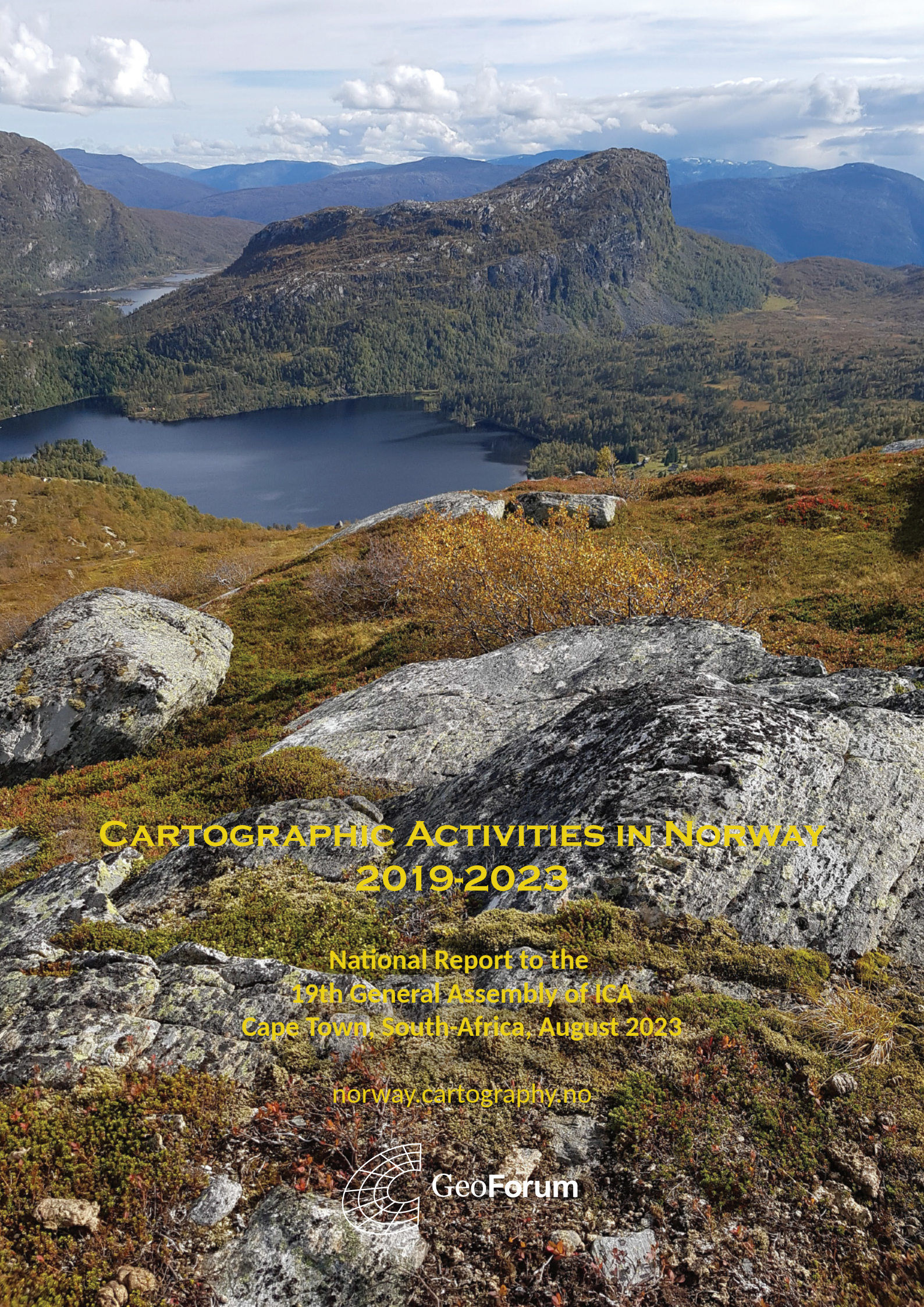
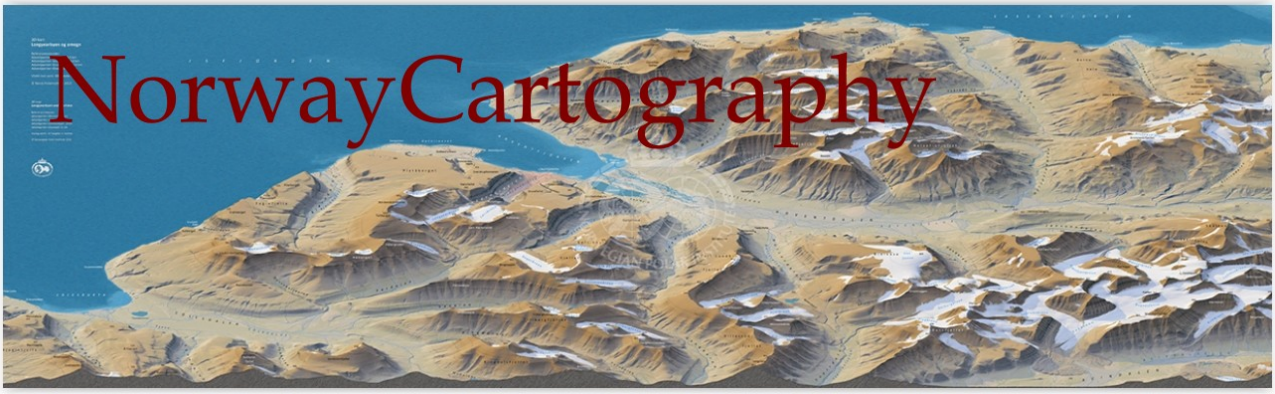


Cartographic Activities in Norway 2019-2023

National Report to the
19th General Assembly of ICA
Cape Town, South-Africa, August 2023

norway.cartography.no

GeoForum



norway.cartography.no

Cartographic Activities in Norway 2019-2023

National Report for the 19th General Assembly of ICA
Cape Town, South-Africa, August 2023

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. The call for contribution resulted in positive answers from invited partners from all categories. 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

Editor:

Terje Midtbø, Norwegian University of Science and Technology (*terjem@ntnu.no*)

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.

ICA bodies with Norwegian representation:

Executive committee: Terje Midtbø (Vice-President)
Education and Training: *Terje Midtbø*
Maps and the Internet: *Sverre Iversen*
Working Group on Cartographic Body of Knowledge: *Terje Midtbø (Chair)*

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 Autority

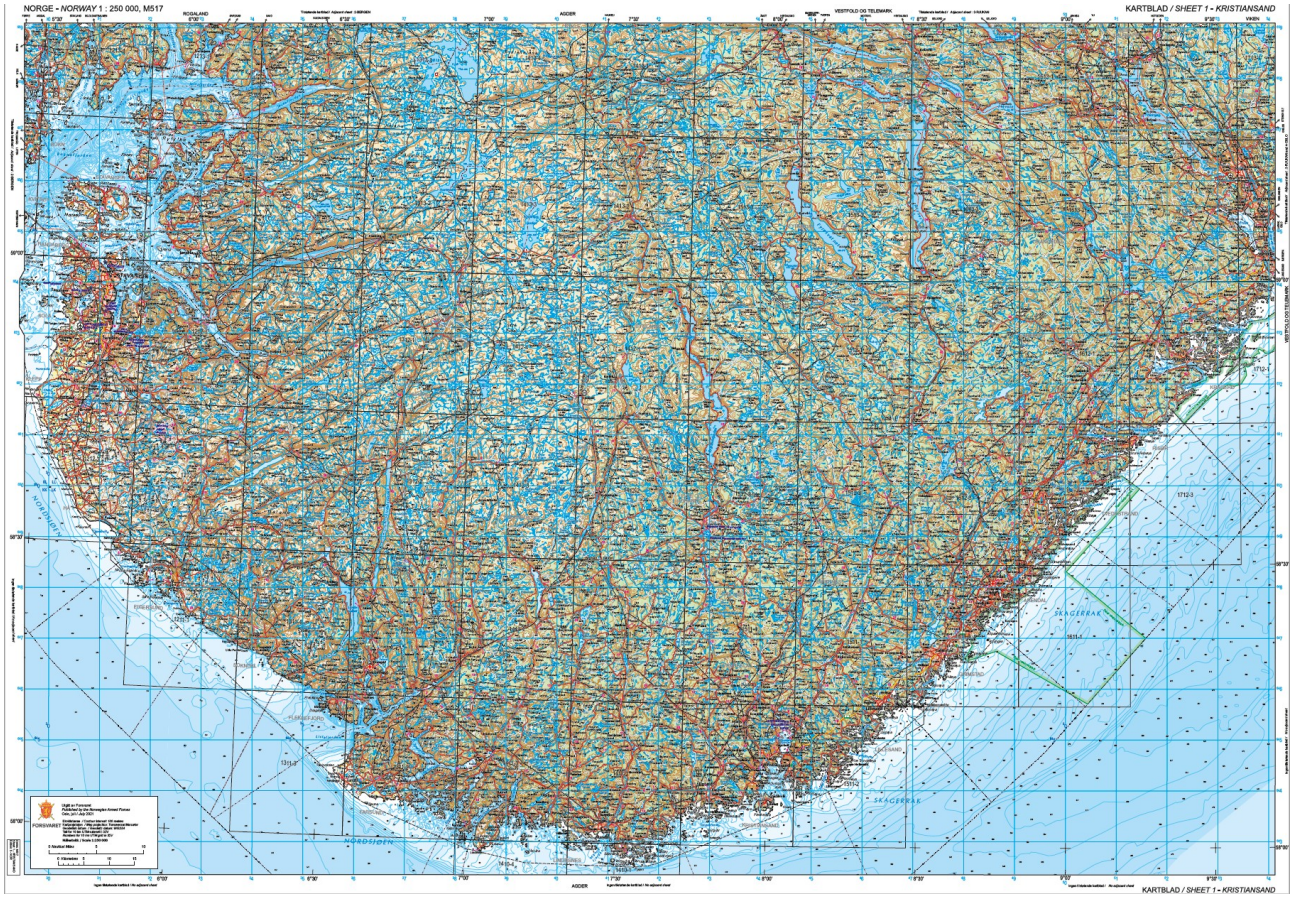
http://kartverket.no/en/about-the-norwegian-mapping-authority/

The Norwegian Mapping Authoraties has made several products in the last 4 years, these includes M517, The Norwegian armed forces overview map of Norway and new county maps after the reform of both counties and municipalities in Norway.

M517 – N250 – 1:250 000

This is a new map series from the Norwegian map authoraties which have been produced per request of the norwegian armed forces. Norway's 1:25 000/M517 primary purpose is to cover the militaries need for an operational map in smaller scale. The map series purpose is to at all times satisfy the operational needs and will be develeoped further according to demands. The maps shall also work as a roadmap in which they will be use in joint operation between air- and groundforces. Airforces uses the map series M517AIR, which has the same mappsheet and basedata. The essential difference is that M517AIR has terrain height in foot and is applied with aviation data and obstacles.

The map sheet divison for M517(and M517AIR) is oriented after natural geographical regions, in addition the map sheet format is increased from earlier versions. The papirformat is adapted to the biggest format which norwegian graphical industry can handle today. The abbriviation «M517» is in compliance with NATOs standardization system and ecompasses coding for geographical regions, scale and series designation for landmap version, while «M517AIR» denotes aviation maps in scale 1:250 000.


NORGE - NORWAY 1 : 250 000, M517
KARTBLAD / SHEET 1 - KRISTIANSAND
ROGALAND
AGDER
VESTFOLD OG TELEMARK
SKAGERRAK
KARTBLAD / SHEET 1 - KRISTIANSAND

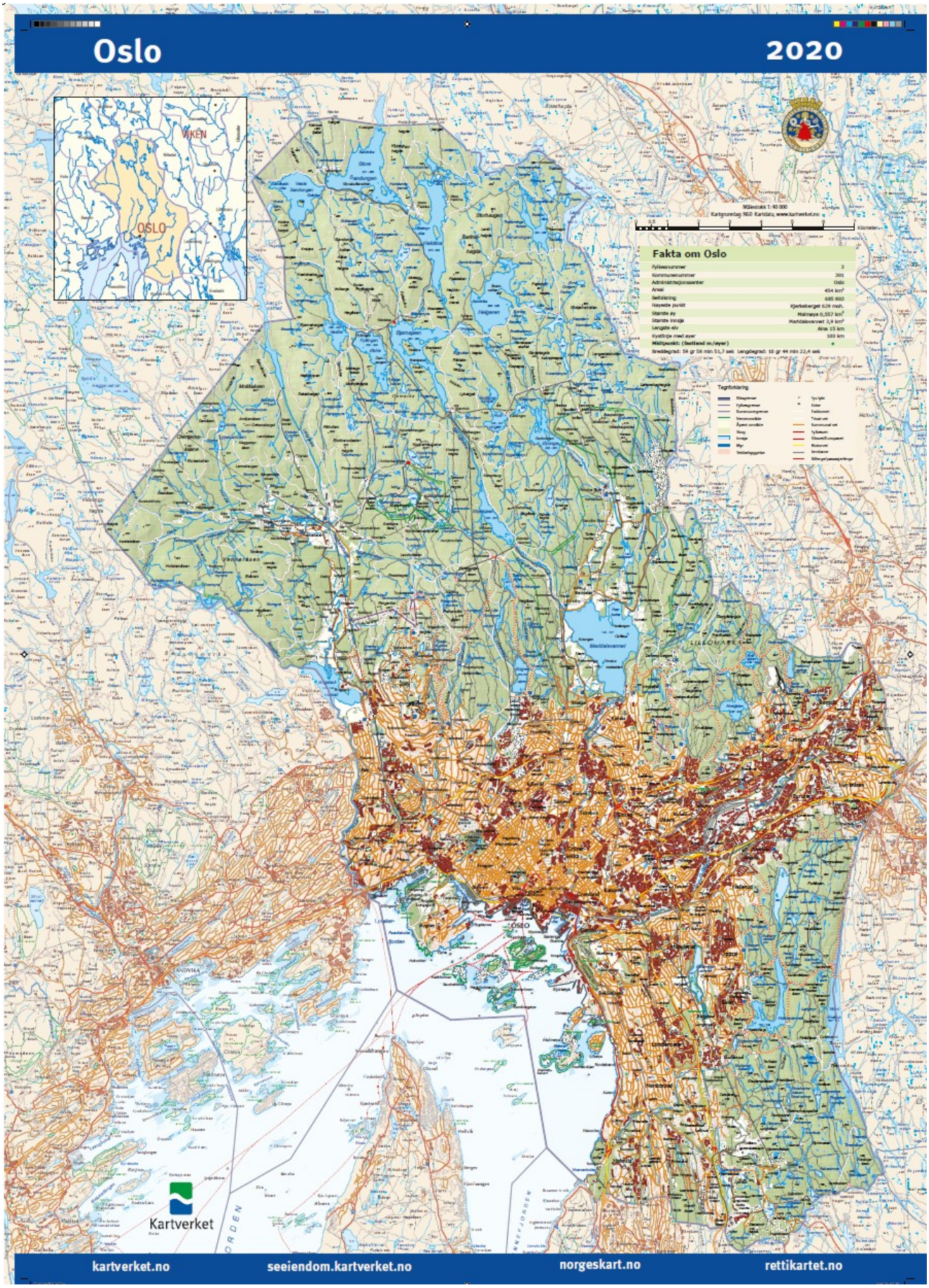

KARTBLAD / SHEET 1 - KRISTIANSAND
VESTFOLD OG TELEMARK
Tilstøtende kartblad / Adjacent sheet : 3-RJUKAN
8°30'
9°00'
9°30'
VIKEN
1513-1
1513-2
1613-1
1613-2
1613-3
1613-4
1713-1
1713-3
1713-4
Skien 1713-2
Porsgrunn
Tilstøtende kartblad / Adjacent sheet : 3-RJUKAN and 4-OSLO

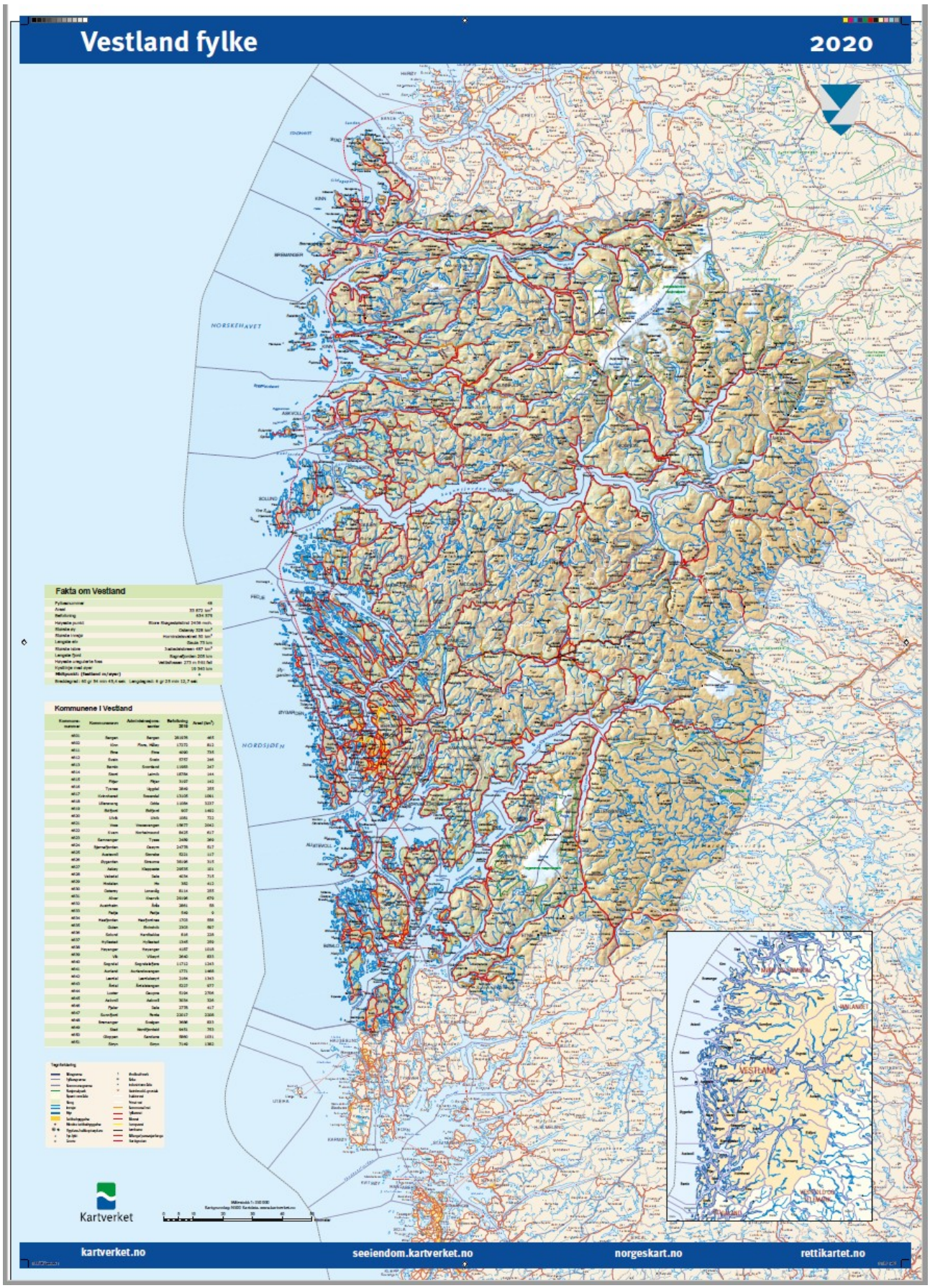
Countymap

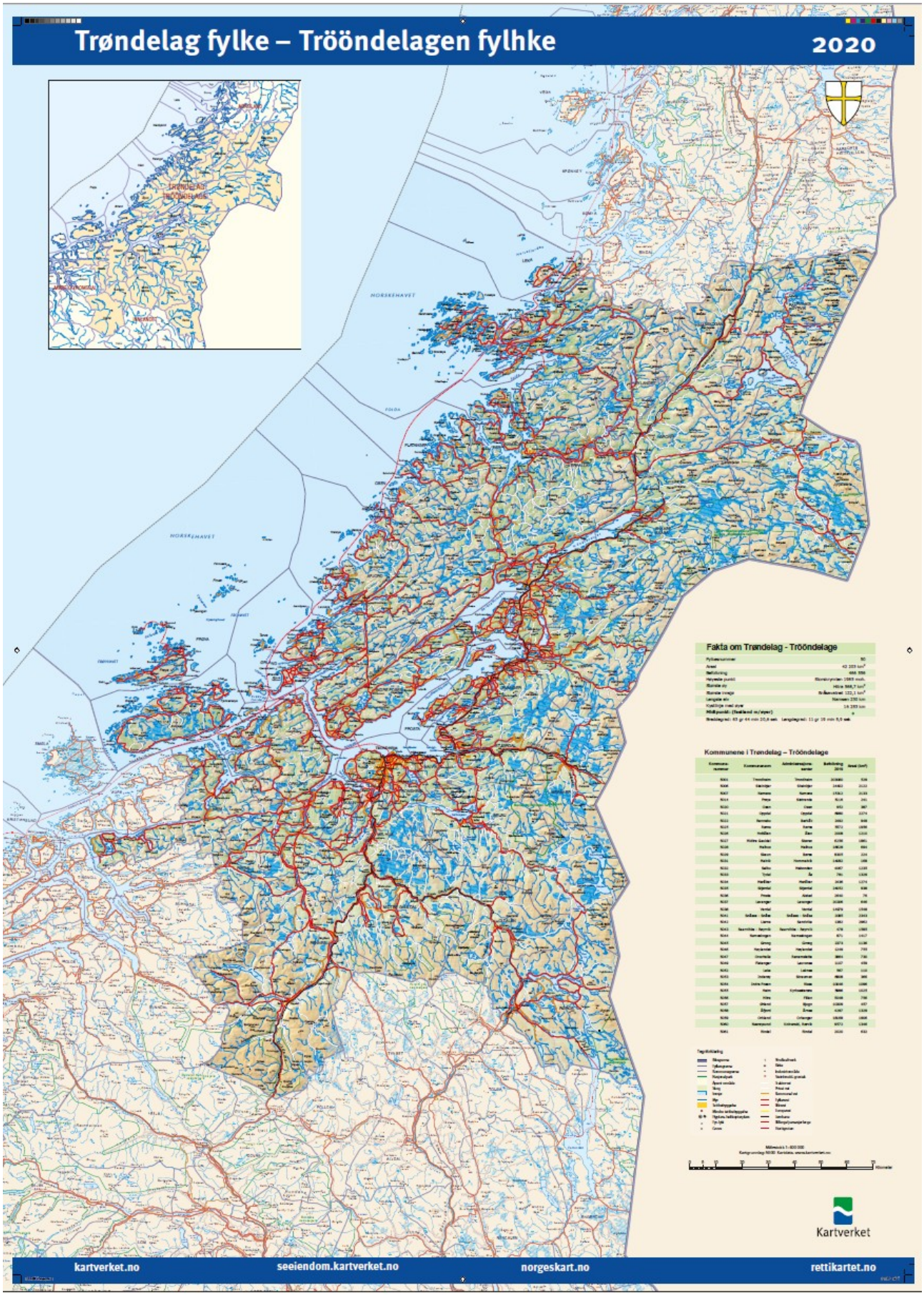
After the county- and municipalityreform in january 2020, the number of municipalities in Norway was reduced from 428 to 356, and the number of counties was reduced from 19 to 11. The Norwegian mapping authoraties made a new updated map over the new counties and minicipalities after the reform and sent these out to the new counties.

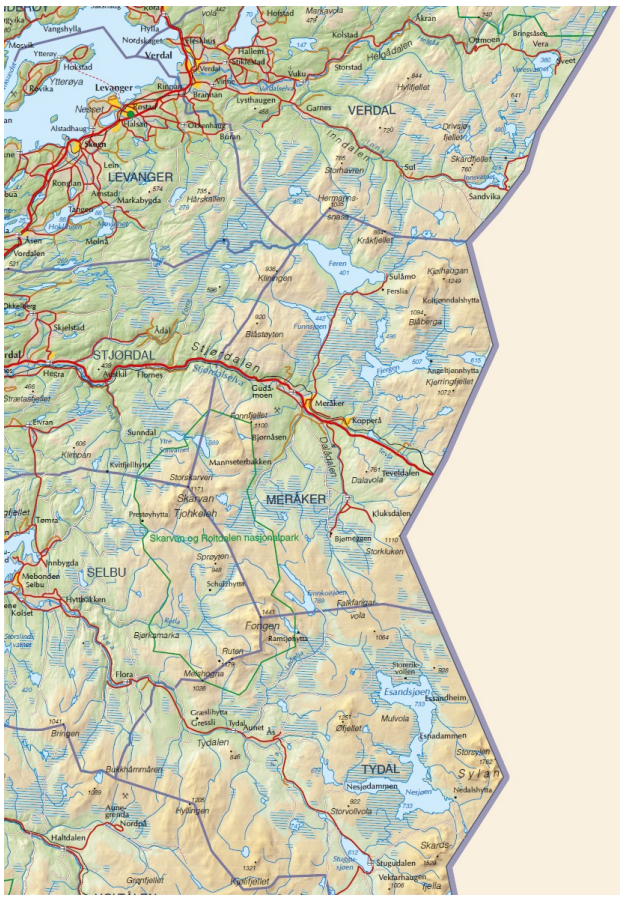
County	**Scale**	**Paperformat**
Troms og Finnmark	1:550 000	841 x 1189mm (A0)
Nordland	1:450 000	841 x 1189mm (A0)
Trøndelag	1:500 000	700 x 1000mm
Møre og Romsdal	1:300 000	700 x 1000mm
Vestland	1:350 000	700 x 1000mm
Rogaland	1:250 000	700 x 1000mm
Agder	1:300 000	700 x 1000mm
Vestfold og Telemark	1:250 000	700 x 1000mm
Viken	1:310 000	841 x 1189mm (A0)
Innlandet	1:450 000	700 x 1000mm
Oslo	1:40 000	700 x 1000mm

N500 mapdata is used on all county maps except on Oslo. The mapdata for Oslo county is from N50.


Oslo
2020
VIKEN
OSLO
Fakta om Oslo
Kartverket
kartverket.no
seeiendom.kartverket.no
norgeskart.no
rettikartet.no


Vestland fylke
2020
Fakta om Vestland
Kommunene i Vestland
kartverket.no
seeiendom.kartverket.no
norgeskart.no
rettikartet.no


Trøndelag fylke – Tröndelagen fylhke
2020
Fakta om Trøndelag - Tröndelage
Kommunene i Trøndelag – Tröndelage
Kartverket
kartverket.no
seeiendom.kartverket.no
norgeskart.no
rettikartet.no



Fakta om Trøndelag - Tröndelage

Fylkesnummer	50
Areal	42 203 km^2
Befolkning	466 556
Høyeste punkt	Storskrymten 1985 moh.
Største øy	Hitra 568,7 km^2
Største innsjø	Snåsavatnet 122,1 km^2
Lengste elv	Namsen 230 km
Kystlinje med øyer	16 253 km
Midtpunkt: (fastland m/øyer)	

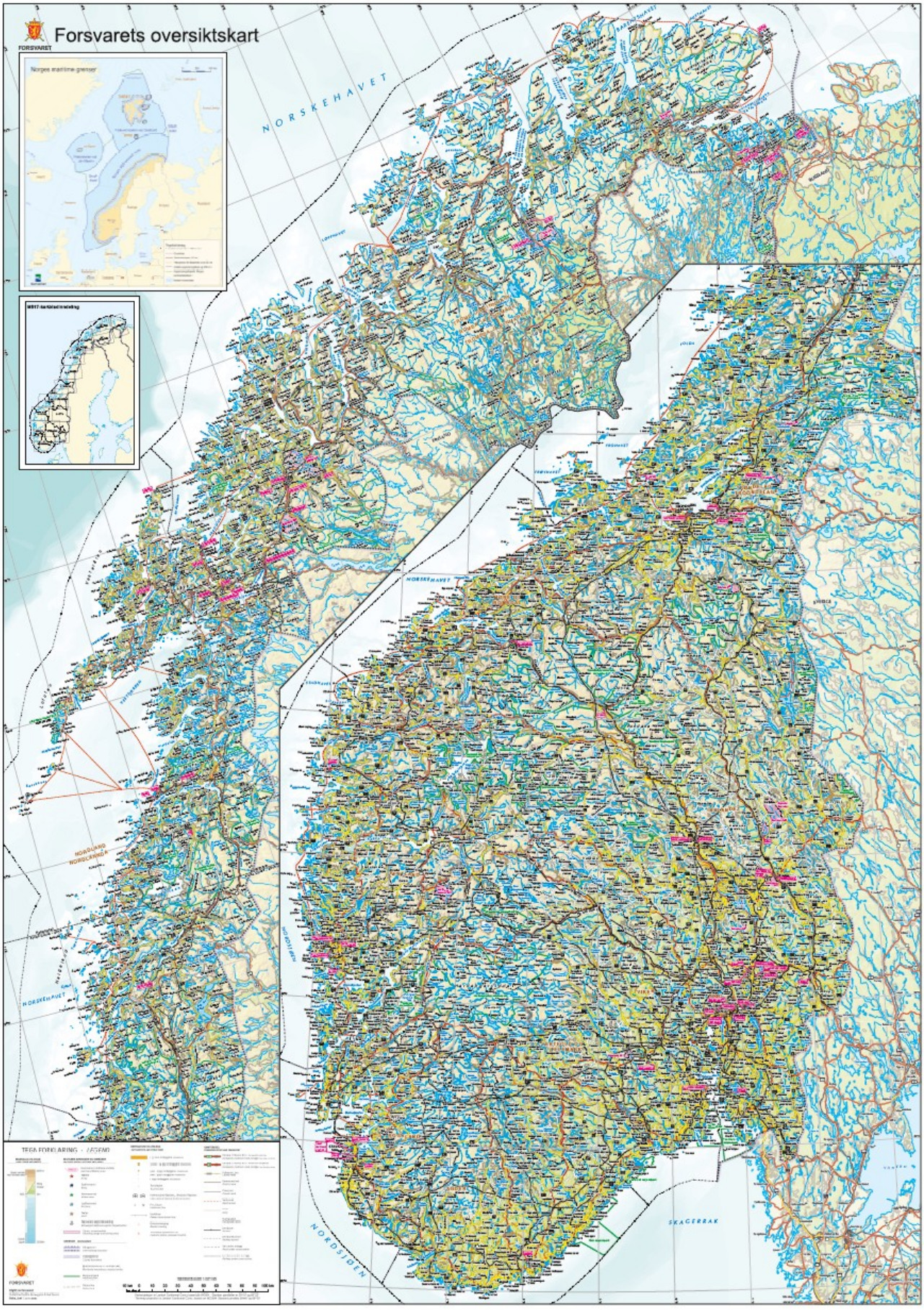
Breddegrad: 63 gr 44 min 20,6 sek Lengdegrad: 11 gr 19 min 5,9 sek

Kommunene i Trøndelag – Tröndelage

Kommune-nummer	Kommunenavn	Administrasjons-senter	Befolkning 2019	Areal (km^2)
5001	Trondheim	Trondheim	203060	529
5006	Steinkjer	Steinkjer	24402	2122
5007	Namsos	Namsos	15312	2133
5014	Frøya	Sistranda	5116	241
5020	Osen	Osen	952	387
5021	Oppdal	Oppdal	6980	2274
5022	Rennebu	Berkåk	2492	948
5025	Røros	Røros	5572	1956
5026	Holtålen	Ålen	2008	1210
5027	Midtre Gauldal	Støren	6256	1861
5028	Melhus	Melhus	16628	694
5029	Skaun	Børsa	8305	224
5031	Malvik	Hommelvik	14082	168
5032	Selbu	Mebonden	4067	1235
5033	Tydal	Ås	781	1329
5034	Meråker	Meråker	2436	1274
5035	Stjørdal	Stjørdal	24052	938
5036	Frosta	Alstad	2640	76
5037	Levanger	Levanger	20206	646
5038	Verdal	Verdal	14979	1548
5041	Snåase - Snåsa	Snåase - Snåsa	2085	2343

The Norwegian armed forces overview map

The Norwegian armed forces overview map's primary purpose is to cover the armed forces needs for a map in smaller scale. The map is to at all times satisfy the operational needs and will be developed in step with demands. The map is produced in scale 1:850 000, and uses data from N1000 which is in 1:1 000 000. In addtion to the armed forces, The map is also delivered to the Storting as a new overview map over Norway.


Forsvarets oversiktskart
FORSVARET
Norges maritime grenser
NORSKEHAVET
NORDSJØEN
SKAGERRAK


Flatflesa
Sandøya
Rossøyvågen
Vågøy
Myrbostad
Steinshamn
Aukrasanden
Harøya
Hollingen
Hjelset
Molde
Årø
E39
Myklebust
Fjørtofta
Harøyfjorden
668
662
Otrøya
Mordal
Røv
Ulla
Nesjestranda
Haramsøya
Skuløya
Flemsøya
Midsund
Storfjorden
Veøya
Austnes
Sekken
Lepsøya
661
Vestnes
Vikebukt
Rødven
659
Fiksdalen
Vigra
Roald
Brattvåg
Tomre-
fjord
Vågstranda
Erkna
.790
1069
Vigra
Søvik
Vatne
Valderøya
Giske
527
Tennfjord
Tresfjorden
Måndalen
Alnes
526
Skodje
Sjøholt
497
E39
Storbua
Innfjorden
Ålesund
Spjelkavik
Valle
Lauparen
1434
Langevåg
656
Magerholm
Storfjorden
Brandal
Solavågen
Dyrkorn
Hareid
650
Sulesund
Stordal
Ikornnes
Sykkylven
Høgstol
1739
61
Hundeidvik
Vartdalsfjorden
Festøya
Hjørundfjorden
Straumgjerde
Valldalen
Stranda
Liabygda
Haddal
Vartdal
60
Linge
Valldal
Sunnmøre
1586
Liadal
1303
Eidsdal
Norddal
Grøtdals-
tindane
E39
Ørsta
Urke
60
Tafjord
652
Sæbø
Patchellhytta
63
Torvløysa
1850
Reindalseter
Hovden
Øye
655
655
Kaldhusseter
Voldsfjorden
Volda
Sunnylvsfjorden
Folkestad
Bjørke
Geiranger
Eyrde
1691

Stryn
Oppstryn
Skridulaupbu
Lote
Randabygda
Loen
Hjelle
Nordberg
Skjåk
Ottadalen
Vågåmo
Hovringen
Sandane lufthamn
Anda
Innvik
Olden
Bismo
Sel
Vereide
Utvik
Bødalsætra
Sota sæter
Lom
Garmo
Smuksjøseter
Sandane
Breim
Bødalen
Lodalskåpa
Breheimen nasjonalpark
Lomseggje
Brimi
fjellstugu
Dale
Byrkjelo
Oldevatnet
Jostedalsbreen nasjonalpark
Sprongdalshytta
Hestbrea-
piggan
Otta
Egge
Fåbergstølen
Trulsbu
Galdesanden
Elveseter
Randsverk
Heidal
Briksdalen
Breheimen
Hatbardsbreen
Jotunheimen Fjellstue
Juvasshytta
Kvam
Longevass-
hytta
Stardalen
Klakegg
Årøtzbu
Gjerde
Nordstedalseter
Bøverdal
Spiterstulen
Glitterheim
Hind
sætrin
Heidals-
muen
Ardal
Skei
Jostedalsbreen
Jostedal
Fast
Sognefjellet
Jotunheimen
Nautgards-
tinden
Kvikne
Ålhus
Jølster
Supphelle-
nipa
Tungestølen
604
Stølsdalen
Sognefjells-
hytta
Krossbu
Memuru-
tinden
Bessstrond
Jølstravatnet
Astruptunet
Lunde
Vigdalstøl
Skjolden
Turtagrø
Leirvassbu
Jotunheimen nasjonalpark
Skåbu
Vassenden
Flatbrehytta
Vettastrond
Luster
Fannaråki
Fortun
Olavsbu
Bessheim
Gjendesheim
Memurubu
Sikkilsdalsseter
Slangen
Ruten
Holsen
Navarsete
Hurrungane
Skogadalsboen
Gjendebu
Heimdalshøe
Dalsetra
Haukedalsvatnet
Fjærland
Gaupne
Marifjora
Knutsholstinden
Valdresflye
Oskampen
Vallestad
Vettisfossen
Eidsbugarden
Tyin
Torfinnsbu
Vetti Gard
Tyinholmen
Fet
Hjelle
Bygdin
Haugastølen
Skjerdingane
Hafslo
Øvre Årdal
Solvorn
Ornes
Skaget
Årdalstangen
Slettningsbu
Bitihorn
Langsua nasjonalpark
Dragsvik
Hella
Sogndalsfjøra
Beitostølen
Storeskag
Liomseter
Høyanger
Seim
Steinbusjøen
Lane
Balestrand
Systrond
Hermansverk
Berdalseken
Tyinkrysset
Beito
Leikanger
Vangsnes
Feios
Kaupanger
Naddvik
Vennisfjellet
Skammestein
Sogndal
Mannheller
Øye
Høre
Hegge
Ortnevik
Fodnes
Kyrkjestølane
Heggenes
Haukåsen
Lærdalsøyri
Filefjell
Sulebu
Ryfoss
Lome
Rabalen
Sæle
Sogn
Vikøyri
Soleistølen
Vang
Slidre
Fresvik
Frevikbreen
Lærdalen
Borgund
Borlaug
Breistølen
Kljåen
Helin
Ron
Skrautvål
Arnafjord
Ulnes
Nord-Etnedal
Valdres
Urdeggi
Åsedalen
Bleia
Store
Ranastongi
Vaset
Fagernes
E16
E16

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 deepwater 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. Primar 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, fair sheets and datasets to different purposes. About 20 persons work in the Chart section, updating existing charts and compiling new charts.

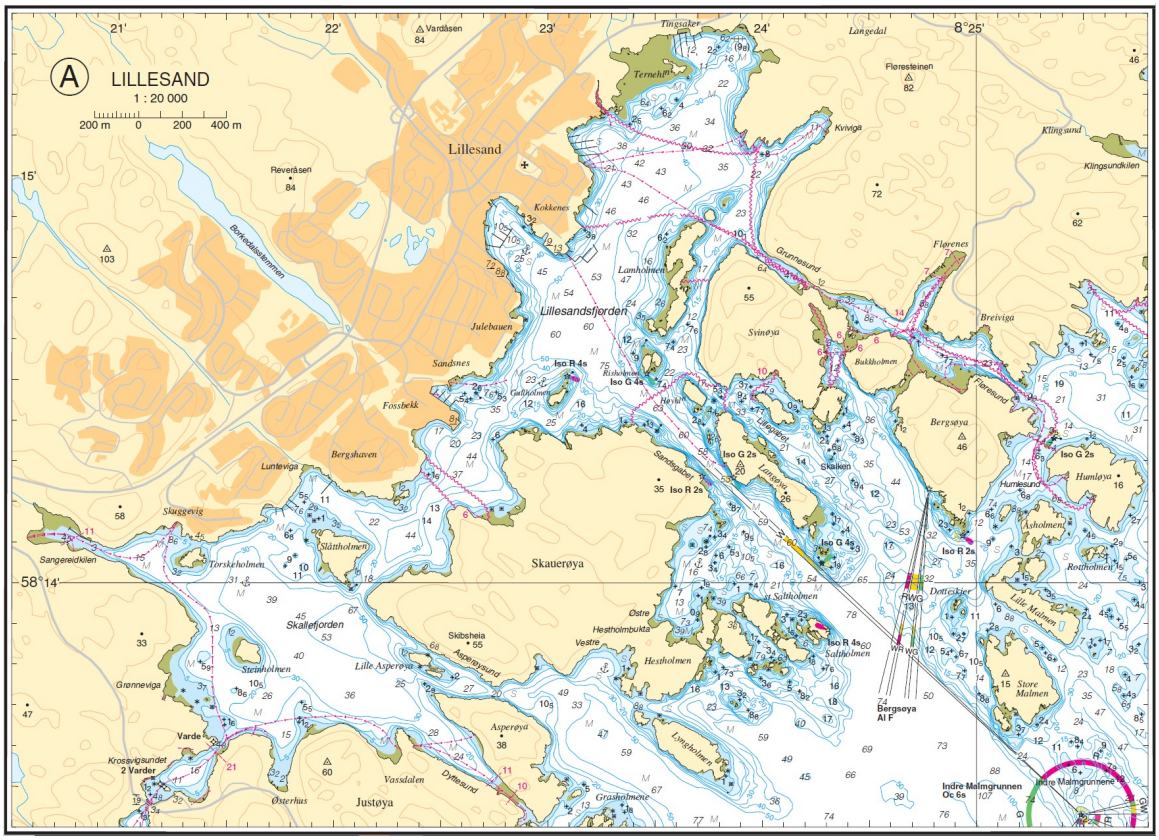


Figure 1: Traditionally chart. The view is from Lillesand at the south coast.

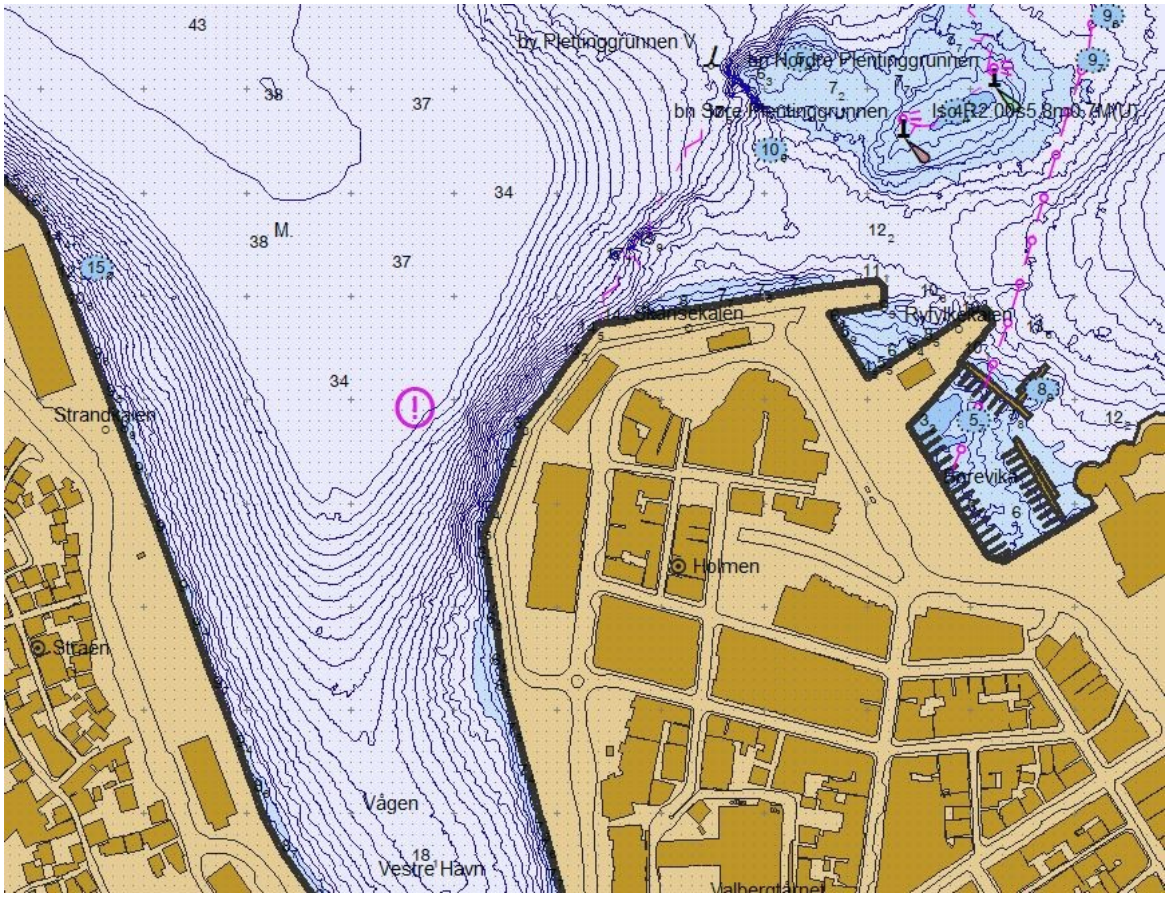


Figure 2: High density ENC from Stavanger harbour. Depth Contour interval 1 meter.

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 43 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 2800 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/. An Aerodrome terrain and obstacle chart is also available as an electronic versjon at:
https://avinor.maps.arcgis.com/apps/webappviewer/index.html?id=a0799fa96eae462682995fe586877455

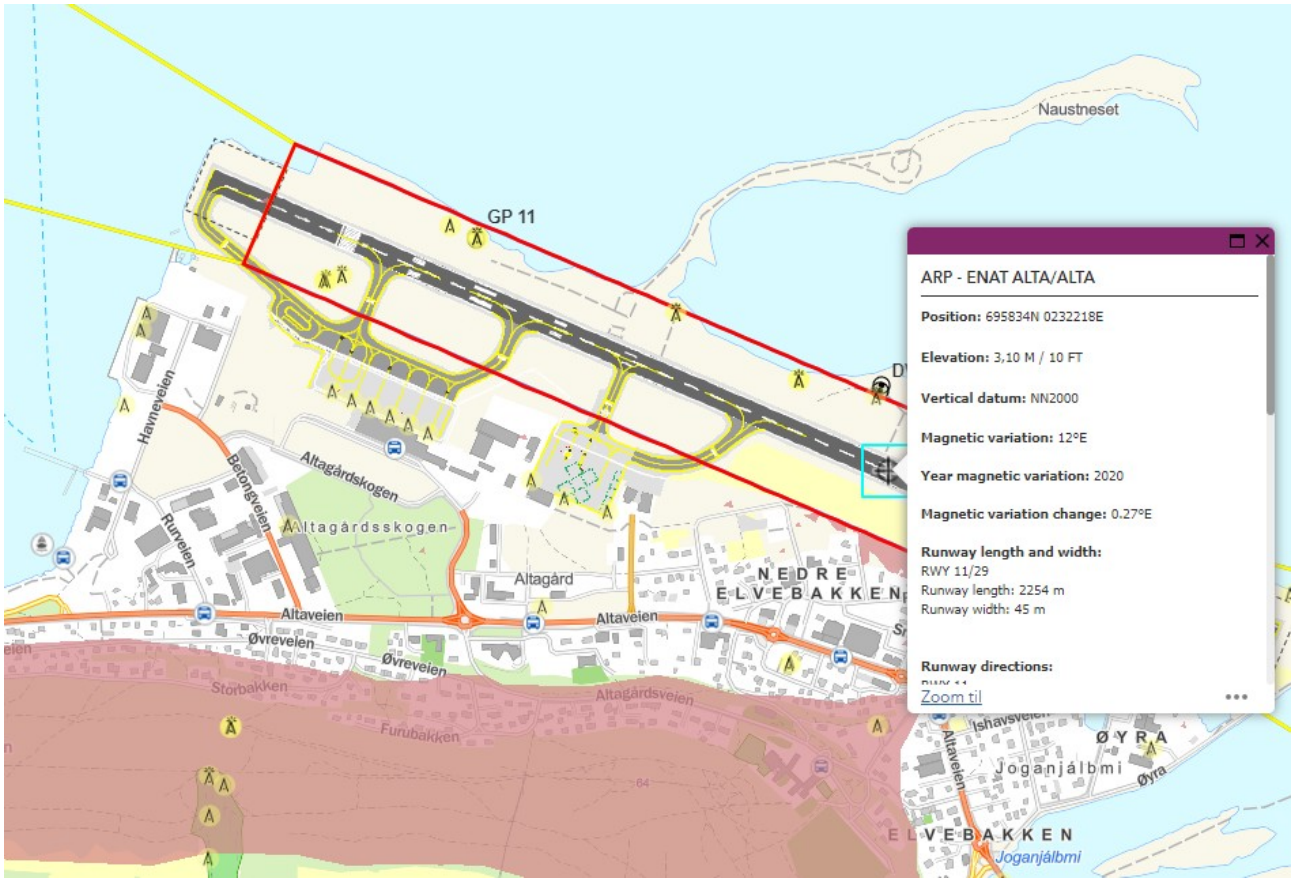
(example below)

• Building restriction area maps for each airport. These maps are available at www.avinor.no.

• Charts showing signs and markings.

• Airport maps: airport overview both indoors and outdoors, 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.


Naustneset
GP 11
ARP - ENAT ALTA/ALTA
Position: 695834N 0232218E
Elevation: 3,10 M / 10 FT
Vertical datum: NN2000
Magnetic variation: 12°E
Year magnetic variation: 2020
Magnetic variation change: 0.27°E
Runway length and width:
RWY 11/29
Runway length: 2254 m
Runway width: 45 m
Runway directions:
Zoom til
Havneveien
Betongveien
Altagårdskogen
Altagårdsskogen
Runveien
Altagård
NEDRE ELVEBAKKEN
Altaveien
Øvreveien
Storbakken
Furubakken
Altagårdsveien
Ishavsveien
ØYRA
Joganjálbmi
Øyra
ELVEBAKKEN
Joganjálbmi

The Norwegian Coastal Administration

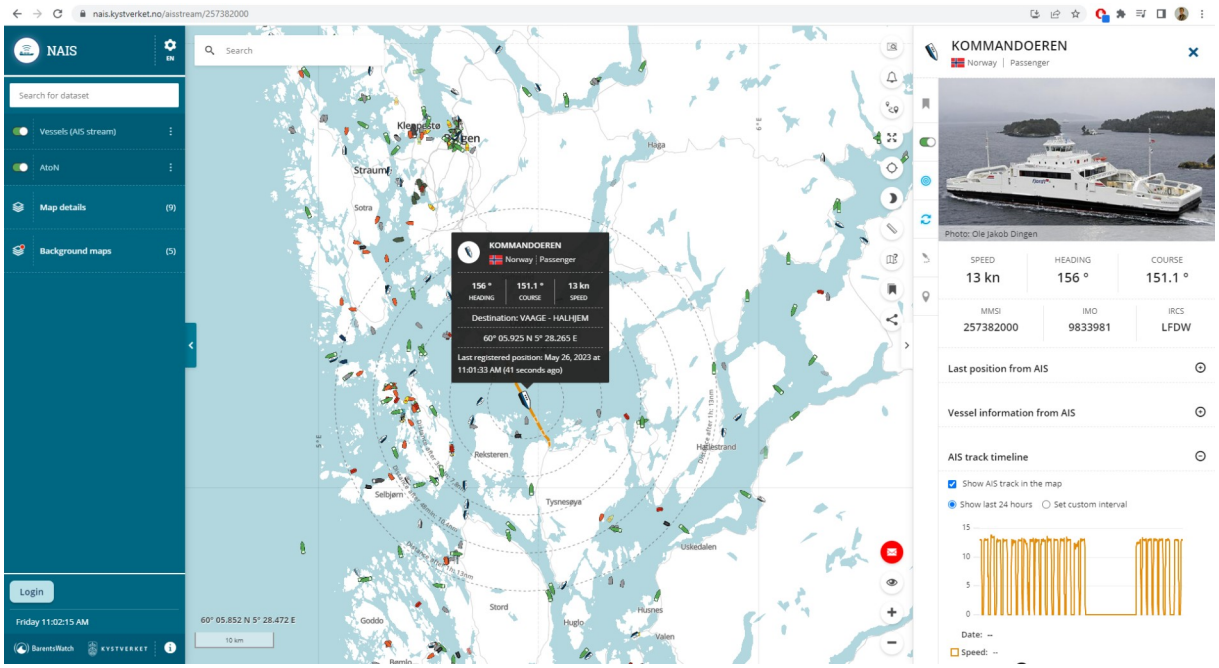
The Norwegian Coastal Administration (NCA) (video) is a national agency reporting to the Ministry of Trade, Industry and Fisheries, and holds responsibilities in coastal management, maritime safety and emergency preparedness against acute pollution. It is structured around four thematic areas:
Transport, Ports, and Fairways: This department manages, builds, and operates the physical infrastructure related to transportation, including conducting analyses and fostering knowledge within the sector.
Navigation Technology and Maritime Services: Responsible for the management, development, and operation of the digital infrastructure, this department monitors and controls traffic while overseeing the pilotage service.
Environmental Preparedness: The NCA actively works towards preventing and minimizing the harmful effects of acute pollution, prioritizing environmental protection.
Pilotage Service: Ensuring the safety of maritime traffic and safeguarding the environment, this department places pilots on vessels and provides crews with necessary knowledge of waterways.
While geographical data and mapping play a significant role in the daily operations of many of the approximately 1000 NCA employees, these competencies are primarily housed within a newly established cross-cutting department, **Digitalization and Innovation**, created in 2021.
By bringing together industry experts, IT specialists, as well as developers, system architects, designers, and geographers, the team supports the digitalization of the NCA's internal and external services. Many of these services rely on geographical data or use interactive mapping tools as front-end interfaces to serve our users' needs. Below are three examples that show the depth and breadth of our map-based tools.

- ***Digital Twin of the Norwegian Coast***

During the COVID pandemic, it became important for NCA to continue training its maritime pilots without requiring them to travel. The NCA developed a virtual reality interface based on available high resolution geographical data (infrastructure, vegetation, elevation, etc.) used to train its pilots on different virtual ships, weather conditions and time of day. In the future, we see that this tool is also extremely useful for other teams responsible to plan and test different changes in maritime infrastructure and fairways.

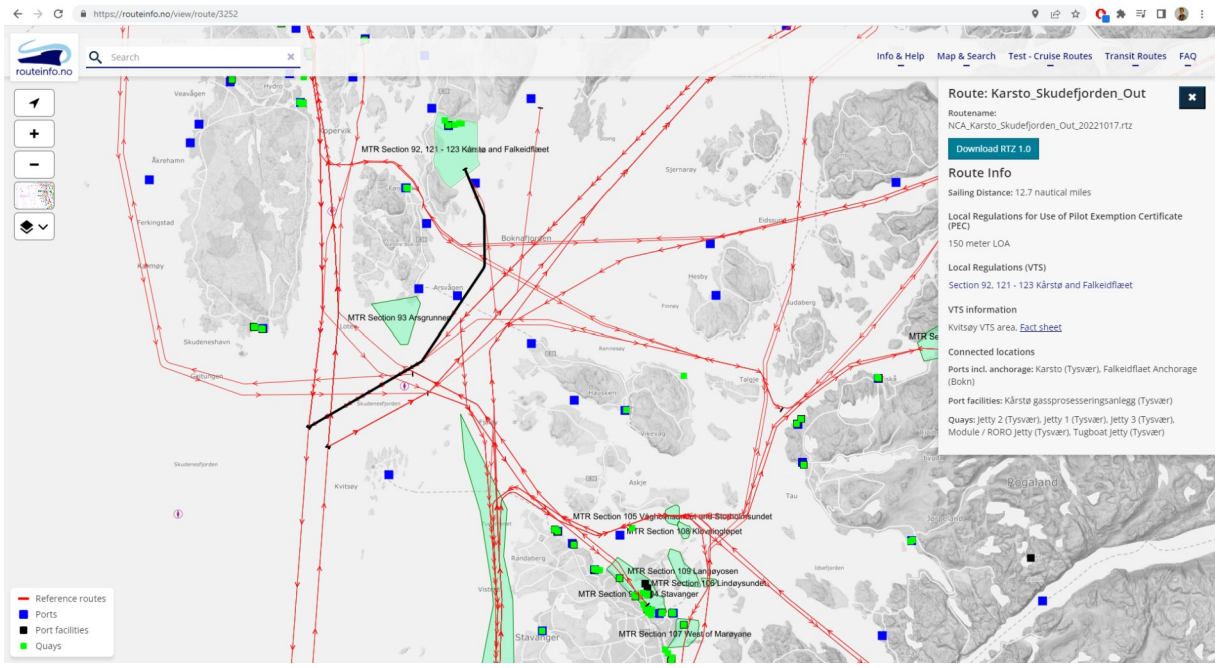
- ***NAIS – Real time Norwegian Vessel Traffic***

Kystverket is unique in that it operates its own land- and satellite-based AIS network. Life traffic data is used in many of our mapping platforms internally and externally. One example is NAIS, a web-based visualization tool that allow its users to search for ships, tracking and visualize historical data. All this data can be freely downloaded from our services for users who may want to use it for research, analysis, or other purposes.



- ***Route Info***

Route Info is another web-based visualization tool build around a center map. As opposed to NAIS, this tool was developed for a very specific audience: professional ship navigators planning their navigation in Norwegian waters, especially those that may be more unfamiliar with a particular area. The system shows reference routes, ports, ports facilities and quays. The different routes can also be downloaded and integrated into the navigator's own mapping systems.



Looking forward, we expect all our services to experience increased digitalization in the coming years. This means more automation, and integration with the end user's own systems and platforms. In terms of mapping, the NCA is seeking to further increase the accessibility and interoperability of our geographical data. Another important aspect of mapping is the efficient communication of geographical information visually. On this front, the NCA is moving towards further standardizing the visual elements of our maps, to ensure a cohesive user experience throughout our platforms.

Geological Survey of Norway

http://www.ngu.no/en

NGU is Norway's national geological survey. We map Norway's geology and disseminate and present data to meet society's needs for basic geological knowledge. NGU is an agency under the Ministry of Trade, Industry and Fisheries. Our mission and activities are designed to promote added value and sustainable economic growth. NGU's headquarters are in Trondheim, and our 200 employees form a highly international work environment. Research is an integral part of NGU's services and activity, and a prerequisite for performing geological mapping, that complies to international standards, on Norway's behalf. Over half of the employees 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 solutions for data collection, geographic database, and map services.

During the last 5 years there has been great progress in coordinated digitalizing of data collection across fields, and a shift towards more use of light-weight tablets and mobile phones. A map dashboard is made for improved registration and administration of field work.

We have a desire for more user-oriented maps to be used in planning through complex classifications calculated from many geological values and properties, but we still have a way to go. A restructuring of the bedrock database makes a range of alternative symbolizations possible, for example for tectonic, age (Figure 1), and content of chalk, which has a utility value.

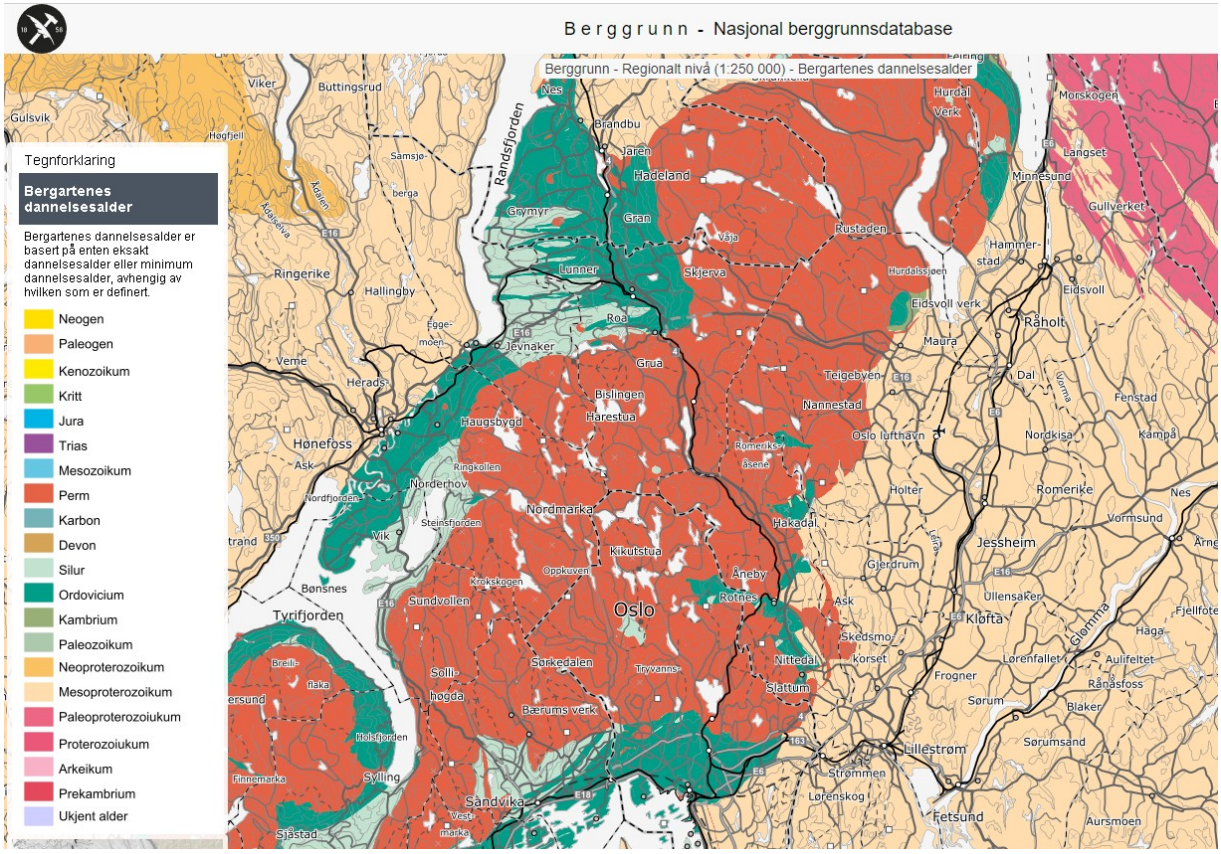


Figure 1: Bedrock age map as it is shown in NGU's web map application.

There is very limited production of printed maps. One of the latest printed maps published is shown below (Figure 2), a Surficial deposits map of Jan Mayen, which collected a price in 2022 (Geomatikkdagene.no).

While ArcGIS Software is mostly used for data collection and editing, map production and selected ArcGIS Online Services, Open-Source Geospatial Software are dominant for Map Services and Web Maps. Our web map applications and fact sheets with object properties are now device independent with "Mobile First" philosophy design. The underlying services that support the Map applications will be gradually replaced with the new APIs from OGC and other modern APIs.

We have just renewed our websites that focus more strongly on the user's need to search, display and download data (www.ngu.no/en). Data and maps can also be found at the national SDI at www.geonorge.no.

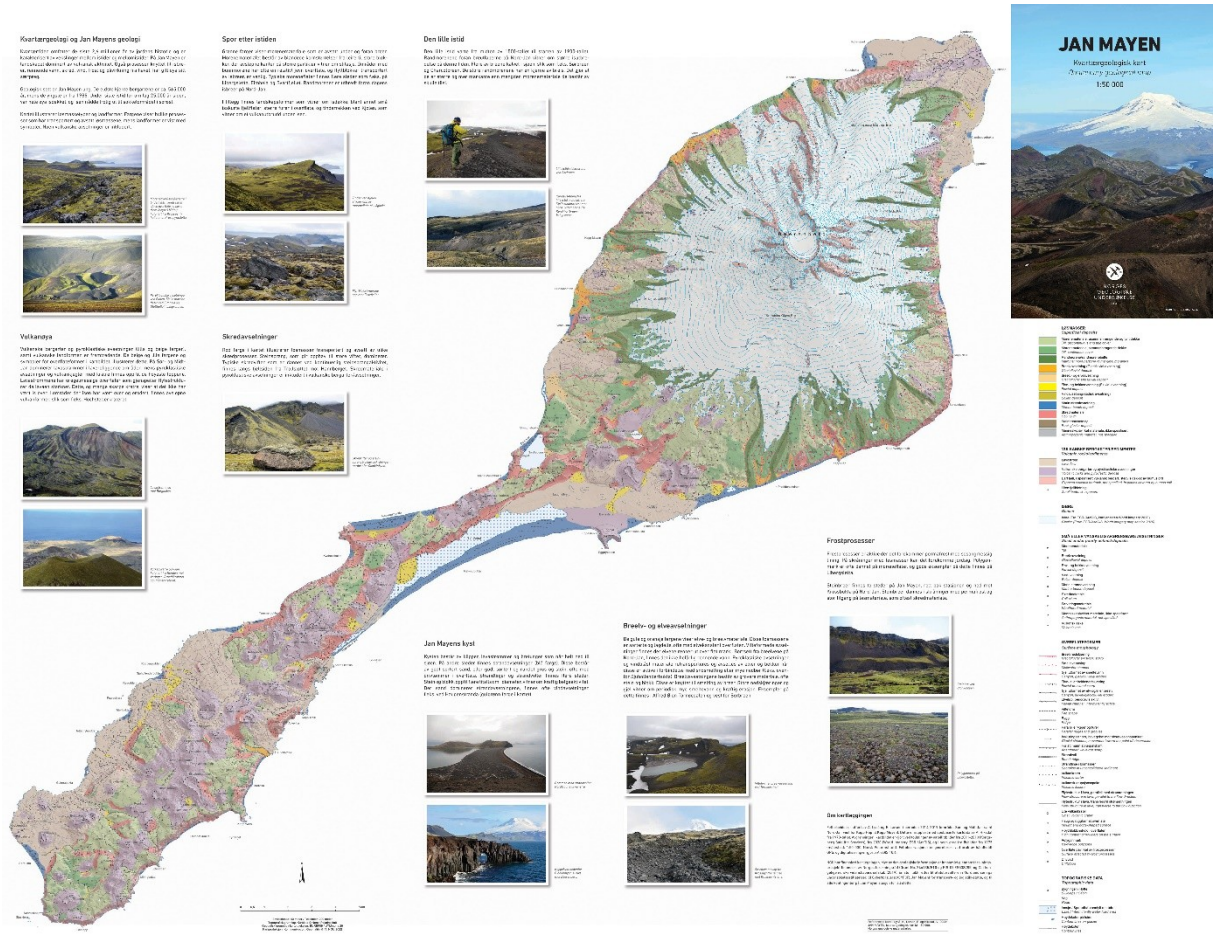


Figure 2: Jan Mayen quarternary geological map in 1:50 000 from 2022.

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 14 regional offices are located 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. Several departments and about 10 skilled employees are involved in the map designing. A great effort is being put into cartography to ensure readable maps of high quality that are easy to understand.

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 QField on cell phones and tablets. We use QGIS for analyses, visualization and creating maps and illustrations. The production of paper maps is small – mainly made on demand for different purposes and for grazing land for sheep and cattle.

Most of our data are presented interactively on the internet. 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.
Screen dumps from the viewing application zoomed in to show the potential of cultivation cauliflower (to the left), carrot (in the middle) and Brussel sprouts (to the right) in Steinkjer in the middle of Norway based on weather and soil.

Weather conditions are shown with green colour while soil quality (texture in the plough layer) is shown with yellow hatch pattern. The darker green, the more suitable weather for cultivating. If hatch is present, the texture is less suitable for growing vegetables. Dark green is best (good weather and good texture), dark green with hatch is second best (good weather, but less good texture) etc. The beige colour indicates that neither weather nor texture are in favour of cultivating Brussel sprouts.

When you click on a polygon, a “Position-icon” will be placed in the chosen polygon and a pop-up window will give you information about the classification and how it was mapped and when. Example from the carrot-polygon marked above:

Objektinformasjon

Gulrot

NIBIO
NORSK INSTITUTT FOR BIØKONOMI

Gulrot – potensial for dyrking	
Klasse	5
Klassenavn	Middels egnet klima, men mindre velegnet tekstur
Klassebeskrivelse	Høsteklar avling i færre enn 9 av 10 år og flere enn 7 av 10 år, men mindre velegnet tekstur i overflatesjiktet
Dominerende tekstur i overflatesjiktet	Siltig lettleire, lite grus
Areal (daa)	34
Kommune	Steinkjer
Kartleggingsår	1996
Kartleggingsmetodikk	Detaljert

Source: http://kilden.nibio.no tab “Jordsmonn” (eng. Soil).

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.

On the next pages you can find examples from the production:

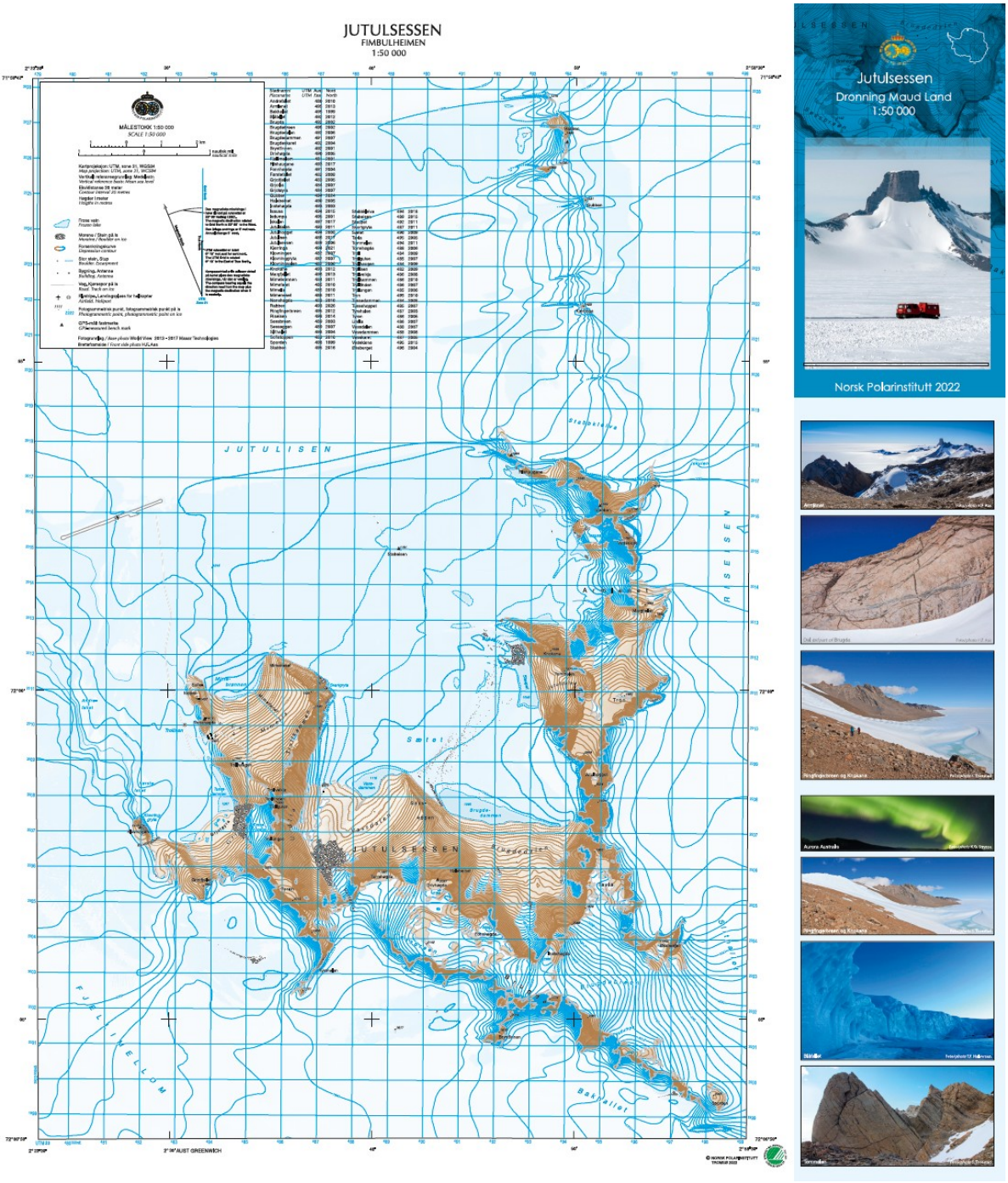


Figure 3: Printed topographic map of Jutulsessen mountain area, Dronning Maud Land, Antarctica, at scale 1:50 000, produced in 2022.

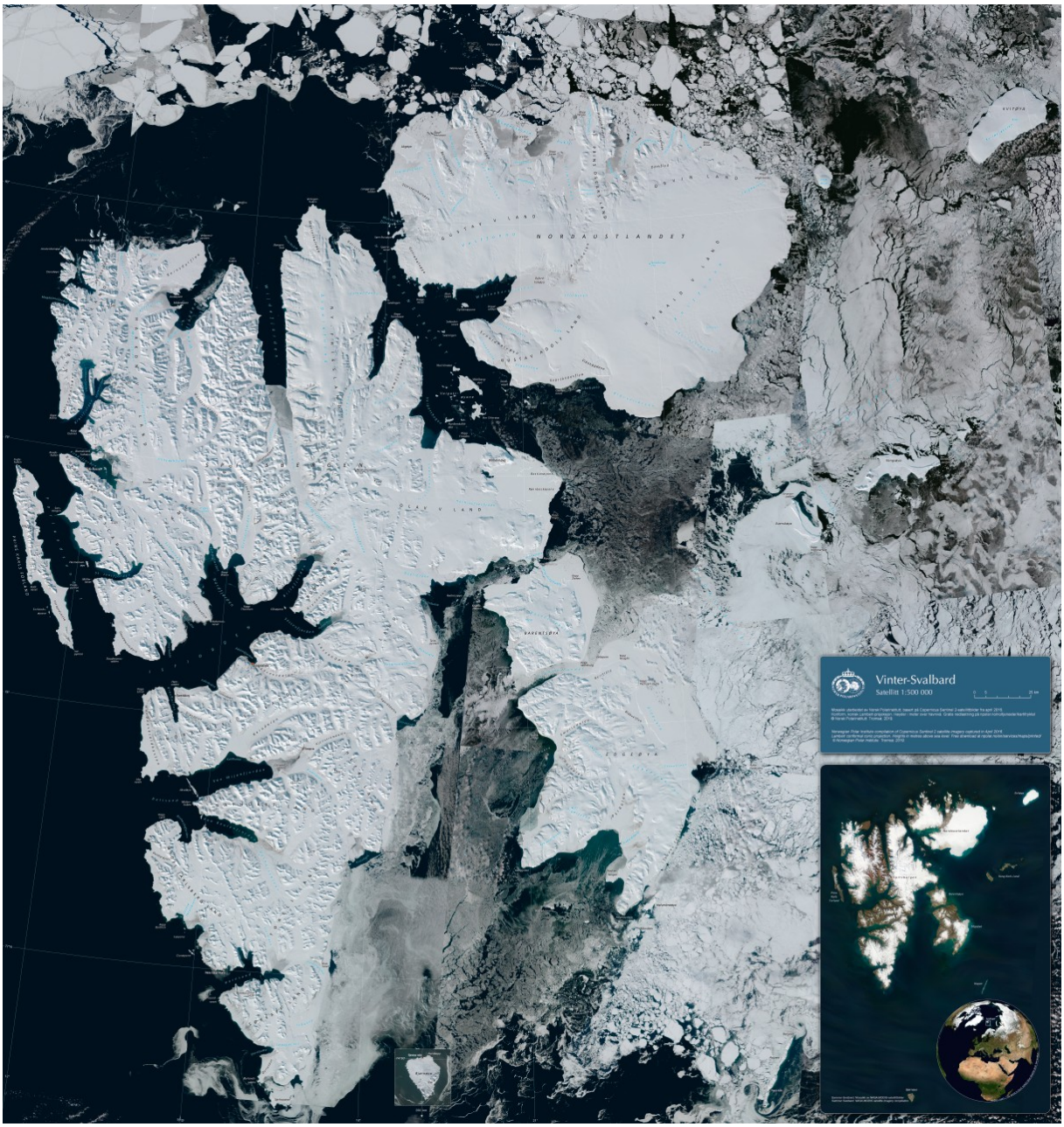


Figure 4: Satellite image mosaic of Svalbard, as typically viewed in the winter season. Digital poster produced in 2019.

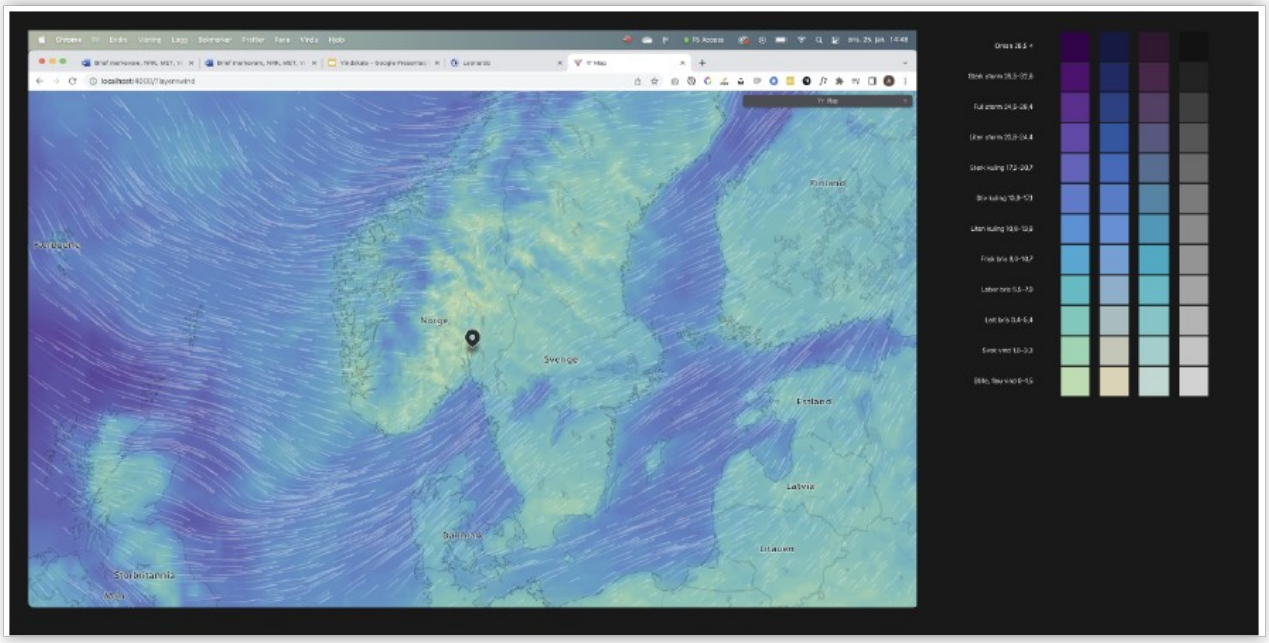
Yr – weather service and application

yr.no

Yr is a Norwegian weather service, using technology to simplify weather information. Yr is provided by the Norwegian Meteorological Institute and the broadcast company NRK. We have maps on both the webpage and our app.

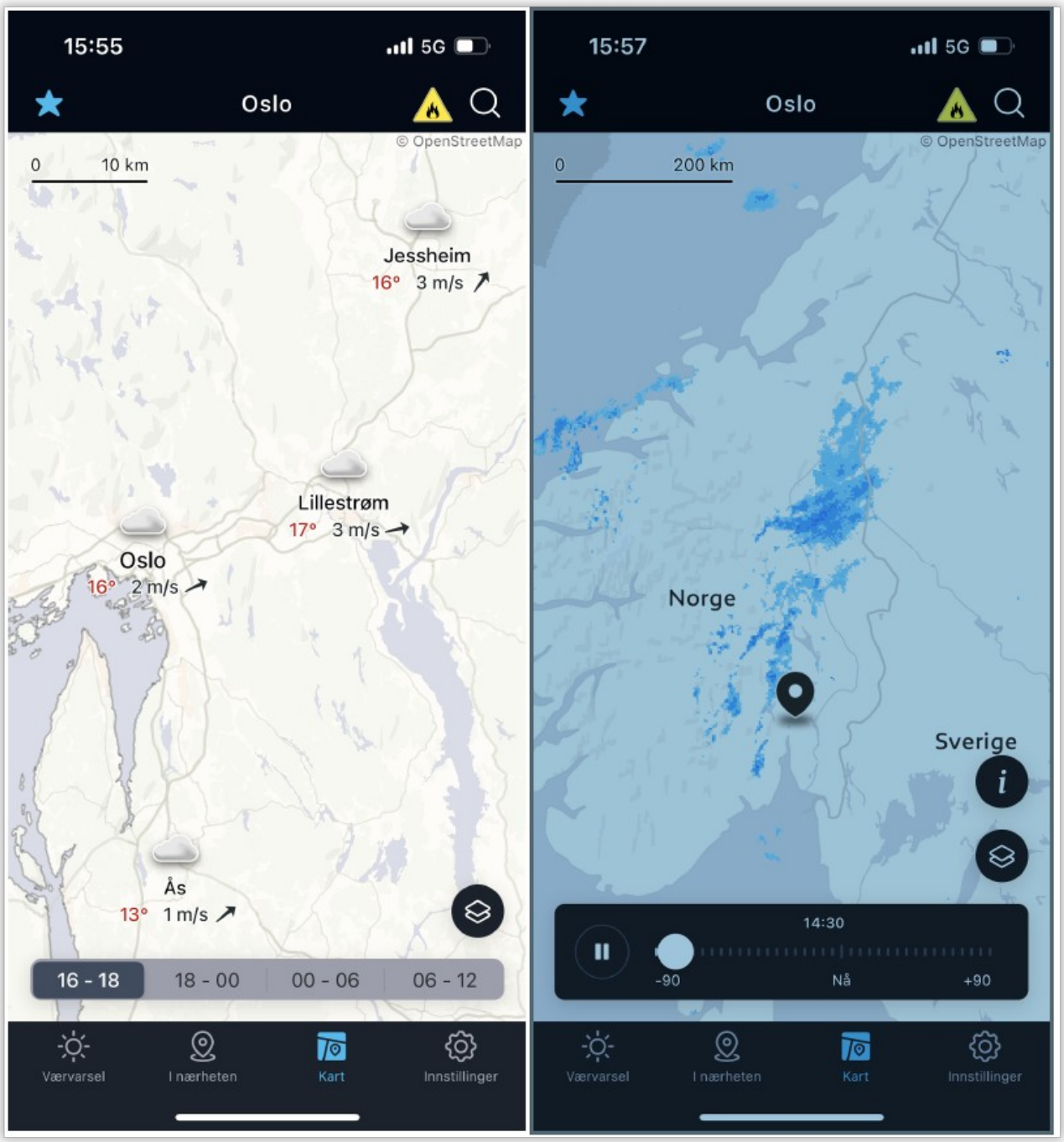
Wind map
In 2023 Yr launched a new map layer for wind on the website. The design focus has been on making the map and the data as accessible as possible. In the map layer this means creating features that allow users to orient themselves, such as points of interest, in a contrast that makes them easy to see even for users with diminished eyesight.

The goal was to create a color palette that gives the users an easy overview of the wind speed and direction. The color palette takes into account the most typical forms of color blindness and makes sure that even those who are unable to discern any color at all still can make out where the wind is intense and where it is weak. The image illustrates a version of the color palette with the bars on the right side representing the colors as seen with the most common forms of colour blindness.



To achieve what we wanted with the wind map, and subsequent map layers, we decided to take ownership of the whole technology stack in the Yr team. We have based the background map on an open source framework called Maplibre, and many of the data layers are from OpenStreetMap. With this basis we add on our own data where we need absolute control, f.ex. location names and national borders. We host the map on our own infrastructure and create map tiles that we style ourselves. On top of these tiles we add the wind data created for the map by MET Norway. To animate the data our developers learned how to program shader code using WebGL.

Weather maps at Yr are connected to Yr's database of 13 million places around the world
In 2020 we created a new simplified digital weather map for the website. This map is used in our apps as well, and we add a weather radar animation for the precipitation forecast (see the map to the right).



This weather map is supposed to give an overview of the weather in an area, by highlighting places that are more exposed to the weather than others.

It is not random which place names appear in our area map. We have put a lot of work into selecting places that can give users the best impression of variations in the weather. We strive to guide the users to make the best possible decisions based on the weather forecast.

Mountain peaks, lighthouses and other places that often experience rough weather, are given extra points in the selection of places to be shown. In this way, we hope to help users make good and safe choices when planning their trip. Both in the mountains and by the sea.

Yr weather app available for download:
- App (iOS): https://apps.apple.com/us/app/yr-no/id490989206
- App (Google): https://play.google.com/store/apps/details?id=no.nrk.yr

Counties and Large City Municipalities

Norway has all together 356 municipalities. The numbers of inhabitants are from 200 to 600 000! This report shows examples on map related work in one large municipality.

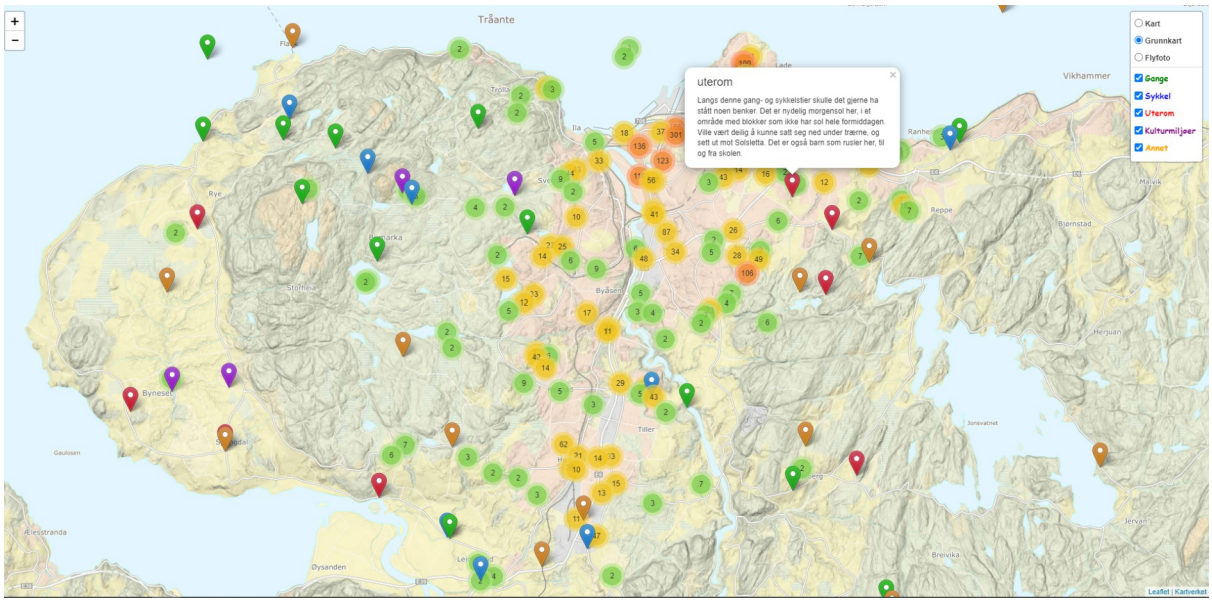
Trondheim municipality

Trondheim is (today) the third largest populous municipality and city in Norway. The city Trondheim was founded in the year 997 by Olav Trygvasson and has gone through numerous transitions over the centuries. There are about 15,000 employees in the municipality today. We are totally 45 in the mapping division (unit for mapping and architecture), of which a significant portion work directly with mapping activities. In addition to establish and update technical maps and maps and registry for planning purposes, we also provide and produce a variety of thematic maps and map solutions for other units in the municipality as well as for the public and external organisations. We also produce 3D models for specific projects. Some examples of maps we provide are as follows:

Citizen participation maps

Hearing: Possible developments in the city center. From 3D model to isometric interactive 2D map: https://sites.google.com/trondheim.kommune.no/framtidstrondheim/plan-for-sentrumsutvikling/omr%C3%A5deplan-for-nord%C3%B8stre-kvadrant-i-midtbyen

Low threshold click and comment - what do you think will make the city more attractive? 3500+ comments handled with Leaflet clustering: https://kart.trondheim.kommune.no/medvirkningskart/attraktivitet



Drone-captured models together with classical 3D GIS came together in Unity to form a virtual tour, replacing the physical tour as Trondheim played host to Nordic City Network during covid.

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.

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, and we celebrate our 35 year anniversary.
Our main focus is the visual presentation and related products where maps play a central role. This includes ordinary topographic 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 is a small company, where two experts of cartography are working on map and graphics production as well as following up our customers.
We make 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 almost all of Norwegian territory. This again enable us to improve the content and visual style of the maps.
We have won awards for our cartographic skills 11 times since the first price in 1997.
Below we present the two of our award-winning maps from the period 2019-2023:

Map of Oslo – *in retro design and retro cartography made in 2022*

Map of the "Lyngsalpene" – *with focus on the shading and sun to make the map easy to see how the landscape looks.* The Lyngen alps is a well know ski touring destination in the winter and also as a great place for climbing and hiking in the summer.

Mesterkart

www.mesterkart.no

Mesterkart is a company which main focus is to produce maps with high cartographic quality, pleasant to the eye. Our specialty is computer generated hillshading, with a natural color gradient from sea to summit. 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.

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.

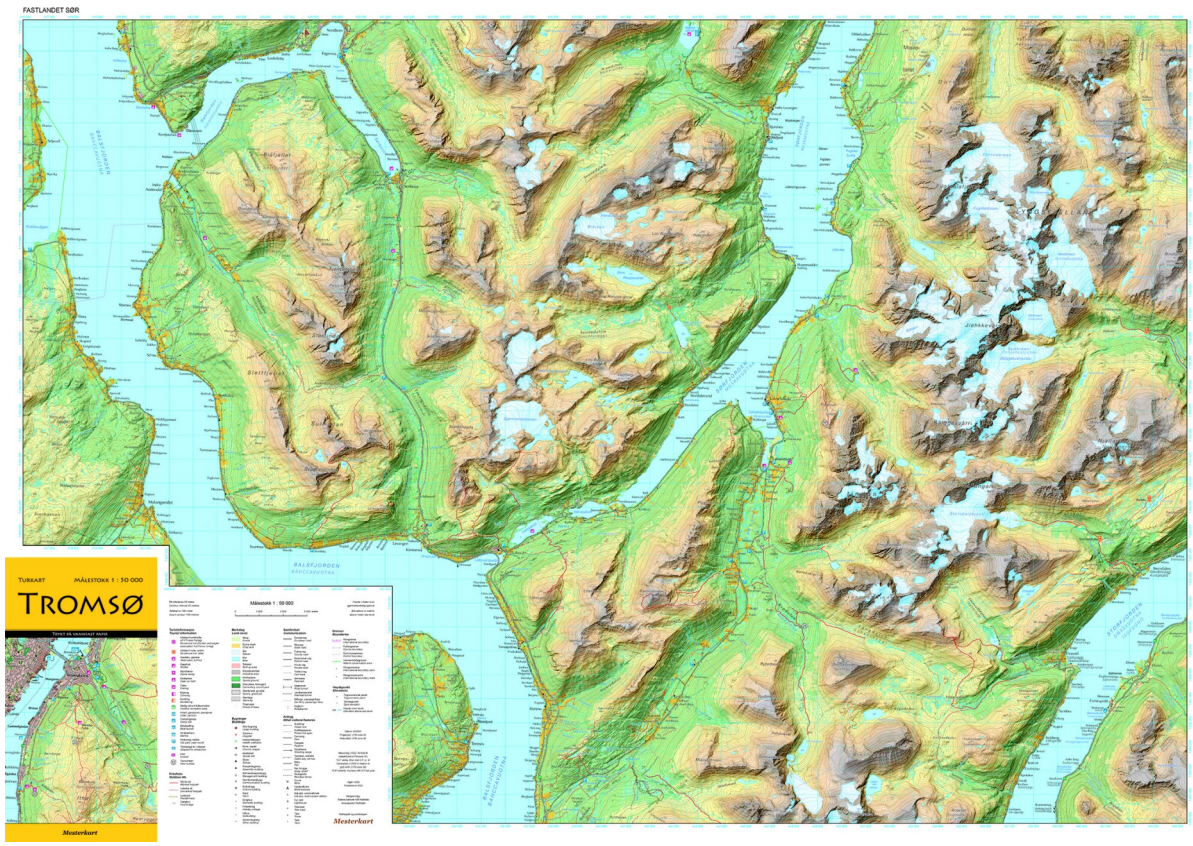


Figure 5: Turkart Tromsø.jpg: Turkart Tromsø, one of our tourist- and hiking maps. Scale 1 : 50 000. Map size 70 x 100 cm.

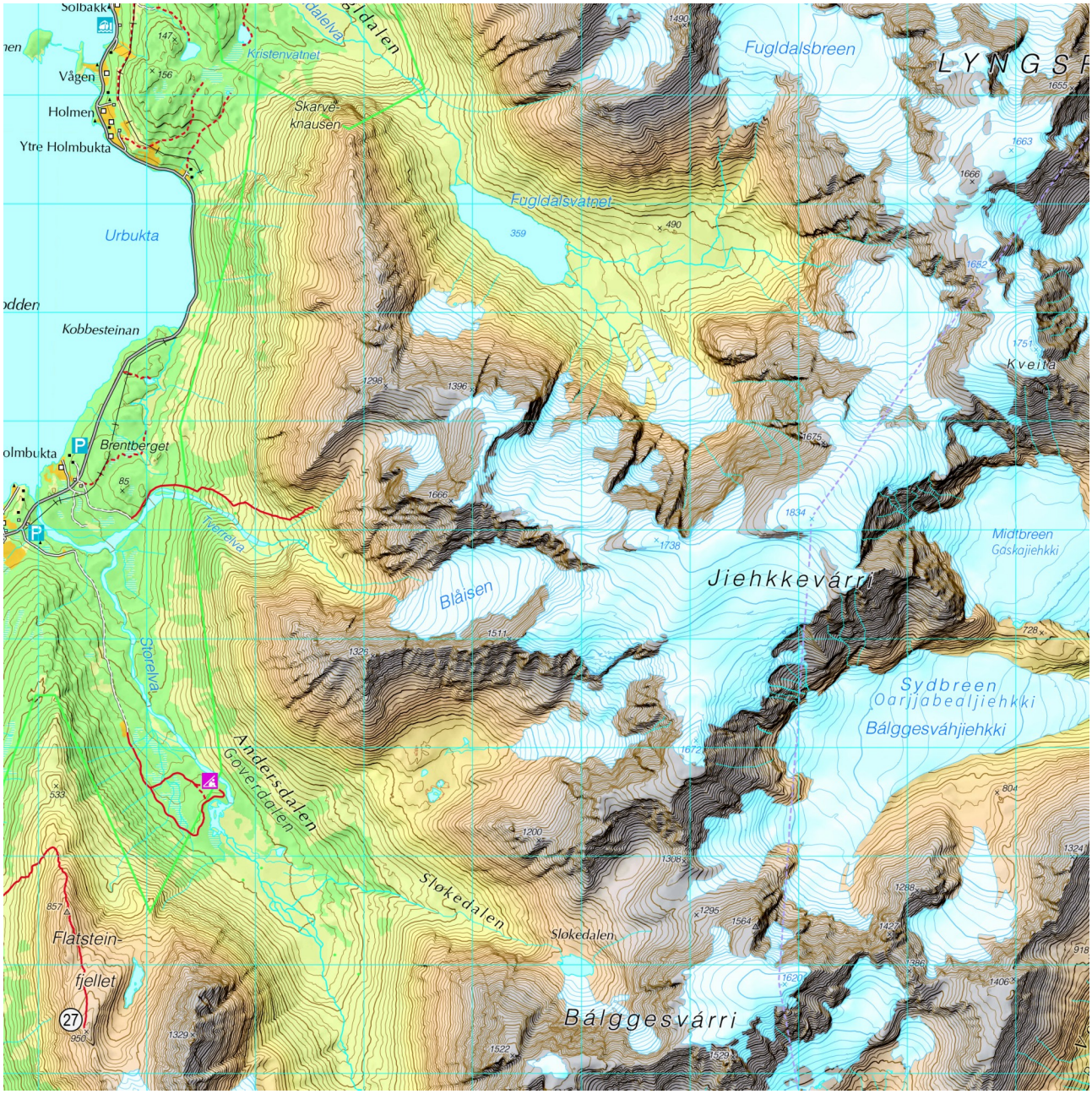
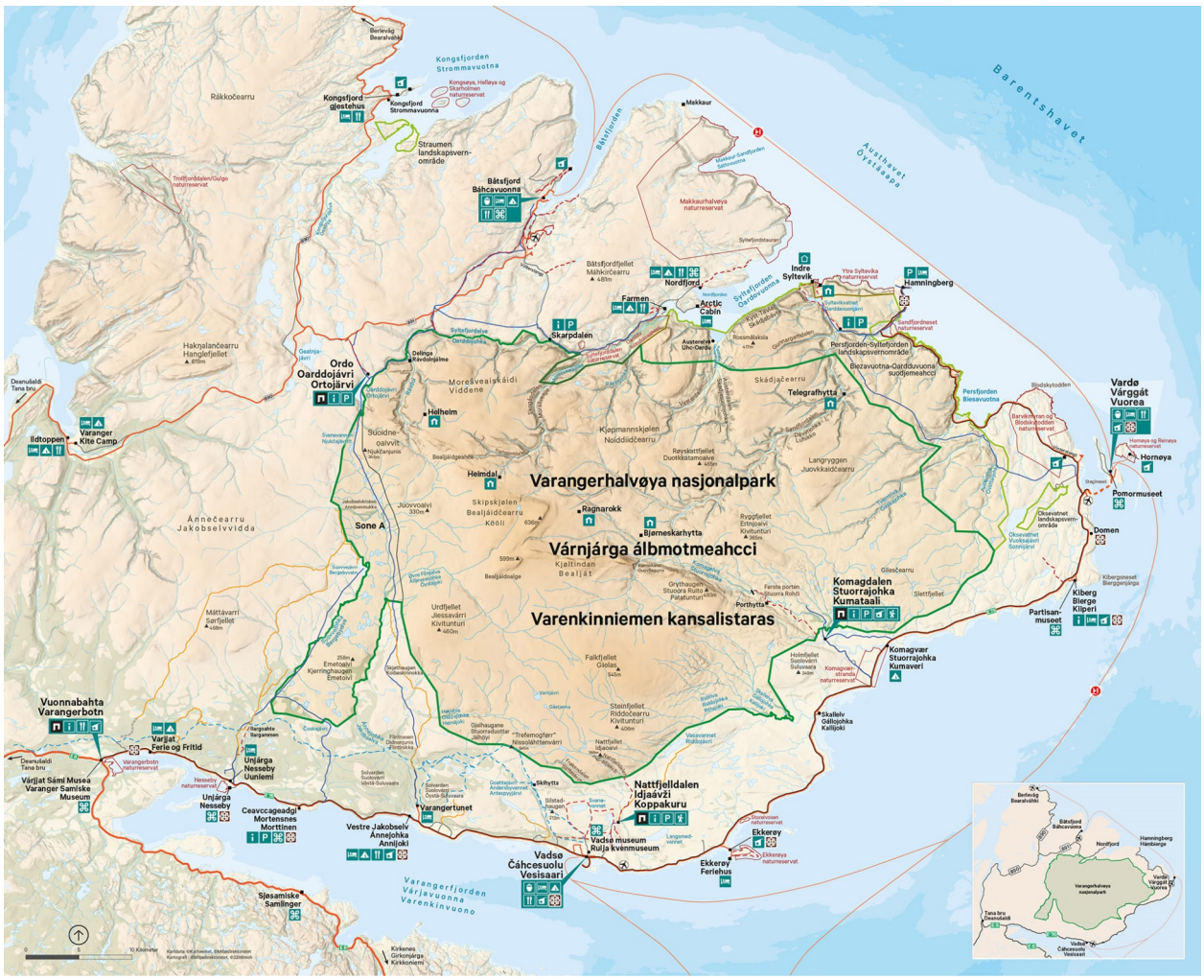


Figure 6: Turkart Tromsø utsnitt.jpg: A section from Turkart Tromsø, showing the alpine mountains of Lyngsfjellan.

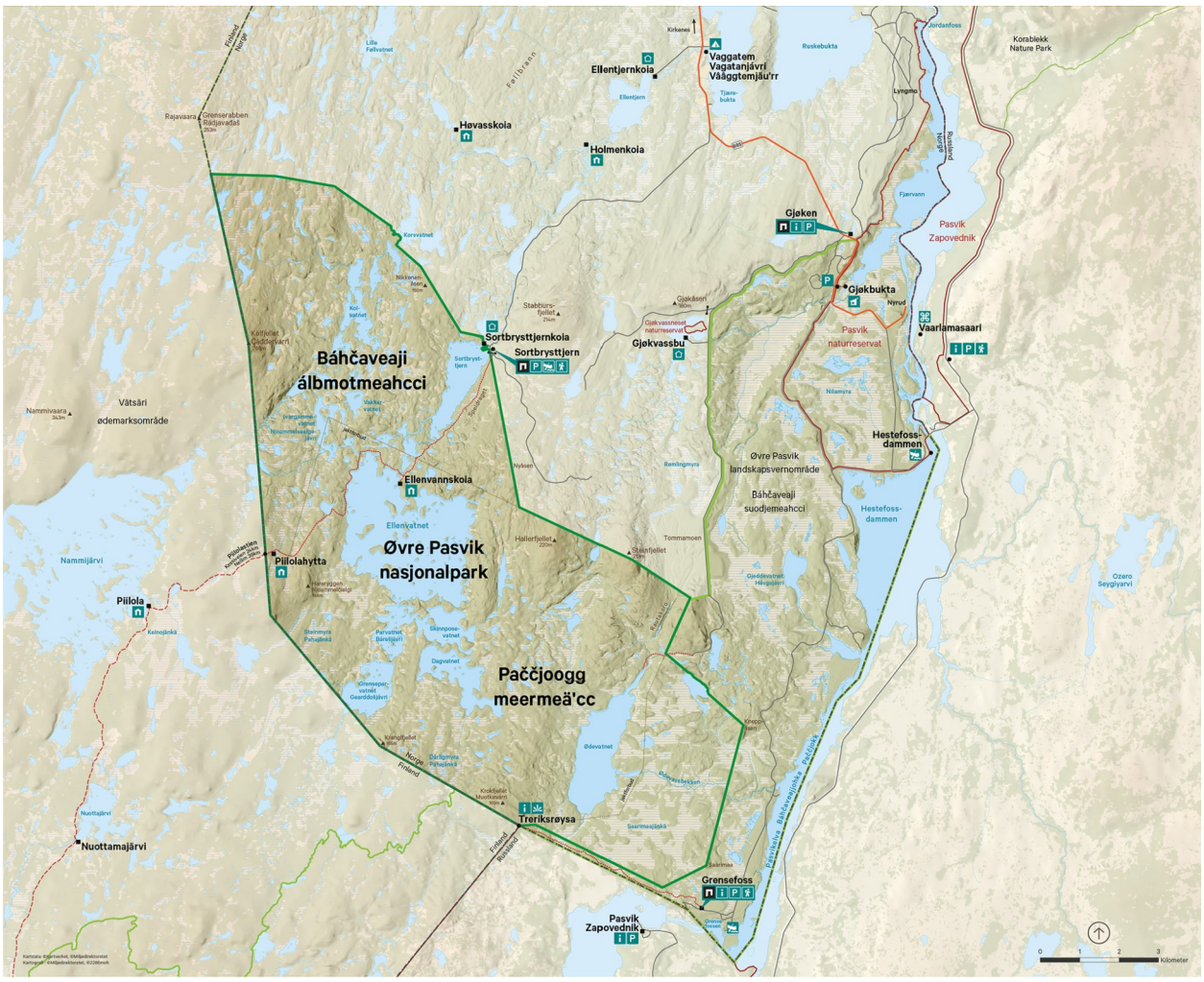
2286moh

www.2286moh.com

The business, 2286moh, is a sole proprietorship based out of Salt Lake City, USA. The name is inspired by the elevation of Snøhetta, the highest peak in Dovrefjell-Sunndalsfjella National Park, the home region of the owner. 2286moh is focused on cartography and map production, especially for print medium, such as brochures, posters, topo maps and books. Most projects are for clients in Norway where a significant amount of mapping data is freely and easily available for download from GeoNorge. The owner worked for the Norwegian Mapping Authority for a year and is familiar with the standards and the quality of the datasets used in the production of maps.
The mapping work for Norway started in 2017 helping the Norwegian Environment Agency finish their pilot project for maps for national parks brochures. The business has grown ever since with many projects spread around the entire country.
Norway's national parks map production
2286moh and subcontractor Trollbinde have, since 2019, had a contract with the Norwegian Environment Agency to produce maps according to their design profile and standards. The design is well developed and can be viewed at https://designmanual.norgesnasjonalparker.no/. The design profile has its own best practices and guidelines for map production and cartography, which we helped develop, https://designmanual.norgesnasjonalparker.no/kart/veiledning-for-utvikling-av-kart. In 2022 the map series for national parks won the jury award for best map at the yearly Norwegian mapping conference 'Geomatikkdagene'. The maps have their own look and feel and are developed from the bottom up with close cooperation with local resource people. A visitor strategy guides the content of what to add and what to exclude. The maps are overview maps and are not intended to be detailed trail or activity maps. In Norway there are three official languages, Norwegian, Sami and Kvensk (originating from Finnish). For some areas two or three of the languages are added to the maps for place names. It has become important to display all the official languages where they exist.



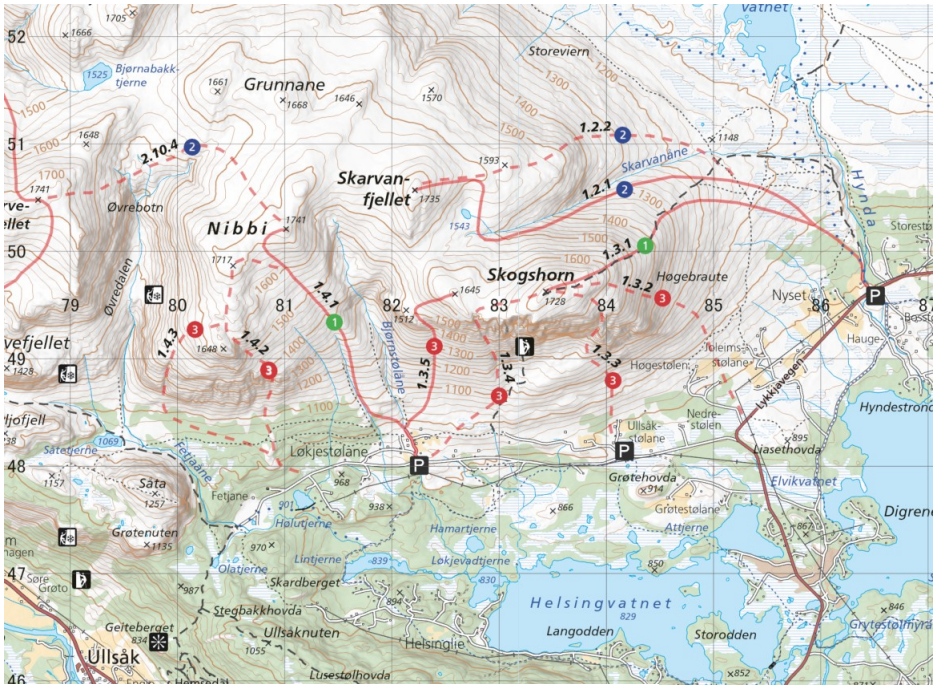
Varangerhalvøya National Park, brochure map. Example with Norwegian, Sami and Kvensk placenames.



Øvre Pasvik National Park, brochure map

Topo map for ski touring

Ski touring is a growing activity in Norway for Norwegians and tourists from abroad. The 2022 map of the Hemsedal area is a traditional topo map but with suggested ski routes added. The routes are from an internationally certified local guide who has written a detailed book about the routes. The map is a compliment to the book, but can be used on its own. Avalanche terrain classification according to the exposure to avalanches for each suggested route provides important information that the visitor can use in planning a ski tour. The map was made in close collaboration with the book author and guide, and the media production company Fri Flyt.



Klassifisering av skredterreng (KAST)

KAST er et hjelpemiddel for at du skal finne turer som passer deg og din gruppe, deres ferdigheter og rådende snøforhold.

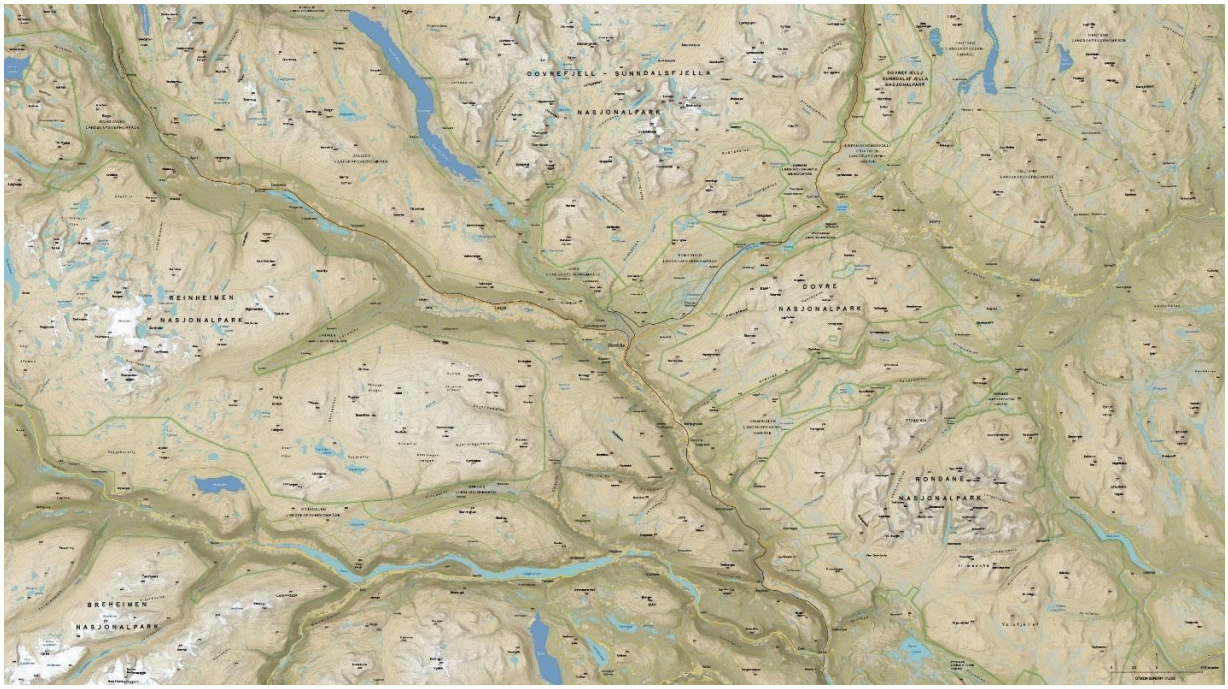
Classification of avalanche terrain

KAST is the Norwegian adaptation of ATES - Avalanche Terrain Exposure Scale. This is a tool to find routes that matches you and your groups experience and current snow conditions.

1 Enkelt *Simple*	For det meste slakt og oversiktlig terreng. Du må forholde deg til utløpsområder og mulige terrengfeller. Løsneområder kan unngås.	*For the most part gentle and open terrain. You have to consider run-out zones and possible terrain traps. Avalanche start zones can be avoided.*
2 Utfordrende *Challenging*	Her er du eksponert for løsneområder, utløpsområder, terrengfeller og flere ulike terrengformasjoner. Mulighet for flere rutevalg, slik at eksponering for skredterreng kan reduseres mye eller elimineres.	*You are exposed to avalanche start zones and run-out zones, terrain traps and different terrain features. Possibility for other route options to reduce or eliminate exposure.*
3 Krevende *Complex*	Terreng som er uoversiktlig og bratt, typisk alpine topper. Du må forholde deg til flere fjellsider og skredbaner samtidig. Utsatt for flere løsneområder og utløp.	*Terrain that is complex and steep, typical alpine peaks. You have to consider multiple mountain sides and avalanche paths simultaneously. Exposure to several start and run-out zones.*

Wall map

This map was made on a low budget for a small sports store in Dombås. It was designed to show all the protected land areas around the town of Dombås. The goal was to encourage conversations about the area and its possibilities, and let the customers explore topo maps for sale for the area of interest.



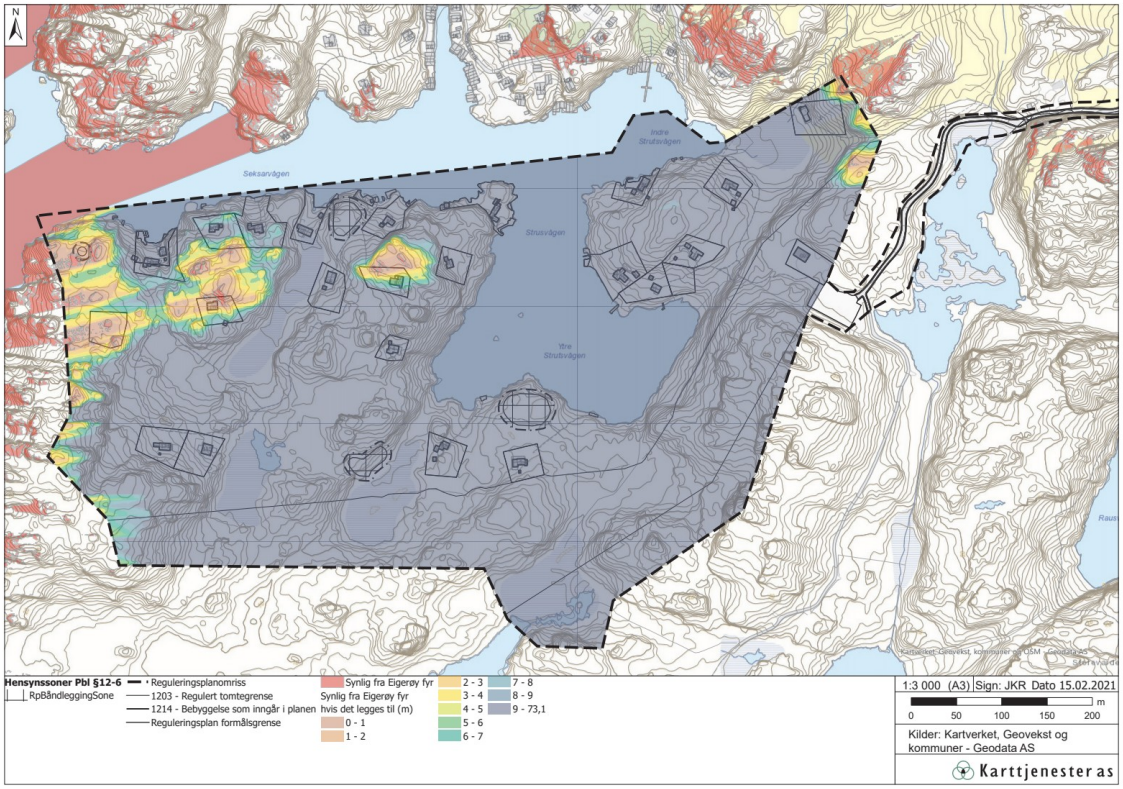
Karttjenester

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 visualization.

Our main field is making detailed local area plans for private and local government.

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.



Rambøll

Rambøll Norway AS *https://www.ramboll.com/*

Rambøll is an international knowledge-based consultancy firm with Nordic roots and more than 17,000 employees located in 35 countries. Based on experience, expertise, innovation, consistent work methods and interdisciplinary teamwork, we offer knowledge-based consultancy with quality and value for public and private customers.

Rambøll Norway is a part of Rambøll (Rambøll Group) and has around 1,600 employees who offers acomplete set of knowledge-based consultancy services within the areas of technical, property and architectural consultancy, environmental consultancy, management consultancy and energy consultancy. Rambøll Norway locates in 18 offices through the country and our well qualified employees are engaged in projects all over the country. We combine a strong and broad presence with the possibility of obtaining specialized expertise and additional capacity from other parts of the Rambøll Group in the project where this is useful. Our goal is to be an innovative, creative, and sustainable partner while ensuring functional, safe and reliable solutions through broad competence.

GIS, Geomatics & Visualization is a department within Rambøll Norway with expertise in map production, GIS, Geomatics and 3D-visualization/XR (VR/AR/MR) solutions. The department has 24 years of experience in producing and managing geospatial data. The employees have extensive knowledge in map production and use of tools related to geographic information systems, as well as being global spearhead for Visualization through the Rambøll Group through 18 years. Based on public geographic data sources, we prioritize accuracy and maintain high standards for visual quality.

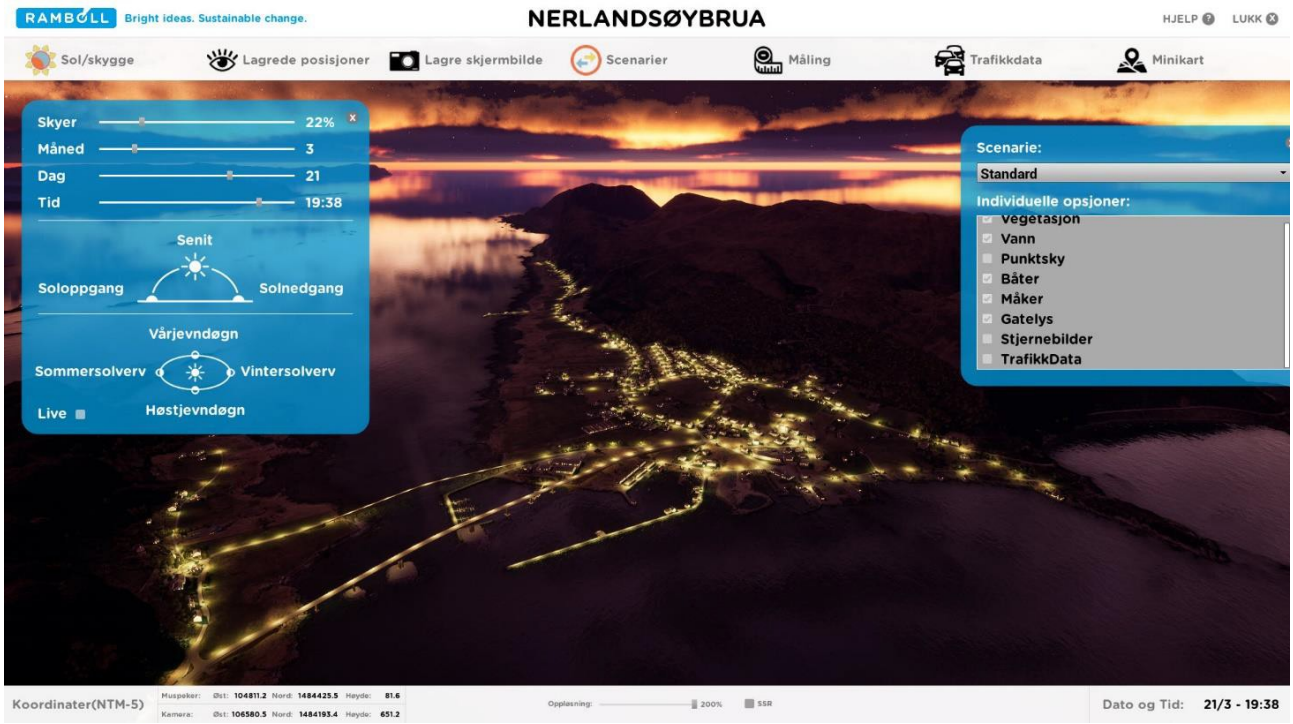
Rambøll Interactive https://rambollvisualization.com/ramboll-interactive/

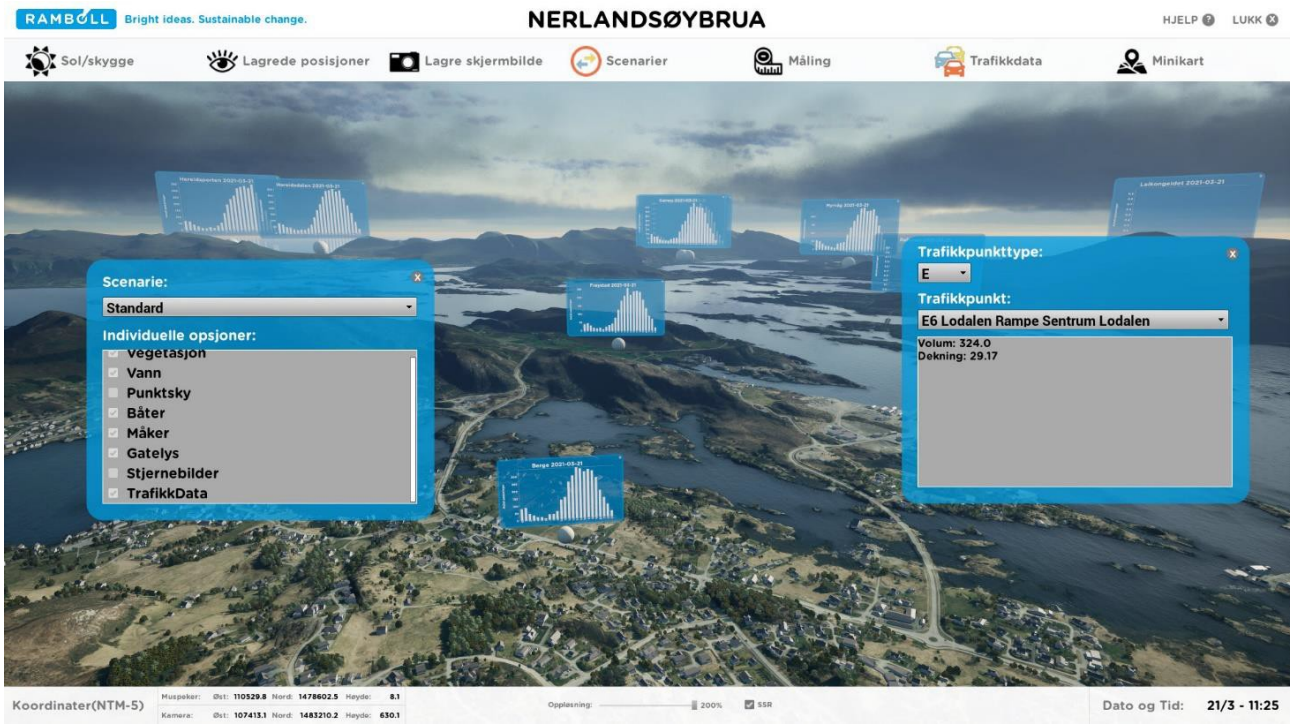
Our visualization team has developed an innovative interactive presentation model called Rambøll Interactive. Leveraging the power of the market-leading game engine, Unreal Engine, we ensure the same exceptional precision and stunning visual fidelity in our interactive models. This is a design and production tool for high-quality real-time renderings. Combined with sensor data, information from REST API’s and other geospatial information it serves as an advanced fully 3D Digital Twin.

This powerful tool enables us to provide stakeholders with an immersive experience in which viewers can explore and interact with the planning concepts, gaining a comprehensive understanding of the project's development and its impact. Rambøll Interactive offers a dynamic visual representation that enhances communication, facilitates informed decision-making and effectively engages the public,
including the youth. Rambøll Interactive supports VR and can be used standalone for meetings, presentations and seminars, or could be integrated into a customer's website or services, further extending its versability. We are proud of our ability to deliver models, 3D films and illustrations that are
both accurate and aesthetically appealing, which are of great assistance to our customers in their planning and decision-making processes as well as for communicating to the public. Unreal Engine allows us to create and develop interactive experiences of tailored scenarios unique to each project.
From 3D visualization and cinematic experiences to interactive project and design analyses, Unreal

Engine gives us the ability to turn the customer's ideas into reality. The default package has basic tools and a user-friendly interface. This package can be expanded upon and further developed to match the
customer's needs. Functions include:

- High quality visual graphics in Real Time
- Navigating the model using VR glasses
- Navigate in walking or flying mode
- Drive by car
- Visibility analyses: 100% freedom from viewing the project from any position
- Sun-shadow analysis: Set sun to any date and time. Realistic light.
- Save camera positions
- Export images up to 4K resolution
- Layer structure and scenarios




RAMBØLL
Bright ideas. Sustainable change.
NERLANDSØYBRUA
HJELP
LUKK
Sol/skygge
Lagrede posisjoner
Lagre skjermbilde
Scenarier
Måling
Trafikkdata
Minikart
Scenarie:
Standard
Individuelle opsjoner:
Vegetasjon
Vann
Punktsky
Båter
Måker
Gatelys
Stjernebilder
TrafikkData
Trafikkpunkttype:
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Trafikkpunkt:
E6 Lodalen Rampe Sentrum Lodalen
Volum: 324.0
Dekning: 29.17
Koordinater(NTM-5)
Oppløsning:
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Dato og Tid:
21/3 - 11:25

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 GISc (systems and analysis). Each year more than 30 students complete their bachelor thesis within Land Administration and Surveying. Many of these students choose geomatics related bachelor projects.

Cartographic Research

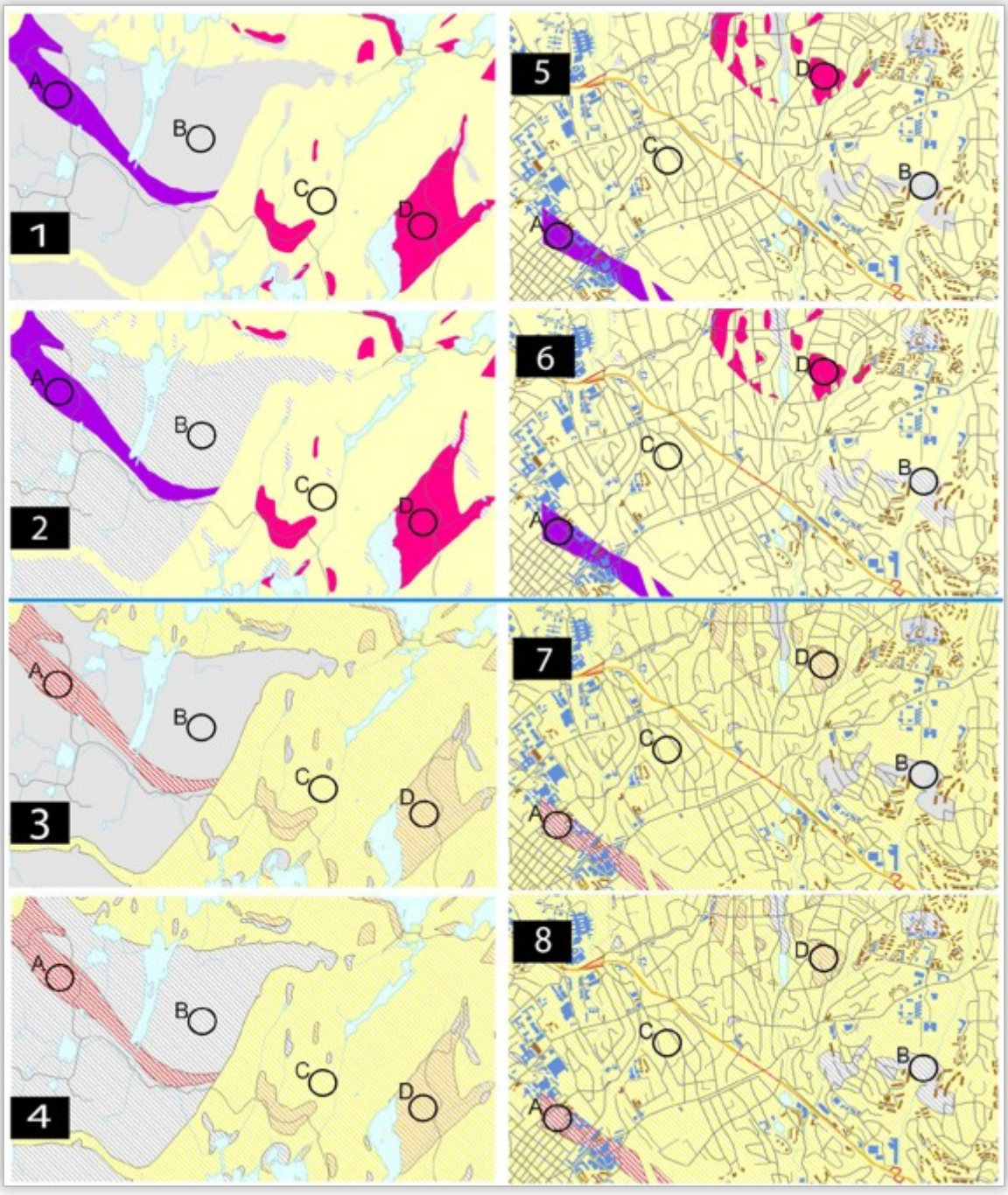
Both governmental institutions and private industry are developing new methods for visualizing maps. However, when it comes to more fundamental and thorough Cartographic research it is the responsibility of the universities. Below some recent projects are introduced.

Norwegian University of Science and Technology (NTNU)

Geomatics at NTNU in Trondheim

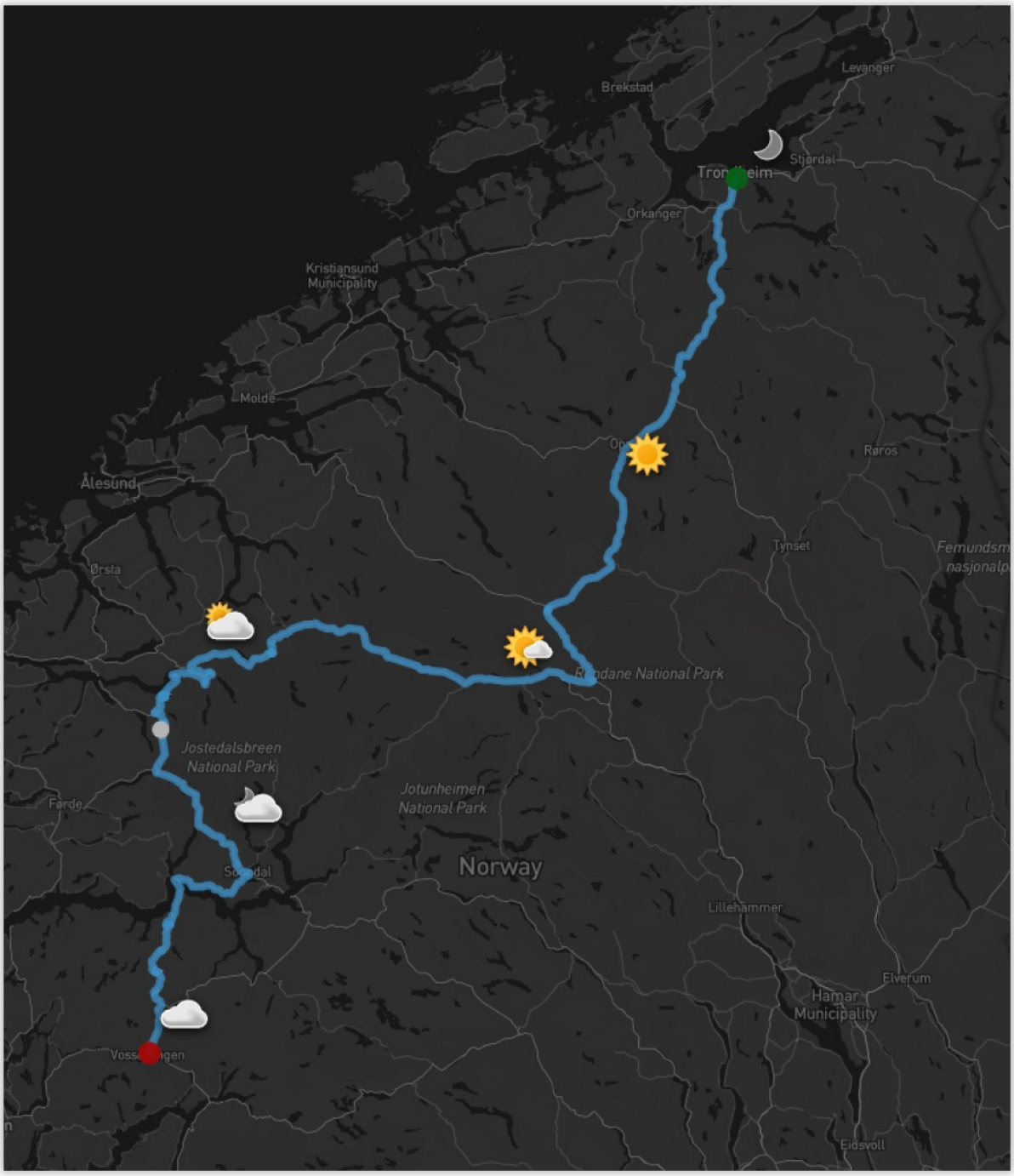
Creating better maps of the subsurface

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. A part of the project is to study the cartography for existing maps through web-experiment. Here is an example where a Radon map is tested:



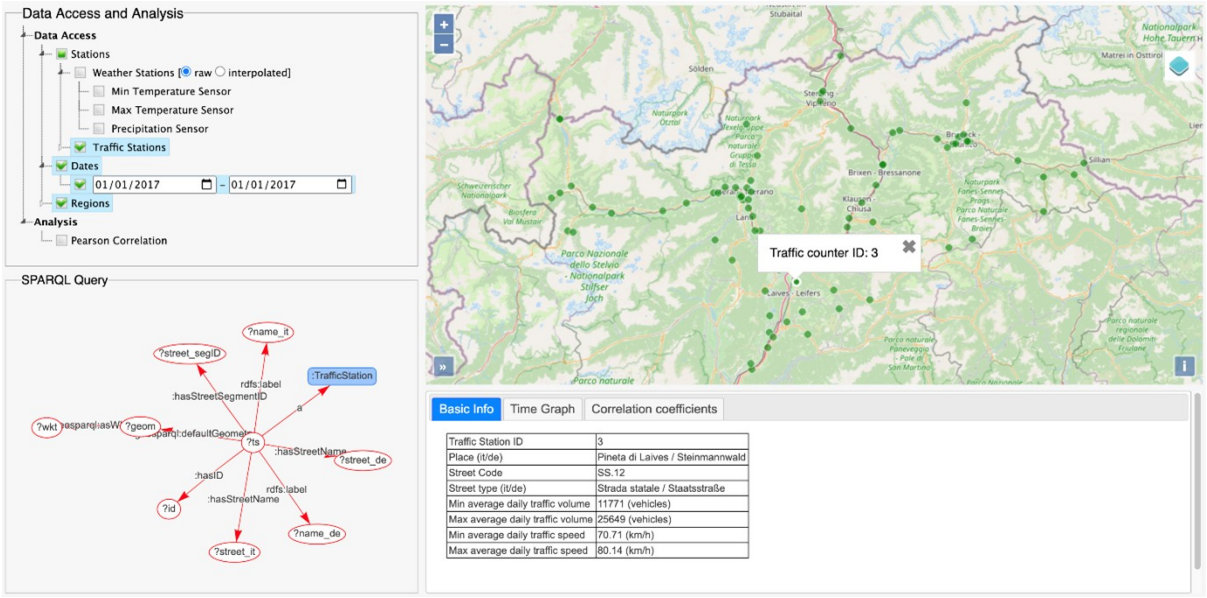
Spatio-temporal weather maps along a travelling route

This master project were focusing on extracting and communicating weather information along a travel route. The weather forcast at different points along the route are based on the actual time when passing the point. Cartography and methods were tested through a web-experiment.



Geospatial Knowledge Graph for Visual Analysis

Geospatial knowledge graph is a semantic technology that structurs geodata in the form of a graph, in which nodes represent entities, places, geometries, or values. This approach is highly relevant for geodata integration and can thus provide a basis for visually analyzing big geospatial data. Figure X shows a visual analytical interface for exploring weather and traffic sensor data based on knowledge graph approach.



The figure shows an interactive visual analytical interface for exploring weather and traffic sensor data based on knowledge graphs, consisting of the core geospatial concepts (upper left), the structure of SPARQL queries (lower left), the spatiotemporal distribution of the stations, sensors, and meteorological and traffic observations (right).