Hirkjølen revisited
– changes in soil, vegetation and tree-line in a mountain forest after 70 years

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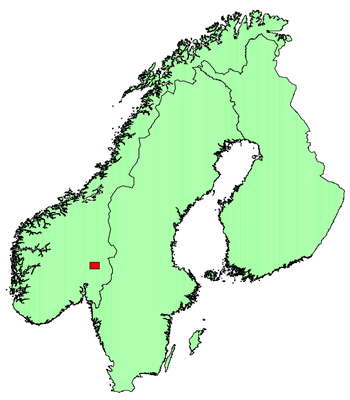
Objective

In this project we repeat botanical and soil investigations done in the 1930's to identify changes in vegetation and soil and their relation to climatic factors

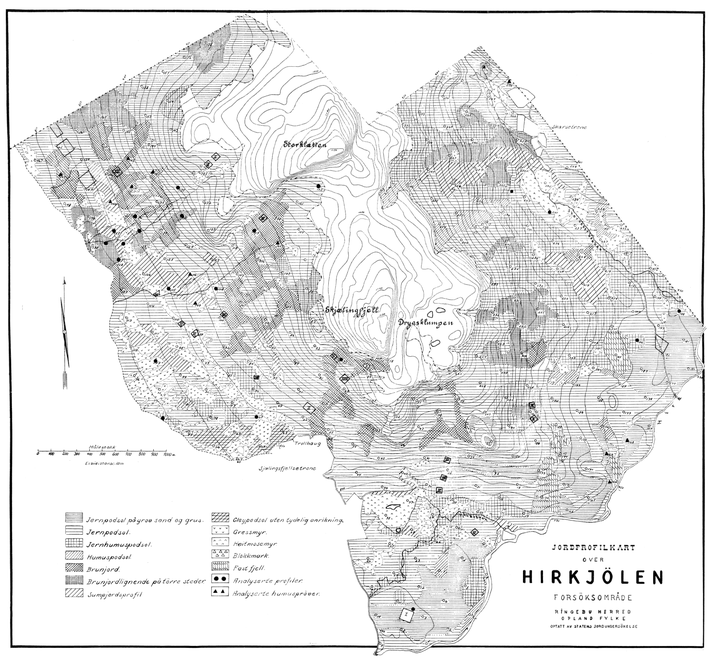
Location

The Hirkjølen experiment area is located in the central part of South Norway, ca. 200 km north of Oslo. The experiment area comprises 1153 ha of mountain forest and 273 ha of mountain heath, ranging from 740 to 1160 m.a.s.l.



Historical records

The research area was established in 1930 and in the years 1931-33 thorough surveys of vegetation, soil and timberline were performed. 347 plots of 100 m^2 were evenly distributed in a 200 meter grid system. Within these plots vegetation analyses and tree measurements were performed. Soil profiles were dug just outside these vegetation plots, and soil type, horizon thickness and parent material were registered. Chemical analysis were done on 25 soil profiles and 31 humus samples, unfortunately none of these samples were store.



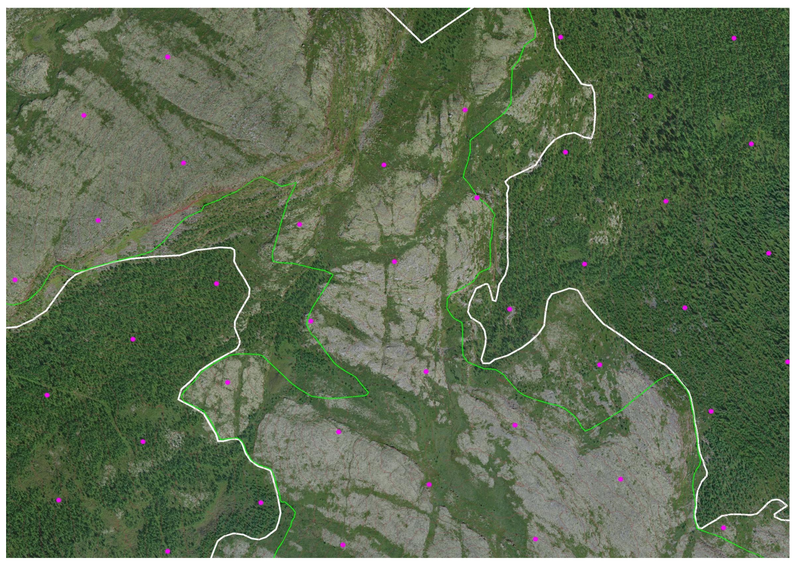
Soil and vegetation maps of the Hirkjølen experiment area were constructed in 1937. (Semb 1937, Mork & Heiberg 1937)

Resampling and reanalysis

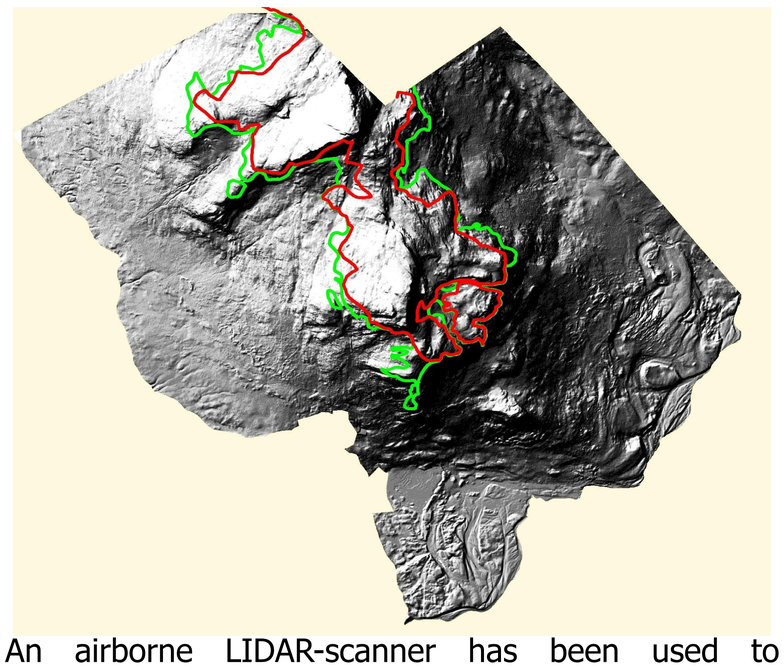
307 of the 347 original plots have been located. So far the ground vegetation and forest biomass have been reanalysed in 100 plots. 11 soil profiles and 15 forest floor sample locations have been re-sampled and analysed. The original analytical methods for soil pH, loss on ignition and Ca extraction by NH_4Cl have been reconstructed.

This poster was presented at the Cost action 639 workshop on Mountain soils under a changing climate and land-use, 6th to 8th March 2008, Birmensdorf, Switzerland. This project is financed by the Norwegian Research Council (CRIBE, grant no. 165035/S30) and the Norwegian Institute for Forest and Landscape. Photographs by the authors. Thanks to Bjørn Tveite, Per Arild Aarrestad, Ingvald Røsberg, Bernt Håvard Øyen and other co-workers in the project. The Hirkjølen Experimental Area is included in the European Network for long-term Forest Ecosystem and Landscape Research (ENFORS).

Tree line

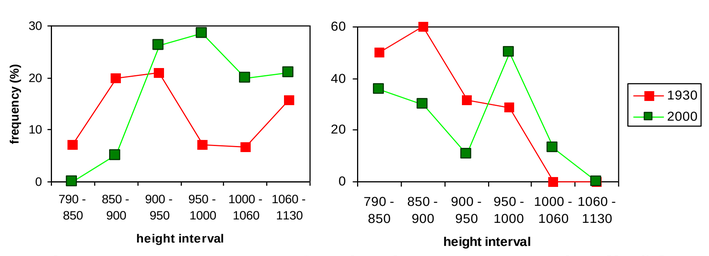


Section of orthophoto from 2004, with the forest limit (white line), the tree line (green line) and some of the permanent plots (pink dots) which were mapped in the 1930's. Preliminary results, based on field work and image analysis, indicate that the forest has expanded upwards, now approximately reaching the tree line of the 1930's.



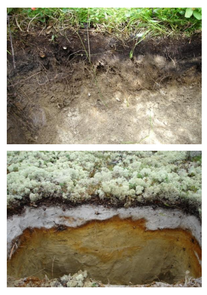
An airborne LIDAR-scanner has been used to establish a digital elevation map and to measure canopy height in the area. The canopy measurements will also be used in a study of forest productivity. The green line is the forest limit and the red line is the tree line from the superimposed 1930 map.

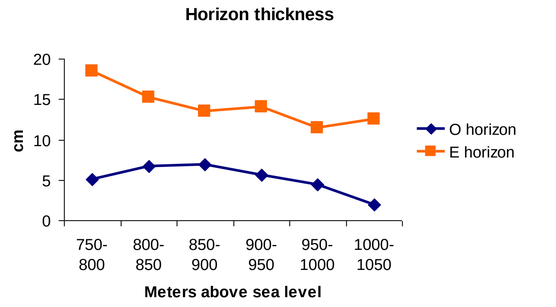
Forest and ground vegetations



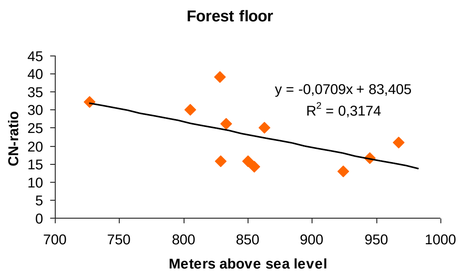
Several species, e.g. *Coeloglossum viride* (left) and *Listera cordata* (right) show distributional patterns along the height gradient and differences in time. However, few statistical significance in logistic regression. The standing volume of trees in the plots have increased from 55 – 85 m^3 ha^{-1} during the period.

Soil



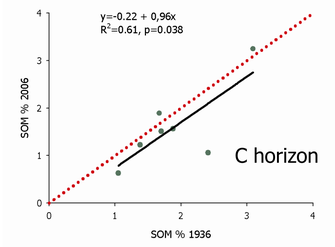


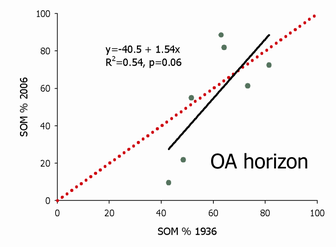
Podzols and Cambisols dominate the area but Leptosols and Histosols are also common. Based on the registrations done in 1931-33 both the O and E horizon thickness of the well drained Podzols (n=158) tend to decrease with elevation.



C and N stock will be calculated for all of the resampled soil profiles horizons. CN ratios of the forest floor decreases with elevation.

Errors in sampling and reconstruction of method may cause noise when comparing the analytical results from 1936 and 2006. However, good relationship between the analysis in the C horizon suggest that the reconstruction of the method was fairly successful. Relationships were less evident for the forest floor suggesting that this is the horizon where changes in ground vegetation, forest and forest management may have caused some changes in soil properties.





Preliminary conclusions and the work ahead

- ✓ The species composition have remained relatively constant during the period of 70 years
- ✓ Several species have "climbed upwards". However, other factors (e.g. reduced grazing, forestry and natural dynamics) probably also cause vegetation changes, and it is difficult to separate climatic effects from these.
- ✓ A local meteorological data set will be included in the analysis to better understand the climatic effects
- ✓ Remaining soil profiles will be sampled and analysed in 2008 and O, A and E horizon thickness will be measured on all plots with vegetation anlysis.
- ✓ Changes in soil properties will be analysed together with information changes in vegetation, forest biomass and climate variables
- ✓ We will extend the soil investigation to over the tree line to better be able to evaluate the effects of future vegetation changes in these areas

References: Semb, G. 1937. Soil conditions in the experimental area of the institute forest research station in the Hirkjølen state forest. *Meddelelser fra det Norske Skogforsøksvesen 5*, 537-616.

Mork, E. and Heiberg, H.H.H. 1937. On the vegetation in the Experimental Area of the Institute of Forest Research in the Hirkjølen State Forest. *Meddelelser fra det Norske Skogforsøksvesen 5(19)*, 619-683.

Project homepage: http://www.hirkjolen.no/cribe

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