Preliminary report of the Project «The inventory of reindeer pastures with satellite techniques in Finland»

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Introduction

About two thirds of Finnish reindeer live year round in the forest area, and at 1.6.1987 the number of reindeer in Finland was about 366 000. The reindeer densities have increased sharply in the whole Finnish reindeer husbandry area during the last ten years. At the same time the multiple-use of land has become more efficient. Thus, the information about the amount and condition of reindeer pastures on the co-operative level is an essential prerequisite of sustained profitable reindeer herding in the long run. It also helps in planning other multiple-use in order to avoid conflicts between different kinds of source of livelihood.

A joint project was founded April 1987 to develop new and easily repeated methods to evaluate vast reindeer range areas. The participants of the study are the Reindeer Research of the Finnish Game and Fisheries Research Institute, the Institute of Photogrammetry and Remote Sensing of the Helsinki University of Technology and the Department of Remote Sensing of the Technical Research Centre of Finland. The project is mainly financed by the country goverment of Lapland and it will be continued for three years.

Material and methods

Study areas

The study areas are located in the northern Finland in the Oraniemi and the Muotkatunturi co-operatives (Fig. 1). Oraniemi belongs to the Peräpohjola vegetation zone. It is mostly coniferous forest with Scotch pine *(Pinus sylvestris)* and lesser Norwegian spruce *(Picea abies)*. Mineral soils cover 51% of the whole land area. Oraniemi represents the major reindeer area well. Because of the efficient forestry a lot of forest access roads are available.

Muotkatunturi is situated further north than Oraniemi (see Fig. 1). It is both in the Forest- and the Fell-Lapland vegetation zones. The pine forest limit runs through the area. There is at mixed pine and birch forest zone between the coniferous and subalpine deciduous forest areas. Barren fell tops are at low-alpine altitude. Peatlands cover about 27% of the whole land area. Both the study areas were selected in order to gain material on the major reindeer pastures types. Thus, the final results may be applied to the northern and central part of the reindeer herding area in Finland.

During the next summer the field work will be started also in southern part of the reindeer herding area to cover the Peräpohjola vegetation zone more widely.

The Oraniemi and Moutkatunturi co-operatives are relatively wide areas for conducting both field work and data processing. Thus, the following five specific test sites were selected for *the first phase of the study:*

1. Tanhua	440 sq.km
2. Koitelainen	199 sq.km
3. Vasaniemi	313 sq.km
4. Orajärvi	368 sq.km
5. Kaamanen	199 sq.km
Total	1519 sq.km

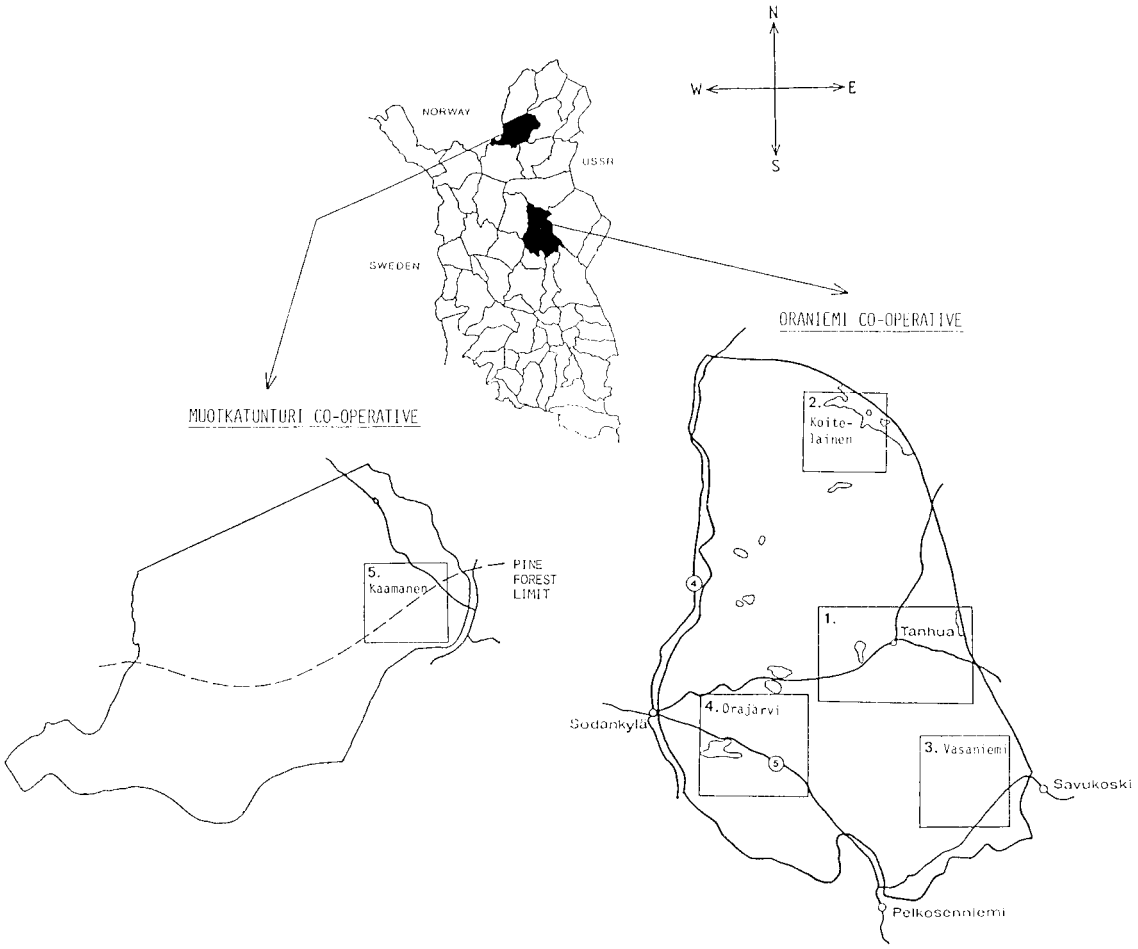

Figure 1. The specific test sites in the study. The co-operatives of Oraniemi Muotkatunturi and are situated in the middle and north part of the Finnish reindeer husbandry area.

Different kinds of reindeer winter pastures, forest site types and forest stands are represented in the test sites. The selection of the sites was done on the colour monitored satellite image.

Aerial photographs and maps

Aerial photographs and forestry and topographical maps were used for planning and indentifying the training areas for classification. Small scale aerial photographs enlarged to scale 1:40 000 were valid for the selection of the training areas. Furthermore, the photograpsh together with the topographic maps 1:50 000 were used for the indentification of training areas in the field.

The forestry maps 1:40 000 of state owned land together with their explanation books have a lot of information about the stands of forests and forests site types, as well as, cutting treatment. In Oraniemi these maps were made in 1977-1978. Thus, only the forest site type was checked from these maps for sampling. In Kaamanen forestry maps were not available, which complicated the selection of training areas.

Satellite images

For this study two Landsat-5 Thematic Mapper imageries (190/13A and 193/11D) have been acquired. The imageries consist of seven different spectral bands. The pixel size in each channel is 30x30 m. At the first stage the imageries were rectified by the liear interpolation method to the uniform coordinate system which conforms to the national grid coordinate system in Finland. The pixel size in the rectification was maintained as original. The root mean square errors at the control points of the rectification

were 19.2 m in the easting and 19.0 m in the northing.

For the field work visual prints 1:35 000 of the satellite imageries were made. So called Japanese false color image was experienced to be visually the best combination of channels. The image consist of original channels 2,3 and 4 (visible green, visible red and near-infra) which are representet with blue, green and red, respectively.

Field work

The training areas were selected discretionarily. The final selection was done in the field. The prerequisites for the training areas were the following:

A) They must represent the whole spectral variation of the imagery.
B) All the variables effecting the spectra and the intensities must be concerned.
C) The areas must be easily reached in the field.

The preliminary classification for the training areas was done with forest site type, dominant tree species, tree stand characteristics and pasture type. The number of combinations in the field was about twenty.

On each training area general observations were made about forest group, site type, ground quality, soil type taxation class, tree stand and tree strata. Of the tree stand the variables measured were number of stems per hectare, dominant and average height, diameter of average trunk, cubic volume of stems per hectare, main tree species and tree species relations. The age of the tree stand was measured by drilling an average tree.

On every training area 20 quadrats of undervegetation were inventoried. Quadrats (0,5 sq.m each) were located systematically along transects 20 meters from each other and at least one pixel width from the stand edge. Transects ran east-west or in south-north directions. The following characteristiscs were measured on every quadrat:

1. The distance from the middle point of the quadrat to the nearest deciduous and coniferous tree.
2. The distance from the middle point to the nearest reindeer pellet group and the number of pellet groups within a circle of radius 4 meters (for relative grazing pressure).
3. The %-coverage of tree canopy.
4. The %-coverage of bushes.
5. The %-coverage of dwarf shrubs, grasses, herbs, lichens and herbs.
6. The %-coverage of cutting rests, litter and bare ground.
7. The %-coverage of forage lichen species *(Cladina stellaris, C. mitis, C. rangiferina, Cladonia uncialis* and *Cetraria nivalis)* and the medium length of the live podetia of *Cladina*-species (in 14 training areas forage lichen biomasses is also gathered).
8. The amount of arboreal lichens with subjective scaling.

Image processing

Instead of classifying pixels the classification will be based on regions. The preprosessing of image, segmentation, will be done with region growing algorithm where the region labeling is done by using directed trees (Narendra, P.M., - Goldberg, M.; Image Segmentation with Directed Trees, 1980). In the segmentation method directed trees are constructed with the image points as nodes, so that the directed trees divide the image into regions. The segmentation method will be applied for several channels. Some tests in the use of the algorithm have been executed, the results have been good enough for applying the method in this study.

Laboratory work

During the summer 1987 in Oraniemi 76 and in Muotkatunturi 24 training areas were inventoried. Of these areas in Oraniemi 41 were subdry sites, 24 dry sites and 11 fresh sites. In Kaamanen 15 sample areas were dry sites, 6 subdry sites and 3 fresh sites. Most of the training areas were Scotch pine forests (76 training areas) or subalpine birch forests (15 training areas) and only 9 training areas were Norwegian spruce forests. Seed tree, small seedling, seedling and sapling and young thinning stands dominated the material. Older, mature stands were about 40% of the training areas.

In 14 training areas the biomasses of forage lichens were gathered. They have been dried and weighted. Files of training area data have been created. The computation of signatures of the training areas has been done ant the analysis of the spectral data is under work. On the next stage the ground data and the spectral signatures will be combined.