LAND COVER CLASSIFICATION AND COMPOSITE TECHNIQUES FOR MEDIUM RESOLUTION SATELLITE DATA

A Pilot Study with RESURS MSU-SK Data over the Central Baltic area.

Björn Ohlson
Swedish Space Corporation
P.O.Box 4207
S-17104 Solna
Sweden
e-mail:boh@ssc.se

The purpose of this project, was to demonstrate the feasibility of medium resolution satellite data for regional land cover mapping and to determine which land cover and vegetation categories can be distinguished with RESURS MSU-SK data. In addition, a method was to be developed for producing composites of RESURS MSU-SK data, reducing the impact of partial cloud coverage in the data set. In order to investigate the potential of the MSU-SK instrument the following objectives were defined:

- to investigate a possible landcover classification approach for the RESURS MSU-SK data using a classification scheme similar to one used in a previous SSC Satellitbild project covering the whole of Sweden by a Landsat TM classification
- to develop a regional pre-operational landcover classification method for classifying areas where reference data only exist in parts of the area, and apply the method to parts of the Baltic Sea drainage basin as a pilot test area
- To develop a method for producing composites of RESURS data, where partial cloud coverage is taken into account and removed, and also to produce a composite of at least two RESURS scenes.

The study was performed during 1996 as a development project by the Swedish Space Corporation as a part of the National Remote Sensing Research and Development Programme of the Swedish National Space Board.

The study area, data sets and results

The pilot area was covered by three scenes, one over south-central Sweden, southern Finland and the northwestern part of the Baltic region [AL190744, 1995 July 9], a second covering southern Finland [Al061709] and a third covering the Baltic region (Estonia, Lithuania and Latvia) [AL061740, 1995 Sep 17]. The scenes, each covering an area of 600 x 600 km, were geometrically corrected and resampled to a pixel size of 200 m and then classified into 8 vegetation and land cover categories (not including clouds). The classification results were evaluated against previous Landsat TM classification.

The evaluation of the classification indicated a total classification accuracy of approximately 90% correctly classified pixels in separating dense and sparse coniferous forest and deciduous forest, and 95% in combining the different forest classes into a single one.

A very good result was obtained for the classes "coniferous forest" (at first divided into sparse and dense), built-up areas, water and open land. Water was derived at from a water mask which was made interactively from the satellite data, originally created for the composite of the "raw" satellite data. This was done in order to handle the problems with sunglint effects in water bodies in the eastern part of the scene.
The main problems were found in the case of decidous forest which could possibly be explained by the sparse occurrence of large homogeneous areas of deciduous forests in Sweden. The normal dispersion is a scattered mixture between coniferous and deciduous trees. Also bare rock and fresh clear cuts in the pilot area were not spectrally separable from other types of open areas. However, the study showed that it was possible to distinguish main vegetation and land cover classes in medium resolution satellite data from the RESURS MSU-SK sensor. Forest (particularly coniferous forest), built up areas, water (derived from the water mask) and open land are best separated whereas further separation of bare rock, deciduous forest and clear cuts is more dependent on local geographical conditions. The study indicates that medium resolution data from RESURS MSU-SK is a new type of satellite data which complements more established sources. Its particular advantages in regional land cover mapping are noted in this study.

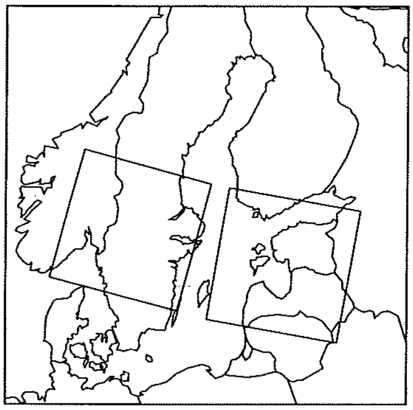
The composite method is pixel based and works by automatically combining satellite scenes, often with large geometric overlaps, and different rules are defining the result of the output. The method gave good results on land, but problems occured in water due to sun glint effects.

The perspectives for 1997 are to determine the possibility of using RESURS MSU-SK data for Telecom purposes by producing classifications of areas (e.g. Central America) with little and/or old reference data with acceptable classification accuracy in a limited period of time.

Following below is an excerpt of a report presented by Helena Larsson and Mats Rosengren of Swedish Space Corporation's Remote Sensing Technology Division at the FIRS conference in Vienna, autumn 1996: "**Preliminary land cover classification of resurs msu-sk data over central Sweden and the Baltic region**". Their study formed the preliminary part of the Baltic Drainage Area Mapping Project.

Study areas and data

Two Resurs MSU-SK scenes, one of central Sweden and southern parts of Norway and one scene of the Baltic region, including Estonia, Lithuania and Latvia, were geometrically corrected, resampled to a pixel size of 200 m and then classified into 9 vegetation and land cover categories plus clouds. The locations and dates of the two Resurs MSU-SK scenes are given below. Each scene covers an area of 600 x 600 km.



Geographic location of the Resurs MSU-SK scenes, AK011614 and AL061740

Methodology

Geometric pre-processing

As a first step towards a coverage of the entire Baltic drainage basin the project requires results of a good geometric quality. For this kind of work, a RMS error of less than 1-2 pixels is required. The geometric corrections carried out before delivery of the products used ground control points from 1:500,000 aerial navigation charts covering the area. The original 160 m pixels were resampled to 200 m pixels for practical reasons. Firstly it helped to reduce the total volume of data to be handled without significant information loss, and as a consequence simplified the development and testing of automatic mosaicing procedures for building the regional database of the Baltic Sea drainage basin.

Radiometric pre-processing

The satellite data was not corrected for sun-angle and view-angle effects. Meanwhile system corrections including destriping was carried out prior to delivery as a system correction using Russian software.

Classification

A supervised maximum-likelihood algorithm on the ERDAS Imagine analysis system was used for the classification. To facilitate this, training areas were selected for the following classes:

- coniferous forest
- deciduous forest
- agricultural land
- open areas
- built-up area

- marshland
- water
- snow
- non vegetated areas (mountains etc.)
- clouds.

These classes and associated training areas in Sweden were selected from a previous national landcover classification using this legend with Landsat TM data. Hardcopy 1:50,000 topographic maps were also used to assist in selection of training areas over Sweden. Over the Baltic states training areas were selected using hardcopy maps at 1:50,000 from base mapping projects being carried out by SSC Satellitbild using SPOT data in Estonia, Latvia and Lithuania, as well as the 1:200,000 scale maps available from the national mapping agencies. None of the map information was readily available in a digital form, and the use of different projections and datum in the maps of each country led to considerable difficulty in co-locating mapped areas with areas on the images. Particular care was required to find appropriately large mapped training areas that could be located in the imagery.

Evaluation results

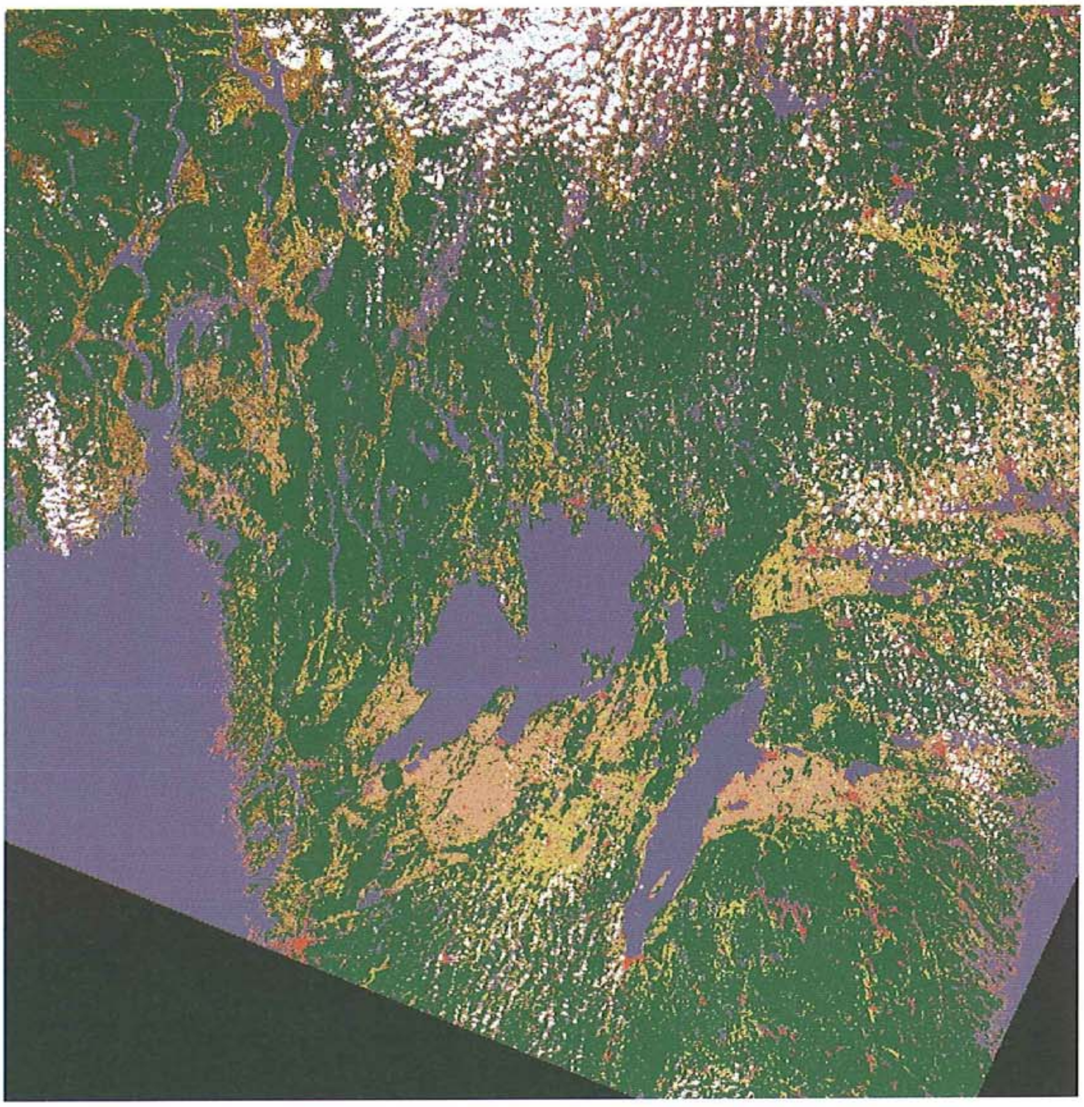
The classification results were evaluated against previous Landsat-TM classifications and maps over the study areas by taking 100 random sample points from each of the two scenes. Please see confusion matrixes below. The study indicated that the classification scheme resulted in a total classification accuracy of between 0.7 and 0.9.

Image data \ **Map data**	*Coniferous forest*	*Marshland*	*Deciduous forest*	*Open areas*	*Agricultural land*	*Water*	*Non-vegetated*	*Built-up area*
Coniferous forest	40		6					
Marshland	1		7		2			
Deciduous forest			5					
Open areas				16				
Agricultural land	2		8		1			
Water						7		
Non-vegetated	1					1		
Built-up area								2

Confusion matrix for the 100 test points evaluated on the Sweden scene. 71 % of these points are correctly classified. The most accurate classes are coniferous forest and open area.

Image data \ **Map data**	*Coniferous forest*	*Marshland*	*Deciduous forest*	*Open areas*	*Agricultural land*	*Water*	*Non-vegetated*	*Built-up area*
Coniferous forest	35		1					
Marshland		17			1			
Deciduous forest			5					
Open areas								
Agricultural land					24			
Water						8	1	
Non-vegetated						1		1
Built-up area							1	3

Confusion matrix for the 100 test points evaluated on the Baltic scene. 87 % of these points are correctly classified. The most accurate classes are coniferous forest, marshland, agricultural land and water.



Results from the classification of the AK011614 scene over south-central Sweden and southern Norway. The image shows part of the scene.

LEGEND:

Colour	Class
Dark green	*coniferous forest*
Yellowish green	*deciduous forest*
Light brown	*agricultural land*
Dark brown	*other open areas*
Red	*built-up areas*
Violet	*marshland*
Blue	*water*
Light blue	*snow*
Grey	*non-vegetated areas*
White	*clouds*

Results from the classification of the AL061740 scene over the Baltic region. The image shows part of the scene.

LEGEND:

Colour	Class
Dark green	*coniferous forest*
Yellowish green	*deciduous forest*
Light brown	*agricultural land*
Dark brown	*other open areas*
Red	*built-up areas*
Violet	*marshland*
Blue	*water*
Light blue	*snow*
Grey	*non-vegetated areas*
White	*clouds*

The main problems are found in the case of deciduous forest in Sweden and Norway. This could possibly be explained by the sparse occurrence of large homogeneous areas of deciduous forests in Sweden. The normal situation is a scattered mixture between coniferous and deciduous trees. Also marshlands in Sweden were not spectrally separable from other types of open areas

Other problems encountered were difficulties due to sunglint effects in water bodies in the eastern part of the scene. Water and non vegetated areas, as well as cloud shadows were sometimes confused because of this. The very special geometric viewing conditions of the MSU-SK sensor may also cause varying illumination and BRDF effects over the scene although these effects are much less than in AVHHR data. At the same time, the constant viewing angle through the atmosphere minimises the atmospheric contribution to these effects.

Discussion and conclusions

The study showed that it was possible to distinguish main vegetation and land cover classes in medium resolution satellite data from the Resurs MSU-SK sensor. Coniferous forest, deciduous forest, water and agricultural land/open area are best separated whereas further separation of built up area, marshland, snow, non vegetated area and clouds are more dependent on the local geographical conditions. The study indicates that Resurs MSU-SK can provide a new source of satellite data that complements more established sources. Its particular advantages in regional land cover mapping are noted in this study.

References

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