Forest Inventory in Finland

Minna Luoto

Euroopan unioni
Euroopan aluekehitysrahasto
Pohjois-Karjala Maakuntaliitto
Metsäkeskus
Luke Luonnonvarakeskus
EFI

Hanketta rahoitetaan osana Euroopan unionin covid-19-pandemian johdosta toteuttamia toimia.

Contents

1 Airborne laser scanning based forest inventory (ALS)

The Finnish Forest Centre (FFC) collects and shares information of Finnish forests. The forest data is collected based on remote sensing technologies, precisely, based on airborne laser scanning (ALS). Finland has been entirely inventoried once. The first inventory round started in 2010 and it lasted 10 years. The second inventory round started 2020 and it will take six years (2020-2025). (Finnish Forest Centre)

FFC carries out laser scanning and aerial photography with National Land Survey of Finland. Finland has been divided in inventory blocks, from which twenty blocks will be inventoried per year. (NLS 2) Simultaneously with the laser scanning, all inventory blocks will be aerial photographed, and field measured. (Finnish Forest Centre)

LiDAR-sensor emits pulses and measures the time required for a reflection to return to its origin. As the sensor position and orientation is known, it is possible to define the 3D position of the target. Laser scanning is currently the only method to get specific data from forests and ground with appropriate costs. (Packalén et al. 2009)

It is important to carry out field measurements at the same time with laser scanning, as well as, to verify that measurements and positioning is done precisely so that statistical modeling is successful. The inventory blocks need to be located in a way that the inventory area is entirely covered both spatially and based on all forest types. In other words, the measurements need to be done in all types of forests appearing in the inventory area, and there need to occur plots throughout the whole inventory area. (Holopainen et al. 2013)

After laser scanning, aerial photography, and field measurements the data will be transferred to remote sensing companies for forest interpretation, which is based on studies carried out at the University of Eastern Finland. The technique was taken into operational use in 2010. (Holopainen et al. 2013, Packalén et al. 2009, Suvanto et al. 2005)

Usually, the forest data collected by FFC is examined as forest stand data. Forest stand is a specific area with similar tree and ground attributes (Figure 1 and figure 2). FFC maintains and updates its forest data with several other data sources, such as growth models, forest use declarations and change detection data. Keeping data up to date enables the use forest data for several years after the LiDAR inventory. (Finnish Forest Centre)

Most of the material collected by the Finnish Forest Centre is openly available in electronic form under the Forest Information Act. Data is available as GIS-data and WMS/WFS. FFC also maintains metsään.fi-webservice where forest owners can get an overview of their own forests, for instance. Additionally, forest service providers can use the service for easy transactions and customer acquisition. The Finnish Forest Centre's material includes information, for example, on forest habitats and tree stand, habitats of special importance, water protection and forest use. (Finnish Forest Centre)

Figure 1. Forest stands and aerial image.

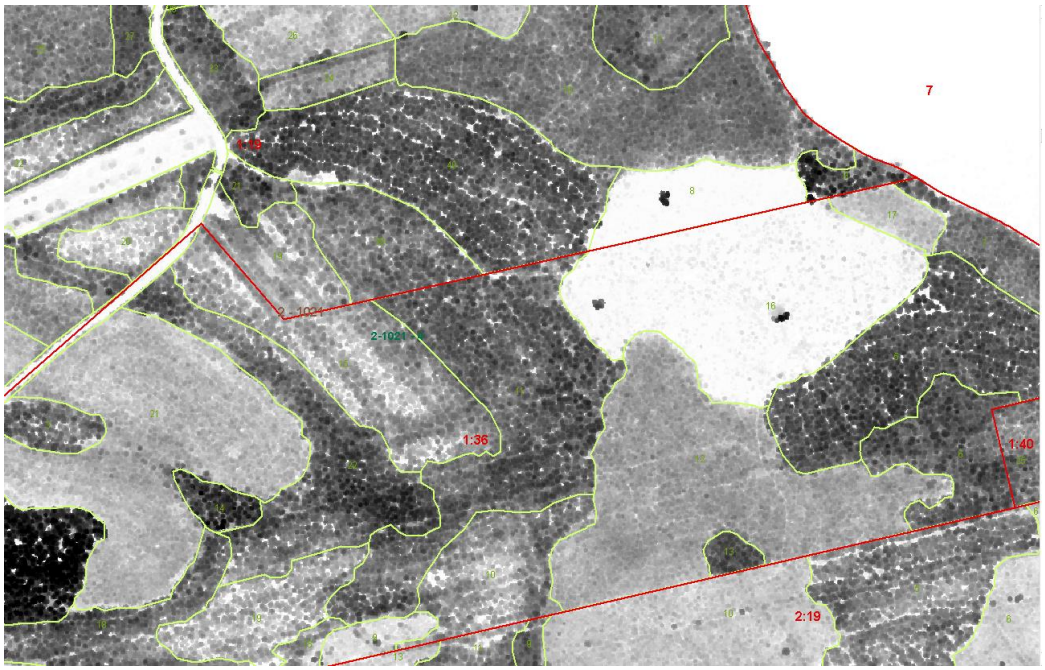

Figure 2. Forest stands and canopy height model.

2 National Forest Inventory (NFI)

Natural Resource Institute Finland (Luke) has been collecting forest data since 1920s with Luke's National Forest Inventory (NFI). The NFI data is collected every 5 to 10 years.

NFI collects data from regional and national forest resources, land use, ownerships, forest health, biodiversity, carbon storage and its changes. (Natural Resource Institute Finland)

NFI is based on statistical sampling where forest field measurements are carried out to cover the whole Finland. The field plots are located in a shape of a regular field plot network. Field measurements are then used to measure the diverse types of habitat, forest structure and, for instance, the indicators of diversity, such as the amount of decaying wood. (Natural Resource Institute Finland)

NFI produces forest information reliably for large areas. A multi-source inventory has been developed to offer more reliable forest information for smaller areas, such as municipalities. This combines satellite imagery and other numerical data with field measurements. (Natural Resource Institute Finland)

NFI data can be used for different purposes, such as political decision making, the assessment of the sustainability of forestry, the assessment of changes in carbon stocks, and as research material (Natural Resource Institute Finland). A greenhouse gas inventory conducted by Luke produces data on greenhouse gas emissions and removals from the Finnish agricultural sector and land use, land use changes, and forestry sector. All the data is produced complying the UNFCCC guidelines, the Kyoto Protocol and the EU's Monitoring Mechanism, as well as the principles of the GHG inventories. (KHKI)

3 Forest inventory based on satellite remote sensing

Satellite remote sensing enables the collection of up-to-date information on the environment over large areas with short intervals. The satellite remote sensing can also provide information from areas that are difficult to reach by other approaches. (NLS 1)

The European Union's Earth observation programme Copernicus has been in operation since 2015. The program is coordinated and managed by the European Commission. Satellite imagery produced by Copernicus is openly available. In addition to satellite imagery, Copernicus collects information also on in-situ systems from land, sea, and air. (Copernicus)

Copernicus offers six different services, which provide information based on processed and analyzed satellite and in-situ data. The information produced by Copernicus can be used in several different sectors, for example agriculture, forestry, and fisheries. Copernicus seeks to support forest management by providing observational data of forests and forest changes, such as illegal loggings or forest fires. (Copernicus)

4 Comparison between different inventory methods

Data produced by different collecting methods offers diverse information for different needs. For example, accurate airborne laser scanning forest data offers up-to-date forest information from a specific given area, as forest stand. NFI data offers information on forest longstanding, and it shows how the forest has changed over time. Satellite data enables getting information in short term about radical changes in a particular area, such as illegal loggings.

Laser scanning forest data is accurate. Mean errors in (RMSE%) average are about 9–11% of total volume (Fig. 3), 7–11% in diameter, 8–11% in basal area, and 3–5% in height. An accurate forest data serves as a reliable basis for efficient forestry planning, and it can be utilized, for example, in the planning of forest management.

More extensive nationwide forest resource data is collected through the national forest inventory. Extensive historical data can be used for example in studies about the effects of forest management and climate change on Finnish forests.

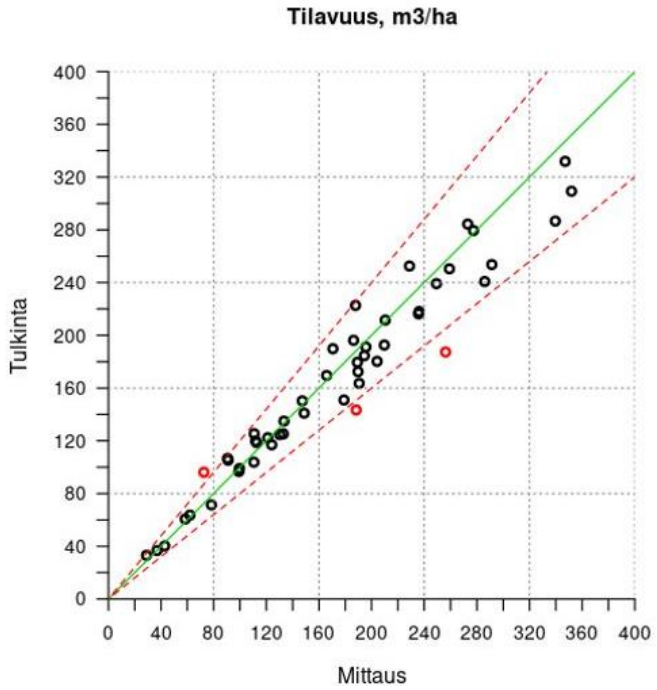

Figure 3. Total volume of stand achieved from interpretation (tulkinta) and field measurement (mittaus) (m3 / ha).

It is important to notice that none of these inventory methods are mutually exclusive, on the contrary. The resolution of satellite images is not sufficient to collect forest data with precise spatial resolution to support forest management. For example, the resolution of the Sentinel-2 satellite is 10 meters, whereas laser scanning data provides 5 observations per square meter. On the other hand, the temporal resolution of laser scanning inventory

is not accurate enough to identify actions that require a rapid response, such as illegal logging. For this reason, the Finnish Forest Center utilizes the change detection based on satellite images produced by Copernicus to locate illegal loggings. Combining forest resource data from different inventories can provide reliable information on current forest resources and their changes. To obtain accurate forest resource data, it is important to utilize all existing inventory methods.

5 References

Holopainen, M., Hyyppä, J. & Vastaranta, M. 2013. Laserkeilaus metsävarojen hallinnassa. Helsingin yliopiston metsätieteiden laitoksen julkaisuja 5: 1–75.

Packalén, P. 2009. Using airborne laser scanning data and digital aerial photographs to estimate growing stock by tree species. Dissertationes Forestales 77. 41 s.

Suvanto, A., Maltamo, M., Packalén, P. & Kangas, J. 2005. Kuviokohtaisten puustotunnusten ennustaminen laserkeilauksella. Metsätieteen aikakauskirja 4/2005: 413–428.

Finnish Forest Centre. Open forest and nature information. Website. Reference date 6.6.2022. https://www.metsakeskus.fi/en/open-forest-and-nature-information

Natural Resource Institute Finland. National Forest Inventory. Website. Reference date 7.6.2022. Valtakunnan metsien inventointi (VMI) - kuvaus | Luonnonvarakeskus (luke.fi)

NLS 1. Satelliittikaukokartoitus. Website. Reference date 3.5.2022. https://www.maanmittauslaitos.fi/tutkimus/teematietoa/satelliittikaukokartoitus

NLS 2. Kansallinen laserkeilaus- ja ilmakuvausohjelma. Website. Reference date 3.5.2022. https://www.maanmittauslaitos.fi/laserkeilaus-ja-ilmakuvaus

Copernicus. Europe's eyes on Earth. Website. Reference date 3.5.2022. https://www.copernicus.eu/fi

KHKI. Kasvihuonekaasuinventaario aikaisempi nimi Kasvihuonekaasujen laskenta ja raportointi. Website. Reference date 5.5.2022. Greenhouse gas inventory | Natural Resources Institute Finland (luke.fi)