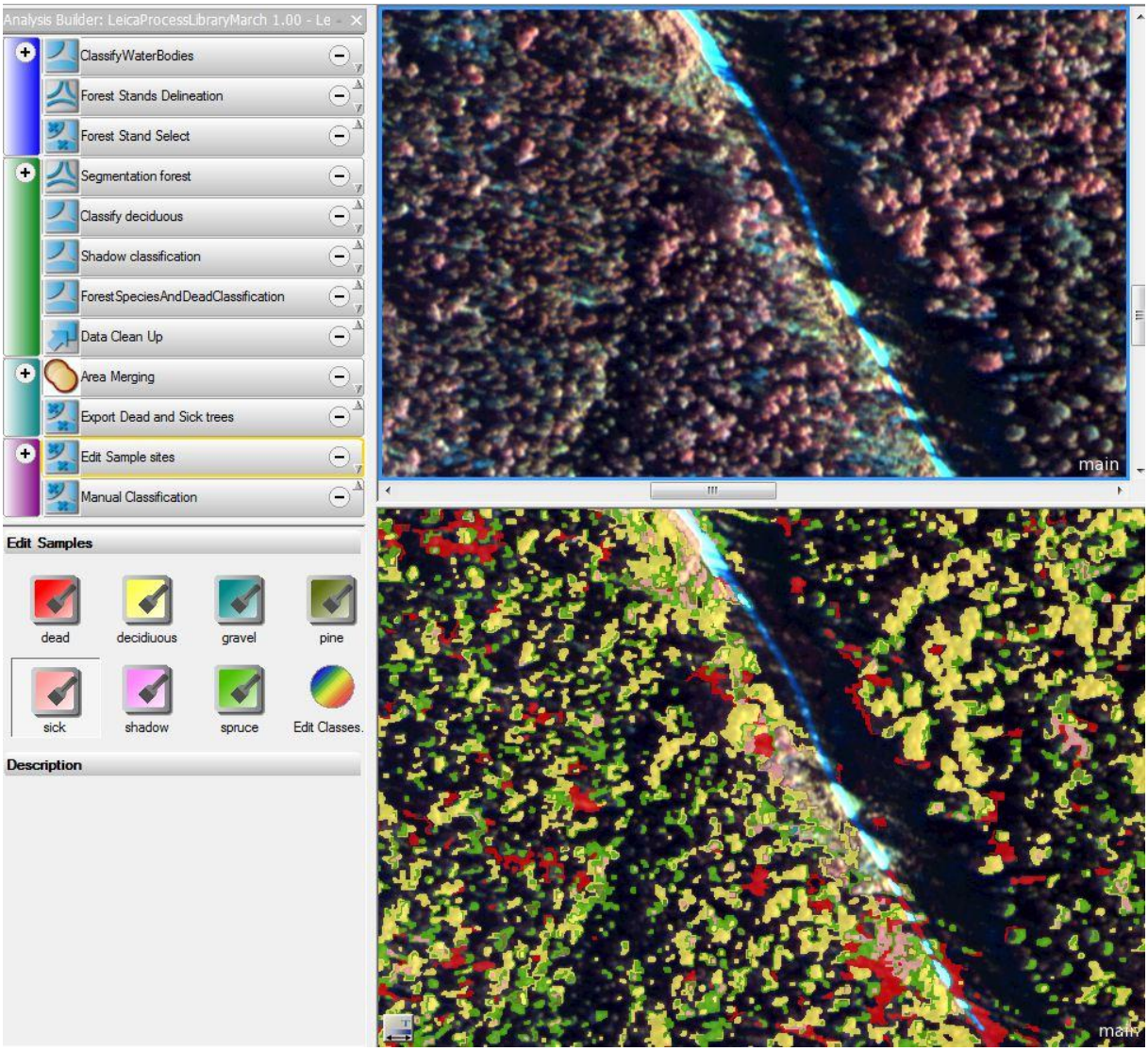
Detect dead and affected trees with ADS 80 sensor from Leica. A project for Swedish Skogsstyrelsen.

April 26, 2012, a preliminary report.



TerraNor

Background:

Mid and Northern Sweden is seriously drabbed by the spruce bark beetle. TerraNor is doing a project for Swedish Skogsstyrelsen to develop a system for detecting the sick trees. The goal is to be able to detect newly affected trees so they can be logged and taken out of the forest before the beetles can spread in large numbers to other trees.

TerraNor develops a simple to use solution based on eCognition software from Trimble. Input to the solution is ADS 80 data captured by Leica on a test flight in August 2011.

Attacks by bark beetles, fungis like Gremeniella and other diseases cost Swedish forestry large amount of money each year. Being able to detect the drabbed trees early can reduce the damage. A large attack may cost the forest owner 15 000 SEK pr ha. In 2009, 220 000 m3 timber was affected by bark beetles and the reduction in value was approximately 44 000 000 SEK.

In August 2011, Leica captured data over 4 large areas in Sweden with their ADS 80 scanner. In cooperation with TerraNor, Leica picked out 3 forest areas. This capture was not part of a professional scanning in forestry, but done as an evaluation project. The main problem was the weather with several clouds over the affected areas. The second problem was that the images had to be captured early in the morning giving a lot of long shadows.
Despite these 2 negative sides, we have received 3 datasets excellent for the type of analysis we want to do.

The project is not finished. Next week, first week of May 2012, we will go out in the field together with staff from Skogsstyrelsen and Sveaskog to collect field samples. They are needed to differentiate between dead trees and newly drabbed trees.
Already now we can tell by preliminary results, that we will reach our goal.

In this document we will present several images and discuss the result. We feel that imagery explain very well the quality of data we have received.

The project contains these features:

- Mapping of species, sick and drabbed trees
- Mapping of water areas
- Use of lidar data from LM new data capture
    - Use to improve analysis
    - Find the height and volume of forests
- Create Digital Surface Model from stereo imagery
    - Compare with lidar data for ground to find tree heights
- Present the result for foresters
- Create an application so non remote sensing specialists can do the job.

Data was captured with 50cm, 25 cm and 10 cm resolution to show the difference in quality.

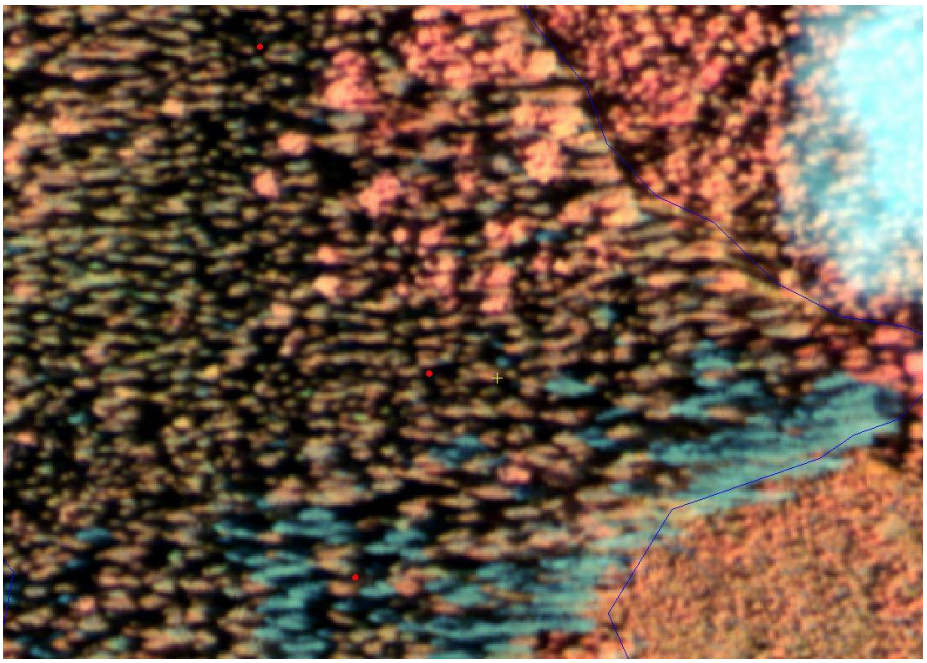


Fig 1: Data to the edge of the image.

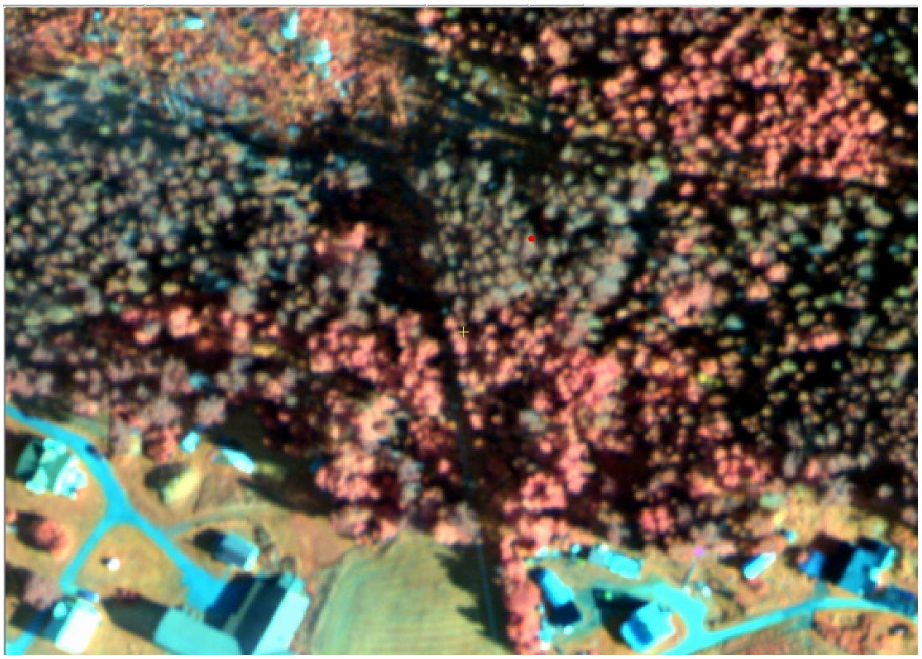


Fig 2: Data at central part of image

Leica ADS 80 is a line scanner / push broom giving central projection seen from the centre of the image and to each side. Along the flight line we have orthogonal projection.

In this project we have to use data far out to each side. Still we find that the classification works well over the whole image. ADS 80 is our choice among aerial cameraes for forest classification due to radiometric quality.

TerraNor has no interest in Leica software or hardware as such. This document reflects the thoughts we have as a professional provider of image classification for forestry and agricultural areas. Our thoughts are based on our own experiences and experiences from partners around the world.

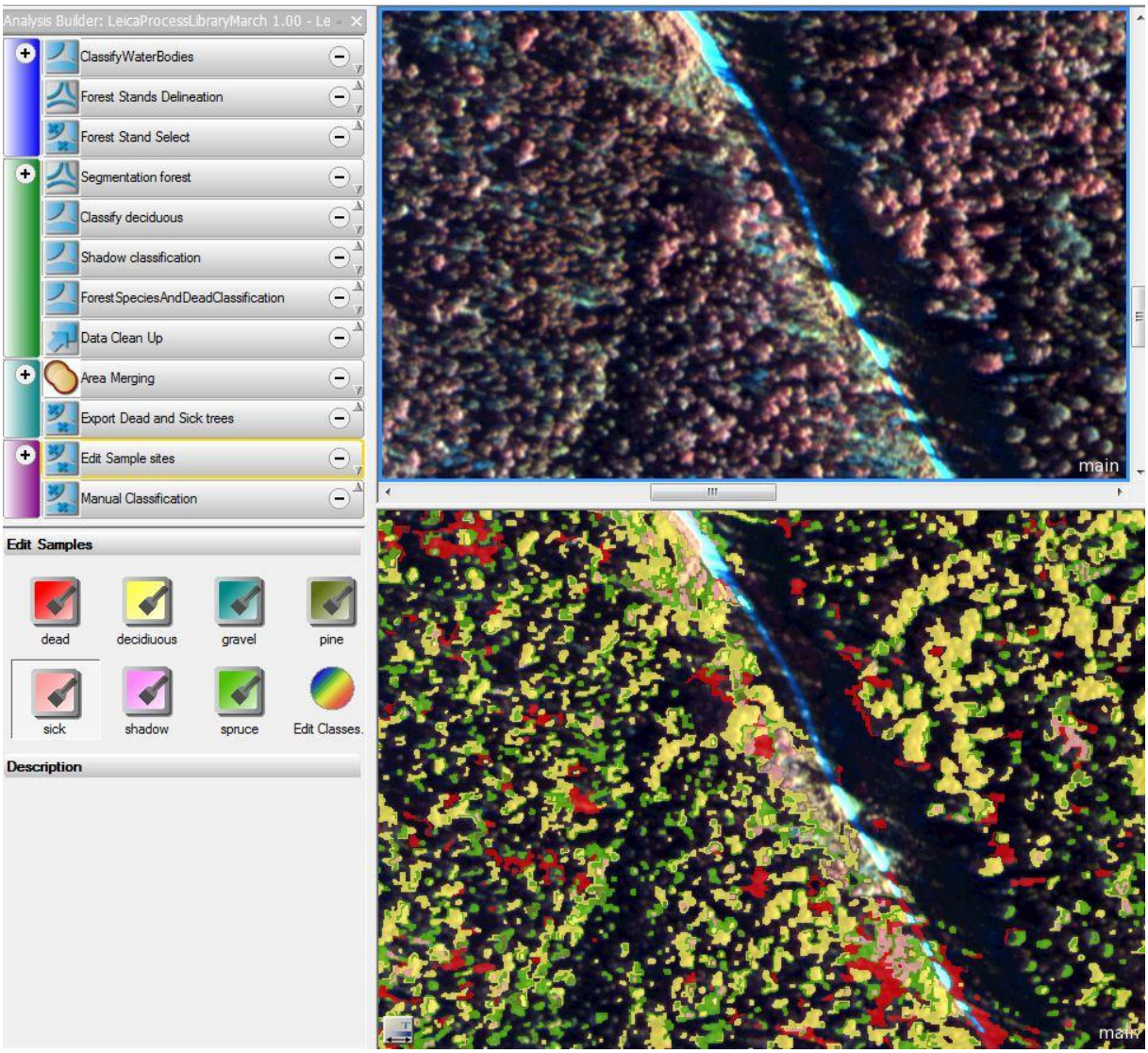


Fig 3.

This image shows the real value of this type of analysis. eCognition can detect sick and dead trees easily and mark them with a red colour. The alternative is to fly with helicopter and mark on a map the attacked trees manually. Trees that have been dead for a while are easy to see, but a normal human will still miss many of them.
It is important to capture trees that have been attacked over the last 2-3 weeks. These trees are normally week trees but they are not dead. It is difficult to detect these trees with a human eye. With a sensor like ADS 80 we can capture the difference between a dead and healthy tree with the Near Infra Red Scanner (NIR).

On the image above we can see deciduous trees with strong reddish colour with use of NIR band in the Red channel. We can also see dead trees and coniferous trees. We need more field samples to find the sick trees (not dead yet). This will be done in beginning of May.

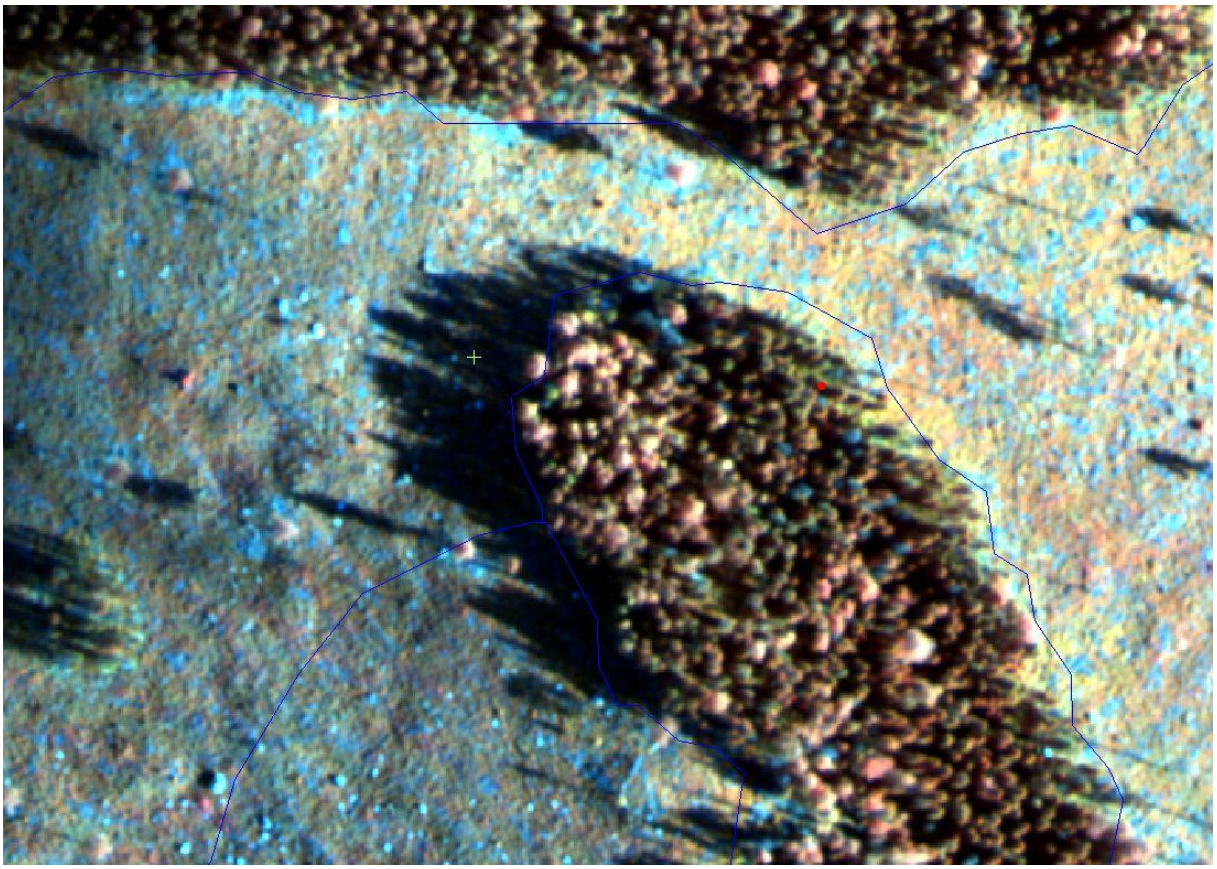


Fig 4.

Fig 4 shows the problem with long shadows. In forest of same age the problems are not large. In forests with mixed tall and short trees, the short trees can fall in the shadow. If the forest is on a hill facing north/west (away from the morning sun), it can be really hard to analyse the trees.

Even with these shadow problems we get a good result of the classification.

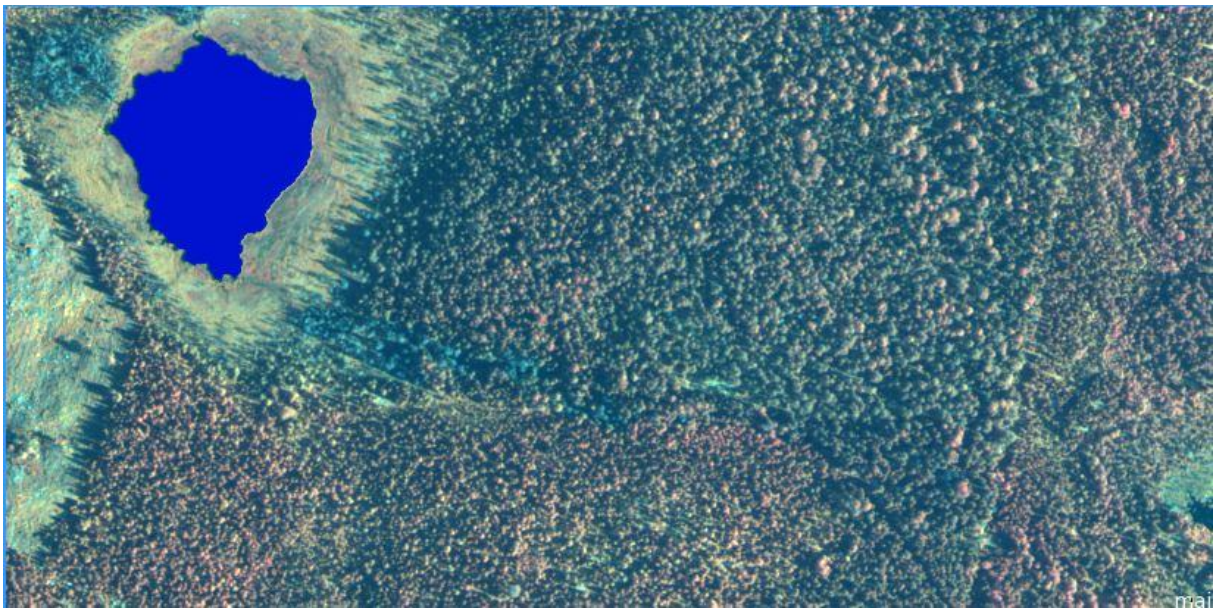


Fig 5.

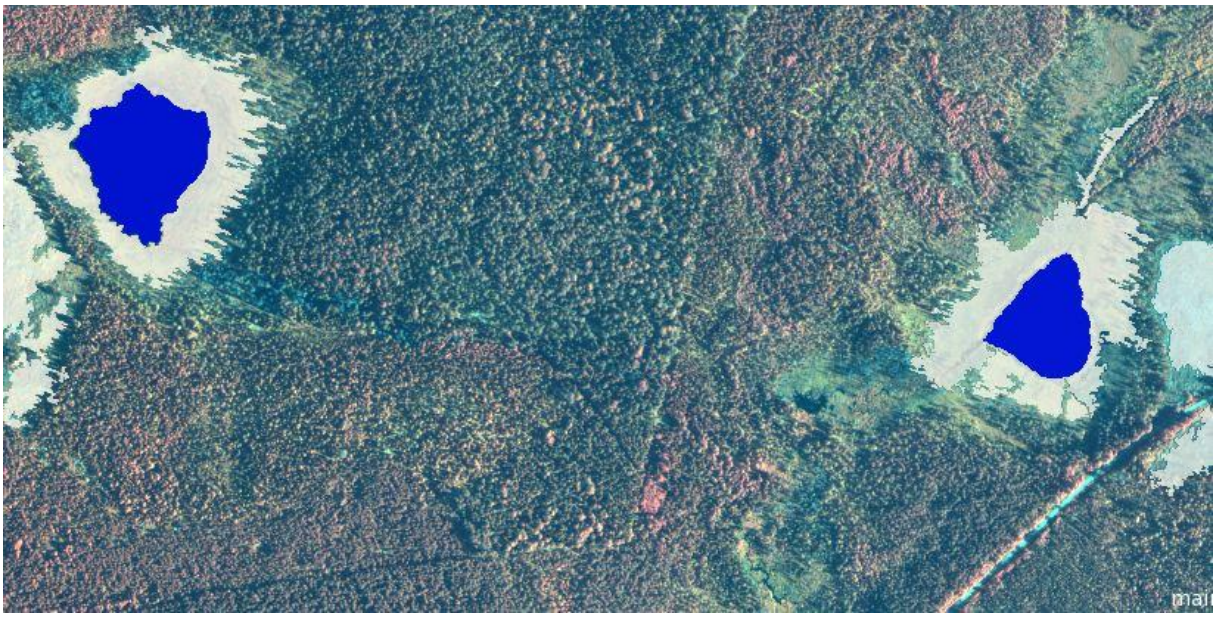


Fig 6.

ADS 80 seem to have a very efficient way to detect water areas. As seen on Fig 5 and 6, the water is detected very accurate.
On fig 6 we have added a mask (white) to non forest areas that we do not want to use in analysis. With ADS 80 data we can easily do this semiautomatic.

This technique can be used to show how water areas are reduced due to vegetation growth in the water. In the Nordic countries it is a problem that small lakes disappear and become swamps.

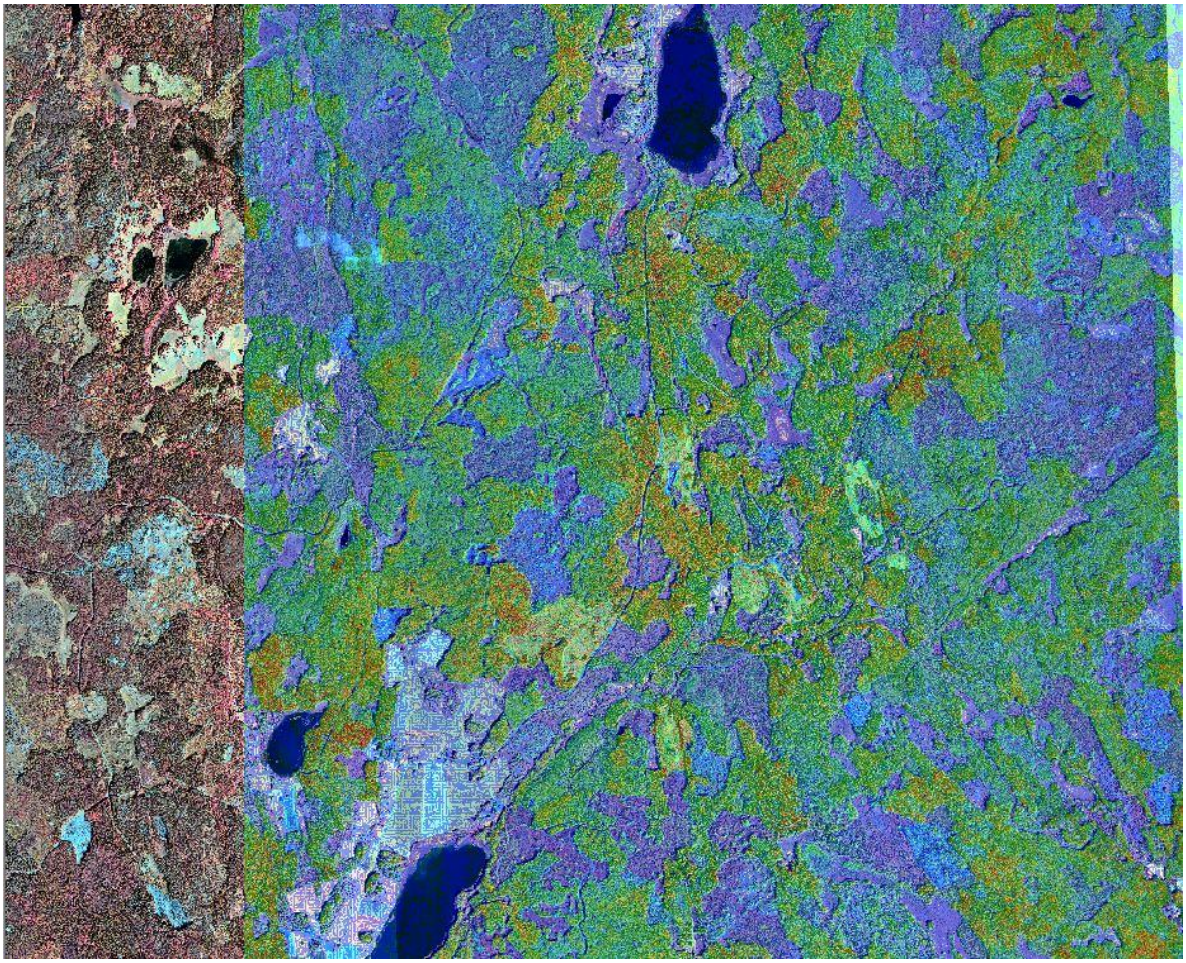


Fig 7

Fig 7 shows lidar data draped on the Leica imagery. The Lidar data shows the height of the vegetation going from 0 m, blue, to 30 m, red.
Lidar data from Swedish Land Survey (LM) was processed in LP 360 lidar software from QCoherent.
LP 360 can export raster with DSM: tree tops and DEM: ground.
In PCI Geomatica we used the raster calculator to create tree heights as DEM subtracted from DSM.

The perfect fit between the lidar data and the ADS 80 images is interesting. On logged pine fields we can see the height of each seedling tree.

Fig 8 and 9 on next page show the perfect fit between lidar and imagery. Notice the variation in colour due to tree heights and how it fits with the imagery.

Next step in this project that will be finished before end of May 2012, is to use DSM created by Leica ADS 80 data to find the height.

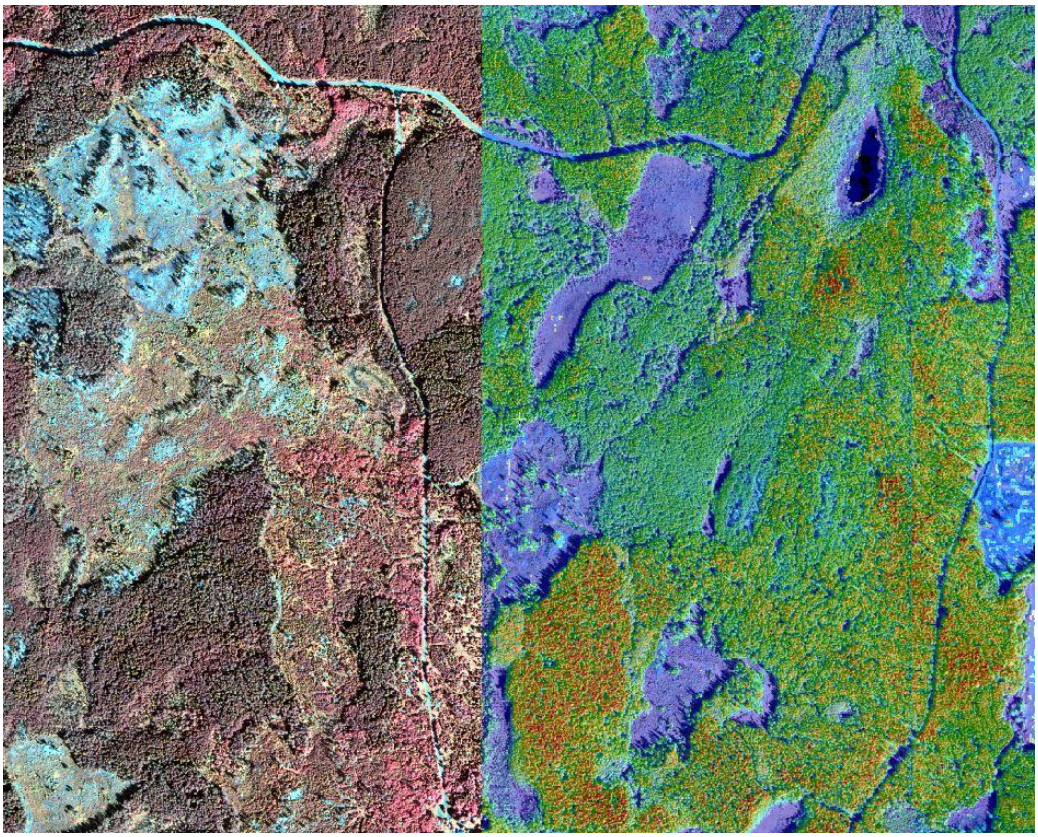


Fig 8.

Fig 9.

The following images show one flight stripe from right to left. This stripe was captured with 25 cm resolution. It is obvious that the better resolution give a lot more details and quality in colours.

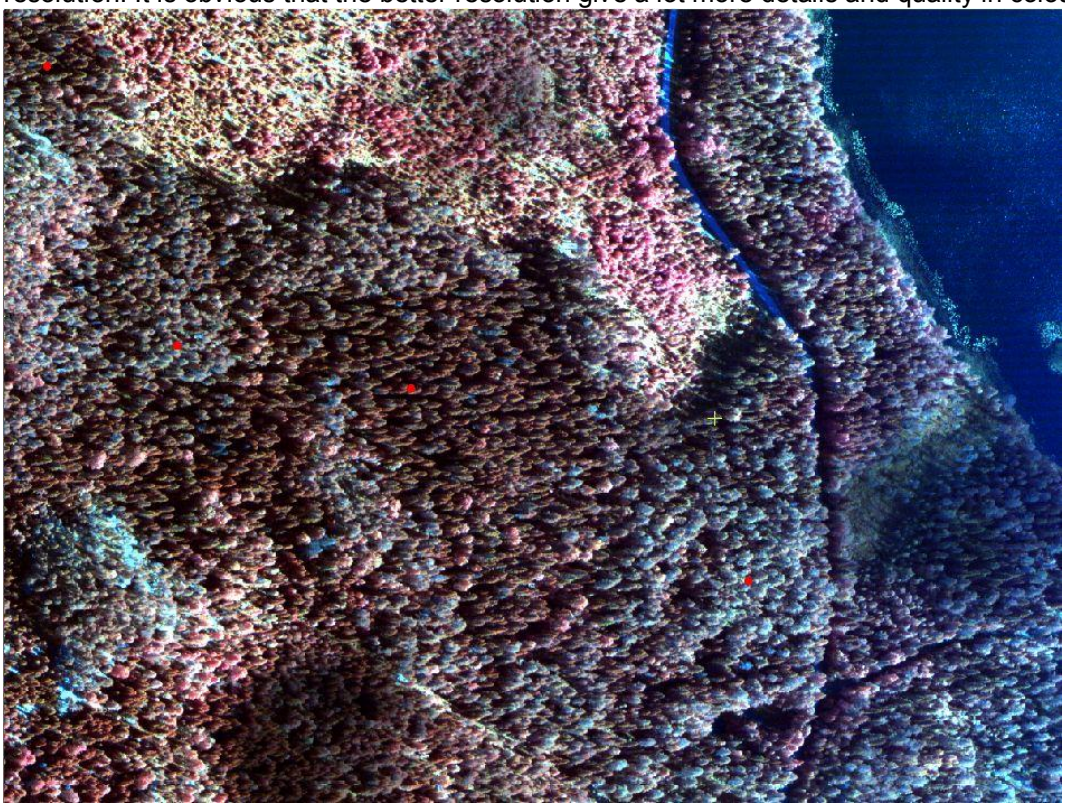


Fig 10, 25 cm image, rightmost

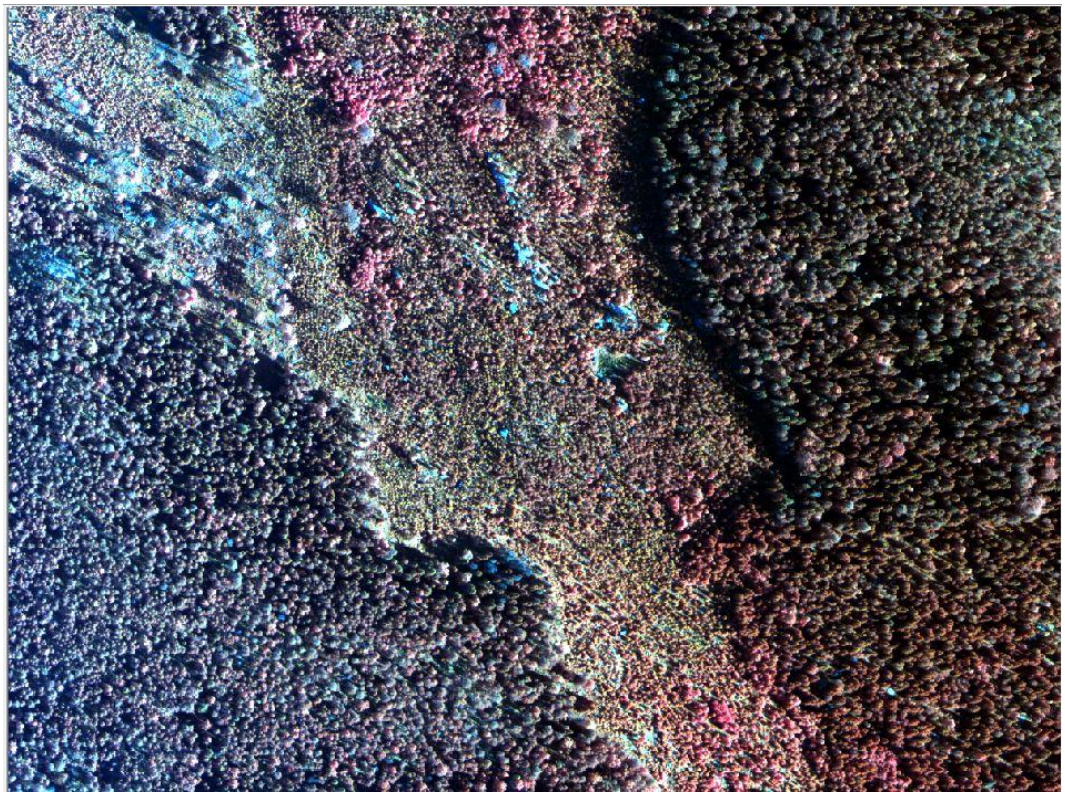


Fig 11, next 25 cm image

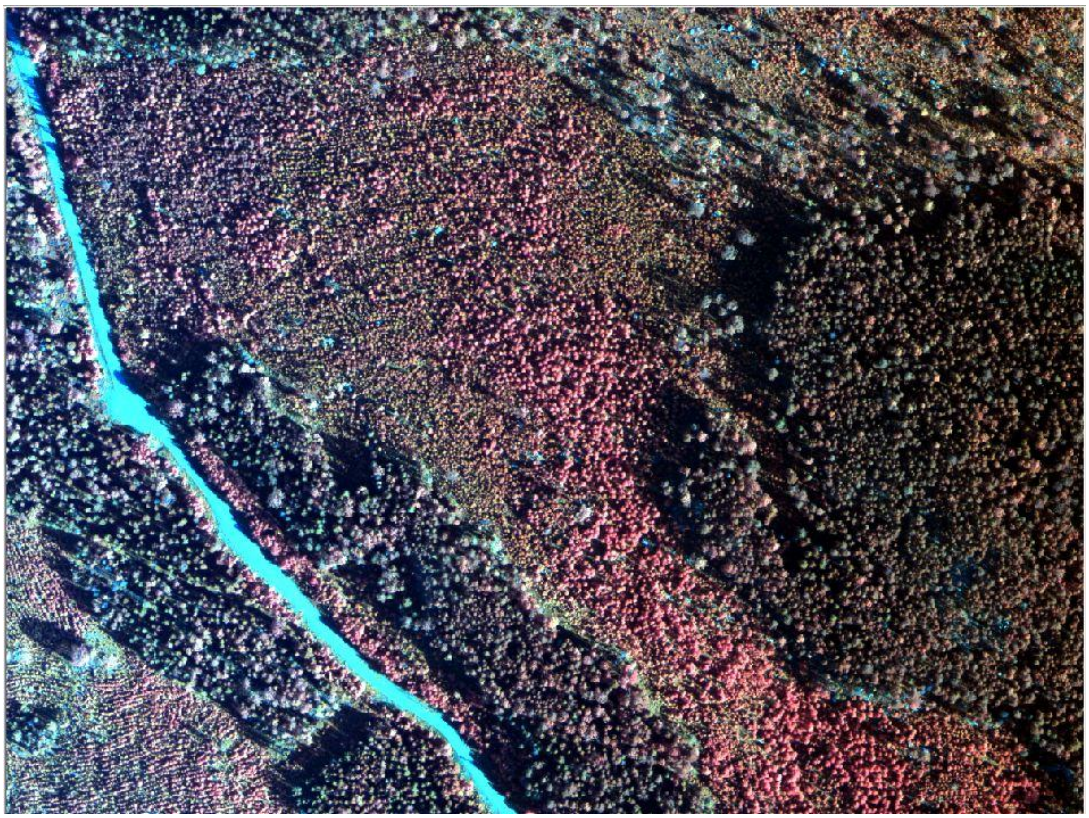


Fig 12, third 25 cm image in the stripe.

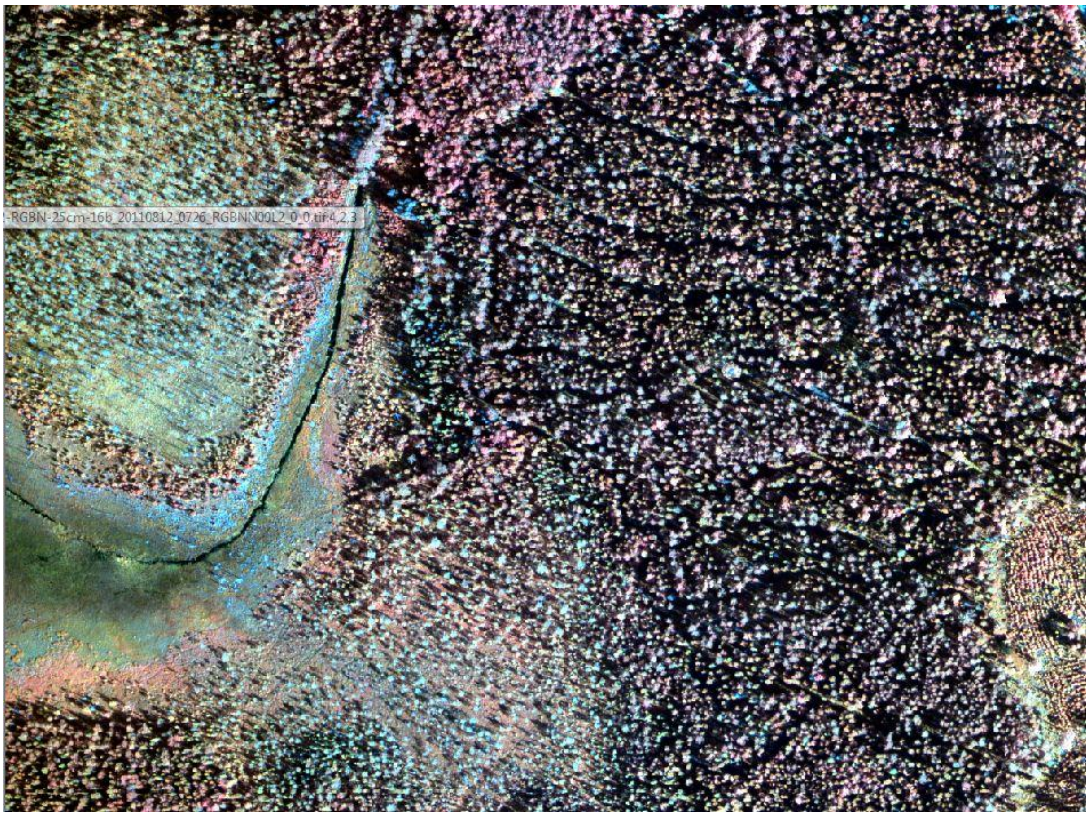


Fig 13, fourth 25 cm image in the stripe

Fig 14, the left most image in the 25 cm stripe.

Analysis of these images give more details. For detection of dead and sick trees it is not sure that we need this high resolution. Leica ADS 80 sensors have a very high quality that distinguishes details well. Still a higher resolution makes it easier to classify young small trees better. This project is mainly aimed at old stands, so 50 cm resolution is 'good enough'.

Frame camera versus push broom

From a partner company in Canada that has done large forest surveys with both push broom and frame cameras, we received image in fig 15:

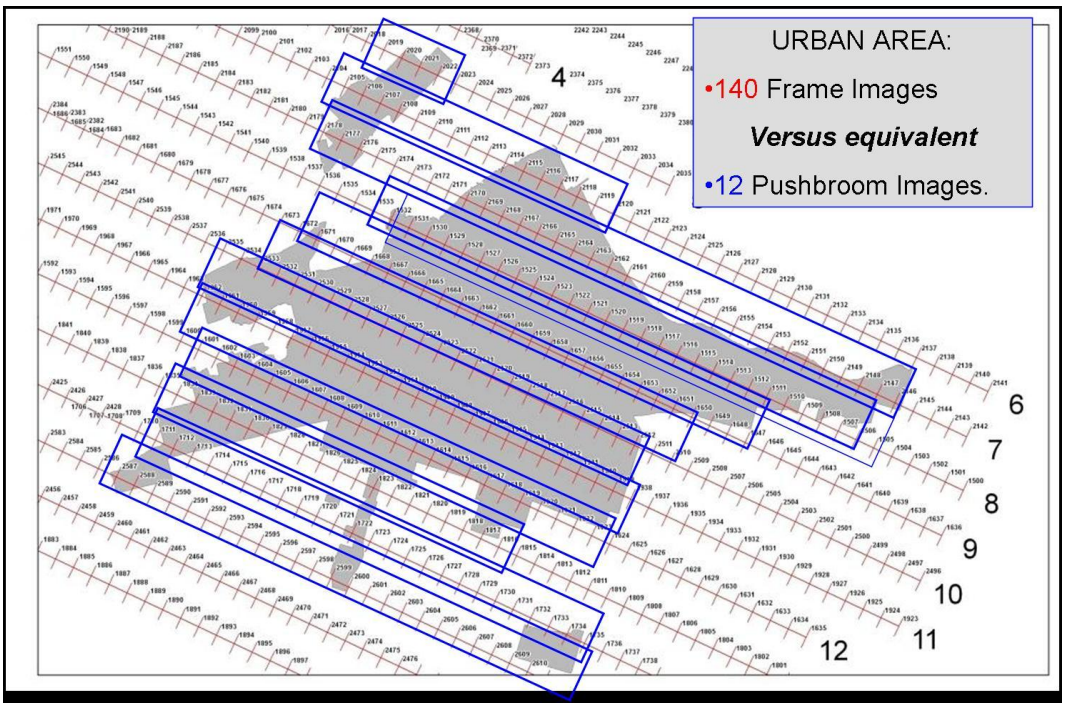


Fig 15: frame versus push broom

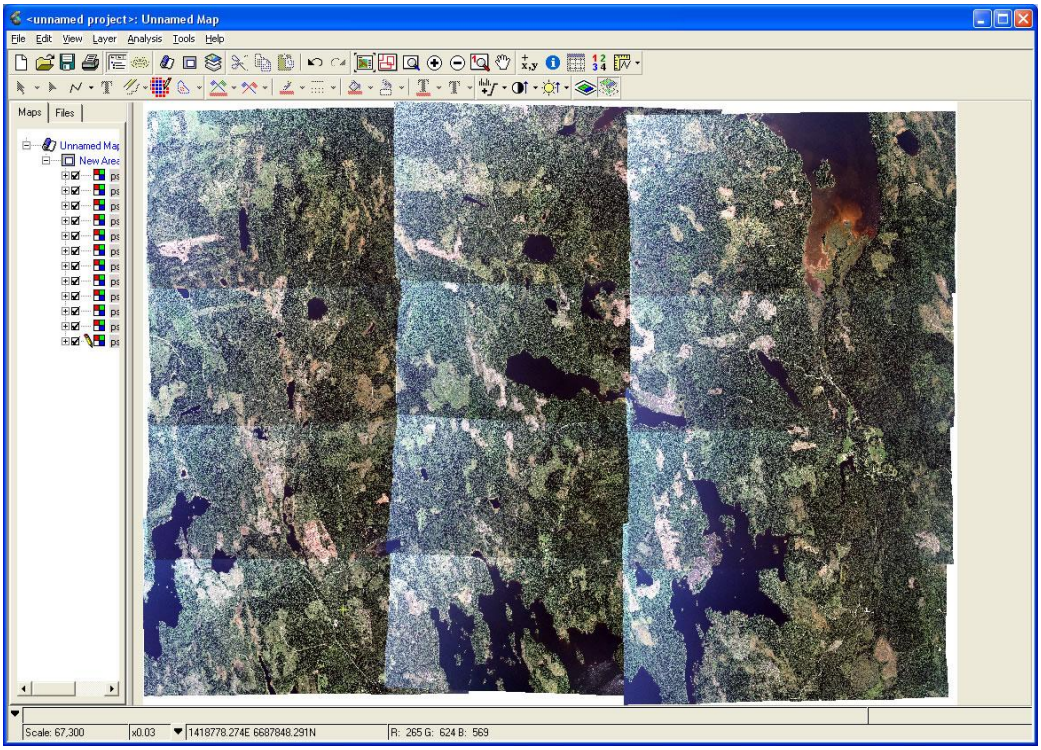


Fig 16: frame camera, images from LM, DMC camera.

Both camera types have their benefits. For forest analysis we need to do far more field samples with frame camera than with a push broom. As seen in fig 15, 12 push broom images is equivalent to 140 frame images. If we need 3 field sites pr frame image, we will need 120 field sites.
If we assume we need 6 field sites pr push broom, we need only 72 field sites. In most cases the difference is bigger.

If we summarize this we find that push broom cameras are more cost effective, are more uniform in quality and give an overall better quality for analysis.

For TerraNor
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Grua April 27, 2012.