

KEPLER Deliverable Report

Report on Deliverable D1.2: Community-Based Observation and Societal Needs

Deliverable name	Community-Based Observation and Societal Needs Report		
Scheduled delivery	month: 06	date:	June 2019
Actual delivery	month: 06	date:	June 2019
Report type	Other: Work Package Report (referenced)		
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Context of deliverable within Work Package

The report contains summaries, Indigenous and community voices on remote sensing, observational and services needs, gaps and solutions from northern Sweden, coast of Norway, Finnish Lapland and NW Russia, including traditional weather knowledge and sections on traditional livelihoods.

Report

Please see attached.

Related Publications and Dissemination Output

<http://www.snowchange.org/pages/wp-content/uploads/2019/04/280419-EU-Project-Kepler.pdf>

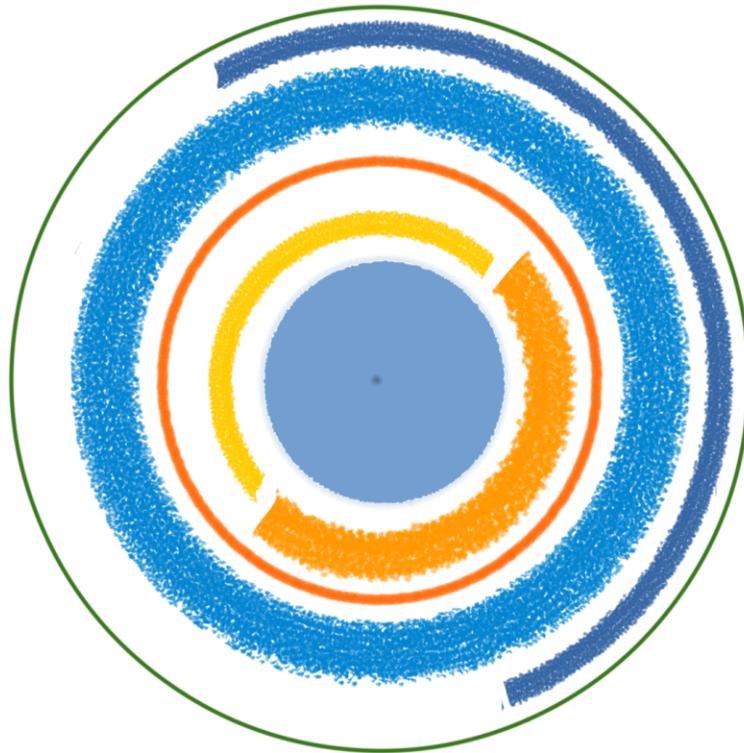
<https://kepler-polar.eu/2019/06/18/community-based-observing-and-societal-needs-report/>



EU Project Kepler:
Community-Based Observing and Societal Needs
Work Report, April 2019

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KEPLER



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I. Introduction and Scope



Participants of the Inari Kepler Workshop: Stefan Mikaelsson, Pauliina Feodoroff, Kaisu Mustonen, Tero Mustonen, Eirik Malnes, Jevgeni Kirillov. Snowchange, 2019

The purpose of this report is to review the stakeholder needs and community-based observations for the EU project “Kepler”¹. It will focus on the remote sensing needs of the local and Indigenous communities of NW Russia, Sweden, Finland and Norway. The approach includes a discussion of cryospheric hazards and traditional weather observation and prediction materials from the Sámi communities. It has been produced to capture the results of the WP 1 of the Kepler project.



Regional Coordinator Jevgeni Kirillov discusses land use changes in Ponoj watershed. Snowchange, 2019

The science lead for the report has been Tero Mustonen from Snowchange Co-op. Co-authors for the regional chapters and cryospheric hazards include

¹ <https://kepler-polar.eu/home/>. KEPLER is a multi-partner initiative, built around the operational European Ice Services and Copernicus information providers, to prepare a roadmap for Copernicus to deliver an improved European capacity for monitoring and forecasting the Polar Regions. Our motivation is to put the public and stakeholders at the centre of Copernicus. This follows the recommendations of the ‘Copernicus User Uptake’ review, and its 4 themes of: Raising awareness for the Copernicus programme, Informing and educating Copernicus users, Engaging Copernicus users in public and private sector, and, Enabling access to Copernicus data and information.

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II. Materials and Methods

In order to review the stakeholder needs and community-based observations from the project we have had to operate under very tight timeframes. This report attempts to capture voices of winter 2019 on the intersecting topics of stakeholder needs and community-based observations. Our emphasis has been to highlight living voices and current information as opposed to a full academic study of the needs – indeed the time, space and resources available have only allowed reporting from the field, and not a full scientific study on the topic.

The following methods have been included in the work:

- The work began with literature analysis and archival work in all regions to establish the scope of the discussions and framework for the Kepler work.
- Regional coordinators then proceeded to interview Indigenous stakeholders anonymously². We used semi-structured interviews with key stakeholders from the Snowchange community network.
- Additional information was gathered from phone and field interviews, discussions with search and rescue operators, and recent media associated with the topic.
- Existing maps and satellite and other remote sensing data was reviewed and has been included as an example of the needs and extent of services, especially in NW Russia.
- One young professional fisherman worked as a co-author to test and put in practice satellite based technologies for winter seining on a boreal test lake by keeping a research diary as a member of a fishing team.
- Online survey amongst Sámi coastal fishermen in Norway for scouting of needs, priorities and wishes.
- Field visits to remote reindeer corralling areas and wilderness areas were undertaken to test the availability of remote sensing services and to meet Sámi practitioners in the field.

² interviewees had the choice to include their names if desired, consent forms were collected

- A geographical analysis of the balance of available services, risks and needs from the viewpoint of the Indigenous communities and other stakeholders in the European peripheries.
- An Indigenous knowledge workshop was organised in Inari, Finland to review and discuss all findings.

As a method³ satellite remote sensing services using the Sentinel-satellites can become very useful for indigenous people in similar ways as satellite-based ice charting today is useful for fishing and navigation in Arctic environments. In this method section we give examples of a few services that can be implemented in regions where reindeer herding, and other nature-based economy demands good knowledge on the extent and quality of snow and other key environmental variables such as ice on rivers and lakes and avalanche activity to name some examples.

Traditional snow monitoring services

The user needs for snow monitoring has been documented in Malnes et al.⁴, Snow monitoring has for a long time been used as an example where satellite data can be used to extract relevant information. Historically the hydropower industry and governmental hydrological services as well as the need to document ongoing climate changes have dictated the needs to develop services. These services are currently quite mature when it comes to regularity and coverage at mid-latitudes, but suffers often from deficiencies in the arctic due to polar night and/or lack of cloud free conditions. Services such as CCI Snow and EUMET/HydroSAF are currently operating but has a limited interest for Arctic users.

³ Primary author of this section is Eirik Malnes

⁴ 2015

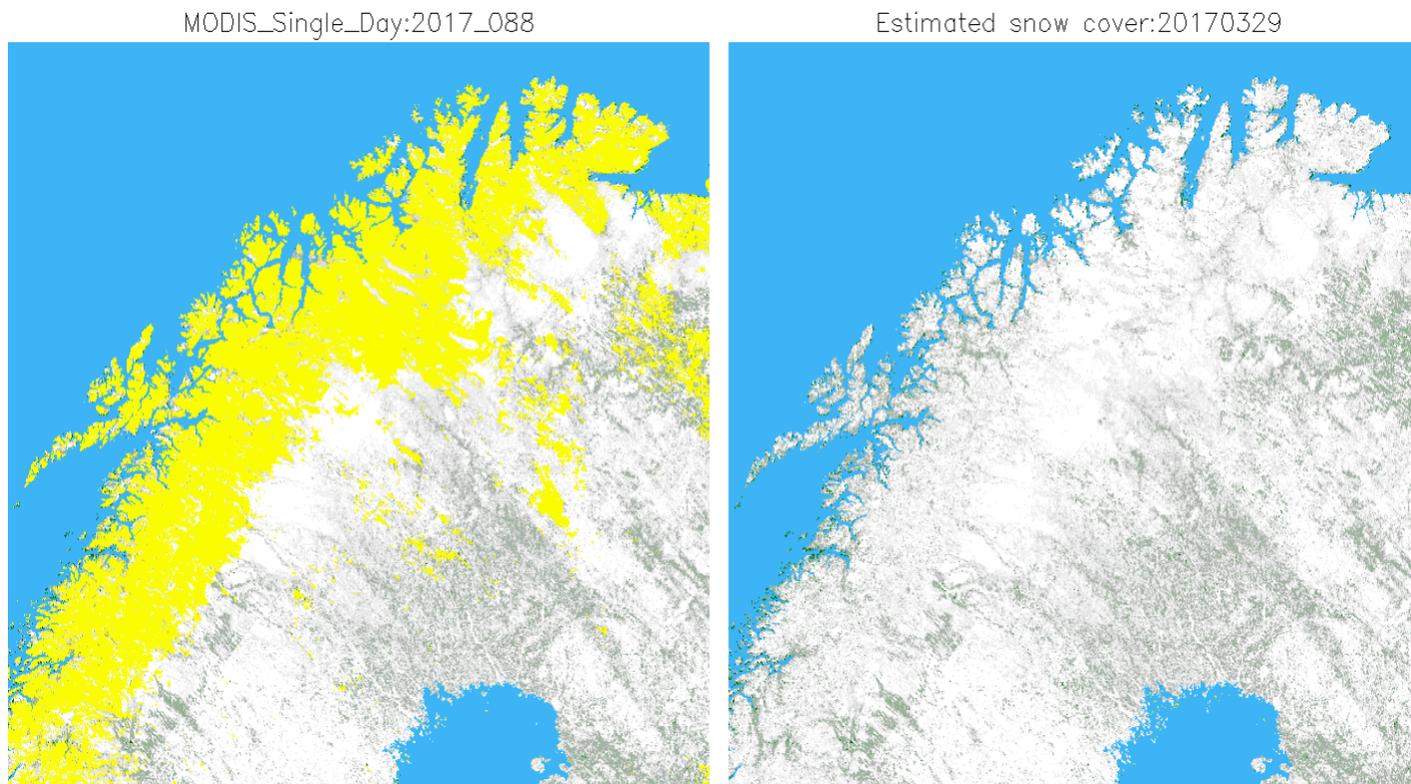


Figure. Example of snow cover map for northern Fennoscandia using optical satellites. Cloud cover can often be a challenge during long periods, Polar night from November to February obscure a long period when observations are of high relevance.

Wet snow monitoring

Radar-satellite data is a complement to optical data for monitoring snow cover⁵. Sentinel -1 data can also be used to monitor whether snow is melting or not. This feature can be very useful for Sámi people and local communities who use snowmobiles very often also has a need to be

⁵ Storrøll et al., 2006

able to move in challenging terrain under periods of cold and harsh conditions. Melting snow can be a problem for reindeer pastures since snow melt with subsequent freezing can lead to ice blocking of the lichen during the mid-winter.

There have been several episodes during the last 20 years where this phenomenon has led to starvation among reindeers, and crash in the populations. Such events will probably occur more frequent in the future due to warmer climate. Melting snow can, however, also be positive since it indicates the timing of the movements from winter to summer pastures for the reindeers.

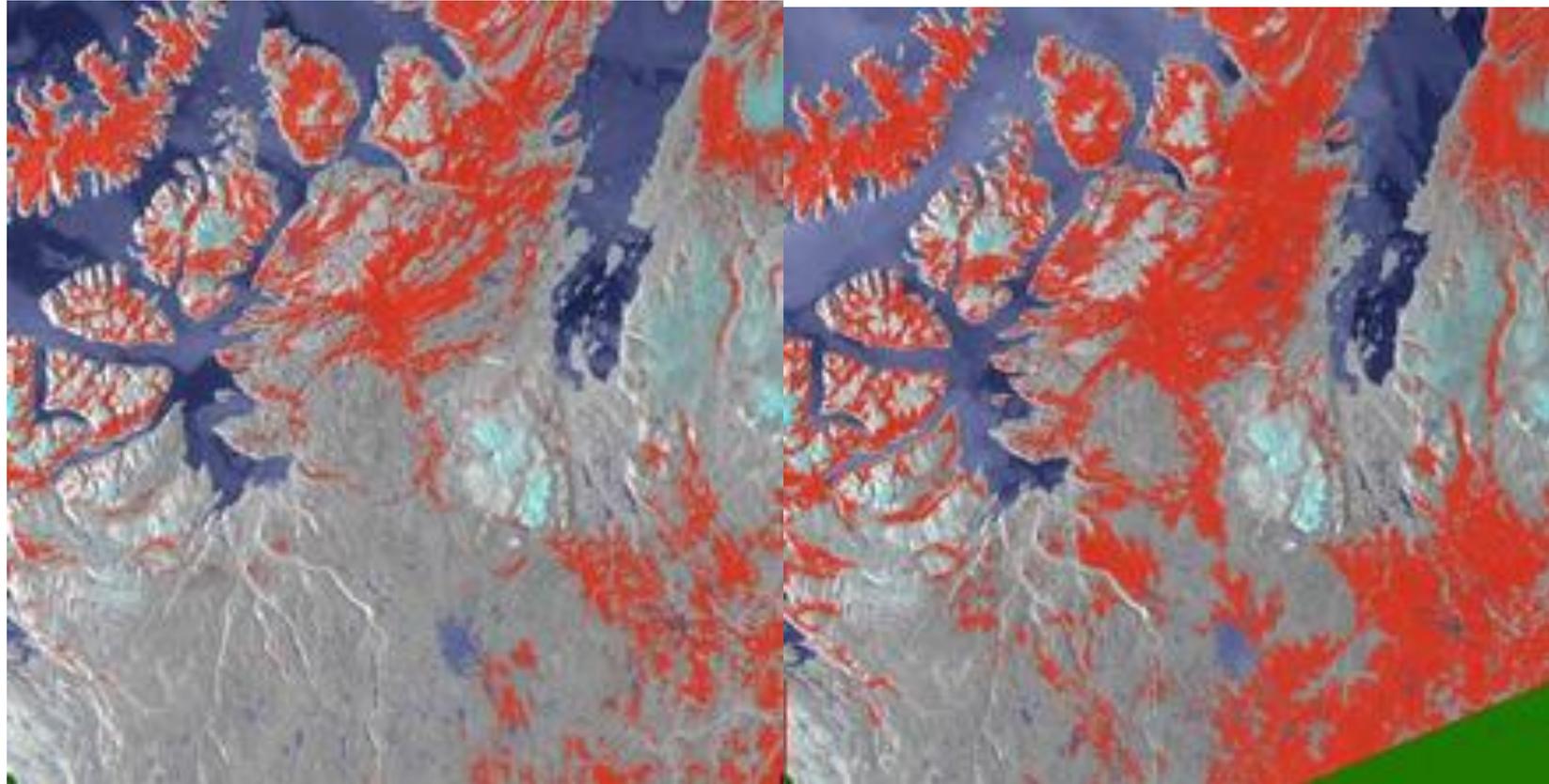


Figure. Examples of finding the first day of extensive melting snow on Finnmarksvidda using Sentinel-1 for April 16, 2015 and April 10, 2016. Red color indicate melting snow.

Snow avalanche monitoring

Sentinel-1 SAR data can be used to monitor snow avalanche activity effectively in the Arctic regions⁶. An effective system for snow avalanche monitoring in Norway is currently being operationalized by the Norwegian Water and Energy directorate using technology from NORCE. Figure below gives an example on how change detection can be used to detect avalanches. Due to the frequent satellite coverage at high latitudes, SAR is an excellent instrument and several examples and studies has shown that both the regularities of satellites and the ability to detect avalanches in regions where there are no roads or no other means of monitoring the activity exist.

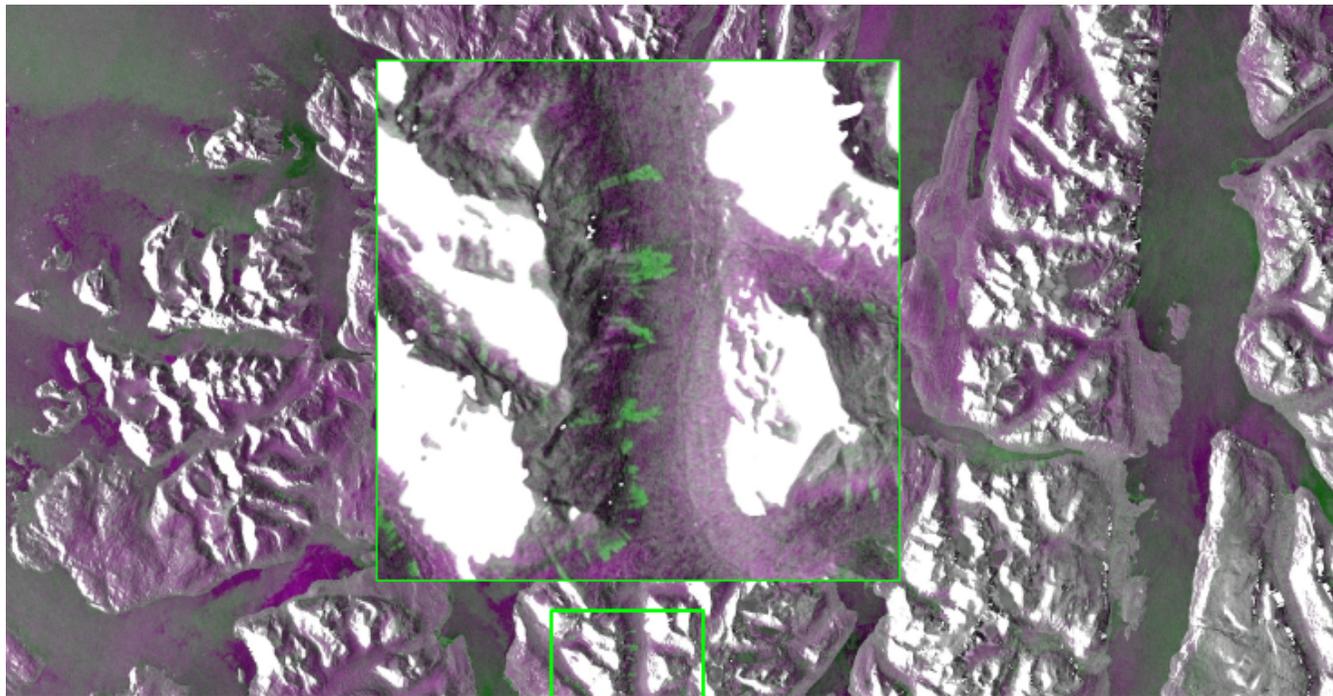


Figure. Example of Sentinel-1 change detection maps in a region nearby Tromsø, Norway where snow avalanches are highlighted in green in the zoom-out.

⁶ Eckerstorfer et al., 2017

Ice on lakes, rivers and fjords

Ice on rivers and lakes can be monitored effectively over vast areas using satellites. In particular the freeze-up of lakes in the Arctic regions is almost impossible to monitor using optical sensors due to the polar night where-as ice can be monitored regularly using radar. Figure below shows an example where the river ice during the ice breakup period of Tana river were monitored in the EU FP7 project CryoLand.

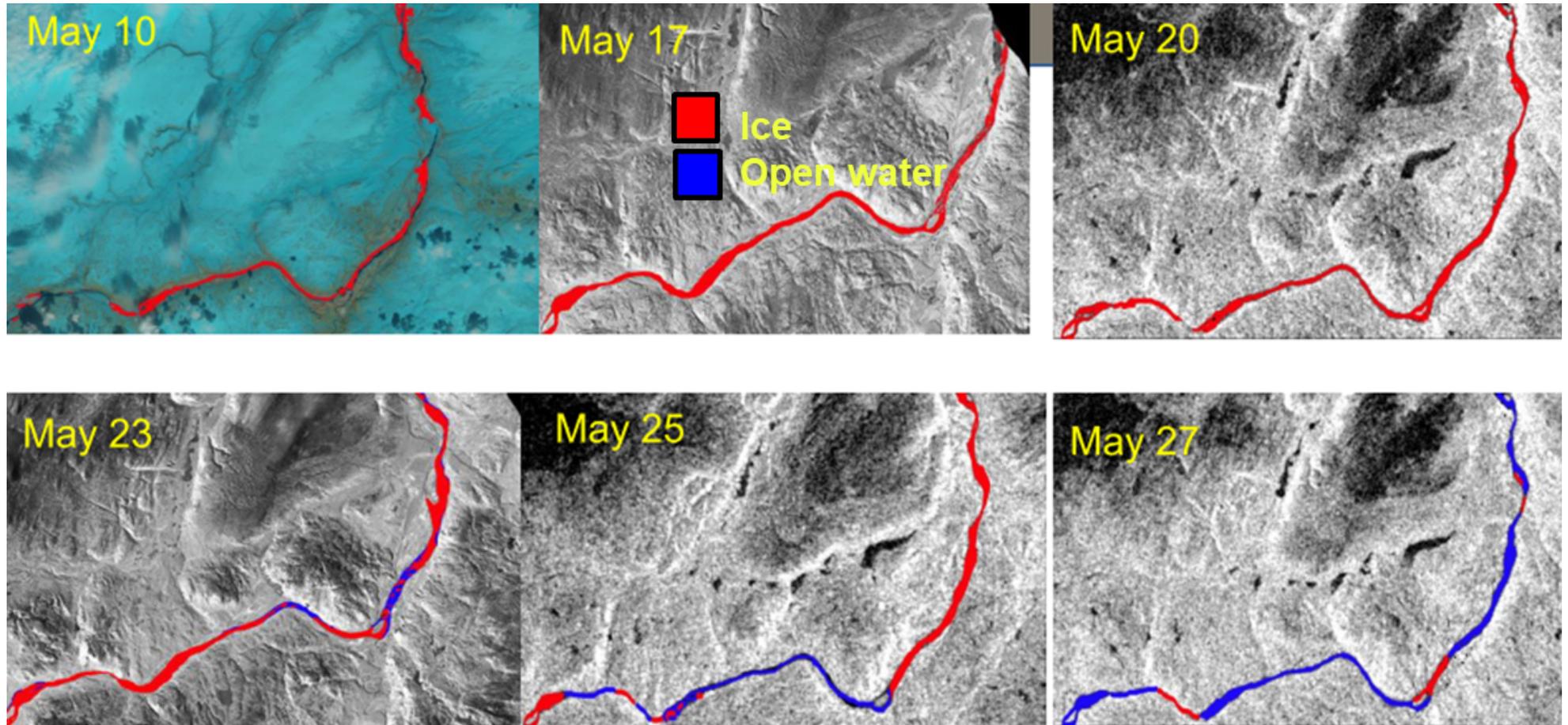


Figure. Monitoring of river ice break up of Tana river (border river between Norway and Finland).

Measurements of snow depth/snow water equivalent

Snow depth and/or snow water equivalent⁷ - SWE is an essential climate variable, and thus highly desired to measure using satellites. Public services are available at coarse scale⁸ using passive microwave sensors⁹, but these are in general too coarse for practical use in the Arctic. Concepts for higher resolution measurement of SWE using SAR has been suggested using backscatter with high frequency SAR¹⁰ or using interferometric principles¹¹ but the launch of suitable satellites sensors have so far not been remedied. Upcoming sensors such as Sentinel-L band SAR or NISAR could be useful for measuring SWE.

Method Summary for Remote Sensing

Several snow and ice services tailored for local communities in the Arctic have been demonstrated to a certain level using radar satellite data. The usefulness of such services has been well demonstrated, but due to practical reasons¹² such services have not yet been prioritized for operationalization. Snow avalanche monitoring is a decent exception where the Norwegian government has acknowledged the usefulness within a large audience and are currently implementing a Copernicus service on a national scale.

⁷ depth x density

⁸ 20 km

⁹ see e.g www.globsnow.info

¹⁰ Rott et al., 2010

¹¹ Guneriusson et al., 2001

¹² mainly funding and the need within a wide audience

III. Needs

During the initiation of the project, questions and concerns about satellite services and GPS issues rose to the forefront of international relations in the European North in a surprising way. Norway alleged that Russia had been disturbing and even jamming a range of GPS services on the borderland areas between Finland, Norway and Russian Federation¹³. This has been seen as a security and safety issue to aviation and other transport such as marine shipping in the region. The initial jamming coincided with large military exercises called “Trident Juncture” in Northern Norway in Autumn 2018. The jamming experienced were also documented in the coastal Sámi fishery for this work¹⁴.



Remote Sámi site in Jokkmokk wilderness. Snowchange, 2019

Sweden¹⁵

Reindeer herding on the Swedish side of Sápmi¹⁶ has been practiced by individual Sámi since ancient times. Today, the right to reindeer herding is a special right which, according to the Reindeer Husbandry act¹⁷ is exclusively for the Sámi people. Also, Recent OECD national report confirms that “the Sámi are important to the economic development and quality of life in northern Sweden”¹⁸.

¹³ Barents Observer 2019b

¹⁴ See section on Norway from pp. 45.

¹⁵ Summarized from Mikaelsson 2019. Primary author of this section is Stefan Mikaelsson.

¹⁶ Sámi homeland

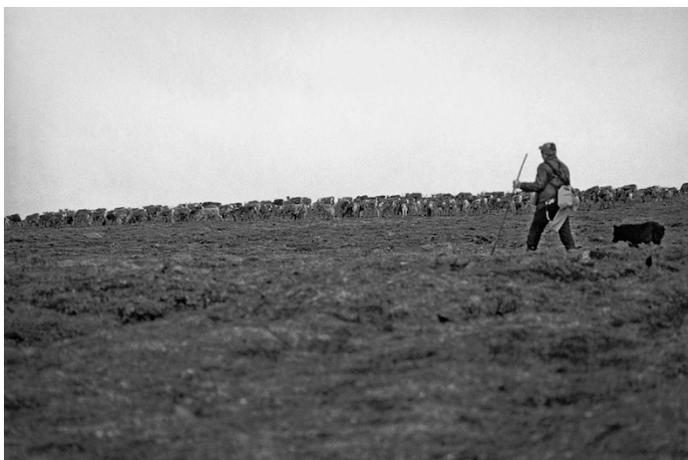
¹⁷ (RNL 1971: 437) §1

¹⁸ OECD 2019: 3

However, in order to exercise that right, one must be a member of a Sámi village, Sameby. This community's current form was established by the Swedish Parliament in 1971 and then became a legal entity in which the Sámi village board represents the members and can acquire rights and undertake obligations. At the annual village council, the board is elected by its members. Since there are two different categories of members, both reindeer herding members and other members, the possibilities for the members of the Sámi village are different.

There are 33 mountain communities, 10 forest communities and 8 concession communities where reindeer husbandry is conducted through a special permit. The number of reindeer is estimated to be between 225,000 and 280,000 reindeer in the winter herd¹⁹.

The reindeer herding area covers half of Sweden's surface. This does not mean that all land is suitable for reindeer pasture. The area is divided into 51 Sámi villages. There are 4677 reindeer owners in Sweden, of which about 40% are women and 60% are men. Nine out of ten reindeer owners or 3,976 people live in Norrbotten County²⁰. Västerbotten County has 342 reindeer owners²¹. Jämtland County²² has about 359 reindeer owners²³.



*Sámi have herded reindeer in the Jokkmokk region for centuries. Jan Håkan Dalhstrom, 1970s.
Used with permission.*

¹⁹ https://www.sametinget.se/rennaring_sverige

²⁰ 32 Sámi villages

²¹ 7 Sámi villages

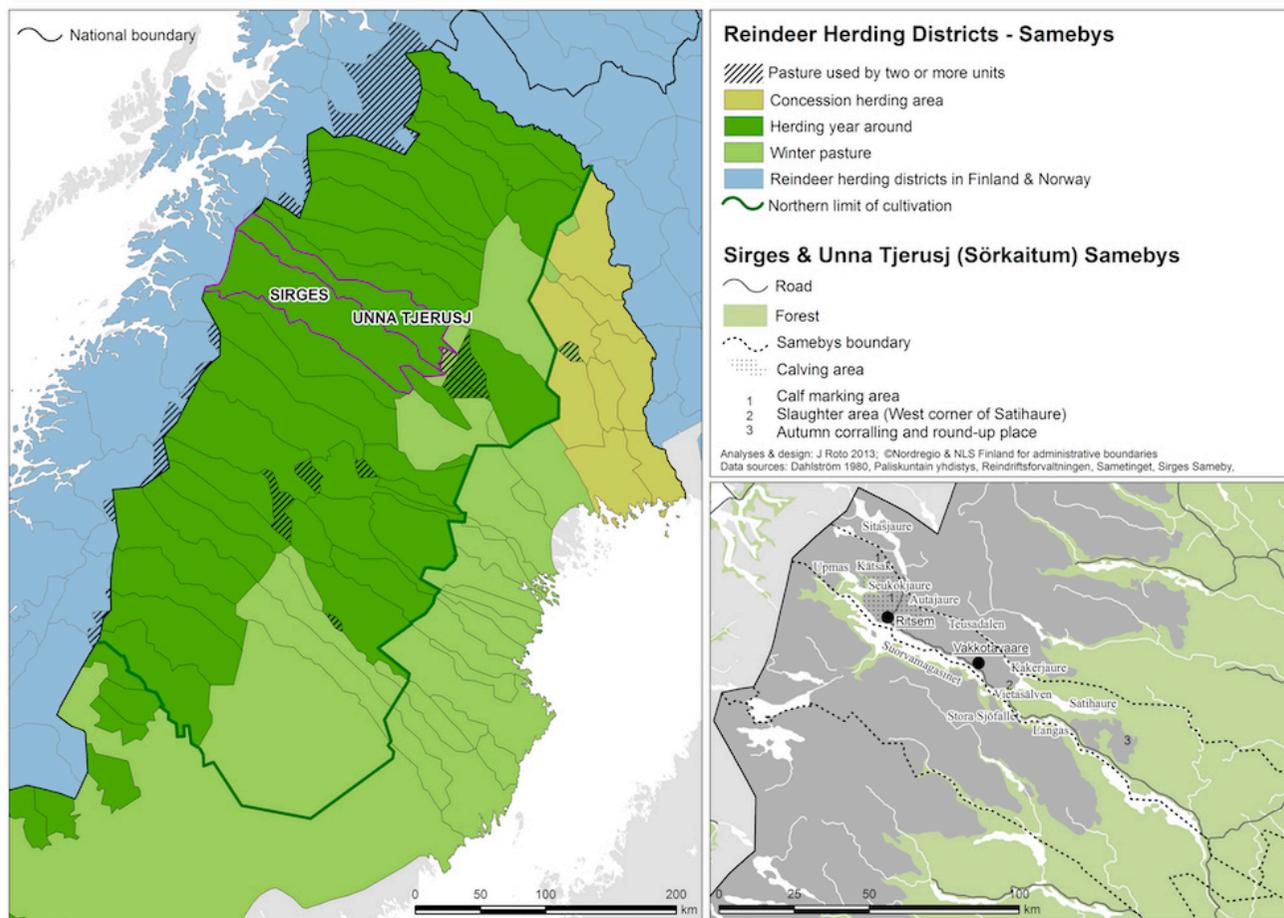
²² incl. Dalarna

²³ 12 Sámi villages. The figures apply to 2013. (Source: <http://samer.se/samernaisiffror>)

No census of the Sámi as a people or of non-reindeer herding Sámi takes place, so it is difficult to know how many individuals the Sámi people consist of²⁴. On the other hand, all of the reindeer must be counted every year, and beginning in 1996 the members of the Sámi village must be assisted with the so-called inventory of predators. This is done on unequal terms compared to that of the County Administrative Board's staff, which then acts as a control authority because the Sámi data must always be verified by more credible persons from the Swedish authorities.

The use of GIS and GPS has escalated in recent years. The use of these tools began as a practice made by single users, and has now evolved to become a common way to follow a specific animal's migration throughout different grazing areas. In reindeer herding it is assumed that the herd instinct is so strong that the paths of the lead animals through the grazing areas are followed. The fact that the reindeer strive to keep together in larger herds is also a way of protecting themselves from predator attacks and keeping their calves alive. The individual reindeer owner also strives to make sure that the reindeer herds are kept on the grazing areas of the Sámi village, so that the reindeer can spread and at the same time disperse.

²⁴ Source: <https://www.sametinget.se/samer>



Map of the reindeer herding areas of Sweden with a special focus on the project communities. Snowchange, 2019

Additionally, the strain on the reindeer is reduced by decreasing the total time for the reindeer in the pasture and the separating areas and during transport. The use of GIS has been developed for these purposes and is now considered to be a fundamental prerequisite for the administration and management of reindeer that the Sámi villages conduct.

The establishment of so-called Reindeer Husbandry Plans is a way to prove the effectiveness of local management practices to dominant society in Sweden. There is an explicit need from various Swedish governmental authorities for documentation on Sámi reindeer herding. It has become

accepted in Swedish society to request documentation that substantiates individual Sámi or the Sámi villagers' statements concerning the bearing, the enforcement and the exercise of Sámi culture in nature and the terrain.

The Sámediggi²⁵ reports in more detail how Reindeer husbandry plans are used:

- 50 of Sweden's 51 Sámi villages have reindeer husbandry plans.
- 400 reindeer herders have participated in educational and training activities so far.
- RenGIS²⁶ with associated data has been installed in 300 computers.
- About 3500 GPS necklaces on reindeer are or have been in operation in 46 Sámi villages over basically the entire reindeer herding area.

Some consequences include:

- improved support for operational reindeer herding
- Improved documentation for consultation discussions with other land users
- Information is produced that can be combined with other databases²⁷

²⁵ Sámi parliament

²⁶ System to track reindeer using GPS in Sweden

²⁷ Source: <https://www.sametinget.se/renbrukplan>



Reindeer round-up in Muttošjävri community. Snowchange, 2003

*Finland*²⁸

Investigations into the land uses, needs and issues surrounding the Finnish Sámi have been closely linked with assessments of competing, overlapping land use priorities from the community view.

Sámi reindeer herding has been negatively impacted by numerous different land use practices from past to present. The responsibility for grazing area sustainability has been put on the reindeer herders in recent decades. The maximum number of reindeer per region or per reindeer herding co-operative²⁹ is determined by the amount of food available in winter grazing areas. Practically, the situation in Finland is such that a reduction of grazing areas forces the reindeer herders to cut down their number of reindeers.

²⁸ The Sámi case and CIA process is primarily a summary from Saijets et al. 2019 with primary coordination by Feodoroff, P.

²⁹ Finnish state unit for organising reindeer herding

Case of Muttošjävri Reindeer Co-operative, Cumulative Impacts and Competing Land Uses

Studies on the impact of other land uses on reindeer herding have shown that forestry likely has the most severe effect in the Finnish side of Sápmi due to a relatively small impact from other land uses. An understanding of the combined impacts of all land uses are needed for a cumulative analysis. We have adopted the methods of the cumulative impact assessment work done in Sweden and applied them to evaluate the cumulative impacts of forestry and present forest structures on the Muttošjävri co-operative, which is our area of research.

In many reindeer herding co-operatives like Muttošjävri all of the important winter grazing areas are dominated by forests dedicated to forestry. Research has shown that forestry and the forest stand development type has a clear effect on important reindeer food sources like the amount of ground lichen or tree lichen. Due to slow tree growth in Sápmi, the effects of forestry accumulate for decades.

International conventions as well as domestic legislation in Finland require that the rights and culture of Sámi people must be protected in land use decisions. Impact assessments of different land use practices must be conducted in order to determine whether the Sámi right to practice their culture has been violated.

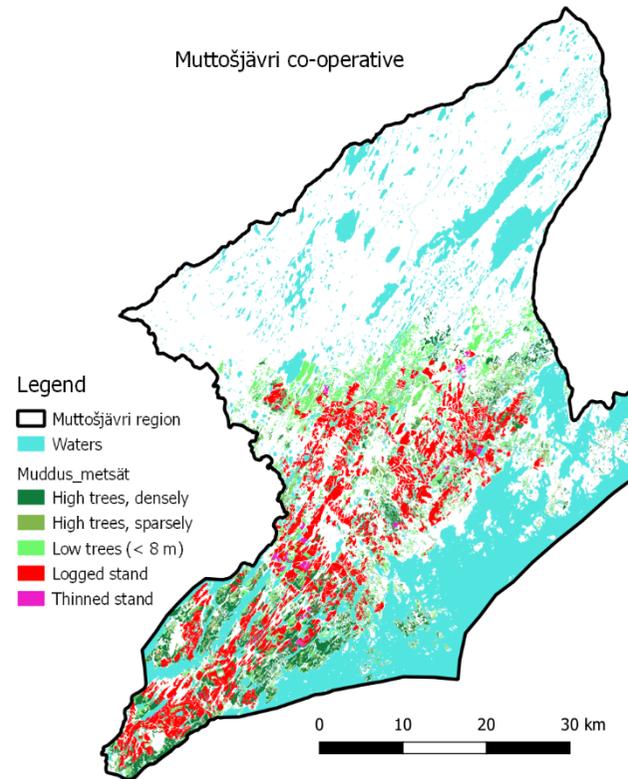


Figure: Map³⁰ of forest development classes of Muttošjävri reindeer herding co-operative.

One important aim of the mapping case study work is to classify the forest development classes of different forest stands as shown in the above Figure. Green areas describe stands in natural and natural-like state, whereas red areas describe logged stands. This information is later used as the basis for estimations of the amount of ground and tree lichen that is available, in co-operation with reindeer herders³¹.

³⁰ All of the data and imagery are publicly available. All of the data can be downloaded publicly and they are typically in a format that can be used by geographical information system (GIS) software. The topographic maps are available in vector format or in raster formats optimized for different map scales. Orthorectified aerial photos are available both in normal colors or in false-color infrared images. The orthophoto resolution is 0.5 m/pixel and are enough for our purposes. In our work, we used false-color infrared photos as they show much clearer the difference between logged areas and otherwise open terrain. The final canopy model raster image has a resolution of 2 m x 2 m.

³¹ This document will describe the mapping work for producing this kind of forest map and what are the required map data that are publicly available.

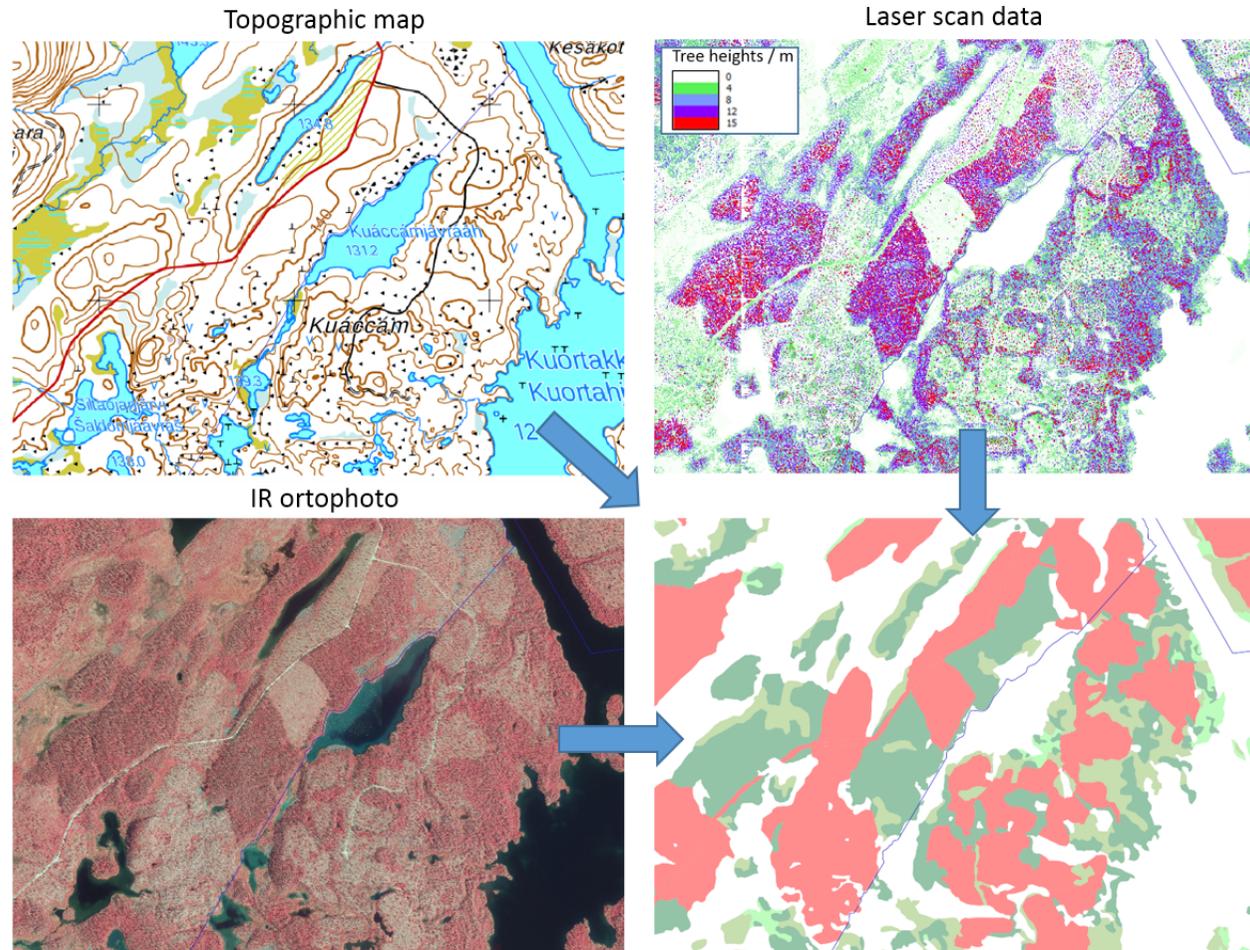


Figure. Drawing the separate polygons of the vector layer along with its forest development classes. Topographic map, infrared orthophotos and tree height data from lidar data was used in this definition process.

We have been assessing and defining the usability of forest stands as grazing areas. The basis of this grazing area usability analysis is our ability to map forest development classes. The resulting work is highly dependent on the traditional knowledge of reindeer herders. We have scheduled terrain inventories with herders in summer 2019, so this work is still undone.

In the usability approach, relative indicators are defined for different variables like ground lichen amount, tree lichen amount, stand usability and disturbance level. Every forest stand will be assigned a relative index which can then be area-weighted by the total area of the co-operative. This method can give a rough model of the present conditions in the co-operative and can then be used to predict the average effects of planned land uses.

Stand and grazing area usability is limited by the disturbance impacts of other land uses in addition to the absolute amount of fodder in the stands. The key approach of our project is to develop stand indicators that integrate this usability with the evaluation of ground and tree lichen amounts.

Need: Some of the Sámi involved in the terrestrial land use shift surveys have called for methods to digitally fingerprint materials, so that the solidity and neutrality of mapping materials could be guaranteed. This would improve verification and ground truthing of remote sensing materials.

Case: Uses of Summer Emergency Services in Lake Pulmankijärvi, North Sámi Area

During field visits conducted by members of Snowchange Co-op in the extremely remote lake Pulmankijärvi catchment area in the Norwegian-Finnish borderlands an emergency event (an axe hit to the jaw resulting in a non-fatal emergency and a need for urgent medical attention) took place. By activating the Nordic joint emergency cell number 112, the phone call was directed to Kirkenes, Norway as a first response. The Norwegian first responders then directed the request to the Finnish emergency authorities. They responded on two levels: a local voluntary fire squad³² was deployed as a first responder unit from approximately 20 kms away; and meanwhile, the Finnish authorities assessed whether a Medi-Heli³³ unit should be deployed. The local responders had enough time and skills to respond adequately to the event and the emergency passed. The chain of response in this case was: Kirkenes (cell service) → Finnish Border Guard → Finnish emergency units including local first responders and a consideration for the Medi-Heli evacuation.

Need: Clarity on the availability of emergency services in the High Arctic on the international borderlands.

³² Vapaapalokunta in Finnish.

³³ Emergency helicopter services out of Rovaniemi



Participants of the workshop in Sevettijärvi, April, 2019. Snowchange, 2019

Case: Thematic Workshop with Sevettijärvi Reindeer Herders on Reindeer Collars, April 2019

In April 2019 a thematic workshop on the available reindeer collar services was organised in community of Sevettijärvi, Inari with six Skolt Sámi reindeer herders and owners³⁴. In general the use of reindeer collars has become common amongst all herders in Sweden and Finland, at least to certain extent.

During the workshop a free form discussion format was utilized. Conversations were stimulated by reviewing three manufacturers of collars and responses triggered from these models. Some collars utilize cell services and others are satellite-based.

Overall the herders wished the collars to be smaller in size and for the batteries to last longer. Accumulation of snow and ice increasing the weight of the collar was also seen as a priority reform. Presence of a good signal would be essential, and models combining satellite services when cell service becomes unavailable in remote areas would be needed. Telespor collars were generally considered cheap but poor in quality and out of the common models Ultracom using GPS services seemed to be accepted amongst the professionals as a reliable model. As well the

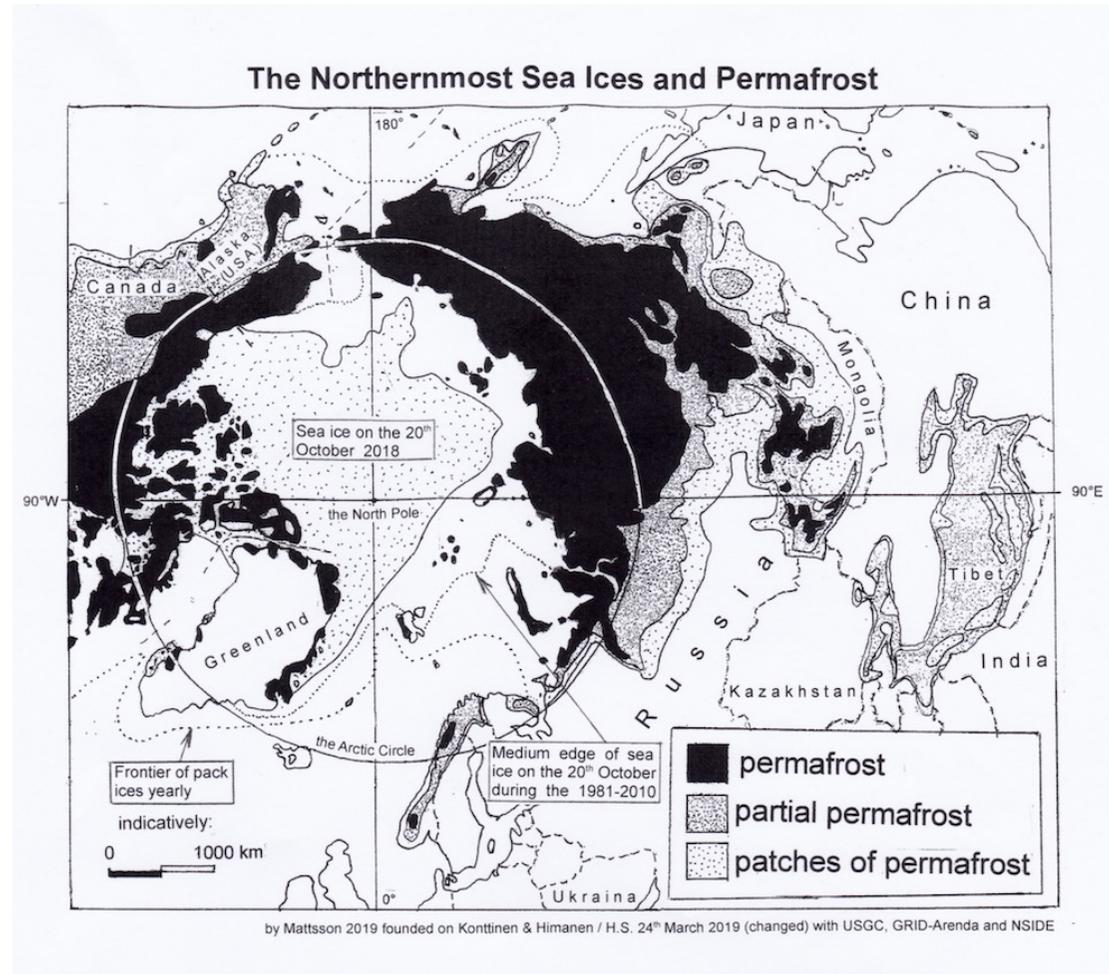
³⁴ Present Juha Feodoroff, Vladimir Feodoroff, Raimo Moshnikoff, Jouko Moshnikoff, Tuomas Semenoff and reindeer owner Pauliina Feodoroff.

Finnish made Tracker Superboazu was complimented. It operates on GPS. The Näätäjä reindeer herding co-op had purchased GPS collars for each of the reindeer herds³⁵ as a test run.

Need: Increase battery life, signals and reduce the size and weight of the collars.

³⁵ three herding units, or tokkakunta, as of April 2019

Case: Photographic Assessment of Melting Palsa mires / Permafrost



Map of permafrost zones in the Arctic. Jorma Mattsson, Snowchange, 2019

Whilst the melt events with permafrost have received much attention in the Arctic, Finland has no permafrost per se. During the project we identified the *palsa* mires being the closest to the cryosphere comparisons regarding how the melt is proceeding and utilized the Snowchange Visual Histories Archive to analyse sites in the Utsjoki highlands to offer a comparative photographic assessment of the *palsa* situation. *Palsa*

mires are mounds which used to have an icy core which does not melt in the summer time. As one of the changes associated with the weather change the Sámi have documented changes to the *palsa* mires, including organic loading that results downstream when the palsa mires melt.



Palsa mires can be found usually in the Utsjoki and other sub-Arctic plateaus of Finland. Stiina Roos, 2018.



With the extreme heat events with temperatures beyond 30 C for weeks, the palsa mires have started to melt and lose their icy cores. This results in organic loading and collapse of the mire. Stiina Roos, 2018



Close-up of a melt. Stiina Roos, 2018



Palsa melt has the potential to increase run off and organic loading downstream in the northern catchment areas. Stiina Roos, 2018



Scandinavian mountains have far more avalanche events than humans observe. Snowchange, 2019

Norway

Case: Avalanche Safety in Winter 2019

In January 2019 four skiers lost their lives in Blåbärfjellet, in Tamokdalen, Northern Norway, close to the Finnish border, in an avalanche³⁶. Despite the lost lives, search and rescue teams were able to arrive to the approximate location of the event by detecting the signals from the avalanche beacons on the skiers.

³⁶ Yle 2019c

According to Mikko Lamminpää³⁷, a nationally-known outdoor specialist in Finland, the window of action in an avalanche event is approximately 15 minutes. Avalanches are triggered by a combination of three conditions: first, the terrain and mountain slope have to be the right gradient³⁸; second, snow has to be layered enough to slide; and finally humans are needed to trigger the actual avalanche event.

According to Lamminpää, remote sensing and satellite services could be utilized more frequently and effectively in rescue operations. For example, potential early detection of avalanche risk using laser scans of the prevailing snow conditions or the use of thermal cameras and so on could lead to improved prevention and rescue methods. However, according to Lamminpää, the window of response in the case an avalanche is triggered is very quick. The use of avalanche beacons, as was the case in the Blåbärfjellet event, improves the chances of finding the victims faster.

Climate change continues to impact avalanche danger and events. For example, in late January 2019 in Lofoten, Norway, after a record snow fall of over 130 cm, over 150 buildings had to be evacuated after a warning was given that an avalanche was imminent³⁹. Improved capacity for remote sensing and analysis could give better forecasts of such events.

Eirik Malnes, a specialist on avalanches from Norway reviewed the uses of remote sensing for avalanche occurrence and safety. According to him⁴⁰ the number of avalanches in northern Norway that has been tracked using satellite services is ten-fold to the number of reported and observed events along the roads. Human triggers are not always needed, rather the snow quality and weather conditions will foster these events on their own.

Need: Remote sensing may have difficulties to predict avalanche events, but the numbers and sites of occurrence can be covered well with satellites. Real time updates on these conditions for reindeer herders⁴¹ may be an important element in services to be offered.

³⁷ Informal interview 27.3.2019

³⁸ around 30-45 degrees

³⁹ <https://www.nrk.no/nordland/kriseledelsen-samles-i-lofoten -minst-100-er-fremdeles-evakuerte-1.14405130>

⁴⁰ Keynote speech in Inari Kepler Workshop 3.4.2019, see also the Method section for this

⁴¹ This could include rain-on-snow ROS events too.



Reindeer herders departing Lovozero. Snowchange, 2019

*NW Russia*⁴²

The inquiry has been mostly focused on the Murmansk region, although there are elements of analysis from Republic of Karelia and Archangelsk region too. Modern trends in the development of telecommunications opportunities significantly change the established way of life and communication abilities for many residents of these remote regions. This is very relevant especially in remote villages of the Murmansk region. In fact, the development of telecommunication technologies has fundamentally changed the capabilities of residents, and a clear distinction between residents of large cities and small villages is being blurred.

⁴² Primary author Jevgeni Kirillov, Sámi Council

Cellular and satellite connection in remote villages, access to the Internet, satellite TV, and the ability to use GPS navigators and satellite phones have all made the life of the inhabitants of these small villages more modern, convenient and safe. The additional communication services provide easy navigation in the tundra, open up opportunities for daily communication with relatives living in other cities and villages of the region, and even other regions of Russia.



Reindeer herd at the "Tundra" basecamp, March, 2019. Snowchange, 2019

A Review of the Cellular Technologies for the Wilderness Parts of the Murmansk Region

According to information from open sources⁴³ in November 2018, 98.66% of the population of the Murmansk region has access to the mobile services of at least two telecom operators and access to the Internet at speeds above 1 Mbit / s.

⁴³ public register of telecommunications infrastructure and television broadcasting of the Russian Federation

The number of telecommunication service providers, competition, and level of services depends on the population in the municipality of the Murmansk region in which the service is provided. Also of great importance is the geographical location of the municipality, since the market depends on the location of communication networks.

In the Murmansk region in all municipalities, except the military city Ostrovnoy⁴⁴, at least 3 cellular companies and Internet providers are operating. In the municipalities of Apatity, Kirovsk, Monchegorsk, Murmansk, Kandalaksha district, Kovdorsky district and Kola district, there are more than 7 companies offering Internet access and mobile communication services.



Polmos, regional base for reindeer herding. Snowchange, 2019

The telecommunication service providers and Internet service providers of the Murmansk region include every large company that conducts activities throughout Russia⁴⁵. Local Internet providers also operate in the region, and their activities are limited to one or several municipalities⁴⁶.

⁴⁴ Gremikha

⁴⁵ Rostelecom, Transtelecom, Beeline, MTS, TELE2, MegaFon, NetByNet

⁴⁶ Elvis Apanet, Tigernet, Teletoria, 51Net, Relant, Optical telecommunications, M2C

Therefore it can be concluded that the market for mobile communications and Internet service providers in the Murmansk region is a market with a moderate level of concentration. There are no dominant economic entities in this market, but large federal players like Rostelecom, Beeline, MTS, TELE2, and MegaFon can influence the conditions and the prices of services provided.



Herder prepares the antenna on base camp, March 2019. Snowchange, 2019

Maintaining communication infrastructure in the subarctic zone and in areas with low population density (such as remote areas of the Murmansk region) can be economically unprofitable. This hinders the development of communication infrastructure in remote areas of the region. Companies in the federal communications market certainly have advantages in terms of costs. These companies are able to invest in infrastructure using finances that were earned in the more densely populated regions of Russia. The second main barrier that limits competition in the telecommunications services market is associated with government regulation of the industry.

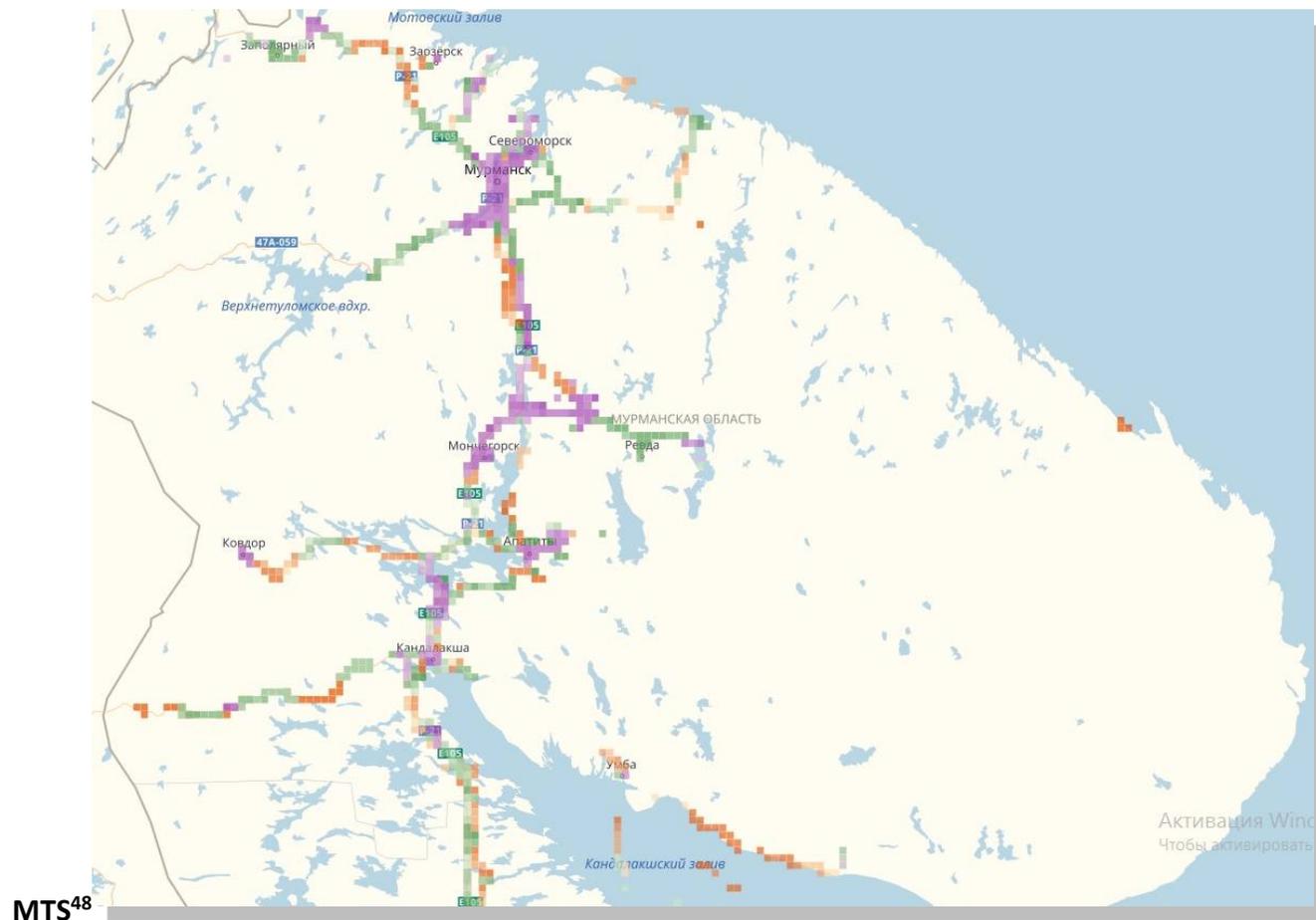
According to information from cellular operators, the majority of municipalities are characterized by a high level of public satisfaction in all indicators of cellular communications and access to the Internet. The exceptions are the Lovozero district and the military settlement Vidyayevo, where satisfaction with quality, price diversity and choices of cellular operators are lower than in other municipalities⁴⁷.



Preparing for journey, March 2019. Snowchange, 2019

⁴⁷ This is due to the fact that only operators of the so-called “big three” - Beeline, MTS, MegaFon cellular operators, operate in the Lovozero district. The TELE2 cellular operator also operates in the Lovozero district, it is one of the cheapest ones, but the quality of communication remains at a lower level than other cellular operators. The only company that provides telephone services over the cable line, as well as provides Internet access via the cable line in Lovozero district is Rostelecom. Because of its monopolistic positions, the prices level is quite high, and tends to constant growth. For example, Internet access via a cable telephone line costs about 700 rubles per month for a person, while the Internet access speed does not exceed 6 megabits per second.

Geographical Analysis of the Cell Coverage in the Murmansk Region, Russia

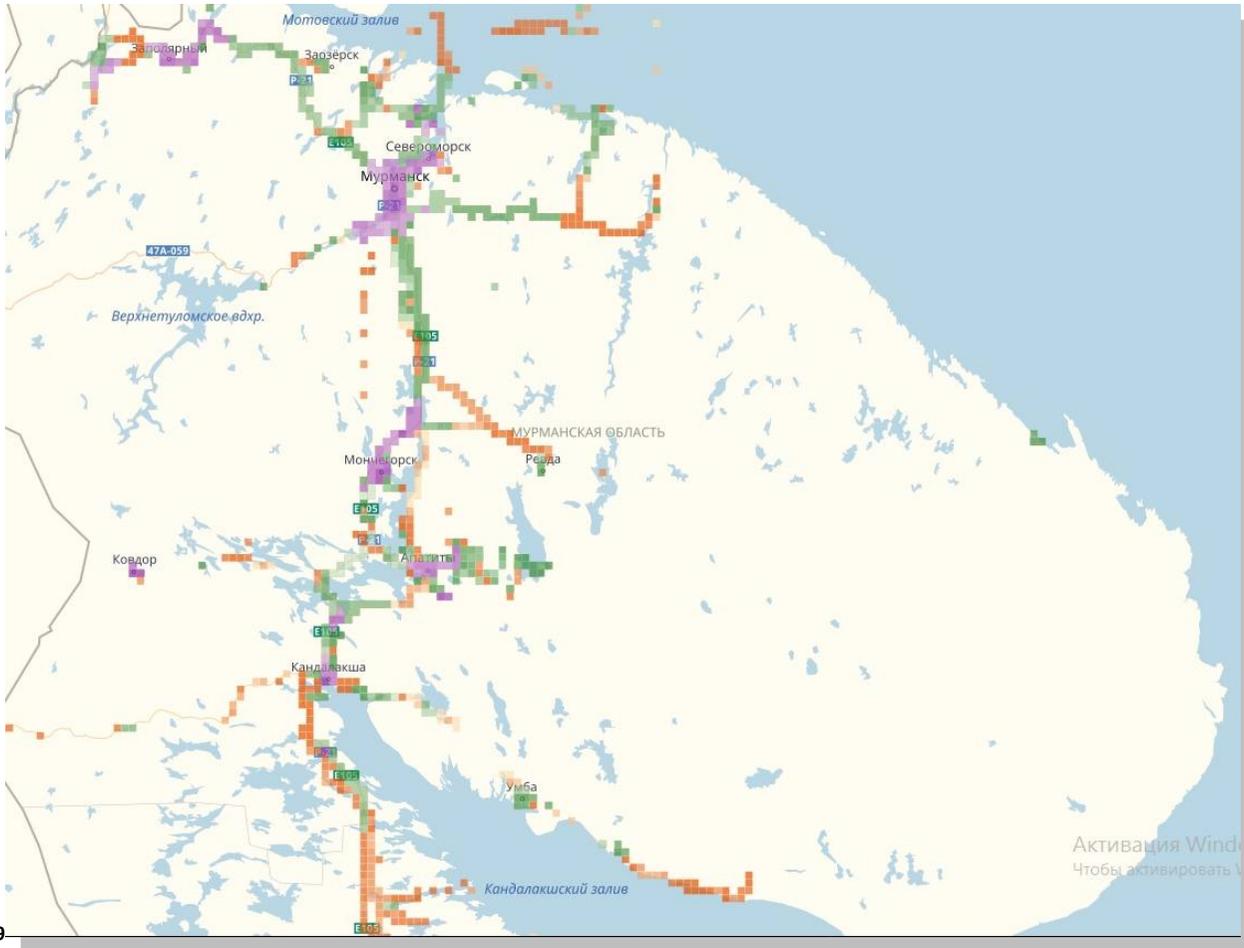


MTS⁴⁸

⁴⁸ MTS - Russia's largest telecommunications operator and provider of digital services, reports the expansion of communication networks in the Murmansk region. In the past 10 years, new MTS base stations have appeared in more than a dozen cities and villages in the region. New base stations will provide for a growing demand for mobile services, will strengthen the network signal in hard-to-reach places in large cities, as well as provide high-quality communications for residents of remote villages. 4G-coverage is enhanced in the cities of Murmansk, Severomorsk, Kirovsk, Gadzhiyevo, Monchegorsk, Polyarnye Zori, as well as in the Lovozero district in Revda and Lovozero. MTS also continued to develop mobile communications of other generations, which remain in demand among clients in Murmansk region. New base stations 2G and 3G were launched in the Kandalaksha district (Zarechensk village, Nivsky settlement), Zaozersk, Lovozero district (provides cell-phones and Internet connection to drivers and military camps on Lovozero-Olenegorsk road), as well as in all major cities of the region. MTS reports that the company is striving to make modern technologies available for the maximum number of residents of Murmansk region, therefore it is important for MTS to continue active development of communication networks in the region in all available ranges. The fourth-generation communication can effectively solve everyday tasks, even where access to the "home" Internet (via telephone cable) is limited or absent. However, the communication of other generations is no less significant, it is 2G and 3G networks that use the majority of devices for data transmission between devices work, including ATMs and navigators. The demand for mobile communications in the region is growing: every month, MTS is seeing an increase in 4G traffic by about 10 percent, which requires constant work on infrastructure

Coverage map of cellular communication operator MTS. The map is taken from public sources: Ministry of Communications of the Russian Federation. (<https://geo.minsvyaz.ru>), Yellow color is 2G network, Green is for 3G, Blue is for 4G

development. Therefore, MTS will continue to improve the quality of infrastructure in large and small settlements of the region," reports MTS' press-office in Murmansk region. MTS became the first operator to launch 4G network in Murmansk region: in mid-2014 high-speed mobile MTS Internet became available to residents of Severomorsk. In September of the same year, the 4G network "covered" all areas of the capital of the Kola Arctic - Murmansk, and in December 2014 - the city of Apatity. In 2015, MTS launched its 4G network in Monchegorsk, Kirovsk and Kandalaksha, and in year 2018 the network of the "fourth generation" appeared in Olenegorsk, Gadzhievo, Snezhnogorsk, Polarnii, Zaozersk, Umba, Polarnie Zori, Kovdor, Alakurtti, a military town Vidjaevo, Murmashi, Pechenga, Kola and the villages of Roslyakovo, Minkino, Severomorsk-2, Olenegorsk-2. Today, more than 420 thousand people in the region can use the 4G Internet of MTS. In June 2016, MTS announced the introduction of LTE-Advanced technology in Murmansk, which doubled the peak speeds in the "fourth generation" network, bringing this value to 225 Mbit / s. The doubled speeds obtained as a result of the "addition" of two 1800 MHz and 2600 MHz bands in 4G, networks are available to residents of 10 settlements of the Murmansk region.



MegaFon⁴⁹

Coverage map of cellular communication operator MegaFon. The map is taken from public sources: Ministry of Communications of the Russian Federation. Yellow color is 2G network, Green is for 3G, Blue is for 4G Map is taken from <https://geo.minsvyaz.ru>

⁴⁹ The network of the cellular operator MegaFon in the Murmansk region was launched on May 8, 1997. MegaFon became the first GSM-operator in the Murmansk region, which first began to conquer the Kola Peninsula, was a pioneer in the development of 3G and 4G networks. Now high-speed 4G-Internet from MegaFon is available to residents of all cities and some small villages of Murmansk region. MegaFon became the first cellular operator to start operating in the Lovozero region (Lovozero, Revda, Krasnoshcheli).

MegaFon has a cellular network even in the smallest settlements, such as Chavanga and Chapoma. Base stations were installed on the Rybachi⁵⁰ peninsula, on Kildin Island, in Dalnii Zelentsy. This is important for the safety of tourists visiting the region and local fishermen. Safety on the road from Murmansk to Teriberka, which has a length of 120 kilometers and lies across the tundra, is provided by several MegaFon base stations, two of which are equipped with several sources of energy, including wind turbines.

MegaFon owns the highest base station in the North-West of Russia, on the Rasvumchorr plateau at 980 meters above sea level. MegaFon also has the deepest one (inside the Rasvumchorr mine, 560 meters from the top of the mountain). These stations were built specifically for the corporate client of the operator, JSC "Apatit".



Satellite dishes at a reindeer camp, Snowchange 2019.

⁵⁰ Kalastajasaarento in Finnish



Beeline⁵¹

⁵¹ The Beeline brand is owned by the well-known company PJSC VimpelCom, under which the company provides telecommunications services to the public. Beeline began to provide cellular services and Internet access to population of Murmansk region one of the last of the so-called “big three”. The company's network is the smallest of all three major cellular operators. However, the situation may change in the near future. PJSC VimpelCom, which provides communication services under the “Beeline” and “Beeline Business” brands, received permission from the Federal Anti-Monopoly Service of Russia to purchase the Polarkom universal operator in Murmansk. The press service of Beeline reported that the third by the number of clients served by the cellular operator of the Russian Federation "is interested in consolidating assets in the market of fixed telephony and broadband Internet access." PJSC Polarkom provides telephone-line services in the largest cities of the Murmansk region. It has data transmission centers in the following settlements of the region: Polarnii, Snezhnogorsk, Vidyaevo, Zapolyarny, Nickel, Olenegorsk, Revda, Monchegorsk, Apatity, Kirovsk, Polarnie Zori, Kandalaksha, Umba, Kovdor. The main activities of the company are data transmission services, leasing of communication channels, construction of telecommunication networks. The company's fiber-optic network has a length of over 245 km. The operator, in particular, owns a fiber-optic network in the sections of Murmansk - Kola - Murmashi - Airport, Murmansk-Severomorsk, Kola - Olenegorsk, Kola - Abram-Mys.

Coverage map of cellular communication operator Beeline. The map is taken from public sources: Ministry of Communications of the Russian Federation. Yellow color is 2G network, Green is for 3G, Blue is for 4G, Map is taken from <https://geo.minsvyaz.ru>.

Rostelecom

PJSC Rostelecom is a Russian telecommunications company. It is the largest national provider of digital services. It provides broadband Internet access, cable and digital television, cellular communications, and local and long-distance telephone communications. The Murmansk branch of PJSC Rostelecom is a structural unit of the all-Russian company Rostelecom, which operates in the Murmansk region⁵². Now the company is the most prominent player in the Murmansk region in the IPTV market.

The short summary of this geographical analysis of public source maps indicates that despite the Megafon presence in some of the peripheries on the NW coast, most of the cell-based services are only available along the main road systems and towns. All of the wilderness areas in the region of Western Kola and Eastern Kola are without any services. Incidentally, these are the main territories used by the Komi and Sámi herders, fishermen and hunters.

In the future, one potential need to be addressed could be the monitoring of endangered wild reindeer especially in Terek and Lovozero districts. Monitoring could be made possible through the use of satellite collaring⁵³. This could alleviate the current poaching pressure and provide an understanding of the population movements and trends.



House of the herders, Polmos, March 2019. Snowchange, 2019

⁵² The Murmansk branch serves about 123 thousand telephone clients, over 172 thousand Internet users, 109 thousand subscribers of digital TV.

⁵³ Barents Observer 2019a

IV. Gaps

*Sweden*⁵⁴

The lands on which the reindeer industry operates in Sweden are becoming increasingly crowded. Mines, modern forestry, wind power and hydropower are all factors that have significant impacts on reindeer husbandry. In addition, roads and railways create barriers in the grazing areas. On top of all of the other factors, climate change is a catalyst that further worsens possibilities of practicing the trade⁵⁵.

The developing use of GIS and GPS in reindeer husbandry has created several side effects. One example is that SLU⁵⁶ has offered the Sámi villages the ability to store their data via WRAM⁵⁷. A framework agreement has also been signed between SLU & Sametinget in order to be able to provide this data storage system free of charge. Wireless Remote Animal Monitoring (WRAM) is a national e-infrastructure for automatic reception, handling, storage, and sharing of biotelemetry sensor data from animals.

Regarding evident needs in Sweden, the use of satellite tracking and GIS services in Indigenous economic activities such as reindeer herding has become standard. However, this improved capacity for data collection and clear demonstration of how reindeer herding is using the lands and the needs of practitioners have not translated into secured rights or land uses. The competing industrial land uses, for example roads, mines and forestry activities, have not paid heed to the data and observations recorded in the RenGIS and WRAM systems.

*Finland*⁵⁸

One of the major gaps remaining in Finland related to mapping, remote sensing and observations is the lack of an overarching situational framework allowing for the synthesis and use of multiple, simultaneous data feeds, land uses and pressures.

⁵⁴ Primary author Stefan Mikaelsson

⁵⁵ <https://www.sametinget.se/122306>

⁵⁶ the National Agricultural University <https://www.slu.se/en/research/research-excellence/research-infrastructure/databaser-and-biobanker/wireless-remote-animal-monitoring-wram/>

⁵⁷ Wireless Remote Animal Monitoring

⁵⁸ Muttošjävri reindeer co-operative summarized from Saijets et al. 2019.

In order to address this for the Sámi areas real inventories of the range of natural resources important to reindeer herding need to be assessed. Steps need to be taken to develop cumulative impact assessments for the case of the Muttošjävri reindeer co-operative territory.

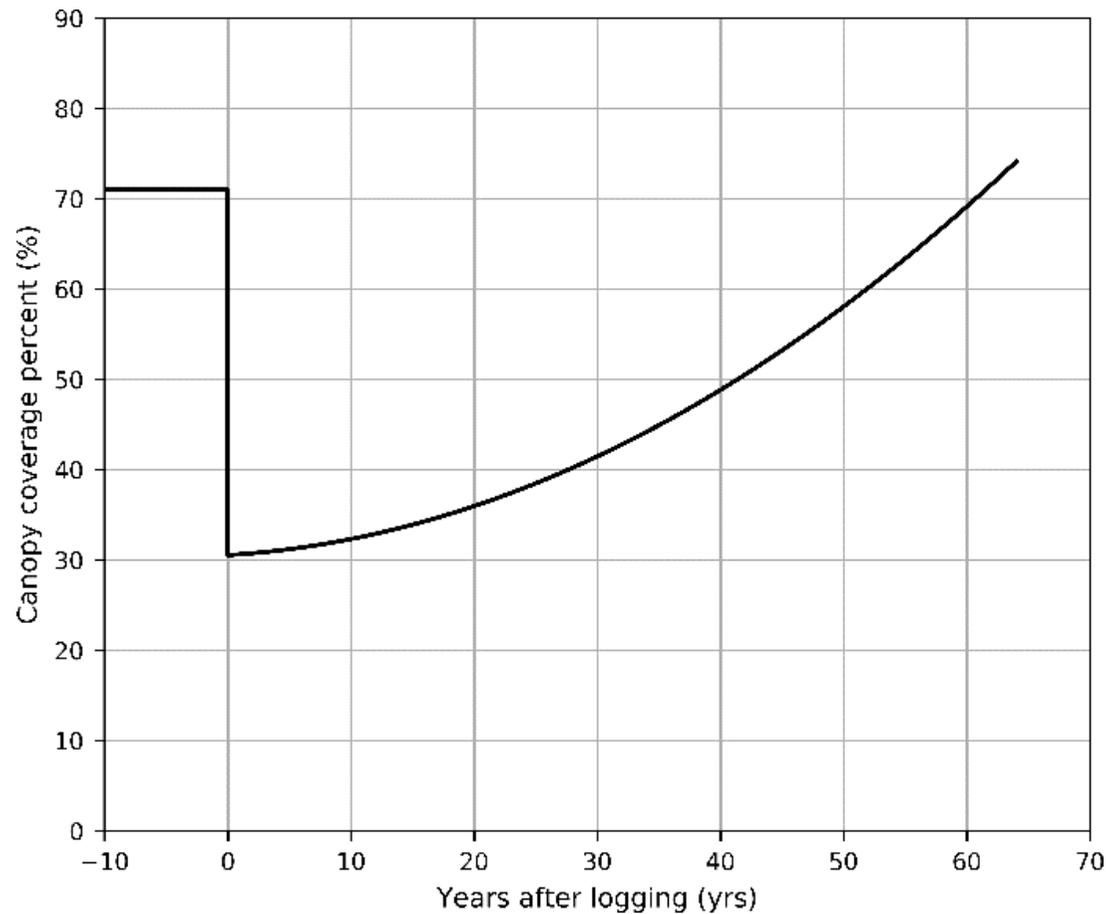


Figure: Relative tree canopy coverage as a function of stand age. Data is based on NLSF Laser scanning data of Muttošjävri forests.

In our case study for the Kepler report, one crucial variable that is needed in the grazing area estimation is the amount of ground lichen. Ground lichen amount is correlated with the tree canopy coverage, which is a practical parameter to measure. We used laser scanning data of tree heights and defined the canopy coverage by the density of points above the ground.

The measured data was then fitted to a 3rd order polynomial equation which is shown in the above figure as a function of stand age after logging. However, in our experience, these numbers highly overestimate the relative canopy coverage of trees. According to data from the Natural Resource Institute Finland⁵⁹, the canopy cover of intact forests in the Muttošjävi co-operative region is 35 - 45 %. This is far less than the 70 % of our figure.

We have a rather typical old growth forest with 200 stems and a treetop diameter of 5 m, and our calculations give a canopy coverage of 39 %⁶⁰. But using the fitted equation above we see that laser scanning pulse width gives a canopy coverage percentage that is 29 units larger - the measured canopy coverage is thus 68 %.

If we consider a sapling stand with 1500 stems and treetop diameter of 1 m, the error is very large. The approximate “real” canopy cover is about 12 % whereas the measured one is 80 % with the 80 cm beam width!

Thus, it seems that we cannot use the modelled tree canopy coverage derived from the above figure, but rather need to make many manual field measurements for every kind of tree stand to get an average number. This is rather a slow process and gives us only an approximation of the canopy cover of different stand development classes.

Resources to address these gaps, like the need for fieldwork to ground-truth remote sensing measurements with the existing inventories and synthesis of data, remain existing challenges.

⁵⁹ LUKE

⁶⁰ See primary data in Saijets et al. 2019



Early morning on a boreal fishing lake. Snowchange, 2019

Case: Mixing Traditional Knowledge Fisheries and Satellite Data on Boreal Lakes

Snowchange conducted a test pilot project of the experiences of using GPS based sonar equipment in traditional knowledge fishing spots in an undisclosed boreal lake for a professional fishery. A map plotter Dragonfly-7 Pro Sonar/GPS was installed on a Yamaha Viking 540 snowmachine and operated by a young professional fisherman who kept a working diary of the routes, locations of harvest, user experiences and comments during the winter 2019. The temperatures for fishing ranged from -30 C to 0 degrees, including extremely bad ice conditions due to the poor formation of ice on the lakes this winter. The comments from the test run included:

- Dragonfly-7 Pro Sonar/GPS was hard to install to a rocking snow machine as the cables were shorter than promised at the outset. Fishermen felt also that there should be prior experience from instalment to make a successful adaptation into the very cold conditions.
- Attachment to the battery required great skills to adapt to the Yamaha battery. It took almost four hours in sub-zero temperatures to install the Dragonfly-7 Pro Sonar/GPS with the Yamaha battery. Also the plastic holders of the unit suffered and fishermen were fearful that they will break in very cold conditions.
- Different traditional knowledge harvest spots were rather easy to mark using different symbols to the plotter.
- To alleviate the poor ice conditions routes had to be constantly fortified with the snowmachines and therefore it was helpful that they were marked on the Dragonfly-7 Pro Sonar/GPS.
- In very bad weather conditions, including snowstorms, mist and high winds with snow and darkness the Dragonfly-7 Pro Sonar/GPS assisted in finding the right fishing spots with ease compared to the traditional knowledge navigation. This alleviated some of the risks with open leads or getting stuck on slush ice.
- USB adapter allowed for rather easy updates of the maps in the process.
- On the Dragonfly-7 Pro Sonar/GPS the sonar element can be turned off so that more power and battery is saved.
- Menu functions in Finnish were a real helper.
- The use of the sonar was a new element at the catch sites in winter. It helped to “see” estimates of how much fish might be available on a site, and how deep they were. This helped the choice of the next days site of harvest and planning. Also the schools of fish, whether they are dispersed or in one group was possible to see.
- For seining the sonar provided a chance to see how quickly the seine moves under ice and how tall and “open” the seine is under ice.

Gaps: A further estimation of optimisation of fishing experiences by using sonar and GPS, and the impacts of its use on traditional knowledge and “ownership” of sites, currently in memory and oral history.



A good catch on seining. Snowchange, 2019

Case: Uses of Summer Emergency Services in Central Lapland, Sámi Area

In late January two outdoor skiers were rescued from the remote part of the UKK National Park in Central Eastern Finnish Lapland⁶¹. The temperature was -42 C. The availability of cell phone services for emergency calls remains sparse in such remote wilderness areas. Head of Response from the Rescue Authority for Lapland, Ari Soppela said: “Some years ago we were trying to locate lost people who had sent an SMS for emergency from the wrong place (due to the poor cellular coverage). They died.” Another incident had included an Estonian delegation with a vehicle that had frozen. They had contacted the Estonian emergency services who in turn contacted the Lapland Rescue Authority and guided the visitors to safety.

Need: Improvements to cell services in national parks and wilderness areas, better preparedness of hikers in winter conditions or otherwise challenging contexts. Weather can be extremely cold in the fjells and national park areas.

⁶¹ Yle 2019a



AIS positions of fishing vessels generally above 15 m and under 1 GT during March 2019. Note the lack of information from fjords such as Porsanger, where smaller vessels in the coastal Sámi fishery have their main activity. Source: Barentswatch

Norway

Case: Use of satellite services and local and traditional knowledge in the small-scale fisheries in coastal Sámi areas, Norway⁶²

Coastal Sámi fisheries are as a rule carried out along the northern Norwegian coast north of the 62nd latitude. This description relates to the use of satellite and radio equipment and services in relation to local and traditional knowledge among fishers utilizing small and medium-sized vessels⁶³. Radio signals were long the most widespread technology in all fisher groups with coastal vessels⁶⁴, and are used to communicate among

⁶² Case author *Camilla Brattland, UiT – The Arctic University of Norway*

⁶³ below 15 meters

⁶⁴ vessels typically between 8 and 13 meters

fishers and between vessels, but have increasingly been replaced by the mobile phone. The smallest vessel group typically rely on local and traditional knowledge in combination with paper sea charts and radio communication both for navigation and fish-finding.



Black-legged kittiwakes (Rissa tridactyla) on the Finnmark coast. Snowchange, 2019

Vessels above 15 meters are required by law to report their positions using satellite, AIS, telephone⁶⁵ or radio, and all vessels when fishing in international waters. The AIS⁶⁶ is a requirement under the IMO and became satellite-based as of 2010⁶⁷ using two satellites, with one AIS receiver also on the international space station. Many vessels below 15 meters however use AIS and other equipment for safety and insurance reasons. In a recent proposal from the fisheries authorities⁶⁸, it is proposed that all vessels should be required to use AIS or other means of reporting their whereabouts and for reporting catches. In the vessel group between 10 and 11 meters, the use of satellite devices and services are most widespread as these vessels generally use more advanced mapping and echo sounder devices with integrated GPS.

⁶⁵ broad band

⁶⁶ Automatic Identification System

⁶⁷ the system used VFH using landbased receivers

⁶⁸ 2018

Traditionally, coastal Sámi and Norwegian fishers used the landmark system for navigation and communicating about locations at sea such as fishing grounds. This system is still in use as it is flexible, inexpensive and popular among recreational fishers and sports fishers. It is also part of the transfer of traditional knowledge between generations, and part of the cultural history and immaterial cultural heritage of the coastal Sámi people. As a result of the Norwegian Place Name Act⁶⁹, place names that are in use locally in the three languages Norwegian, Sámi and Kven⁷⁰ are inscribed on official topographical maps, including sea charts.

As an example, only in the Porsanger fjord in Finnmark, of the over 80 named fishing grounds in the fjord, a majority is named in Sámi language. Local fishers rely on their knowledge of the seascape using known landmarks from the local oral tradition in relation to their position at sea, thus arriving at the desired named fishing spot. As an example, the fishing ground “Fáhccoŋcoagis” is arrived at when the top of a certain mountain and a house on the nearer shore are both visible at the same time to the fisher.

According to an interview with an active fisher from the Fávllis project⁷¹, fishers rely on their local and traditional knowledge of the landmark system⁷² when new technology fails, and the other way around – when it is too foggy or dark to find the desired place, they rely on (new) technology such as GPS. As some underground structures are not mapped on paper or electronic sea charts, fishers also rely on local knowledge in open boats without technology, and when in closed vessels with radar or echo sounders, to avoid these.

A small internet survey conducted in April 2010 and directed at fishers in the northernmost regions of Norway returned six answers from fishers settled in Vardø in the east⁷³ to Lofoten⁷⁴ in the west. The vessels were all below 11 meters and one vessel fished as far out as 12 nautical miles from the shore, whereas the smallest vessel of 4 meters fished only inside the Porsanger fjord. Most vessels are rigged for whitefish and king crab fisheries⁷⁵. All of the vessels but the smallest reported that they had a need for satellite services all of the time, using both smartphones and map plotter/tablet with integrated GPS.

⁶⁹ 1992

⁷⁰ Finnish

⁷¹ Brattland and Nilsen 2011

⁷² mea in Norwegian, vihtat in Sámi language

⁷³ at 70 degrees north

⁷⁴ at 69 degrees north

⁷⁵ eastern part of Finnmark

In addition, fishers used mobile phone and radio using land-based internet services. Fishers reported being dependent upon satellite services for the conduct of an effective fishery, and that the systems in general performed well. However, they complained that the GPS coverage is generally bad in the northern regions, and especially in areas with high mountains. Also, two of the fishers mentioned the challenge of Russian jamming of signals and that conditions would hopefully improve upon the establishment of the Galileo system.

Fishers reported using satellite services at all times of year independent of sight and weather. Purposes for the use of services mentioned were:

- knowing your own and other vessels' positions
- knowing the position of the fishing net
- navigation
- knowing bottom conditions
- and weather forecasting (radio and telephone).

The advantages of satellite services mentioned are higher precision relative to other sources of knowledge such as local knowledge, for instance in foggy weather when landmarks are not visible. As for future needs, satellite radio is especially mentioned as the current DAB radio system does not always work at sea. One fisher also mentioned the need for a simple system with one button only for emergencies, and one for tracking the vessels' position as a replacement for a conglomerate of systems such as AIS, EPIRB and SART.



A medium-sized vessel from Porsanger fjord. Camilla Brattland, 2019



Coastal Sámi have a closely interconnected socio-ecological system with the fjord and its resources. Snowchange, 2019

Case of the Wilderness Villages of the Kola Peninsula, Russia⁷⁶: Cellular and Internet access, satellite connection, the use of GPS navigators, satellite TV in Lovozero, Krasnoshelie, Kanevka and Sosnovka and reindeer-herder brigades

Lovozero district is the biggest one in Murmansk region⁷⁷ and it is also the home of the Indigenous Sámi and a minority people, the Komi, who arrived in the late 1800s to the region. Lovozero district is one of the most difficult to work in for telecommunication companies. The large size of the district and a complex geography, only one road that ends in Lovozero⁷⁸, and large distances between villages make it difficult for residents to access good telecommunications technologies.

Cellular communications in the Lovozero district began being offered in the late 1990s. Until that time, the only way to communicate with other cities was using landline phones. However, despite such a small number of residents, all cellular operators of the so-called “Big Three” are now actively working in the largest villages of the district - Lovozero and Revda. At the end of 2010, cellular services became available to the residents of Krasnoshelie when MTS opened a base station there.

In Lovozero district, Rostelecom is the only telecommunication operator that provides landline phone communications to the residents of the district. By means of a telephone cable, communication is carried out with the most remote villages of Lovozero district - Krasnoshelie, Kanevka and Sosnovka. After cellular communication of MTS started to work in Krasnoshelie, the number of Rostelecom clients in Krasnoschelie was significantly reduced. But for Kanevka and Sosnovka, where there is no cellular connection, Rostelecom's landline phone is the most common and accessible means of communication for its residents.

⁷⁶ Primary author Jevgenii Kirillov (2019), secondary author Tero Mustonen

⁷⁷ The area of the district is 52978 square kilometres. At the end of 2018, 11014 people lived in the district. The largest number of residents live in the town Revda (about 8000), about 2,600 people live in Lovozero. The population of Krasnoshelie does not exceed 650 persons, and not more than 50 permanent residents live in Kanevka and Sosnovka.

⁷⁸ Krasnoshelie, Kanevka and Sosnovka villages do not have a road connection with the district's central settlement Lovozero, the only way to get there in the summer time is a helicopter, in winter one can also use an all-terrain vehicles and snowmobiles.

Map of availability of communication operators for the settlements in Lovozero district

Wilderness Settlement	MTS	Beeline	Megafon	TELE2	Rostelecom (landline phone)
Lovozero	+	+	+	+	+
Revda	+	+	+	+	+
Krasnoshelie	-	-	+	-	+
Kanevka	-	-	-	-	+
Sosnovka	-	-	-	-	+



Satellite technology is reaching remote camps on Kola Peninsula. March, 2019. Snowchange, 2019

Case: A View of Traditional Knowledge and Climate Change from Kola Peninsula, Russia⁷⁹

In recent years, many residents of the Kola Peninsula have noticed that the climate in the Arctic has changed quite significantly. Autumns come much later than 20-40 years ago, and spring season vice versa. These climate changes are more noticeable by people whose current or previous activities are related to a life in nature. In the Lovozero district, these are Sámi reindeer-herders and those who, one way or another, are associated with reindeer-herding activities.

According to these community-based observations, climate warming has greatly influenced activities in reindeer-herding cooperatives. Rivers and lakes now freeze much later, notes Nikolai Yuriev, who has worked as a reindeer-herder with the “Tundra” cooperative for 35 years: *“In 1980s the slaughter campaign⁸⁰ in the cooperative had begun in November and ended before the end of December, now it is only in the middle of December we start the slaughter campaign. Rivers and lakes do not freeze up as it used to do, that’s why it is impossible to move the herds from the grazing places to Lovozero, so the reindeer-herders have to move the time of the slaughter campaign to a later time. For example, this year the slaughter campaign ended only in the second half of March.”*

Climate change also affects reindeer food. Besides lichen, reindeer eat a lot of mushrooms, which, according to reindeer-herders, significantly affects the weight gain of reindeer. Herder Yuriev elaborates: *“In case of good weather in summer, if there’s a lot of mushrooms, reindeer can gain significant weight. Due to the abnormal heat during the summer of last year there were no mushrooms at all, which had a negative effect on the weight gain of reindeer. This incurs financial losses to the reindeer husbandry”*.

Reindeer herders also note that in hot weather reindeer calves grow up much more slowly and do not grow to normal sizes. Reindeer herders believe that warm weather, to which the reindeer are unaccustomed, does not allow calves to develop properly and the reduction in size is a reaction to climate change: *“Over the past 30-40 years, the size of reindeer on the Kola Peninsula has greatly decreased. If earlier reindeer were sometimes called ‘horses with horns’ because of their large size, today, there are no such large reindeer left.”*

Nikolay Yuriev noted, and this is confirmed by the observations of other residents of Lovozero district, the number of fish in the rivers and lakes of the district has decreased: *“20 - 30 years ago in Lovozero there was a fishing team that caught fish in the lake with nets, but the quantity of fish in lakes and rivers wasn’t reducing. Despite the fact that the fishing brigade does not exist for a long time, and lately even number of ordinary fishermen had become much less than it used to be in the past, the quantity of fish is still decreasing.”*

⁷⁹ This is a shortened summary of Kirillov 2019, The oral histories of the Sámi and other local people were recorded using consent forms and FPIC – Free, Prior and Informed Consent.

⁸⁰ The part of the seasonal herding when animals were slaughtered in the cooperative.

Reindeer herders believe the reason for this is the warming of the climate resulting in winters with little snow. Nikolai Yuriev often goes fishing on the nearby Lovozero lakes, and since the lakes have become shallower, he says it's harder to ride a motorboat. Nikolai even started to think about selling his motor boat.

The number of birds and animals in the vicinity of settlements such as Lovozero, the neighboring village of Revda and even Krasnoschelie, has become much smaller. Valentina Kirillova, whose parents worked all their life in reindeer herding, believes that the reason that there are fewer birds and animals near Lovozero is ecological deterioration around the village. According to the memoirs of Valentina, there were always a lot of willow ptarmigans near Lovozero, but now, in order to see this bird it is necessary to go 30 to 40 kilometers away from the village.

As the Sámi people of the Kola Peninsula noted, willow ptarmigans can be an indicator of terrestrial pollution. These birds never settle in places with poor environmental conditions, and the fact that they are not around Lovozero these days suggests that even in a village where there are no nearby industrial enterprises, there are impacts and problems within the environment.

Traditional weather knowledge is part of Sámi culture. Anna Nikolaevna Yurieva is one of the oldest residents of the village of Lovozero. She was born and raised on the tundra, her parents were reindeer-herders. With her husband, a reindeer-herder, Anna lived all her life on tundra, where she worked as a housewife. According to Anna, almost all the signs that her parents and husband used to predict weather do not work now due to the fact that the weather has become unpredictable. Here are some signs that she was able to remember:

- Forerunners of good weather are scattered cumulus clouds, slowly floating high in the sky.
- The weather will worsen if cumulus clouds formed in the morning, start to grow rapidly and turn into more dense ones.
- Bad weather will come when cirrus clouds run from west to east, covering the whole sky.
- If these cirrus clouds are followed by rapidly darkening dense gray clouds, it will rain in summer and snow in winter.
- Weather will worsen if one notices the strengthening of the wind in the evening and close to night time.
- If the wind increases closer to the night, the weather will worsen.
- And if there's a fast wind during a rain – it is a sign of a good weather to come.
- If the fog rises up off the ground in the morning – it will rain, and if it settles on the ground, the weather will be dry.
- It will be rainy, windy weather and thunderstorms if one can see the twinkling of stars.
- Twinkling of stars begins 2-4 days before the rain starts.
- If the sun turns red in the evening - the next day will be windy.
- If the stars start to shine very much – good warm weather soon will come.
- If there are a lot of mosquitoes in the evening, and they bite very much - it will be raining next day.
- If the dogs tumble in the snow – it will be windy soon.

V. Priorities

Sweden⁸¹

Right now, many of the Sámi villagers' GPS data are "scattered" on various GPS collar manufacturers' servers without the guarantee of future access. The Sámi villages have expressed concern about the status of storage systems offered by the respective GPS collar manufacturers. Some of these key concerns have included:

- How safe are the manufacturers' storage systems?
- How long can you ask the manufacturer to store the data?
- What happens if a manufacturer ceases his business or is bought by another company?⁸²

An interview was conducted⁸³ with a 62-year-old man who is a reindeer herding member of a forest community in Norrbotten County: *"It is especially good for the forest communities and thus also for our own reindeer herding to be able to use GPS on the reindeer, it is a good opportunity and we can keep track of where and how the reindeer move. There are many areas with thick, impenetrable forest and sometimes even rocky steep slopes on mountains. We always attach a GPS transmitter to a reindeer that already has a bell, so that the bell will attract more reindeer. While in the Sámi village we can sit at home in the evening or early in the morning and see how the transmitter moves. We can thereby plan the work with edge surveillance or collection and this happens more efficiently. The reindeer who receive GPS transmitters, we know how these are moving before we mount the transmitters, so that we can calculate in advance how the reindeer move. The Sámi village has been able to substantiate its claims by presenting the reindeer movements with statistics from GPS-supplied reindeer. I would not want to go back to abandoning the use of GPS. However, there are disadvantages. The batteries are partly sensitive to cold, and there are also areas where the coverage is poor. We change batteries twice a year on each transmitter. It is possible to change the number of markings on each GPS, normally we have a blink per 12 hours, but we can reduce this if we need to get signals more regularly to be able to get better positions at the reindeer positions. The coordinates that exist per received signal give us the positions we need to be able to look for the reindeer through hand-held GPS."*

Another Sámi woman, a member of a mountain community in Norrbotten County said in an interview⁸⁴: *"About 10 percent of our reindeer have transmitters. We select the reindeer that will carry the transmitter. It is not necessary to provide the transmitter on a reindeer carrying a bell. Using transmitters on reindeer for our own needs is an aid, a valuable tool since the reindeers are very mobile. With the help of transmitters you can keep control of the reindeer herd and also save the environment. All GIS history is saved so we can check it out later if needed. The batteries*

⁸¹ Primary author of this chapter is Stefan Mikaelsson

⁸² Source: <https://www.sametinget.se/113887>

⁸³ on March 21, 2019. Free, informed and prior consent was applied and the possibility of anonymous participation was a standard to all interviewed people.

⁸⁴ Recorded 28th March, 2019.

only get better and better and have now a lifetime of 4-5 years. The application that one can have in his or her smartphone should be developed to be better, also with Sámi names or words as an option. We will continue with transmitters on our reindeer because the experiences are so positive.”

The indigenous cultures in the Arctic are also influenced by global warming and escalating climate change in different ways. The possibility of using traditional knowledge to predict the weather has decreased, which negatively impacts the ability to prepare and adopt the appropriate approach in advance. A varying climate with mild temperatures and precipitation that is significantly changed compared to a few decades ago is very evident.

The impacts of this changed climate entail, among other things, rain on snow (ROS) events on pastures and very uncertain ice conditions. In the past, ice-covered lakes and watercourses could be used for relatively safe transport of people together with equipment and animals. Nowadays, much greater caution must be observed throughout the ice-covered period.

Rain on the pastures before they have a protective ice or snow cover can lead to the ground lichen and other near-surface vegetation being covered by an ice crust that effectively blocks this food source for grazing reindeer. The uncertainty and the unpredictability in movements – such as unpredictable ice and snow conditions, creates permanent problems for the indigenous cultures in the Arctic.

The Arctic is far from large population areas, but is nevertheless highly exposed to the effects of air pollutants and climate-influencing emissions. Climate change in the Arctic is evident now with higher temperatures, greater mixing of air masses with different temperatures in the atmosphere and more precipitation. The Arctic sea ice distribution has decreased, as has the ice thickness. In the last 100 years, the average temperature in the Arctic has increased approximately twice as much as the global average temperature⁸⁵.

The traditional food that the indigenous peoples rely on requires an opportunity to be able to control the supply and use. And for winter fishing, conditions have deteriorated due to inferior ice. During the 1930s, when many reindeer died, many settled on lakes and began to support themselves on fishing. The arrival of the float plane provided the infrastructure and a direct link with a buyer. That fishing accounted for most of the Norwegian municipalities' catches in the 1970s.

Fishing has now decreased significantly, but it is still an important income for many, as the main occupation or as a side income for reindeer husbandry. Whitefish, char and lake trout are fished especially in the summer. In the winter, fishing with nets under the ice is still done but mostly for personal use⁸⁶.

⁸⁵ Source: <https://www.sametinget.se/klimat>

⁸⁶ Source: <http://www.slowfoodsapmi.com/r-varor.html>

The claims of reindeer herding Sámi on fishing waters have resulted in selected fishing waters being exempted from public use. The fishing rights in these selected lakes have been associated with membership of the Sámi village. This has given rise to envy and conflicts between Sámi reindeer herders and the Swedish population, and also with non-reindeer herding Sámi.

In the autumn of 1993, however, general access to small game hunting and free hand fishing on state land was given above the standard harvest limit⁸⁷, despite great opposition from the Sámi and nature conservation organizations. This meant that the number of waters specifically reserved for the Sámi decreased from about 20-15% to about 5% of the total number of fishing waters⁸⁸.

Provisions in the Swedish law, including from 1928, were designed without regard to Sámi hunting and fishing traditions. This is evident from several litigation proceedings during the 1940s where the law enforcement authorities showed great eagerness to punish Sámi who were not considered to be members of Sámi villages for illegal hunting or fishing.

The principle that the Sámi right to land and water only covers Sámi who are members of a Sámi village still exists today. Several investigations have pointed out the need to change the rules for the Sámi villagers' activities so that non-reindeer herding Sámi can also become a member of a Sámi village and obtain hunting and fishing rights. However, the Government and the Riksdag⁸⁹ have not shown any interest in bringing about such changes in the legislation⁹⁰.

⁸⁷ Administrative boundary of the Sámi and the "settlers", that has never been clearly established. The cultivation limit is marked with green on maps and was drawn up in 1867 as a definitive protection for the Sámi who lived on reindeer husbandry, hunting and fishing because the patch line was not respected. To the west of the cultivation boundary, no new buildings, neither Sámi nor Swedish, would be included, except for the new buildings that the patch villages had previously approved. The whole idea of protecting the patches was "forgotten" when it turned out that the state could make big money on mining in the Sámi areas. Jämtland, Härjedalen and northern Dalarna are not covered by the Lapland boundary. It is most likely that these areas were already too important for the state power. During the same time as the patchwork boundary was confirmed by King Gustav Vasa, a decree came that the Sámi in Dalarna, Hälsingland and Västmanland would be deported to the patch areas. (also from <http://www.samer.se/4329>)

⁸⁸ Source: <http://samer.se/1214>

⁸⁹ Swedish parliament

⁹⁰ Source: <http://www.samer.se/4659>

Finland

For remote sensing issues in the future, Finland is investing in the Arctic Space Center⁹¹ located in Sodankylä and operated by the Finnish Meteorological Institute. The Center has large-scale antennae with which it can follow the circumpolar satellites reporting on snow cover, permafrost, ice thickness and so on. The Center provides data to paying customers around the world, including companies in the US.

According to the Director of the Center Jyri Heilimo interest from China especially has been on the rise⁹². The link between Chinese satellite feed interests and Sodankylä can be explained by the geopolitical needs regarding the Northern Sea Route that China aims to connect with the “Polar Silk Route” initiative. China has also been active in the Northern Swedish satellite ground station in Kiiruna, but this cooperation has raised some concerns in Sweden as the contents of the data remain secret in accordance with the Swedish Space Corporation⁹³. The EU has given the status of “critical infrastructure” to these satellite receiving ground stations.

In the context of the Muttošjävri case as developed by the Sámi team for this report, cumulative impact assessments are needed, but agreement on the methods and data sharing remain challenges.

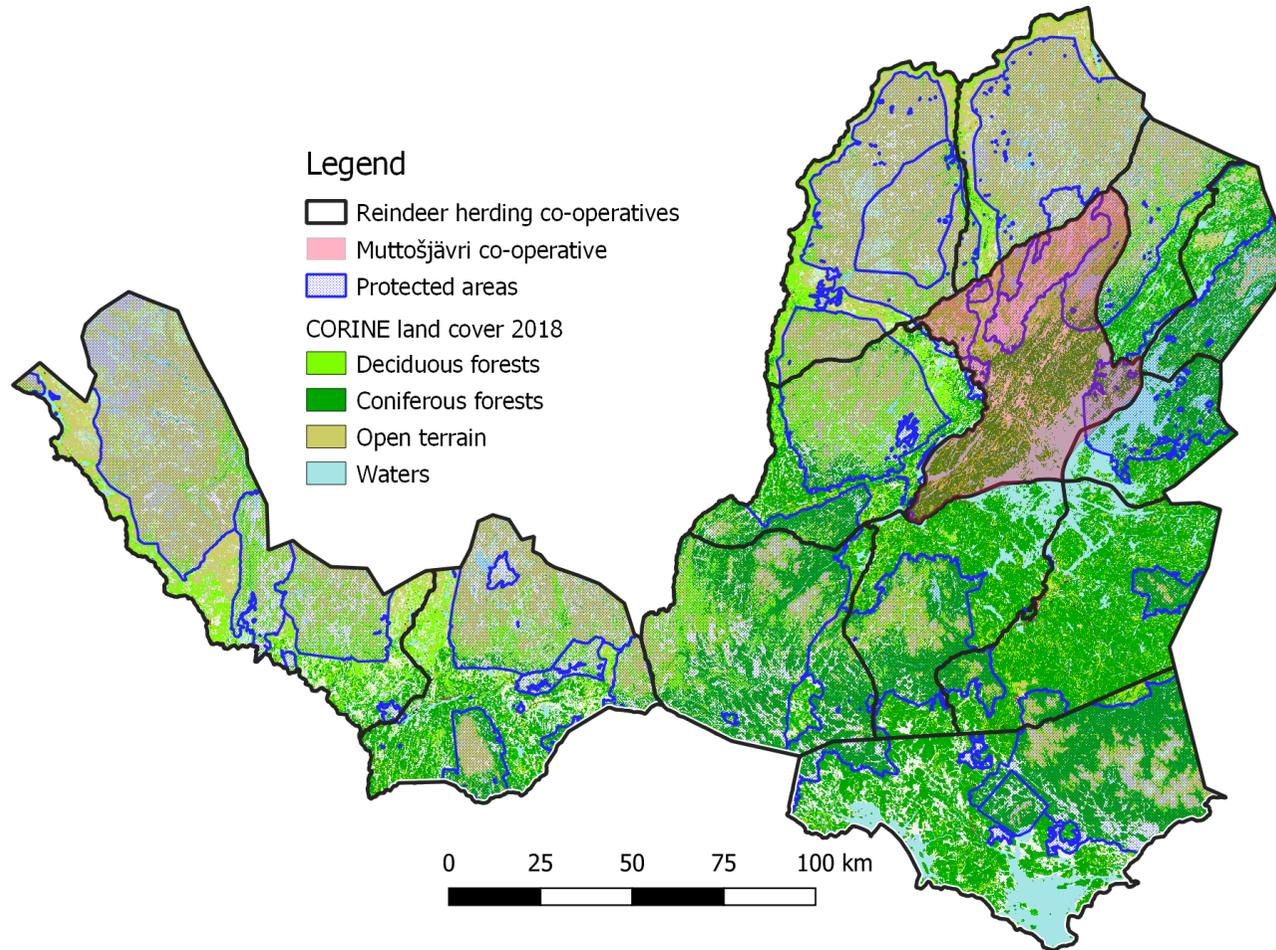
To address some of the current limitations of the Muttošjävri case, an automated method could be applied where a drone is used for making a 3D point cloud based on many aerial photos. On a small scale, this could be done for chosen regions with consumer level drones, however this is not practical on a larger scale.

For a more automated approach, an automated drone with custom software like the Wingtra drone could be used. Large areas can be covered using a predefined and automated flight pattern. Time consuming ground-based field measurements could be avoided and real canopy coverage data could be used for grazing area evaluations.

⁹¹ <https://en.ilmatieteenlaitos.fi/arctic-space-centre>

⁹² Yle 2019b, especially regarding China’s Haiyang 2 satellite feed.

⁹³ Yle 2019b



Map. Forests and reindeer herding co-operatives of Finnish Sápmi. Also, protected areas are shown.

In the near future there is a distinct need for carrying out similar CIA⁹⁴s in other reindeer herding co-operatives of Finnish Sápmi. There are altogether 13 co-operatives that could benefit from this work. The map here shows both productive and unproductive forest lands and protected areas of the 13 co-operatives. There are productive forests lands that are used for forestry in seven other co-operatives. These co-operatives

⁹⁴ Cumulative impact assessment

suffer from other land uses too, like gold mining and many forms of tourism related impacts. Future mining industry and infrastructure⁹⁵ plans are cause for concern and need to be assessed in a systematic approach.

A systematic CIA approach is being developed that can be applied to all reindeer herding co-operatives. After the pilot CIA, the developed method can be utilized in a rather effective manner, much faster and cheaper than with the pilot project. The need for this is evident due to the increase of current land use disputes caused by the reduction of usable grazing areas. The next CIA need is likely developing in Båtneduottar⁹⁶ co-operative which is located just South of Muttošjävri co-operative.

*NW Russia*⁹⁷

Currently, there are two large reindeer collective farms in the district – “Tundra”⁹⁸ and “Olenevod”⁹⁹, which employ several hundred people. About 70 of them are reindeer-herders who work in wild tundra. The approximate number of reindeer in the district is less than 50 thousand reindeer.

The specificity of the work of reindeer-herders is that they have to follow reindeer herds, and, for example, in the summer reindeer flocks go to the coastal region of the Peninsula to escape bloodsucking insects.

Until the end of the 1990s, VHF radio stations were the only means of communication for reindeer-herders. In recent years, reindeer cooperatives have been able to use cellular and satellite communications. There are also television satellite antennas at most of the reindeer-herding base-camps, where the reindeer-herders spend from five to seven months a year. This type of equipment makes both television and the Internet available to people working on the tundra.

While the Internet speed is slow, it still allows the ability to check email messages and use such mobile phone applications as “Viber” and “WhatsApp” for both personal and work related communication. Nevertheless, mobile communication is limited by the distance from transmitting communication devices, located on cell-towers near settlements in Lovozero and Krasnoshelie¹⁰⁰.

⁹⁵ e.g. Arctic Railway

⁹⁶ Hammastunturi in Finnish

⁹⁷ Summarized from Kirillov (2019)

⁹⁸ head-office is situated in Lovozero

⁹⁹ head-office is situated in Krasnoshelie

¹⁰⁰ As a rule, the range of cell signals of such transmitting devices does not exceed 30 - 40 kilometers.

Yuri Filippov works as an animal specialist and technician¹⁰¹ at the cooperative “Tundra” and has a so-called trans-shipment base called “Polmos” where reindeer-herders from most of the reindeer bases gather to count and corral reindeer. After the reindeer are counted, herds are driven to the slaughterhouse in the village of Lovozero.

The “Polmos” base is located 48 kilometers in a straight line from Lovozero and 64 kilometers along a winter snowmobile road. Reindeer-herders spend significant time there and for the comfort of workers, satellite antennas were installed on the base's residential buildings. This allow workers not only to watch television programs during leisure time, but also to go online. According to Filippov, the reindeer herders themselves believe that this is quite convenient, since by using mobile applications such as “Viber” or “WhatsApp” they can contact their loved ones, or solve work issues with colleagues from other bases or with the leadership of the cooperative.



A community member explains the satellite phone uses during the Polmos visit, March 2019. Snowchange, 2019

¹⁰¹ He works with the 2nd, 8th and 9th brigades of the reindeer- cooperative “Tundra”.

In order to provide reindeer-herders with these services the cooperative "Tundra" specifically identifies a certain number of reindeer to sell in order to ensure payment for communications¹⁰².

Cellular communication costs are paid by each employee. The range of use of this communication is limited, since it is tied to the satellite antennas or to the range of the transmitting device of the cellular operator. There is no mobile communication at the Polmos base-camp¹⁰³.

The rest of the reindeer-herding bases have no cellular communication due to the great distance from the transmitting devices of cellular operators. In the tundra, in the location of the reindeer grazing territories, there is also no cell communication for the same reason – the bases are located in very remote areas. The only means of communication in these regions is the satellite phone.

Yuri Filippov reflects on the situation: *“Currently, the agricultural cooperative ‘Tundra’ has only two satellite phones. Satellite phones allow workers in the brigades which are located far away from Lovozero and other settlements to contact other brigades or leadership of co-op to coordinate actions in order to complete assigned tasks. Unfortunately, satellite phones are quite expensive devices. In addition to the high cost of the satellite phone itself, the cost of a minute of communication is also very high. This does not allow cooperatives “Tundra” in Lovozero and “Reindeer” (Olenevod) in the village of Kranoshelie to provide its employees with such means of communication. Cooperatives are not able to purchase and maintain satellite phones for all of their reindeer brigades”.*

In addition to cell and satellite communications, the workers of the reindeer -herding farms are very widely using GPS navigators. Yuri Filippov explains: *“These days every second reindeer-herder has GPS navigators, mainly they are the reindeer-herders of the younger and middle ages. GPS navigators give a number of advantages to reindeer-herders. With help of these devices, they can mark and fix the location of the herd at a certain time, as well as fix the migration path of reindeer. GPS navigators also allow reindeer-herders to navigate in tundra even in very bad weather — in heavy snowfall or snowstorm, as well as at night, accurately determine their own location in wild tundra, set a route and move exactly in a given direction, which eliminates the danger of getting lost.”*

Despite the obvious advantages, GPS navigators also have serious disadvantages when it comes to reindeer-herding. Yuri Filippov has observed gaps developing in the traditional knowledge: *“Old generations of reindeer-herders point out that younger generations are losing skills and knowledge to properly navigate in the tundra. Young reindeer-herders do not learn orienteering and do not know the area where they work at, fully relying on equipment, the possible failure of which can lead to very bad consequences. They can simply get lost, and to search for them we have to distract from the work other reindeer-herders, that had already happened.”*

¹⁰² For these purposes, an additional position was even introduced in the co-op, in which the appointed person must monitor the timeliness of payment for communications and the provision of services of television satellite operators.

¹⁰³ In order to “catch” a signal from a transmitting device located on a tower in Lovozero, it is necessary to climb on a hill in distance of a kilometer from the base-camp.

However, a more serious disadvantage of GPS navigators for reindeer-herding in Lovozero district is that these devices are widely available for public and are used by people engaged in the illegal hunting of reindeer, i.e. poaching. In the past poachers hunted only in areas they knew well, and, as a rule, did not dare to go to more remote pastures because there was a serious risk of getting lost.

The use of GPS navigators significantly reduced this risk. With the help of modern high-speed snowmobiles and GPS navigators, poachers are able to reach reindeer herds in places which were unreachable in the past. Satellite communications have also allowed hunters who illegally shot reindeer to receive information about police raids on time and to avoid capture and further punishment by the law. Thus, technical progress in the form of new communication devices brought both positive and negative aspects to the reindeer herding of Lovozero district that must be taken into the account.

The most remote village of the region is Sosnovka, where only a land-line connection exists. Since the village is almost three hundred kilometers from the district center, only twenty people live there permanently. Cellular operators do not consider it profitable to build communication towers there. However, there is a permanent land-line connection as well as the possibility of satellite TV antennas. Therefore people in Sosnovka have access to the Internet. In the village there are also two satellite phones. One of these belongs to the cooperative "Olenevod" and they use it for the needs of Sosnovska's brigade of the co-op, and the second phone is privately owned.

All residents of remote villages consider it very important to be able to use high telecommunication technologies. In their opinion, it is GPS navigators and satellite phones that can save lives in emergency situations.

For example, Alexey Kukoverov, a resident of the village Krasnoshelie, believes that satellite telephones should be available for every inhabitant of villages that are located so far from "civilization": *"Fortunately, in my village Krasnoshelie, MegaFon had built a cell-tower a few years ago, and the residents of our village have the opportunity to use cellular services. But, taking into account the enormous distances between all the villages of the district, as well as the fact that the number of inhabitants in these villages is not large, cellular communication companies will never have the desire to build a cellular communication tower in each remote village. And the range of a cell phone is very small. For example, when leaving Krasnoshelie along the winter road to the administrative center of the district -the village of Lovozero to visit a doctor, or to visit relatives, after 30 kilometers from the village the cellular communication stops working. This means that if a snowmobile breaks down or if a person gets lost in the tundra, there is a serious threat to human lives. The only way to save life in this situation becomes a satellite phone."*

According to Kukoverov, the main problem for the villagers is the purchase of the satellite phone hardware itself¹⁰⁴. Local residents are willing to pay individually for communication services: *“It is very expensive for us to buy such a phone. If in our village there would be at least 3-5 phones that would located at the administration of the village or a private person in charge, and which we could rent for a few days, then we would be happy to pay for communication services, despite their high cost, safety is more important than any money.”*



Seining has ended for the day, Finland. Snowchange, 2019

¹⁰⁴ which can cost up to 1,200 thousand US dollars

Conclusions¹⁰⁵

This report has captured the voices, processes, stakeholder needs, and community-based observations related to remote sensing, satellite and cellular services in Northern Sweden, Norway and Finland as well as Northwestern Russia. Special attention has been given to the needs of Indigenous and minority communities as stakeholders, as well as search and rescue operators. This report builds on thematic interviews, workshops, and an analysis of media and academic sources to capture some aspects of a large topic that merits a cross-thematic in-depth study in the region in the future. The report and the work package have investigated these interfaces between Indigenous knowledge and technology not only from the viewpoint of pure needs of services, but also following a larger meta-level discourse on the meaning of extremely rapid proliferation of technologies on remote communities and cultures.

Following this, overall thematic summary¹⁰⁶ from all of the materials was that as long as the best available technologies and the best available practises are used for the well-being of the Sámi culture it is a good argument for their use. But critical views remain. For example in Sweden Sámi felt that at the moment the Western political, economic and scientific aims as well as the target of the Swedish authorities, is to apply the new (GIS) technology to supervise the Sámi livelihoods and activities on the Sámi home territory.

Some Sámi felt that that is an out-dated colonial way of controlling the Sámi culture and the traditional land and waters. Today the Sámi experience lack of respect for the traditional Sámi culture and its practitioners. Similar lack of respect can be seen and felt in all countries in the Circumpolar Arctic according to the Sámi representatives.

Uses of new technologies such as GIS and GPS are practical ways that the Sámi can still survive for example in Northern Sweden. This territory is also a location of growing number of industrial activities causing impacts to the northern ecosystems. On top of these drivers global warming and escalating climate change will affect the peoples in the North harder than elsewhere.

Sámi argued in a unified way that traditional/Indigenous knowledge, skills and indigenous cultures are in the core of their existence. Sámi can use old traditions together with progressive, modern innovations to benefit themselves. In this context the Sámi representatives wanted to remind that *"it should be always remembered that we Sámi walk to the future in the footprints of our ancestors. Once a technology within a given cultural practice or something else not rooted in the core of the cultural existence will become more important than the core of a cultural essence then the indigenous traditional culture will become less and less important, lose its values and gradually decline."*¹⁰⁷

¹⁰⁵ Contains summaries written by Tero Mustonen and Stefan Mikaelsson

¹⁰⁶ From Mikaelsson 2019

¹⁰⁷ From Mikaelsson 2019

Summarizing the work we can detect the following six key messages from the materials gathered and stakeholder voices captured:

1. **The proliferation of cellular services, on par with the so-called snow machine revolution of the 1960s in the region, has improved and expanded the availability of personal access and communications possibilities in the European North.** However, the mission has been only partly accomplished. As demonstrated by listening to peripheral voices from the search and rescue services of Finland regarding emergencies in the national parks as well as the wilderness villages of Kola Peninsula¹⁰⁸ communications access is not available or remains very low in these regions. Deaths have followed when the services have not delivered on location or temporal scales. The infrastructure to establish such services in the wilderness remains also a challenge as these areas are the least populated in the region and incentive to provide services remains low. This is combined with system-wide climate impacts including melt events of the *palsa* mires¹⁰⁹ in Sámi home area, changes in avalanche frequency and numbers, heat spells of 30 C and more in the summer time, droughts and other major regional events.
2. **Satellite services and user access have been partly connected with the proliferation of cellular services associated with GPS-enabled smartphones becoming available to “ordinary people” as well as authorities and specialists. Yet, maintaining traditional knowledge is essential on the local scales.** This has included the “Russian GPS”, or GlONASS¹¹⁰ with services located in the Russian Federation, CIS countries and Brazil. Our research has completed several pilot scouting missions as a part of the project. **First, the use of satellite service-based navigation tools as a part of an ice fishery on a boreal lake and its relationship with traditional knowledge was explored.** GPS and associated sonar tools provided improvements in navigational safety and fish location information especially in rough conditions of blizzards, darkness and mist. Traditional harvest sites could be marked with ease on the devices. Challenges included customary ownership of these sites, data protection including of the digital maps of the sites, and too much of a reliance to the technologies in below -30 C contexts where batteries may have low life and satellite services are not available. **Second, we spoke with the Sámi traditional knowledge holders in NW Russia on the questions of traditional weather prediction** and uses of cell and satellite services. Whilst the satellite services and forecasting are improving, the weather forecasting data comes in such large blocks that the Sámi felt the regional variation is not taken into account. Therefore “reading nature” and her signs, especially in tundra and high Arctic conditions, is required to maintain skills and ways of navigation using traditional knowledge. The Sámi felt that people should only partly trust the satellite and cell services and maintain a healthy scepticism. This includes, for example, the deep and historical connection to place names and seasonal life cycles the Sámi have across the region. **Third, the uses of RenGIS and other satellite-based tools have provided a more complete view of Swedish Sámi land use and needs, but this has been slow to translate into changes in practice and governance** of multiple other competing land uses. **Fourthly the use of satellite and radio services on the coastal Sámi fishery is daily.** Traditional navigational

¹⁰⁸ Westerm Kola and Krasnochelye, Kanevka and Sosnovka.

¹⁰⁹ Whilst there is no permafrost in most parts of Fennoscandia the *palsa* mires of Northern Finland contain a icy heart. Many of these mires have started to melt in recent years.

¹¹⁰ Глобальная навигационная спутниковая система; transliteration *Globalnaya navigatsionnaya sputnikovaya sistema*

knowledge of the coast is reflected for example in Sámi language maritime place names and land mark system. According to a practitioner survey the use of a satellite radio and improved emergency tools are needed in the coastal small-scale fisheries.

3. **A preliminary view of the satellite receiving stations in Sodankylä, Finland and in Kiiruna, Sweden¹¹¹ show they are providing services to global clients, but concerns have been raised regarding the geopolitical interests and intentions of some of the nations, especially China. Additionally in recent months Russia has aggressively disrupted and jammed GPS services as a part of the global international tensions.** China is constructing a “Polar Silk Road” initiative to explore the uses of the Northern Sea Route, and investigating data services and other mechanisms to enter into the Arctic as a major player this century. Chinese delegations have visited satellite receiving stations and are already working with Sweden to secure said services. Some stakeholders in Sweden question the validity and aims of the Chinese data streams and services and whether they constitute threats or challenges to the hosting countries. Whilst the Arctic hosts these receiving stations the satellite services and remote sensing capabilities are not necessarily available or affordable to the communities next to these stations. International facilitation is needed to avoid dangers associated with the GPS jamming events, given the great reliance of, for example, aviation routes on these services in Kirkenes, Ivalo and other close-by airports.
4. **Uses of remote sensing services such as satellite data analysis provide a more up to date situational view locally of natural resources uses in the northern taiga or boreal.** They have provided mechanisms to analyse the cumulative ecological impacts of forestry, mining, infrastructure and so on in new ways, if the openness of the data is guaranteed¹¹². This is of high value to those communities who may have equity issues or even a land and water conflict with outside parties. Equally so the uses of publicly available remote sensing services can provide important data on ice and snow cover to improve safety and trip planning, at least in Finland, Norway and Sweden. The issue was highlighted also by the coastal Sámi fishermen in Norway. This highlights the potential usefulness of easy-to-use end products that synthesize Arctic research and data into user-friendly interfaces with open access. Also, the future application of drones could be one method used to increase the coverage, scale and ecosystem-based assessment of change.
5. **Following the recent OECD¹¹³ discoveries the Sámi and other minorities in the European North and NW Russia should be positioned as special access stakeholders for remote sensing services.** This may mean culturally appropriate interfaces in Sámi languages, tailored services for reindeer herding communities and subsidies for example to allow satellite phones to be purchased for those remote communities who are otherwise removed from the technical mainstream.
6. **We should recognize the global trend that favours the speedy development of and further reliance on technologies this century. Traditional knowledge, life skills and wilderness economies lose out in this particular process if steps are not taken to provide feasible alternatives.** These steps might include protected territories and contexts and mechanisms that foster the use and revitalisation of traditional land uses, languages, place names, economies and ways of life as determined by the communities, families and individuals themselves. The European North still contains semi-nomadic and seasonal lifeways unique in the world as well as Indigenous societies

¹¹¹ The station in Svalbard services US companies and clients and is considered the biggest of its kind in the world.

¹¹² Some participants were calling for digital finger printing of maps to verify their neutrality.

¹¹³ 2019

which have maintained a very close relationship with nature. The dominant narrative of Arctic monitoring and research rests on remote sensing and its applicability. To a certain extent we should perhaps resist this dominant narrative and challenge its implications for the local cultures and other navigational, weather and subsistence systems that are more endemic and suitable in the local contexts. Technology is always and only a tool, not a substance. We should also be aware of the context of increased technological solutions that are embedded in geopolitical ambitions in the Arctic as a transport and natural resources periphery, as opposed to a thriving homeland and home of the Indigenous peoples.



Small boat being anchored in the Porsanger fjord, Norway. Camilla Brattland, 2019

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