Human and climate impacts on northern ecosystems

World Dendro 2010 Excursion to the Kola Peninsula (June 19 - 23, 2010)

Heikki Kauhanen, Mauri Timonen, Jari Hietanen & Sirkka Tapaninen

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WorldDendro 2010
8th International Conference on Dendrochronology

Excursion 2: Human and climate impact
Poljarnye Zori–Alakurtti–Salla–Rovaniemi

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<td>University of Göttingen</td>
<td>Germany</td>
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<tr>
<td>Bogino, Stella</td>
<td>University of San Luis, Argentina</td>
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</tr>
<tr>
<td>Génova, Mar</td>
<td>Universidad Politécnica de Madrid</td>
<td>Spain</td>
</tr>
<tr>
<td>Ektvedt, Tone Marie</td>
<td>University of Bergen</td>
<td>Norway</td>
</tr>
<tr>
<td>Herva, Hannu</td>
<td>Finnish Forest Research Institute</td>
<td>Finland</td>
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<tr>
<td>Heussner, Karl-Uwe</td>
<td>German Archaeological Institute</td>
<td>Germany</td>
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<tr>
<td>Hyppönen, Mikko</td>
<td>Finnish Forest Research Institute</td>
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<tr>
<td>Jauhiainen, Hannu</td>
<td>Metsälehti</td>
<td>Finland</td>
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<tr>
<td>Kalela-Brundin, Maarit</td>
<td>Museum of Forestry, Sweden</td>
<td>Sweden</td>
</tr>
<tr>
<td>Kauhanen, Heikki</td>
<td>Finnish Forest Research Institute</td>
<td>Finland</td>
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<tr>
<td>Mielikäinen, Kari</td>
<td>Finnish Forest Research Institute</td>
<td>Finland</td>
</tr>
<tr>
<td>Muntan Bordas, Elena</td>
<td>University of Barcelona</td>
<td>Spain</td>
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<tr>
<td>Pourtahmasi, Kambiz</td>
<td>University of Tehran</td>
<td>Iran</td>
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<td>Pudas-Timonen, Margit</td>
<td>Rovaniemi</td>
<td>Finland</td>
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<td>Puoskari, Jouni</td>
<td>Finnish Forest Research Institute</td>
<td>Finland</td>
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<tr>
<td>Robert, Elisabeth</td>
<td>Vrije Universiteit Brussel / Royal Museum for Central Africa</td>
<td>Belgium</td>
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<tr>
<td>Rothe, Andreas</td>
<td>University of Applied Sciences Weihenstephan</td>
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<td>Shumilov Oleg</td>
<td>Kola Science Centre</td>
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<td>Suty Nicole</td>
<td>University of Agricultural Sciences</td>
<td>Sweden</td>
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<tr>
<td>Timonen, Mauri</td>
<td>Finnish Forest Research Institute</td>
<td>Finland</td>
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<td>Wrobel, Sigrid</td>
<td>Federal Research Institute for Rural Areas, Forestry and Fisheries</td>
<td>Germany</td>
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Preface

Welcome to the Russian post-conference excursion! We hope you to find this guide useful supporting the talks and experience encountered on the tour. We shall drive over 1700 km in five days. But that’s not bad, because the roads both in the Finnish and Russian sides are either in good or even in excellent condition, except the last day’s 45 km road construction!

The first and partly the second day show a whole spectrum of the most beautiful Finnish Lapland. We enjoy the sceneries of the amazing Utsjoki valley and the Finnish-Norwegian border river called Tana river (Teno in Finnish), famous for its salmon. In the northernmost Finnish village Nuorgam, we head to the nearby exotic Lake Pulmankijärvi wondering glacial land terraces and the over 7000 years old pine subfossil logs that our scuba diving field group excavate from the muddy bottom layers of a small lake. After some hours we enjoy the Norwegian open scenery, the proximity of the Arctic Ocean and some small fishing villages. We stay overnight in Svanvik, located beside the beautiful Pasvik (Paatsjoki) valley approximately 40 kilometres south from Kirkenes.

The next day we cross again the border and enter the Russian Federation. It is exciting to pass the border Security Zone and admire the areas once owned by the Finns (e.g. Pechenga). We stop at Nikel wondering a vast manmade desert caused by industrial pollution. On the way to Murmansk, we break at a massive memorial called “Valley of Glory” that was known during the Second World war as the “Valley of Death”. The turning point of our trip, Murmansk, is a white and beautiful city in the Arctic. Definitely worth experiencing!

During the next days of the tour we shall drive about 400 km along the 1300 km long highway connecting Murmansk and St. Petersburg. We Finns are proud to tell that this road is getting a new asphalt covering contracted by the Finnish company Lemminkäinen! In Apatity we have an excellent chance to enjoy the Kola Peninsula scenery at the massive Hibiny mountains. We also learn something about the activity of researchers at the Kola Arctic Centre of the Russian Academy of Sciences. The last day we shall have a long drive, but there are also some interesting historical wartime spots inspiring talks.

We warmly welcome you experiencing on the tour good company, fine nature, touching past climatic and geological history, strong human activity and nostalgic nation history!

The authors
Saturday 19th June

08:00 - 09:30 Rovaniemi-Sodankylä (128 km)
  - Astropolis Sodankylä
09:30 - 10:30 Sodankylä-Peurasuvanto (60 km)
10:30 – 12:00 Ääätövittikko (climate and soil studies). Coffee/Tea/_snacks
12:00 – 13:00 Peurasuvanto-Saariselkä (80 km)
13:00: 14:00 Lunch in Saariselkä
14:00 – 14:30 Spruce timberline forests at Kuusipää
14:30 – 16:00 Saariselkä-Inari (Karhunpesäkivi) (70 km)
16:00 – 17:30 Oldest pines in Finland. Ice age in Finland
17:30 – 18:00 Drive to Inari (10 km)
18:00 – 19:00 Accommodation in Hotel Kultahovi Inari
19:00 – 21:00 Dinner

Sunday 20th June

08:00 - 09:00 Inari-Syysjärvi (50 km)
09:00 - 10:00 Pine forest limit
10:00 - 11:00 Skalluvarrri reindeer round-up (75 km)
11:00 - 12:00 Skalluvarrri - Kevo Research Station
12:00 – 13:00 Introduction of Kevo and lunch
13:15 – 13:45 Skalluvvarri-Mantojärvi
13:45 - 14:00 Mantojärvi church cabins
14:00 - 15:00 Utsjoki-Nuorgam-Lake Pulmankijärvi (56 km)
15:00 – 16:30 Supralong Finnish pine chronology
  - Marks of ice flows in rocks
16:30 – 19:15 Lake Pulmankijärvi-Nuorgam-Kirkenes-Svanvik (206 km)
  - Palsas and permafrost
19:15 – 20:00 Accommodation in Hotel Svanhof (Svanvik)
20:00 – 22:00 Dinner in Hotel Svanhof

Monday 21st June

07:30 – 08:30 Breakfast (Hotel Svanhof)
08:30 – 11:00 Svanvik-Nikel (87 km)
  - Crossing the border
11:00 – 11:30 Man made desert
11:30 – 12:00 Nikel-Zapoljarnyi (33 km)
  - Smeltery and satellite images
  - Dendrochronological point of view
12:00 – 13:00 Lunch in Zapoljarnyi
13:00 – 17:00 Zapoljarnyi-Murmansk (169 km)
  - Memorial Valley of Death
17:00 – 18:00 Accommodation in hotel Poljarnie Zori
18:15 – 19:00 Visit to “Alesha”
19:00 - 21:00 Dinner in Poljarnie Zori
Tuesday 22\textsuperscript{nd} June

07:30 – 08:30 Breakfast  
08:30 – 09:30 A visit to a Nuclear Icebreaker  
09:30 – 11:15 Murmansk-Montsegorsk (145 km)  
11:15 – 11:30 Smeltery from outside. Snack in the bus  
11:30 – 12:00 Forest death zone  
12:00 - 13:15 Montsegorsk-Kirovsk (85 km)  
13:15 – 14:00 Accommodation in Hotel Severnaja  
14:00 – 15:00 Lunch  
15:00 – 16:30 Botanical garden in Kirovsk (Kola Scientific Centre)  
16:30 – 19:00 Khibiny mountains (tundra)  
19:00 – 21:00 Dinner in Kirovsk

Wednesday 23\textsuperscript{st} June

07:30 – 08:30 Breakfast in Kirovsk  
08:30 – 09:00 Drive to Apatity (20 km)  
09:00 – 10:00 Kola Scientific Centre (headquarter)  
10:00 – 10:30 Geological museum  
10:30 – 12:00 Apatity-Poljarnyje Zori (82 km)  
12:00 - 13:00 Lunch in Poljarnyi Zori  
13:00 – 16:00 Poljarnyje Zori-Kantalahti – Alakurtti (152 km)  
16:00 – 16:30 Memorials (Russian side)  
16:30 – 17:30 Alakurtti-Kelloselkä (74 km)  
17:30 – 18:00 Crossing the border  
18:00 - 18:30 Kelloselkä-Salla (23 km)  
18:30 – 19:00 Snack in Salla  
19:00 – 19:15 Memorial (Finnish side)  
19:15 – 21:00 Salla-Kemijärvi-Rovaniemi (152 km)  
21:00 Arrival in Rovaniemi
1. Astropolis – Sodankylä

High technology in Northern Finland is being developed by the so called Multipolis Network with Astropolis Sodankylä being the northernmost member of the network. The basis for Astropolis in Sodankylä is the research work carried out in Tähtelä, where Sodankylä Geophysical Observatory, Arctic Research Centre of FMI (FMI-ARC) and Eiscat Scientific Association, Sodankylä site have their research centres. Geophysical measurements and research has been carried out by the Geophysical Observatory since 1914. EISCAT Sodankylä site, one of the receiving sites of the incoherent scatter radar system, has been operated by EISCAT Scientific Association since 1980. FMI-ARC has been active in various ground based ozone and UV measurements and research projects since 1987.

2. Vaalolehto and Äältövittikko (Raimo Sutinen)

Site Vaalolehto: Airborne gamma-ray mapping of soil moisture

Low-altitude airborne gamma-ray (AGR) data, obtained with the aircraft-mounted 25-l NaI(Tl) gamma spectrometer and interpolated into a 50 × 50 m pixel size, over 1200 km² of glaciated terrain in Finnish Lapland, were applied to classify and interpret site suitability for Scots pine (Pinus sylvestris L.). The selection of the training and validation sets for the classification of AGR data was based on the forest management history and soil moisture content (θv) determined by dielectric (ε) measurements. The ground calibration measurements showed a significant negative correlation between the soil ε (i.e., θv) and terrestrial gamma-ray flux (TGR-γ) from potassium (γK) and thorium decay series (γ Th), suggesting that the attenuation of gamma flux is due to soil θv. Both ground and airborne surveys indicated that γK was significantly higher in drift of Scots pine stands than in drift of Norway spruce (Picea abies (L.) Karst.) stands. Out of four tested combinations of the AGR channels, i.e., (i) potassium (K), (ii) K and thorium (Th)/K, (iii) K, Th, and Th/K, and (iv) K and Th, K alone resulted in the best overall accuracy of 80.44% (Kappa coefficient, κ = 0.609) to classify drift materials suitable for Scots pine. The present study demonstrates that the TGR-γK and AGR-γK measurements provide a basis to delineate soil θv patterns within the site and landscape level, thus having a significant implication for the forest management planning to assess sites suitable for Scots pine.


Classification image of the AGR potassium produced with a maximum likelihood classifier. Dots indicate validation sites “suitable for pine” and triangles indicate sites “unsuitable for pine.”
3. Tankavaara Gold Village – from a Lapp’s dream into an international gold centre

The Tankavaara Gold Village with its international Gold Prospector Museum, gold panning area and Old Prospector’s café is Europe’s only genuine gold village, where visitors can experience the atmosphere of the gold rush. The museum shows the gold digging history of Finland and gold rushes around the world.

The gold of Tankavaara was found by Sauva-Aslak Peltovuoma, a local Lapp from the nearby village of Purnumukka in 1934. He saw this place by the Hopiajoja creek in a dream. The first claim was established in 1935. In the beginning the deposit was worked by the fellow villagers of Sauva-Aslak, and the deposit was considered as a bank of Purnumukka villages. Later many outsiders also staked claims along the creek.

In 1969 two gold diggers from Lemmenjoki, Yrjö Bear-Korhonen and and his friend Niilo “Nipa” Raumala, decided to make a claim over Tankavaara. The price of gold had sunk already in mid-1950’s so much that the usual gold prospecting was not profitable anymore. So, the companions decided to move there where the tourists travelled. They carried out experiments in Tankavaara for one summertime to ensure there really was gold in that area. Nest year they opened the first tourist gold panning centre in Finnish Lappland and started to “pan” tourists.

Site Äältövittikko: Significance of snowpack for soil water and temperature cycles

Snowmelt timing is a critical factor for tree growth in high latitudes, but threshold conditions with respect to soil moisture availability and soil temperature for the root-zone processes are not well known. We monitored snowpack thickness, air and soil temperature, and water content in the soil, sapwood and roots of downy birch (Betula pubescens Roth.) in Finnish Lapland through 1999-2003. An extreme cold event in January 1999 (TAIR=−49°C) resulted in soil freezing (at 10-cm-depth) down to T10=−26°C at a snow-free site, but beneath the 50-cm-thick snowpack the soil temperature was T10=−0.5°C. Snowmelt water was able to infiltrate partially frozen soil sequences, such that an increase in water content of the soil and birch roots occurred two-to-six weeks before soil temperatures rose notably above 0°C. The soil T10 reached +0°C a week after the disappearance of snow. The increase in water content of birch trunks was coincidental with the air temperature rises notably above 0°C. The systematic inter-seasonal pattern of water content in the birch root-trunk system, i.e. high peaks in late winter-early spring and fall, suggests sap flow in downy birch.

4. Vuomaselkä – Norway spruce forest limit  
(Raimo Sutinen)

Spruce forest limit, Vuomaselkä (68°16’N, 27°16’E, #6 in map)

Climate-driven northern limits of cold-hardy conifers, Norway spruce (Picea abies (L.) Karst.) and Scots pine (Pinus sylvestris L.) reach latitude 70°N in Fennoscandia. Spruce timberline is located at significantly lower latitudes than that of pine, but factors contributing to this exceptional pattern have remained obscure. We assessed soil water and nutrient regimes across the spruce timberline in Finnish Lapland with terrestrial electromagnetic (EM) measurements; soil dielectric permittivity (ε), which is positively correlative as well as gamma radiation (γ), which is negatively correlative to soil water content (θv) and electrical conductivity (σ), which is a measure of solute content of a soil. The soil EM data acquired at 15 sites, carrying mature (>150 yrs) stands dominated either by spruce or pine, along a 50-km-long transect cross the spruce timber line. The correlation and artificial neural network (ANN) analyses revealed that the soil moisture and solute content were significantly higher in drift of Norway spruce stands compared to those of stands formed by Scots pine. The stands dominated by spruce were associated with mesic-wet and nutrient-rich drift derived from mafic amphibole and hornblende gneisses of the Tanaelv Belt. Dry and nutrient-poor drift derived from felsic garnet gneisses of the Lapland Granulite appeared to constitute an edaphic dispersal barrier for Norway spruce.

5. Kuusipää – spruce timberline (Raimo Sutinen)

Climate-driven northern limits of cold-hardy conifers, Norway spruce (Picea abies (L.) Karst.) and Scots pine (Pinus sylvestris L.), reach latitude 70°N in Fennoscandia. Spruce timberline is located at significantly lower latitudes than pine timberline, but factors contributing to this exceptional pattern have remained obscure. Some recent new studies topiced here expose some possible reasons.

Kuusipää – The Laanila Diabase, Soil calcium

Relations between soil chemical and physical properties and understory vegetation were studied along transects across a felsic-mafic lithological sequence in central Finnish Lapland. At 119 northern boreal forest sites, several mineral soil chemical elements, soil electrical conductivity, soil dielectric permittivity, and coverages of understory vegetation were measured. We found that soil Ca concentration and Ca:Al ratio are the main variables determining forest vegetation composition and diversity. Ca-rich soils are characterised by high electrical conductivity, pH, and Mg concentration, and furthermore by low C:N ratio and concentrations of Al, S, and Zn. Average soil Ca:Al ratio is only 0.02, which presents a considerable risk for aluminium stress. Furthermore, a significant long-term decrease of soil electrical conductivity, correlating with Ca concentration, has been observed after mechanical site preparation in the study area. To maintain long-term forest productivity and to prevent eutrophication of waters due leaching of nutrients, it is important to prevent soil degradation. Ca-rich sites are few and hold the highest plant diversities, which indicate that they are probably important in maintaining high biodiversity. We found especially Geranium sylvaticum and Rubus saxatilis to be good indicators of Ca-rich regimes and high plant diversity.

6. Urho Kekkonen National Park and old forest fires

Urho Kekkonen National Park is Finland’s second largest national park covers 2,550 sq. km between the Highway 4 and the Russian border. The park was established in 1983 in an endeavour to preserve the forest, wetland and fell land habitats of East Lapland, named Koilliskaira. Reindeer husbandry needs also safeguarded. The park offers excellent opportunities for hiking, research and teaching.

The national park consists of three different sections: the Raututunturi-Saariselkä fell chains, the northern boreal forests of Itäkaira and the large aapa-mires of Sompio. The pearl of Saariselkä is Lake Luirojärvi in the midst of the park and next to the highest fell Sokosti (718 m). In the eastern corner of the national park Jaurujoki and Nuortti rivers flow in almost 100 m deep canyons before crossing the Russian border.

Reindeer husbandry, pearl fishing, hunting and fishing have long traditions in the region. They have left their mark in the form of pit traps, reindeer fences, herders’ huts and restored Kolta Sámi settlements. Since late 1950s the area has been popular also among hikers. Metsähallitus, the manager of the park, has built excellent facilities, e.g. 33 huts and numerous fire places, for the hikers.

Charred wood and scars on pine trees provide evidence of past forest fires.

Forest Fires

In northern coniferous forests, fire has been considered as the most important factor of forest dynamics. Based on the past fire frequencies it has been suggested that a more or less natural fire cycle would be 60-150 years. However, past fires have not been exclusively of natural origin. Some recent studies point to a considerable effect of humans in augmenting the number of fires and burnt area already centuries ago. As regards to the northern boreal zone there are still large areas, like northern Fennoscandia, northern Canada and Siberia, which are poorly studied.

Fire scars on living and dead trees were systematically sampled in 256 study plots in three Pinus sylvestris dominated landscapes in the eastern Finnish Lapland. Altogether 1030 tree discs or partial cross sections including scars from 98 different forest fires were dendrochronologically dated. Extraordinary well preserved old Pinus snags and stumps allowed us to reconstruct fire chronologies from the beginning of the second millennium. The cross-dated chronology extended from the year 653 AD to the present.

The first fire occurred in 940 and the last one in 1954. The number of detected fires increased with time. In the first half of the millennium fire cycle of the region was about 400 years. Gradually from the beginning of the 15th century the number of fires increased and fire cycle shortened, approaching 200 years in the 18th century, after which annually burnt areas declined. The relative number of fires peaked in the first half of the 20th century. It is likely that changes in the fire regime were caused by changes in human activity. The estimated fire cycle for the past millennium was 350 years. This gives an indication that the fire regimes of poorly studied remote regions cannot be extrapolated from fire regimes of more southern regions examined in more detail.

7. Karhunpesäkivi – old pines

The Cave of the Karhunpesäkivi is situating near the lake of Myössäjärvi in Inari. The cave is inside a garnet-cordierite-gneiss -boulder, which has dimension of 6 x 6 x 4 metres. The mouth of the cave is under the block. You must creep under the edge of the rock if you like to visit the cave.

The cave is about 5 m long, 1,5 m wide and 1-2 m high. It is formed through “tafoni”-weathering mainly by disintegration caused by differences in temperature between the inner rock and the surfaces of the cavities. The cavities have thus developed from an initial pit or score on the bottom side of the boulder. The weathering now proceeds along the comb-like cavities. Tanner (1935) considered the cave as a result of cavitation erosion made by flowing water, because cavities resembled the holes of the stones or small pot holes in river rapids.
8. Siida – Lappish culture

The exhibition center Siida is located on Lake Inari, near the surge of the Juutua River. Siida is the home of the Sámi Museum and a Nature Centre. With its cultural and nature exhibitions, it provides the visitor with new experiences and information on Sámi culture and nature of Northern Lapland.

The cultural and ecological exhibitions of Siida tell about how northern nature and an indigenous people, the Sámi, have adapted to life in extreme conditions. By bringing their knowledge and skills together, the Sámi Museum and the Northern Lapland Nature Centre have created an information package that focuses on the seasonal cycle of the North and becomes an unforgettable experience for the visitor.

Before becoming the museum center SIIDA, the Sámi Museum in Inari was an open-air museum. This outdoor museum, which supplements the indoor exhibitions of SIIDA, is still open in summer. The typical dwellings and hunting and fishing methods of the Sámi - both Reindeer-Herding, Fishing and Skolt Sámi - are displayed in the seven-hectare museum area situated on Lake Inari.

SIIDA also offers a versatile set of temporary exhibitions for the visitor. These range from Sámi cultural history, art and handicraft to nature photographs, conservation themes and the special phenomena of northern nature.

The Northern Lapland Nature Centre in SIIDA is situated in the middle of Finland’s largest conservation and wilderness areas, in the heart of northern nature. In the nature centre, the visitor can learn about the characteristics of northern nature, the management of conservation areas, and the hiking services provided by Metsähallitus (the Finnish Forest and Park Service).
Reindeer Research Station, established in 1994, belongs to the Finnish Game and Fisheries Research Institute. In order to develop reindeer herding and to support its administration, it is necessary to conduct basic and applied multidiscipline research programs which focus on the practical constraints of reindeer herding. The major part of research is carried out in co-operation with national and international research institutes and universities.

The three most important fields of reindeer research are: pastures, population dynamics, and herding. In pasture research, the quality, quantity, and productivity of reindeer pastures are examined. Reindeer population dynamics concentrate on factors that specifically influence productivity. As a whole, reindeer herding is concerned with the economy of the business. Profits acquired from the sale of meat, milk, hides, and antlers greatly influence the level of success of the reindeer herding industry.
The Inari-Utsjoki road crosses the northern limit of the continuous Scotch pine forest in Syysjärvi. East of the road, in the area of Näätämöjoki River (in the Norwegian side), the continuous pine forest extends further north than anywhere in the world. An isolated and vigorous pine forest exists near the 70th latitude in the Utsjoki and Kevojoki valleys. A smaller isolated pine forest extends as far north along the River Pulmankijoki.

Since trees at the northern and upper limits of their range are sensitive to climate and climatic stresses, tree-lines are ideal study objects for monitoring the ecological consequences of regional and global climate change. Subfossil trunks of pines have been found beyond the present occurrences of this species and those findings give concrete evidence of its former wide mid-Holocene distribution area. The maximum spread of pine in Finnish Lapland occurred 6000-4000 BP at which time all Lapland was covered by pine forests. The pine limit has retreated during the past 5000 yr indicating a 2°C lowering in temperatures.

In order to monitor the projected advance of tree-lines “The Finnish Timberline Project” was started in early 1980s. Circular monitoring plots were established in 13 localities along an altitudinal gradient from forest to alpine zone. The first mapping was carried out in 1983 and 1984. The second inventory was made on the same plots in 1994, the third in 1999, and the fourth in the first half of this century. Combined with the monitoring project pine seed maturity and the number of cones in the trees were investigated at five pairs of study sites during the period 1997–2003.

The latter study showed that both cone production (bud formation) and seed maturity may be limiting factors for successful reproduction in the climatically marginal habitats. Monitoring surveys since 1983 gave evidence of more or less regular regeneration of pine and spruce in all the zones during 1983–1999. However, seedling mortality of pines was much higher compared to spruce. In general, initially small sized seedlings showed higher mortality compared with larger ones. The results suggest that besides restrictions in reproduction, stand dynamics in the timberline habitats are strongly controlled by seedling mortality due to a variety of causes. New regeneration and tree establishment during the study period indicate a potential for the tree line to advance.

In our stop at the pine timberline in Syysjärvi, we focus on the development of timberline structure. According to our measurements, there exists at least two generations of trees: those initiated in the 1750s–1800s and 1920s–1940s.
11. Kevo Research Station

The Kevo research station is situated by Lake Kevojärvi, in the commune of Utsjoki, the northernmost municipality in Finnish Lapland. The site (69°45’N, 27°01’E; Grid 774:50, 80 m a.s.l.) lies about 60 km north of the continuous pine forest line and belongs to the subarctic or forest tundra zone, a birch subzone of the boreal coniferous forest. Research station buildings (“Tutkimusasema” on the map) and the main road (on the right side of the map) are separated by Lake Kevojärvi and River Utsjoki. There are small boats for everyday use, and a maintenance road Kevontie.

Topography is characterized by low mountains with river valleys; the elevation varies mostly between 250 and 400 m. There are also deep valleys, with cliffs which provide important ecological niches for many southern and arctic plants. One of the most spectacular valleys is the Kevojoki gorge, lying within the Kevo Strict Nature Reserve, a protected area of some 700 km².

Most of the terrain surrounding the Kevo station is mountain birch (Betula pubescens ssp. czerepanowii) forest, while areas lying above 300-350 m are low treeless alpine heaths. Dwarf shrubs and vegetation rich in lichens and mosses are typical. Around the research station, however, there is an isolated pine forest which follows the Utsjoki and Kevojoki river valleys. In the vicinity of the station the topography is varied; the vegetation includes bogs, luxuriant woods, riverbanks, cliffs and the meadows which surround some of the Sami farmhouses.

Kevo lies only one hundred km south of the Arctic Ocean. Therefore the climate is not as continental as in central Lapland. The average temperature for the coldest month (January) is -16 °C, and that for the warmest one (July) is +13 °C. The annual mean temperature is -2 °C. The snow period begins in late October and lasts on an average until the latter half of May. The polar day begins in mid-May and lasts till the end of July. Correspondingly the sun remains below the horizon from late November to mid January. The growth season is approximately 110 days and the thermal sum (+5 °C d.d.) varies between 400 and 900.

12. Kevo Strict Nature Reserve

Kevo Strict Nature Reserve covers an area of 712 km². The park was established in 1956 (extended 1982) to protect the unique Kevo Canyon and adjoining areas of sensitive subarctic fell habitats. The rock walls of the canyon get warmed by the sun early in the spring. Fertilised by water running down, and birds, these walls make an interesting habitat for plants. Many rare species grow on the slopes. Therefore these walls are sometimes called miniature botanical gardens. Pines also grow surprisingly well in the canyon, because the climate is more favourable than in the surroundings.

The abundance and diversity of the animal and plant species of the Kevo Canyon stand out from the set of species in the rest of the area. This is due to the varied soils, sufficient water resources and favourable microclimate in the canyon. Rarities such as Fragrant Fern (Dryopteris fragrans) and Cliff Stickseed (Lappula deflexa) occur in the Kevo area. The steep cliffs of the canyon also offer safe nesting places for rare birds of prey including Rough-legged Buzzard (Buteo lagopus) and the Common Kestrel (Falco tinnunculus).
13. Forest Line Arboretum

In order to promote ecological and physiological forest line research Kevo Subarctic Research Institute of the University of Turku took the initiative in collecting all tree species from the circumboreal forest limit in the same place. With the support of Metsähallitus and Metla an arboretum was established in Utsjoki and Inari northernmost, Finland in 1977.

The forest line arboretum consists of three units. The northernmost garden is situated at about 270 m a.s.l., close to the local upper birch limit. The second garden is 1 km north of the Kevo station on a glaciofluvial terrace formation in the Utsjoki valley at about 100 m a.s.l., and the third one is situated in northern Inari at the northern limit of the continuous pine forest.

Numerous origins of Betula species and their hybrids from different parts of Finland, northern Fennoscandia, Iceland and Greenland have been transplanted in the arboretum. The coniferous treeline species are represented by Abies balsamea, Larix dahurica, L. laricina, L. sibirica, Picea abies, P. glauca, P. mariana, Pinus banksiana, P. contorta, P. pumila and P. sylvestris from different parts of the circumpolar area.

14. Skalluvaara reindeer round-up

Skalluvaara reindeer round-up corral (Timo Helle)

In Finland, the northernmost third of the country belongs to the reindeer husbandry area. The winter herd amounts to about 200 000 animals, which are owned by 4 800 reindeer owners. Thus the average herd size is so small that reindeer husbandry is for the most owners a side-lively, combined to agriculture and forestry and nowadays commonly also to “new livelihoods”, such as tourism, part-time salary work etc. Economically and culturally reindeer husbandry is most important for Sami people in Upper-Lapland, in the municipalities of Enontekiö, Inari, Utsjoki and the northern part of Sodankylä. Until 1852 Sami people migrated between winter pastures in Finland and summer pastures in Norway along the shore of the Ice Sea. After the closing of the border the seasonal migrations, as they still exist in Sweden and Norway, shortened or ceased.

The reindeer corral in Skalluvaara is located in the herding association of Kaldoaivi, where the number of reindeer accounts to 5 300, owned by 89 people. Some of them are full-time herders, the most have also other jobs, which are commonly related to salmon fishing (traditional/tourism) in Tenojoki.

Traditionally, reindeer have been gathered twice a year, for calf marking in mid-summer and then in autumn-winter for counting (taxation) and slaughtering of the reindeer. Motor bikes (later four-wheelers) and snow mobiles were taken in the use in the 1960’s. After the round-ups each village takes the own herd to a closer care, including nowadays supplementary feeding in late winter. Before calving in May the reindeer are let to go and to select the pasture freely. About for 20 years ago calf markings ceased, because in salmon fishing and tourism is just during the same time the peak season; calves are marked in the round-ups in autumn and winter.
Northern Fennoscandia has experienced high-magnitude postglacial fault (PGF) events, yet the role of seismic tremors in subglacial deformations and meltwater discharge has remained obscure. We studied glacial geomorphology in Utsjoki, Finnish Lapland, an area characterized by the Utsjoki drumlin field fanning out north and northeast to the Younger Dryas End Moraines (YDEMs) in northern Norway. Paleolandslides were common on fells (i.e. mountains shaped by Pleistocene glaciations) and were formed in nunatak position evidencing fault-instability in app. 11,900 calibrated (cal) BP. Anastomosing network of eskers was found common in Utsjoki, and the network was probably generated via short-lived sliding bed stages during the discharge of subglacial lake(s). The formation of networks is different from time-transgressive evolution of single-ridged eskers in arborescent (treelike) systems. The most probable triggering mechanism for the meltwater outburst(s) was an earthquake tremor(s) associated with fault-instability during the late and post-Younger Dryas (YD). The alignment of the esker network was inconsistent with parallel-to-ice-flow streamlining and the eskers erode or superimpose drumlins. Hence the esker network post-dates the streamlining. In some cases, hummocky moraine (Pulju) was observed to coexist with esker network and peculiar ‘kettle’ and ‘liquefaction’ features. We propose that glacio-seismotectonic events contributed not only to landslides but were also primary force behind subglacial evolution of esker networks and possibly even hummocky moraine.

The reindeer corral in Skalluvaara was built in the early 1970's, and it was the first one in Lapland having strong electric lamps around the corral making work possible even in the darkness of mid-winter. In the 1980's, the slaughtering house fulfill the strict EU-standards, therefore reindeer meat could be exported directly. Later the reindeer were transported alive by trucks to other slaughtering houses, even to Kautokeino, Norway. At present the slaughtering house is under preparation and possibly already in the use.
15. Church huts of Utsjoki

Church life began on the shore of Lake Mantojärvi during the early part of the 18th Century. The first church building was completed in 1701. The present stone church was architect Carl Ludvig Engel’s (1778-1840) last and most northern project and it was built between 1850 and 1853. The vicarage on the shore of Lake Mantojärvi is from 1843.

The church huts were the lodgings for Sami families during church events and market days due to the long journey they had back to their own homesteads. The oldest surviving hut is from the 18th Century. The huts, restored by the National Board of Antiquities, are small and dimly lit. The stone fireplace standing in the corner was the only source of warmth and it was also where the cooking took place. Nationally significant landscape, cultural and nature values are united in the area of the church huts.

16. River Tenojoki

The transboundary River Tenojoki running between Finland and Norway is a sub-arctic, oligotrophic river. The river is 382 km long and the total catchment area of the Tenojoki River Basin is 16 386 km² of which approximately 70% lies in Norway. The River Tenojoki is one of the biggest and the most productive Atlantic salmon rivers in the world that is still in its natural state. The brooks, tributaries and main channel of the River Tenojoki form a river reach in excess of 1 000 km long that is a suitable habitat for salmon and has potential areas for spawning. This very popular salmon fishing river attracts many tourists also by beautiful scenery.

17. Birch ecosystem

In Fennoscandia, the mountain birch (Betula pubescens) forms the ecotone between the boreal coniferous forest and the alpine areas, and between the northern taiga and the coast and tundra. These sub-arctic mountain birch forests, characterized by a climate that has both oceanic and continental elements, are almost exclusively a Fennoscandian phenomenon, with a midpoint in northern Norway. Important features of this ecosystem are that (1) it is naturally large-scale fragmented. The sub-arctic birch forests occur in form of narrow belts and isolated areas cut off by mountain/tundra areas and exposed coast lines. (2) It has a special regime of natural disturbance factors. The dominating, natural disturbance factor is biotic, composed of massive outbreaks of herbivorous insects, especially the two geometrid moth species Epirrita autumnata (autumnal moth) and Operophtera brumata (winter moth).
18. Insect outbreaks (Seppo Neuvonen)

Outbreaks of geometrid moths, the autumnal moth (Epirrita autumnata) and winter moth (Operophtera brumata) occur regularly at 9-11 year intervals in (sub)maritime mountain birch forest and more irregularly in continental areas. The cyclic dynamics of the larvae are mainly driven by specialist parasitoids and to some extent also by changes in foliage quality and quantity. In continental areas the outbreaks are limited by cold winter temperatures killing the eggs overwintering in birch canopy. Higher winter minimum temperatures can increase the area of mountain birch forests susceptible to these outbreaks. If the birches are killed by repeated defoliation, warmer winters may lead to a counter-intuitive outcome: the altitude of mountain birch forest line may decrease.

The birches in this area (Skipagurra – Varangerbotn) have recently experienced very hard times: first an autumnal moth outbreak in 2002-2004 and then a winter moth outbreak in 2004-2007. In addition to damaging birches, the geometrid outbreaks had a negative impact on dwarf shrubs (Vaccinium myrtillus, Empetrum hermaphroditum) in the field layer, but grasses have benefited from nutrients released from birch foliage and from increased light.

19. Supralong chronology and the megafossils of Lake Pulmankijärvi

A long well established dendrochronological record from a climatologically sensitive area can provide valuable indications of the Holocene climatic variability. The over 7500 years long continuous Scots pine tree-ring record was collected from the treeline area of northern Finland. Scots pine (Pinus sylvestris, L.) immigrated to northern Finnish Lapland by 8500 years ago and spread in favourable climatic conditions to a larger area than that occupied by pine forests today. The time of the maximum extent was between 7000 and 4500 years ago.

A large number of subfossil pine trunks and stumps have been preserved in small lakes in Lapland in the present treeline area and also beyond it. We shall have a look of those tree remnants at the small lake beside lake Pulmankijärvi.
20. Ancient sea level (Raimo Sutinen)

Pulmanki delta. Highest post-glacial marine shore line at 75 m. 69°98’N 27°,98’E

21. Nuorgam

Nuorgam (70°05’22”N, 27°57’45”E), the northernmost village in Finland and in the EU, is located on the southern bank of Teno River in the Utsjoki municipality, 510 km north of the Arctic Circle. The period of the midnight sun lasts in Nuorgam from 16th May to 27th July and that of the winter twilight from 26th November to 16th January.

The proximity of the Norwegian border crossing point gives the village with its 200 inhabitants an international atmosphere. In Nuorgam people speak Finnish, Sámi and Norwegian in their everyday life. Nuorgam is a popular village among tourists during the late winter and the summer season. The main attractions are salmon fishing on Teno River, ice fishing in lakes up in the fell area, trips to the Arctic Ocean, hiking and snowmobiling. Nuorgam is the starting point of the hiking and snowmobiling trails to Sevettijärvi. Except shops there are a primary school, a chapel, a custom and a border guard detachment in Nuorgam.
22. Varangerfjord

Varangerfjord, located in the county of Finnmark, is some 100 km long bay of Barents Sea. It is the easternmost fjord in Norway. The mouth of the fjord, between the city of Vardø in the north and Grense Jacobselv – near Kirkenes – in the south, is about 70 kilometres wide. In the west the fjord is only 8 km wide. The warm air from the Gulf Stream ensures that the sea is free of ice all year round.

Vadsø, the administational centre for Finnmark County, is situated on the northern shore of Varanger fjord. It is an exciting multi-cultural town with Finnish, Saami and Norwegian populations. Plentiful fishing stocks in the Arctic Ocean are one of the reasons why people have lived in Varanger for centuries. People have always made their living from the sea. Varanger fjord is a mecca for birdwatchers with a rich birdlife, some of them quite rare. Each year, large numbers of birds make the Varanger fjord and the Arctic Ocean their home while nesting along the coast.

23. Varangerbotn Palsa (pingo) formations (Raimo Sutinen)

The term Palsa comes from the Lapish and Finnish word for 'a hummock rising out of a bog with a core of ice'. Although there is no general consensus about the correct usage of the word palsa, it is usually defined as 'a peaty permafrost mound possessing a core of alternating layers of segregated ice and peat or mineral soil material'. Palsas are low circular or oval mounds which may rise up to 10m above the surrounding terrain, with long axes up to 100m or more. However, most palsas are considerably smaller than this. Palsas usually occur in groups or 'fields', with individual structures displaying different ages of formation. As palsas consist of an ice core growing within a bog or mire (a 'palsa mire'), their superficial covering usually consists of peat. However, some palsas have a very thin peat cover, or none at all. In this case their cover usually consists of silty sediments of lacustrine or glaciomarine origin. The latter type are sometimes referred to as 'mineral palsas' or lithalsas (from lithic palsas). The distinction however is not always very clear, as most researchers find that the peat usually overlies at least some mineral sediments and that the ice which forms the core of the palsa mostly occurs in these sediments; hence the confusion about the terminology.
24. Kvens and Pykeija – Finnish originated village

Kvens are a Norwegian ethnic minority descended from Finnish peasants and fishermen who emigrated from the northern parts of Finland and Sweden to northern Norway. The main immigration of Kvens to Norway can be divided into two periods. The first large immigration was from about 1720 to 1820, when Finnish speaking people moved to Troms and the western parts of Finnmark. The second, larger, immigration was from about 1820 to 1890 to the coastal areas of eastern Finnmark, motivated by the blooming fishing industry in Northern Norway. The Kvens were registered as a separate group in the Norwegian censuses in the period 1845 to 1930. The peak was in 1875 when 24.2% of the population in Finnmark considered themselves as Kvens.

At the beginning of the first immigration until the 1860s, the Norwegian government was positive to the Kvens establishing farming colonies in the sparsely populated areas in North Norway. Later, until the World War II the government initiated the norwegianization policy with the goal to assimilate the Kven and Sami people, and culture, into the national majority. The Sami and Kvens even became to be considered a national “security risk”. Both groups were monitored by the Norwegian security police. In 1996 the Kvens were granted minority status in Norway, and in 2005 the Kven language was recognized as a minority language in Norway.

Bugøynes is a place where Finnish immigrants created their own vital necessity after years with summer frost in Finland. Now Bugøynes, located 95 km west of Kirkenes, a picturesque and lively small community with some 230 inhabitants. The village is one of the few places in the municipality that was not burnt down in the World War II. As a result, the village has preserved its Finnish architecture from the migrant days in the 1800s. Many of the inhabitants still speak the old Finnish language. This is the municipality’s only fishing village; today the main industry in the village is king crab fishing.

25. River Neiden

The River Neiden (Neidenelva in Norwegian, Näätämöjoki in Finnish) flows from Lake Iijärvi (in Finland) to Norway and discharges into the Arctic Ocean. The total length of the river is some 72 km, from which 45 km flows in the Finnish side. After crossing the border, it runs through a forested sandy valley for approx. 27 km before it meets the Neidenfjord, which is a fjord arm on the southern side of the Varangerfjord.

Neiden River is one of the best salmon rivers in Norway, but it is also very good for other species such as sea trout, trout, grayling and pike. The lower course of the river is characterized by some waterfalls, from which the Skoltefoss Waterfall is known by all fishermen. In the rapid water migrating salmon was traditionally caught by throwing nets. This originally an East-Saami method is still a living tradition but today highly regulated.

26. Kirkenes

Kirkenes, a small town with 3,300 inhabitants, is known as the capital of the Barents Region and the gateway to the East. The town is situated in the extreme north-eastern part of Norway, about 400 km north of the Arctic Circle and between two time-zones (Helsinki and Moscow). Kirkenes is the eastern turning point of Hurtigruten, which cruises daily up and down the Norway coast to and from Bergen.

Kirkenes was one of the most bombed areas during the World War II, with as many as 320 air attacks and more than one thousand alarms. In October 1944 only 13 houses were left in the town. Just outside Kirkenes is Andersgrotta, a vast underground bunker built during World War II, which provided shelter to the town’s 9,000 residents.
The secretariat of the Barents Region is located in Kirkenes. One of its tasks is to create cross-border cultural, educational and business relations in the Barents Region. There is now substantial optimism in the town as a consequence of the increased petroleum drilling activity in the Barents Sea.

27. Svanhovd – Conference Centre, Visitor Centre and Research Station

Svanhovd Conference Centre is located in the heart of the Pasvik valley, in East-Finnmark, and is a beautiful and exotic place for conferences, meetings and private accommodation. The guests you have free access to the Øvre Pasvik National Park Visitor Centre, Svanhovd Botanical Garden, sauna and the arctic wilderness.

Svanhovd is the authorized Visitor Centre for the Øvre Pasvik National Park and serves as an information centre for the National Park and other protected areas in the region. Through films and exhibitions the centre presents the nature, culture and history of the Pasvik Valley.

Svanhovd is also one of the research stations belonging to the Norwegian Institute of Agricultural- and Environmental research -Bioforsk. Bioforsk Soil and Environment, Svanhovd work with issues related to nature resources, protected areas, biological diversity and environmental research in the Barents Region. Bioforsk Svanhovd has the national responsibility for genetic monitoring of brown bear in Norway.

28. Pasvik Valley and the Trilateral Park

The Pasvik Valley stretches about 100 km southwards and forms a wedge between Russia in the east and Finland in the west. The Pasvik River, flowing from the Lake Inari (in Finland) and extending to the Barents Sea, constitutes most of the 196 km long border towards Russia.

Pasvik is known for its rich flora and fauna. Several species live here at the extreme limit of their distribution. The species composition is a mixture of European, Asian and Arctic species. The Siberian Jay, which can be found in old-growth forests, is an eastern species typical to the area. Norway’s largest bear population lives in Pasvik.

The borders of Finland, Norway and Russia meet at the border mark at Muotkavaara. Several protected areas in the three neighbouring countries have been established to preserve wilderness areas. A vast trilateral co-operation area stretching across three national borders, consisting of the Øvre Pasvik National Park, Øvre Pasvik Landscape Protection Area and Pasvik Nature Reserve in Norway, Pasvik Zapovednik in Russia, the Vätsäri Wilderness Area in Finland, is protected.

Øvre Pasvik National Park (1 199 km²) was established in 1970 and extended in 2003. The largest remaining area of primeval forest in Norway is situated in Øvre Pasvik. The pine forest here is a north-western offshoot of the Siberian taiga. The bird life is interesting because eastern species that are rare in Norway and Western Europe are found here. Pasvik is the only area in Norway where brown bears reproduce regularly.

The Pasvik Nature Reserve (Zapovednik) is the youngest nature reserve in the Kola Peninsula. It extends as a narrow belt on the verdant southern bank of the blue Pasvik River along the Russian-Norwegian border.

The Russian part (Pasvik Zapovednik, 147 km²) of the Trilateral park) is the youngest nature reserve in the Kola Peninsula and was established in 1992. Pasvik Zapovednik is a territory of untouched nature, and most of the area is only used for scientific research. Especially the ornithological research has long traditions, and over 200 species of birds has been observed in the area.
29. Russian border and border zone

Old technical border security system with barbed wire fences, observation towers, electronic alarms etc. are still in place on the Russian border to Norway and Finland as an inheritance of the Cold War time. The actual boundary line is a strip of land between poles and stones acting as boundary marks. In the Russian side the barbed wire fence with a border surveillance road follows the border a few kilometres away from the border.

The width of the Russian Border Zone has changed since early 1990s. During the Soviet time the restricted area along the border was almost 100 km wide. In 1993 it was changed down to 5 km but, in 2006, it was expanded up to 25 km. After the last change in 2007 the security zone on the border with Finland has been some 15 km. In the Finnish Lapland the maximum width of the border zone is three kilometres. The outermost limit of the zone is marked in the terrain using yellow signs, yellow rings painted on trees or yellow plastic tape attached to trees.

30. Pechenga – former part of Finland

The Pechenga District borders with Finland and Norway and the Barents Sea. The area was indigenously inhabited by Samis. In 1533, it became a part of Russia, and the settlement was founded as the Pechenga Monastery at the influx of the Pechenga River into the Barents Sea by St. Tryphon of Pechenga, a monk from Novgorod. Six years after Tryphon’s death, in 1583, the wooden monastery was raided and burnt down by the Swedes. It was destroyed again in 1764, but was restored in 1880.

The area was given to Finland as a result of the Treaty of Tartu in 1920 and renamed Petsamo. The nickel ore was discovered in 1921, and the commercial exploitation began in 1935. Road construction from Sodankylä to Petsamo, started in 1916, was completed in 1931. As a result Petsamo became an attractive and famous tourist destination. The area was captured by the Soviets during the Winter War in 1940 but was returned to Finland after the war. During the Interim Peace Liinahamari was Finland’s most important route for foreign trade due to the ice-free port. In 1944 Petsamo was incorporated into the Soviet Union. Skolt Sami people from the village Suenjel were relocated in Inari municipality. After the war the Pechenga area has been a military zone due to its proximity to the Norwegian border. Pechenga is still important for its ice-free harbour and deposits of nickel. The Kola Superdeep Borehole (12 262 m) is located in northern Pechenga.
31. Nikel and smelter

Nickel is an urban-type settlement in Murmansk Oblast, Russia, located on the shores of Lake Kuets-yarvi some 196 km northwest of Murmansk and 7 km from the Norwegian border. The town is linked to the Norilsk Nickel plant nearby where many of its citizens are employed.

The border area between Russia, Norway and Finland has been severely affected by sulphur dioxide and heavy metal emissions since nickel and copper processing started in Kolosjoki (later called Nikel) in 1942. Emissions from the smelter in Nikel and roasting factory in Zapolyarny, which since 1946 has constituted the Petchenganickel Combine, peaked at about 380,000 t SO2 in 1979, but have been reduced to some 120,000 t/year. Air pollution has caused major environmental problems in the NW part of Murmansk Region, and the vegetation has been changed or destroyed.

32. Zapolyarny

Zapolyarny is a mining town in Pechensky District of Murmansk Region. The area of the town belonged to Finland in 1920–1944. The Skolt Village “Moskva” was situated near the town. The settlement was founded in 1956 as Zhdanovsk and was granted town status and renamed in 1963. The name of Zapolyarny means “beyond the Arctic Circle”. The population of the town is some 18,000 (2009). Zapolyarny is the largest city of Russia (4620 square km). The town is built around an open pit mine of nickel. Zapolyarny is known also for the World’s deepest borehole which is located 12 km north of the town.

33. Kola Superdeep Borehole

In May 24, 1970, the former USSR started an ambitious drilling project whose goal was to penetrate “Moho”, the part where the Earth’s crust and mantle intermingle. The project is known as the Kola Superdeep Borehole (KSDB-3) located near Zapolyarny in Kola Peninsula. Several boreholes were drilled by branching from the central hole but the deepest (SG-3), a hole about nine inches wide, reached a final depth of 12,261 m (40,230 ft) in 1989, and still remains the deepest hole ever drilled until today. The drill was halted due to the higher than expected temperatures at this depth and location, 180 °C (356 °F) instead of the expected 100 °C (212 °F), and drilling deeper was deemed unfeasible. That is why the drilling was finally stopped in 1994, about 2.7 km short of its 15,000-meter goal. The site was able to share many surprising information about what lies beneath the Earth’s surface and is still scientifically useful until today as research still continues.

34. Kola Peninsula and Murmansk Region

Kola Peninsula borders upon the Barents Sea in the north and the White Sea in the east and southeast. The western border of the Kola Peninsula stretches along the meridian from the Kola Gulf through Lake Imandra to the Kandalaksha Gulf. The peninsula covers an area of about 100,000 square km. There are two mountain ranges, the Khibiny Massif and the Lovozero Massif in the western part of the peninsula. Kola Peninsula is extremely rich in various ores and minerals, including apatite, alumina sources, iron ore, mica, ceramic raw materials, titanium ore, philogopite ore, and vermiculite, as well as ores of less-common and colored metals.

The Murmansk Region covers the total Kola Peninsula and a large area west of it. The total area is 144,900 square kilometers and extends 405 km from north to south and 536 km from east to west. The region borders Finland in the west, Norway in the north, and the Republic of Karelia in the south. The total population is about one million people. The administrative center of the Murmansk Region is the City of Murmansk.
35. Valley of Death memorial

The Valley of Glory memorial, known as the Valley of Death during the war, is dedicated to those who lost their lives defending the Kola Peninsula during the Great Patriotic War of 1941-1945. The memorial complex is located by the highway Pechenga-Murmansk, 74 kilometers before Murmansk. Memorial stones with names of two thousand soldiers were mounted in 1974, and a IS-2 tank was opened in 1999. Some 100 metres to the east of the tank is the Soldier’s Cemetery with some 3,000 graves. Visitors are warned not to visit the battlefields on one’s own. There is plenty of still lethal unexploded ammunition, both from World War II and the Cold War.

36. Severomorsk

Severomorsk, a Closed Administrative and Territorial District (ZATO), is situated on the coast of the Kola Bay 26 km north-east of Murmansk. The headquarters of the Northern Fleet is located at Severomorsk along the northern edge of the Kola Peninsula. Severomorsk is also a major port and handling facility of weapons. This coastline, which is ice-free all year round, provides the Northern Fleet unrestricted access to open water. Severomorsk was founded in the second half of the 19th century as Vayenga. The settlement was renamed Severomorsk when it was granted town status in 1951. Together with its subordinated urban-type settlements it has about 70,000 inhabitants.

37. City of Murmansk

The city of Murmansk is the administrative center of the Murmansk region. It is the largest city in the whole world situated beyond the Arctic Circle. One third of the region's population lives in Murmansk. It is a relatively young city, established in 1916 and was the last town founded in the Russian Empire. The city was first known as Romanov-on-Murman and was named after the royal Russian dynasty of Romanovs.

The city is situated among the hills and on the non-freezing Kola bay coast at a distance of 50 kilometers from the outlet to the Barents Sea. The city stretches along the coast line for more than 10 kilometers. The distance from Murmansk to Moscow is 1967 km, and from Murmansk to Saint-Petersburg is 1448 km. Standing on the shore of the never freezing Kola Bay, Murmansk is a major center of fishing industry and big cargo port.
38. Kola

The ancient town of Kola is located 12 km south of Murmansk at the merge of the rivers Kola and Tuloma. It is the oldest town of the Kola Peninsula. In the Russian chronicles Kola is first mentioned in 1264 as a pomer settlement “volost Kolo”. Presumably, the city name originates from the name of the River Kola (from Finno-Ugric “Kuljoki” - “the fish river”).

Kola was officially classified as a rural locality between 1926 and 1965 but on its 400th anniversary in 1965 it was granted a status of a town. Nowadays it is commonly considered to be a satellite of Murmansk. However it is an administrative centre of the Kola district. Kola’s main landmark is the Annunciation Cathedral (1800–1809), which may have been the first stone building constructed in the Kola Peninsula.

39. Murmansk Railway

Murmansk Railway is a broad gauge (1,520 mm) Russian railway that links Murmansk in the north and Saint Petersburg in the south. Construction of the railway from St. Petersburg to Petrozavodsk, 400 km in length, started in June 1914, financed by French credit, and was finished in the summer of 1915.

In the beginning of the World War I, Russia had a great lack of weapon and ammunition. Connections to the west via the Baltic Sea were cut off, and the port of Arkhangelsk was icebound for almost half a year. Under these circumstances the urgent building of the second section of the railway from Petrozavodsk to Kola Bay was started in June of 1915 and was finished in November of 1916. In all more than 70,000 people took part in the railway building. Under extreme conditions some 1,050 km of the railway were built for less than a year and a half. In the autumn of 1916, before the building of the railway was completed, a new Russian port – Romanov-on-Murman – was founded on the coast of the ice-free bay. The port was renamed Murmansk in April 1917.

The construction of the railway and the port in Kola Bay changed not only the military-strategic situation but also the economic situation of the Kola region, providing infrastructure for the future development.

40. Olenegorsk and iron mining

Olenegorsk (literally Reindeer City), a city of 22,400 residents, is located in the midst of the Kola Peninsula, 112 km south of Murmansk. It was founded in 1949 to exploit the large iron-ore deposits discovered by geologists as early as 1932. The labour settlement of Olenegorsk was granted the city status in 1957.

Olenegorsk region is rich in iron ore reserves. The Mining and Processing Complex “Olkon”, which is located in the town, is the producer of iron-ore concentrate and crushed stone for construction works and for railway line bed. There is a huge open pit to the west and northwest of the city. In all the company operates five open iron ore deposits. The main consumer of Olkon iron ore concentrate is Severstal Russian Steel (Cherepovets, Vologda Region).

Olenegorsk Air Base is a major Russian Navy reconnaissance base. The base and its staff settlement are located across the Lake Permuozero from the city of Olenegorsk. Its 3500 meter runway is the longest on the Kola Peninsula, making it a key facility for intercontinental flights across the North Atlantic basin. Olenegorsk is also an Early Warning Radar Site. The radar is placed on a building 200 meters long and up to 75 meters high. It can monitor a sector of space at a distance up to 5,000 kilometres.
41. Monchegorsk

Monchegorsk is a town of some 50,000 inhabitants in the central part of the Kola Peninsula 145 km south of Murmansk. The town was founded in 1937 on the western coast of Lake Imandra. The name of the town derives from Akkala Sami word monce, meaning “beautiful”. Up to the mid-1930s, virgin pine forest and impenetrable spruce forest with ‘beards’ of pollution-sensitive epiphytic lichens covered the area a few kilometers to the south of the recent position of Monchegorsk.

Times have changed, because today Monchegorsk is located in one of the most heavily polluted areas in Russia. The Severonikel smelter near Monchegorsk was officially opened in 1937, but regular work began in 1946–1947. Visible signs of forest damage around the smelter appeared immediately after the beginning of smelting. In the early 1950s, clear changes in forest vegetation were detected within 2–3 km distance from the smelter. However, nobody was aware of environmental problems; landscape degradation was considered to be a normal, unavoidable result of industrial development.

The condition of the forests around Monchegorsk began noticeably deteriorate in the end of 1960s, and in 1970s the forest began to die out disastrously fast. This was to a rapid increase in emissions due to the increasing smelting of Norilsk ores (up to 30% S). The environmental degradation finally attracted the attention of the government, leading to the more systematic study of environmental pollution. Some 20 research teams worked in the area affected by the Severonikel smelter during 1970–1990. Changes in the political situation in the USSR/Russia at the end of the 1980s made possible the involvement of researchers from other countries in large-scale studies of environmental effects in areas formerly closed to foreign visitors. As an immediate result, a number of international projects were launched in the late 1980s and early 1990s. The Lapland Forest Damage Project, funded by the Government of Finland during 1990–1994, was one of the first attempts by western scientists to explore the most polluted areas of Scandinavia.

The total area influenced by aerial pollution recently exceeded 10,000 km², with industrial barrens covering tens of square kilometres (Kryuchkov, 1993). Intensive soil pollution with nickel and copper started almost simultaneously with the operation of the Severonickel smelter at the end of 1940s. Total concentrations of the main pollutants, Ni and Cu, in the organic soil increased from about 10 mg/kg at the reference site in Finland to about 5000 mg/kg at the most polluted site in Russia.

Termination of the use of Norilsk crude ore, decrease of the production and technical improvements in the Severonickel smelter have decreased the emissions since 1990s. The natural recovery of the vegetation in the industrial barren has started to some extent. Among deciduous tree species willow will appear as most tolerant to industrial pollution. Some increase in the numbers of birch trees in the moderately polluted zone has been observed also. This may be interpreted as the phenomenon of mountain birch substituting for spruce that has perished under the impact of pollution (Tsvetkov, 1991; Zhirov et al., 2007).
42. Lake Imandra

Imandra is a lake in the south-western part of the Kola Peninsula, Russia, slightly beyond the Arctic Circle. With an area of 885 km² and a volume of about 11 km³ it is the largest lake in the Kola Peninsula. The maximum depth of the lake is 67 m. There are three principal stretches of water connected by narrow straits: Greater Imandra or Khibinskaya Imandra in the north, Ekostrovskaya Imandra in the centre, and Babinskaya Imandra in the west. Lake Imandra is located 127 m above sea level, and drains into the Kandalaksha Gulf of the White Sea by the Niva River. The lake is known for the transparency of its water and its abundance of fish.

Utilization of the rich deposits of mineral resources in the watershed of Imandra, especially the apatit-nepheline industry in Kirovsk and Apatity, has contaminated the lake water. Pollution started as early as in 1930s. Since mid-1970s Lake Imandra has been loaded by heat pollution from the Kola Nuclear Power Plant. Contamination resulted in a decrease of arctic species and biodiversity. During the last two decades pollution has decreased and the lake has been re-colonized by arctic water species.

43. Apatity

Apatity, the second largest city in Murmansk region, lies between the beautiful Imandra Lake and the Khibiny mountains. It is youngest among the cities of Murmansk Region and was established in 1966. The city was after one of most abundant natural resources, apatite, mined in Kirovsk and refined in Apatity. The OAO Apatit Company employs as much as one-third of the city’s population. Not only is Apatity an industrial city, but it is also Kola’s scientific center. The famous Kola Science Centre is situated in Apatity and not in Murmansk. The famous Kola Science Centre of RAS, Geological museum and Mineralogical museum are located in the city.

44. Khibiny Mountains

The Khibiny Mountains are located between Lake Imandra and Lake Umbozero almost 150 km north of the Arctic Circle. The massif is of oval shape and occupies about 1,300 square km in the central part of the peninsula. The highest point is 1200 m above sea level and is also the highest point in the Kola Peninsula. The peaks are of plateau type, with steep slopes, with glaciers, ice fields and snowfields in some places.

The Khibiny Massif is an alkaline pluton and extremely rich in various minerals, mainly apatite and nepheline. There are more mineral species at Khibiny than anywhere in the world. The number of well-described and characterized mineral species identified there is some 360. However, as measured by the number of type minerals, the Lovozero massif east of the Khibiny, is even richer. The latter is the type locality for 90 and Khibiny for 80 minerals.
45. Kirovsk

Kirovsk, located in the valley of Vudjavr Lake and surrounded by the Khibiny Mountains, is one of the best cities in Kola. It is the most sportive town of Murmansk Region. The highest alpine ski slopes of western Russia are found in the surroundings of Kirovsk, and most of the trekking routes to the Khibiny Mountains start from the city.

Kirovsk is a mining city, built around the rich apatite deposits of the Khibiny Mountains. Mining began in the 1930s in the so-called 25th km suburb. The mines and railway were built using prison labour. The ore was extracted with picks and transported by horses. The workers lived in tents and ground pits. The first wooden barracks were built below slopes prone to avalanches. After the war the city centre was moved to its current location. Kirovsk was originally called Khibinogorsk, but after the murder of its founder and Leningrad’s party leader Sergey Kirov it was renamed Kirovsk.

The majority of the 34 thousand residents of Kirovsk are engaged in a mining industry. Apatit company, which extracts phosphorus-rich apatite, employs some 13,500 people in Kirovsk and Apatity. Apatite concentrate is manufactured in two refineries, one in Apatity and the other near the South Slope ski centre.

The city primarily consists of Soviet-era apartment buildings spread out in rows along the slopes of the fell. In the very centre of the city are the older buildings from Stalin’s period. The most architectural view opens from Lenin Square up the main street Lenina towards the culture building adorned with massive columns. The pearl of Kirovsk is the Botanical garden Institute, where visitors may not only become acquainted with the local flora but also visit the real tropical jungle.

46. Polar Alpine Botanical Garden-Institute

The Polar-Alpine Botanical Garden-Institute (PABGI) belonging to Kola Science Centre RAS and its arboretum are located 7 km north of Kirovsk. It is one of the three botanical gardens in the world situated beyond the Arctic Circle, and the most northern botanical garden in Russia. PABGI was founded in 1931. The decision of the foundation was made at the meeting of the leaders of Kola expedition headed by Academician A. E. Fersman. The arboretum covers an area of 1670 hectares.

More than 400 plant species growing in the Murmansk Region are found in the arboretum. There is also a greenhouse for tropical plants. Besides the garden, there is a protected area belonging to the Arboretum. The flora and vegetation of the altitudinal zones of the Khibiny Mountains is preserved in the area of 1250 ha. Investigations within the areas of plant and soil resources, adaptation of plants to harsh con
47. Kola Science Centre

The Kola Science Centre of the Russian Academy of Sciences (KSC RAS) includes 11 research institutes (e.g. Industrial Ecology of the North, Polar Geophysical, Polar Alpine Botanical Garden – Institute), and is the biggest scientific institution in the Barents Region. It was founded in 1930 by Academician A. E. Fersman as a Khibiny Alpine Station of the USSR Academy of Sciences. The buildings of the centre, called Akademogorodok or “academic city”, are situated in a large park-like area on the northern side of the Lenin Square.

48. Museum of Geology and Mineralogy

The museum of geology and mineralogy of the Geological Institute of Kola Science Centre, RAS exhibits a natural collection of minerals, samples of ores and rocks of the Kola Peninsula. The museum was established in 1930s at the Khibiny Mining Station. The first collection was destroyed by fire during the World War II. In 1961 the museum was moved to Apatity. With more than 9000 samples of minerals, ores and rocks of the Kola Peninsula collections of the museum represent the most complete collection of minerals that can be found on the Kola Peninsula. Among them are more than 100 new minerals first discovered on the Kola Peninsula. The most beautiful minerals are astrophyllite, eudialyte, dark-blue corundum of Khibiny, murmanite, zircon crystals and crystals of blue kyanite. Museum also exhibits a various types of apatite ores of Khibiny deposits, copper-nickel ores of Monche pluton and Pechenga deposits, iron ores of Kovdor and Olenegorsk deposits.

49. Lapland Biosphere Reserve

South of the Monchegorsk city, high, treeless fells are visible in the west of the main road. Chuna Tundra forms a nearly 50 km long mountain chain that belongs entirely to the Lapland Biosphere Reserve (LBR). LBR is the largest wild nature reserve on the Kola Peninsula and is situated 120 km north of the Arctic Circle.

The Reserve is a complex of different ecosystems: spruce, pine and birch forests (53%), alpine tundra (30%), bogs and mires (6,5%), rocks and screes (6%), and water bodies (3%). The landscape lies in the elevation range of 130 m to 2200 m above sea level. Pine, spruce and birch forests reach the elevation of 300–400 m. At higher altitudes forests are replaced by mountain birch shrubs, dwarf birch thickets and alpine tundra. The alpine zone represents lichen tundra and to smaller extent low-grass meadows.
The nature reserve was established in 1930 to protect northern taiga and alpine tundra and particularly the wild reindeer. In 1929, there were only 99 wild reindeer left in the area of Chuna and Monche Tundra. In early 1980s the wild reindeer stock comprised more than 12,000 animals. When the population was counted from a helicopter with Finland’s support in 2003, there were 1000 animals. The stock is regulated by three packs of wolves in the reserve area.

In 1983 the Reserve was extended to the west, and nowadays its area is 2784 square km. In 1985 the Lapland Reserve was included into the World Biosphere Reserve Network by the resolution of UNESCO. The Reserve is roadless and supervised from guard huts located around the reserve. All economic activities, including fishing, hunting, and gathering, are forbidden.

The information centre is situated on the shore of Chuna Lake in the southern part of the reserve. In the summer there are guided tours from the Chuna base to the closest peak of the Chuna Tundra. Long ago the area was pastureland of Sami communities. Tens of sieidi sacrificial rocks have been found in the reserve.
50. Poljarnye Zori and Kola NPP

Poljarnye Zori, a small (15 000) town south of Imandra Lake, was built for the employees of the Kola Nuclear Power Plant (KNPP). The first two power generating units of the KNPP were commissioned in 1973 and 1974. Today the plant comprises four power generating units and produces 60 percent of electricity in the Murmansk region. Rosatom, the Russian state nuclear energy corporation is going to build a new nuclear power plant in the vicinity of KNPP. The plant would be a major power supplier of the massive Shtokman gas field in the Barents Sea.

51. The Verman Front

Some 25 km before the Alakurtti there is a bridge over a rather small river Verman (p. BEPMAH in Russian). On the eastern side of the river there are long systems of trenches and the Verman front memorial on the right hand side. In the beginning of the Continuation War German and Finnish troops crossed the old border and advanced to the Verman River. The Soviet troops received a replenishment of 5,000 men, and local residents were commanded to build fortifications. The Red Army could no longer retreat, as the Murman railway was only 60 km away. The Germans did not receive additional troops, and they halted there on 19 September 1941. The situation was locked into a three-year trench war at the Verman River. The eastern side of the river was held by the Red Army, the western side by the Germans with some Finnish support. This was basically the situation in the area until 10 September 1944, when the Soviet troops stormed westwards from this point.

52. Alakurtti

Alakurtti is a military village 73 km east of the Finnish border. The village is situated by the River Tuntsajoki, which was a famous salmon river in the past. The settlement has tank and helicopter troops and a frontier guard. The population of the village increased in early 1990s when Russian soldiers demobilized from East Germany were transported to Alakurtti. The former Finnish village of Alakurtti was located on the other side of the Tuntsajoki River a couple of km downstream.

53. Kuolajärvi

The former Finnish village Kuolajärvi was located between two lakes 28 km east of the current border. The highway crosses the river between the lakes. Near Kuolajärvi there are traces of cornfields from 1950s, which were cleared as a result of Party Leader Nikita Hrushchov’s enthusiasm over corn, which he got from his visit to America.
54. Parish of “Old Salla” and Military cemeteries

Up to the Winter War the parish of Salla municipality (before 1936 Kuolajärvi) was located in Sallansuu by the River Kuolajoki, about 10 km east of the present border. Nothing but foundations are left of the parish, because the Finns burned it as they retreated on 8th December, 1939. The Empire style log church designed by C. L. Engel in 1840 also burned. Finland lost half of the municipality of Salla to Soviet Union during the World War II, a 6000 km² area from the current border to the east side of Alakurtti. “Old Salla” was one of the broadest municipalities in Finland.

Today all one can find in Sallansuu are civilian and military cemeteries located in the most strictly supervised part of the border zone. Just behind the frontier guard checkpoint with the barbed wire fence are the gravesites of the Russian cemetery. A little further west are the Finnish military cemetery and the cross memorial designed by Ensio Seppänen visible from the road. There are as many as 12,000 soldiers buried in the German military cemetery south of the main road.
World Dendro 2010 Excursion to the Kola Peninsula: Human and climate impacts on northern ecosystems (June 19 - 23, 2010)

The field excursion will address the effects of human and climate impacts to the northern forests along a transect from the Arctic Circle to the Kola peninsula in Russia.