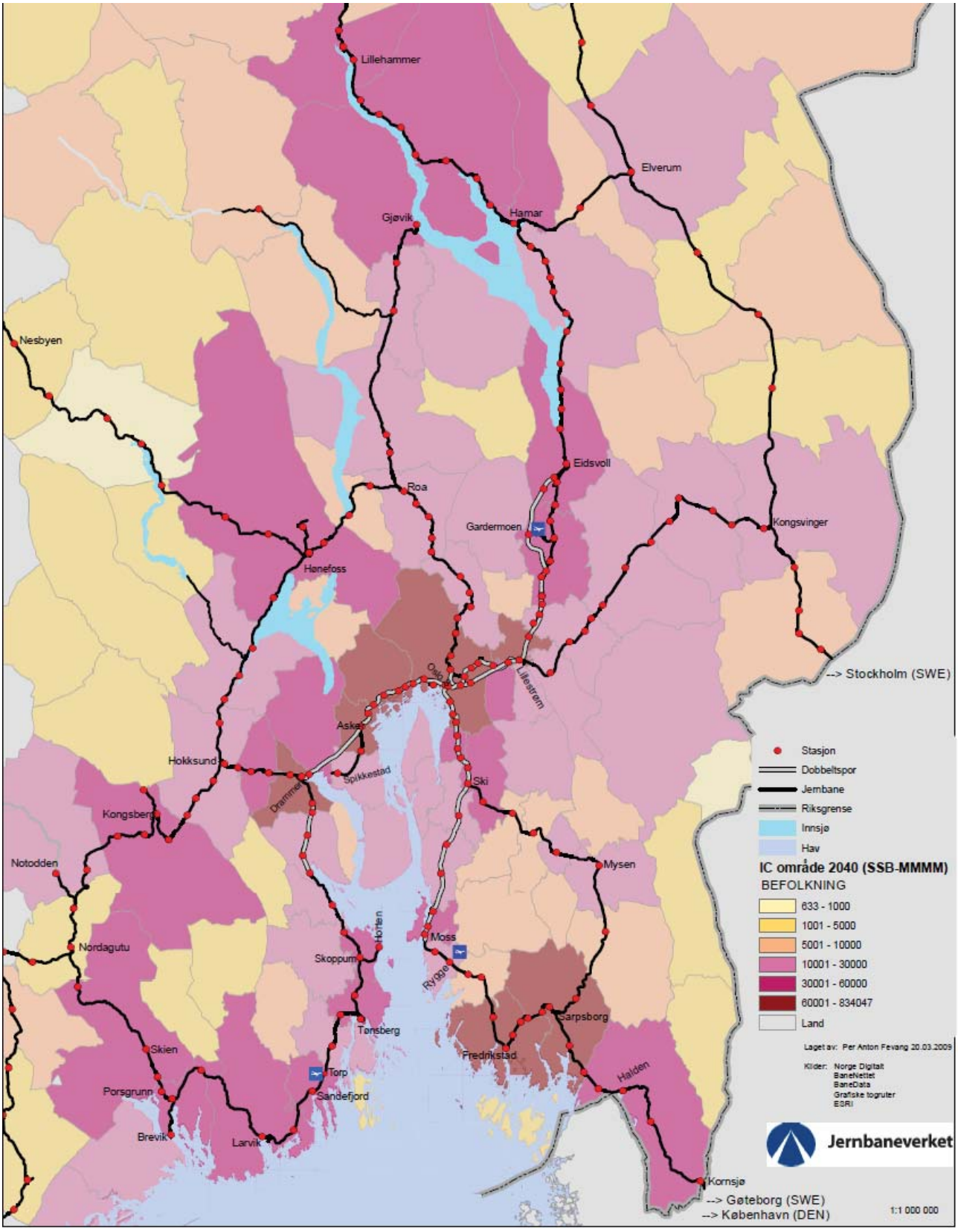


Figure 19: Predicted population in 2040.

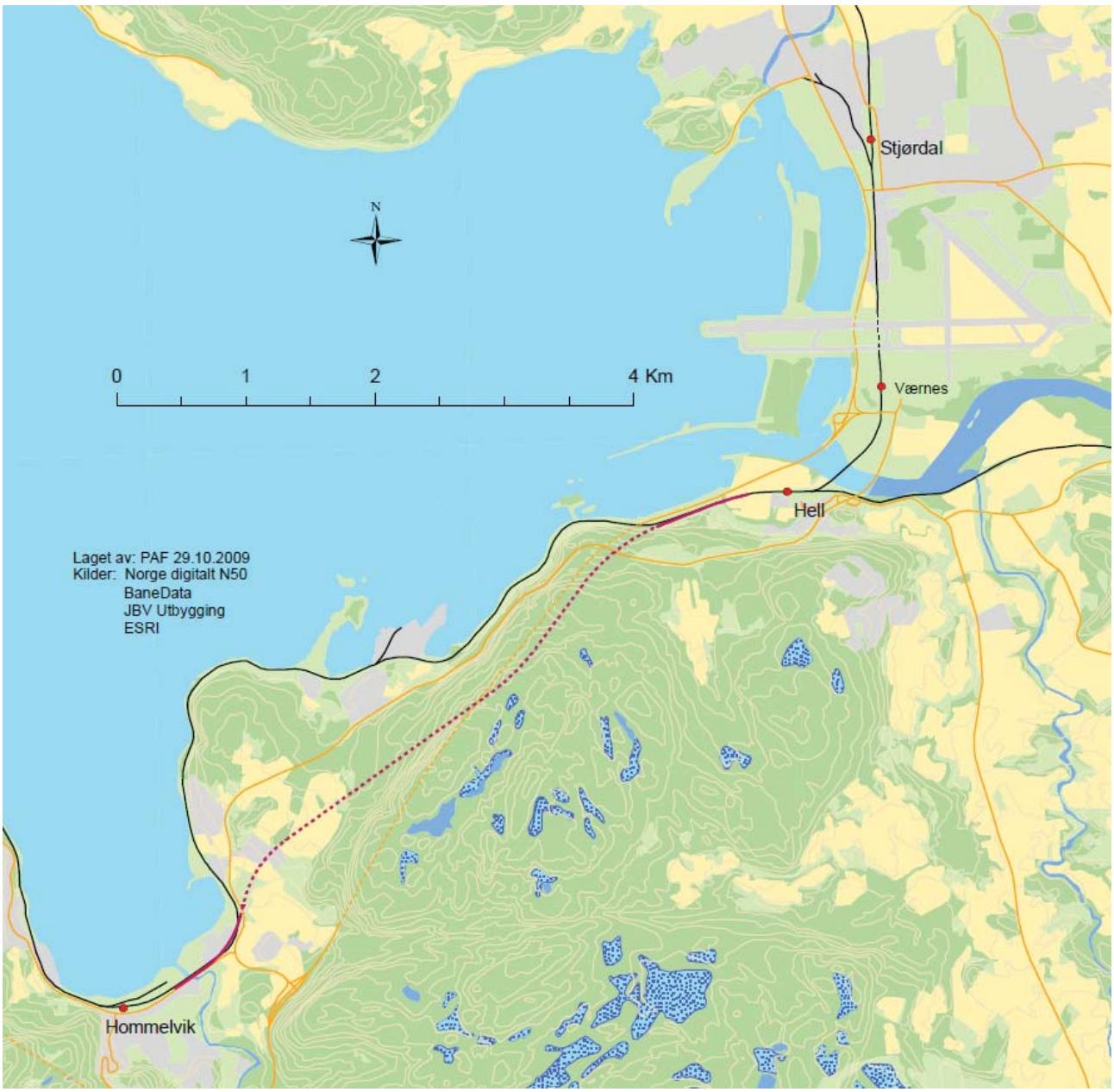


Figure 20: Planning railway tunnel.

The Norwegian Meteorological Institute

http://met.no

The Norwegian Meteorological Institute is the meteorological service for both The Military and the Civil Services in Norway, as well as the public. Our mission is to protect life, property and the environment, and to provide the meteorological services required by society. The Norwegian Meteorological Institute focuses on:

- Meteorological services for both private and public sectors.
- Meteorological services for the Civil Aviation Authorities.
- Meteorological services for military purposes.
- Meteorological and climatological observations in Norway, its adjacent seas and the polar

areas.

- Research and development for both private and public sectors.
- Climate research.
- Advocating the use of open source data.
- Contribute to, and advocate for the international meteorological cooperation. Norway is a member of the World Meteorological Organization (WMO), the European Centre for Medium Range Weather Forecasts (ECMWF), and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). The institute is actively involved in the work of these organisations.

The Norwegian Meteorological Institute is situated in Oslo, Bergen and Tromsø and there are about 20 employees that are involved in Cartography, representing a range of the departments within the organization.

met.no develops software, such as Diana and Kilden, and numerous WMS-solutions where meteorological and oceanographic data is presented using maps. Maps are also used in our production of radar- and satellite images. The provided information describes the weather and climatic conditions in time series with daily, monthly, seasonal, yearly and normal values.

met.no's services cover both climatic and forecasting purposes, and they are continuously improved both by our own developers and with contribution from other users.

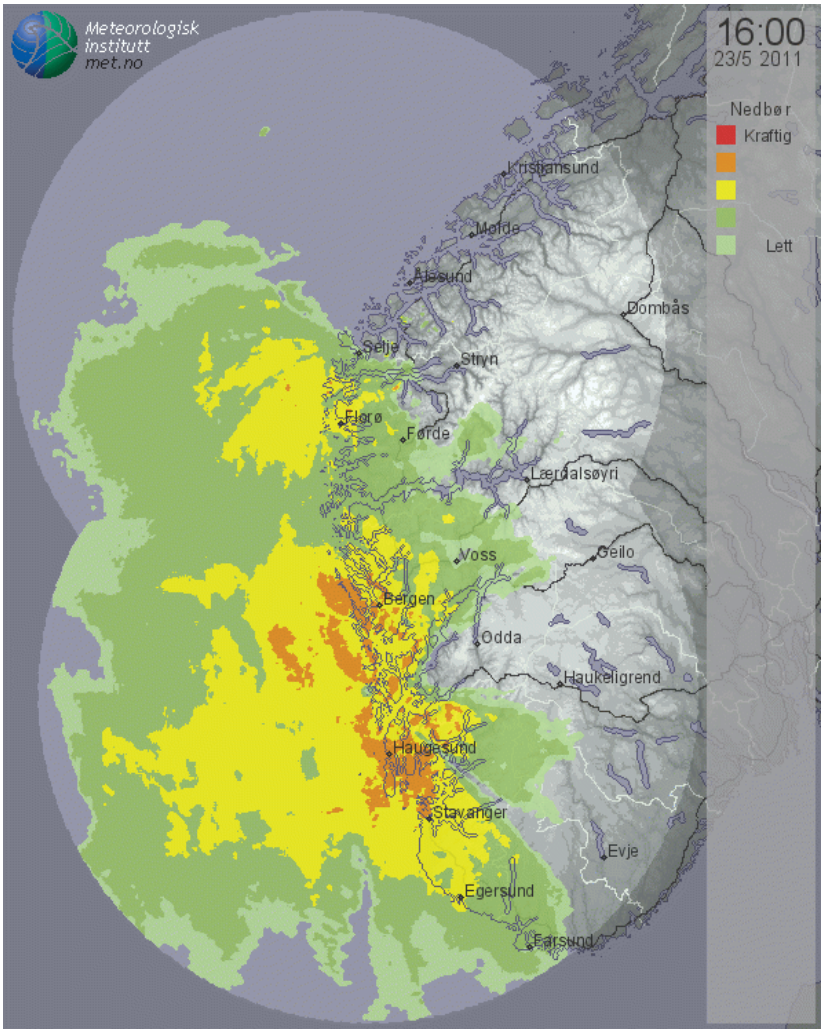


Figure 21: Precipitation in the western part of Norway.

Large City Municipalities

Fredrikstad

http://www.fredrikstad.kommune.no/no/Diverse-sider/Translate/

Fredrikstad is a city with 75.000 inhabitants. The local authority is serving the people with services of school, health, infrastructure and environment. Fredrikstad municipality have 5000 employees where 7 persons are working with cartographic activities. Bellow some examples on maps from the municipality of Fredrikstad.



Figure 22: Streetmap of Fredrikstad and Hvaler municipality.

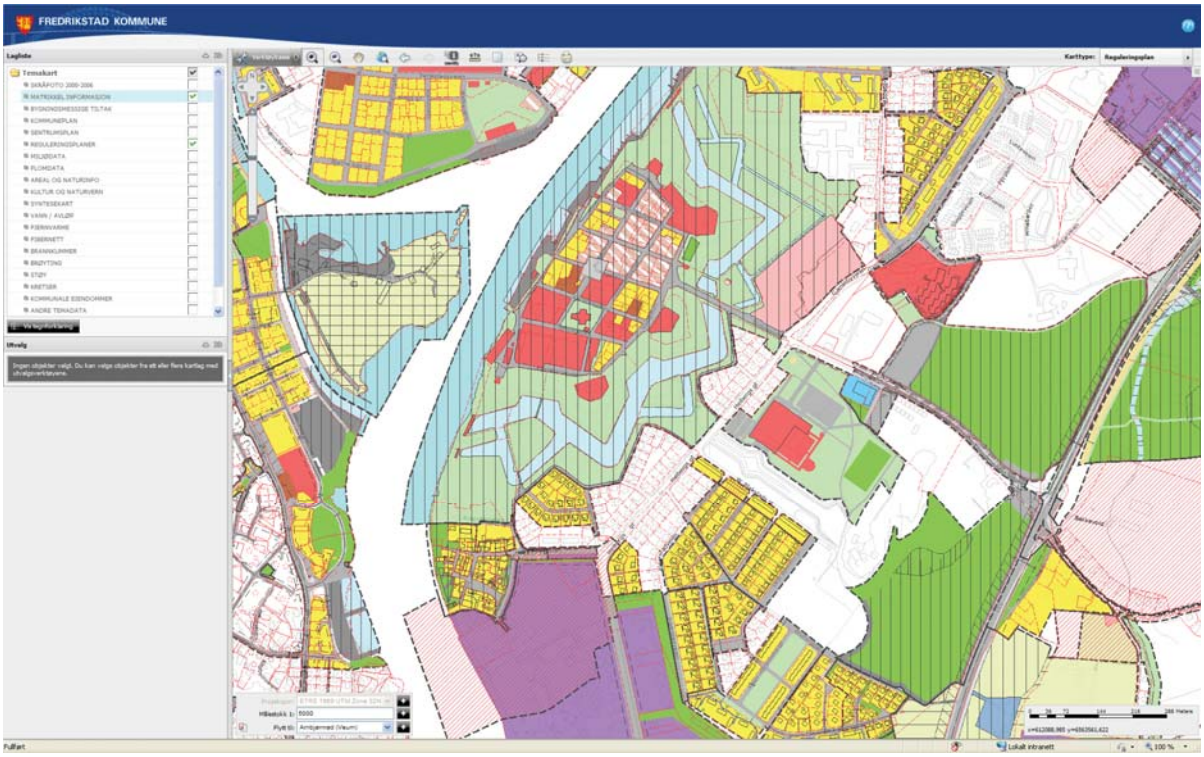


Figure 23: Web-client for Intranet and Internet.

Drammen

http://www.drammen.kommune.no/no/english/

The mapping division is a part of the municipality organization of the city of Drammen, Norway. Drammen is a city with 60.000 inhabitants. The mapping division's main products are services within the areas of GIT, mapping and ground properties. We are handling all dividing of land and giving out addresses, involved in planning and more. Most of the services are developed because of a new law for land register, and another one for plan and building regulation. These regulate our services.

Our markets are mainly the inhabitants and businesses of the city of Drammen. Anyone who needs maps, geographical information, the dividing of land, addresses and so forth. Architects, contractors and city developers are amongst our biggest customers.

The mapping division in the municipality of Drammen consists of 14 people. 8 of them work with cartography and visualization. We also have a responsibility for keeping the data up to date. This is done by continuously adding to the map all new approved buildings as well as updating maps from aerial photography and laser scanning.

From these data we produce all sorts of maps, from world cup ski maps to maps showing areas affected if there is a big flood in our river.

In later years 3D has become increasingly popular. Drammen has made a 3D model of the whole city. We can also offer our services as regarding to visualization of new projects. How they fit into the surroundings, sun/shadow analyzing and more.

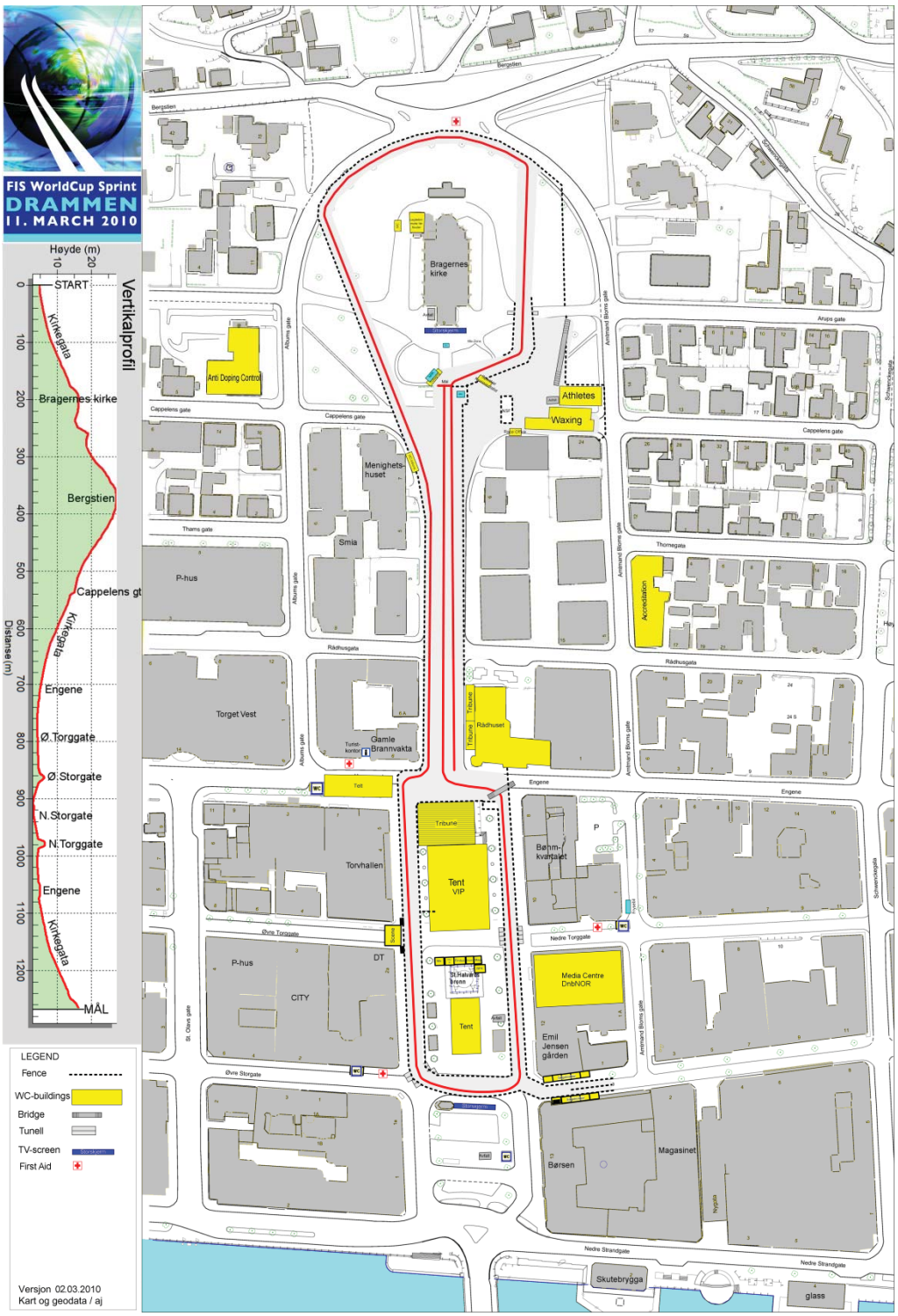


Figure 24: An example of a map made for the FIS World Cup ski sprint in Drammen.



Figure 25: An example of visualization of a new project.

Private Companies

Many private companies are dealing with geographic information and the visualization of this by the use of Cartographic presentations. Some of them are focused on Cartographic methods and making the map, while the main focus of others may be collection of data, data analysis etc. However, these last categories also have interests in the presentation of the collected and analysed data. Below some of the companies are presented together with examples on Cartographic products made over the last years.

Blom

http://www.blomasa.com/

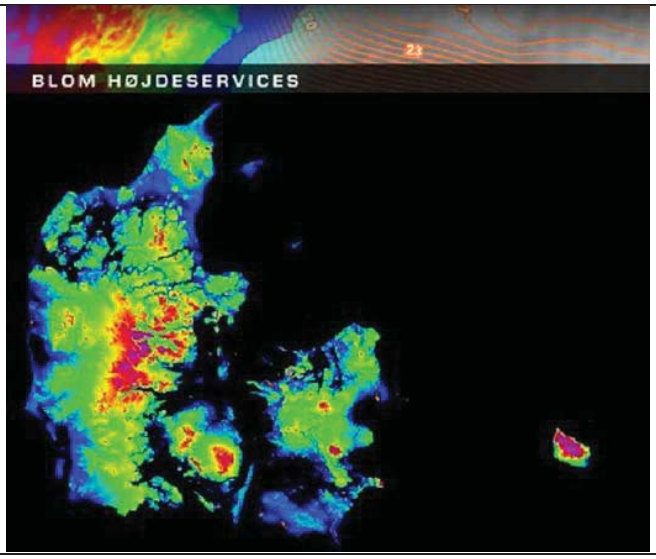
The BLOM Group is the largest provider of geospatial services in Europe for both government agencies and private commercial organizations and companies. BLOM owns exclusive spatial databases composed of maps, images and 3D models. Focused on online services, BLOM provides data and solutions to its customers in many markets and allows its partners to create high added-value applications based on BLOM data models and services. This strategy is backed by BLOM's major technical capacity in aircrafts, cameras, laser scanners and mapping systems. This makes it possible for projects to be carried out within the company, assuring that a high quality product is delivered both on-time and to budget. BLOM has more than 1,000 employees and offices in 13 countries and its HQ is located in Oslo, Norway. BLOM is listed on the Oslo Stock Exchange (ticker BLO).

The demand of advanced and high quality geographical information is steadily growing. Blom has

many years of experience working in both local and central government. Historically, Blom provided traditional core services such as aerial or topographical survey. As government technology and requirements have changed, so have the services. Blom now also provides hosted services and solutions to the government agencies to allow them to use the data to provide efficient and informed decisions easier and faster.

Examples of key products and services include terrain modelling (DTM/DSM), 3D city modelling and forestry. Forest inventory is a very interesting and fast developing business area. Based on aerial laserdata, aerial imagery and field datasets it is possible to produce exact tree species specific results. Forest attributes are estimated and for each tree species mean diameter, mean height, number of stem, basal area and volume is estimated. Correct and effective use of these advanced and modern map data are very important. In other words, visualization and cartography are important topics in most of our workflows, products and services.

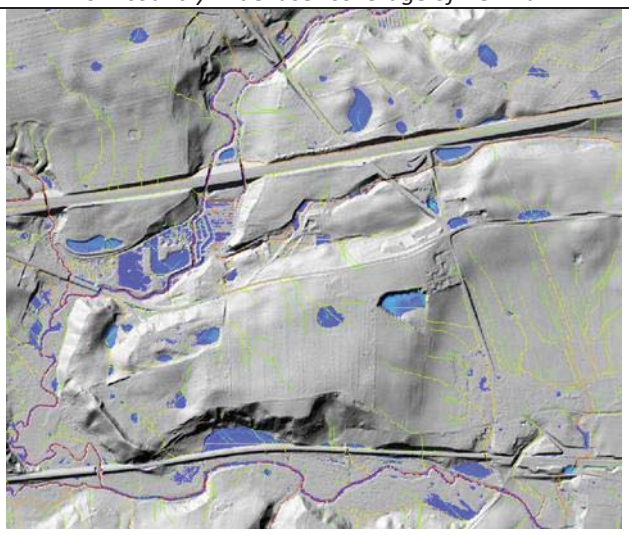
Blom is currently executing some of the largest laserscanning projects in Europe. Two examples are the national coverage of Sweden (450 000 km2) for the *Swedish mapping, cadastral and land registration authority* and 20 000 – 30 000 km2 annually for the *National Land Survey of Finland* (contract period 1st January 2010 to 31st December 2013).



Blom country wide laser coverage of Denmark



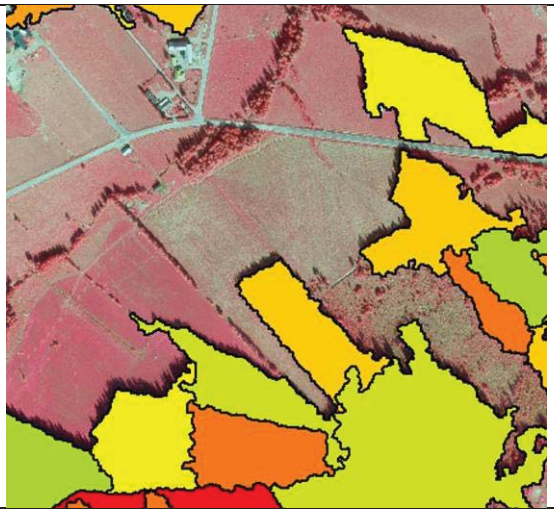
Blom 3D model of the city of Stavanger.



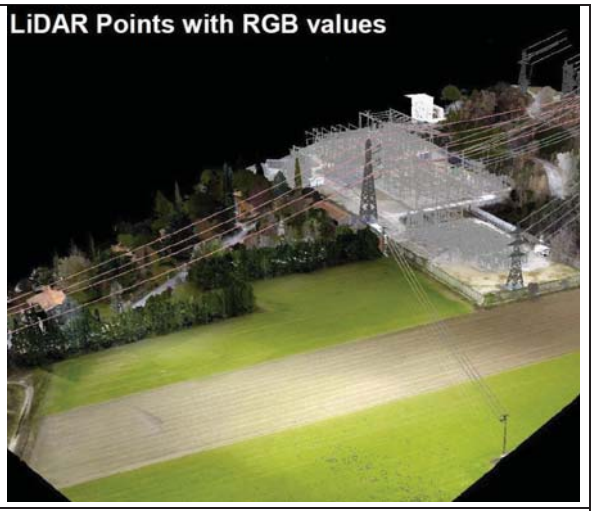
Blom hydrological analysis



Blom forest inventory



Blom forest inventory



Blom high density laser

Figure 26: Examples on activities in Blom.

Geodata AS

http://www.geodata.no/English/

Geodata is creating and publishing a set of on-line cached map services for the commercial market, first of all to support ESRI user with well updated and well performing background maps with adapted cartographic design and content.

The services are created in ArcGIS Desktop 10.0. Publishing and caching is done with ArcGIS Server 10.0. The three main groups of services are:

- Geocache Basis (Basic)
- Geocache Landskap (Landscape)
- Geocache Bilder (Pictures)

Geocache Basis is a neutral base map suited for use with a broad variety of thematic overlays. Geocache Landskap (Figure 27) is a topographic map with hillshading and elevation tint suited to present nature information and information related to outdoor activities such as hiking and skiing. Geocache Bilder is a high performance satellite imagery and orthographic photo service, also suited for use with a broad variety of thematic overlays.

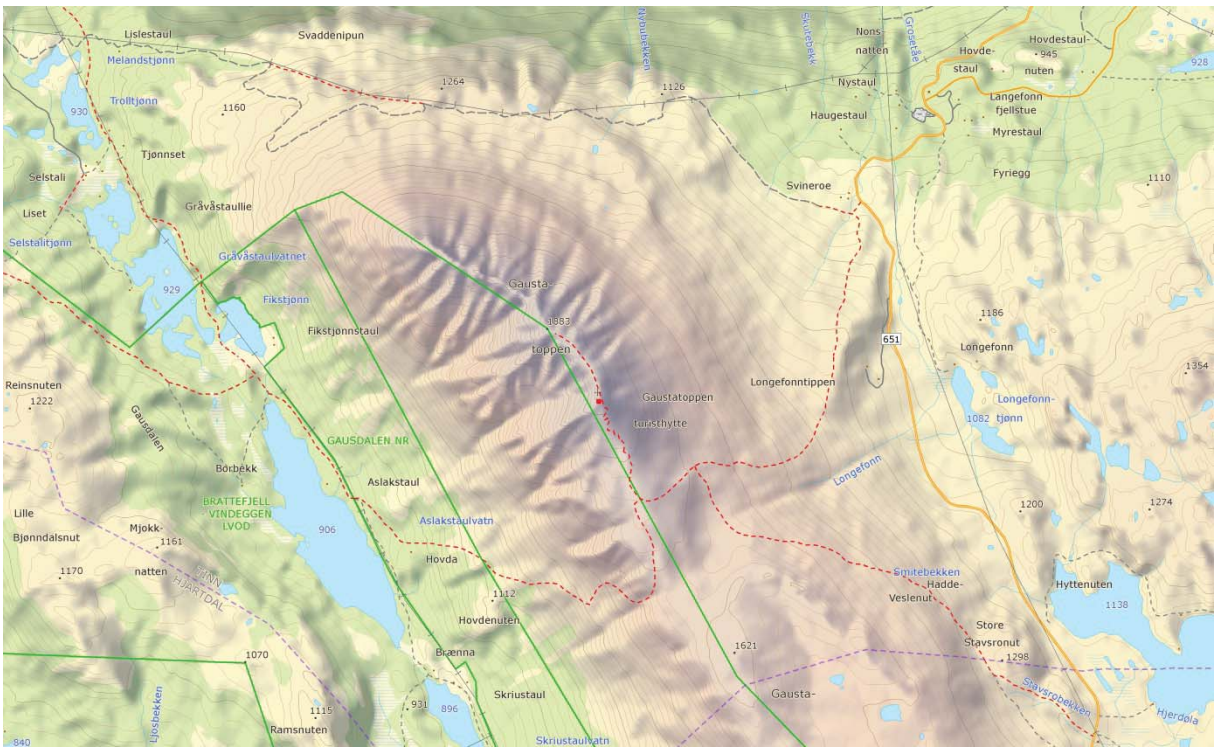


Figure 27: Geocache Landskap.

Geomatikk IKT AS

http://www.geomatikk-ikt.no/ (Only in Norwegian)

Geomatikk IKT AS was demerged from Geomatikk AS 20009 in order to better safeguard the increasing demand for new and better developed and intelligent systems in GIS. The firm has been in existence prior to the demerger as a separate department for about 15 years, the development of solutions in GIS and the provision of services and management of geographic data has been an important role.

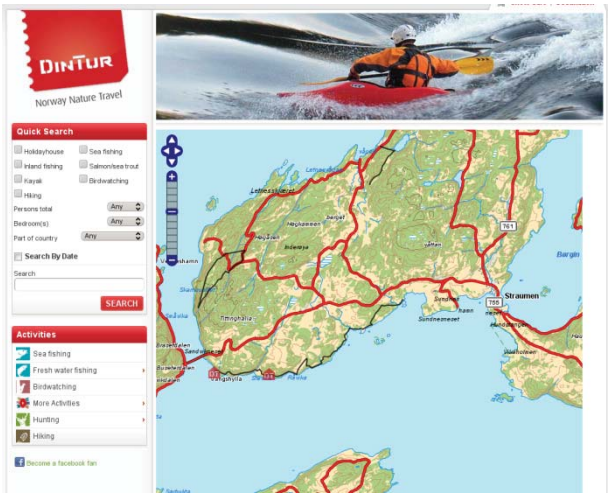


Geomatikk IKT AS has 45 employees, of which about 20 are system developers, about 15 advisors and 5 are system administrators. Six of these employees are working directly with the development and adaptation to cartography and visualization of geographic data. One of the company's main fields is the management of the largest database of electricity, telecommunications, gas and water pipes. Data is updated daily and information from this database is available to entrepreneurs engaged in excavation work in all major municipalities in Norway.

The company has solutions for scanning archives, based mainly on the technical archives where georeferencing is an important part. All documents will be attached to a property or a building. Here we also develop mobile solutions for downloading and viewing documents regarding properties and building based on the mobile unit's position. Information on properties and other geographical objects can thus be obtained directly from the archive as needed.

All products developed in Geomatikk IKT AS are in relationships with geographic information. Most systems have connected map solutions where information and position obtained from the map is linked to data in databases through the use of web-services between the different systems.

The latest products we have developed are registration of pollution and the registration of Proprietary Information in WEB solutions where the map is an Essential Part of the solution. We see an increasing need for updated solutions where users do not need to run the applications, but where these services are operated from service providers as Geomatikk IKT AS also offer.



Rambøll Norway

http://www.ramboll.com

Rambøll Norway has for several years focused on 3D models for the visualization of different projects. This has usually been building projects or projects concerning infrastructure. The basic 3D models are generated from map information. In Norway newer map related information contains 3D information about buildings etc. Hence this information can be used generating 3D models by automatic methods.

A basic 3D model consists of:

1. A Digital Elevation Model generated from map data. A texture generated from orthographic photos is draped on this model.
2. All elevated objects like buildings, fences, hedges, poles, traffic lights etc.
3. Trees which are generated from airborne laser measurements.

Rambøll Norway has developed their own “prototype cartography” for the visualization of elevated objects (example below). The example shows a 3D visualization captured directly from a VR-model.

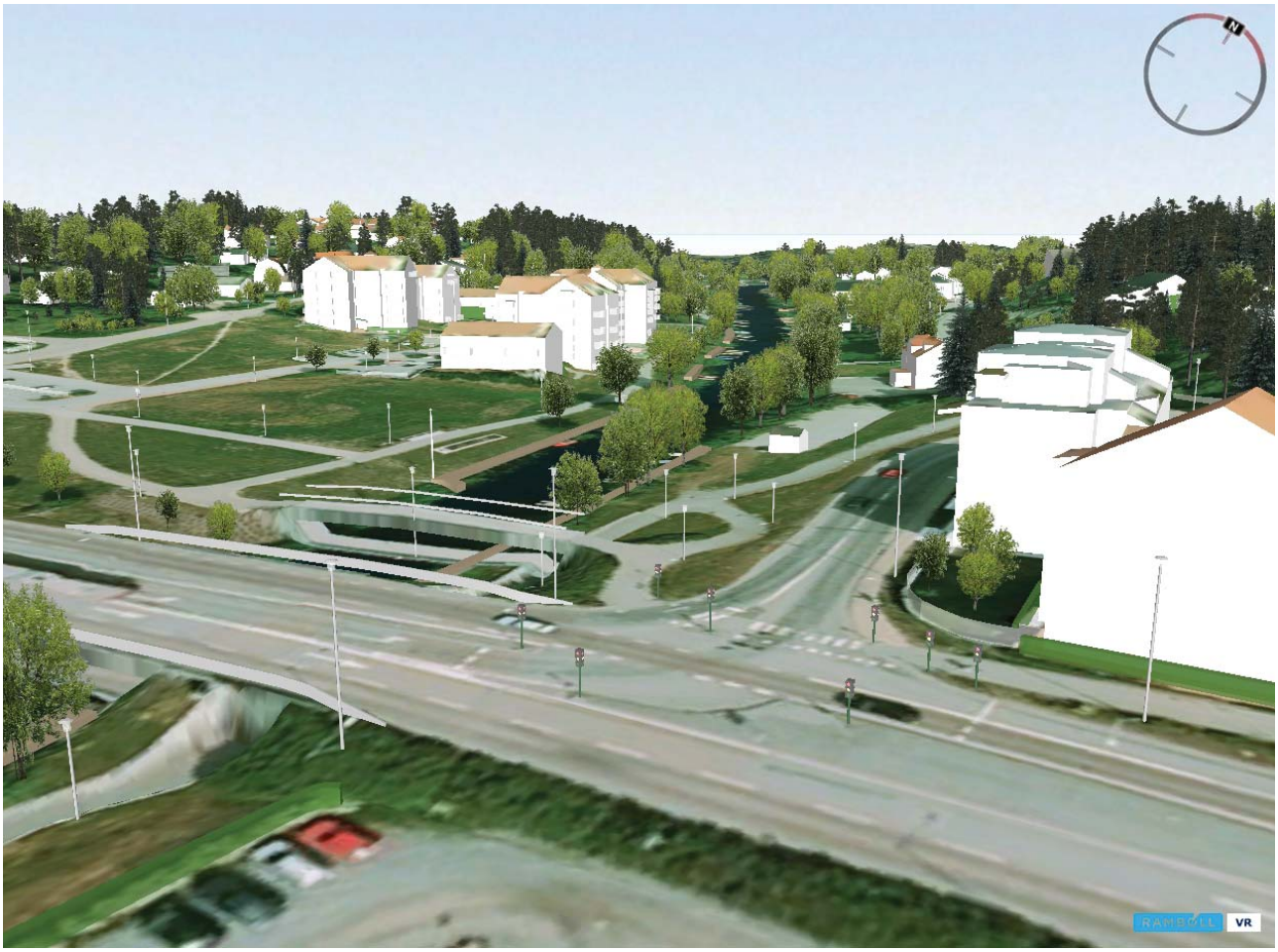


Figure 28: 3D model. Poles, traffic lights, hedges and trees are generated automatically.

Norkart Geoservice AS

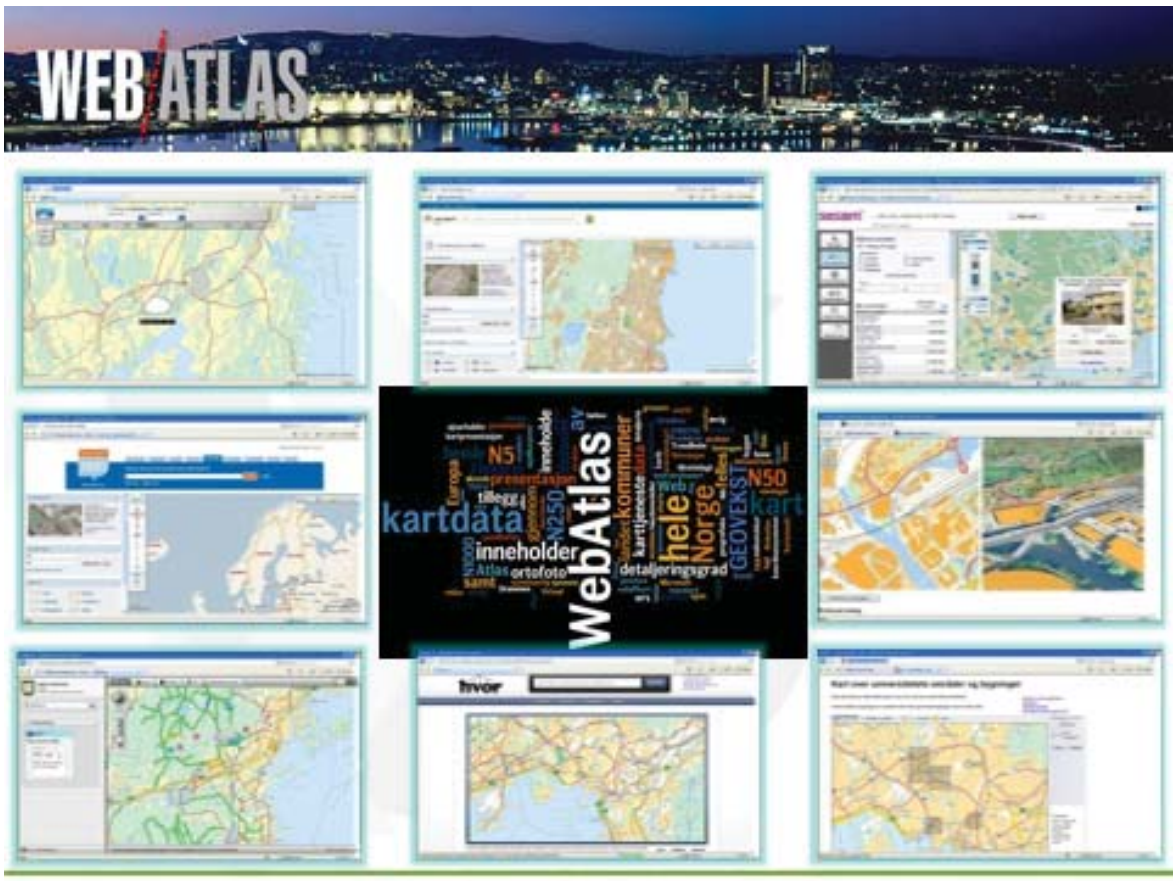
http://www.nkgs.no/wip4/

Norkart Geoservice AS (NKGS) is an independent and neutral vendor with 50 years behind her in the Norwegian marked. The company develops the most advanced software products for managing and distributing geographic information in Scandinavia. The main products are as follows:

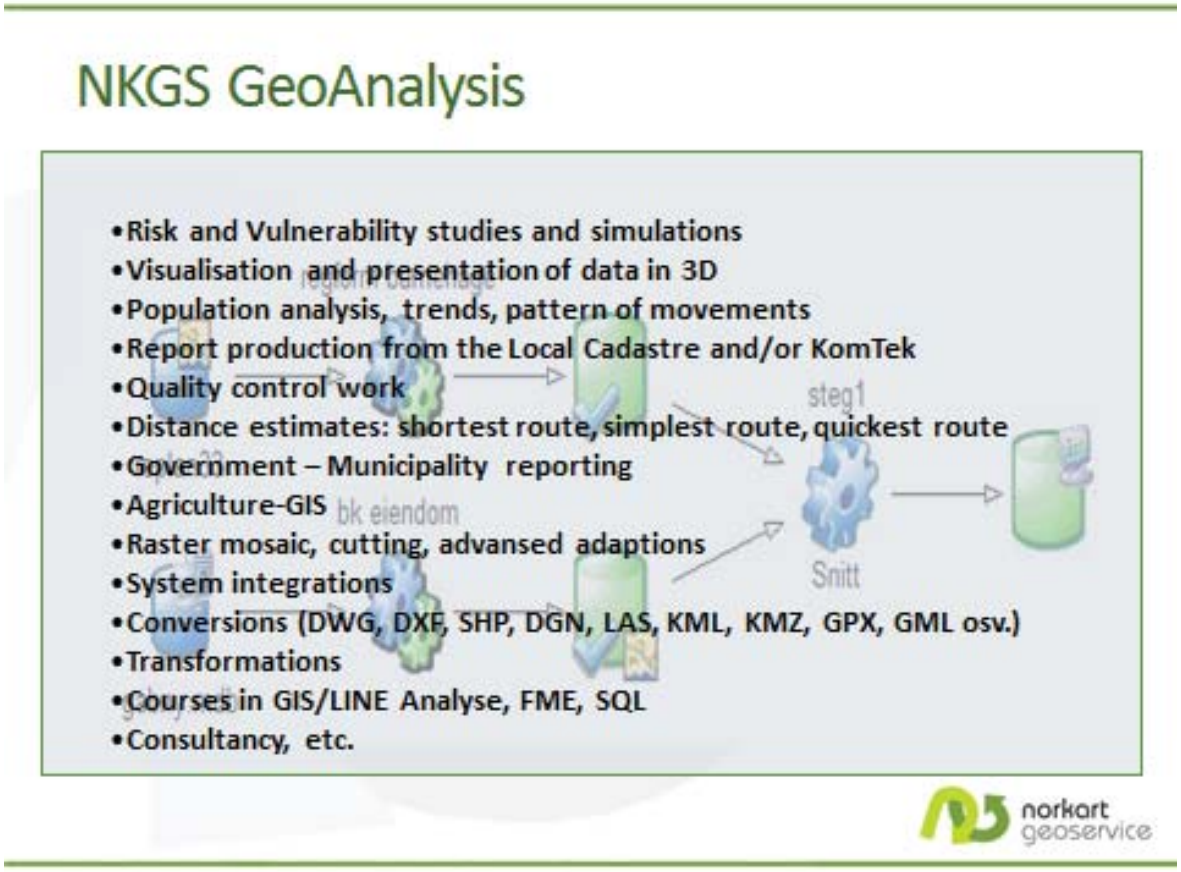
- QMS - a geodata server. A synchronizing service in QMS enable users AUTOMATICALLY to retrieve changes only, without having to down load entire DBs. All the QMS – owners in the data network will thus continuously be synchronized with data from each other.
- GIS/LINE – a complete family of GIS software for data capture, - production and – processing, through expert systems for maps, cadastre, plan and analysis to data access and – distribution. 80 % of the Norwegian municipalities are GIS/LINE customers.
- WebAtlas – a complete coverage of updated maps data and orthographic photos, route planning and 3D systems.
- KomTek - systems for municipal service production within all technical expert areas as fee administration, property taxation, fire protection, water and drainage, garbage disposal etc. More than 60 % of the municipalities in Norway are KomTek users.

Out of 140 employees approximately half of them are directly or indirectly involved in cartographic activities. The R&D-department is far the biggest in the company. All the software is developed from scratch, totally independent of products from the world dominating software producers.

Through a number of net portals the WebAtlas delivered 550 million digital maps to the Norwegian society in 2010 and even more this year.



Consultancy work, conferences and customer education are also important activities within NKGS. So is different analysis, many based on cartography.



Mesterkart

http://www.mesterkart.no (In Norwegian only)

Mesterkart is a company which main focus is to produce high quality maps for printing. Our speciality is computer generated hillshading. Our most important products are tourist- and hiking maps, other thematic maps, wall maps, and map illustrations for books. The maps usually have a scale between 1 : 25 000 and 1 : 1 000 000. In addition to map production, we also do some geographic analysis. Our customers are local governments, private companies, non-commercial organizations and private individuals. Most of our customers (and maps) are from Norway, but we also have some customers abroad.

Mesterkart was established in 2005 by Tore Tonning. Before that Tonning worked with map production in the Norwegian Mapping Authority. In this period he got two awards for excellence in cartography at the ICA map exhibitions in 2001 and 2003. Tore Tonning is still the only “employee” in Mesterkart.

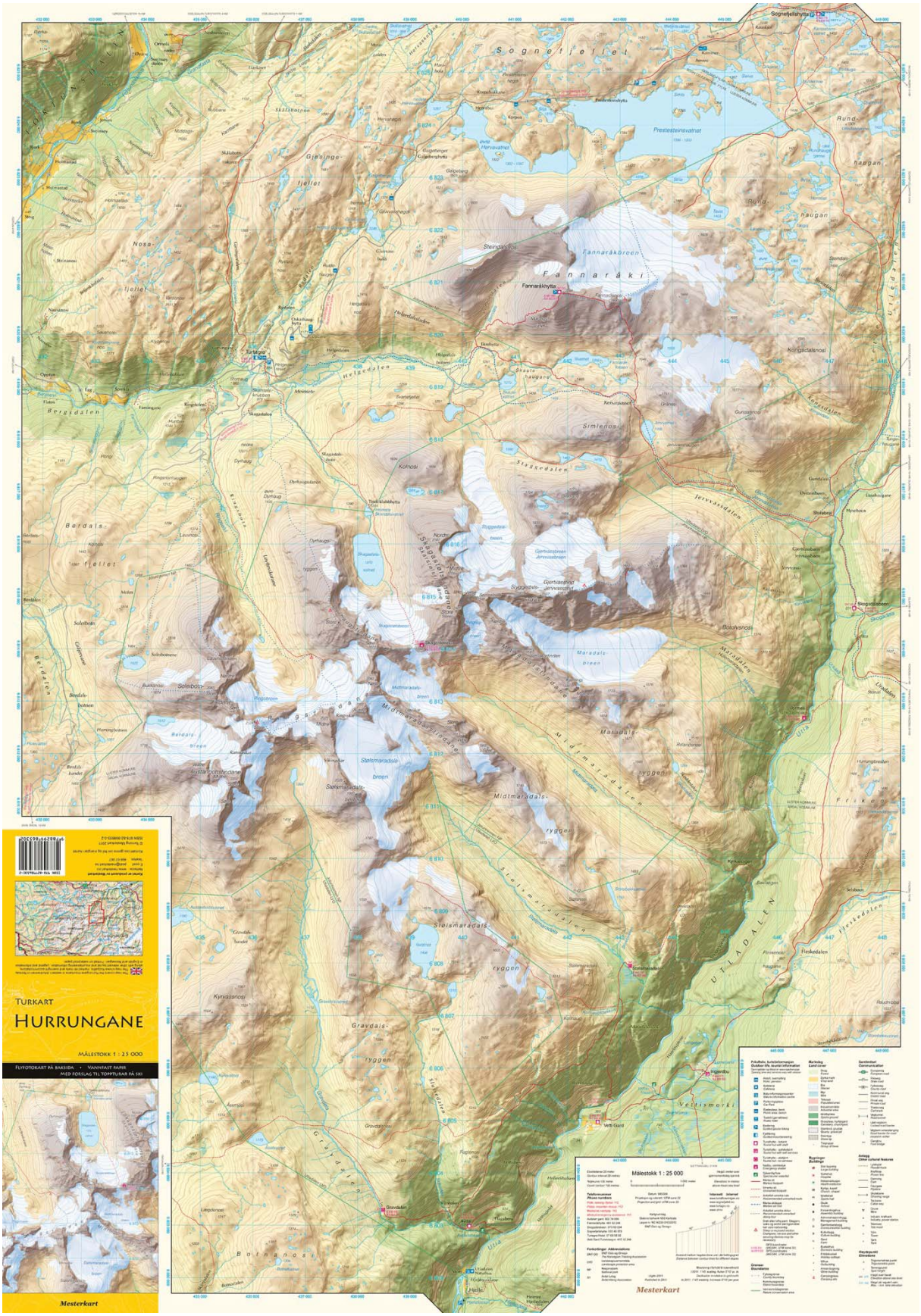


Figure 29: Turkart Hurrungane - the last tourist- and hiking map from Mesterkart. Original size 70 x 100 cm.

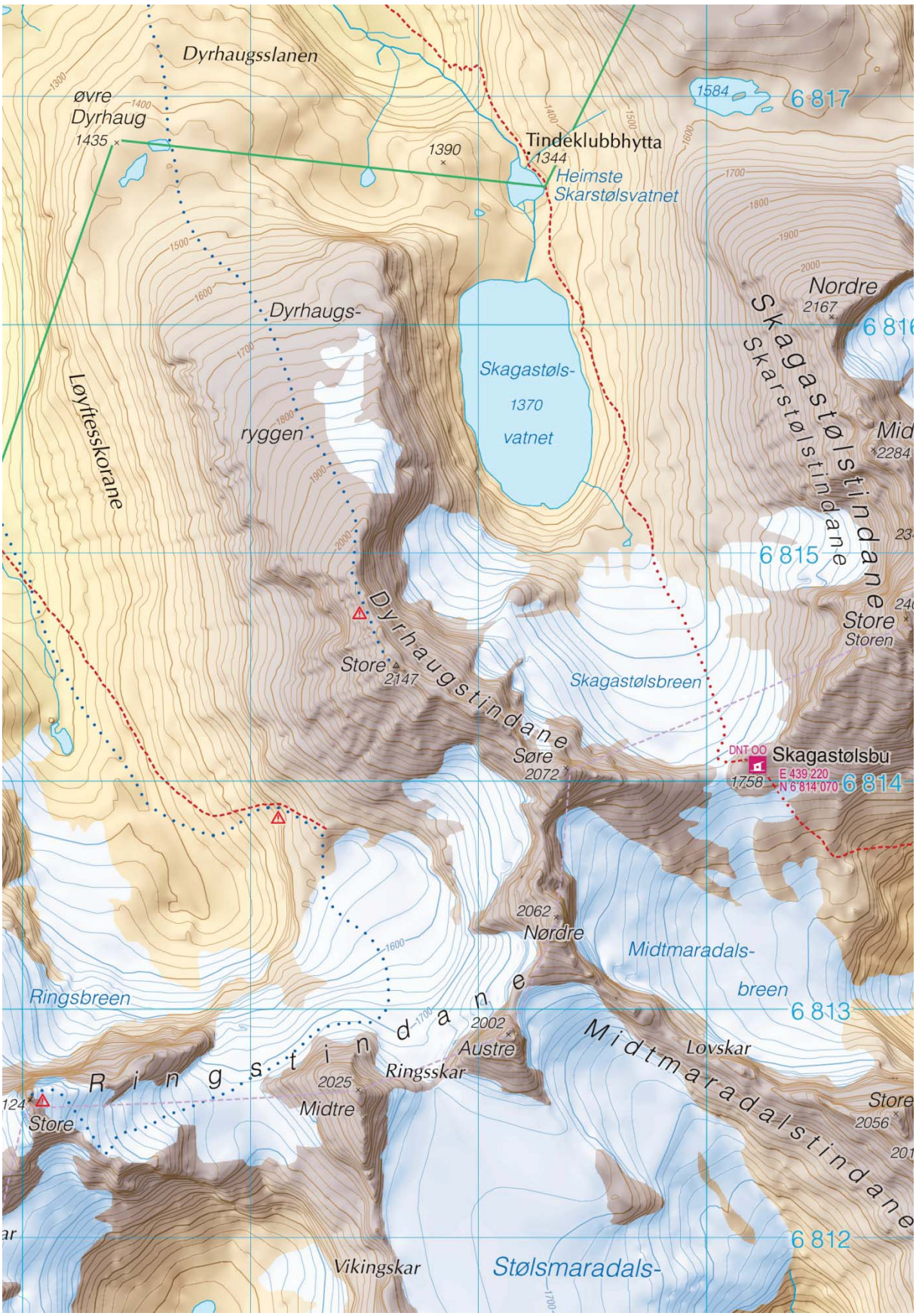


Figure 30: A section from Turkart Hurrungane at original scale.

Norconsult Informasjonssystemer AS

http://www.nois.no/ (In Norwegian only)

Norconsult Informasjonssystemer AS (NOIS) is a fully owned subsidiary of Norconsult AS. Norconsult is the largest consulting engineering company in Norway with approximately 1750 employees.

Norconsult Informasjonssystemer is today a major supplier in the information and communication technology market having long experience in the business as well as broad-based expertise. Our major competitive advantage is our ability to combine our knowledge of the discipline, systems and industry into user-friendly and integrated ICT solutions.

The following GIS software systems are provided by Norconsult Informasjonssystemer:

ISY WinMap is a complete GIS solution for mapping, analysis and presentation. WinMap contains a flexible web based viewer, an effective tool for maintenance of the GIS data and advanced tools for spatial analysis. It is suited for all kinds of users in the organization, from the viewer of geographic data to the most advanced user and producer of geographic data.

An open GIS-solution for the power supply and distribution market. The solution contains powerful and user friendly functions for GIS-analysis, as well as registration and maintenance of data related to the utilities and net distribution with related maps.

Our organization reflects the different markets we operate within. In this way we provide the best service for our customers in addition to a good environment for further development of our products

Norconsult Informasjonssystemer has currently 125 employees and is closely integrated with the business of Norconsult, and has access to competence and staff from Norconsult when needed. The ICT-environment in Norconsult has 130 employees in the fields of programming, communication technology, automation technology and IT-security.

The GIS department is responsible for our maintenance systems within GIS and Network Information (NIS). The staff has long experience with development, implementation and use of the tools which have been on the market since the 80's.

Reference projects:

National Tourist Routes in Norway.

The tourist attraction National Tourist Routes - scenic roads for exploring Norway's breathtaking landscapes - comprises 18 selected stretches from north to south. Mountains, fjords and coastline form the core of the travel experience.

Norconsult Informasjonssystemer has produced all cartographic map presentations for the boards along the tourist routes. The maps are produced from the national map series in scale 1:50 000. One of the major challenges in this project was to find methods to produce several cartographic products from the same base map series. Contact: Jon Sunde Mæhlen, Project manager, NoIS.

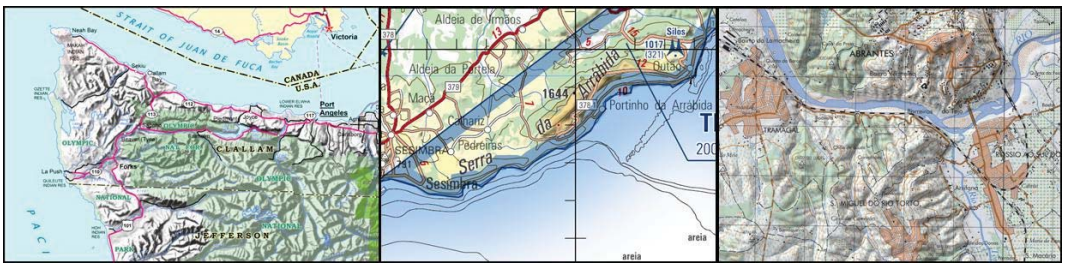


Figure 31: National Tourist Routes in Norway

"Digital Plandialog" for 12K – A cooperation between municipalities in the county of Vestfold

The goal for this project was to establish a web mapping application providing an integrated areal information system. Digital PlanDialog is a web portal to show the process status and documentation for both approved area plans and area plans under construction. The solution is used as a reference project for cartographic representation of area maps on the internet.

Contact: Kåre Conradsen,
Phone +47 907 25 905

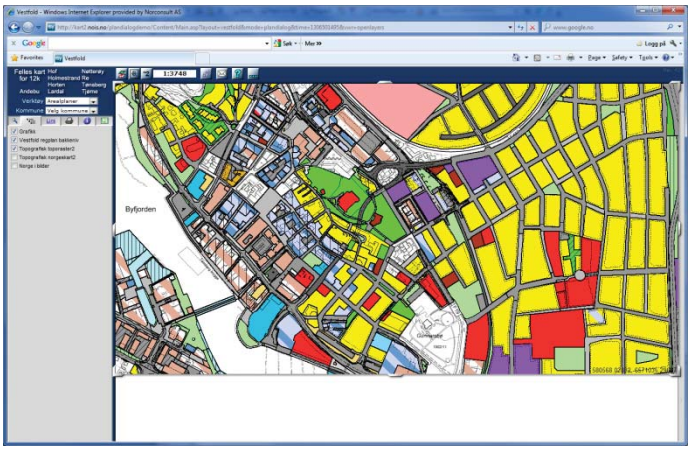


Figure 32: Digital Plandialog

Inter-municipal GIS solution for the region of Gjøvik

The municipalities for Gjøvik, Østre Toten, Vestre Toten, Søndre Land and Nordre Land have selected Norconsult as the supplier of a common GIS-solution for the region. The project includes GIS applications for base mapping, cadastre information system and tools for areal planning based on ISY WinMap Pro.
ISY WinMap WebView is used for cartographic mapping on the internet. Both the mapping applications and the web map solution are run as an ASP service by Norconsult.
Contact: Knut Gulbrandsen,
phone +47 61 14 15

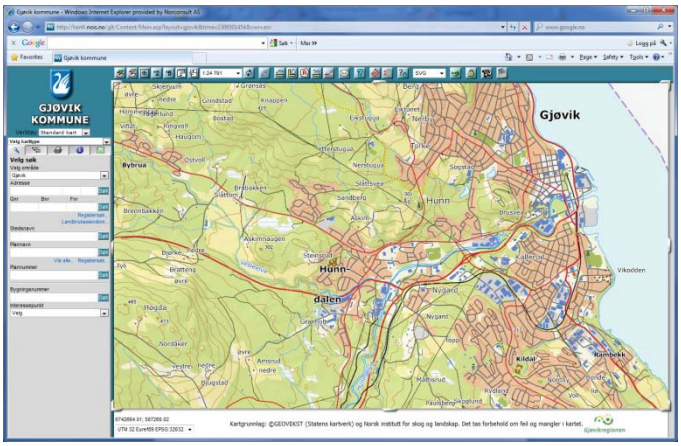


Figure 33: Intermunicipal GIS solution, Gjøvik

eMap AS

http://www.emap.no/

eMap is a mapping company that has produced maps for print since late 1980's. Our main focus is custom mapping for customers and to publish maps on our own label. Amongst our specialties are topographic maps for leisure and outdoor, street maps/city maps, and map illustrations for the commercial and tourist/travel market.

Currently, eMap has only three employees, including one full-time cartographer, and one which spend part of his time on cartographic activities. Despite the small company size, we still consider ourselves a significant contributor in the Norwegian mapping market.

The maps are produced using desktop publishing software such as Adobe Illustrator, Photoshop and InDesign. The data are prepared using GIS software, and imported to and manipulated in Illustrator using a plug-in we developed in-house. We consider map production as a craft rather than an engineering process, where data goes in and paper goes out without due consideration of quality, legibility, fitness for use or aesthetics.

Generally, we have over the last decade seen a decrease of quality in map data provided by the Norwegian Authority, and the national geographical infrastructure Norge Digitalt (Norway Digital). This particularly applies to important features for way-finding in topographic maps, such as paths and trails. Moreover, data produced to support the municipalities in the daily work, are not always suitable for printed maps. We therefore spend more and more time on quality control, and to correct and supplement public data.

We are also spending time on improving our cartographic style to improve legibility and intuitiveness for the audience. This includes techniques described by Tom Patterson to give our maps a more "realistic look". One activity which should be of particular interest in this respect is the use of high-resolution laser-data to produce shaded relief as well as textures, for example in forested areas (see city map example below). A future vision of ours is to use laser data to automatically produce some kind of rock hachure, or to extract crags and cliffs.

Another research activity that we are focusing on is the development of a database structure that will facilitate map production in a range of different map scales. Several of our maps that we publish cover the same area, but are now updated separately, once for each map scale. We need an infrastructure that allows us to update our maps in one single master database, from which different main products and by-products will derive data from with minimal adaptation.

Below are shown two examples from maps finished and printed in 2011. Figure 34 shows a topographic leisure map covering the municipality of Hægebostad in Southern Norway, It is printed in scale 1:40 000 for a local outdoor and leisure organization. It is based on *N50* map data from the Norwegian mapping authority, and supplemented with data, such as paths, trails, and points of interest collected by a local project group.

Figure 35 shows a city map of the city of Hamar in the South-eastern part of Norway. It is published on our own label, and printed in scale 1:12 500. The map is produced in cooperation with the local municipality which also have provided us data. Of particular interest is the use of high-resolution laser data to produce shaded relief and texture in forest areas. Laser data was also used to look for changes from the previous edition of the map. We will also look forward to use laser data to detect changes for the next edition of the map.



Figure 34: Topographic leisure map of Hægbostad.



Figure 35: Hamar city map.

Cappelen Damm

http://www.cappelendamm.no (In Norwegian only)

Cappelen Damm AS is the largest Publishing house in Norway. The company publishes books and maps intended for the public market, and distributes mainly through bookstores. The number of employees for 2010 was appr. 350, while only 3 of these are working with cartography.

Main cartographic products are: Road- and tourist maps and atlases, hiking maps, city plans.

Hiking maps are now being produced by using a new ArcInfo production line. Earlier our maps have been produced by using a graphic environment (Adobe).

Examples from the production:



Figure 36: Tourist map of Middle Norway, scale 1 : 335 000.



Figure 37: Oslo street atlas 2011, scale 1 : 10 000.

Statoil

http://www.statoil.com

Statoil is an international energy company with operations in 34 countries.

Building on 35 years of experience from oil and gas production on the Norwegian continental shelf, Statoil is committed to accommodating the world's energy need in a responsible matter.

Some key information:

- Equity oil and gas production.
- Operates 80% of all oil and gas production in Norway.
- Second largest gas exporter to Europe.
- World leader of crude oil sales.
- World's largest operator in waters deeper than 100 meters.
- World leader in carbon storage

Statoil has 20,000 employees worldwide with operations in 34 countries and there are currently over 1,000 registered users of the GIS system with an estimated 300 active users. Included in these numbers are GIS analysts, "super-users", a dedicated data management group and IT operation resources. Many more are general consumers of internal web mapping information through the intranet.

Statoil uses GIS technology to use, analyse, produce and disseminate information based on geospatial information. This is in addition to the use of many other applications and technologies for visualization of exploration and production information. The product types include:

Paper map products:

- Geological maps and integration of information from various sources/applications
- Field layouts (with pipelines, cables, platforms and other infrastructure objects)
- Rig move maps used for planning and operations
- Environmental information
- Wind energy
- Licence and activity maps
- Information material / visual design

Web maps and map services:

- Offshore Infrastructure map with near read-time vessel tracking
- Inspection web maps (pipelines and structures)
- Web map with links to digital videos through web interface
- Prospectivity atlas
- Project specific web maps for planning and follow up of activities

Map services are developed to include scale dependent displays and area tuned for optimal performance:

- Satellite imagery
- Bathymetric surveys
- General base map information (country borders, locations and place names, elevation)

Statoil is currently focusing mapping technology on automated data management routines and a

map plug-in developed give users easy access to standardized map layers and search interface based on ISO19115 topic categories. Statoil also sees a growing need and use of web mapping and map services technology. New routines and technology for web map interfaces will be implemented this year.

Paper map example:

The map shown below provides an overview of pipelines, installations, fields, discoveries, and current licensing status for petroleum activities on the Norwegian continental shelf. The map includes a table showing company operators and partner shares. The map is very popular.

See also http://www.esri.com/mapmuseum/mapbook_gallery/volume25/environmental-management/environmental-management-3.html

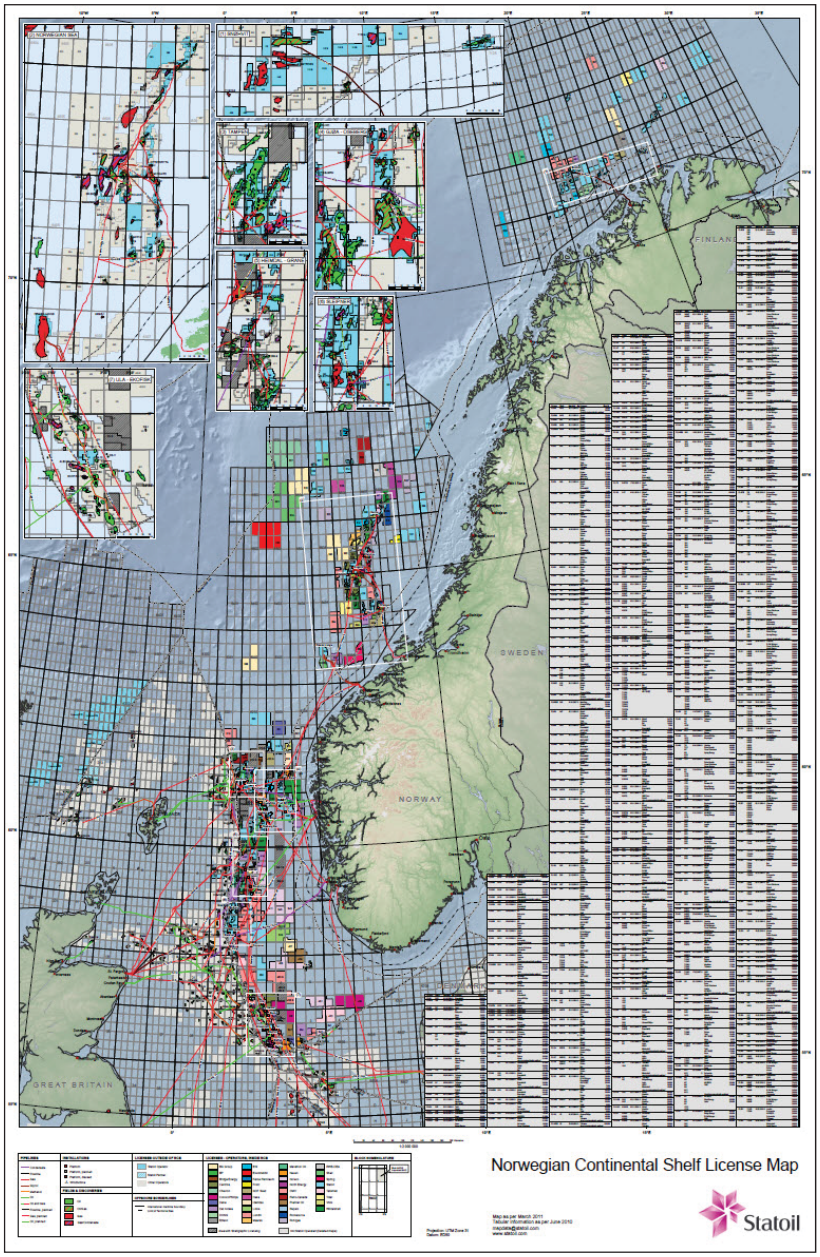


Figure 38: Activities on the Norwegian shelf.

Web map example:

Mapping and GIS is actively used in connection with the Sheringham Shoal Offshore Wind Farm. The wind farm is located just off the Norfolk coast, U.K.

The web map includes AIS information on the installation vessels in near-real time plotted on the map. The web map is actively used for planning and status.

See also http://www.scira.co.uk/offshore/FoundationsMap.html

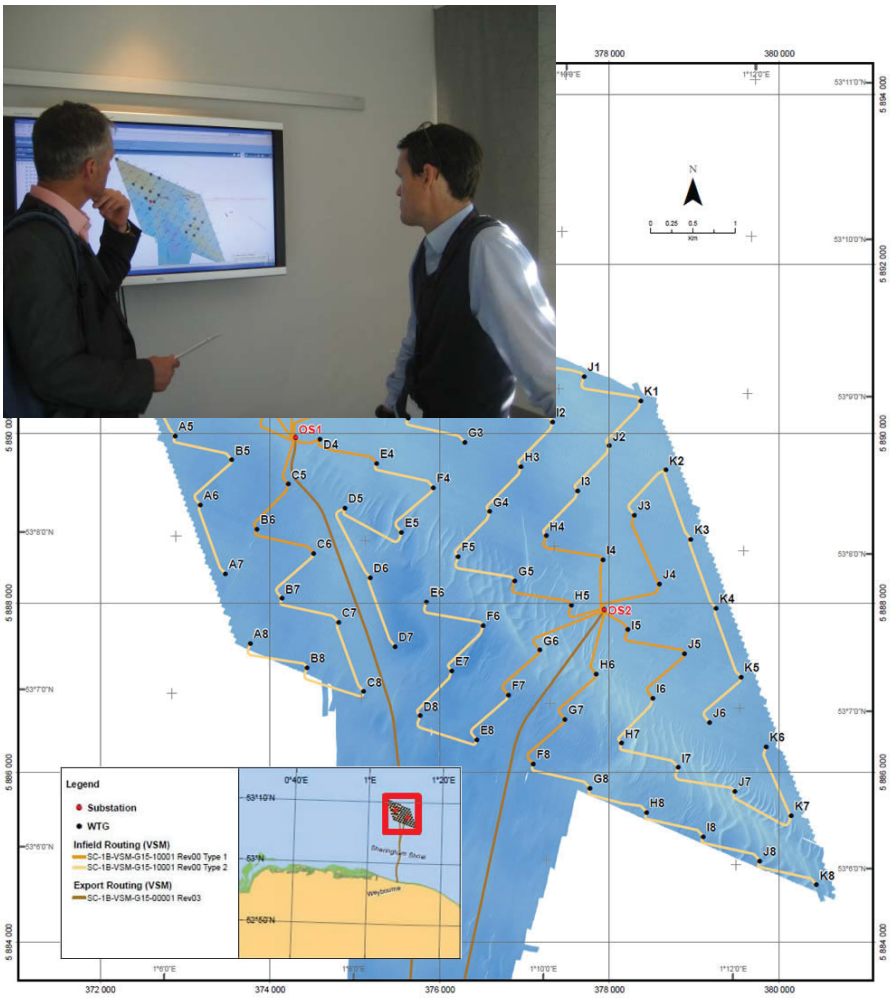


Figure 39: Wind farm map including AIS.

Cartographic Education

In Norway Cartographic education is provided by Geomatics and Geography departments at different educational institutions. Most of these have a wider focus where Cartography is a part of courses within geographic information science on basic levels. On a Master level the students can choose to concentrate on Cartography in projects and Master Thesis. Below the most central educational institutions are presented.

Norwegian University of Science and Technology

http://www.ntnu.edu/

At the Norwegian University of Science and Technology (NTNU) there are Cartographic education both at Division of Geomatics and Department of Geography.

At the Division of Geomatics at NTNU the study is focused on the combination of subjects within Geomatics and Computing Science in combination with other technological subjects and more general courses. The Geomatics group offers courses within GIScience/Cartography, Photogrammetry and Geodesy. All together the GIScience/Cartography courses have a value of about 65 credits (Master Thesis included).

At the department of Geography 3 of the 16 professors are involved in teaching and research wherein GIS related methodologies and technologies are applied. Additionally, there are one devising engineering who regularly work with GIS, web- GIS or cartography and four PhD student use mapping methodologies (GIS) in their projects. At present Department of Geography at NTNU offers five GIS subjects, two on bachelor level and three at master level. The three master courses are given in English and thus attract many international students as well as students from a number of disciplines (including geography, biology, engineering, hydrology, and archaeology).

Norwegian University of Life Sciences

http://www.umb.no/english

At the Norwegian University of Life Sciences (UMB) there is a bachelor programme and a master of technology programme in Geomatics at the Department of Mathematical Sciences and Technology. The Geomatics study at UMB encompasses surveying / geodesy, photogrammetry / remote sensing and GIScience / cartography. All together the GIScience/Cartography courses make up about 70 credits (master thesis included).

University of Oslo

http://www.uio.no/english/

At the University of Oslo (UiO) Cartographic education are offered at the Department of Geosciences. Geomatics at UiO focuses on the handling of geographical information: Spatial analyses of geographical data, Remote sensing, Geodesy and Photogrammetry, with focus on land resource mapping, mapping and monitoring of surface movements, and hazard assessments.

Bergen University College

http://www.hib.no/english/index.html

Bergen University College offers a bachelor program in Land surveying and Land administration. The program is focused on the combination within Geomatics and land administration. The geomatics courses (Land surveying, GIS, Cartography, Geodesy) have a value of about 70 credits (Bachelor thesis excluded). The number of students starting the program is about 45.

Cartographic Research

Both governmental institutions and private industry are developing new methods for visualizing maps. However, when it comes to more fundamental and thorough Cartographic research it is the responsibility of the universities. Below some recent research are introduced.

Norwegian University of Science and Technology

- Division of Geomatics

Some examples on Cartographic related research at Geomatics group:

- Visualization of large rock-slides. In the Norwegian fjords there are many steep mountains, and some of them fall down from time to time! At the moment there are a few cites that critical and are consequently given special attention. Different spatial related data about the mountains are collected, both over and under the ground. This project introduced new visualization methods for the presentation of the 3D situation.

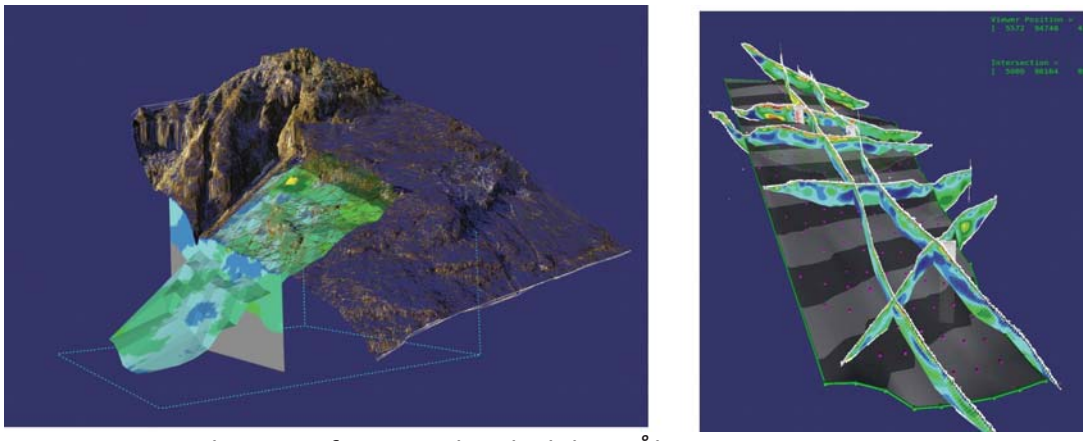


Figure 40: Visualization of potential rock-slide at Åkneset



Figure 41: Zoom experiment on handheld device

- Zooming in map. One project studied how different zoom-techniques (stepwise and sliding) on Web-maps influence on how the user can recognize the map content on different zoom-

level. A subsequent experiment studied how change in content of the map influenced zoom operations on mobile phones.

- Web methods for Cartographic research. To carry out different experiments there has been developed methods for running different Cartographic experiments on the Web and on handheld units.
- Indoor Cartography. The ubiquitous use of web maps on both mobile and desktop devices will inevitably demand access in indoor environments. Advances in indoor positioning are promising and hypothesized to be more integrated in the infrastructure in near future. The cartography should be ready to meet this in terms of scientifically validated designs and methods. This project focuses on the development and research on new methods for indoor cartography, in particular in relation to large enterprises.



Figure 42: Indoor Cartography

-Department of Geography

This spring (2011), the Department had much media cover due to its social vulnerability mapping of Norwegian municipalities. The article (with map) from the Norwegian newspaper Dagbladet is attached as an example.

Contact person: Jan Ketil Rød (http://www.svt.ntnu.no/geo/jan.rod/default_e.asp)

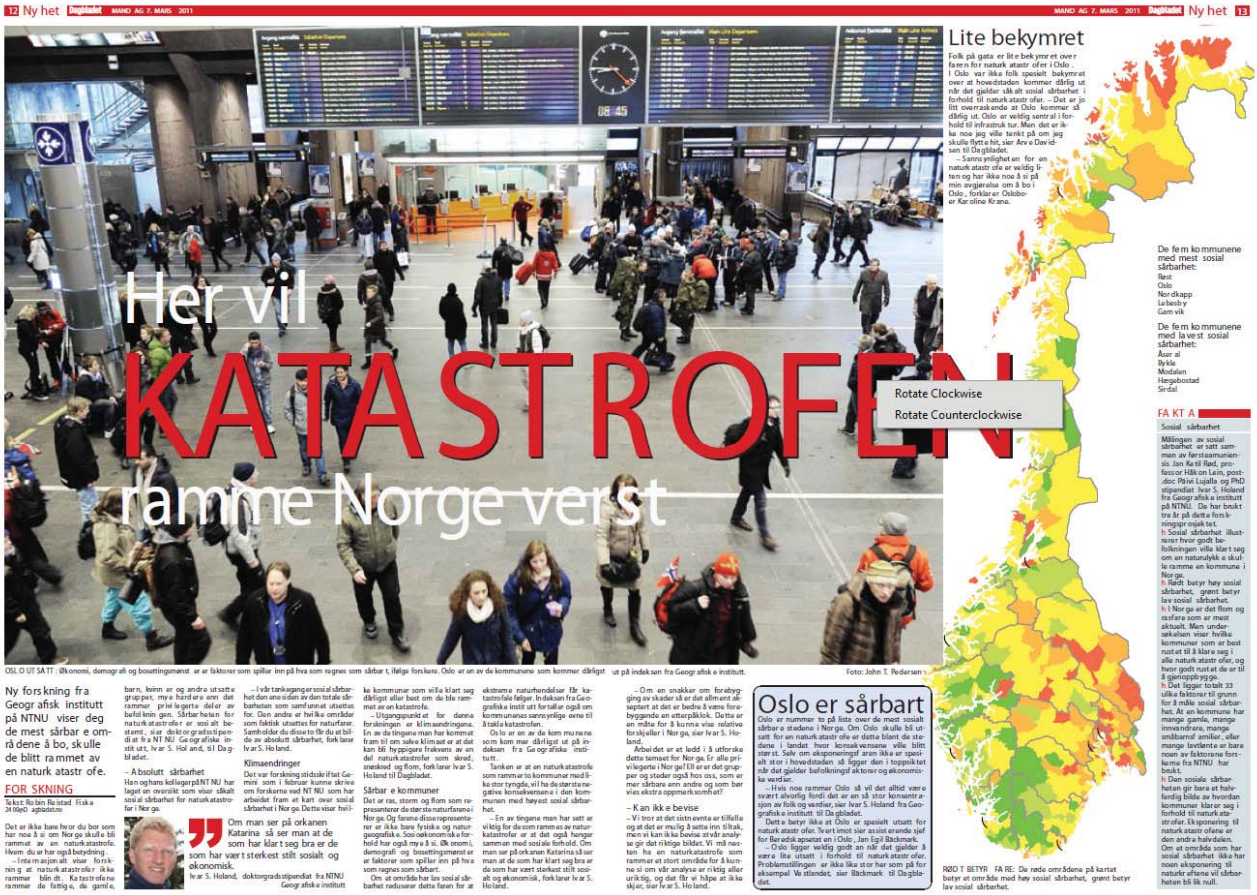


Figure 43: Facsimile of article about social vulnerability.

Norwegian University of Life Sciences

UMB has been involved in the documentation of the cartographical capabilities of Mapserver, an Open Source map server.

Through our former adjunct professor, Jan Terje Bjørke, UMB has participated in research projects on perception, cartographic generalisation, digital terrain models, fuzzy modelling, cartographic communication and more.