

REMOTE SENSING FOR FOREST MANAGEMENT - THE SWEDISH ISY CONTRIBUTION PROJECTS

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ABSTRACT

The Swedish contribution in the celebration of the International Space Year has materialized in an active participation in the World Forest Watch project of the Earth Science and Technology panel but also in the Training in Remote Sensing Applications programme within the panel Education and Applications.

The Swedish World Forest Watch contributions have been formed under the theme of "Remote Sensing for Forest Management". The projects comprise a wide range of forest and forestry remote sensing applications using different technical approaches.

Keywords: Swedish ISY activities, remote sensing, forest management.

1. BACKGROUND

During the planning of the project World Forest Watch (WFW), under the panel of Earth Science and Technology, a Swedish participation was discussed within the Swedish National Space Board (SNSB). After the initial international planning of the global WFW project contributions, the idea grew steadily that Sweden, having well recognised scientific as well as practical experiences in the field of forest and forestry applications of remote sensing, should contribute to this project.

With a good knowledge of the domestic activities in this field, the Swedish Space Corporation (SSC) gathered the research community with in house experts of forest applications, to outline a Swedish WFW contribution. It was mutually agreed upon to form this contribution under the theme "Remote Sensing for Forest Management". The projects represent a spectrum of remote sensing applications with the aim of increasing forestry planning and productivity or of surveying deforestation and forest damages. They show techniques from visual interpretation to advanced digital segmentation, applications for individual forest stands as well as entire nations from boreal Sweden to the arid Sudan.

By this approach it was thought that planned and ongoing activities could be extended, results to be published and displayed at several occasions, but also to inform a wider audience about the potential of remote sensing for sustainable management of forest resources.

2. ORGANISATION

After the decision by SNSB to support the Swedish WFW initiative, the planning and undertaking of the subprojects emerged in the late spring of 1990. The coordination of the eight WFW projects was ensured by establishing a Swedish ISY Coordinator (SISYC), undertaken by SSC. The task of SISYC was to materialize the outreach of the joint effort and to accomplish this in cooperation with the Swedish remote sensing community.

The projects included are undertaken by Swedish remote sensing research laboratories and SSC and are financed by SNSB. Presentations of the projects are summarized below.

A GIS/Remote Sensing Workstation for the Updating and Revision of Forest Maps

At the Faculty of Forestry, Swedish University of Agricultural Sciences, an integrated method has been developed that uses old map information and tabular data for the production of new forest information. The existing digital map data is edited interactively with new satellite imagery displayed on the monitor. Quantitative estimates of stand variables are derived from the reflectance properties of each stand. These estimates are statistically combined with tabular and ancillary data to produce new composite estimates with higher precision. Map regions still requiring additional refinement of delineation or estimation accuracy are surveyed and the new field inventory data incorporated in the estimates.

The estimated costs using this new method are about half as compared to conventional ocular field inventories. The developed GIS/workstation software can be implemented on a 386-PC.

Change Detection of Forest Stands

Two methods for change detection of forest stands have been studied at the Faculty of Forestry, Swedish University of Agricultural Sciences. In the first method - visual interpretation of change imagery - the difference images from two SPOT P and Landsat TM band 7, respectively, are interpreted. The study showed that all clear felled areas and all soil scarification are possible to interpret. Cleanings and thinnings can be delineated, but require field knowledge for identification.

In a more authorized method - region based change classification - the compartments in the forest maps are divided into smaller regions of spectral homogeneity. This is automatically done based on the change image and the late satellite image. The regions are then classified in change classes. Using Landsat TM bands 5 and 7, all clear felled areas and soil scarification could be classified. Two thirds of the cleanings and thinnings were correctly classified.

Forest Management Planning with the Aid of GIS and Integrated Satellite Data

Interactive digitization of satellite data with a GIS is a cost effective method adopted by SSC primarily for forest management planning. Merging SPOT Panchromatic data with multispectral data ensures the resolution needed for forestry applications. The multispectral data often used is Landsat TM, bands 4, 5 and 3. Digital cadastral maps and aerial photos can be incorporated to map features not interpretable in the satellite imagery, i.e. property lines or swamps. Contour lines can also be included to improve the basis for planning. The compartments are delineated and a preliminary forest map is produced in the traditional scale 1:10 000 to serve in forest inventory field work. Based on the field work, the map is revised.

The maps can be used for forest management planning but also for planning of specific operations such as fertilization and cleaning.

Forest Decline Monitoring Using Landsat TM, Digital Forest Maps and Elevation Models

The use of satellite data for forest decline assessment is often complicated by terrain effects and stand characteristics, e.g. species composition and density. The effects were studied by the Swedish Environmental Research Institute.

Landsat TM late summer imagery give a clear indication on spruce defoliation. Analysis showed that low variations in slope gradients, hardwood component, pine component and slope gradients have effect on the defoliation estimation.

As no band rationing can compensate the terrain effect, a spruce defoliation model incorporating elevation model data, was developed. It uses slope/aspect data from the DTM and digital forest maps to account for terrain and compartment characteristics. Evaluation showed the model feasible to separate the defoliation into two classes; more than and less than 20% needle loss, respectively.

Swedish Forest Information Atlas

SSC has undertaken a national land use and vegetation cover classification during one year. 46 LANDSAT TM scenes and 12 SPOT XS scenes were geocoded to the

Swedish National Grid. 900 digital map files (50m pixelsize) showing 13 vegetation cover and land use classes were produced. These were merged and filtered to 500 m pixelsize to give the resulting image showing proportions of forest cover.

The legend of the atlas comprise three forest classes - open and closed coniferous, deciduous - together with water, urban and open areas. Additional cartographic elements will be superimposed on the classification. The atlas will be produced both as printed maps and in digital format with a proposed pixelsize of 500m.

Tropical Forest Monitoring with High Resolution Satellite Data

The project was accomplished by SSC and the Swedish Faculty of Forestry in co-operation with FAO to develop operational methods for a continuous tropical forest monitoring. The methodology was tested and evaluated for the Chiang Rai province in northern Thailand.

Digitally enhanced multi-date Landsat color hardcopies were interpreted. A point sampling design was used to estimate forest area cover. Aerial photographs were used as reference data to evaluate interpretation accuracy and to calibrate area estimates. The deforestation was calculated and showed that forest had decreased to 2/3 of its former area in 13 years.

The interpretations were digitized for further analysis. From these maps, yearly spatial distributions were interpolated to demonstrate the deforestation process in an animated video.

Deforestation in African Drylands - Assessment of Changes in Woody Vegetation in Semi Arid Sudan

The changes of woody vegetation in terms of areal extent and woody resources in the western Sudan 1973-'87 have been studied by the Department of Physical Geography, University of Lund. Wood resources were quantified using the normalized vegetation index and irrigated and mechanized rainfed agriculture was manually delineated. Maps were produced that show the extent of wooded areas and agriculture.

The study concludes that the threat to woodlands and forest resources comes from the expansion of rainfed mechanized agriculture. The extent of woodlands varies with climatic fluctuations and is more threatened by expansion of large agricultural schemes than by domestic use of fuel wood.

Remote Sensing Education for Educators in Sweden 1992

In support of the United Nations program for creation of indigenous capabilities of space science and technology in developing countries, Sweden is giving a five-weeks course in remote sensing techniques and

usage in June 1992. The course is aimed at university teachers and is open for participants from Africa, South-East Asia and South America. The course is organised by the Department of Physical Geography, University of Stockholm and SSC Satellitbild.

Under the Training in Remote Sensing Applications programme within the panel of Education and Applications, the course will be partly focused on forest and forestry applications.

3. ACTIVITIES

Presentations of the ISY-WFW projects are given at domestic and international conferences, exhibitions and workshops in oral and poster sessions. For this purpose a joint mobile exhibition, giving an overview of the different contributions, has been produced.

Also, actions are being taken to distribute the ISY idea through media. Contacts are taken with radio and television broadcasting companies for participation in programmes with an environmental, scientific or technical profile. Daily newspapers receive press releases. Technical and scientific periodic journals are receiving project information and press material.

Schools receive information about the Swedish activities in the field of remote sensing for forest monitoring and can have access to the material produced. Sweden also participates in the joint production and distribution of a Nordic ISY brochure covering remote sensing activities in the four countries. For two years, a bus-born exhibition will tour Sweden, starting in the autumn of 1992.

Major events during 1992 in which the Swedish ISY contribution is planned to be or have been presented include the following:

- Skogsveckan, Stockholm, Sweden
- Inventory of the forest environment, Umeå, Sweden
- European ISY Conference, Munich, Germany
- Kartdagarna, Gävle, Sweden
- World Forest Watch Conference, São José dos Campos, Brazil
- ISPRS Congress, Washington D. C., USA
- World Space Congress, Washington D. C., USA
- Asia Pacific ISY Conference, Tokyo, Japan.