

# CARTOGRAPHIC ACTIVITIES IN NORWAY 2011-2015

NATIONAL REPORT TO THE  
16TH GENERAL ASSEMBLY OF ICA  
RIO DE JANEIRO, BRAZIL, AUGUST 2015



**GeoForum**

Organisation for geographic  
information

[WWW.GEOMATIKK.NTNU.NO/NORWAYCARTOGRAPHY](http://WWW.GEOMATIKK.NTNU.NO/NORWAYCARTOGRAPHY)



[www.geomatikk.ntnu.no/NorwayCartography](http://www.geomatikk.ntnu.no/NorwayCartography)

## **Cartographic Activities in Norway 2012-2015 National Report to the 16th General Assembly of ICA Rio de Janeiro, Brazil, August 2015**

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### **Introduction**

This is the Norwegian report describing Cartographic activities in Norway over the last four years. The contents of the report is based on contribution from invited governmental institutions, private companies and educational/research institutions. About 20 of the invited “candidates” did choose to contribute to this report. 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 contributing to 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](http://www.geomatikk.ntnu.no/NorwayCartography)

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# Cartographic Societies



## GeoForum

GeoForum, founded in 1969, 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, five 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, Geomatikkdagene (Geomatics conference) where various Cartographic works are presented. Contributions to the ICC exhibition are selected from this national "competition".

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 2014, 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 Bergen 2014 gathered about 30 participants. This course is open for participation from all Nordic countries. Most of the participants in 2014 were however from Norway.

ICA Commissions with Norwegian representation:

Education and Training: *Terje Midtbø*

Geovisualization: *Terje Midtbø*

Maps and the Internet: *Sverre Iversen*

Mountain Cartography: *Kristoffer J. Kristiansen*

# Governmental Institutions

As in most countries, Norway has different governmental institutions that 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://kartverket.no/en/about-the-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 as well contribute to the international development in the field. The Mapping Authority is a public agency under the Ministry of Local Government and Modernisation.

### **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 Local Government and Modernisation.. 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 databases. 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 within Norway easily accessible digitally on the internet and to the users ([www.geonorge.no](http://www.geonorge.no)).

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

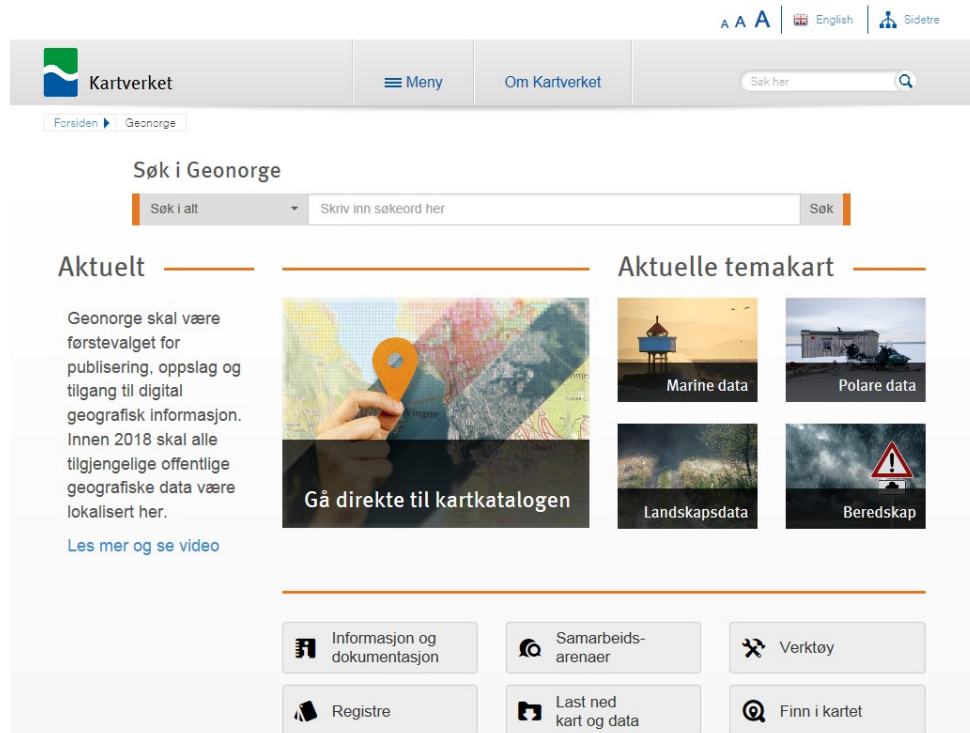


Figure 1: [www.geonorge.no](http://www.geonorge.no) is an important node for available geographic information in Norway.

### State commission and joint financing

The Mapping Authority's governance and production tasks are defined by the Ministry of Local Government and Modernisation through the state commission in the annual Budget Propositions.

The geodetic task, nautical charting and management tasks are fully funded 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 428 municipalities, the Norwegian Public Roads Administration, Telenor, 123 energy companies, agricultural producers and the Mapping Authority. The Geovekst collaboration is a very important supplier of data to Norway Digital. In 2014, NOK 137m were invested in Geovekst projects.

## Data sets freely available for downloading

In 2013, several data sets were made available for free downloading. These data sets are:

- Topographic map data bases in scales 1:50.000 to 1:5 million in vector and raster format, called N50-N5.000 Map Data and N50-N5.000 Raster Data)
- Administrative boundaries
- Road data with addresses
- Digital Terrain Models, with resolution 10x10 meters and 50x50 meters.
- Place names
- Historical maps. The Mapping Authority has about 10.000 historical land maps in different scales, from as far back as the 1700s, and we have approximately 500 historical charts and documents from as far back as the 1500s.
- Sea data. Sea data are intended for purposes other than navigation. Sea data involves depth data (marine primary data), sea terrain models and depth curves.



Figure 2: Example of historical map available at [www.kartverket.no](http://www.kartverket.no), Smålenenes amt nr. 10, 1703: Carte von Oberberg.

## Crowd sourcing

In January 2013, the Norwegian Mapping Authority officially launched their website for the users to make contributions to their maps and map data. This website is called Rett i kartet ('Fix the Map'), and can be found at [www.rettikartet.no](http://www.rettikartet.no). From January 1<sup>st</sup> until April 30<sup>th</sup>, the users contributed with 780 registrations, with each registration containing one to several contributions. This includes both correcting errors in the map data and adding features currently missing.

In June 2015, a new version of the website launched, this time also supporting contributions from users with tablets and smartphones.

## Organisation

The Norwegian Mapping Authority is organised in four divisions: The Geodetic Institute, Mapping and Cadastre and the Land Registry are located in Hønefoss headquarter, 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.

## 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.

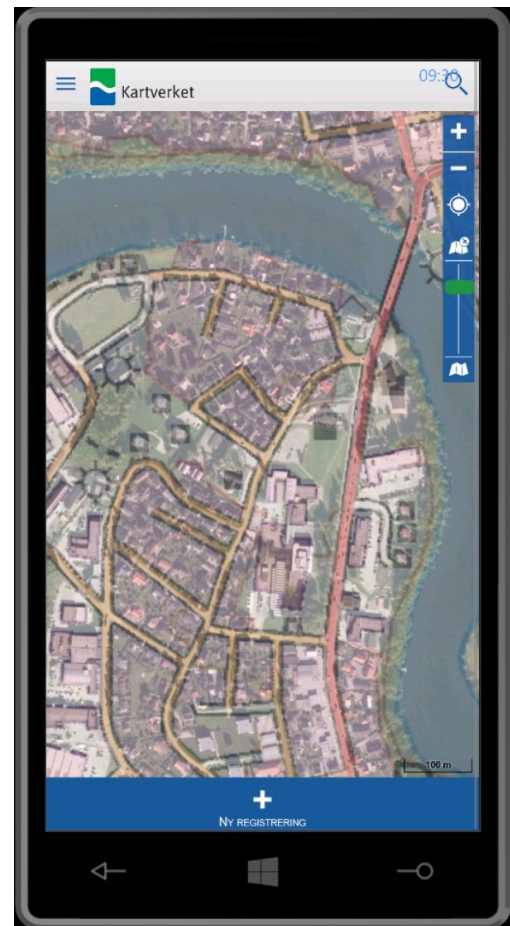


Figure 3: Crowd sourcing solution Rett i kartet running on Windows Phone.



## **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.

## **Hydrographic Service**

The Norwegian Mapping Authority Hydrographic Service (NHS) is responsible for preparing and updating nautical charts, and covers all marine and coastal waters in Norway and around Svalbard, as well as polar waters.

### *Official nautical charts*

NHS is the only authorized producer of official nautical charts in Norway, and vessels over a certain size are obliged to use these charts. As well as cartographical work, NHS is also responsible for information about tidal waters and currents.

### *Safe navigation*

NHS is required to facilitate safe and effective navigation in Norwegian coastal and marine areas. NHS undertakes this task by gathering, administering, processing and publishing official maritime information to a range of user groups.

### *Charting the ecosystem*

While safe coastal navigation takes top priority, NHS's deep-water database is also useful for other purposes, including coastal zone planning and administration of fisheries.

As a supplier of deep-water data, NHS helps to improve knowledge of the structure, mode of operation and status of the marine ecosystem. This knowledge provides a framework for establishing sustainable management of coastal and marine areas in Norway.

### *International nautical charts*

NHS has operational responsibility for Primar, the international nautical chart service. This supplies official electronic nautical charts for international shipping on behalf of around 40 nations.

### *Cartographic activity*

NHS is responsible for official navigational charts, both digital (ENCs) and paper maps. Cartography is most appropriate in designing paper charts where there are traditional requirements for readability. Cartography in nautical charts is defined by the standards of the IHO.

The NHS also supplies terrain models, raster files, hydrographic originals and datasets to different purposes.

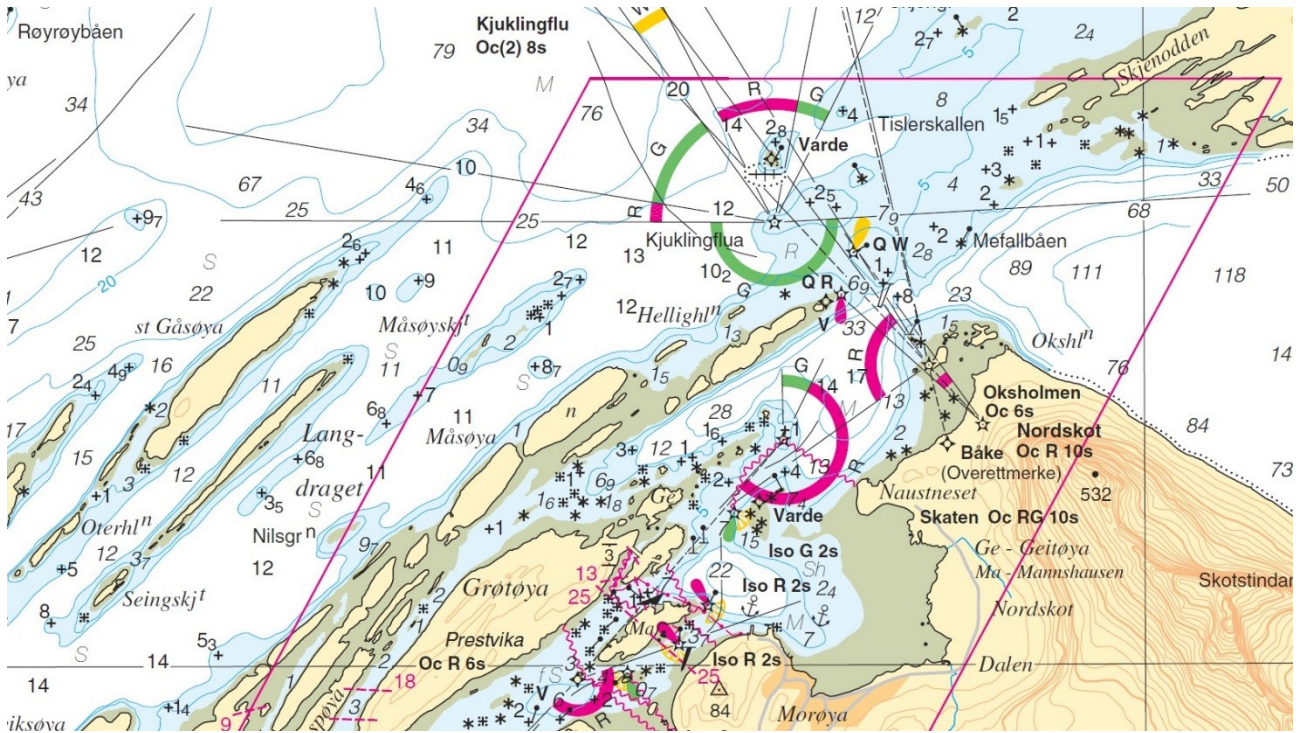


Figure 4: Traditionally chart. The view is from Grøtøyleia in Nordland.

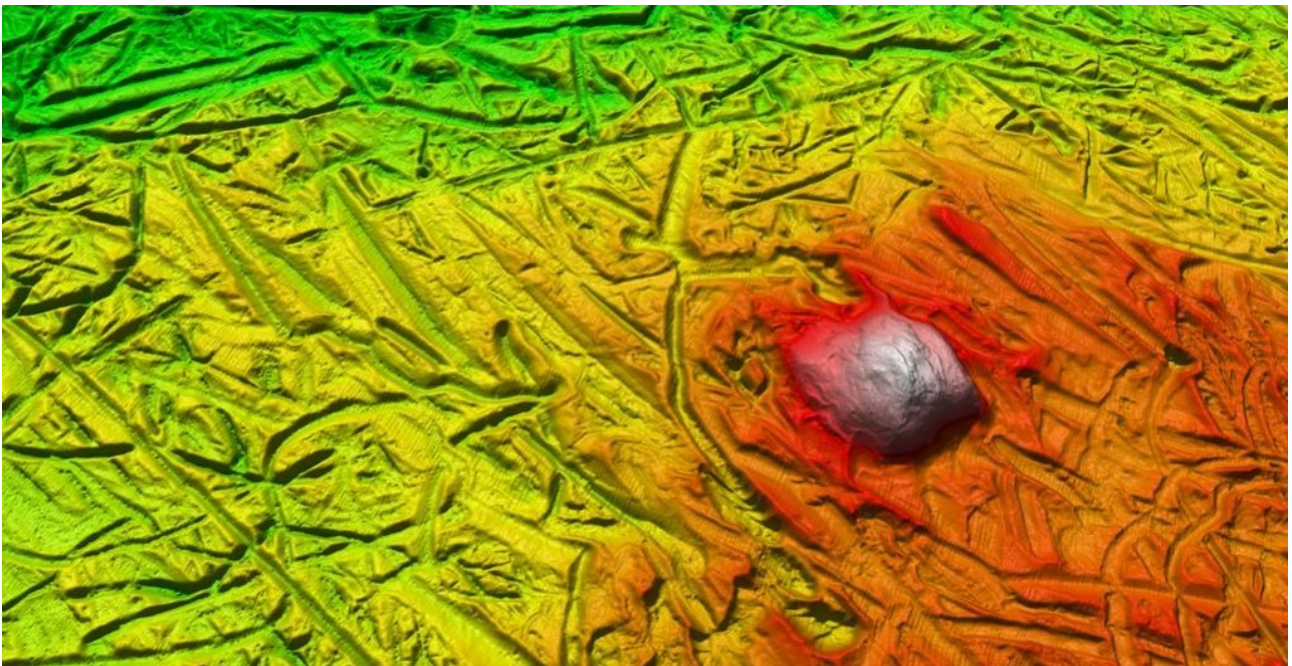


Figure 5: Terrain Model based on survey data from the Barents Sea. Depth approximately 220 m. The apparent hump has a diameter of about 800 m.

## Norwegian Polar Institute

<http://npolar.no/english>

The Norwegian Polar Institute is Norway's central governmental institution for scientific research, mapping and environmental monitoring in the Arctic and the Antarctic. The institute is a directorate under the Ministry of Climate and Environment, and advises Norwegian authorities on matters concerning polar issues.

Of the 170 employees, a staff of 8 work in the Mapping section. The main tasks are the production of Svalbard map data with corresponding printed topographical maps and map services online. In addition, the section assists other departments with the production of thematic maps, such as printed geological map series and custom maps for papers etc.

Main recent activities (2011–2015):

- Continued production of Svalbard topographic map data.
- Renewal of 14 of 62 sheets in the Svalbard 1:100 000 map series.
- New printed leisure map Longyearbyen and environs, at scale 1:50 000.
- New printed map Antarctica, at scale 1:10 000 000.
- New plotted 3D map of Longyearbyen and environs.
- Renewal of the tourist map of Svalbard, at scale 1:1 000 000.
- Substantial development of the TopoSvalbard map service with more functionality and content.
- Released map data to the public, under the CC-BY 4.0 license.

Examples from the production:

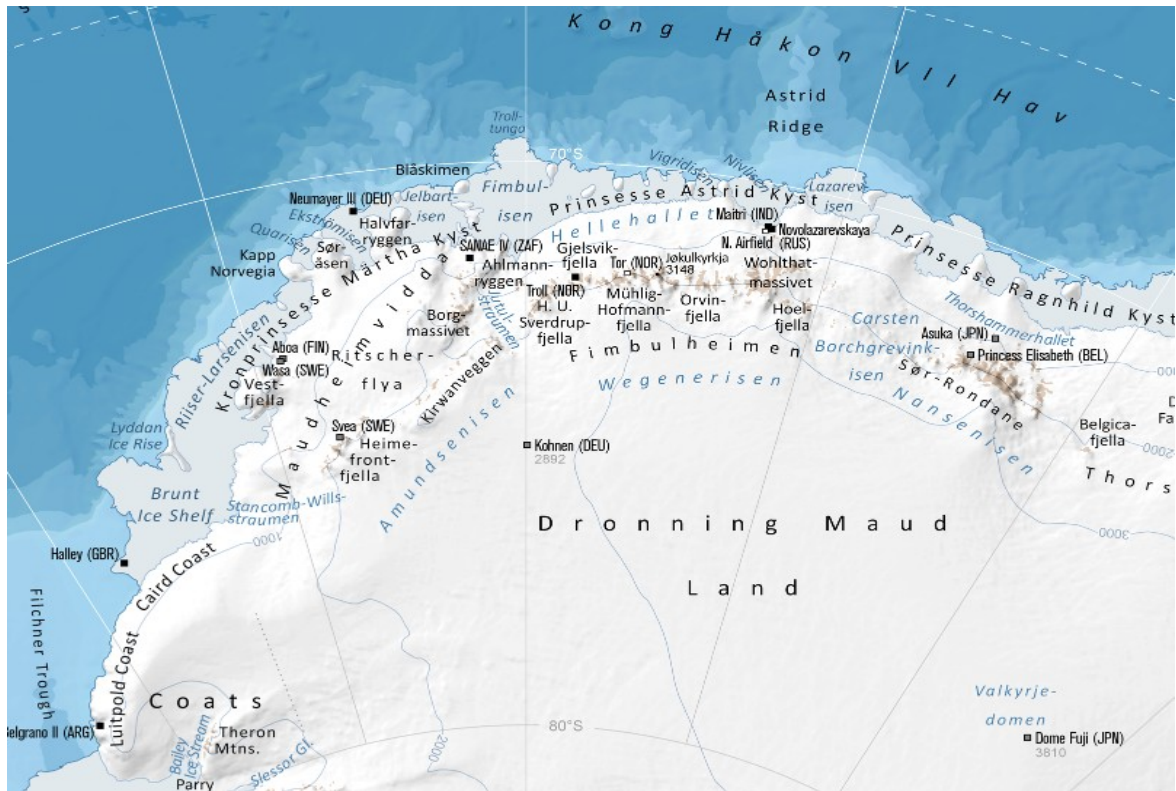


Figure 6: Map of Dronning Maud Land, Antarctica.

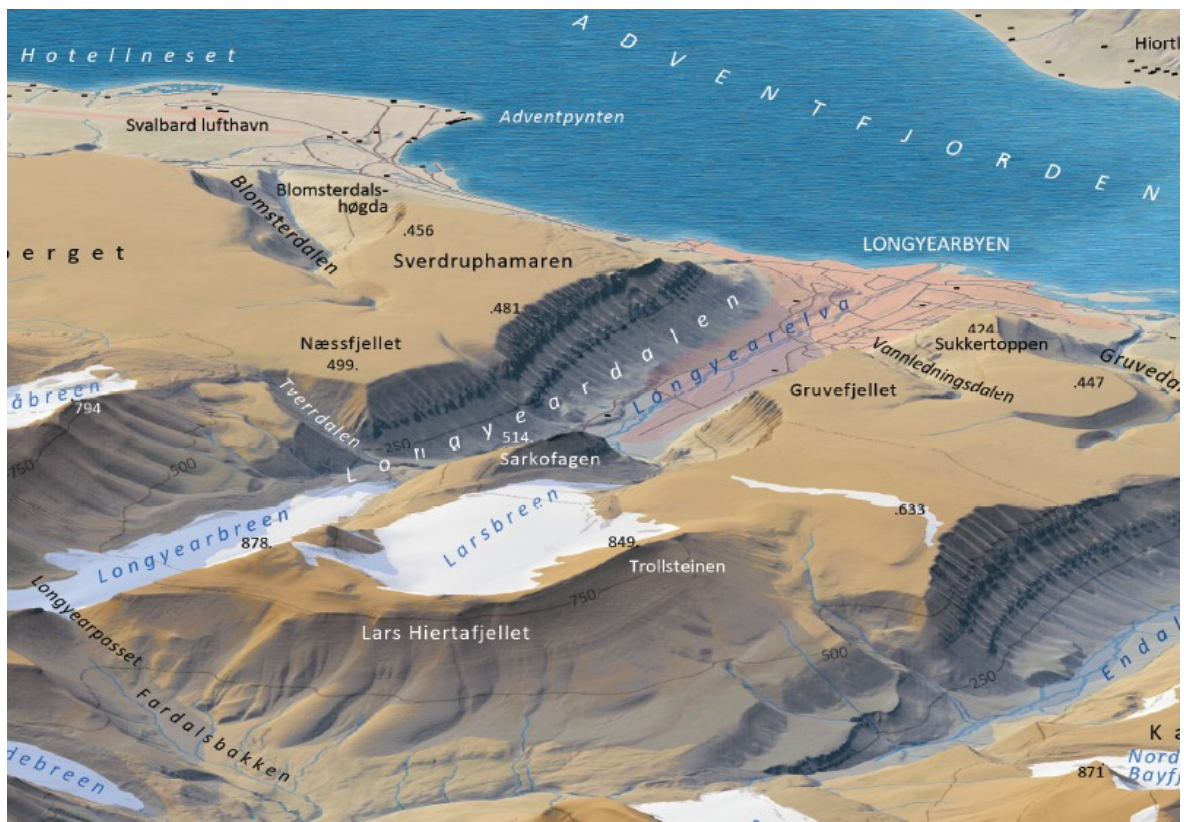


Figure 7: 3D map of Longyearbyen.

## 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 428 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 “mapping” software used by the institute is open source; the data are stored in PostgreSQL object relational database using PostGIS, GeoTools and GDAL for different GIS tasks. However, ESRI’s ArcMap is used for the production of paper maps. Our internet application for viewing and downloading maps is entirely based on open source software like GeoServer, MapServer, OpenLayers, Leaflet and GeoExt. The layout and colours on the analogue maps may differ from the digital version of the datasets for optimizing the readability depending on paper or screen.



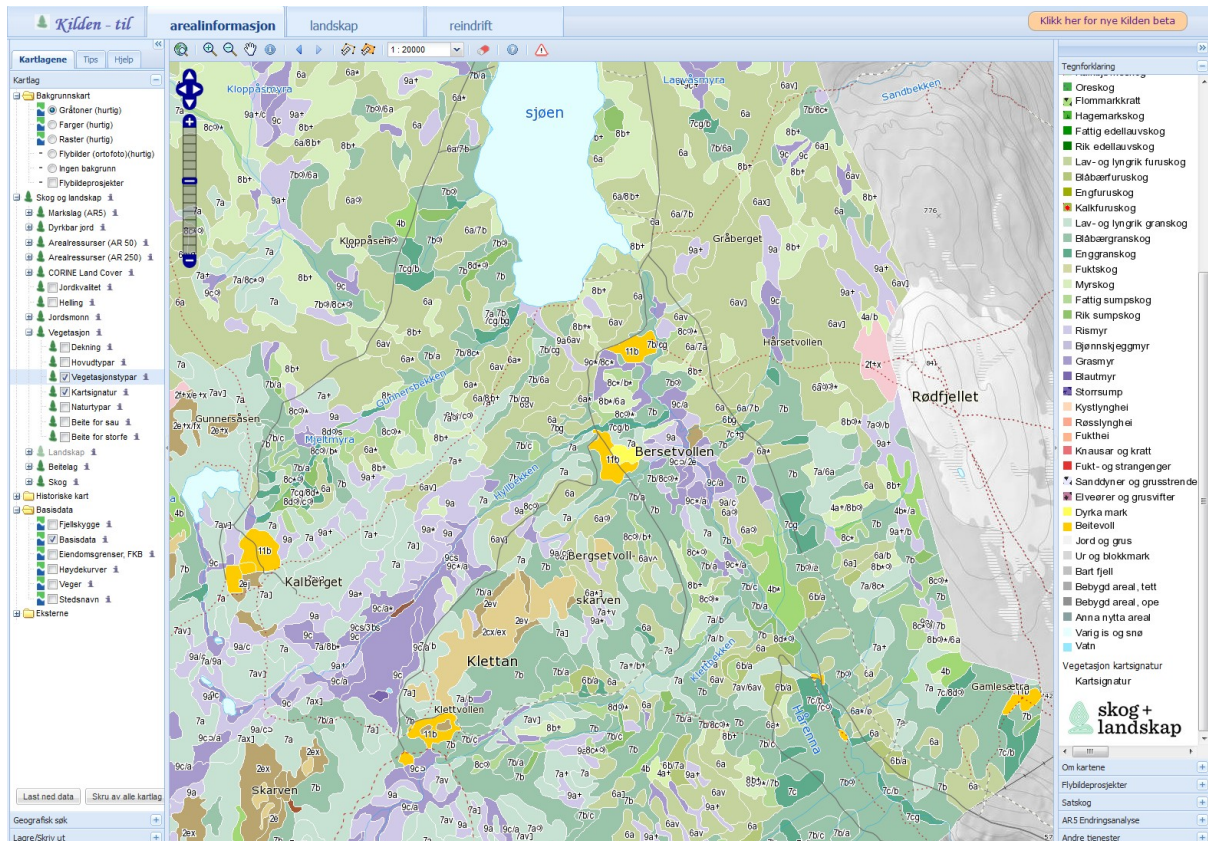


Figure 9: Screen dump from the viewing application zoomed in to the same vegetation map (Source: <http://kilden.skogoglandskap.no>).

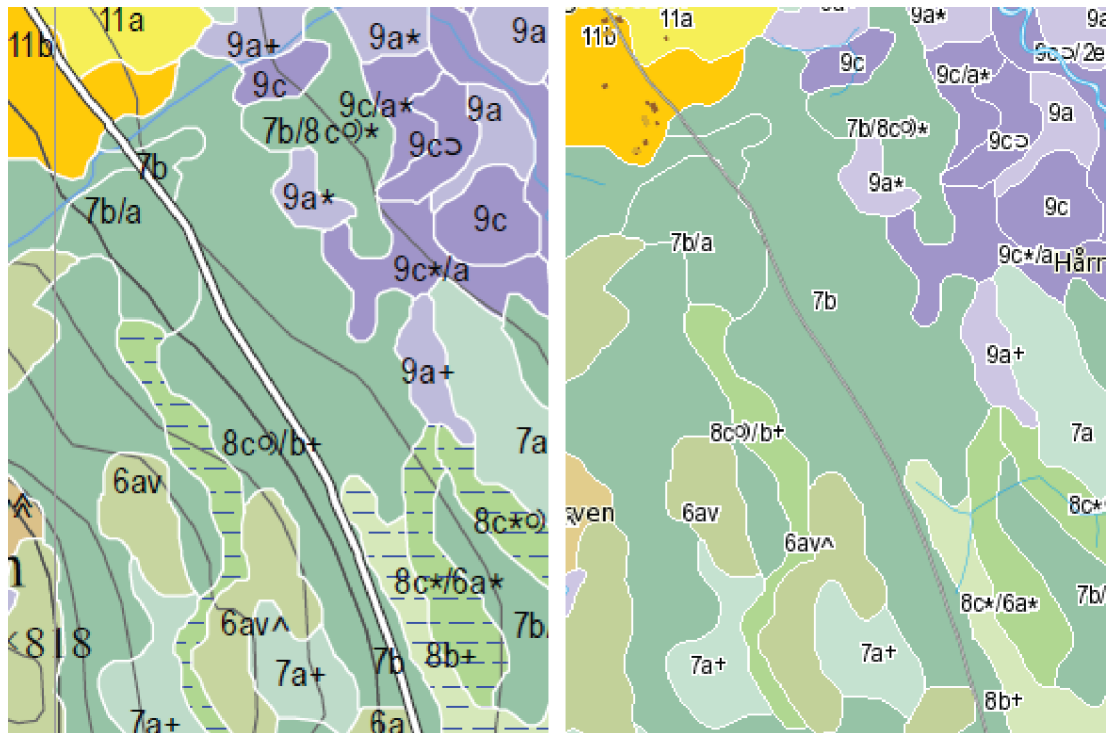


Figure 10: The layout and colours differ depending on media. To the left: The paper version. To the right: the digital version from the viewing application on the internet.

## 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. 160 employees at the directorate, 3 are employed with full time cartographic work. Our main effort is to ensure that geographic data for cultural heritage monuments are readily available for regional and local management authorities, where the most important map production takes place.

Our four biggest projects involving cartographic data are the Norwegian National Cultural Heritage Database, Cultural Heritage Search, MedievalGIS and the Cultural Heritage Portal.

### 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 165,000 sites containing 343,000 immovable 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 and RESTful API interfaces 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.

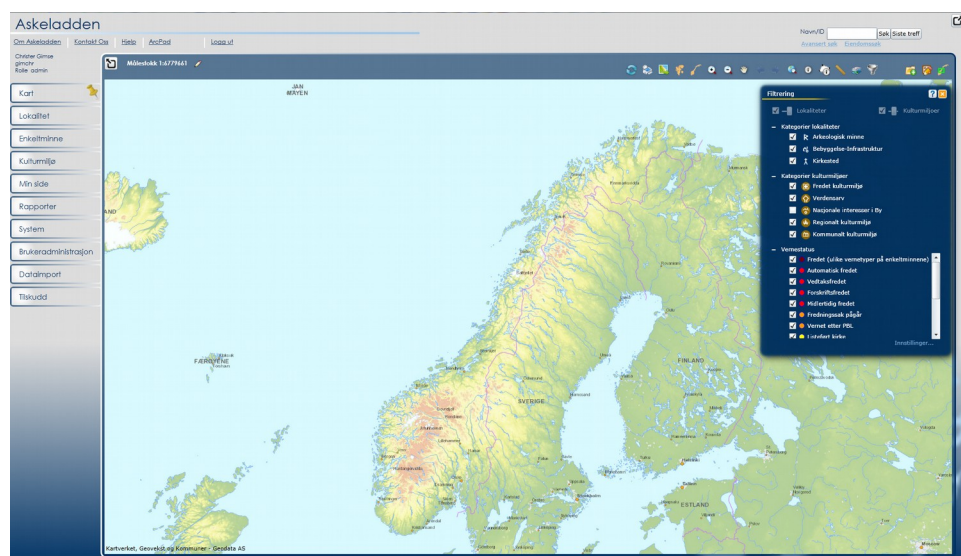


Figure 11: The Norwegian National Cultural Heritage Database.



## 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 are 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.

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- 27 april 2015 Nettsidene ustabile 28/4 kl.08-09  
På grunn av oppgraderingsarbeid vil Kulturminnesøk-sidene være ustabile og delvis nede mellom kl. 08 og 09 tirsdag 28. april.
- 24 april 2015 Hvordan formidle historiene fra krigen?
- 23 februar 2015 Driftsproblemer løst
- 21 januar 2015 Oppdatert: Kulturminneregistrering ute av drift fra 26. januar til 2. februar

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Stillebukta (27 april)  
Under planering av egen tomt 42/113 fant vi to...

MAJORBØ ( BØ MED VEIERUD, NERBØ) (27 april)  
Denne garden er søndre delen av det gamle Framb...

LINDERUD (22 april)  
Omvisninger og åpen hage hver søndag f.o.m. 31...

TRANBY KONG FREDRIK V'S OBELISK (19 april)  
Det er beklagelig at kulturminnesmerket ikke bl...

RIKSANTIKVAREN

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Tlf: 22 94 04 00, Faks: 22 94 04 04 E-post: postmottak@ra.no

Figure 12: Cultural Heritage Search.

## 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 13: MedievalGIS.

## The Cultural Heritage Portal

The Cultural Heritage Portal project uses semantic technology to compile data from several sources, such as the Norwegian National Cultural Heritage Database, archives and case handling systems. It compiles the data as RDF in a triple store accessible through a SPARQL endpoint. The project's purpose is to make case proceedings and dissemination simpler by facilitating cross-systems access to data.

## Norwegian Water Resources and Energy Directorate (NVE)

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

NVE is a directorate under the Ministry of Petroleum and Energy with responsibility for the management of the nation's water and energy resources. It is the duty of NVE to ensure an integrated and environmentally sound management of the nation's water resources, to promote an efficient energy market and cost efficient energy systems, and to promote efficient use of energy. NVE plays a central role in flood and accident control planning and operates the national flood, landslide and avalanche forecast. NVE is based in Oslo and has 5 regional offices and has approximately 600 employees.

About 10 people are involved in cartography related work. The main products are made for NVE's map applications on Web, like NVE Atlas (<http://atlas.nve.no>) and xGeo ([www.xgeo.no](http://www.xgeo.no)). In addition, a range of thematic maps are produced to be used in reports, books and presentations.

Such products may be avalanche susceptibility maps, areas prone to flooding or catchments with river network and hydropower plants.

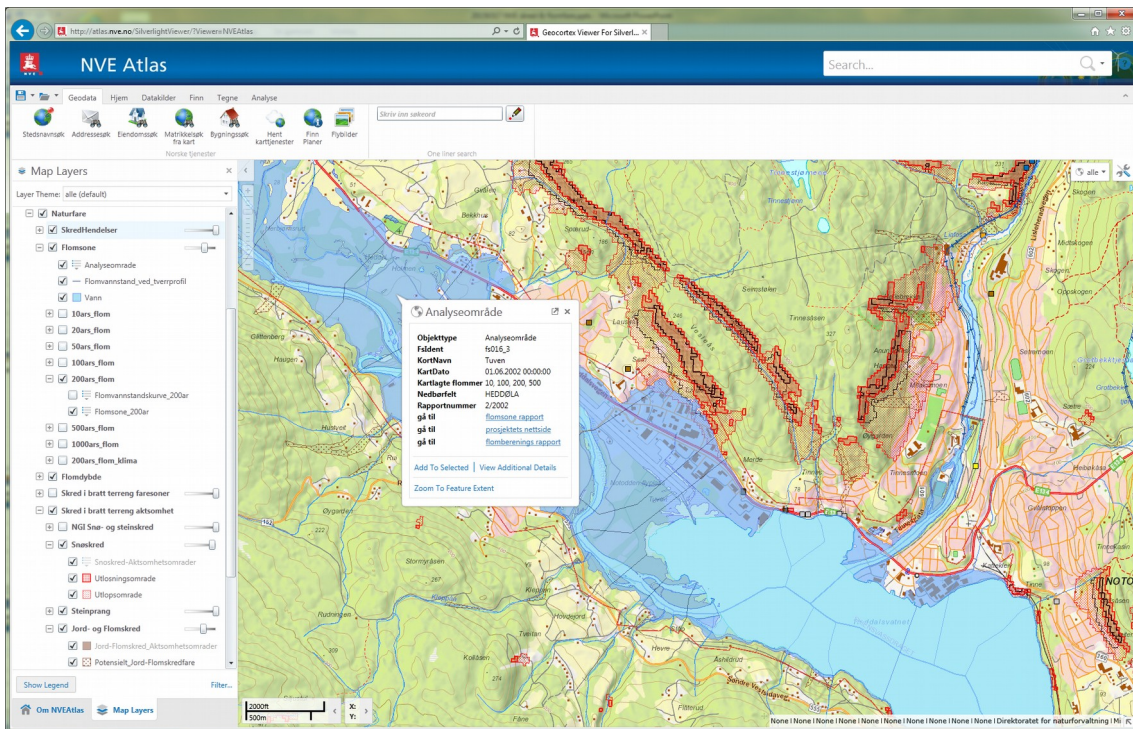


Figure 14: Flood prone areas and avalanche and rock fall susceptibility areas for Notodden, presented in NVE Atlas, <http://atlas.nve.no>.

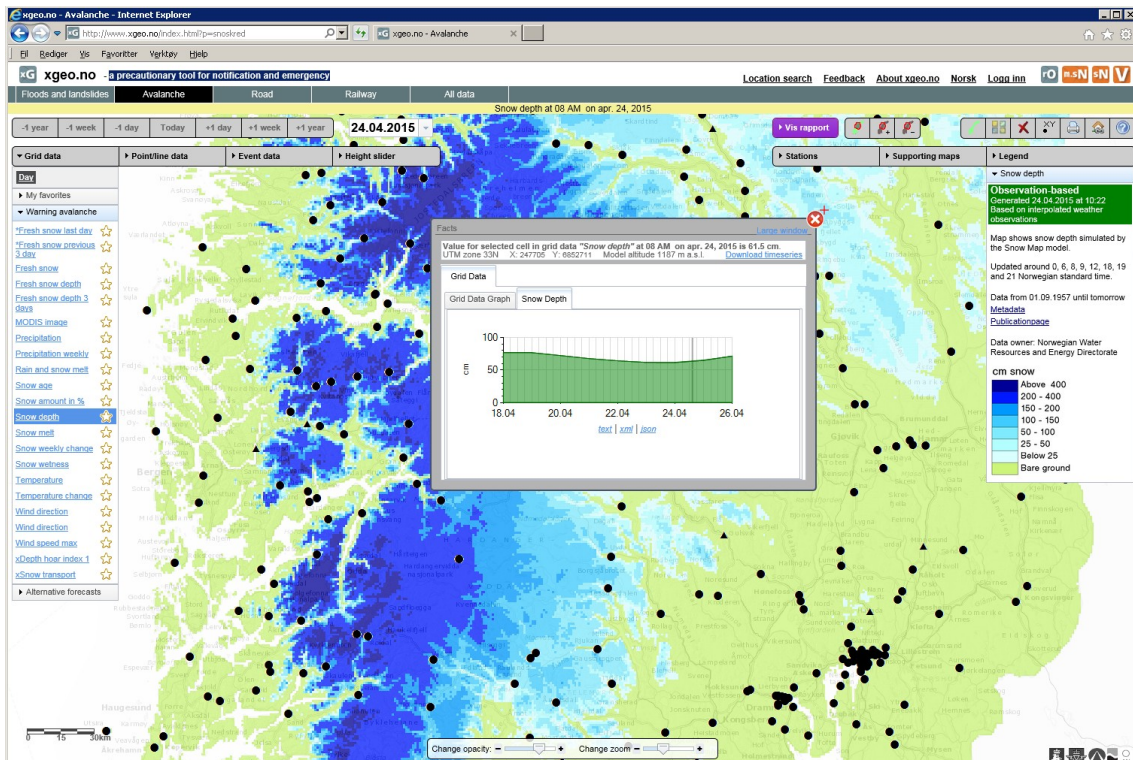


Figure 15: Snow depth for Southern Norway 24 April 2015 presented in xGeo [www.xgeo.no](http://www.xgeo.no), a precautionary tool for notification and emergency.

## 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 centers 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's department for Information Management is responsible for most of Avinor's cartographic production. In this department, around 8 employees work with map and chart production, whereas another 6 work with geographic information systems and geographical data management. In addition, Oslo Airport has its own department which produces maps of the airport.

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\\_en.html](https://www.ippc.no/norway_aip/current/main_en.html)
- Building restriction area maps for each airport. These maps are available at [www.avinor.no](http://www.avinor.no).
- Charts showing signs and markings
- Airport maps: security, airside safety, emergency planning, noise pollution, utilities, etc. Some of these are published as interactive maps on [www.avinor.no](http://www.avinor.no).
- Airport maps for the general public used in information kiosks and apps.
- Ad-hoc chart production (see example of chart for Troll airfield in the Antarctic)

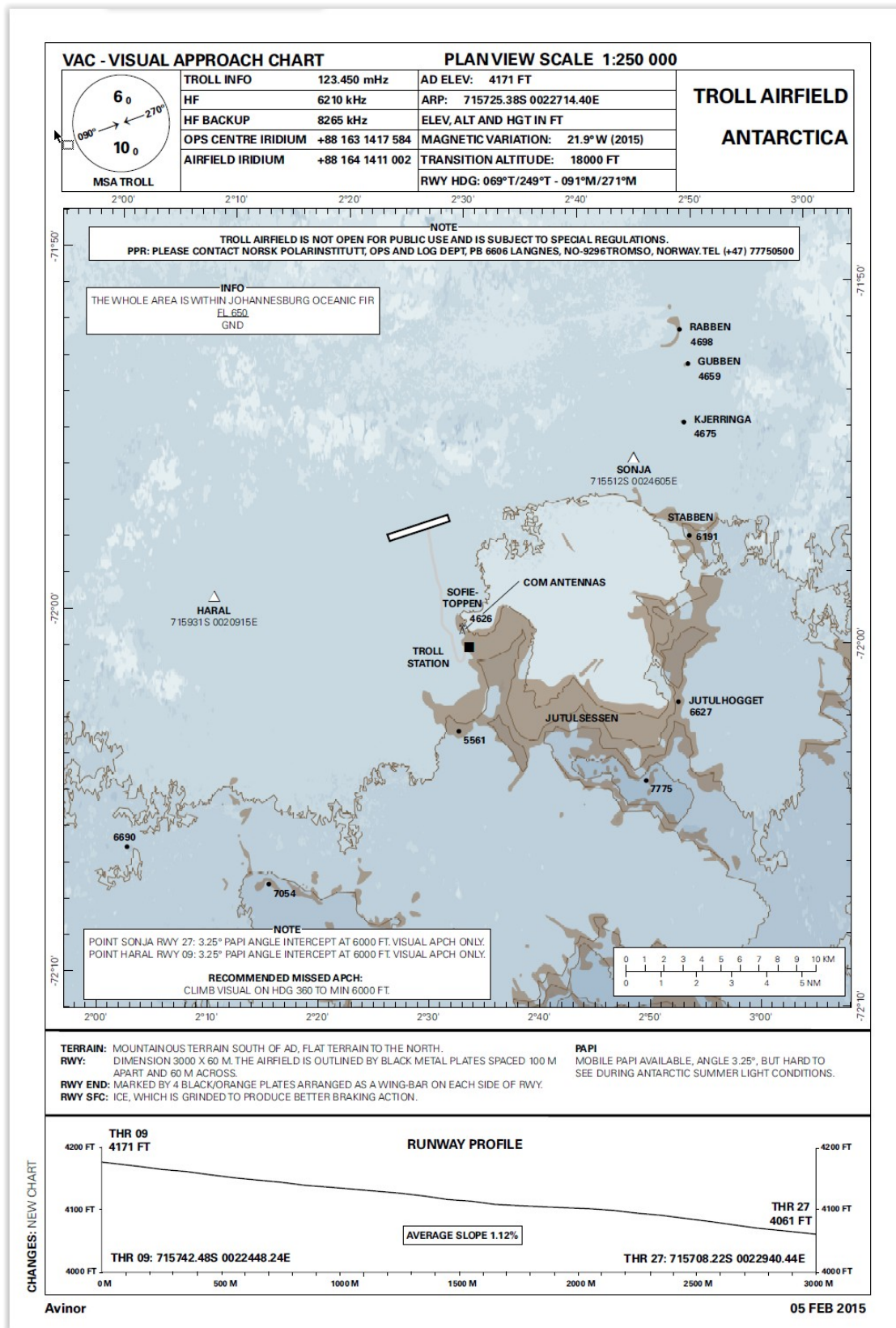


Figure 16: Troll airfield, Antarctica.

## Norwegian National Rail Administration

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

The National Rail Administration (Jernbaneverket) use and produce maps in planning, operation and maintenance of the 4219 km rail network. Maps are produced by GIS with access to central resources as Norway Digital and enterprise databases as well as locally stored data. 3 examples are selected to show some variety of cartographic methods and formats in use.

### Web map solution for rail infrastructure objects and event

The example shows animal fatalities along the Meråkerbanen line in central Norway. The solution is available for Norwegian National Railway Administration employees to see infrastructure objects and events on orthophoto or geographic map background from a web server. Data is extracted weekly from the Banedata enterprise infrastructure database and can be seen on PC 's, tablets or mobile phones. The objects are placed by coordinates or linear referencing route events using the railway km. Symbols are based on geometric primitives and standard colours used in the national Hjortevilt (Cervidae) register owned by The Norwegian Environment Agency enhanced with black silhouettes for selected species.



Figure 17: Visualization of animal fatalities along the Meråkerbanen line.

### InterCity project

The map shows where the InterCity project is planning to build new railway with double tracks enabling train speed up to 250 km/hour. The map is a combination of geoschematic representation of existing and planned railway lines placed on top of a geographical background map with water and population density. The stations are located by km value on the geoschematic network represented as straight lines and angles in multiples of 45 degrees. The population density is shown below the municipality level, ("grunnkrets"). The map illustrates how the rail network will make the capital Oslo and the cities in Vestfold, Østfold and on the eastern side of Lake Mjøsa into a connected living and working area of 2 million people.

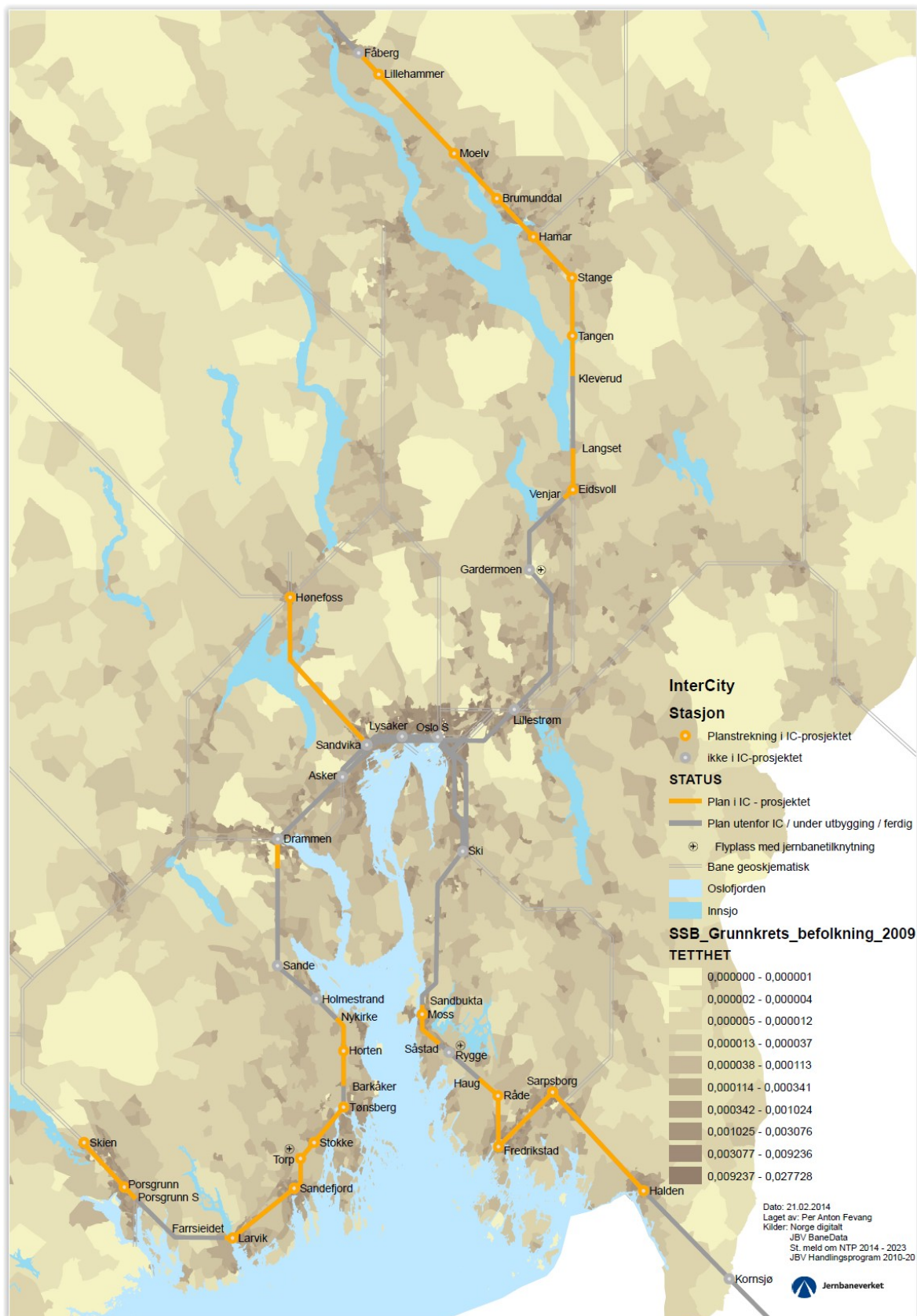


Figure 18: Inter City project.

## The Norwegian Petroleum Directorate (NPD)

<http://www.npd.no>

The Norwegian Petroleum Directorate (NPD) is responsible for resource management of the oil and gas activities on the Norwegian Continental Shelf (NCS) and the objective is to contribute to creating the greatest possible values for the Norwegian society from the oil and gas activities by means of prudent resource management based on safety, emergency preparedness and safeguarding of the external environment. NPD is based in Stavanger with a regional office in Harstad, has around 220 employees and reports to the Ministry of Petroleum and Energy.

The NPD has a national responsibility for data from the Norwegian continental shelf. The NPD's data, overview and analyses constitute a crucial factual basis on which the activities are founded. Maps and geography play important parts of this work, and in 2014 we launched a new version of the NPD's interactive [FactMaps](#).

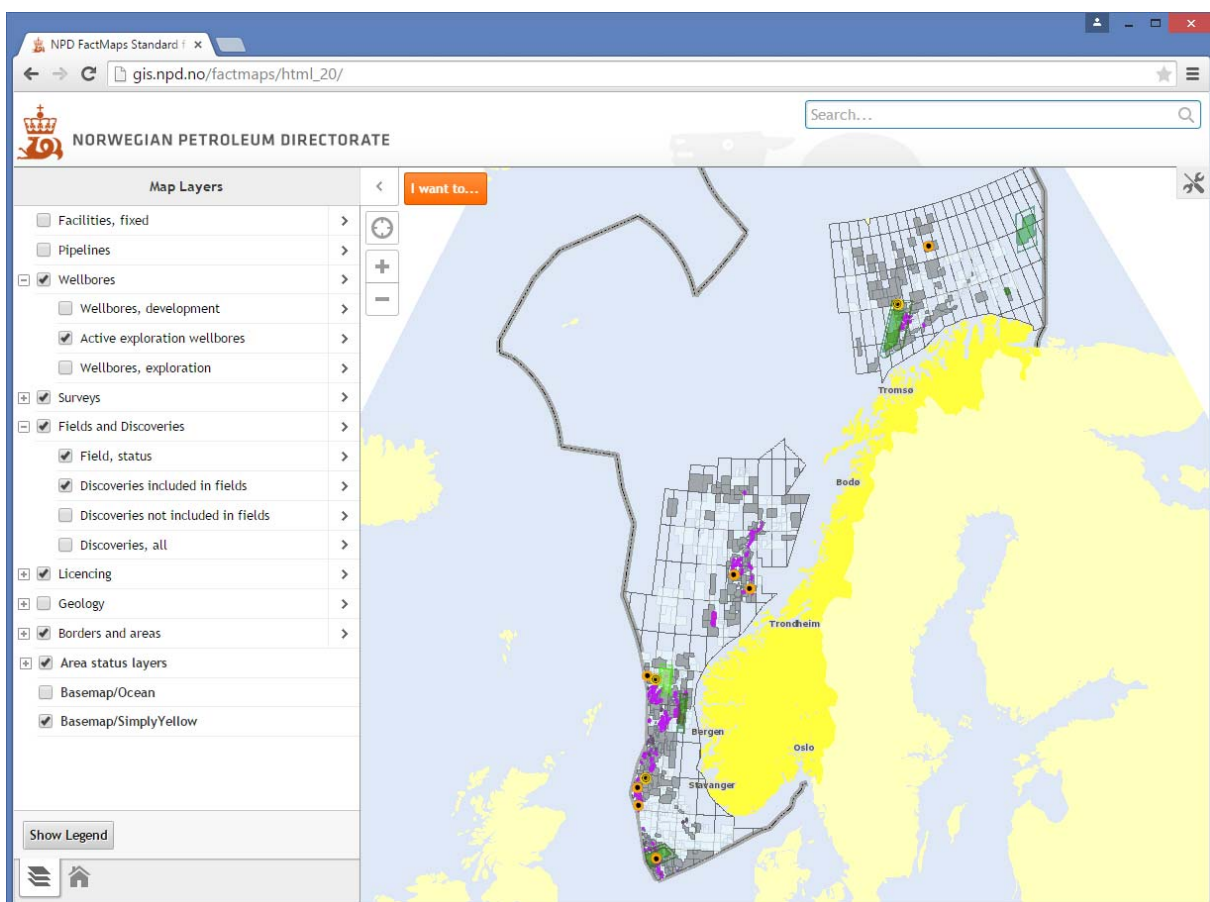


Figure 19: NPD interactive FactMaps.

Along with the NPD's [FactPages](#), the FactMaps provides access to most of what is relevant to know about petroleum activities on the NCS. Information on discoveries, fields, operators, licensees, wells, production licences, pipelines and seismic surveys is updated on a daily basis. The content of the FactMaps is also available as map services and downloadable data for those who wants to take a deeper dive into geographical analysis on the shelf and integrate NPD's data in their own map tools.

GIS and digital map data provide endless opportunities for comparing and communicating such information. But paper maps still have their place. The FactMap poster "[The Map](#)", is still available



and very popular.



Figure 20: Den norske kontinentalsokkel - "The Map".

Both the interactive FactMaps and the poster version have existed for many years, and in 2014 we also launched a Story Map presenting the [CO<sub>2</sub> Storage Atlas](#), a report on the storage and use of CO<sub>2</sub> on the NCS made by the NPD. The Story Map presents geographic information with a close and userfriendly link between map display and explanatory text:

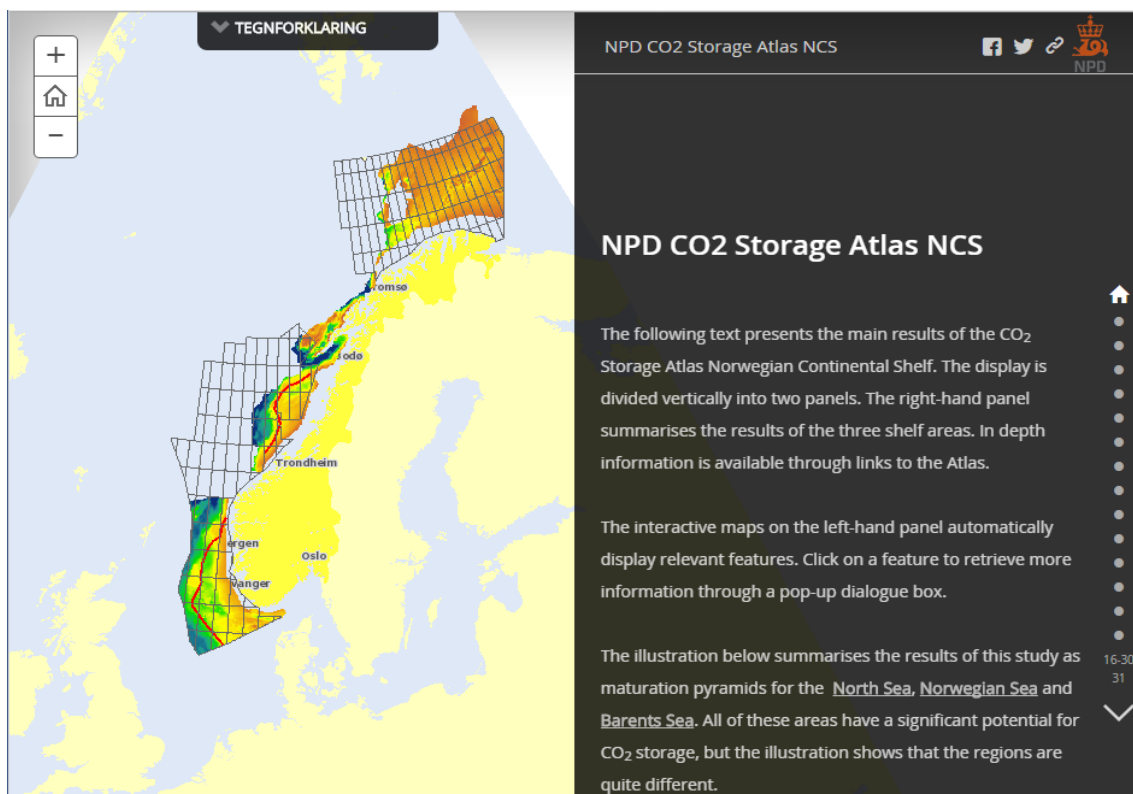


Figure 21: NPD CO<sub>2</sub> Storage Atlas.

The Story Map way of communicating geographical information has also increased the interest of maps within the NPD, because geography matters!

## Statsbygg

<http://www.statsbygg.no/>

Statsbygg is the Norwegian government's key advisor in construction and property affairs. Statsbygg provides appropriate, functional premises to public sector enterprises, as well as carrying out sociopolitical objectives in relation to architecture, planning, and preservation of heritage sites. On behalf of the Norwegian government, Statsbygg owns 2,350 buildings distributed among 600 property complexes. These buildings range from the Government quarter, the Supreme Court, Courts of Appeal, Norwegian Embassies abroad, customs houses, museums, opera houses, prisons and open use cabins. The company has 880 employees.

The GIS staff consists of three people, working in close collaboration with the BIM (Building Information Models) staff. We have many users from different departments and fields such as architects, urban planning, geo-technique, cultural heritage and property management.

The main focus of the GIS group is to provide geo-information and tools to this wide range of users. Managing buildings and properties for various governmental departments and directorates, we provide easy access to the information through our web-based GIS solutions. We incorporate data from the Norwegian Mapping Authority and from our National Spatial Data Infrastructure (Norge Digitalt) into our own web-applications. We also produce services based on our property database and our base of geotechnical surveys.

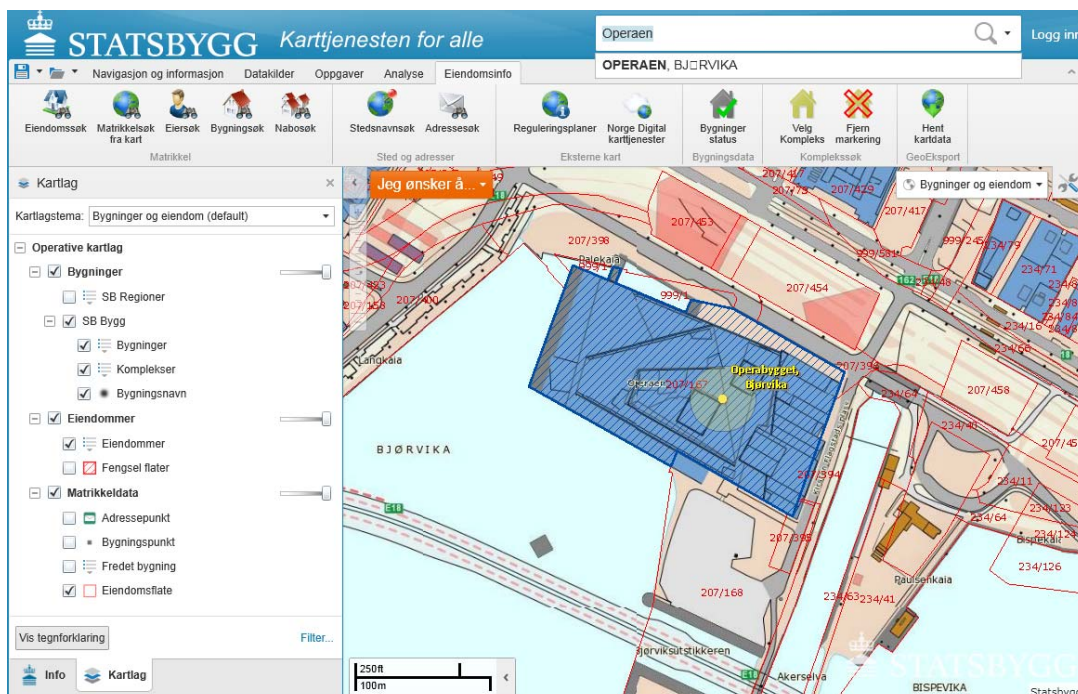


Figure 22: All-purpose Web-GIS, "Karttjenesten for alle", mainly for retrieving property related information.

### All-purpose Web-GIS: "Karttjenesten for alle"

This is our general purpose web-GIS portal, providing access for our internal users to georeferenced information on buildings, properties, thematic data, cadastral information etc. Both internal and external services are integrated into an easy to use web application. Custom tools for managing and retrieving data and information have been developed. The service comprises tools for integrating our own data with national cadastral and thematic databases, including protected buildings and sites, risk factors such as flooding, landslide risk, ground pollution, radon, etc.

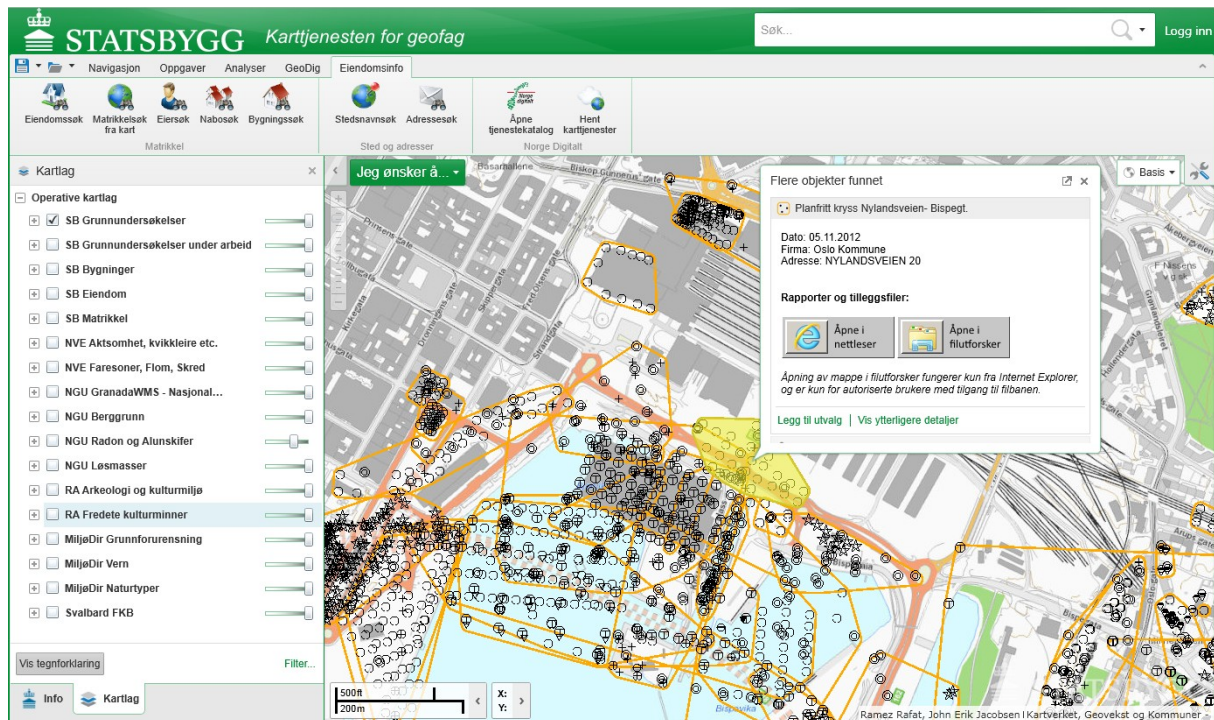


Figure 23: Web-GIS for storing and retrieving geotechnical surveys. Reuse of data is saving both time and money.

## Web-GIS Geotechnical

This is a focused version of the GIS portal, providing easy access to the Statsbygg database of geotechnical surveys. Special tools have been developed to make it easy to find surveys and read related reports and documents, as well as update and manage the database from the web. This system has received a great deal of attention and acclaim at the national level, for being time and cost saving and reducing the risk of conducting overlapping surveys.



Figure 24: The College of Østfold campus in Halden in 3D; a GIS and BIM mixed model.

A great deal of our resources are spent on supporting ongoing planning- and development projects with detailed maps and detailed spatial data, and to provide 3D models of sites for visualization and analysis. Some notable projects are; the new Life Science Campus, Oslo; the rebuilding of the new government precinct in Oslo, the expansion of the Viking ship museum at Bygdøy, and the College of Østfold campus in Halden, amongst others.

## Statskog

<http://www.statskog.no>

Statskog SF is Norwegians largest landowner managing about 1/5 of Norway's mainland, or about 59000 km<sup>2</sup>. Statskog SF is state owned by the ministry of agriculture and has about 20 offices with its head office in Namsos, Nord-Trøndelag. The company's main business areas are resource management, forestry, property management and development, and providing hunting and fishing areas to the public.

Statskog SF started in 2009 a large project program called «Geodataprogrammet» which had the goal to establish and implement a GIS strategy, infrastructure, and solutions for all Statskog's business areas so that the company could meet its goal as Norway's most professional landowner.

The program has delivered 21 project through its period, spanning from establishing server and Esri infrastructure, to develop apps and solutions for offline use of maps and theme data. GIS is now a natural part of the business processes and critical for the daily operations. Statskog SF received in 2011 the GIS lighthouse award from Esri's user Group in Norway, and the Special achievement in GIS on Esri user conference in 2012.

Statskog has developed a solution for analysing the demographic base for our properties and how many that has the potential of using our properties within distinct times of travel by car. These maps makes it possible to understand how the properties could be used, and how they should be managed. In Figure 25:

- The red lines shows one of Statskogs properties in Hedmark county
- The green, yellow and red areas show the areas covered by driving time from the property in 30, 60, and 90 minutes
- These maps gives Statskog insight in the potential use of the properties, and how many people that is likely to use them.

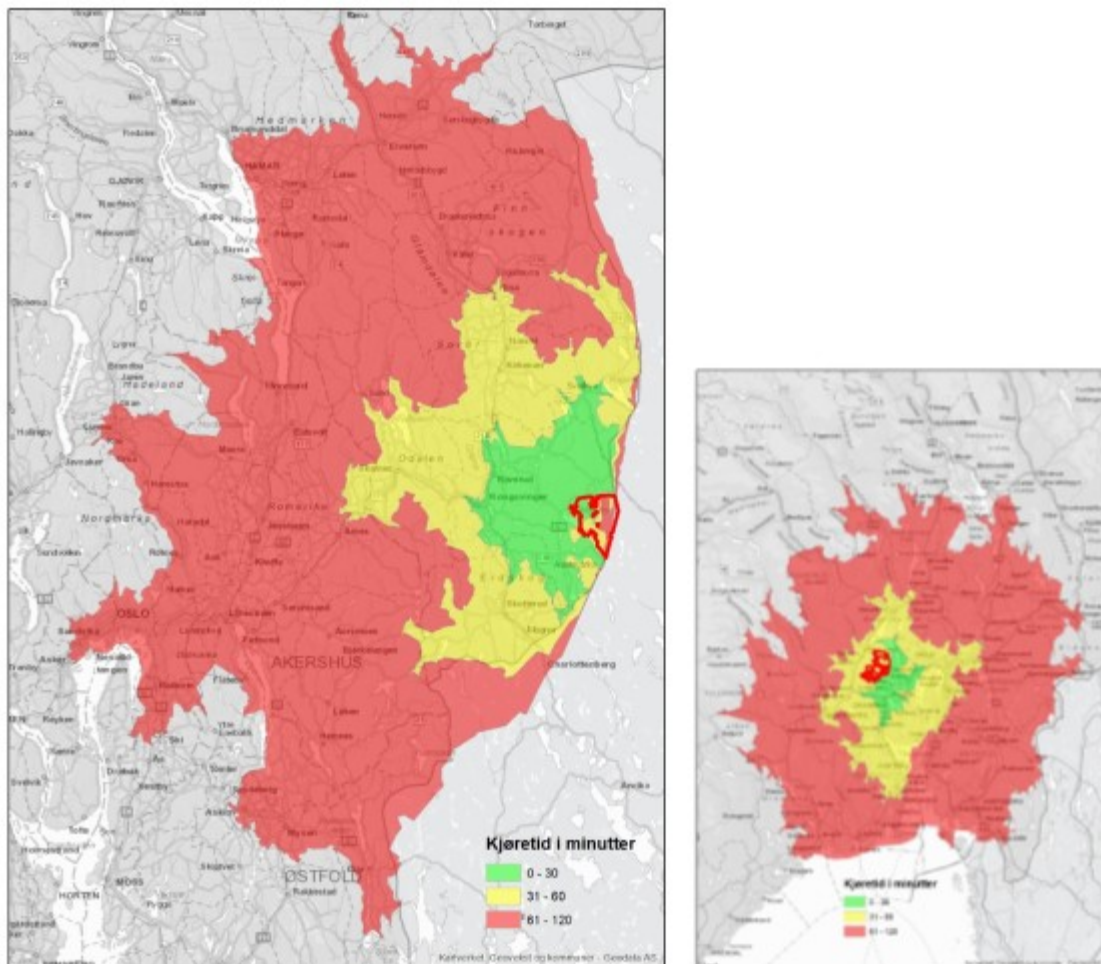


Figure 25: Demographic maps for hunting, fishing, and recreational activities.

Statskog has developed an IOS app for big game hunters on Statskog owned land (Figure 26). The app lets the user see his designated hunting area, his quota of animals, the road network and other map features offline. The app lets the user mark where the game was seen and shot, hunting

posts, and other registrations in the map. They also can report which animal of the quota that were killed, and how much it weight was, generating an invoice of the animals that shows in the app when online. All this can be done offline, and it is synchronized with Statskogs central databases when online on mobile or wifi.

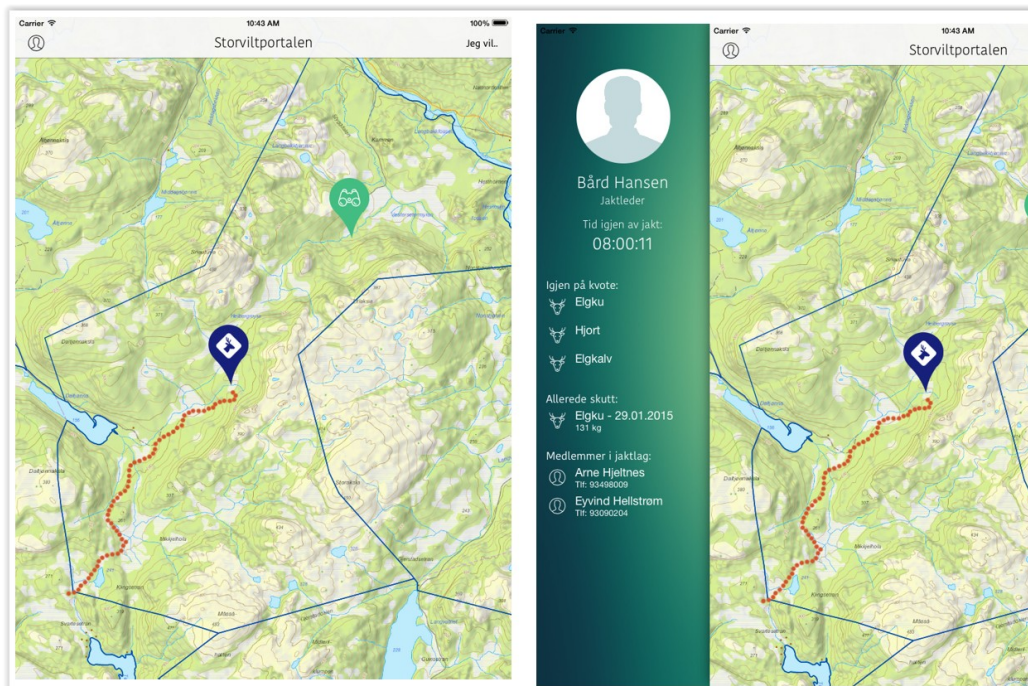


Figure 26: IOS app for big game hunting.

## Norwegian Public Road Administration (NPRA)

<http://www.vegvesen.no/en/Home>

For the NPRA, the launch of open, public API to the Norwegian Road database (NVDB) was by far our single most important cartographic achievement since 2011. This API is a fundamental core service in our renewal of the IT architecture and portfolio internally in NPRA. A public available API also lowers the threshold for other governmental institutions to integrate NVDB functionality in their systems.

***This is not just open data -- it is open government!***

The use of modern “lightheight” formats (xml, json) makes development of web portals and clients a breeze -- of which our own web application Vegkart is a prime example. However, to use the NVDB API in your local GIS software you do need to transform from the NVDB data model into a GIS data model. For most applications, this transformation is straightforward to implement, as demonstrated by our open source plugin for QGIS and ArcMap. Information about these plugins can be found at our development blog, <http://www.vegdata.no/>

We have not forgotten classical geographical services -- WMS, WFS and other OGC-compliant services, as well as metadata-services including our national geoportal <http://www.kartverket.no/geonorge/>. We are just now doing major upgrade to this part of our IT infrastructure. A new installation of our trusted open source components (geoserver and

geowebcache) is underway in 2015. This will give us much more flexibility in content management than our present installation.

We do want to bridge the gap between NVDB data model and the SOSI GML representation of the same data. We explore several options of how this can be carried out in a timely manner -- and "timely" means avoiding file based information management like the plague. Our vision is to have SOSI GML - compliant WFS - services with NVDB data. We explore several avenues of research, including but not limited to FME server, Geoserver, "Go publisher" (Snowflake software) as well as adding SOSI GML writing functionality directly on the NVDB api.

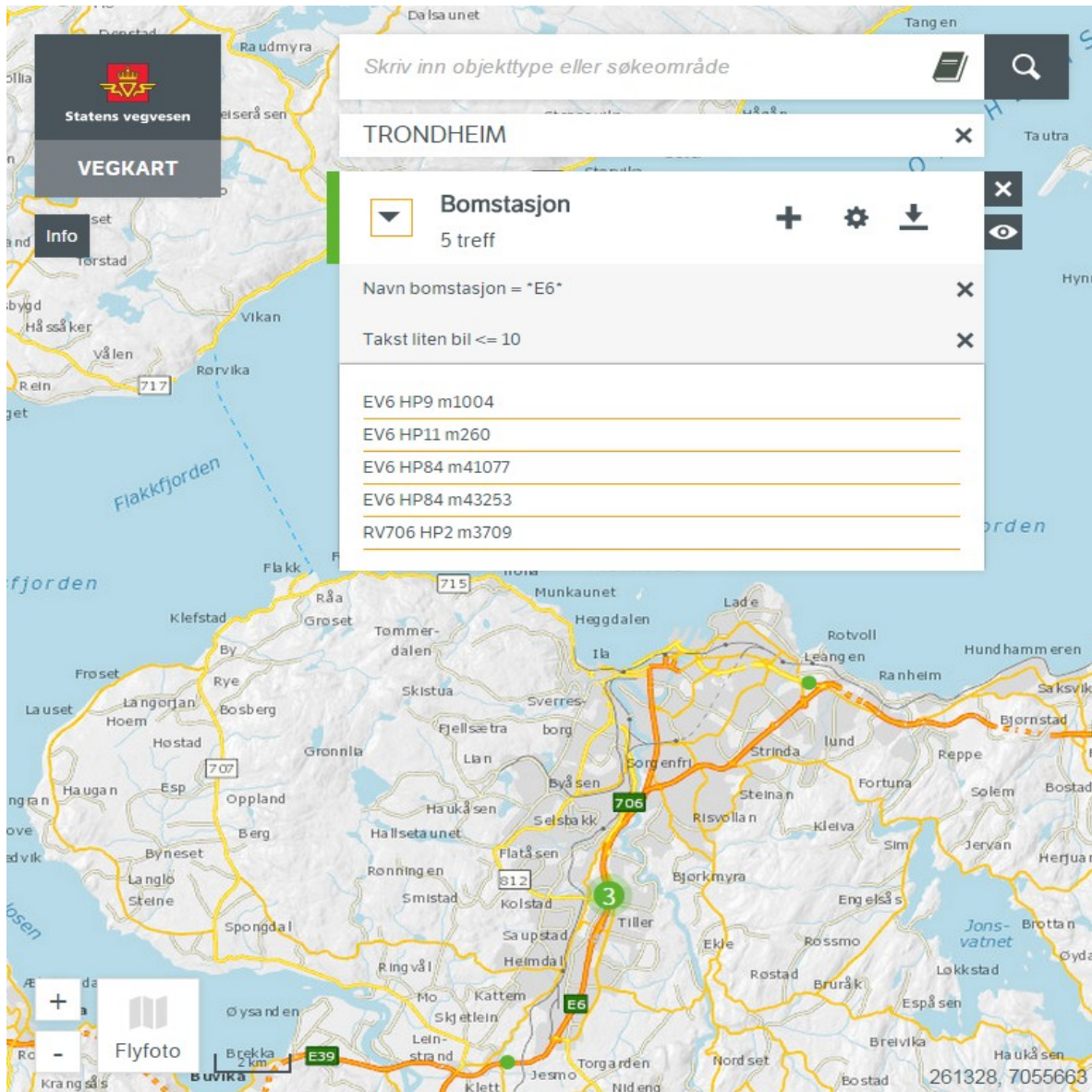


Figure 27: The web application "Vegkart" is a prime example of modern web application built upon the NVDB API, with advanced search and filter capabilities.

# Large City Municipalities

## Sarpsborg

<https://www.sarpsborg.com/>

Sarpsborg is located in Østfold county in the south – eastern corner of Norway, about 1hr by car from Oslo. It has 54.000 inhabitants and is Norway’s tenth largest city. Founded 1016 by “Saint Olaf” Olaf II Haraldsson (995 – 1030). There are ca. 4100 employees in the municipality; the mapping division consists of 15 people of which four persons are working on cartographic activities. We produce a wide range of maps for citizens of Sarpsborg, but also carry out projects in cooperation with different organizations in Østfold county. A few examples below:



Figure 28: “Hike of the month», May 2015.

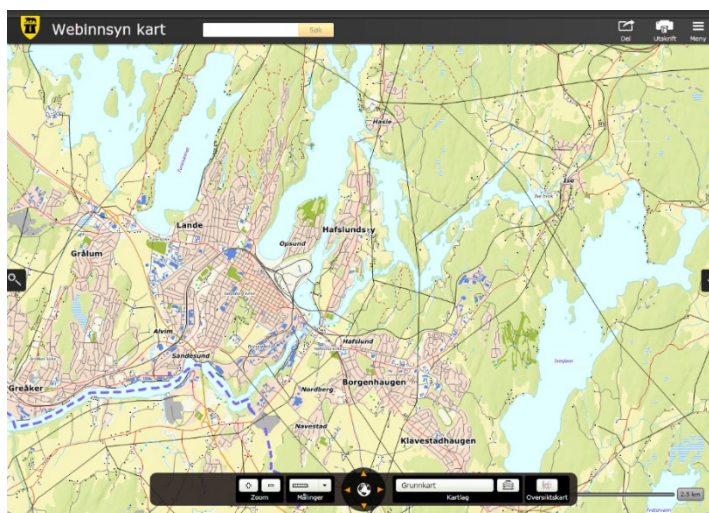


Figure 29: Web – client with different types of maps.



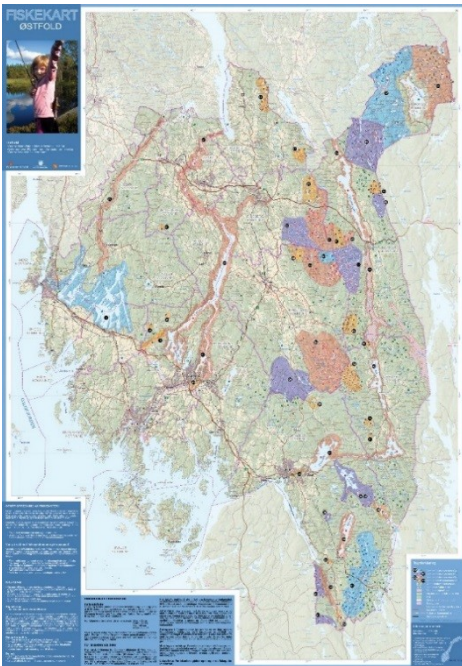


Figure 30: Fishing map, published 2011.

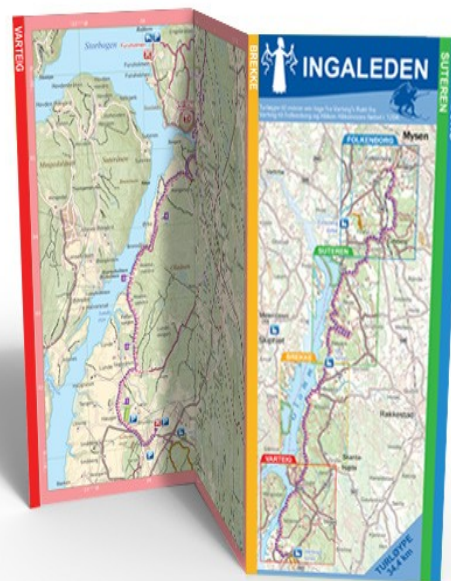


Figure 31: A four tab foldout hiking map from the 34 km long "Ingaleden" trail. Published 2015.

## 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.

### Geodata AS

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

Geodata AS is a Norwegian IT company that was established in 1988. Already from the start, we were operating as a distributor of Esri software. Since the beginning, we have been faithful to our core business - distribution of geographical information systems (GIS) and consultancy services in connection with implementing and using GIS. The last 4-5 years serving Online GIS Services to the commercial market, Geodata Online, has also been an important part of our core business. Our services are served from the cloud and we are managing continuously updated copies of a wide variety of GIS Data sets in our cloud based GIS Data Warehouse. Among the datasets in our Warehouse are the most detailed map data available in Norway, FKB, and a seamless coverage of high-resolution Orthophotos for the entire country. Our main GIS-platform is ArcGIS for Server.

Our most popular services are our pre-generated (cached) basemap services. They are covering scales from 1:82 mill up to 1:625 and has a rich content and cartography. They are used by our customers in all kinds of mapping applications, both on desktop and mobile platforms.

- Geocache Basis (Basic)
- Geocache Bilder (Imagery)
- Geocache Landskap (Terrain)
- Geocache Gråtone (Grayscale)
- Geocache Hybrid (Overlay for Imagery)

In addition to UTM the services are also supporting Web Mercator projection, and can easily be used in conjunction with Google Map

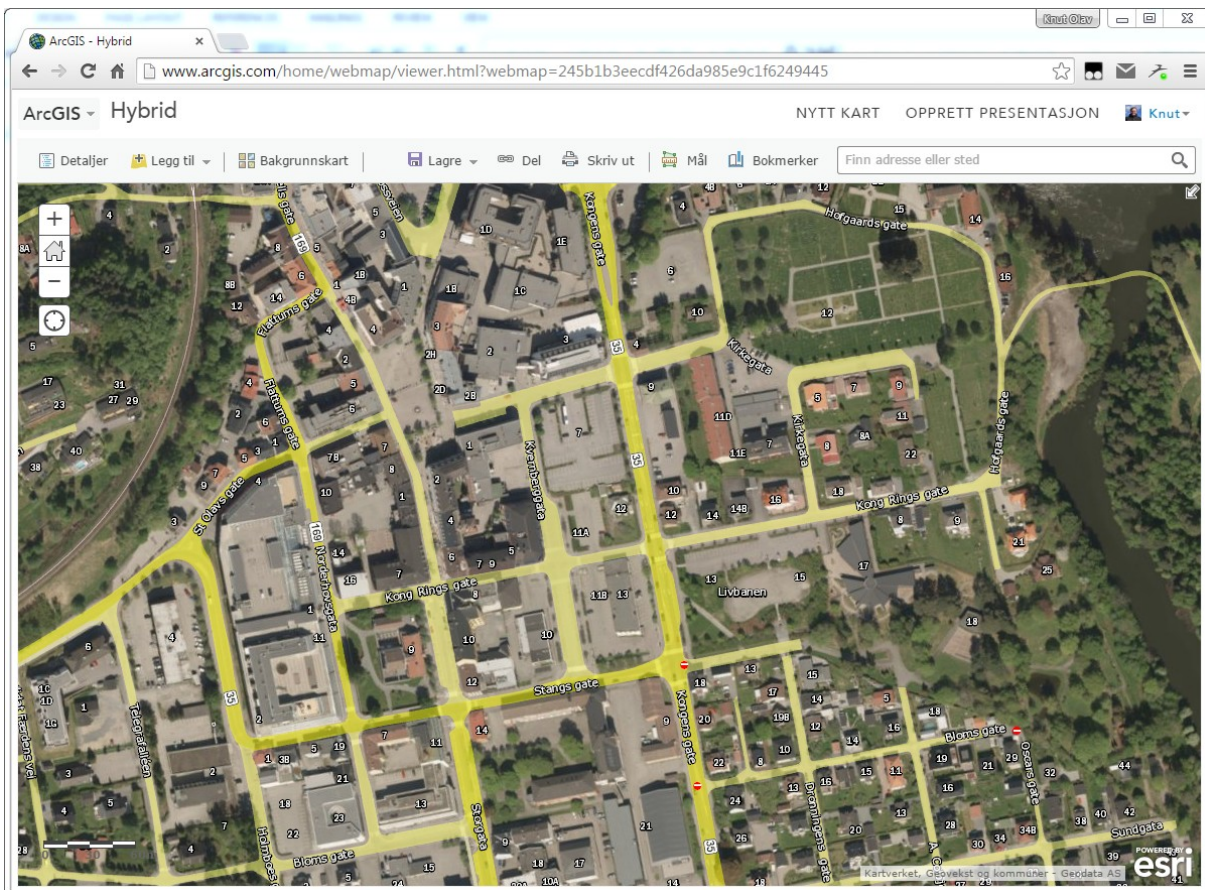


Figure 32: Geocache Bilder and Geocache Hybrid used together in ArcGIS.com.

In addition to the basemaps we are serving several kinds of thematic map services that could be used as thematic layers together with the basemaps. Among these are natural risks like flood and avalanche, demography, transportation, administrative units, education and business.

In addition to online map services, we are also serving “map-on-demand” services for high quality map printing. As an example, we are for the Norwegian Red Cross serving a print service for topographic maps with rich content intended for planning and performing rescue operations. Together with our partner Ambita we are offering large scale base maps in PDF-format for the entire country used for Real Estate sales.



Figure 33: Geocache Landskap used in an IOS app.

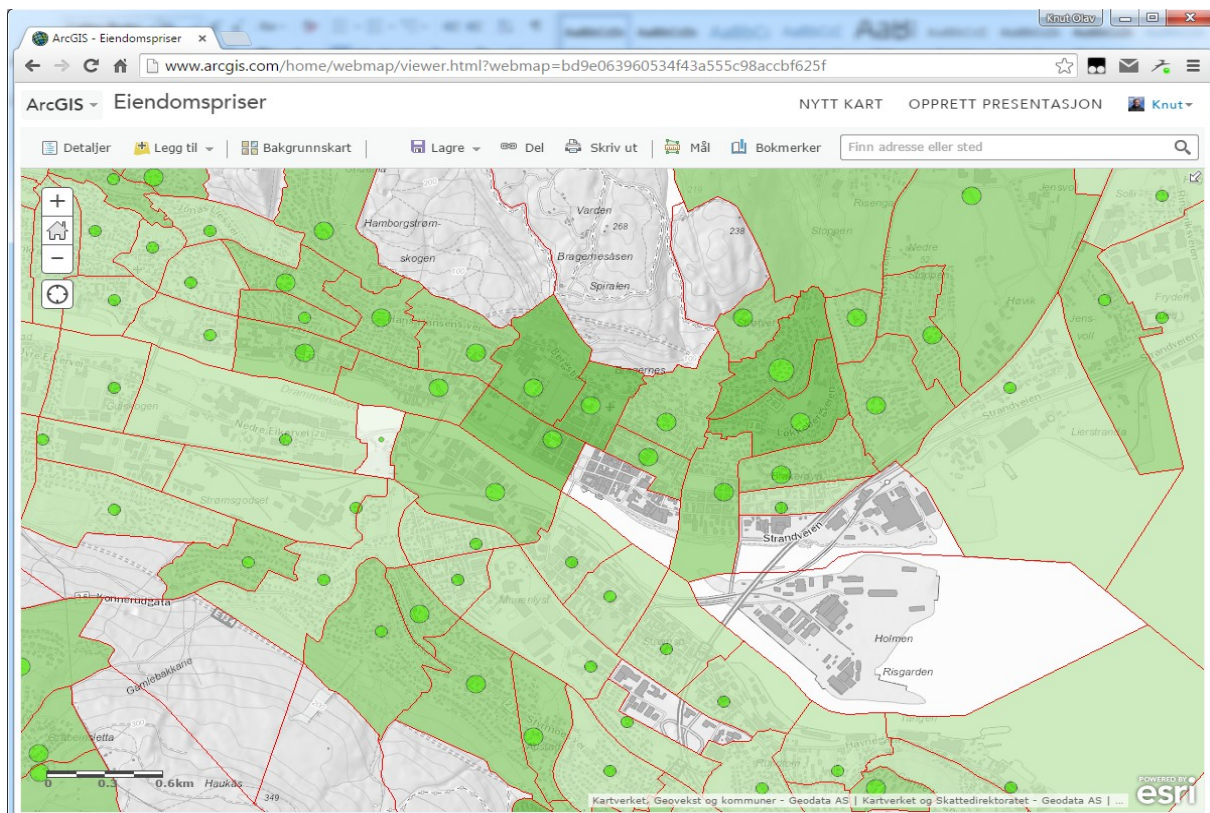


Figure 34: Geomap Demografi and Geomap Admin showing Real Estate pricing in Drammen.

## Geomatikk IKT AS

<http://www.geomatikk.no> , <http://www.geomatikk-survey.no> and <http://www.geomatikk-ikt.no/> (Only in Norwegian)

Geomatikk Group is formed by three Norwegian companies: Geomatikk, Geomatikk Survey and Geomatikk IKT. Together, we employ about 250 highly qualified employees. In addition, we have a sister company in Sweden, Geomatikk AB ([www.geomatikk.se](http://www.geomatikk.se) ).

**Geomatikk AS** is the biggest company in the Group, administering most of the digital infrastructure data of electricity, telecommunications, gas and water pipes for the largest technical infrastructure owners in Norway. The customers send daily updates and changes to their technical infrastructure data which



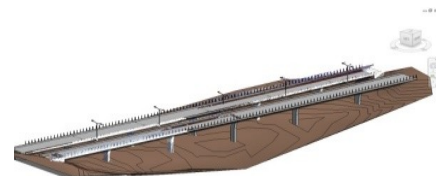
are incorporated into the data administering system developed by our sister organisation Geomatikk IKT. The data owners and engineering companies will then turn to the call centre of Geomatikk in front of any project where digging in the ground is necessary. Geomatikk then provides information on effected and potentially conflicting technical installations or networks owned by any of our customers. Whenever necessary, our field personnel accurately locate, identify and mark the underground infrastructure as part of the service.

**Geomatikk Survey AS**, established in 2013, is the youngest company in the Group. Geomatikk Survey is a continuation of the surveying activities in Geomatikk AS and employs 50 highly skilled surveyors working out from 6 offices around Norway. The company has a targeted focus on new technologies and efficient work-methods such as drones, terrestrial laser scanning, 3D-modelling and BIM. In addition to all traditional land surveying activities, we operate



several UAV/RPAS (Unmanned Aerial Vehicle / Remotely Piloted Aircraft Systems) with both cameras and lidars. We also work with 3D modelling using terrestrial laser equipment with subsequent modelling in different software

(including REVIT, AutoCad, Civil3d etc.).



**Geomatikk IKT AS** is developing systems and administrating databases and data infrastructure within the group. We sell several products for data collection and presentation on field equipment such as smart phones, tablets and hand held GPS devices. We have the largest scanning factory in Norway for scanning of historical/ technical documents related to building, planning and estate projects. All documents in our databases can be georeferenced and referred to from any GIS-system. We are one of Norway's leading real estate and property taxation companies, using GIS for planning and quality assurance during the taxation processes.



## eMap AS

<http://www.emap.no/>

eMap is a mapping company that has produced maps for print and visual presentation since the end of the 1980's. Our main focus is to produce maps that are optimally suitable for their purpose for private and public customers in Norway in addition to a few map titles published on our own. Amongst our specialities are topographic maps for outdoor and leisure, city maps, as well as map illustrations for books, information boards and tourist brochures.

Despite being a small company with few a small market and few employees, we consider ourselves a significant actor and trendsetter on cartography in Norway. We have won no less than 8 awards for best cartography on the Norwegian geomatics convention. We use GIS software for analysis, conversion and preparation and does the actual map production in desktop publishing software such as Adobe Illustrator, Photoshop and InDesign with the help of software and plug-ins developed in-house.

We consider map production a craft rather than a technical process where data goes into a 'black box' and comes out as a map, without due consideration of quality, legibility, aesthetics or fitness for use.

We experience a lack of concern for the *quality* of map data maintained by municipalities and the Norwegian Mapping authority. However, so-called FKB-data maintained by municipalities are designed to support municipal management and inventory on a daily basis, and are not suitable for direct map production, and the data is more often produced from photogrammetry in low cost countries where photogrammetrists have little or no knowledge of Norwegian topography and culture.

A typical problem for topographic maps are footpaths, which in FKB are not included if they are hidden beneath the forest canopy; and in smaller scale topographic data sets, they can – particularly in forested areas – be roughly sketched from A to B. Over the years, eMap has therefore used a considerable amount of time on quality control, and looking up on alternative sources to correct the input data. Many frequently used footpath is therefore missing in the map data, or there are footpaths in the data that does not (any longer?) exist at all.

However, more and more municipalities are partly or completely mapped their territory with high resolution *LIDAR-data*. Where they exist, they have become an invaluable corrective source for the

data. By clever processing, features such as footpaths and streams become visible. LIDAR-data also gives us an opportunity to visualize forest (bump-mapping), and cliffs and crags in our maps. The latter are features which is of great importance in terms of accessibility in the terrain for those who are trekking outside the footpaths.

Based on what we have learned while working with the LIDAR-data, we have also begin preparing base material for orienteering maps. With LIDAR-data processed and visualized in the right way, it has now become possible to produce orienteering maps with an unprecedented accuracy. This has also become a problem as some mappers are tempted to include more detail than has been possible before, thereby making the maps cluttered with unnecessary detail and thus become illegible.

A new development in our production is the integration of *texture shading* by Leland Brown, and which Tom Patterson utilized to perfection in the Grand Canyon and Sun Road maps presented at the ICA mountain cartography workshop in Canada in 2014. Texture enhances smaller variations in the terrain surface and result in better portrayal of slope than traditional hillshading methods., which is useful in Norwegian terrain (se examples below).

Another issue of concern is the *toponymy*, which we think has become a bit messy in Norway. This is a legacy from the times when Norway was a part of Denmark and place names would have a Danish spelling. Official place are maintain in a central place name database (SSR), and names are constantly changed based on proposals and bills from municipal councils. The whole process is governed by law and language consultants.

Moreover, in the aftermath of the July 22-masacre at Utøya in 2011, it was discovered that roughly half of the place names communicated between police and other rescue personnel was not in SSR, making the operation harder to coordinate.

The result is that name on places can be spelled differently on maps, on road signs, in written text, and also differ from local pronouncement, and place names in frequent use today may be totally missing from the map.

There is no single issue that engages our customers more as when we present maps with (according to them) wrongly spelled place labels or place labels that are missing all together. Some even want to clutter the map with as many place names a possible. We think a topographic leisure map is an aid to navigation, not a place to document the name of everything.

Some map examples:

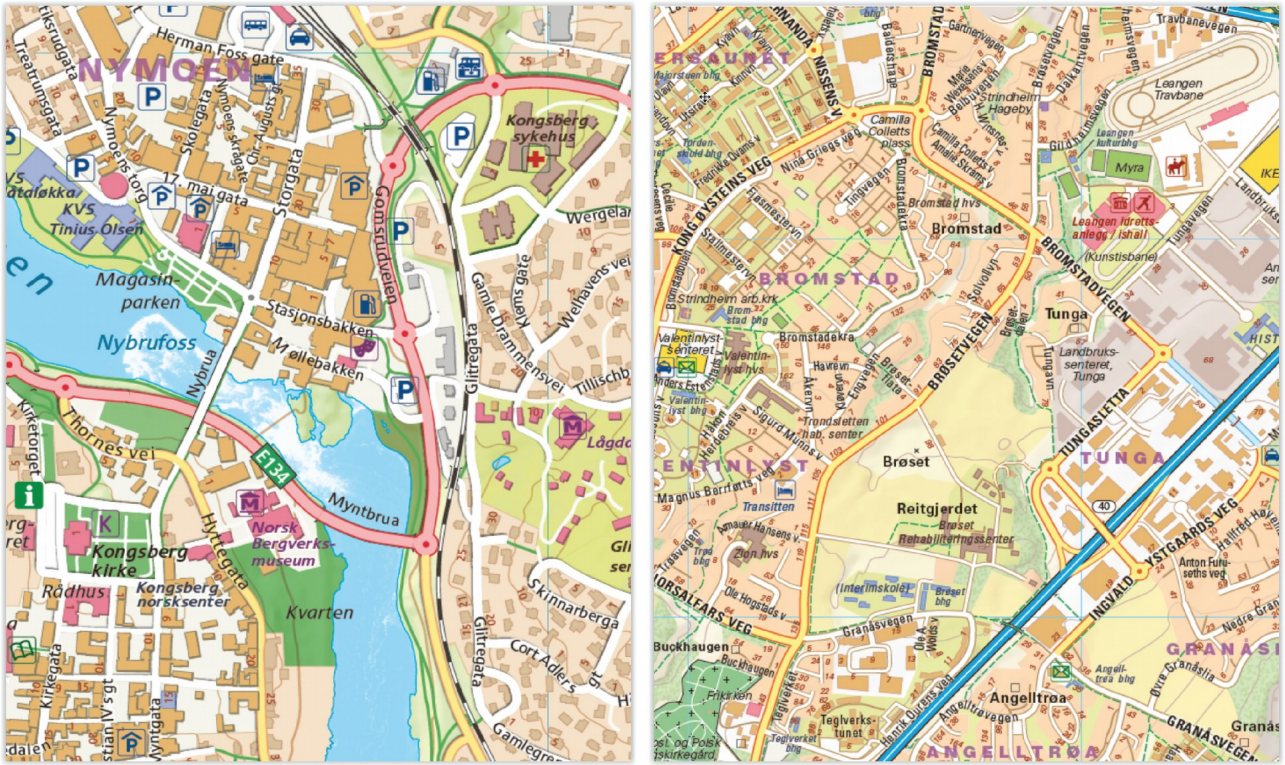


Figure 35: City maps (Left: Kongsberg, 1:10 000, Right: Trondheim, 1:20 000).



Figure 36: Topographic leisure map (Hitra, 1:50 000).



Figure 37: Topographic wall map (Trollheimen, 1:50 000).



Figure 38: Pilgrim ways in Europe, wall map.





Figure 39: Wall map of Norway.

## 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 2015 was appr. 350, while only 2 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 40: Extract from the Oslo atlas, scale 1:10 000.



Figure 41: Extract of Norway road map 1: 1 mill.

## Asplan Viak AS

<http://www.asplanviak.no>

Asplan Viak AS is a Norwegian consultancy company, which uses and produce maps in a variety of projects. Our spatial planners, architects and landscape architects have high competence and experience in using GIS and 3D visualization as planning tools.

Our own developed transport model "ATP-modellen" is widely used for public transport planning in Norway. The transport model can perform lots of transport analysis with length or time as cost. Examples are average travel time to centres, passenger potential and difference in travel time bus vs. car. When combining density of population, density of workspace and the public transport catchment, it is easy to see the missing links in the public transportation system.

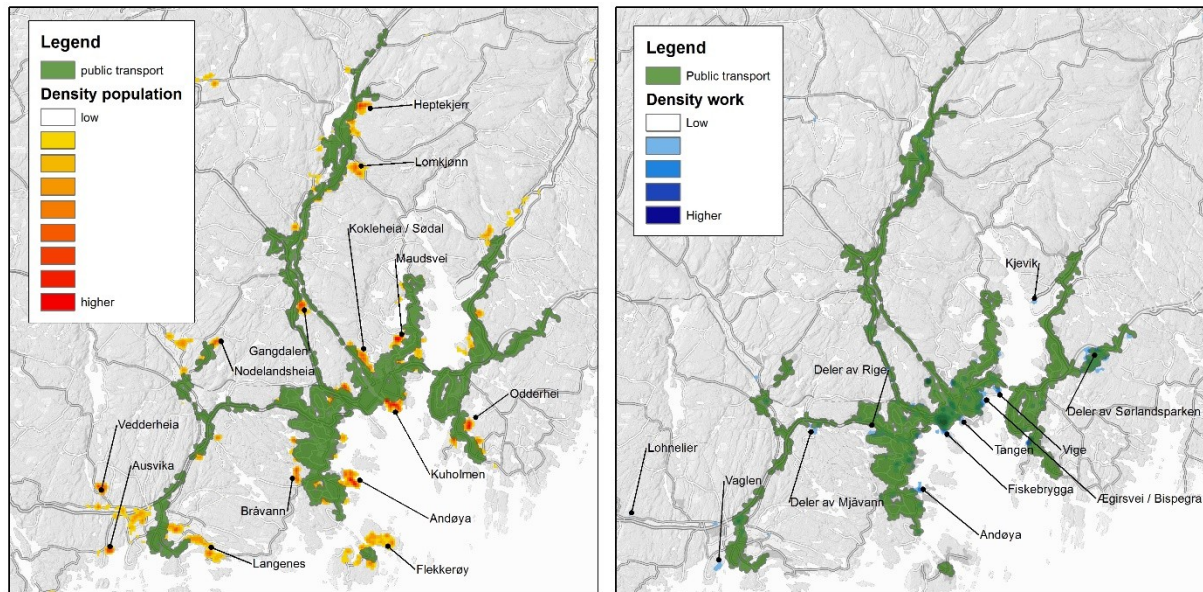


Figure 42: Public transportation planning.

Asplan Viak Internet – or Avinet, for short – specializes in web based map and database solutions. Avinet is active within in R&D projects, and in addition offers a range of map based web applications for public sector, tourism and e-learning.

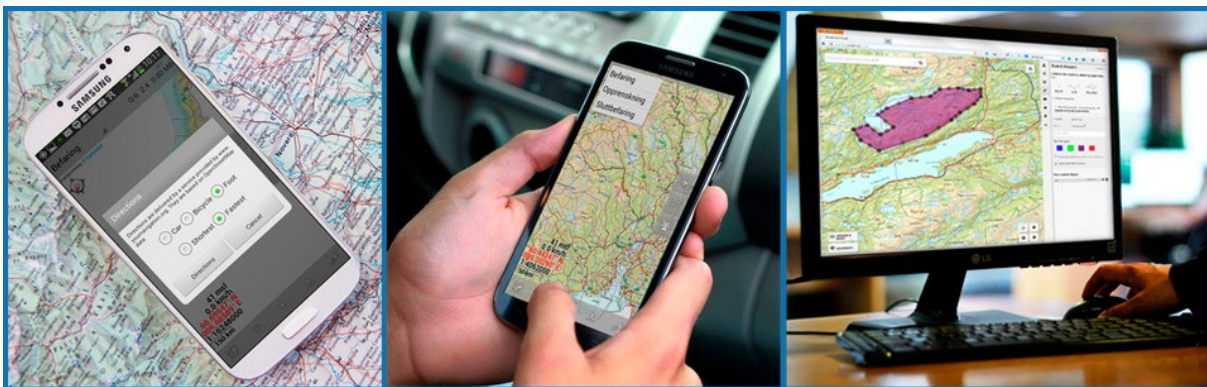


Figure 43: Web technologies.

Project based consultancy within map, database and web technologies is a core activity in Avinet.

We provide a wide range of services such as:

- Specification, development, running and maintenance of web based map and database solutions
- Participation in national and international research and development projects in order to develop new knowledge and innovative services
- Academic lectures within GIS, courses related to Avinet products and tailor-made courses to suit the need of individual customers

Another core activity for Avinet is the development and maintenance of a range of highly innovative map and database based web applications addressing various thematic areas. See more on [www.avinet.no](http://www.avinet.no).

# 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 that includes cartography 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 Geomatics at the Civil and Transport Engineering department and Department of Geography.

At Geomatics 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. Since 2012 we have a researcher who develops web-based cartographic visualization applications such as ViewExposed (<http://setebos.svt.ntnu.no/viewexposed/>), VisAdapt ([http://visadapt.itn.liu.se/va\\_base/](http://visadapt.itn.liu.se/va_base/)) and the ClimRes (<http://setebos.svt.ntnu.no/climres/>) tools. 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).

# 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

### - Geomatics

Some examples on Cartographic related research at Geomatics group the last couple of years:

- The last year we have been involved in map based experiments by the use of Oculus Rift. Oculus Rift is a low cost virtual environment equipment, mainly intended for the gaming industry. In our research we have tested if this equipment can replace the real world while testing how the orientation of the map should be.

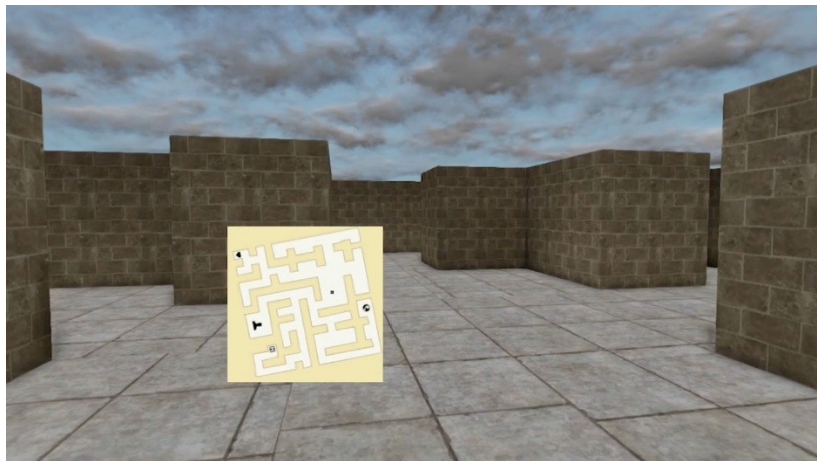


Figure 44: Investigating map orientation in a virtual maze.

- In another project we studied how 3D models made in Sketchup could be used together with terrain data from a Web Coverage Server (WCS) and ortographic photos from a Web Map Server (WMS) in a virtual reality model for Oculus Rift.

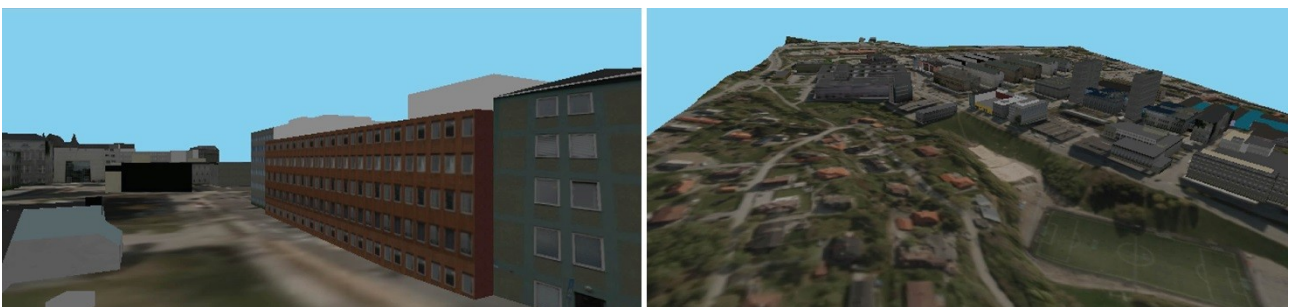


Figure 45: VR-model (Oculus Rift), Campus Gløshaugen

- We have still interests within indoor cartography and indoor navigation. In a “test building” at the NTNU university campus we have investigated how accurate the Cisco WiFi-based positioning system is able to determine positions. We have also studied how different elements like locations of access points, building constructions etc. influence on the positioning.
- We have also been involved in some studies of important elements in orienteering maps in indoor environments.

### -Department of Geography

The Department participates in several Nordic and national research project on the effects of climate change and have produced several web-based cartographic visualization tools which have received considerable attention.

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

Examples:

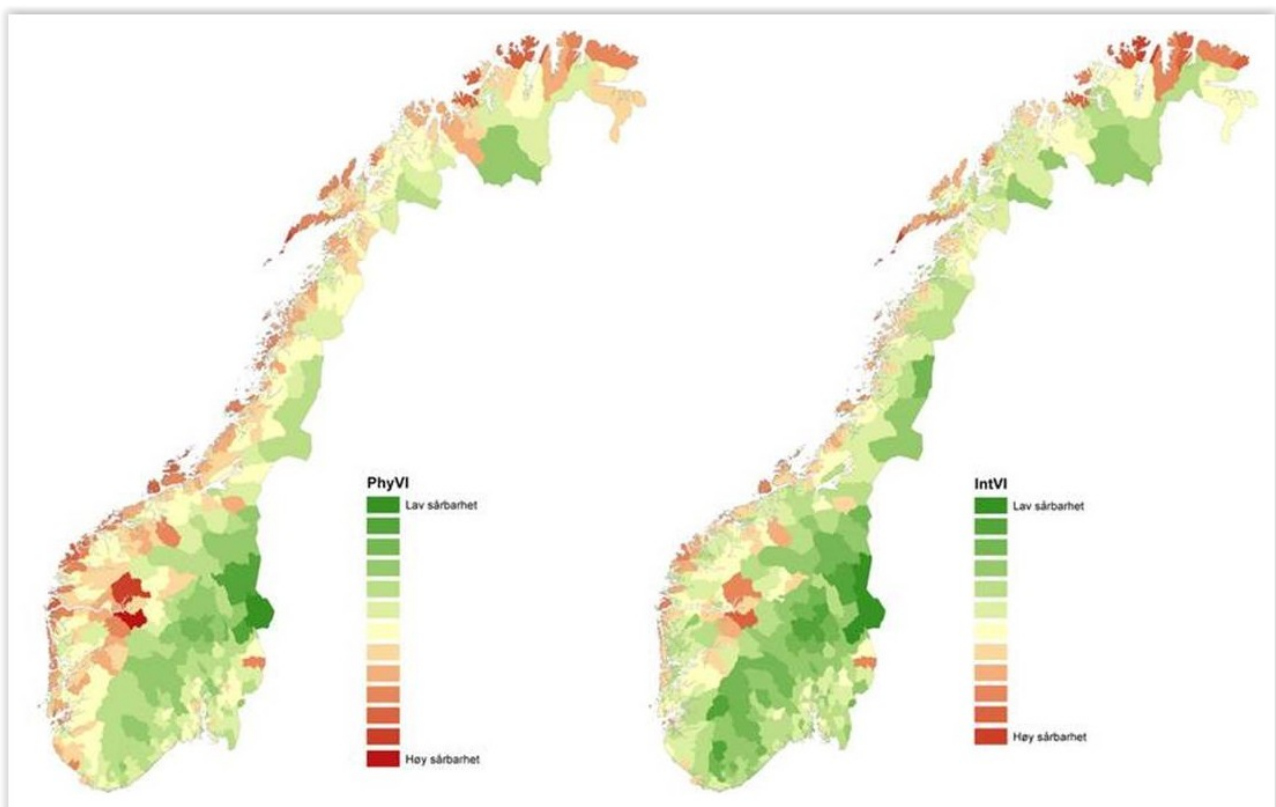


Figure 46: ViewExposed, <http://www.tu.no/bygg/2013/01/24/dette-er-norges-mest-sarbare-kommuner>.

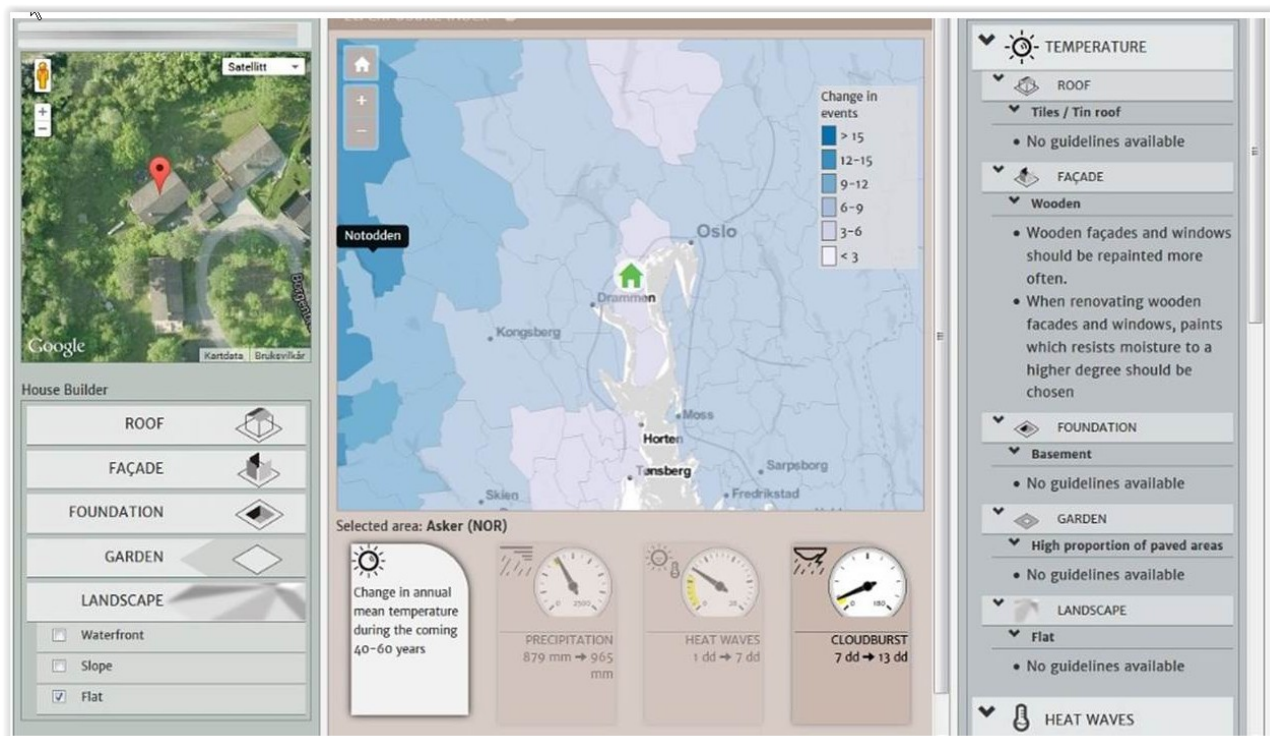


Figure 47: VisAdapt, <http://www.nrk.no/norge/nytt-nettverktoy-viser-hvordan-klimaendringer-vil-sla-ut-hos-deg-1.12062505>.