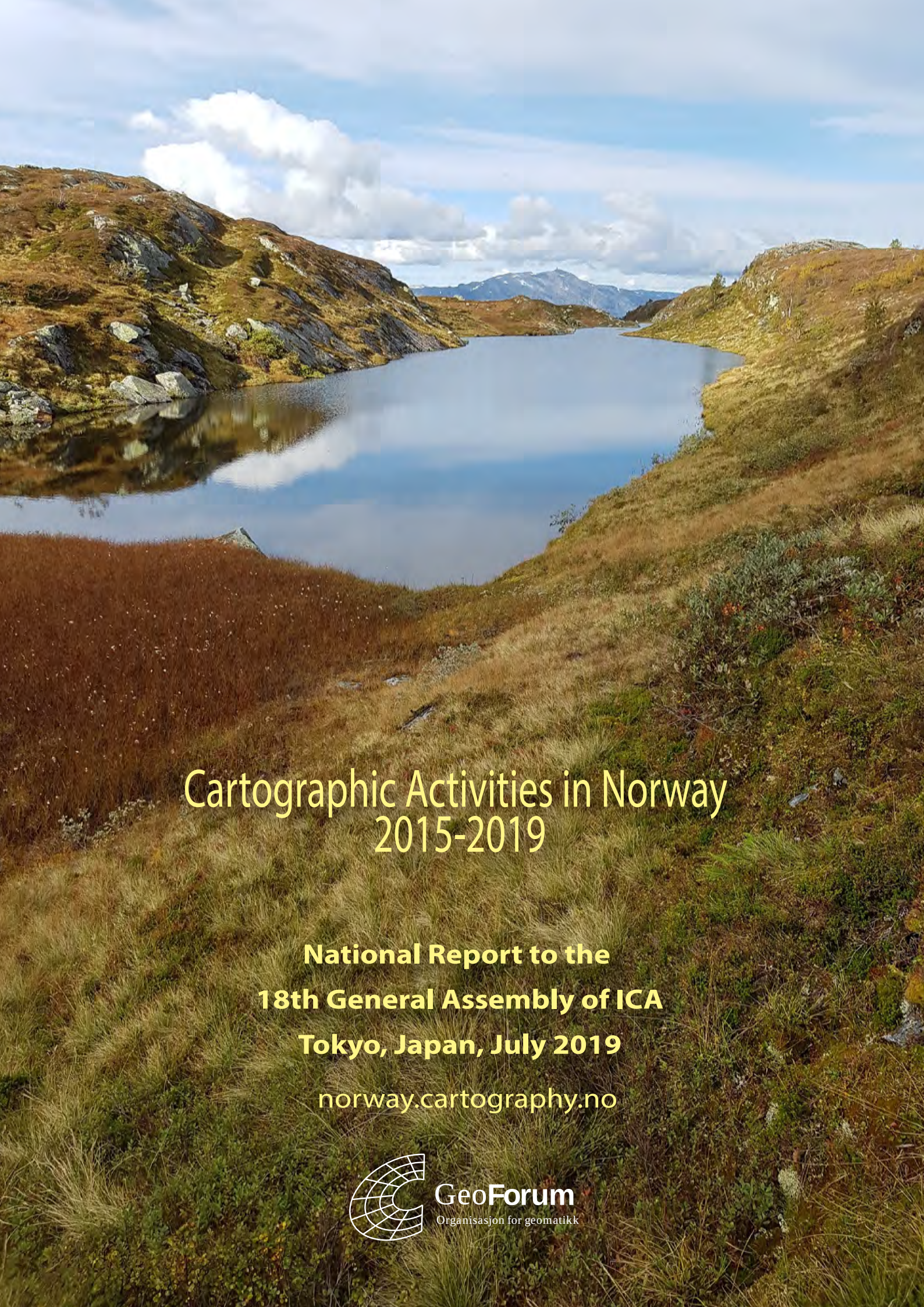


Cartographic Activities in Norway 2015-2019

National Report to the

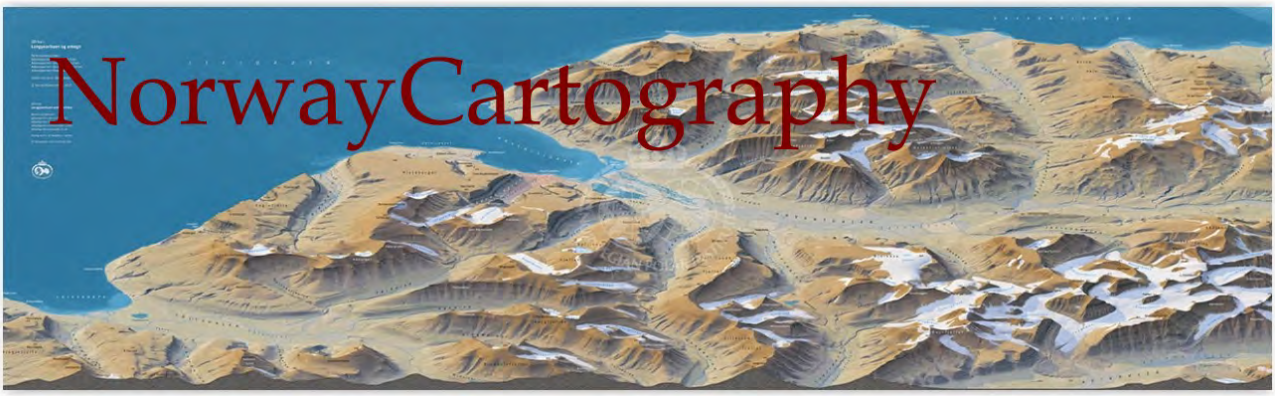
18th General Assembly of ICA

Tokyo, Japan, July 2019

norway.cartography.no

GeoForum

Organisasjon for geomatikk



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Cartographic Activities in Norway 2015-2017

National Report for the 18th General Assembly of ICA
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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. 24 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 report has a broad approach to "cartographic activities". It was considered preferable to collect information about activities with a connection to cartography, rather than pure cartographic activities only.

Each contributing 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: norway.cartograhy.no

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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 2018, GeoForum hosted a Nordic course in Cartography. This took place in Tønsberg, and was a successor of the earlier "Nordic summer school in Cartography". The arrangement in 2018 gathered almost 30 participants. The course is open for participation from all Nordic countries. While most of the participants were Norwegians, we also hosted some visitors from our neighbours in Sweden.

ICA Commissions with Norwegian representation:

Education and Training: *Terje Midtbø*
Maps and the Internet: *Sverre Iversen (and Terje Midtbø)*
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 in- formation 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 partners are responsible for, are made available to the partners themselves and to the general public. All partners 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 organizational 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).

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

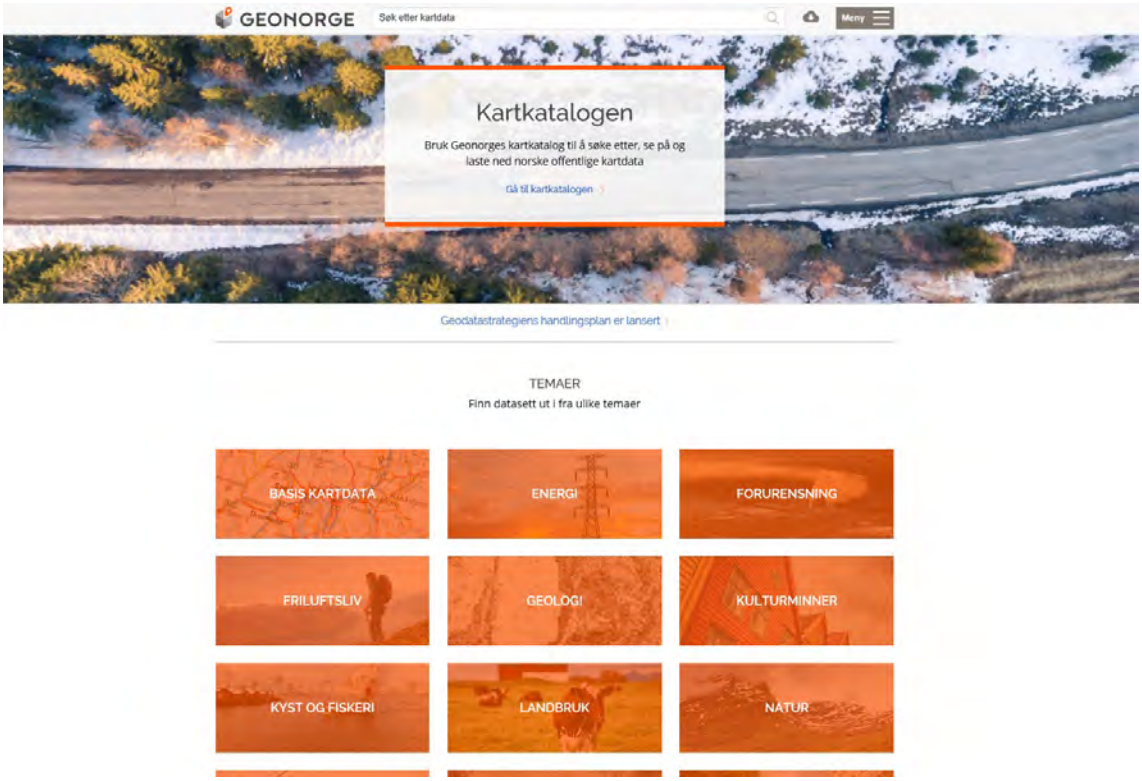


Figure 1: www.geonorge.no is an important node for available geographic information in Norway.

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 356 municipalities (merging of municipalities from 2020), 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.

Data sets freely available for downloading

From 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.
- Nautical data are intended for purposes other than navigation. Nautical data involves depth data (marine primary data), sea terrain models and depth curves.

Figure 2: Example of historical map available at 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 crowd sourcing. Here the public can contribute to NMA's maps and data, both by pointing out errors and by submitting new features. This website is called "Rett i kartet ("Fix the Map'), and can be found at www.rettikartet.no. It is designed for easy use also on tablets and smartphones, and contributions are made by sketching in the map, or by importing GPX-files for more accurate contributions. In 2018, the public submitted 4777 contributions, and each contribution often includes several features.

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

Organisation

The Norwegian Mapping Authority is organised in four divisions: Geodecy, Land 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 Land Mapping 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 updating and administering the national map databases N50-N5000 Map Data, the topographical national map series Norway 1:50 000, nationwide terrain models and coordination and operation of the National Programme for Orthophotography. The division also manages historical mapping, aerial photography materials and operates a registry of air traffic obstacles.

The Land Mapping Division is located at the Norwegian Mapping Authority's headquarters in Hønefoss, but also has twelve regional offices, ranging from Kristiansand in the south to Tromsø in the north. The regional offices coordinate work on geographical information, which is provided locally by the various municipalities and public agencies. The Land Mapping Division plays an important role in regard to coordinating and facilitating work on planning, area, environmental and community information at both national and regional levels. This is a partnership between the municipalities, regions and other public operators.

The National Elevation Model of Norway

The Norwegian Mapping Authority (NMA) started in 2016 a mapping program which aim is to generate a new detailed elevation model based on LiDAR and image matching. The Ministry of Local Government and Modernization and 7 other national government bodies sponsor the project. The goal is to have a complete new set of national elevation and surface models at various detail levels by 2022 covering the whole country (325 000 km^2) . All elevation datasets, both raw point clouds and derived grid products, collected in the program are open data and are freely available to everyone to use and republish. Terratec AS in Oslo was awarded the LiDAR acquisition and the processing in the project back in 2016. A total of 229 000 km^2 are to be covered by minimum 2p/m^2 LiDAR. Per May 2019, more than 140 000 km^2 has been scanned, processed and delivered by Terratec AS. (Terratec deliver to NMA for quality control in a two-stage process: QC1 is carried out on an auto classified dataset and is designed to identifying operational issues such as sensor calibration, strip adjustment, point density and coverage. After the dataset passes QC1 the contractor will carry out further work on the classification, resulting in a final delivery of the point cloud. 1m elevation contours are also generated and delivered to the NMA).

In addition to the contracted deliveries, existing LiDAR data of good quality are utilized to achieve a countrywide elevation model of good quality. In areas with high mountain plateaus, the elevation model will be generated using photogrammetric image matching using existing or new images from large coverage aerial surveys. The total area is approximately 39 000km^2 and are produced inhouse at the Mapping Agency.

In order to maintain and distribute the elevation datasets, NMA got a solution built using an ESRI based platform. The aim of this data management system is to hold all raw and derived elevation data and distribute these via download, webpage and web map services. The web portal is available at https://hoydedata.no, also in an English version.

The system consist of a data management module and a data access module. In the data management module, the contractor themselves uploads the point cloud and metadata and the system then carries out a set of logical tests before the dataset is flagged for external QC. Once passed the external QC the system generates high resolution DTM and DOM grids and publish these as web map services.

In the data access module, the datasets can be visualized using a variety of web map services such as height, hillshade, inclination, local height, skyview etc. These layers can also be viewed in via the portal https://hoydedata.no. In addition, a 3D viewer makes it possible to look at and manipulate the point cloud for each project. All export of both raw point cloud and grid models are handled by in the portal. Project status/progress can be followed at a dynamic map (weekly updated):
http://kartverket.maps.arcgis.com/apps/webappviewer/index.html?id=b918b4b16b1d49359aeb789e5eea644b

Figure 4: Example from www.hoydedata.no DTM hill shade with elevation colors

Automatic generalization of map data

The first acceptable map made by automatic generalization, was produced just a few years ago. Since then, several National Mapping Authorities (NMAs) around Europe have been working with automatic generalization, with promising results. As a National Mapping Authority we always work towards higher efficiency and improvement of our established production lines. Since Norway lacks the 1:100 000 scale and perceives the potential for more efficient map production, we started the project "AG N100" in the beginning of 2018. The map data source used in the project has the scale 1: 50 000 (N50 Map Data), and is the largest scale covering all of Norway with equal quality.

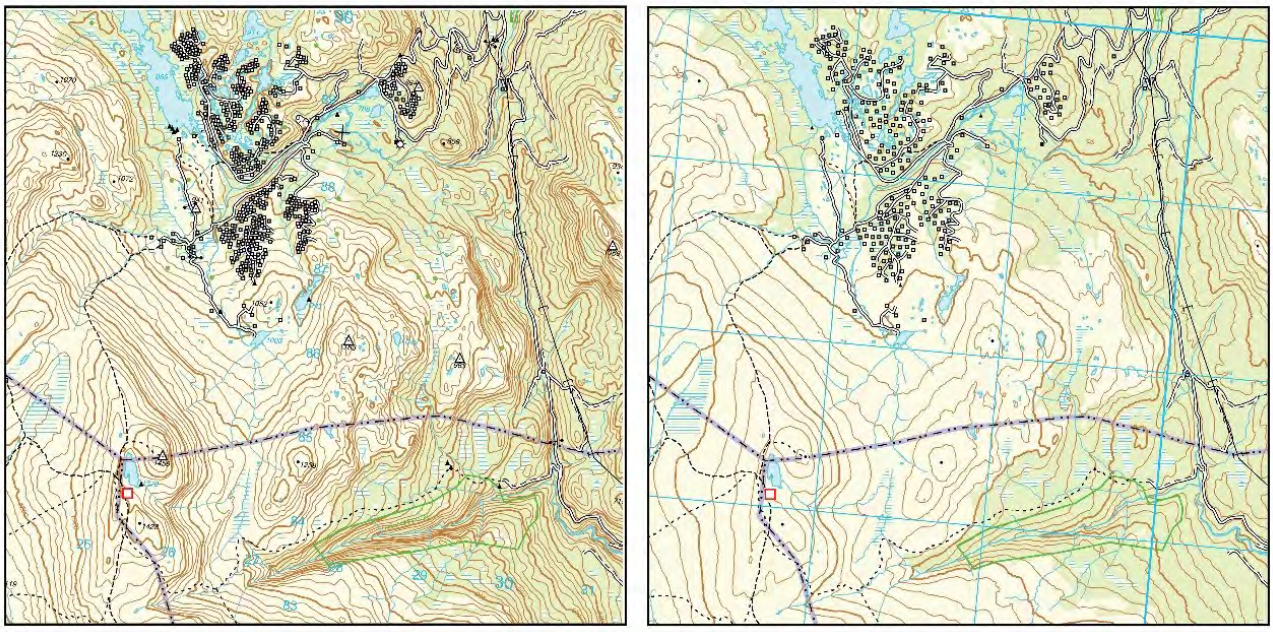


Figure 5: The two maps are illustrating the differences between contour lines for N50 Map Data and N100 Map Data. The left map is from N50 Map Data. The right map is from the N100 Map Data. The automatic generalized N100 Map Data is not entirely finished, so there are features missing in the map to the right.

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 Cadastre and Land Registry

The Norwegian Mapping Authority's Cadastre and Land Registry is the national agency for property rights registration of fixed property and flats in cooperative housing. The Cadastre and Land Registry ensures that property rights are registered at the right time and administers land registry data. The land registry is a public register of official documents relating to fixed property. The division is also responsible for the New Cadastre (matrikkelen) and handles administrative tasks relating to the Norwegian Place Names Act and administrative borders.

The New Cadastre (matrikkelen), the national property registry, is continually updated in partnership with the municipalities. The New Cadastre contains information and maps concerning all properties, addresses and buildings in Norway. The municipalities are in charge of local cadastral services and are responsible for entering information into the registry. The Norwegian Mapping Authority is the central cadastral authority with responsibility for the development, operation and administration of the New Cadastre.

The Norwegian Mapping Authority is also responsible for training, guidance and inspection in regard to the way in which the municipalities enter data into the registry. Cadastre and property rights registration is provided from the Norwegian Mapping Authority's headquarters in Hønefoss, which also has a property rights registration section.

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 for most of the world.

Cartographic activity
NHS is responsible for official navigational charts, both digital (ENCs) and paper charts. 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. About 20 persons work in the Chart section, updating existing charts and compiling new charts.

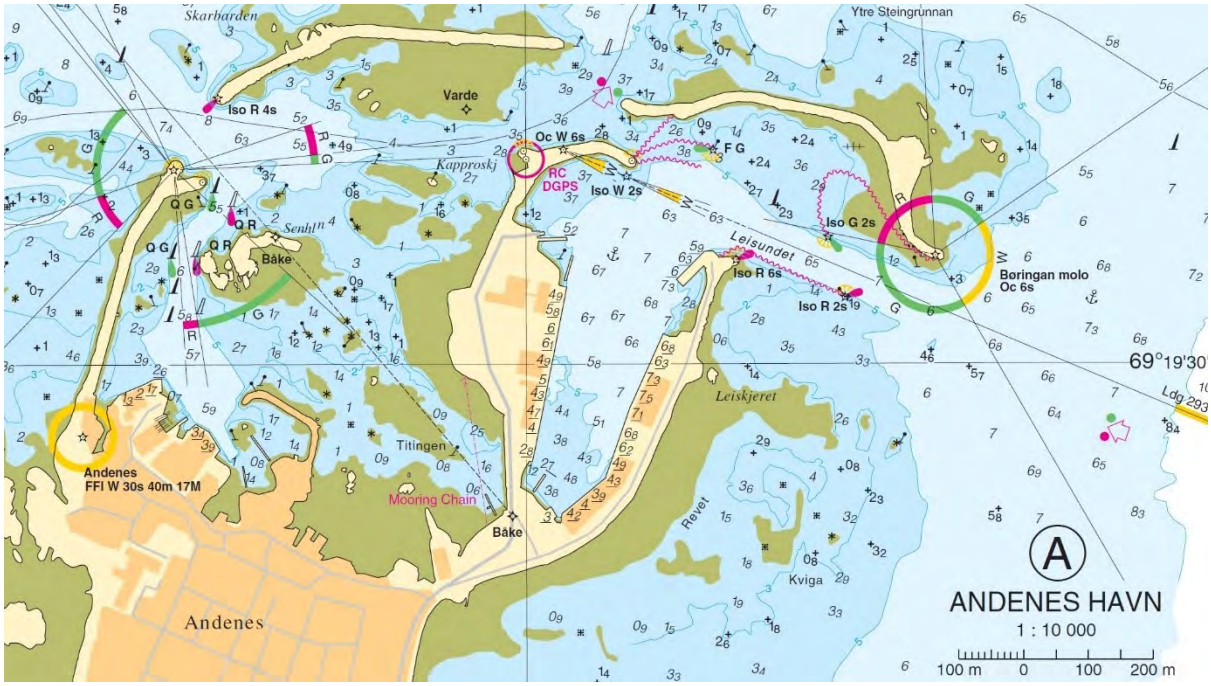


Figure 6: Traditionally chart. The view is from Andenes in Nordland.

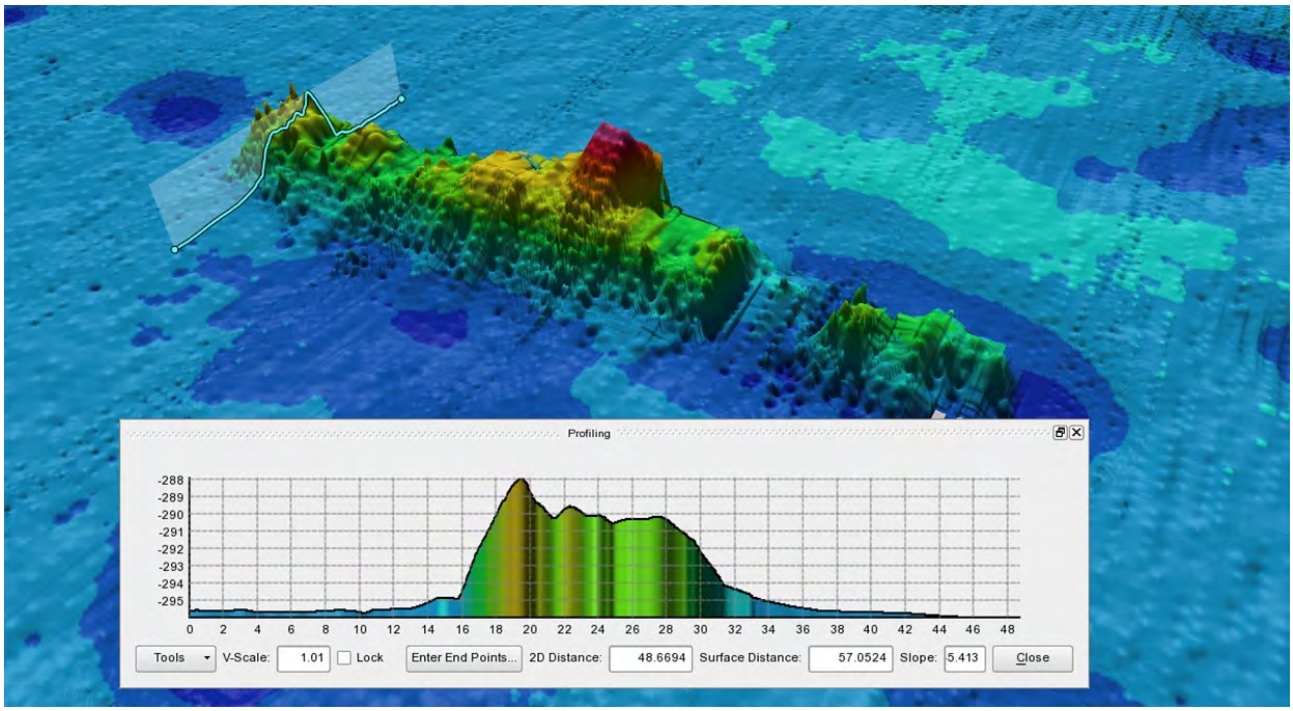


Figure 7: Wreck at 300 meters depth in the Barents Sea. The Wreck in approximately 130 m long and 15 m wide. Picture from MAREANO/Kartverket.

Norwegian Polar Institute

https://www.npolar.no/en/

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.

Examples from the production:

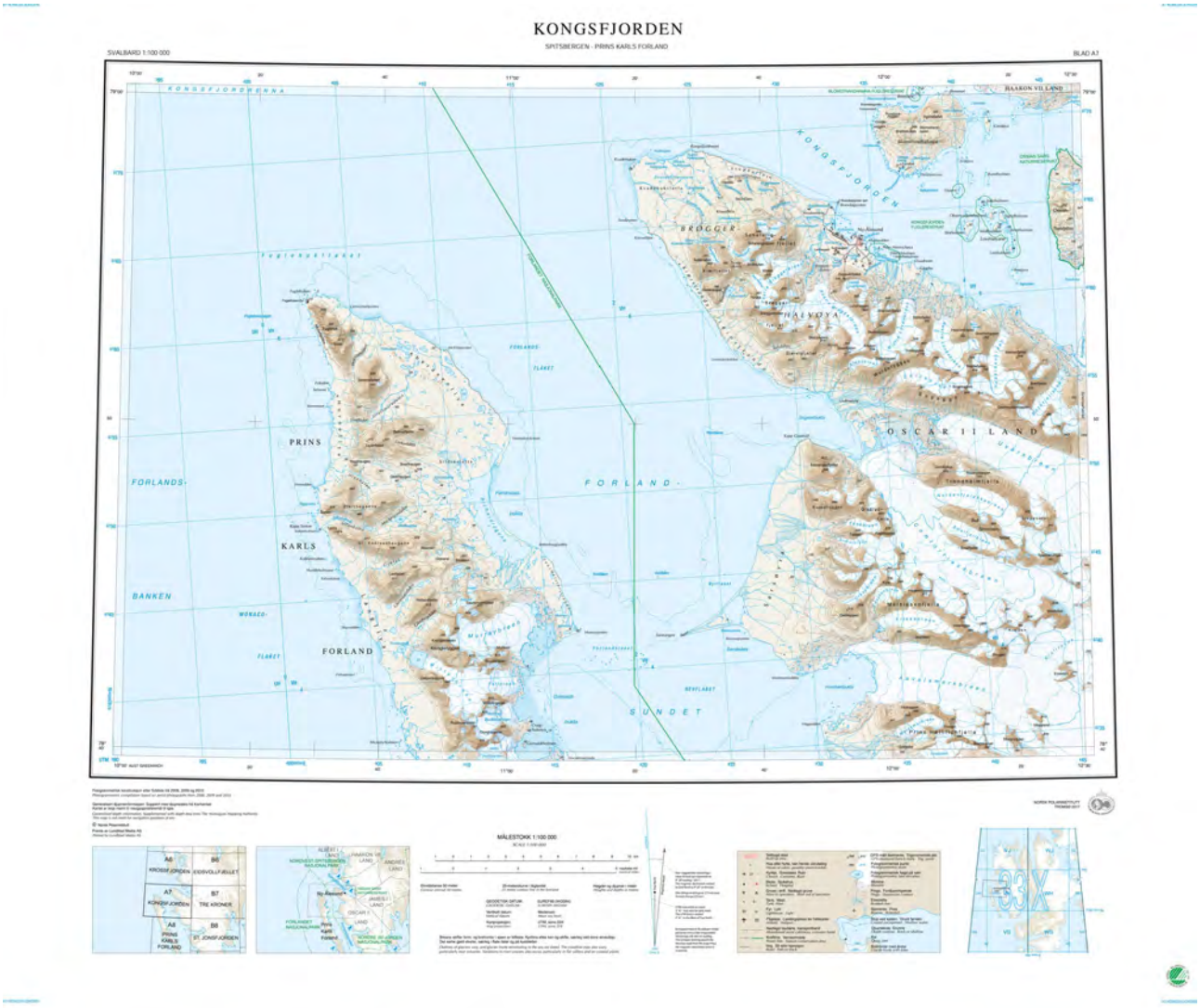


Figure 8: One of the updated topographical map sheets in the Svalbard 1:100 000 map series, produced 2017.

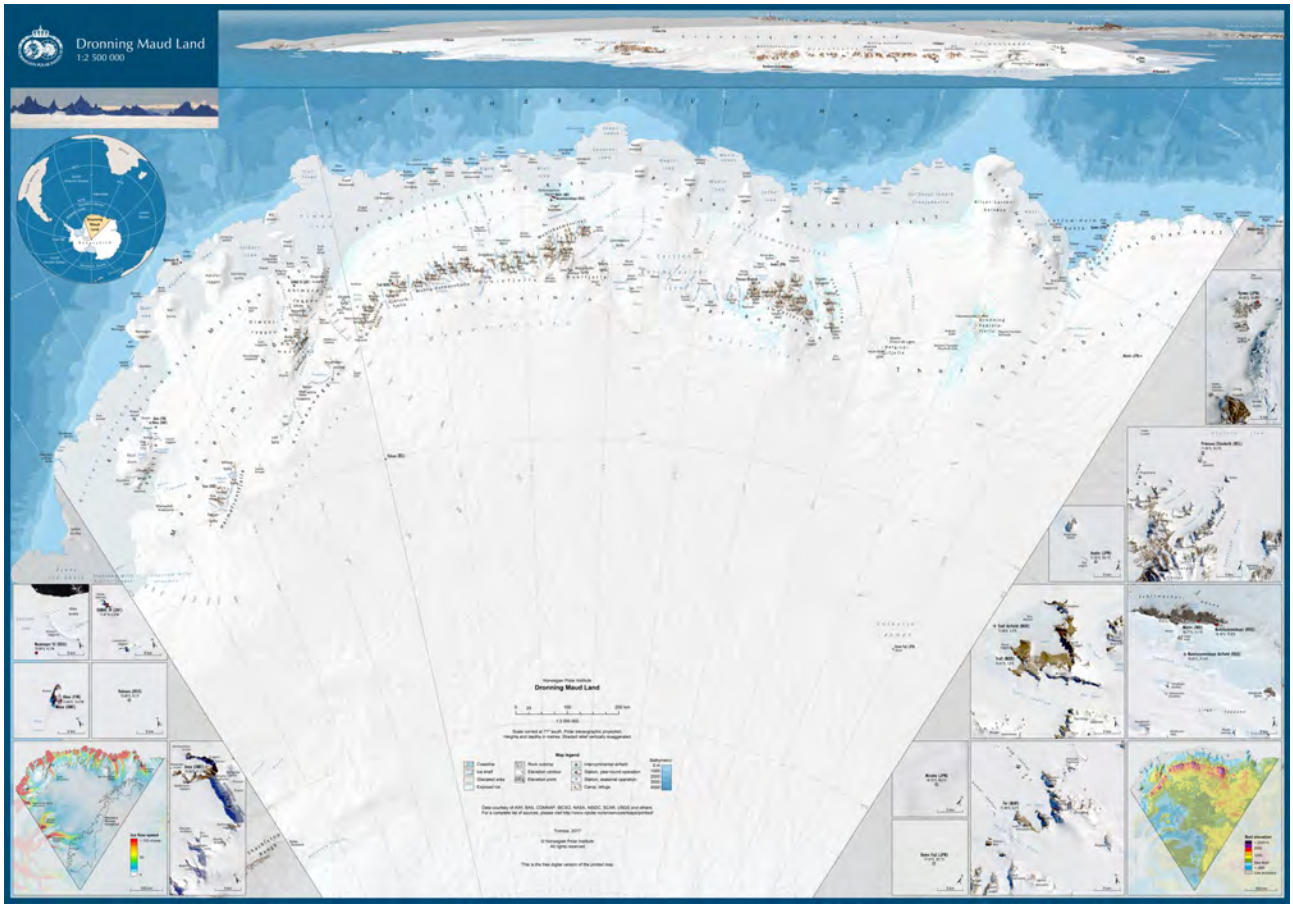


Figure 9: Overview map of Dronning Maud Land, the Norwegian claim in Antarctica, produced 2017.

Norwegian Institute of Bioeconomy Research (NIBIO)

https://www.nibio.no/en/

Norwegian Institute of Bioeconomy Research (NIBIO) is conducting research and providing information about the land resources; including land cover, forest, soil, vegetation and landscape. NIBIO is to contribute to food security and safety, sustainable resource management, innovation and value creation through research and knowledge production within food, forestry and other biobased industries.

NIBIO 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. NIBIO provides knowledge to the authorities, industry, commerce and the public to contribute to the sustainable management and formation of values of land resources through research and data collecting.

The institute has approximately 700 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 many various thematic maps, some on paper but mostly on the web. Several departments and about 10 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 422 municipalities and in scale 1:250 000 for all counties in Norway and grazing land for sheep and cattle in scale 1:20 000.

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 and complex GIS tasks. Data collection in the field is carried out with QGIS on tablets. Paper maps are also made in QGIS. However, the production of paper maps is decreasing. Most of our data are presented interactively on the world wide web. Our internet application for viewing and downloading data 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 10: Screen dumps from the viewing application zoomed in to show to the left: the quality of soil (red is good quality, yellow is less good quality) and to the right: the risk of erosion (the darker purple the higher risk).

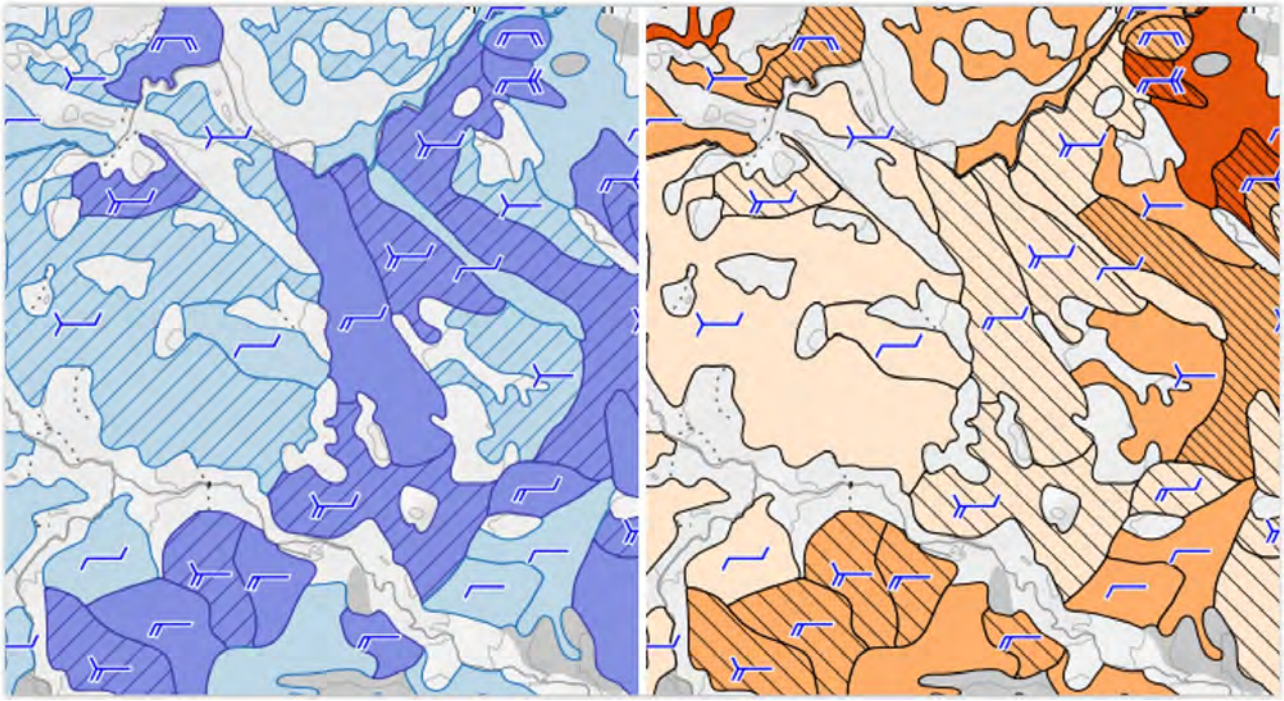


Figure 11: This example showing peat information regarding peat depth and vegetation to the left and the rate of decomposition to the right. All the information in both images, given through colours and the hatches, is summed up in the symbol (called the 'peat brush') within each polygon.

Source: http://kilden.nibio.no.

Avinor

http://www.avinor.no

Avinor is a wholly-owned state limited company under the Norwegian Ministry of Transport and Communications and is responsible for 44 state-owned airports. Avinor provides safe and efficient travel for around 50 million passengers annually, half of which travel to and from Oslo Airport.

Over 3000 employees are responsible for planning, developing and operating an efficient airport and air navigation service. Avinor is financed via airport charges and commercial sales. The air navigation services is organized as subsidiary wholly-owned by Avinor.

Avinor's departments for Information Management and Building and Infrastructure are responsible for most of Avinor's cartographic production. Approximately, 7-8 employees work with map and chart production, whereas another 8-10 work with geographic information systems and geographical data management. The Building and Infrastructure department also maintains a large number of CAD-drawings.

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://avinor.no/en/ais/aipnorway/.
- Charts for Avinor's helicopter manual: https://avinor.no/en/ais/AHMcurrent/.
- Building restriction area maps for each airport. These maps are available at www.avinor.no.
- Charts showing signs and markings.
- Airport maps: airport overview (see example below), security, airside safety, emergency planning, utilities, noise pollution, ground pollution, etc. Some of these are published as interactive maps on www.avinor.no.
- Ad-hoc map and chart production.

Figure 12: Oslo Airport.

Norwegian Land Consolidation Court

Morten Strand and Tom Christensen, Norwegian Courts Administration

https://www.domstol.no/en/the-land-consolidation-courts-of-norway/

The organisation of land consolidation activities may vary between countries. Some have it as part of the administration, others have temporary commissions, special commissions or programs. In Norway it has been organised as a court ever since the The Norwegian Land Consolidation Court was established back in 1859. It plays an important role in the Norwegian judiciary. The court contributes to solving problems related to real property or property rights and the jurisdiction is established by the Land Consolidation Act. The purpose of land consolidation is to provide the basis for a more efficient exploitation and use of real properties, see section 3-2 and 3-3 in the Land Consolidation Act.

Here is an overview of some types of cases that the court can handle:

- Boundary and land disputes in rural and urban areas
- Dissolving joint ownership
- New layout of properties and perpetual easements
- Prescribing rules for joint use
- Replace easements and usufruct rights
- Joint measures
- Division of properties
- Valuation in connection with expropriation and exchange of properties (appraisement court)

The court conducts surveys and makes maps to process the case and document the verdict and the land consolidation rulings. Mapping and other technical work are mainly done by the staff of the court. Key instruments in this are the survey- and GIS systems. Today the court are located at 34 different places in Norway. The technical staff counts about 90 employees, which is a little more than one third of the total number of employees.

Over the years the land has been divided into rather small parcels many places in Norway. Today one property may consist of a great number of parcels. Many of those may have an awkward shape. This is not very economical for anyone.

An example is a case from a forest area in south-eastern part of Norway, at Hof vestside in the municipality of Aasnes, where an area of 80 km² were divided into 240 different properties and 782 parcels. One of the parcels was about 10 m wide at the widest, 2 km long and tapering to a point at the other end. The land consolidation case in this area resulted in a new layout with a significant reduction in the number of parcels and the number of km with property boundaries (Table 1).

Table 1: Total reduction in the number of parcels and in the number of km property boundaries in an example case for the Land Consolidation Court. The example is from Hof vestside at the municipality of Aasnes, Norway.

	Number of parcels	Number of km property boundaries
Before the land consolidation	782	870
After the land consolidation	358	520
Reduction in %	-54 %	-40 %

Maps covering a small part of the case are shown in Figure 13 and 14, illustrating the change in a very divided area.

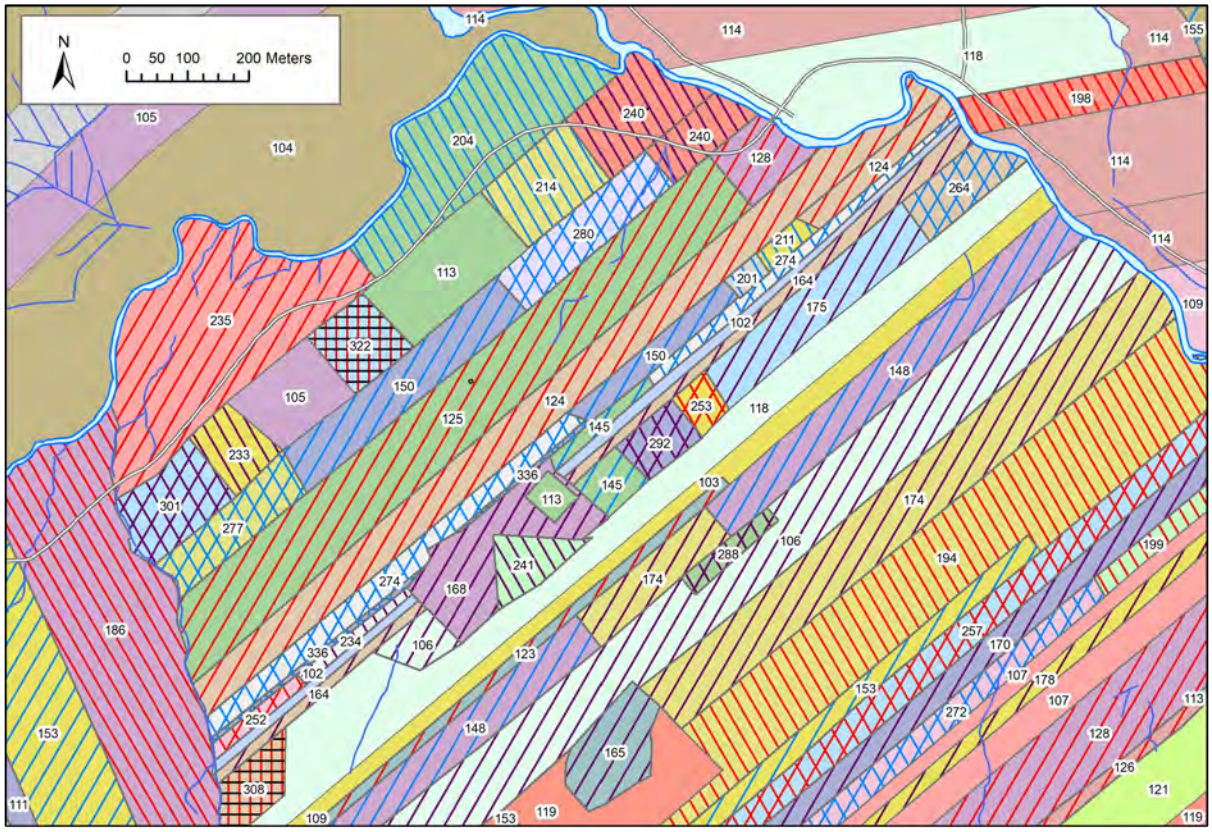


Figure 13: Map showing the ownership of a small part of the area in the case BEFORE the change. Each property has its own carthographic signature and a property number. It could be challenging to define hundreds of different readable polygon signatures. The properties have all kinds of shape, and they combine rather randomly on the map. In an attempt to ease the readability, the biggest properties have got the cleanest signature (lower part number).

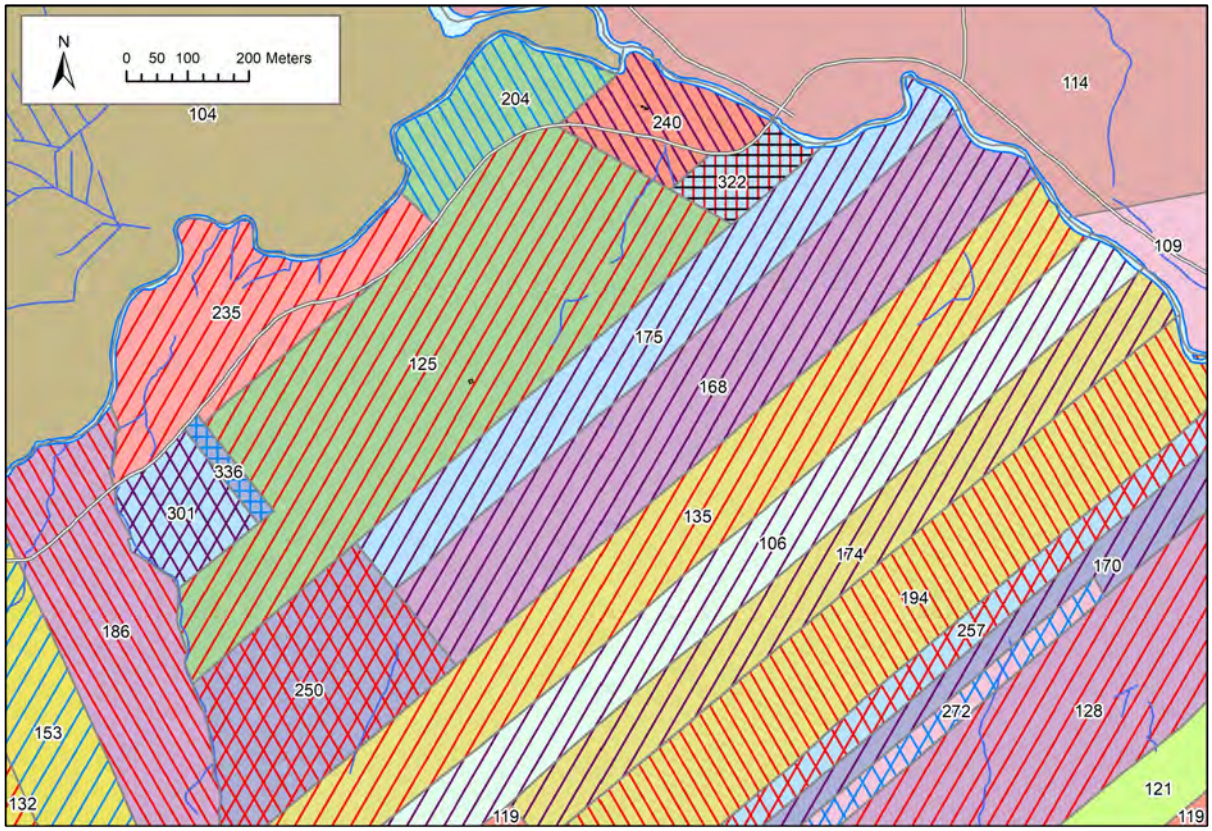


Figure 14: Map showing the ownership of a small part of the area in the case AFTER the change (same area and property signature as shown in figure 1). Many of the properties have now been moved to other locations within the land consolidation case area.

Achievements for one of the properties, no 111:

- The number of parcels were reduced from 25 to 4.
- The number of km property boundaries were reduced from 46 to 17.
- The owner could leave co-ownership in 8 roads.

The new layout was based on a valuation of the forest land. A commercial Python application written for ArcGIS, called Geoskog, was used to convert the forest stand data to values.

According to the Land Consolidation Act, nobody should loose values on the change, see section 3-18 in the Land Consolidation Act. A change like this should be a win for all parts.

For more information: https://www.domstol.no/en/the-land-consolidation-courts-of-norway/

References:

Land Consolidation Act: https://lovdata.no/dokument/NLE/lov/2013-06-21-100?q=land consolidation act

The Norwegian Coastal administration

The Norwegian Coastal Administration (NCA) is an agency of the Norwegian Ministry of Transport and Communications responsible for services related to maritime safety, maritime infrastructure, transport planning and efficiency, and emergency response to acute pollution.

The Norwegian Coastal Administration's most important tasks are:

- Development and maintenance of fairways and fishing ports
- Aids to navigation services
- Vessel Traffic Services
- Pilot services
- Reporting services and navigational warnings and services
- National preparedness against acute pollution
- Exercising maritime legislation
- Transport planning
- Port Facility Security (ISPS)

The main objective of the NCA is to ensure safe and efficient navigation in the fairways along the coast and into ports, as well as national preparedness for acute pollution.

The Norwegian Coastal Administration has around 1000 employees in total, and around 700 of these employees are engaged in operative activities.

Of a total of 1000 employees, there are 4 positions working directly with geodata issues and cartography related work. The main products are different web map applications, analyzing ship traffic, routes at sea and different information portals. Examples on Web Map application from NCA is Kystinfo (https://kystinfo.no), Havbase (https://havbase.no), Routeinfo (https://routeinfo.no), Kystdatahuset (https://kystdatahuset.no), og Lavutslipp (alternative fuels) (https://lavutslipp.kystverket.no)

In addition to these public portals, we also have several, more specialized, portals for internal use.

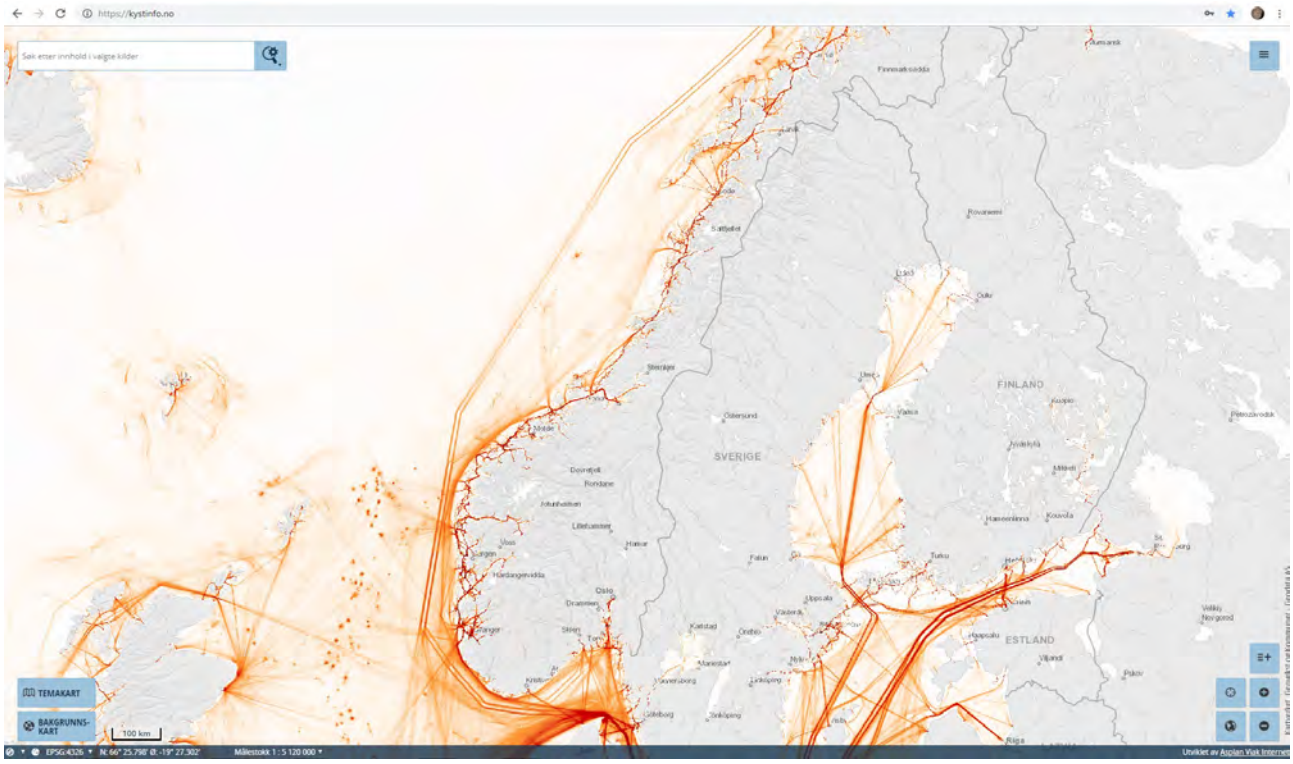


Figure 15: Density map based on ship traffic fra AIS. (from https://Kystinfo.no)

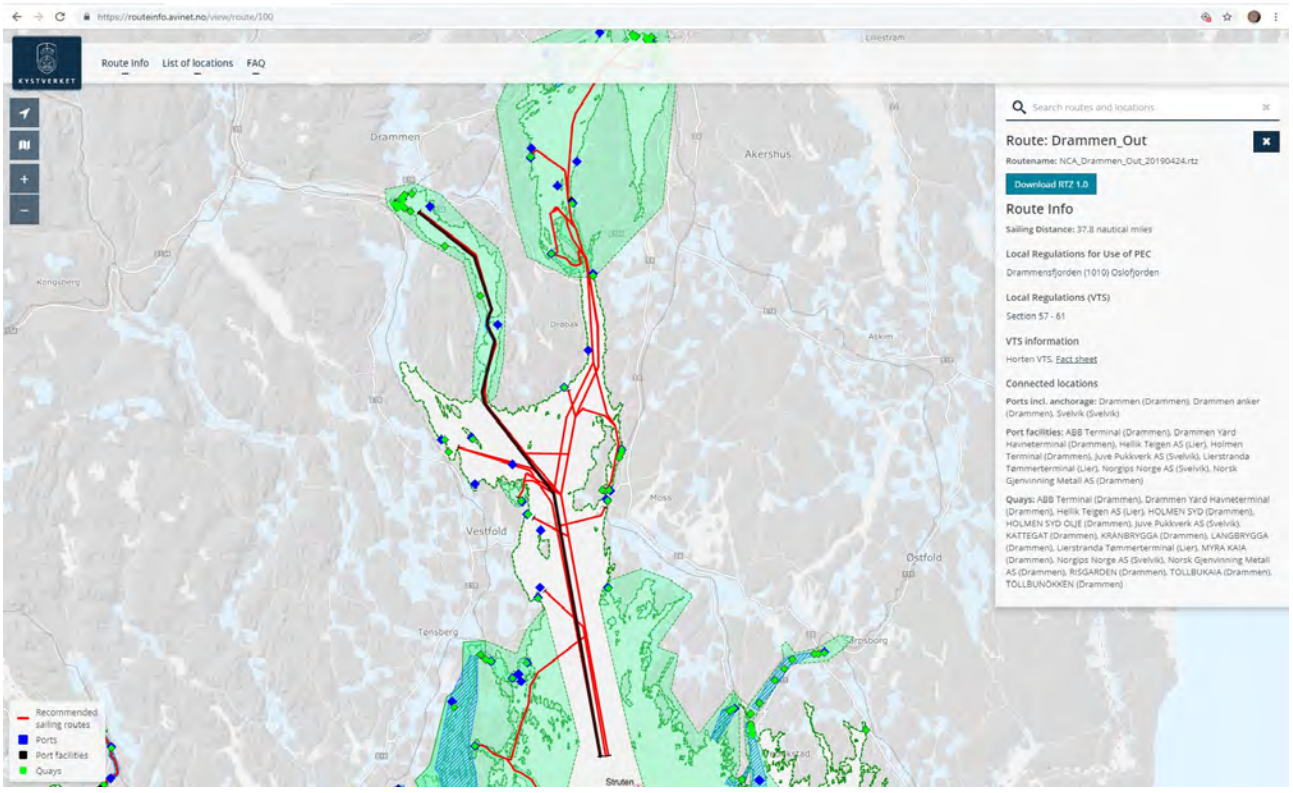


Figure 16: Shipping routes and local regulations in the Oslo fjord. The routes are downloadable in formats useable on the ships mapping system.(from https://routeinfo.no)

Geological Survey of Norway

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

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, Industry and Fisheries. NGU currently has 200 employees. Over half of them 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 27 datasets and 17 WMS-services accessible through the national SDI "Norway Digital". The Geomatics and IT group at NGU has 22 employees. The group works on all cartographic activities, with a special focus on developing and managing the geographic databases and map services. The use of Open Source Geospatial Software for Map Services and Web Maps are dominant, but ArcGIS Software is mostly used in data, Map production and selected ArcGIS Online Services.

Production of printed Maps are toned down resent years. Our Web Map Applications are now device independent with the “Mobile First” philosophy. Stronger prioritization of what is shown and downloaded to the user is therefore more important than earlier years. We are still working to complete a mobile friendly display of Map Object properties (“Fact Sheets”). We have developed more user-oriented maps to be used in planning through complex classifications computed from multiple geological values and properties, but we have still a way to go. The Web Map applications are available at www.ngu.no.

Two examples of Web Map Applications with underlying Map Services are shown below. The first example is collected and edited by the Survey. The second example is from a ground surveys database (with geotechnical borehole) where all the data are delivered from several partners. NGU presents the data with different filter options and in combination with several other services, as well as making them available for downloading.

NGU Example 1 – Unstable Rock Slopes:

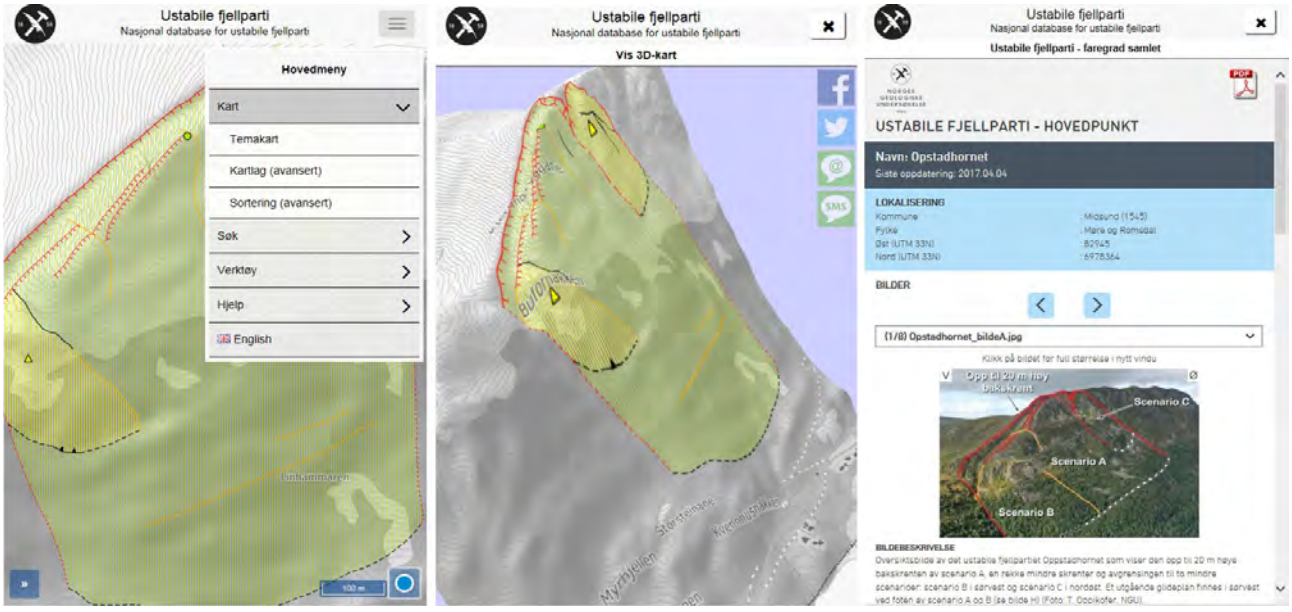


Figure 17: "NGU Example 1" from left: Map & Menu (a), 3D Map (b) and Fact Sheet (c).

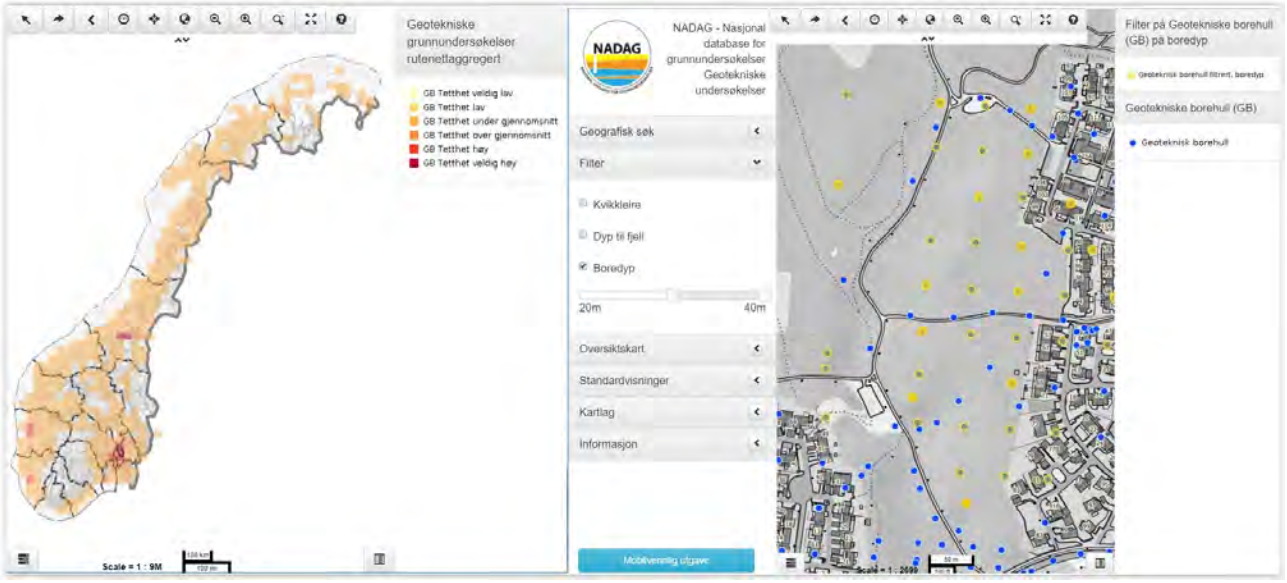


Figure 18: "NGU Example 2" – National database of ground surveys (NADAG): left a "heat map" showing surveys and right with a filter identifying boreholes with bore depth from 20-40m.

Statsbygg

http://www.statsbygg.no/

Statsbygg is the Norwegian government's key advisor in construction and property affairs, building commissioner, property manager and property developer. Statsbygg provides functional premises to public sector enterprises, as well as carrying out socio-political objectives in relation to architecture, planning, and preservation of heritage sites.

Statsbygg owns more than 2000 buildings distributed among 600 property sites. These buildings range from the Government quarter, Norwegian Embassies abroad, customs houses, museums, opera houses, prisons and open use cabins. The company has 850 employees. See https://www.statsbygg.no/Om-Statsbygg/About-Statsbygg/

The GIS staff is working in close collaboration with the BIM (Building Information Models) staff. Statsbygg have a diversity of users such as; architecture, 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.

Statsbygg provides access to geo-information through our web-based GIS solutions, and incorporates data from the Norwegian Mapping Authority and from our National Spatial Data Infrastructure (Norge Digitalt). Other products provided for the public are services such as Statsbygg's property data and geotechnical surveys.

All-purpose Web-GIS: "Karttjenesten for alle"
This is our general purpose web-GIS portal, providing access for our internal users to Geo-referenced information on buildings, properties, thematic data, cadastral information etc. Both internal and external services are integrated into an easy to use web application.

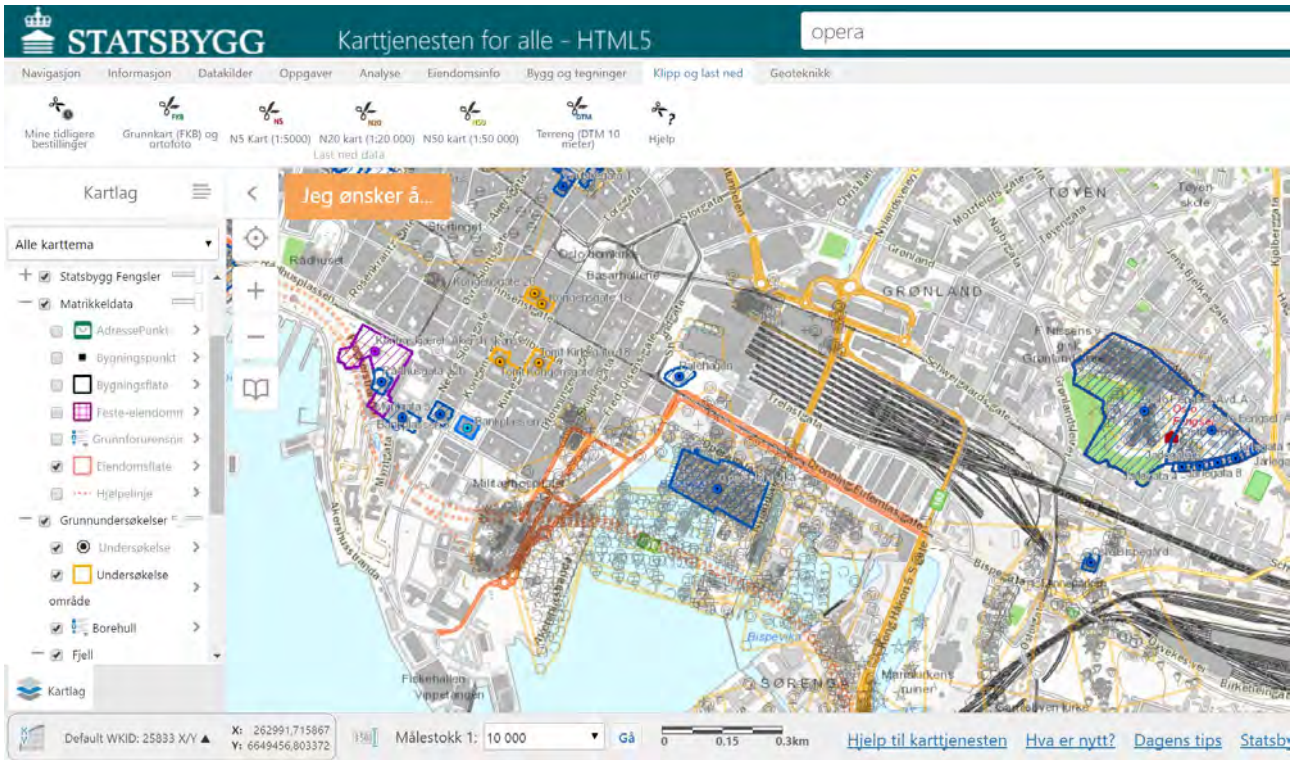


Figure 19: All-purpose Web-GIS. Statsbygg's geo surveys and property data are on screen.

This web-portal comprises tools for integrating Statsbygg's databases with national cadastral and thematic data, including protected buildings and sites, risk factors such as flooding and landslides, pollution, etc.

Routines for producing data for 2D maps, 3D data models and more are available for all users in Statsbygg. Snipping tools for production of areas of interest are provided. A range of projections, datum and common formats are produced and can be distributed for building and planning purposes.

New use of 3D GIS technology:
A great deal of resources is spent on supporting ongoing planning and development projects with detailed maps and models of the existing situation on the building site. Web-based services and apps are Increasingly used for presenting 3D GIS models, often combining geospatial data with architectural building information models (BIM). This allows for visualization in a lightweight web-browser client without the use of 3rd party plugins.

Figure 20: Building heights on a Camus area, possible solutions with site and building models.

The 3D models are fully interactive and are used for a wide variety of purposes, like exploration of Statsbygg's building locations on a virtual globe, evaluation of architectural models with regards to the surrounding environment, and analyzing climate and flooding hazard on a building site. Presenting GIS data in a 3D model can convey a more powerful message and may increase the recipient's ability to understand effects by presenting the site in a more recognizable context.

Integration and publication:
Statsbygg uses portals for producing online services and applications for distributing and showing geographical information. By using server technology and web-portals, the possibilities for a digital production line for the users is at hand. The portal allows you to share maps, scenes, apps, and other geographic information.

Figure 21: Levels of visualization by using web portal, Stavern fortress, the "Citadell" island.

The illustration shows three different levels of detail; visualization for properties on a global, national and local level.

Bane NOR

Bane NOR is a state-owned company responsible for the national railway infrastructure.

Bane NOR's mission is to ensure accessible railway infrastructure and efficient and user-friendly services, including the development of hubs and freight terminals.

The company is responsible for the planning, development, administration, operation and maintenance of the national railway network, traffic management and administration and development of railway property. Bane NOR has operational coordination responsibility for safety work and for the coordination of emergency preparedness and crisis management.

Bane NOR has approximately 4,500 employees and the head office is in Oslo, Norway.

The Geomatics section has 6 people which supply geomatic services to entire Bane NOR, including:

- Supply different types of map data via national cooperations and projects
- Distribute map data for survey, planning and construction projects
- Produce thematic maps for various purposes
- Assist ordering and control of field measurements
- Manage and develop web mapping solution for Bane NOR (Banekart)
- Advising and training for users of Banekart
- Counselling in use of geodata

The thematic map production in the geomatics section aims to visualize the data from other parts of the organization in either a schematic or a geographic format. Usually the product is delivered digitally for screen viewing, via file sharing or e-mail. Sometimes, a paper output in layouts for A4, A3, A1, A0 or other formats is required. The scales can be small to accommodate the whole of Norway or bigger to allow more details when looking at individual lines, stations and projects. The cartography is a mixture of national and international standards with addition of Bane NOR special developments to support the requirements of internal or external clients. About 15-20 people use the geodata and/or GIS/CAD tasks in planning, engineering and construction projects for Bane NOR.

Map examples:

1. schematic map: % of capacity used over 24h (Figure 22)

The schematic network is constructed according to principles established by the eminent technical draftsman Harry Beck working for the London Underground in the 1930s. All lines are drawn straight, all angles are multiples of 45 degrees and topologically accurate. In addition, the Bane NOR network is linearly referenced by km, allowing dynamic segmentation and automatic visualization of data by km. Error in position along the line is within a km, stations are geographically correct in any direction within 10-15 km. The thickness of the line is in this case proportional to the capacity for train traffic, and the line colour show how much capacity is used by the timetable for 2016. Annual editions of these maps have been used in statistical reports for decades and aid executives and politicians in understanding bottlenecks and support decisions of infrastructure investments. Today, similar maps are produced by the Norwegian Railway Directorate.

2. geographic map: Wind exposed railway lines (Figure 23)

This example is part of a 10-map series covering all of Norway, showing in colour what parts of the Northern line has a history of strong winds. The wind data is collected from meteorological stations near (< 20 km) from the railway in the period 1960-2019. The strongest average wind is shown in squares and gusts are the larger surrounding circles. 5 shades of green indicate Beaufort 7-11, with strongest being the darkest. Beaufort 12 (hurricane) is substituted by the Saffir-Simpson I-V categories of hurricanes, with V at the top (red) level. The wind gust data is projected on to the railway line in segments between railway stations. Anticipated increases in gusts strength and better proximity of measurements can be expected to better advise freight operations on the line.

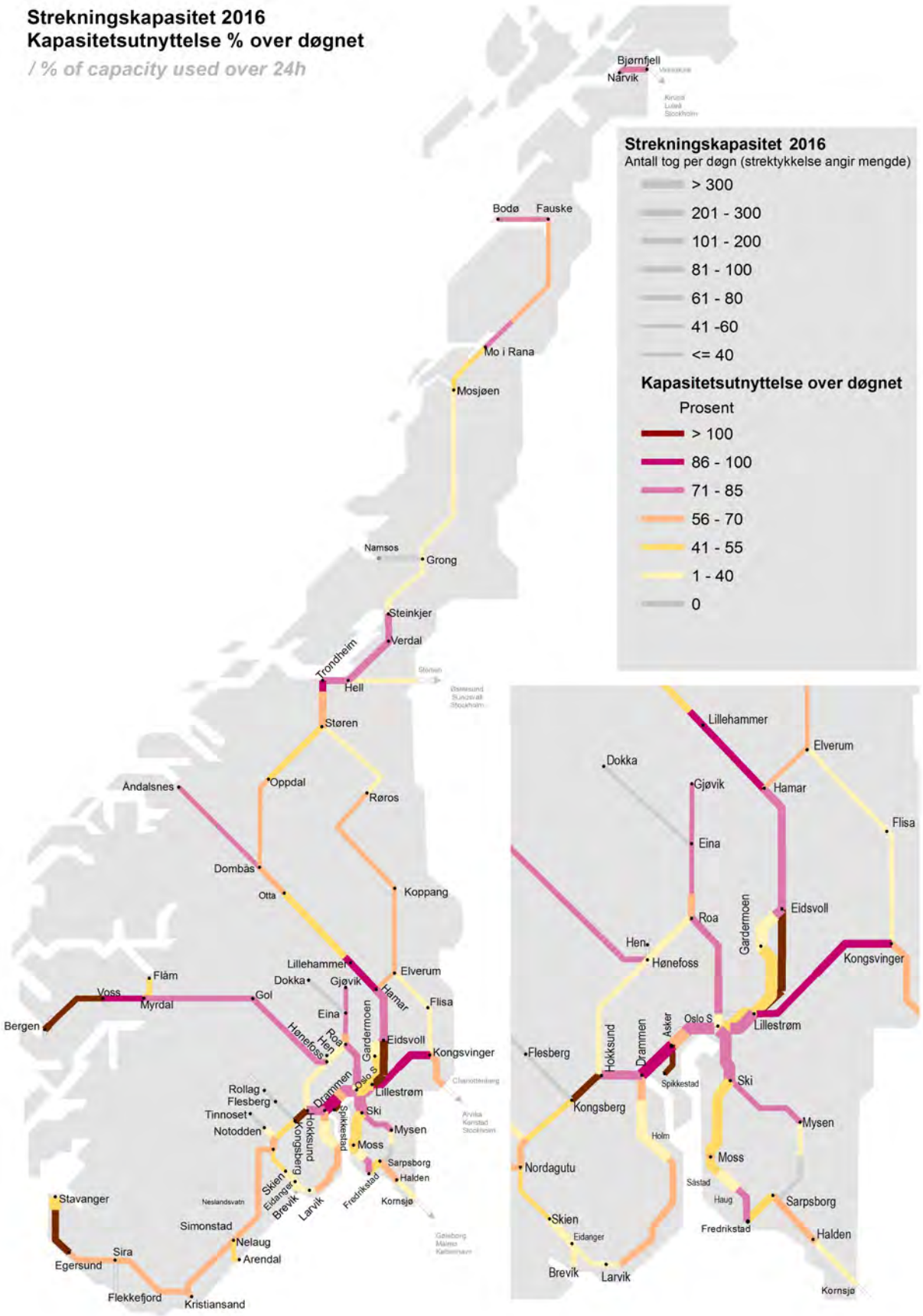

Strekningskapasitet 2016
Kapasitetsutnyttelse % over døgnet
/ % of capacity used over 24h
Strekningskapasitet 2016
Antall tog per døgn (strektykkelse angir mengde)
> 300
201 - 300
101 - 200
81 - 100
61 - 80
41 -60
<= 40
Kapasitetsutnyttelse over døgnet
Prosent
> 100
86 - 100
71 - 85
56 - 70
41 - 55
1 - 40
0
Bjørnfjell
Narvik
Bodø
Fauske
Mo i Rana
Mosjøen
Namsos
Grong
Steinkjer
Verdal
Trondheim
Hell
Støren
Åndalsnes
Oppdal
Røros
Dombås
Otta
Koppang
Lillehammer
Elverum
Dokka
Gjøvik
Hamar
Flisa
Eina
Roa
Hen
Hønefoss
Gardermoen
Eidsvoll
Kongsvinger
Oslo S
Lillestrøm
Asker
Drammen
Hokksund
Flesberg
Rollag
Tinnoset
Notodden
Kongsberg
Spikkestad
Ski
Mysen
Moss
Sarpsborg
Halden
Fredrikstad
Kornsjø
Skien
Eidanger
Brevik
Larvik
Nordagutu
Holm
Såstad
Haug
Flåm
Voss
Myrdal
Gol
Bergen
Stavanger
Egersund
Sira
Flekkefjord
Kristiansand
Simonstad
Nelaug
Arendal
Neslandsvatn

Figure 22

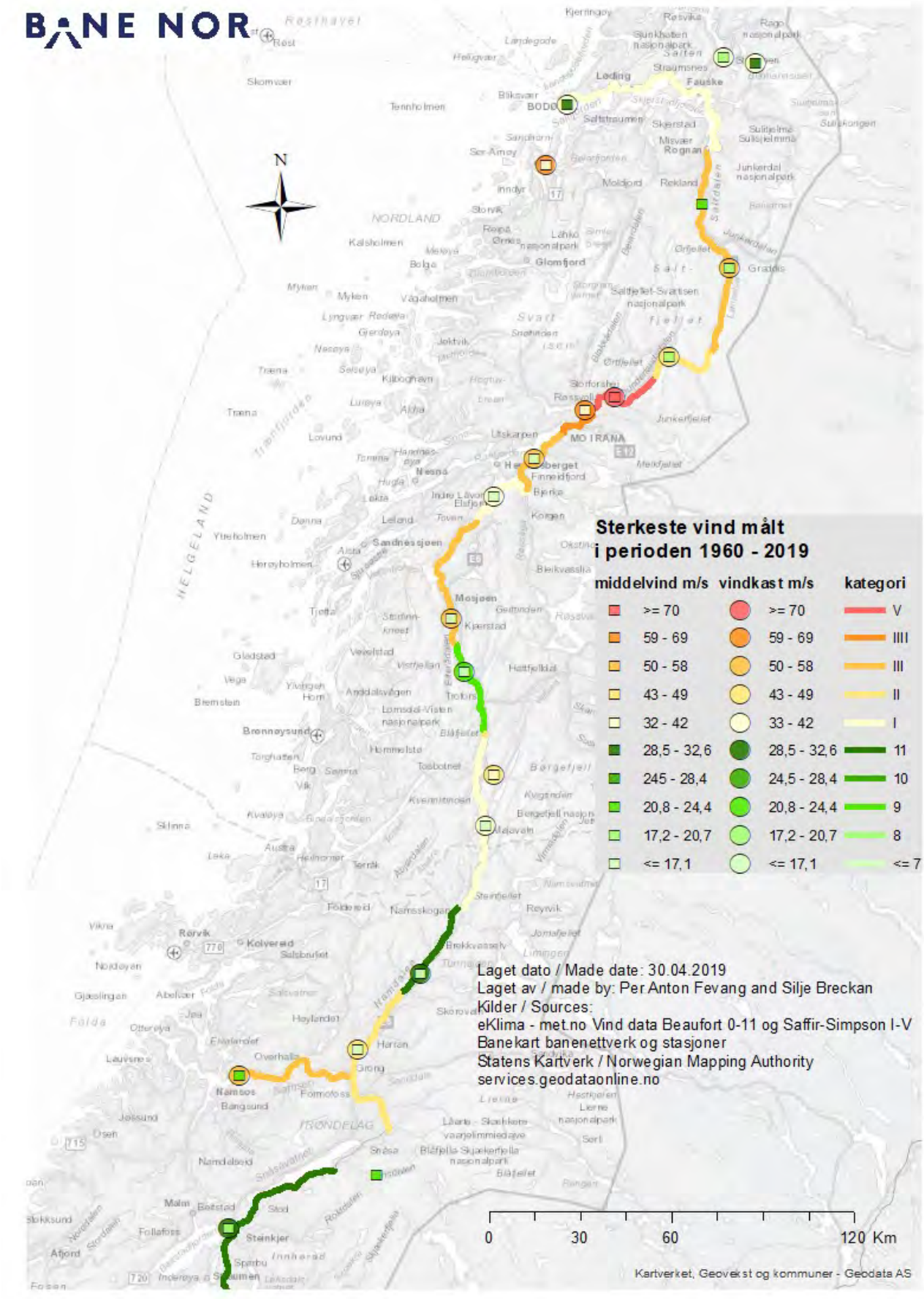

BANE NOR
Sterkeste vind målt
i perioden 1960 - 2019
middelvind m/s
vindkast m/s
kategori
>= 70
59 - 69
50 - 58
43 - 49
32 - 42
28,5 - 32,6
245 - 28,4
20,8 - 24,4
17,2 - 20,7
<= 17,1
V
IIII
III
II
I
11
10
9
8
<= 7
Laget dato / Made date: 30.04.2019
Laget av / made by: Per Anton Fevang and Silje Breckan
Kilder / Sources:
eKlima - met.no Vind data Beaufort 0-11 og Saffir-Simpson I-V
Banekart banenettverk og stasjoner
Statens Kartverk / Norwegian Mapping Authority
services.geodataonline.no
0
30
60
120 Km
Kartverket, Geovekst og kommuner - Geodata AS
N
BODØ
MO I RANA
Mosjøen
Mosjoen
Sandnessjøen
Sandnessjoen
Brønnøysund
Brønnøysund
Rørvik
Namsos
Steinkjer
NORDLAND
HELGELAND
TRØNDELAG

Figure 23

Statistics Norway

https://www.ssb.no/en/

Statistics Norway is the national statistical institute of Norway and the main producer of official statistics. We are responsible for collecting, producing and communicating statistics related to the economy, population and society at national, regional and local levels.

In addition to having primary responsibility for meeting the need for statistics on Norwegian society, Statistics Norway is also a driving force in international statistical cooperation.

Official statistics is the nation's common factual basis and is essential for a living democracy. The statistics aim to reflect society and show trends for the population, living conditions, the economy, the environment and employment. Individuals, businesses, the authorities, the media, educational institutions and researchers alike can all enjoy and benefit from Norwegian official statistics.

Statistics Norway reports to the Ministry of Finance and is subject to the provisions of the Statistics Act. However, Statistics Norway is a professionally autonomous organization, which means it can determine what it publishes, as well as how and when the publishing takes place.

The institute has 850 employees in total (2018), broken down by 310 at the Kongsvinger office and 540 at the Oslo office. Statistics Norway consists of 7 departments, of which 3 are statistical departments; Department of prices, financial and external statistics, Department of social statistics, and Department of national accounts and industry statistics.

In 2018 Statistics Norway published 814 statistical releases on 315 statistics (yearly, quarterly, monthly and weekly statistics) in addition to analysis and research publications (https://www.ssb.no/en/). Many of the statistics contain figures on regional level (counties, municipalities, basic statistical units in addition to different administrative and dynamic borders). Our main dissemination product for statistics on regional level is the Statbank (https://www.ssb.no/en/statbank).

Our expertise at GIS and geospatial data is mainly gathered in the Division for housing, property, spatial and agricultural statistics. In addition, there is a Centre of Excellence – the “GIS resource centre” – which coordinates many GIS activities in the institution. On a regular basis, around 10 persons are engaged in activities involving GIS, cartography and visualization at Statistics Norway.

Statistics Norway is responsible for some map data sets in accordance with the INSPIRE directive. These data sets can be found at the Geonorge Map catalogue (https://kartkatalog.geonorge.no/search?Facets%5B0%5D.name=organization&Facets%5B0%5D.value=Statistics%20Norway), and can also be found at our own map application Maps from Statistics Norway (https://kart.ssb.no/).

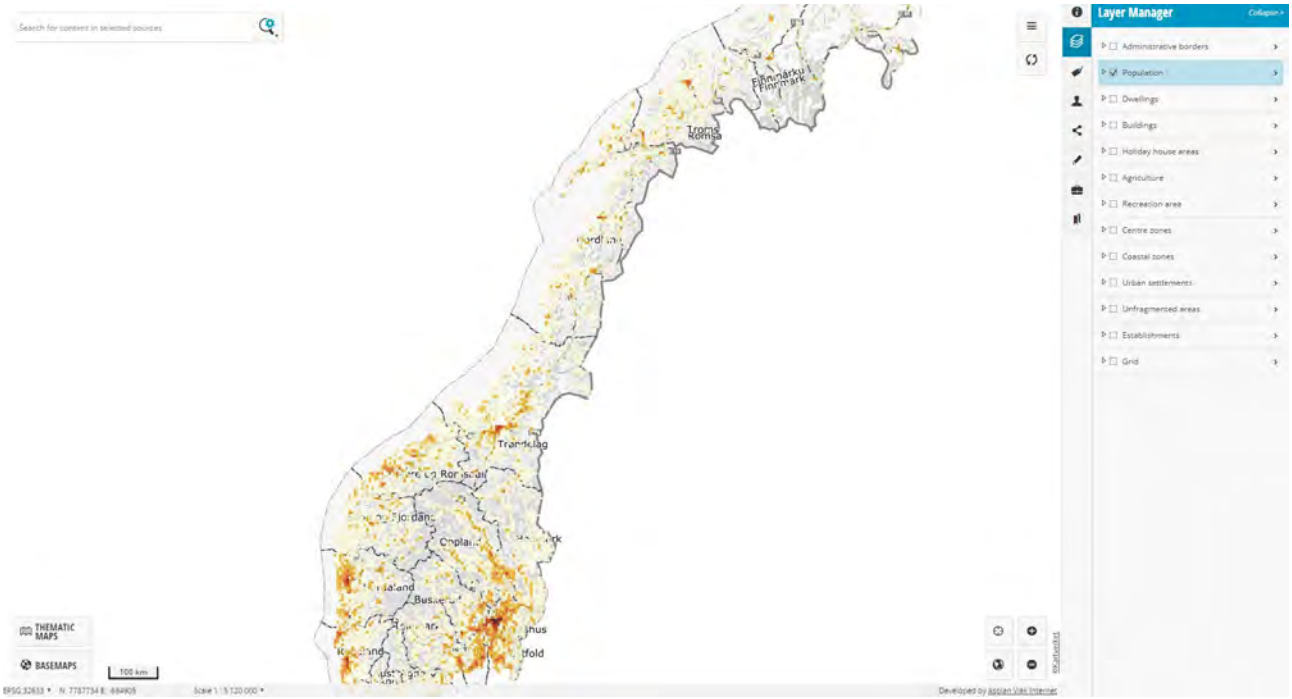

Layer Manager
Administrative borders
Population
Dwellings
Buildings
Holiday house areas
Agriculture
Recreation area
Centre zones
Coastal zones
Urban settlements
Unfragmented areas
Establishments
Grid
THEMATIC MAPS
BASEMAPS
Troms
Romsa
Finnmárku
Finnmark

Figure 24

Choropleth map applications

Gender equality

The indicators for gender equality in Norwegian municipalities are a set of twelve indicators that are important and relevant for describing gender equality at a local and national level over time, such as gender distribution in private and public sector, share of men/women in work force and part-time employment, gender distribution among leaders in private and public sector and among municipal council representatives. The indicators are based on administrative register data available at municipal level. These indicators are presented on a choropleth map (Norwegian language version only) (https://ssb1.maps.arcgis.com/apps/MapSeries/index.html?appid=7e3c8ea937754b9d84952585cb9fdf85)

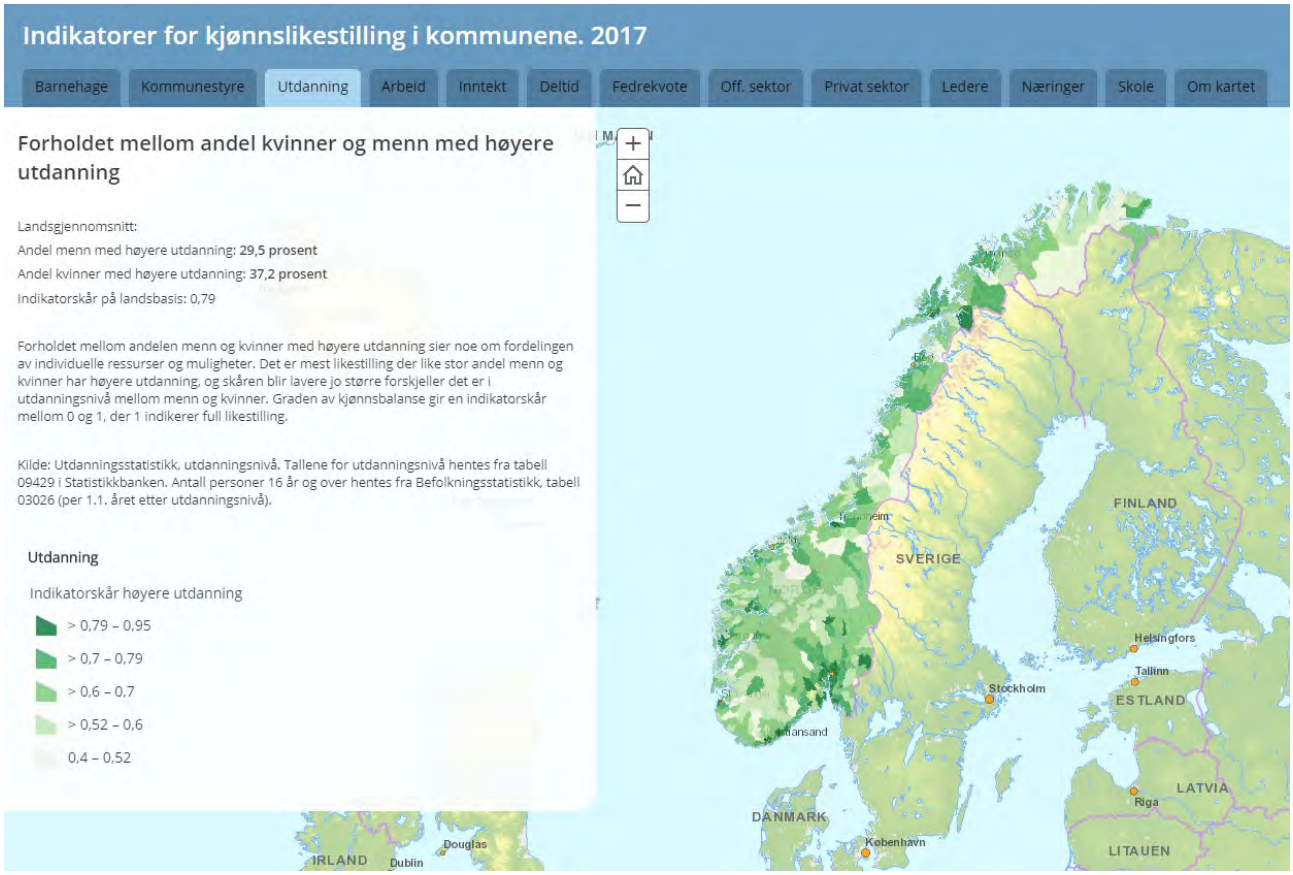


Figure 25

Population projections

Population projections are calculations of how the population in Norway will potentially develop over time, given different assumptions about fertility, mortality, internal migration, immigration and emigration. These projections are presented on a choropleth map (Norwegian language version only) (http://ssb1.maps.arcgis.com/apps/MapSeries/index.html?appid=59ccdd3707ef4a76bdab47e760e7674a)

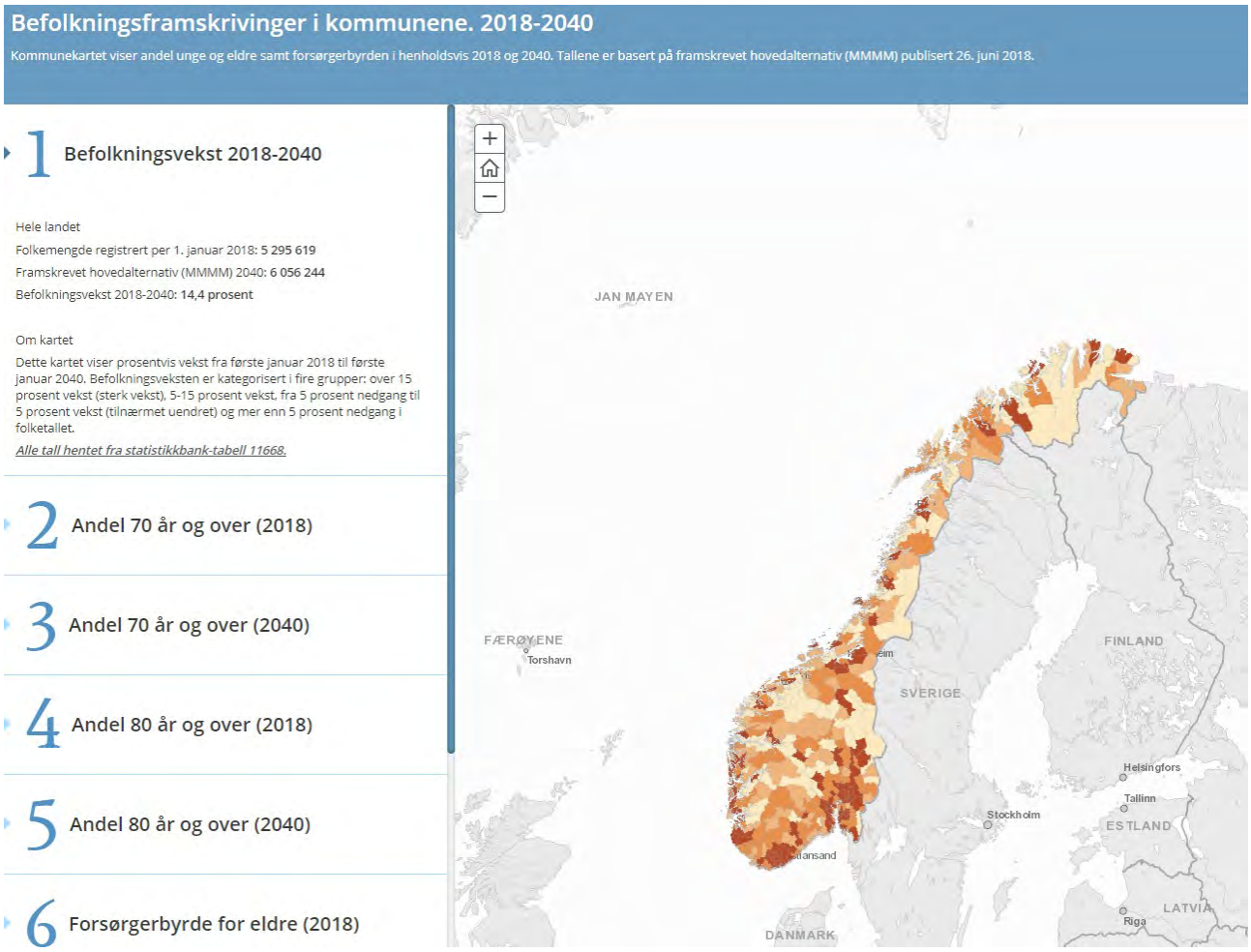


Figure 26

Møre and Romsdal County Municipality

https://mrfylke.no/Tenesteomraade/Plan-og-analyse/Kart-og-fagdata

Møre og Romsdal County Municipality solves tasks that are to big for the local authorities. The municipality is political governed. Our main tasks are to manage county roads and public transport. Another big task is operating high schools. Møre and Romsdal County Municipality is a large workplace with over 2500 employees, where five of us work with maps in different ways.

Our institution uses products from ESRI to produce different thematic maps with ArcGIS online (eg. figure 27) as well as ArcGIS Pro. We also use Geocortex Essential from Latitude geographics to publish a huge number of thematic maps for use in public planning (eg. figure 28).

We will continue to develop routines towards open source data from Geonorge (Norway's official map catalog) and SSB api (statistical agency).

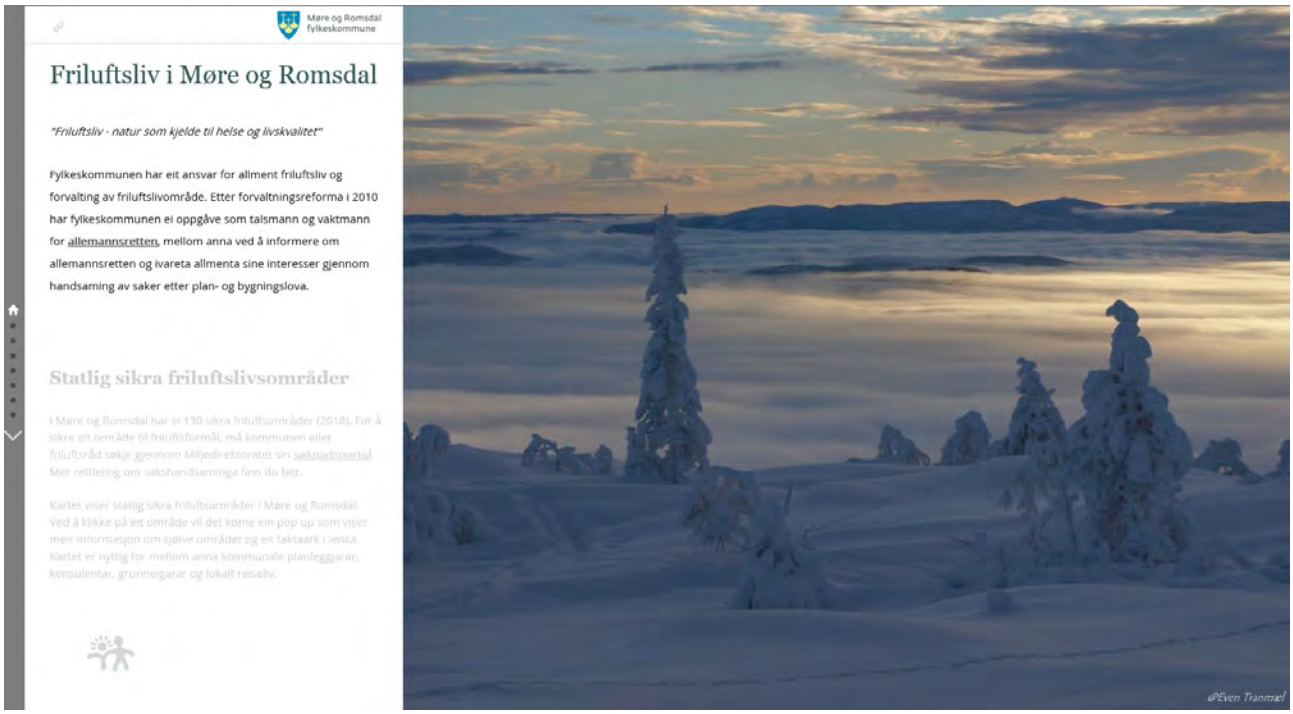


Figure 27: ArcGIS online Storymap to promote outdoor activities in Møre and Romsdal (link: http://mrfylke.maps.arcgis.com/apps/MapJournal/index.html?appid=8a96ad6db1eb4658b5b2c031087f0ce4)

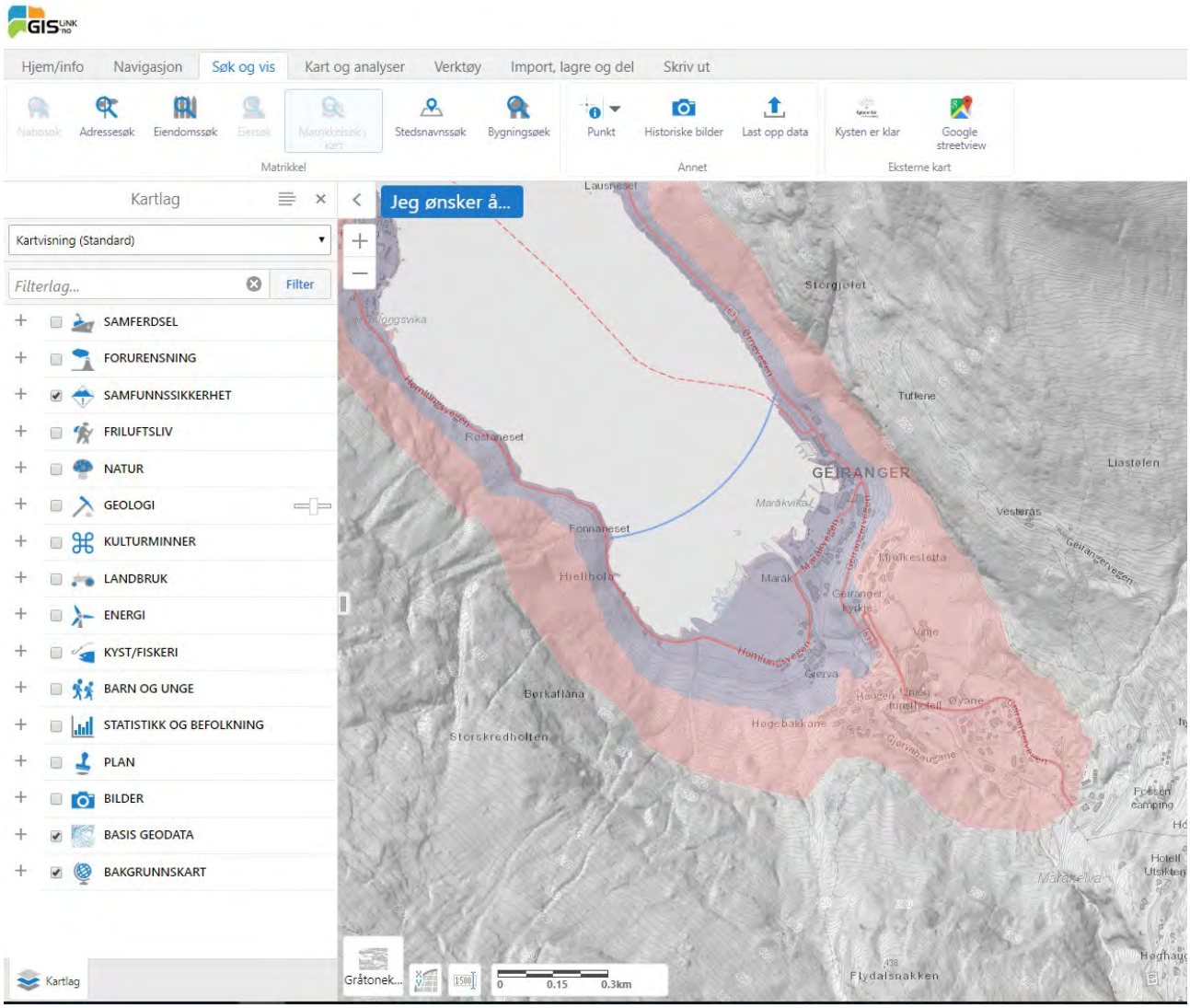


Figure 28: Thematic map portal produced with Geocortex Manager (link: https://kart.gislink.no/kart/?viewer=kart)

For more information about our map activity you can visit our homesite here: https://mrfylke.no/Tenesteomraade/Plan-og-analyse/Kart-og-fagdata

Oslo

Oslo is both the capital of Norway and the most populous city. Founded in 1040 under the name Ánslo, it has gone through numerous transitions over the centuries, both in name and prominence. It got its current name in 1925. As in its early days, it is a hub of trade and commerce, as well as a key location within the maritime industries. There are more than 50,000 employees in the municipality; The mapping division consists of roughly fifty individuals, of which a significant portion work directly with cartographic activities. We provide a variety of maps for other parts of the Agency for Planning and Building Services, as well as for the public and other departments. We also produce 3D models for specific projects. Some examples of maps we provide are as follows:

Figure 29

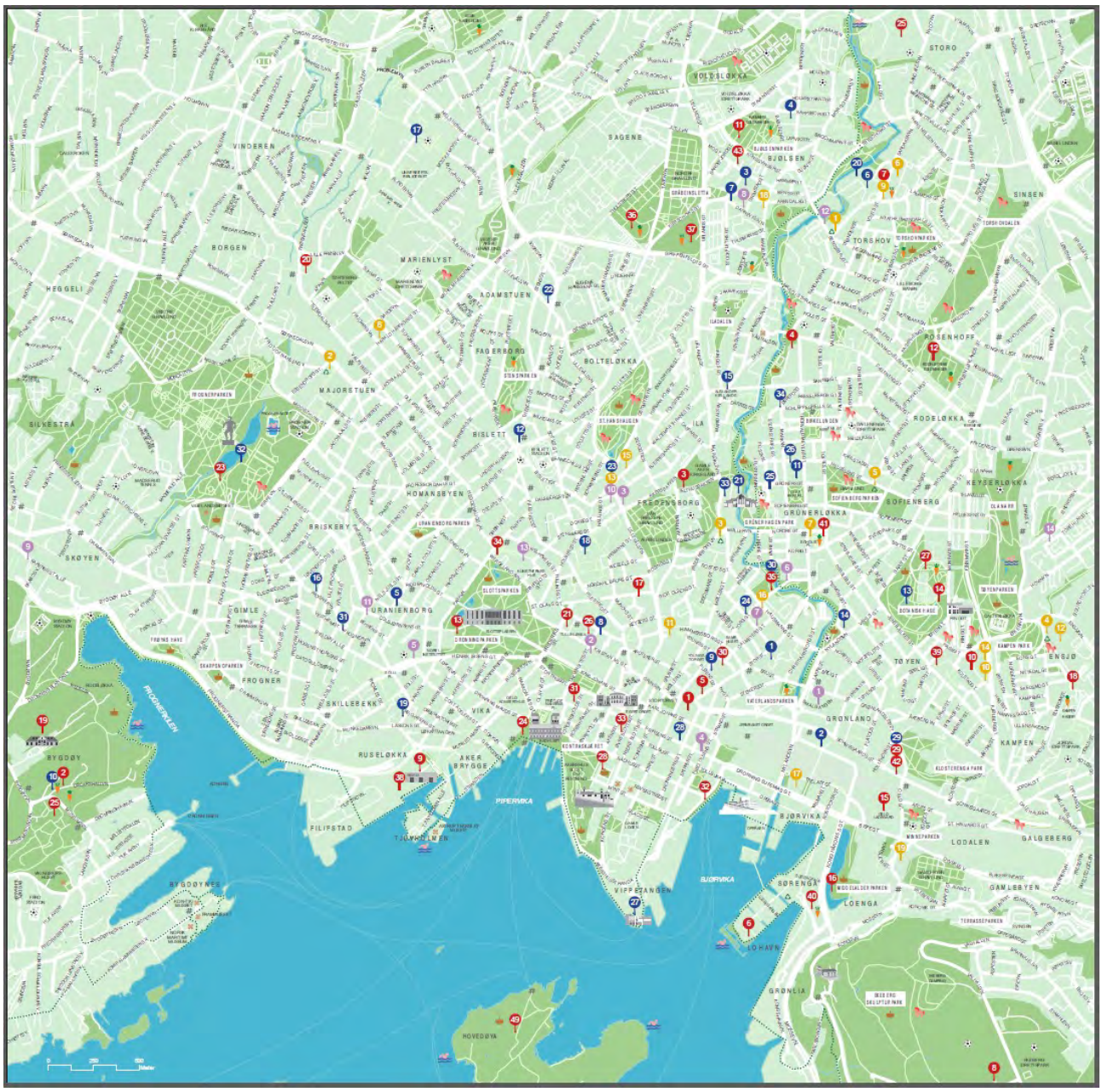

VINDEREN
BORGEN
HEGGELI
MARIENLYST
ADAMSTUEN
FABERBORG
BOLTELØKKA
MAJORSTUEN
SILKESTRA
BISLETT
HOMANSBYEN
BRISKEBY
SKØYEN
GIMLE
URANIENBORG
FROGNER
SKILLEBEKK
VIKA
AKER BRYGGE
RUSELØKKA
BYGDØY
BYGDØYNES
FILIPSTAD
PIPERVIKA
VIPPETANGEN
BJØRVIKA
SØRENGA
LOENGA
LOHAVN
GRØNLIA
HOVEDØYA
FROGNERKILEN
STORO
SAGENE
BJØLSEN
TORSHOV
SINSEN
ROSENHOFF
RODELØKKA
KEYSERLØKKA
SOFIENBERG
GRÜNERLØKKA
TØYEN
ENGJØ
GRØNLAND
KAMPEN
LODALEN
GALGEBERG
GAMLEBYEN

Figure 30

Stavanger

Example on map use from Stavanger kommune:

https://www.stavanger.kommune.no/en/culture-and-leisure/recreational-activities/52-everyday-trips-find-tours-in-stavanger/

In Stavanger there are 52 different routes marked up in and around the city to make it easier for people to live active lives.

Scattered around the municipal there are 52 routes, one for each week, that will take you through many different parts of the local area. These are a great way to get to experience new places and to get some fresh air and exercise.

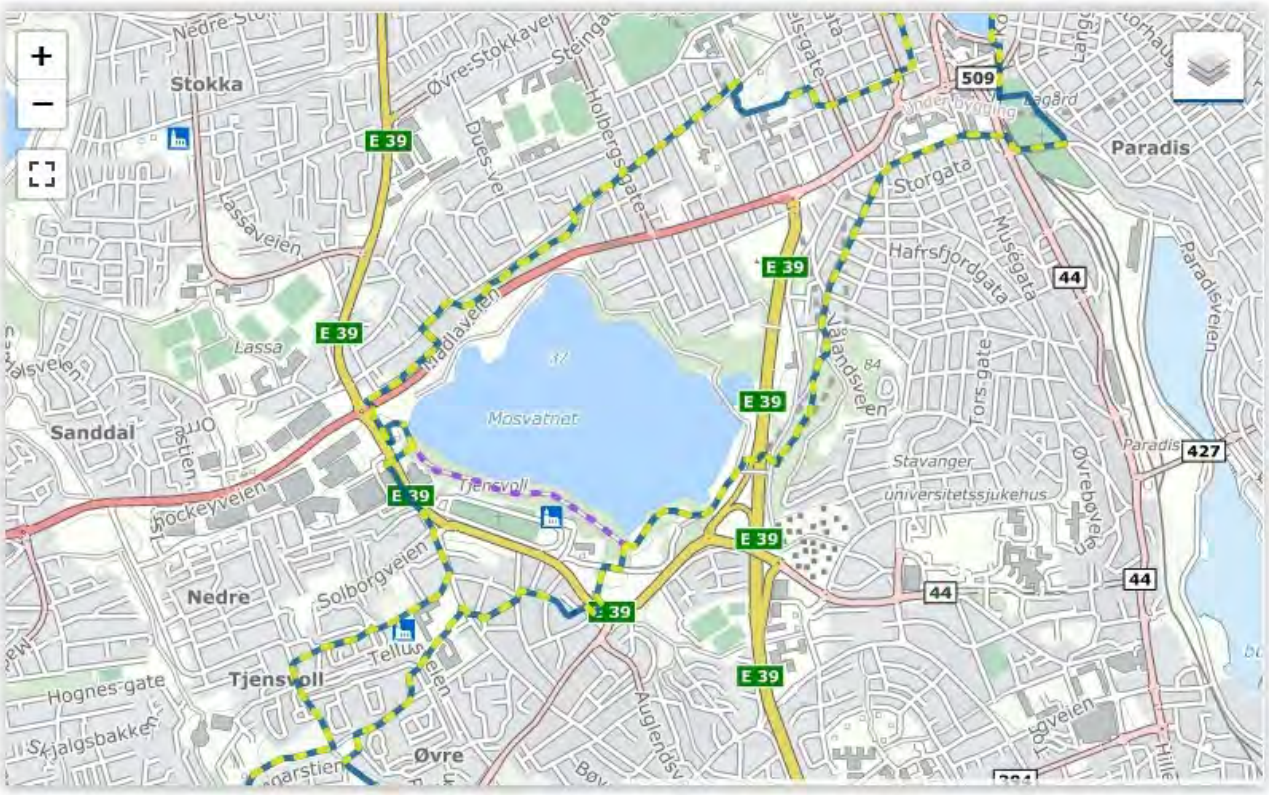


Figure 31: Walking route in Stavanger

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/

Geodata AS is the business leader in Norway distributing geographical data and technology in both private and public sector. We cover all industries from the Petroleum industry, through infrastructure and public services like the Norwegian Environment Agency, National Office of Building Technology and Administration to the largest Telcom companies in the country. Geodata has 140 employees. 125 of these are engaged in cartography/visualization.

Our main ambitions:

- Geodata intend to be the best workplace in Norway
- Geodata intend to prove that GIS creates value for the society
- Geodata intend to be an innovative tech-company
- Geodata intend to be the best in customer experience
- Geodata intend to grow faster than the marked

We are sole distributors of Esri software in Norway and have a large professional services division making custom design, functionality and analysis. We base our solutions mainly on Esri SDKs and API's and in addition of reselling software "of the shelf", we make large geographical based solutions in agile projects to our customers. We have a highly skilled staff with more than 70% having a bachelor/master's degree in Geosciences or development, and develop our portfolio of expertise through new projects, POCs and investing up to 20% of each employee's time increasing his or hers technical- and soft skills.

Geodata aim to be advisors for our customers and in the market. We want to show the possibilities in GIS and visualization and introduce more companies and industries to spatial technology.

Core business:

- Data – gathering and sharing large amounts of data through our own data cloud in Amazon
- Cloud – Amazon and Azure – Software as a service, solutions for customers and integrations
- Integrations – data and sources (lakes, different formats and sources)
- Software – distributing Esri software
- Geoscience – on premise and in our own projects
- Development – custom development in up to date-tech
- Design – front end and IA
- Agile projects

- Data science – Machine learning, AR, VR, satellite imagery,
- Analytics
- IoT – sensors, showing sensors in context and react on events
- 3D and 4D
- Smart city
- Digital Twin

A few examples on products:

iMarka – an app showing cross country tracks with live updates from the track machines. In summer it shows trails and tractor roads. www.skiforeningen.no iMarka (Appstore)
Askeladden.no – Norway's official database of cultural heritage sites. Containing more than 500.000 heritage sites, with administrative UI for history and maintenance.
https://www.riksantikvaren.no/en/
Norgeibilder.no - for The Norwegian mapping Authority. We developed work flows with UI gathering aerial imagery and visualizing them in context, with historic data and functions for comparison (also in 3D). www.norgeibilder.no
Police Operations – A new map solution to increase efficiency and to see more information in context when an incident occurs, and to be able to share information with other involved systems or personnel.
3D clip and ship – from our own data warehouse in Amazon. A service building a complete 3D scene for a selected area. With, among others, structures, terrain and vegetation.
Maps and services : https://www.geodata.no/produkter-og-tjenester?originId=430

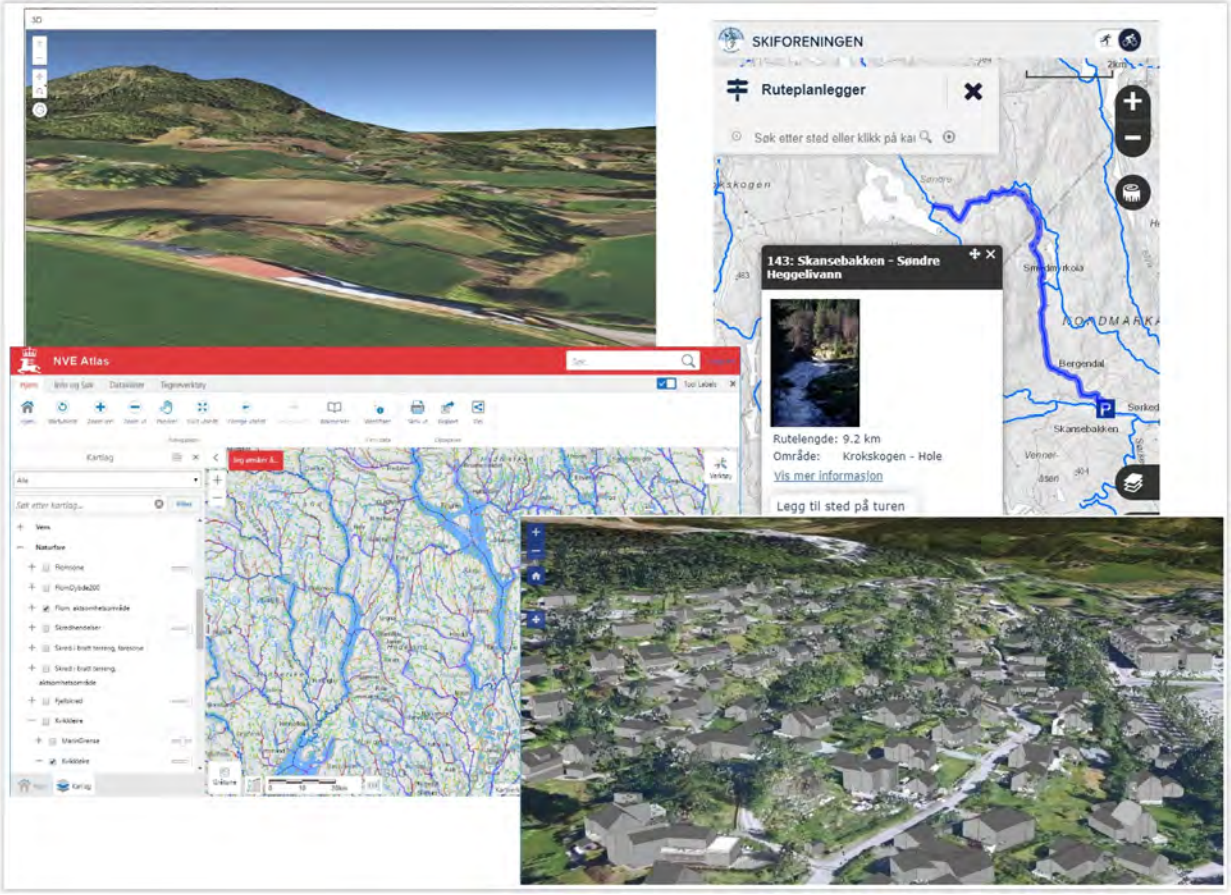

SKIFORENINGEN
Ruteplanlegger
Søk etter sted eller klikk på kar
143: Skansebakken - Søndre Heggelivann
Rutelengde: 9.2 km
Område: Krokskogen - Hole
Vis mer informasjon
Legg til sted på turen
NVE Atlas
Kartlag
Bergendal
Skansebakken

Figure 32


Motorsykler
0
Sykler
3
Fotgjengere
5
Lastebiler
8
Biler
126
Busser
1
291,768

Figure 33

Blom Norway AS

http://www.blom.no/

Blom Norway AS is a leading supplier in the Nordic market for capturing, processing and modelling of geographical information. Our main fields of business are stereo mapping, DTMs, DSMs, technical maps, forest stand maps, forest inventory, disaster mapping (flood, land slide, earthquakes, etc), orthophotos, 3D-modeling and visualization, oblique and street image libraries. Blom owns rights to unique European geospatial databases of maps, imagery, and models. Blom offers online electronic services within Governmental departments, private and consumer markets. Partners can access our services and create applications based on our databases and location-based services. Blom Norway AS is recognized by its skilful personnel and ability to create new solutions and services. The company has 18 employees, two of which are working with visualization.

BlomFORESTVIEW™ bridges the gap between advanced LiDAR data and simple use for vegetation mapping. 3D point clouds contain a lot of information, but they are difficult to use in their original format. BlomFORESTVIEW™ is a raster representation of a digital surface model (DSM) that is generated from LiDAR-data and the vegetation is visualized with different colours based on its height. The result is both easy to interpret for non-experts and analytical with respect to tree heights. It can be used -together with aerial imagery- for the delineation of forest stands. Examples of other uses are mapping of small vegetation elements in the landscape and the mapping of vegetation in powerline corridors.

BlomFORESTVIEW™ is based on standard LiDAR data, in Norway this means a density of 2 or 5 points per m^2. The visualization will be first produced for Norway, but it can be made for LiDAR data anywhere in the world.

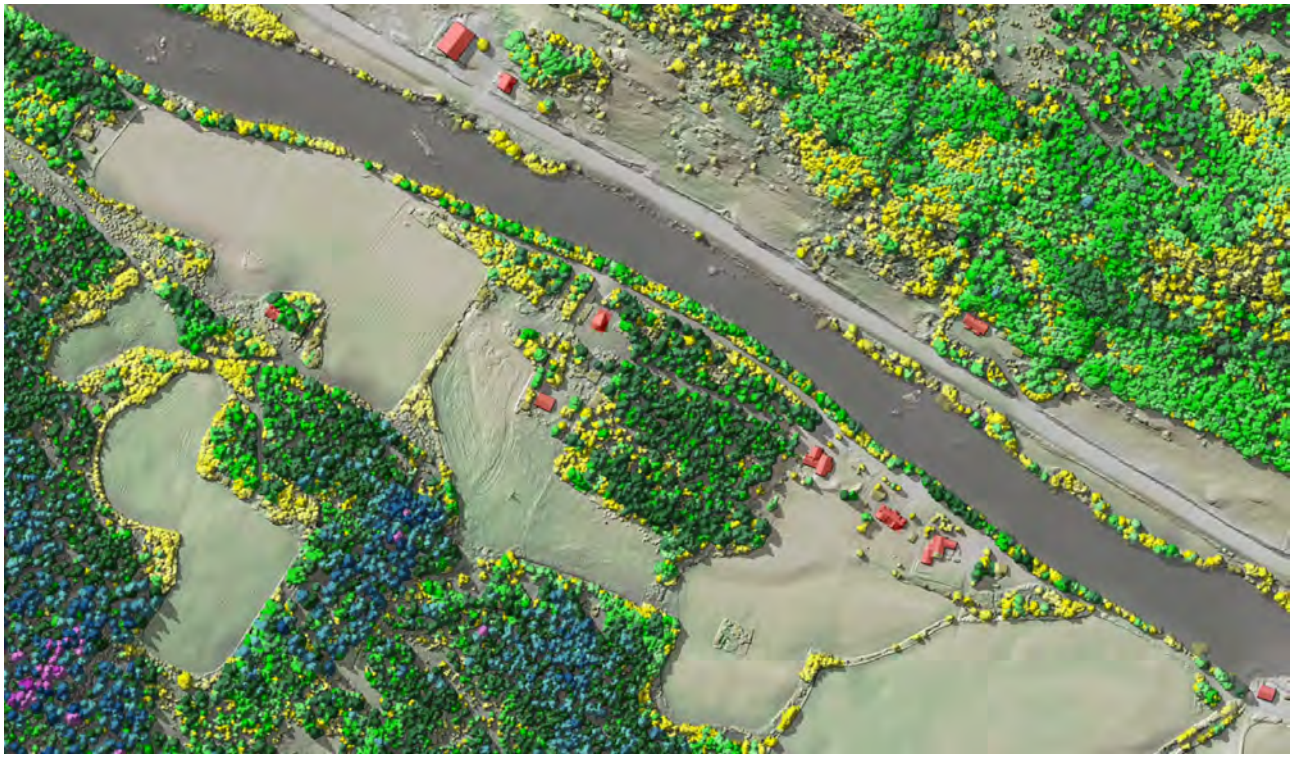


Figure 34

Figure 36

eMap

www.emap.no

eMap makes any products where the map is a central part of the end product. Often, the end product is the visual or cartographic map itself.
This includes, amongst others, street maps, topographic hiking maps, car and tourist maps to fishing and hunting maps, illustrative maps, information boards, and wall maps.
We have had continuous operations since 1988 and are one of few specialized cartographic companies in Norway.

Our main focus is the visual presentation and related products where maps play a central role. This includes ordinary topograpgic maps, map illustrations in books, wall maps and trailhead maps. Often, layout is to comply with a graphic profile, and we then strive to make the map itself comply with the same profile as well. We both offer a complete enterprise as well as providing just the map file for other projects.

eMap has three employees, where two are working on map and graphics production as well as following up our customers.

We make cartographical maps from geodata via software for graphic use like Adobe Illustrator, Photoshop and InDesign. Most often, we produce print ready PDF-files. Printing, plotting, and other services are done by subcontractors, with whom we cooperate closely with. We also make digital products for the Internet. This can be static maps or interactive maps with customized content (Point of Interest).

Other activities include product and production line improvements. We are constantly working on improving map content by looking for new sources of information for our maps. Lately, free Lidar-data has become available for more and more of the Norwegian territory. This again enables to improve the content and visual style of the maps.

On the next pages you can find two examples (sections) of products made during the period 2015-2019:

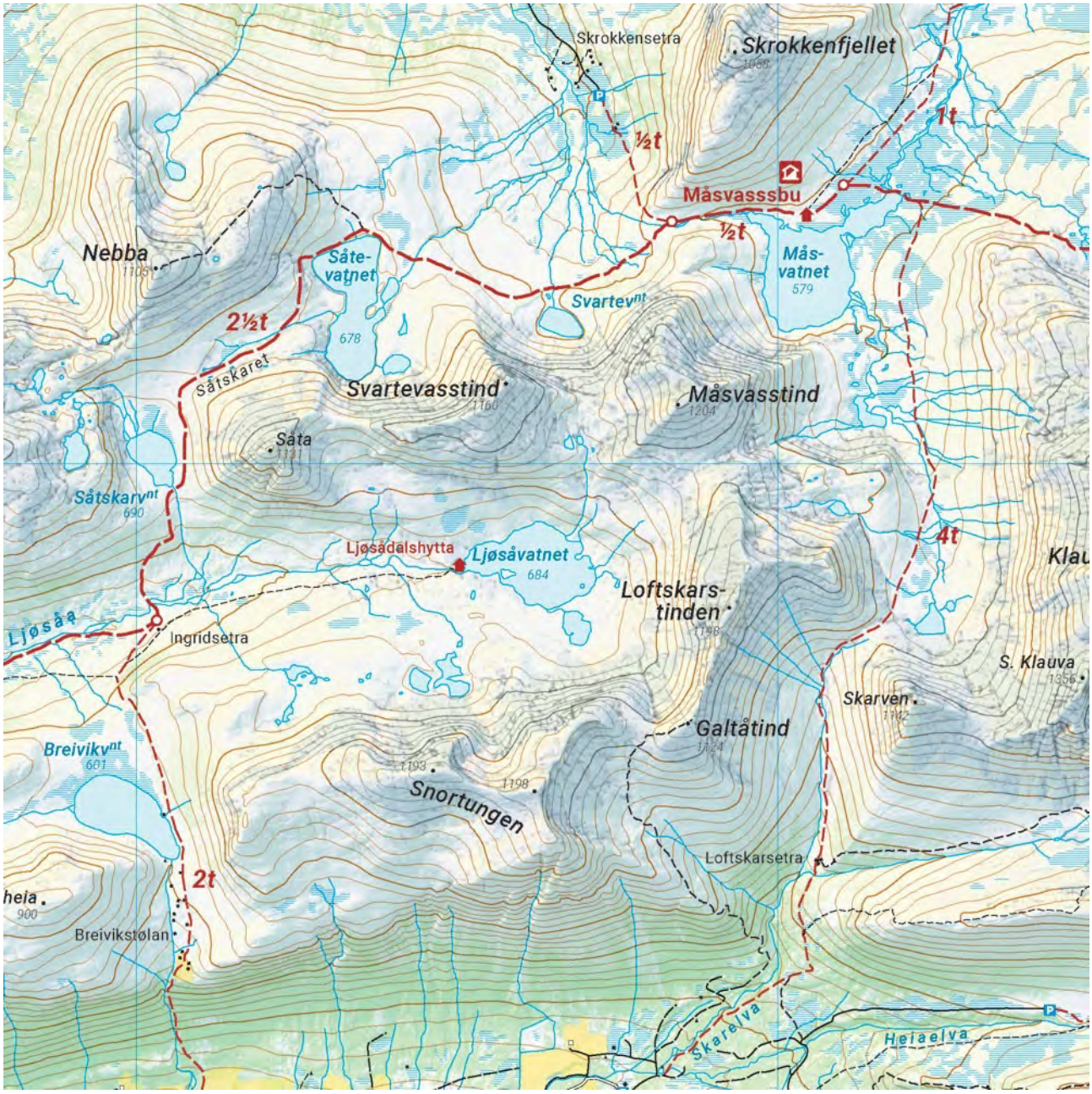

Skrokkensetra
Skrokkenfjellet
1088
1t
½t
Måsvasssbu
½t
Nebba
1105
Såte-
vatnet
678
Svartevnt
Más-
vatnet
579
2½t
Såtskaret
Svartevasstind
1160
Måsvasstind
1204
Såta
1131
Såtskarvnt
690
Ljøsådalshytta
Ljøsåvatnet
684
4t
Klau
Loftskars-
tinden
1198
Ljøsåa
Ingridsetra
S. Klauva
1356
Skarven
1102
Galtåtind
1124
Breivikvnt
601
1193
1198
Snortungen
Loftskarsetra
2t
heia
900
Breivikstølan
Skarelva
Heiaelva

Figure 37

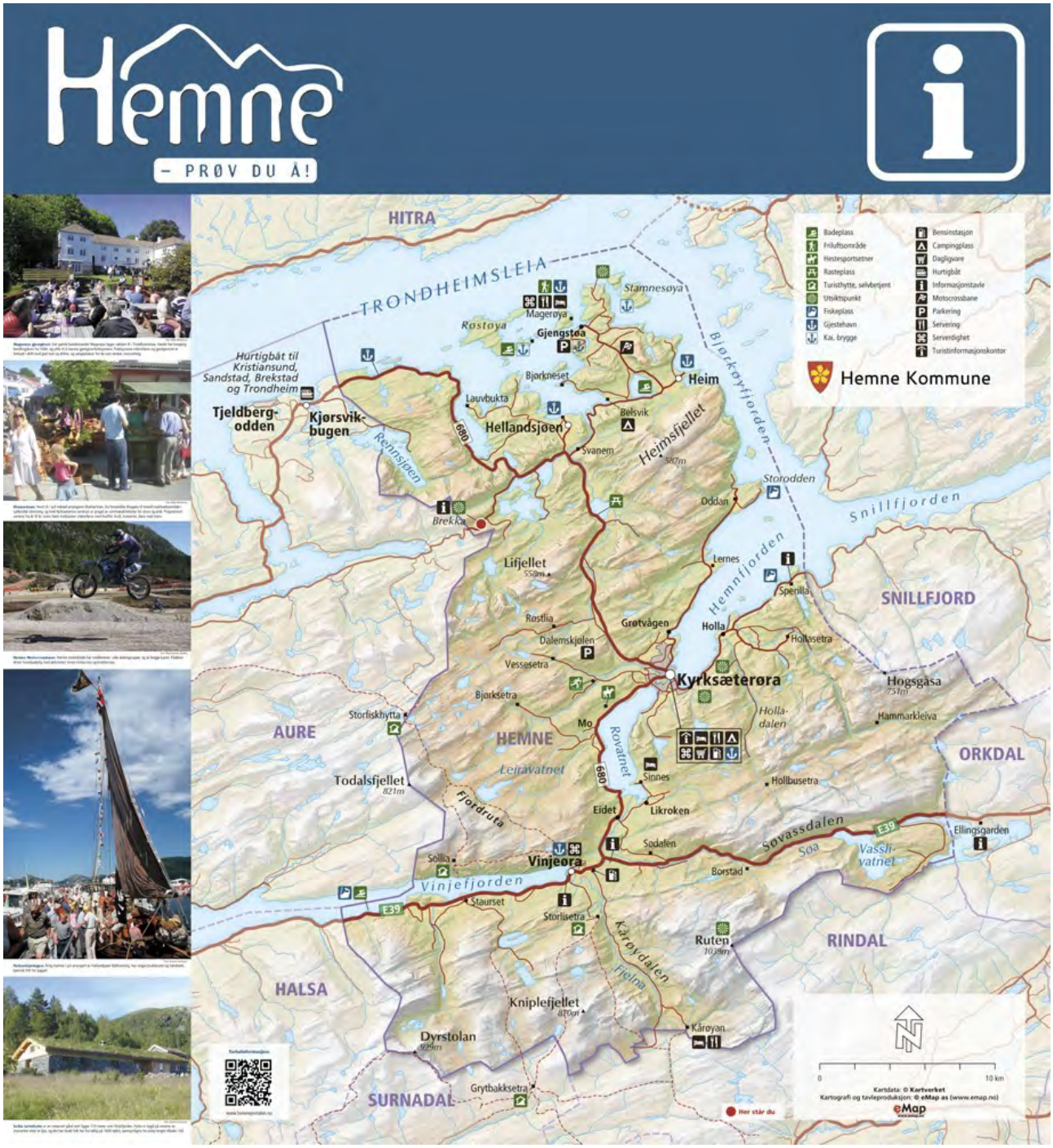

Hemne
– PRØV DU Å!
HITRA
TRONDHEIMSLEIA
Stamnesøya
Røstøya
Magerøya
Gjengstøa
Hurtigbåt til Kristiansund, Sandstad, Brekstad og Trondheim
Tjeldberg-odden
Kjørsvik-bugen
Bjørkneset
Lauvbukta
Hellandsjøen
Heim
Belsvik
Heimsfjellet
Svanem
Reinnsjøen
680
Bjørkøyfjorden
Storodden
Oddan
Brekka
Snillfjorden
Lifjellet
Lernes
Hemnfjorden
Spenilla
SNILLFJORD
Røstlia
Grøtvågen
Holla
Dalemskjølen
Hollasetra
Vessesetra
Kyrksæterøra
Hogsgåsa
Bjørksetra
Holla-dalen
Hammarkleiva
Storfiskhytta
AURE
Mo
HEMNE
Rovatnet
ORKDAL
Leiravatnet
Sinnes
Hollbusetra
Todalsfjellet
821m
Fjordruta
Likroken
Eidet
Søvassdalen
E39
Ellingsgarden
Sodalen
Søa
Vassli-vatnet
Solla
Vinjeøra
Borstad
Vinjefjorden
Stauset
Storlisetra
Kårøydalen
Ruten
1019m
RINDAL
Fjelma
HALSA
Kniplefjellet
870m
Kårøyan
Dyrstolan
929m
Grytbakksetra
SURNADAL
Badeplass
Bensinstasjon
Friluftsområde
Campingplass
Hestesportsetter
Dagligvare
Rasteplass
Hurtigbåt
Turisthytte, selvbetjent
Informasjonstavle
Utsiktspunkt
Motocrossbane
Fiskeplass
Parkering
Gjestehavn
Servering
Kai, brygge
Serverdighet
Turistinformasjonskontor
Hemne Kommune
Her står du
Kartdata: © Kartverket
Kartografi og tavleproduksjon: © eMap as (www.emap.no)
eMap

Figure 38

Mesterkart

www.mesterkart.no

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.

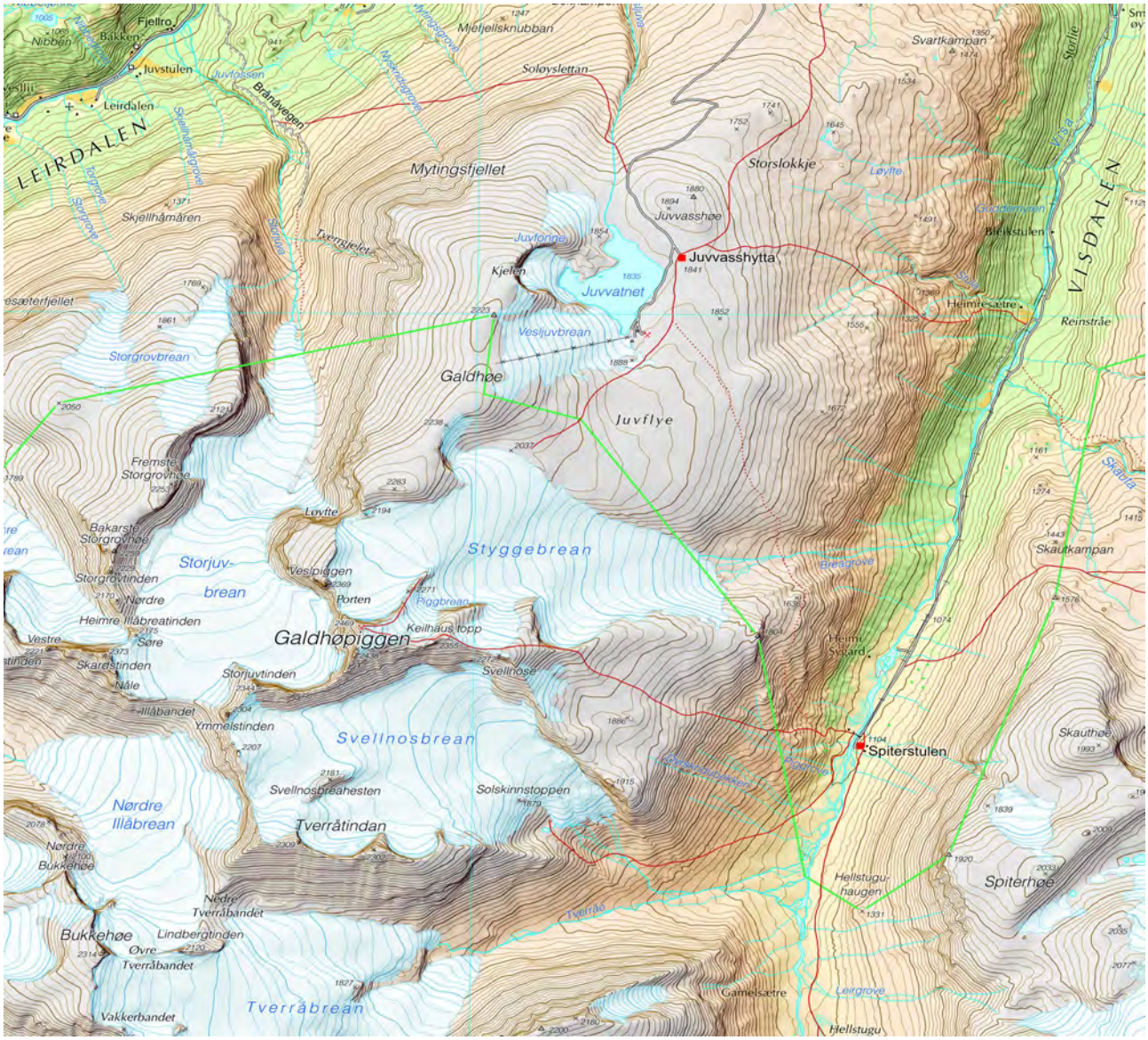


Figure 39: Galdhøpiggen. A section from a topographic wall map covering the eastern part of Jotunheimen, a large mountain area in Norway. The section shows Galdhøpiggen, the highest mountain in Norway. Scale 1 : 50 000. Map size 100 x 150 cm.

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.

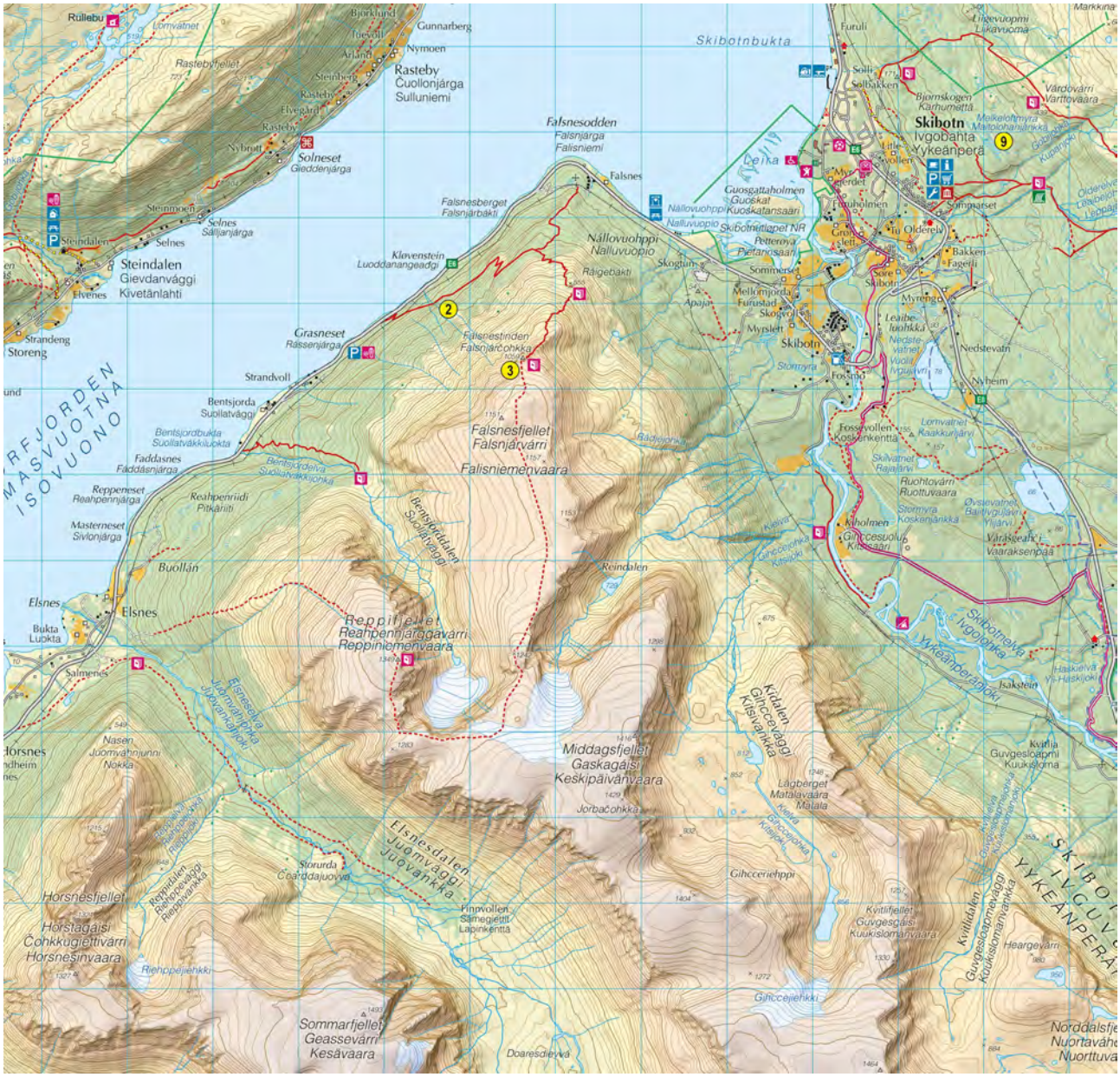


Figure 40: A section from Turkart Storfjord, one of our tourist- and hiking maps. Scale 1 : 50 000. Map size 70 x 100 cm.

Karttjenester AS

http://www.karttjenester.no/

Karttjenester AS is a privately owned company located in Tonstad, Sirdal. We are four people in the company, three working with cartography and visualisation.

Our main field is making detailed local area plans for private and local government. Currently we are also working on a project to bring the maps online as a supplement to paper or pdf.

Apart from area plans, we also do road engineering, web-GIS, different thematic maps, 3D modelling/visualization, framed wall maps and other map products. One of our products is LøypeDrift, a web based management system for recreational infrastructure.

Two examples on the next pages.

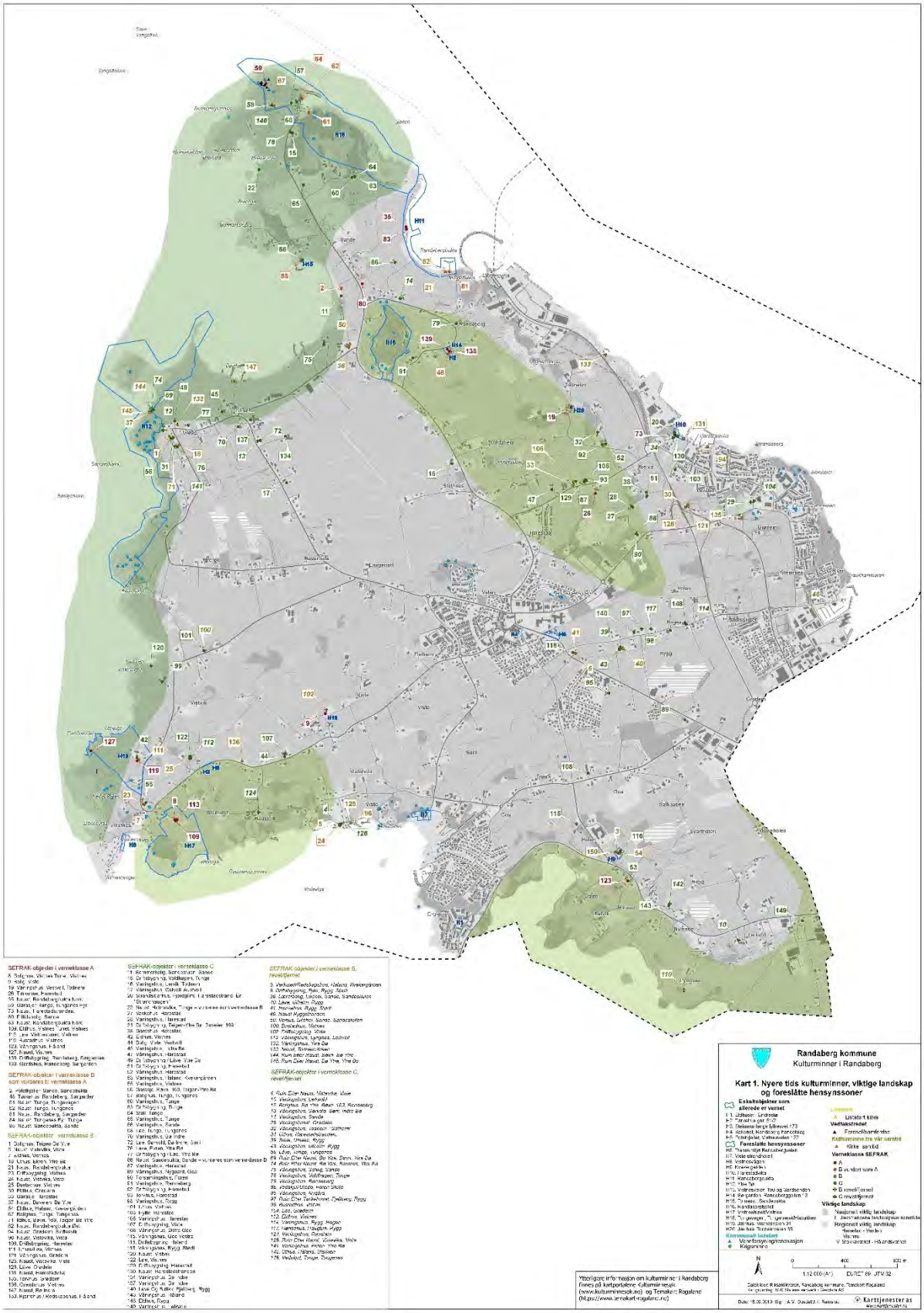
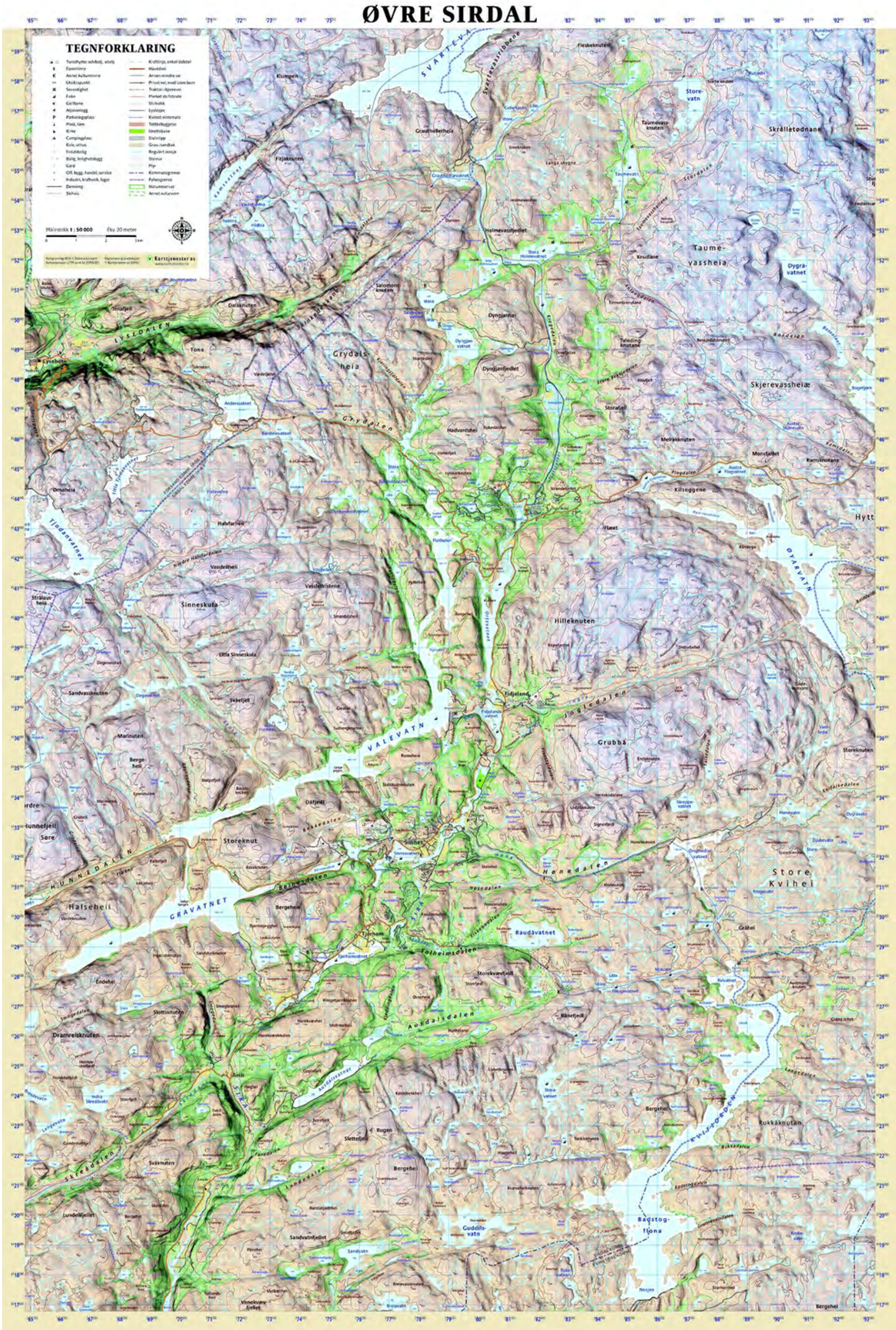


Figure 41: Cultural heritage map, Randaberg



[5] *Figure 42: Wall map, Upper Sirdal*

Hans Ragnar Mathisen

I belong to the Indigenous people of Fenno-Scandia, the Sámi people. Mapmaking is one of several outlets or branches of my artistic activity. I have 7 years of art education in Norway, from Art school and Art Academy in Osolo 1971-78, in addition to study tours in North-America, South East Asia, Japan, Chine, Australia and Aotearor/New Zealand, lasting several years.

Another branch of such activites is bookbinding, binding my owns sketchbooks, and art on paper collections, more than 100 so far. By profession I am a painter and a graphic artist (woodblock print and lithography), and freehand drawing goes through it all like a basic line. My themes are portraits, landscapes, symbolic art and also non-figurative art. Being a Sami it is not unusual top have abilities in several art activities, just like most Sámi are bilingual or more, as a consequence of being and Inter-Nordic and Inter-national people.

On the next pages you can find some examples on hand-drawn maps based on the Sámi culture:

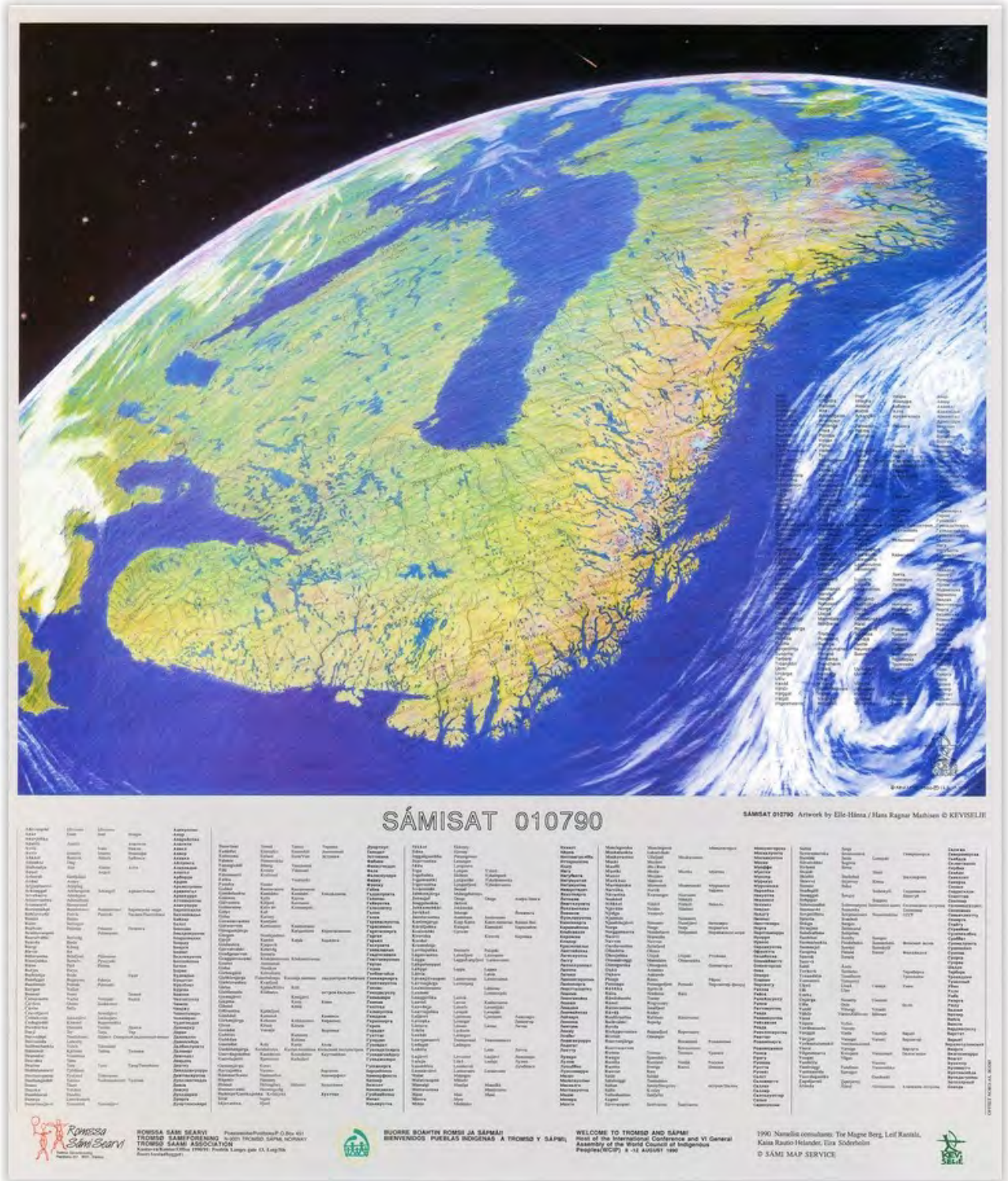

SÁMISAT 010790
SÁMISAT 010790 Artwork by Ele-Hánsa / Hans Ragnar Mathisen © KEVISELIE
Romssa Sámi Searvi
ROMSSA SÁMI SEARVI
TROMSØ SAMEFORENING
TROMSØ SAAMI ASSOCIATION
BUORRE BOAHTIN ROMSII JA SÁPMÁI
BIENVENIDOS PUEBLAS INDÍGENAS A TROMSØ Y SÁPMI;
WELCOME TO TROMSØ AND SÁPMI!
Host of the International Conference and VI General Assembly of the World Council of Indigenous Peoples/WCIP) 6 -12 AUGUST 1990
1990 Narration consultants: Tor Magne Berg, Leif Rantala, Kaisa Rautio Helander, Eira Södergården
© SÁMI MAP SERVICE

Figure 43

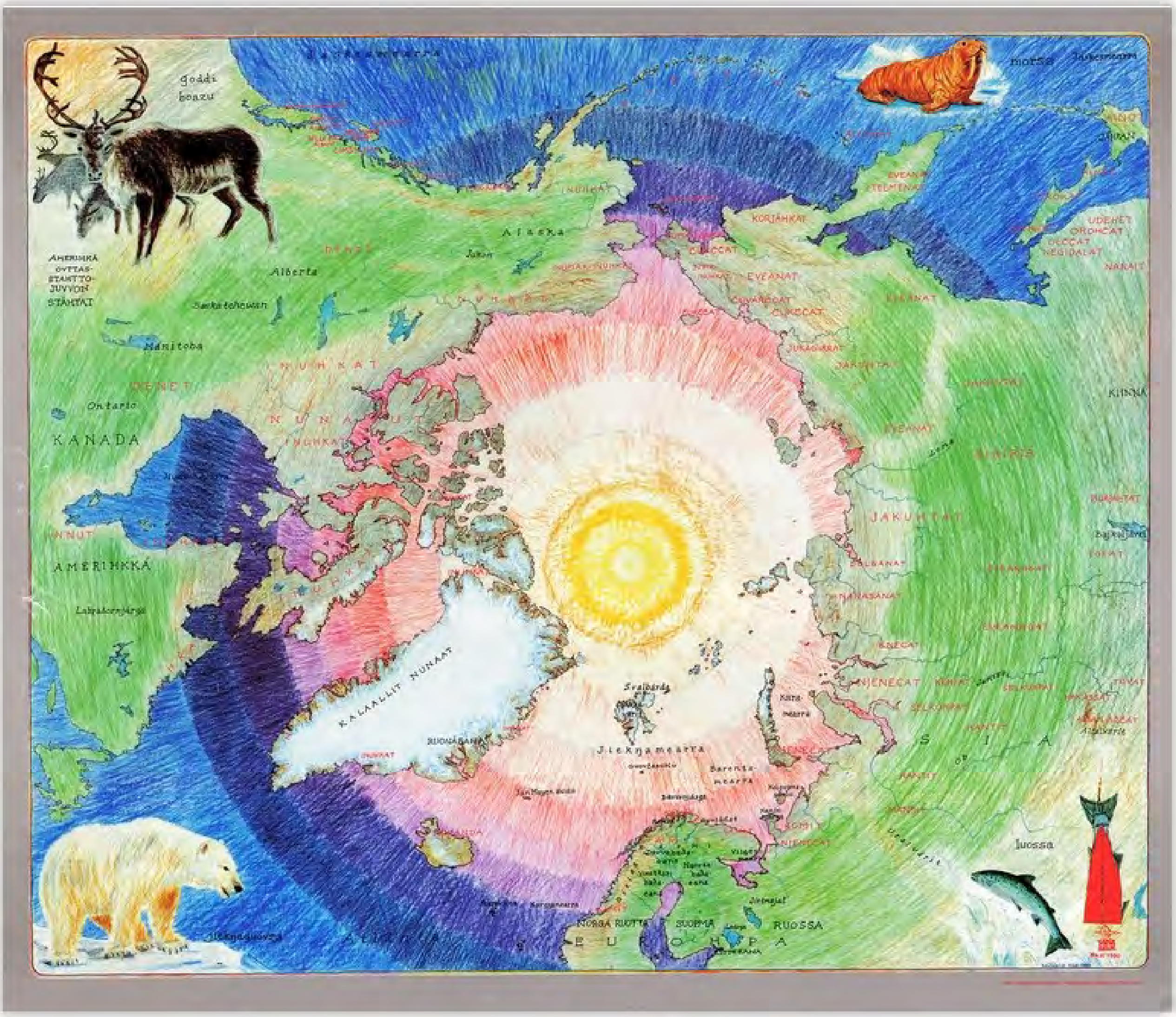

goddi
boazu
morša
KANADA
AMERIHKKA
Alaska
Alberta
Manitoba
Ontario
KALAALLIT NUNAAT
Jieŋŋamearra
Svalbárda
Barents-
mearra
JAKUHTAT
NORGA
RUOŦA
SUOPMA
RUOSSA
EUROHPA
KIINNÁ
luossa

Figure 44


MAADTOE
DAJVE
RUOVAT
KVÄNE
VALDSTE
BURKIJE
GÁSKELAANTE
SAANTE
SIJTE
VÄLRIEN
SVÄNKEN
TROLLHEIMEN
Sametinget

Figure 45

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

www.ntnu.edu/

At the Norwegian University of Science and Technology (NTNU) there are Cartographic education both at Geomatics at Department of Civil and Environmental Engineering and Department of Geography. Both these are located in Trondheim. I addition there is a Bachelor programme in Geomatics at Department of Manufacturing and Civil Engineering in Gjøvik.

At Geomatics, the 5 year Master programme is focused on the combination of subjects within Geomatics and Computing Science. The Geomatics group offers courses within GIScience/Cartography, Photogrammetry/3D modelling and Geodesy. All together the GIScience/ Cartography courses have a value of about 70 credits (Master Thesis included).

At Department of Geography a few professors are involved in teaching and research wherein GIS related methodologies and technologies are applied. 5 courses are related to applied GIS. Bachelor- or Masterthesis may also be related to GIS.

Norwegian University of Life Sciences

www.nmbu.no/en

At the Norwegian University of Life Sciences (NMBU) 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).

Western Norway University of Applied Sciences

www.hvl.no/en/

Western Norway University of Applied Sciences (HVL) is one of the largest higher education institutions in Norway. HVL was formed through a merger between Bergen University College, Sogn og Fjordane University College and Stord/Haugesund University College on January 1 2017.

HVL has a clear professional and working life-oriented profile. At department of civil engineering, a study programme in Land Administration and Surveying is offered. This study programme leads to a bachelor degree and contains various geomatics related subjects such as land surveying (including engineering-, industrial- and cadastral surveying) and geographic information science (systems and analysis). Each year more than 30 students complete their bachelor thesis within Land Administration and Surveying. A large number of these students choose geomatics related bachelor projects.

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 projects are introduced.

Norwegian University of Science and Technology (NTNU)

Geomatics at NTNU in Trondheim (5-year Master study)

Creating better maps of the subsurface

Due to complicated geological structure, geological information are difficult to understand for “then man in the street”. At the same time there are societal and environmental benefits of making geological information easier to use. This project investigates the use of graphics for communicating information about sub-urban geology to non-geologists.

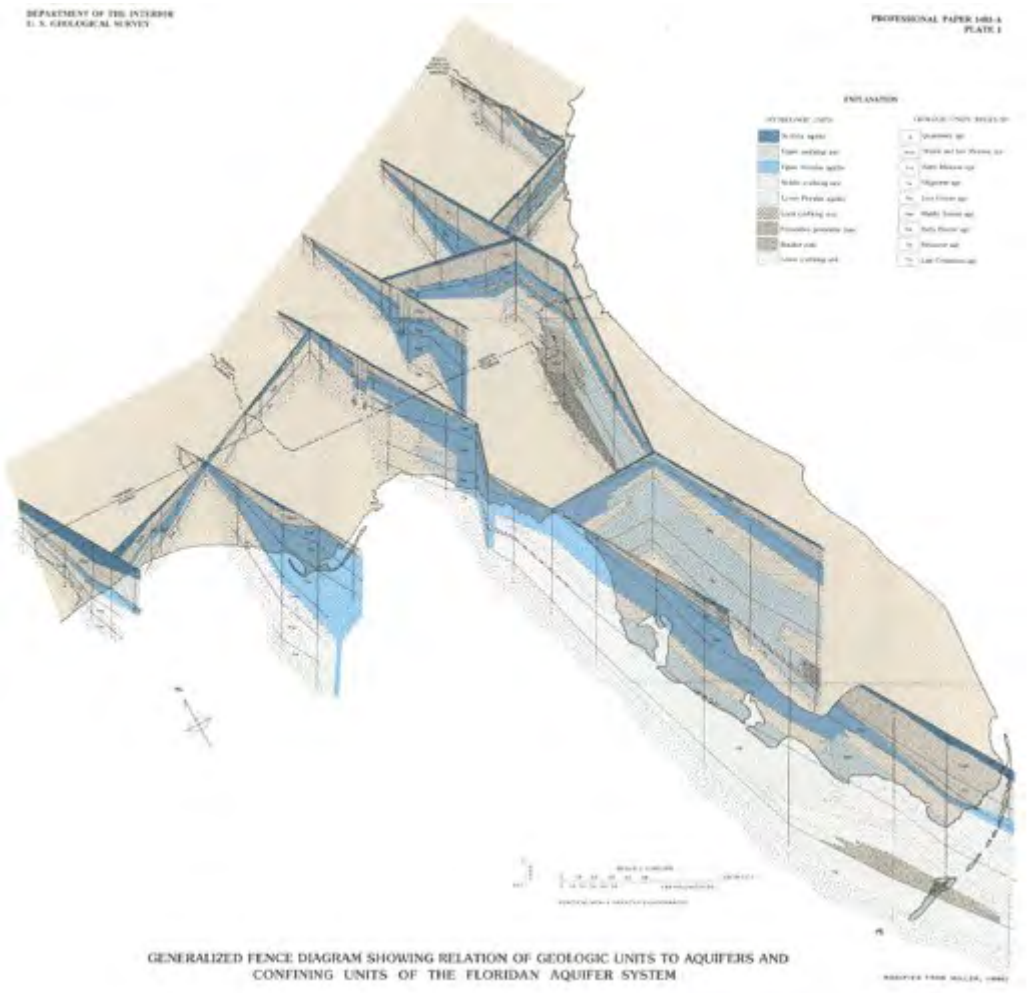


Figure 46

(Big) Open Geospatial Data Management

Open geospatial data volume increases because of release of gvernmental data, VGI, Crowdsoucing etc. This project investigates how to apply techniques from open geospatial data in traditional geospatial data management. Creation, validation and verification of data are studied, as well as techniques as Micro-tasking. Another, related question is how changes can be handled in open geospatial data. Automatic detection of changes, and distribution of changes are central topics.

Basemaps in map mashups

What kind of basemap is best to use when conveying information through a map mashup? This question is researched by using a web-based experiment.

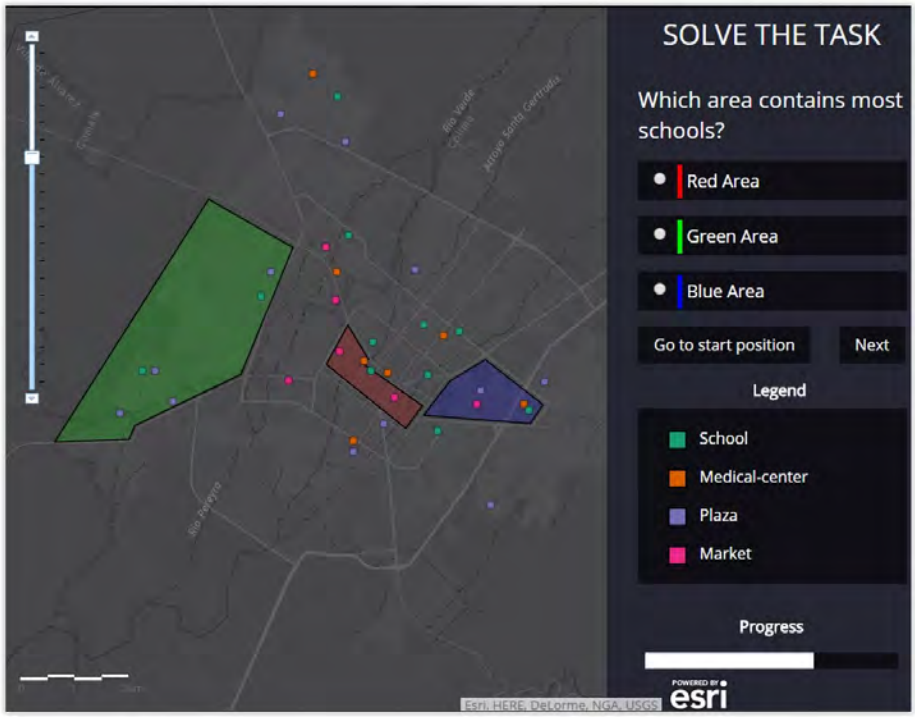


Figure 47: Interface for Web-experiment

Detecting map objects from aerial images by the use of deep learning

In this project data from the large scale primary data in Norway, Felles KartBase (FKB), are used together with aerial images inorder to “learn” a computer to select the map objects itself. Image segmentation by deep learning is tested.

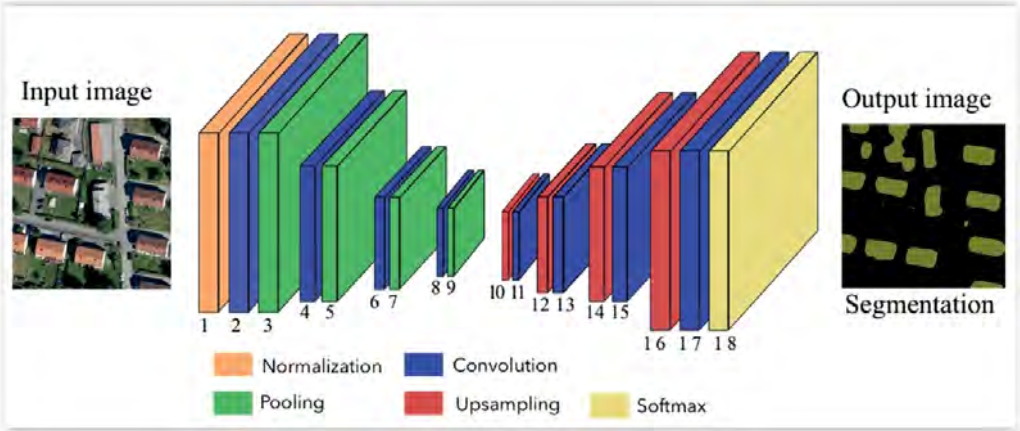


Figure 48

Geomatics at NTNU in Gjøvik (3-year Bachelor study)

Accessibility and colour universal design for colour deficient observers were among the topics for the HyPerCept project funded by the Norwegian Research Council. Two PhD candidates in Computer Science at the Norwegian Colour and Visual Computing Laboratory have been investigating how to make natural images, information graphics and maps more accessible to colour vision deficient observers. Further, master student in Interaction Design have explored the use of colour in overlay maps, including universal design methods and daltonization methods. In collaboration with the Norwegian Universal Design Research Laboratory, the results of the cartographic work have been presented at conferences as the Universal Design 2016 in York, the ICC 2017 in Washington and the ICC 2019 in Tokyo.

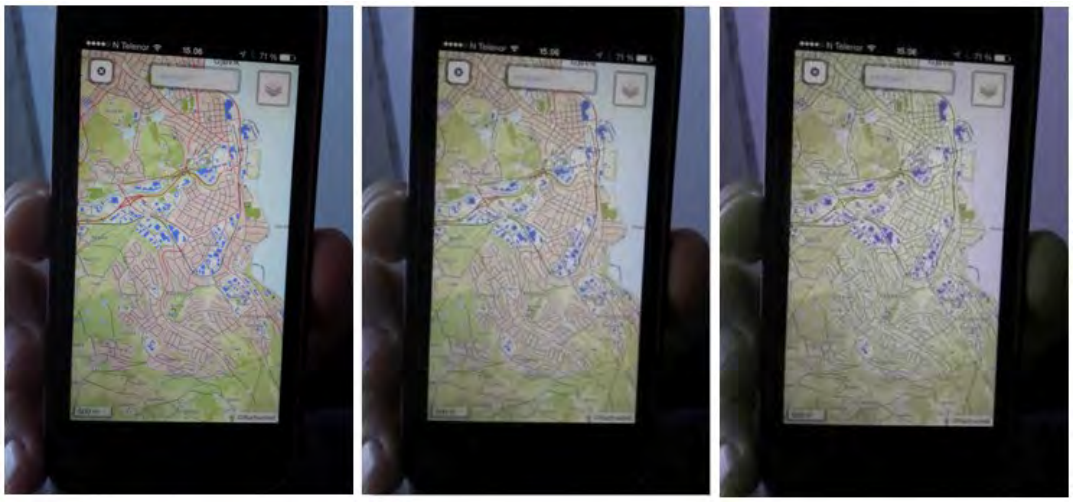


Figure 49: CVD simulations showing how the original map colours (left image) may appear for an observer with deuteranomaly colour vision (middle) and deuteranope colour vision (right).

Figure 50: Traffic flow illustrated by original (left), protanopian (middle) and deuteranopian simulation (right).

Norwegian University of Life Sciences

Classification of the Norwegian AR5 (land use / land cover) dataset from LiDAR point cloud data using deep learning

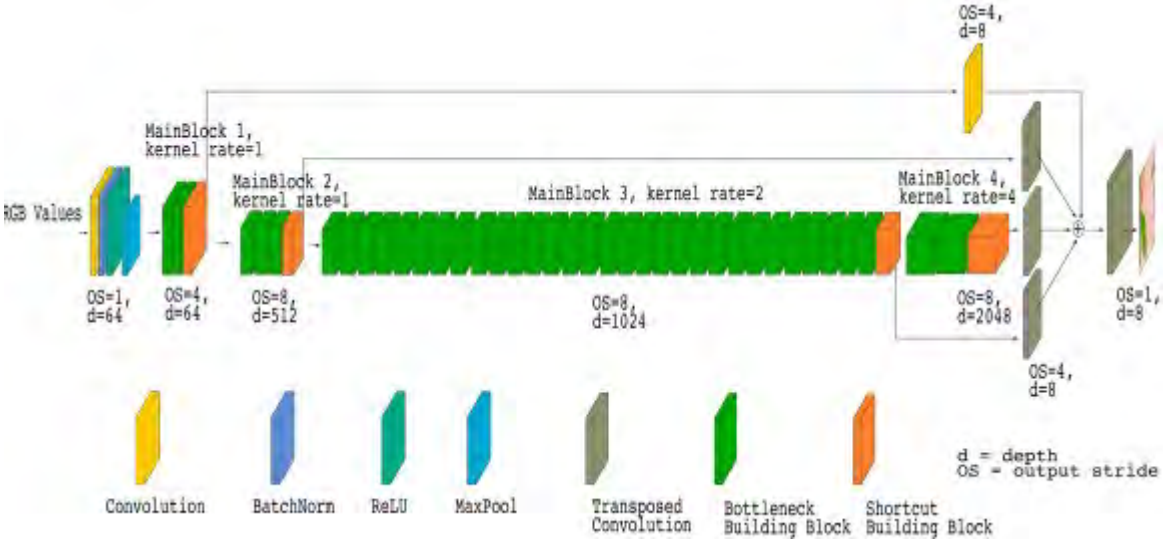


Figure 51

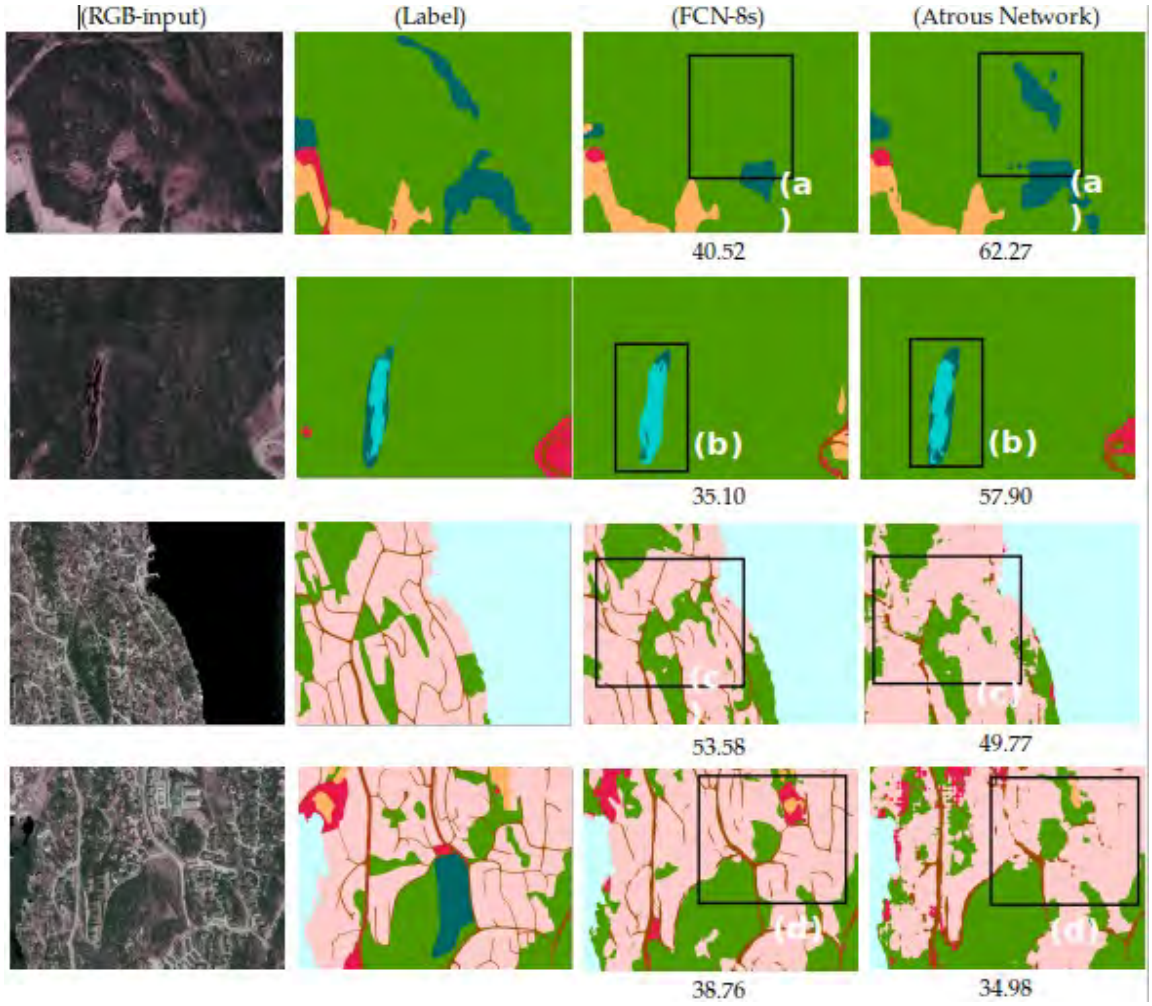


Figure 52

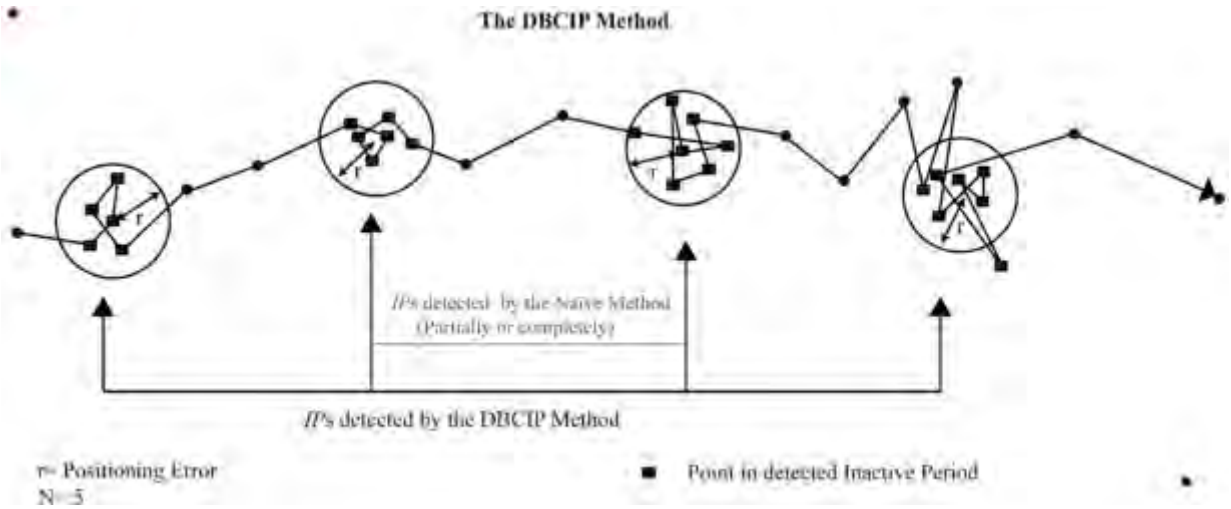


Figure 53

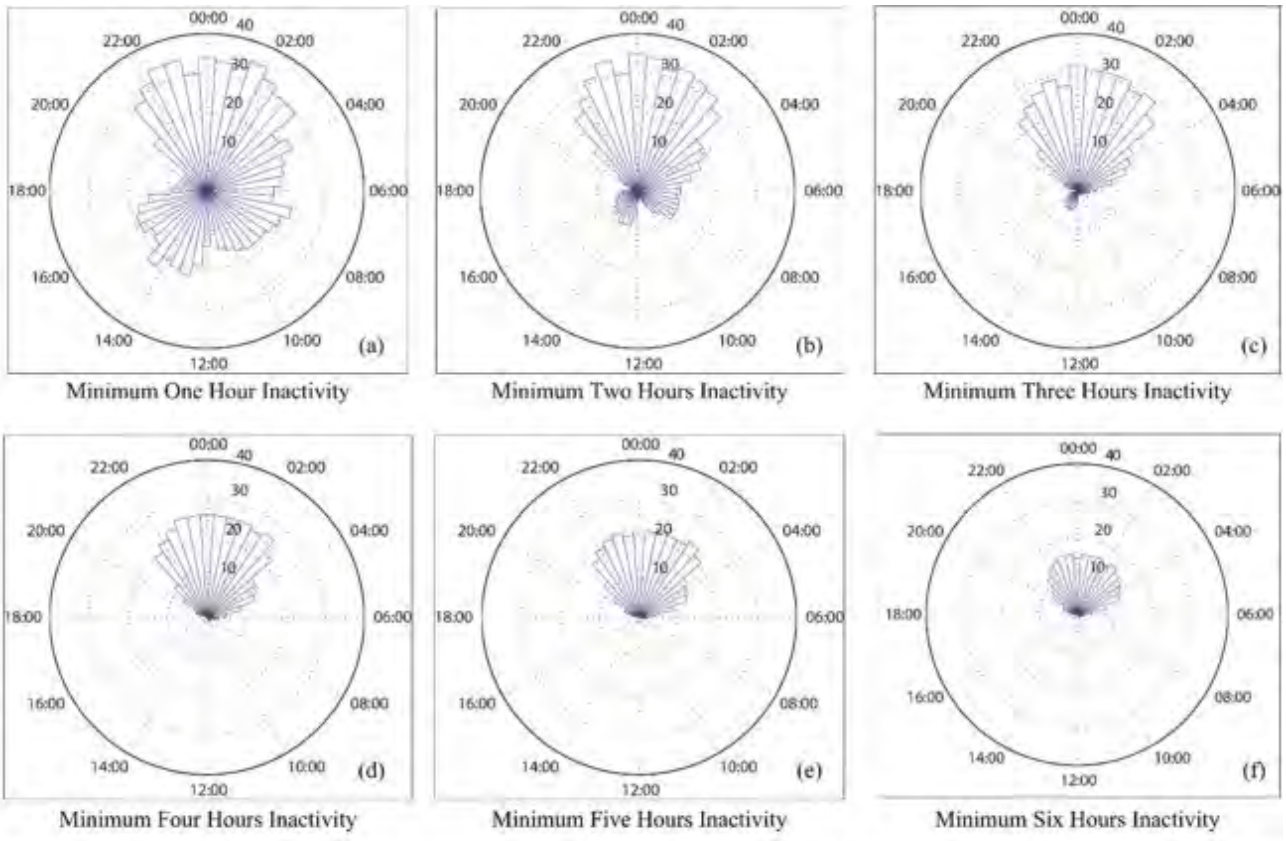


Figure 54: 24-hour histograms of the JPs detected by the DBCIP method with T=1h (a), T=2h (b), T=3h (c), T=4h (d), T=5h (e) and T=6h (f) of inactivity

Several plugins have been developed (and are being maintained) for research and teaching: Standarard deviational ellipse, Line direction histograms (circular statistics, rose diagrams), standard deviational ellipse, nearest neighbour join, multi-distance buffer, thin greyscale image to skeleton, climb / descent along line.

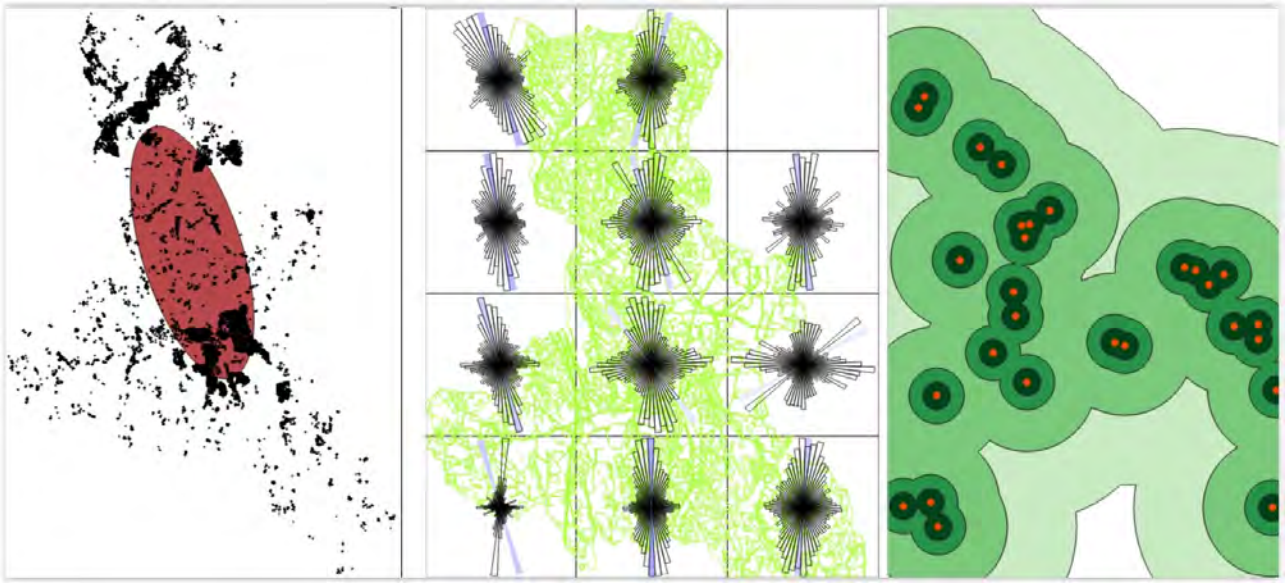


Figure 55

Western Norway University for Applied Sciences (HVL)

Research at HVL are often connected to Bachelor thesis. The figures show results from an award-

winning thesis from 2018 that documented Kaupanger stave church both outdoor and indoor in full 3D by utilizing high-resolution photogrammetry and laser scanning techniques.

Figure 56

Figure 57