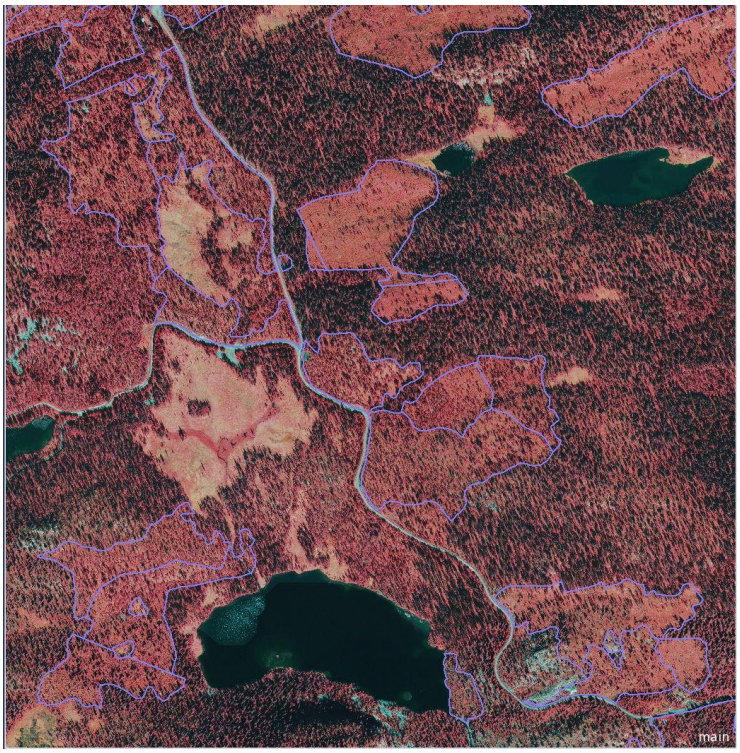
Mapping Plant Field with eCognition Developer



Background:
In the summer of 2019 TerraNor carried out a project of counting plants in all populations in age class 2 in a forest property in Eastern Norway. The result was very good. We will be able to do the same for your forest.

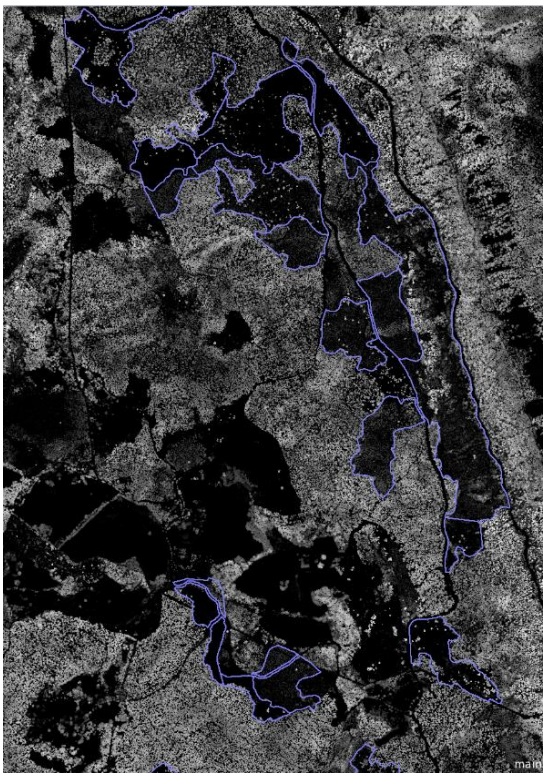
Counting plants in plant fields takes a lot of time. The sources of error are numerous and you cannot manually count all plants in the field. You must rely on counting the number of plants in a laid grid.

With eCognition you can automatically count all plants in the stock based on lidar data. There are two prerequisites: lidar data (laser) must have good density and should be taken early in the summer. The timing depends on how much leaf spread you normally have.

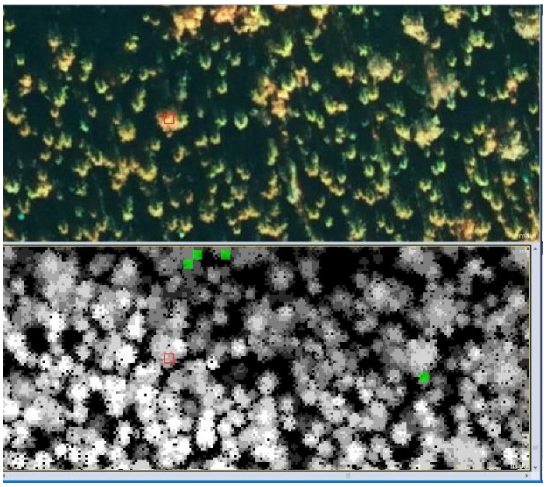
Data input:
We need orthophoto over the area, GIS file map of upper class 2 and raster data with terrain model (DTM) and surface model (DSM) made from lidar / laser data.
In the picture on the left we have an infrared map where the IR channel is placed in the red channel on the computer. In this project we were fortunate that the Mapping Authority had stored the IR channel together with Red Green and Blue.

The IR channel is a prerequisite for classification of forests, see mapping of deciduous further down and Forest mapping single trees.

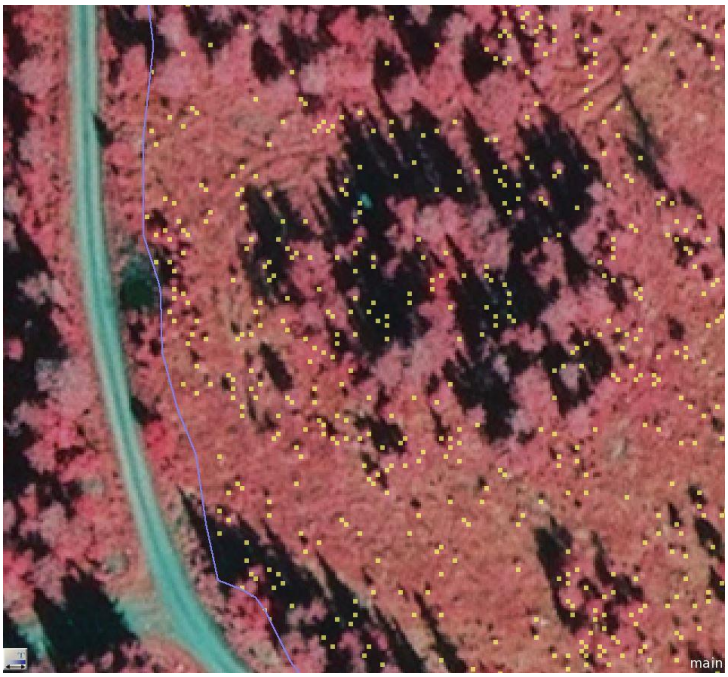
In TerraNor we always use IR-G-B channels to visualize the forest. In analysis we include the red (R) channel.



Lidar:
Lidar mapping of terrain has the advantage that we get a detailed model of the ground (DTM) and of the surface (DSM), ie the crown roof in the forest. Mostly, lidar manages to penetrate the canopy in most places so that DTM becomes accurate.
We can calculate three heights with this simple formula:
nDSM = DSM - DTM.
Note the notation nDSM that stands for Normalized DSM. In the picture on the left we see the tree heights as light areas. Harvested areas are mostly dark and forests of 25m very bright.

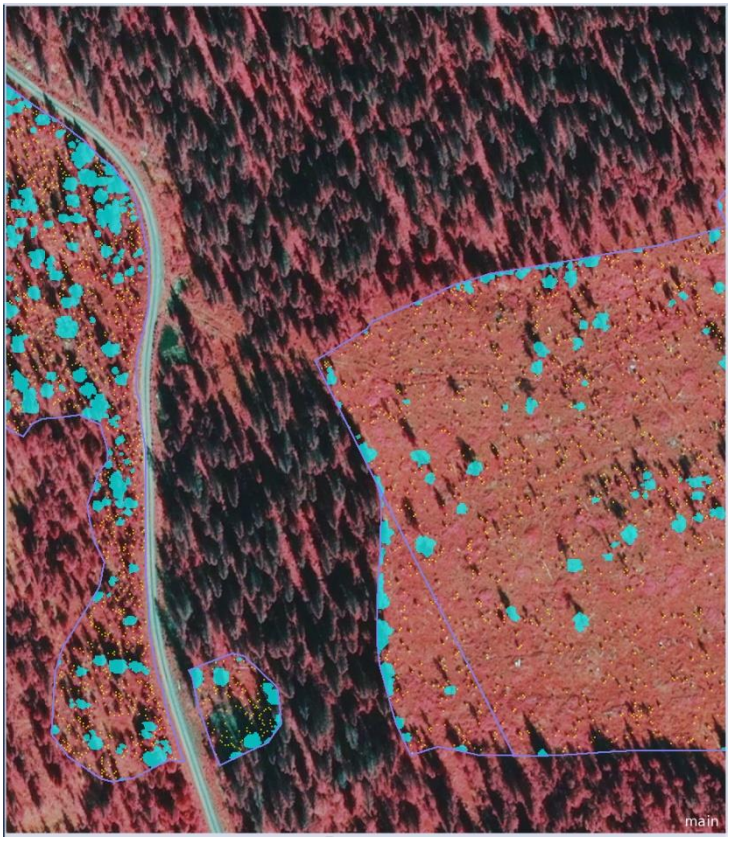


nDSM and IR:
On the left we see nDSM data along with orthophoto. This is in old forest. In young forest it is more difficult to separate individual trees since the trees are denser.



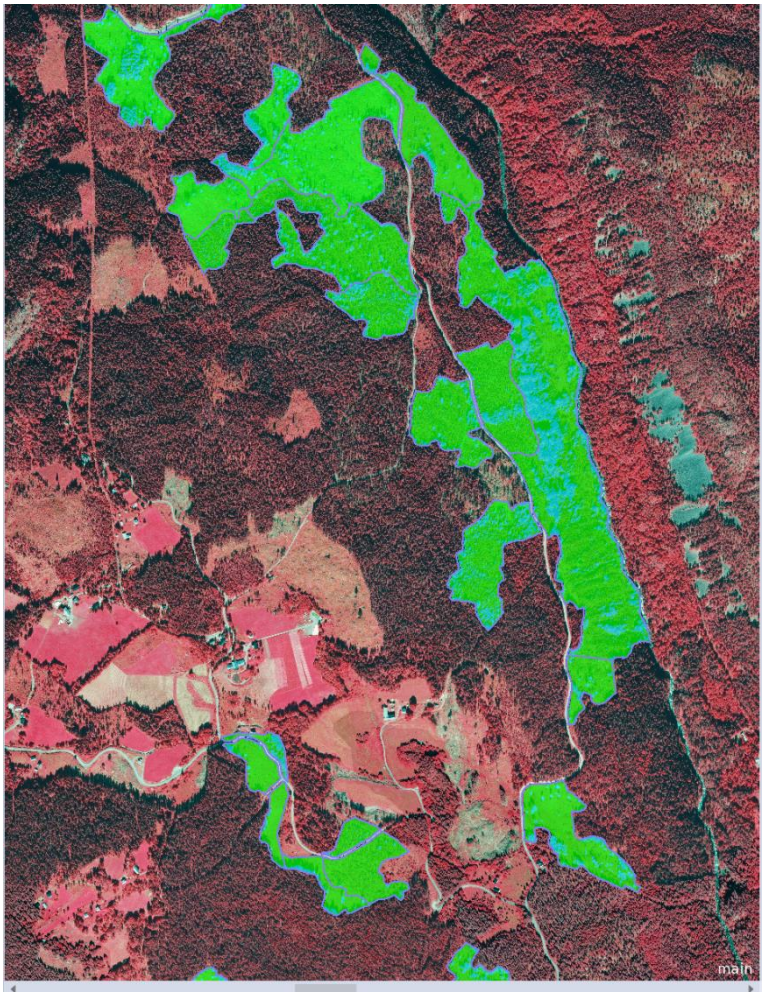
Counting of plants.
Each yellow dot represents a coniferous plant. We tested plants with a height of 0.2m; 0.3m and 0.4m. We were unsure how carefully lidar data managed to separate plants from the surrounding terrain. It turned out that we could get all plants from 0.2m and above.

This means that we can create a map showing plants at different heights in the stock. It can give an indication of how much is planted, normally tallest, and plants that have come naturally.



In the picture on the left we see the plants as yellow dots. The green areas are young forest and seed trees that are left in the plant field.

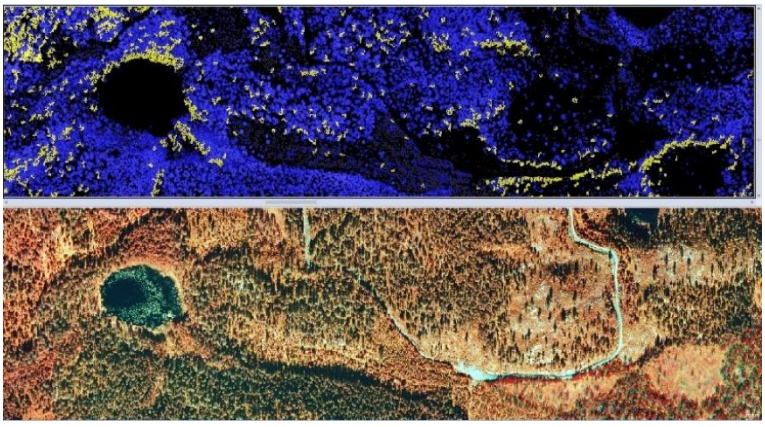
In some plant fields it will show areas of plants that have grown faster than other plants, while in other plant fields it will show the remaining young forest after harvest as well as seed trees.



Infrared (IR) photo is the natural to work with in forest and agriculture. The reason is that high-foliage vegetation reflects IR light very strongly. Together with light in the blue, green and red channels it can be used to determine tree species. See this article from Dr Gidske Andersen's lecture at our user conference 2020 for a professional explanation of IR light from plants.

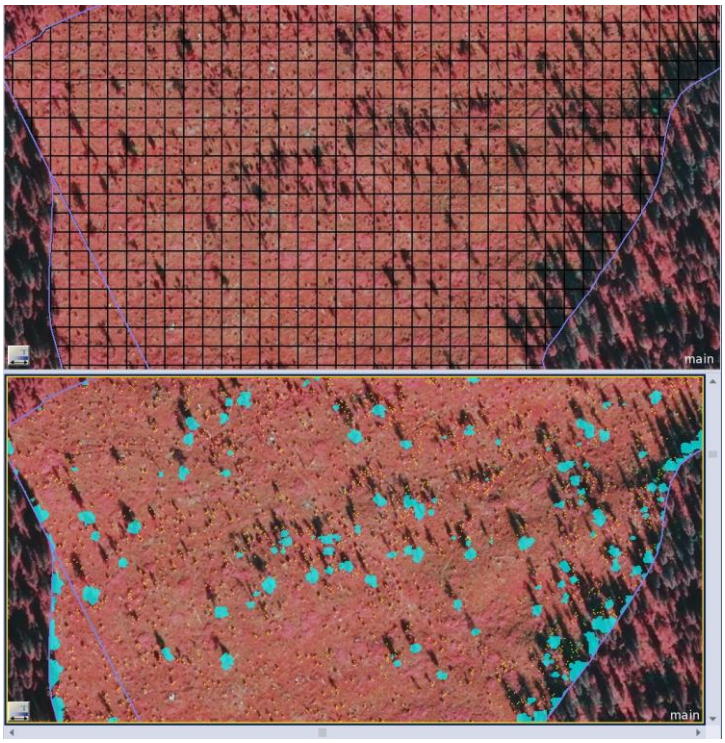
The picture shows roads, harvests (new), buildings, fields (before growth) and buildings like blue or green-like. Adult pine and spruce are more reddish, while deciduous forests and good-growing soils have a strong red colour.

In the picture there is a theme map with harvest class 2 green with young forest in blue / green.

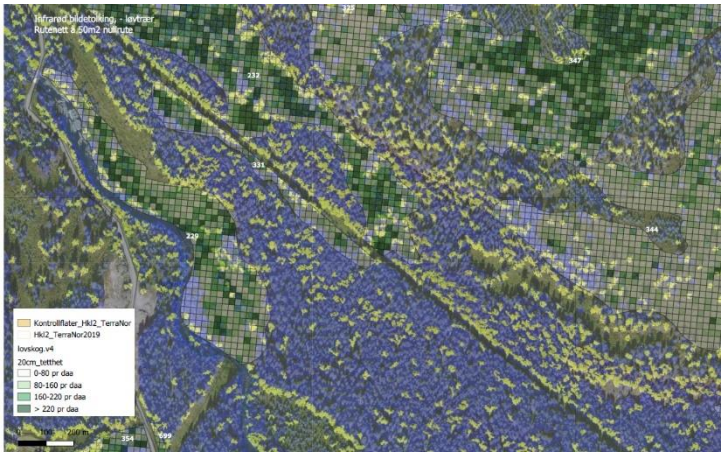


The forest owner asked for a map showing coniferous and deciduous forests. With the IR channel it is easy to separate deciduous from the coniferous. We used nDSM to separate forests above 5m from other vegetation. Blue is coniferous, yellow is deciduous.

What can this be used for:
First and foremost to see the need for clearing and distance control in young forest. In older forests, deciduous forests will show where you can lay the edges of new stocks without having sun burning on the trees at the edges. Deciduous forests are often a sign of edges to marshes, streams and roads.

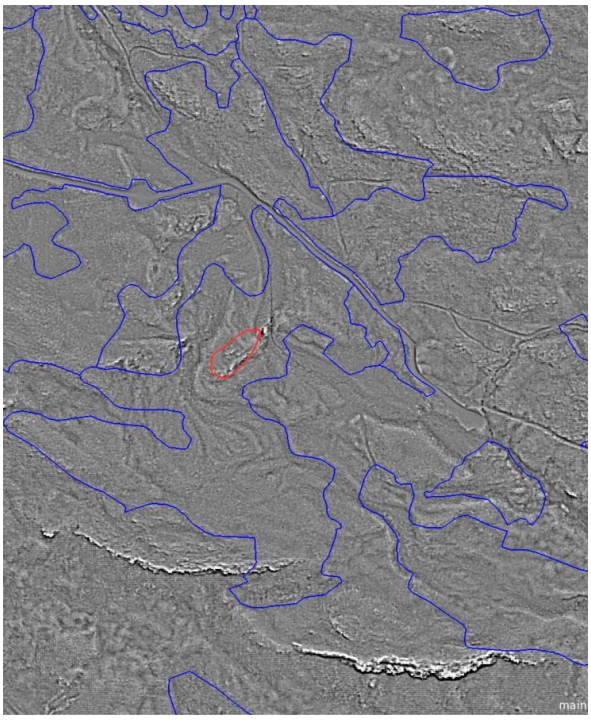


Plant density:
To calculate plant density, we laid out a grid of a given size and let the machine count the number of plants found in each grid.



The forest owner used this to create a density map of the forest. The map showed where additional field preparation and planting were needed.
In older forests, bar and foliage emerged.

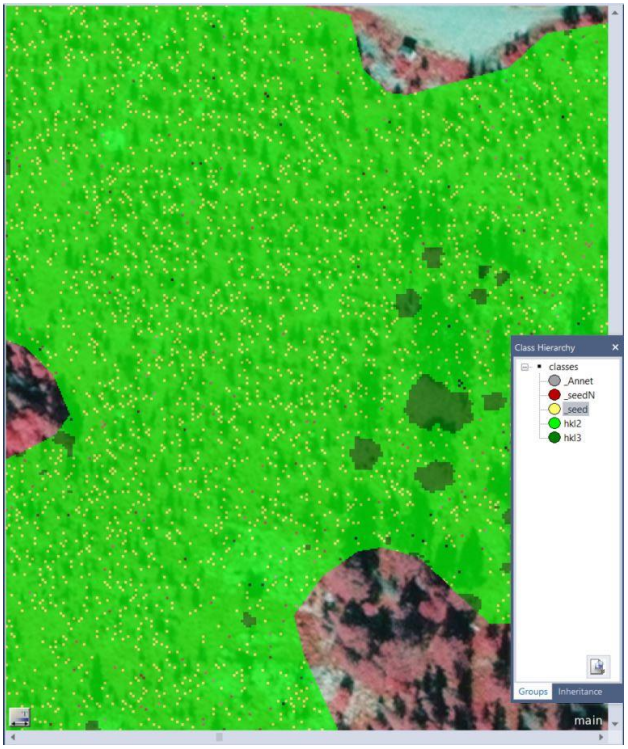
Here you can see articles on complete mapping of single trees in forest with subdivision into spruce, pine, birch, aspen and other tree species.

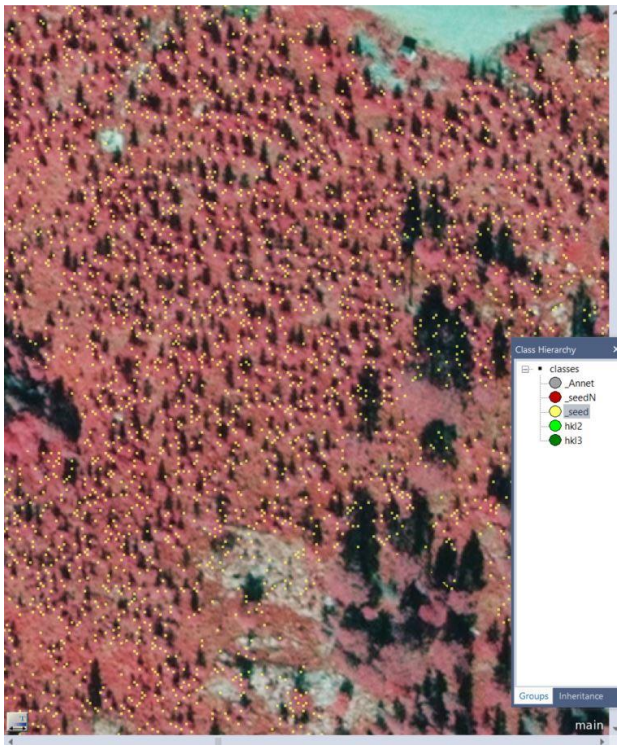


Analysis of lidar data:
The basis for counting plants is height data from lidar / laser. When we have a terrain model data for the property, it is easy to let the machine run multiple analysis on altitude data. The analysis are done in minutes for large areas.

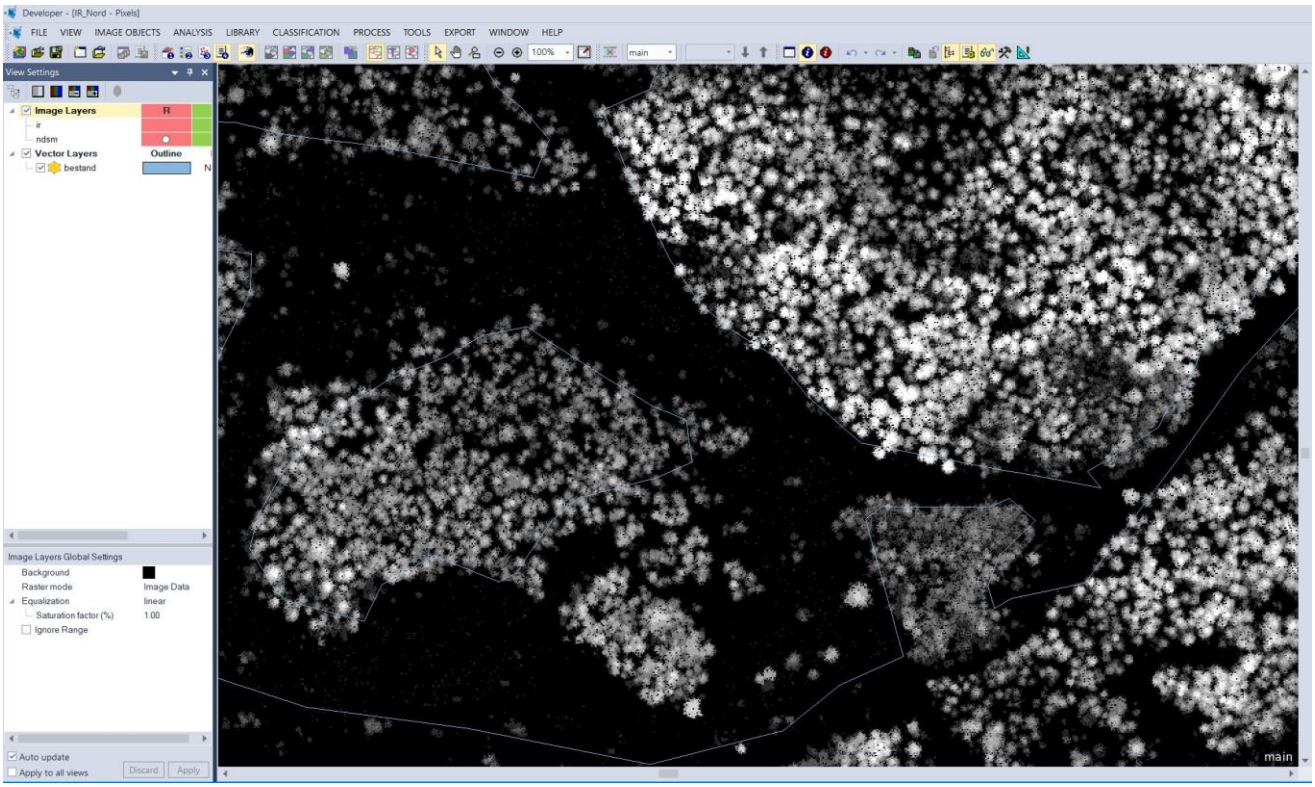
Analysis on the left is called Topographic Position Index - check Wikipedia. In short, pits are dark while tops and edges are bright. The number value goes from -1.0 to +1.0. Flat areas get the value 0.0. This can be used to plan driveways for timber in the terrain.

By combining this map with slope and IR images, one can see where there are moist areas.





Some stocks had extreme density with plants. After planting, natural sowing / planting has multiplied the number of trees.



Can we help you with your forest?
Plant counting is possible in most places in Norway where it has flown lidar after you have planted. We can give you the number of trees and height of the trees in plant fields, young forests and older forests.
You can find Lidar projects in Hoydedata.no. There you can easily check what applies to your own forest. Data is free. You can download them yourself or get help from TerraNor. Many countries have free lidar data available.

Tree species:
In order to distinguish tree species we must include IR images. It is possible to distinguish spruce and pine from leaves with RGB, but accuracy is significantly poorer than if we can use IR + RGB images.

Norwegian Mapping Authority:
Stores and sells only RGB images. Forestry in Norway has free access to aerial photos and orthophotos. Occasionally the mapping also stores the IR images. Then we can make analysis of tree species very easy. TerraNor can assist in obtaining aerial imagery and finding the quality that best suits the project. Many other countries have free access to orthophoto for everyone. We can help you.

Satellite imagery:
It is possible to purchase satellite images through TerraNor. We have suppliers that can deliver images with resolution from 30cm up to 1m. In woods we would recommend 50cm. In addition to better price, it provides better quality of colours in the image with larger pixels. Of course, satellite images have RGB + IR. Some satellites have multiple IR channels.
Check http://terranor.no/SatelliteData.aspx.
Free Copernicus data:
Sentinel 2 has the best resolution with 10m. The data is good for separating spruce stock, pine stock and leaf stock. Single trees are difficult if they are not very large trees. Newly harvested stocks are clearly emerging in Sentinel 2.

The project was implemented with eCognition Developer provided by TerraNor.
Lidar data: raster data from Hoydedata.no, it is possible to use lidar points
Aerial images: IR + RGB from the Mapping Authority.
Stock boundaries: forest owner