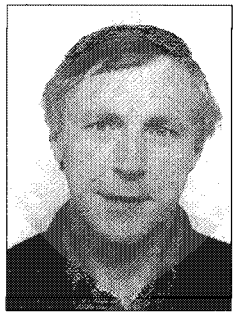
Dissertation



Hans Tømmervik defended the thesis «To what extent can vegetation change and plant stress be surveyed by remote sensing» for the degree of Dr. Scient. at the University of Tromsø, Norway, in February 1998. His thesis was based on six different papers.

Tømmervik was born in Mosjøen, northern Norway in 1955. After Cand. Scient. studies in ecological botany at the University of Tromsø, he worked as area planning consultant at the Norwegian Sami Reindeer Herders' Association (NRL) from 1985 to 1988. From 1988 he was employed as a research scientist at the Earth Observation Group at NORUT Information Technology in Tromsø. After the doctorial work he has joined the Tromsø department of the Norwegian Institute of Nature Research (NINA).

Abstract: The objectives were to detect if vegetation damage and plant stress can be surveyed by remote sensing methods and to assess use of chlorophyll fluorescence measurements to detect plant stress in the field. The study was carried out in the border areas between Norway and Russia. Two spaceborne sensors (Landsat MSS and TM) and one airborne sensor, casi, were used. In order to verify the different methods they used field inventory data collected by other institutions and by NORUT Information Technology.

Changes in vegetation cover could be monitored with a degree of accuracy varying from 75% to 83%. A hybrid classification method monitored changes in both lichen dominated vegetation and in vegetation cover types dominated by dwarf shrubs and green plants, which were significantly associated with the differences in SO_2 emissions during the period from 1973 to 1994. Vegetation indices (NDVI, MNDVI), change detection maps and prediction maps provided information on biomass and coverage of green vegetation. This was associated with the differences in the amount of emissions of SO_2 during the same period. The vegetation and land cover types (based on Landsat MSS) with the greatest stress and damage had the largest modelled SO_2 concentration levels in the ground ambient air, while the vegetation cover types with the lowest degree of stress (lichen dominated vegetation cover types) had the lowest modelled levels of SO_2 in the ambient air. Comparison of the airborne *casi* map with the previously processed Landsat TM map from the same area showed that the *casi* map separated the complete vegetation cover (including damaged and air pollution influenced areas) into more detail than the Landsat TM map (accuracy: 87.6% ±4.9% at a confidence level of 95%). The *casi* images showed indications of a red-edge shift for the medium to heavy damaged vegetation cover types. Problems with using airborne remote sensing by *casi* include variability in cloud cover in this region, lack of a synoptic view, and expense.

The variation in chlorophyll fluorescence of 11 plant species at 16 sites in southern Varanger was most influenced by precipitation, temperature and continentality. In addition, plant species in birch forests were highly correlated with the modelled distribution of SO_2 concentration in the ambient air. Species from the birch forests (*Vaccinium myrtillus, Empetrum hermaphroditum, Betula nana, Arctostaphylos alpina, Salix lapponum, Parmelia olivacea,* and *Cladina* spp.) had average Fo (chlorophyll content) values that were positively correlated with the NDVI values extracted from a Landsat TM image from 1994.