Bofori: Increased cross-border business activities and cooperation of SMEs in forest sector

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Forest business activities in cross-border context

Challenges

- Increasing area of young stands without management
- Lack of cooperation between SMEs in Russia and Finland
- Climate change:
    - Forest roads
    - Carbon sequestration
    - Pests and diseases

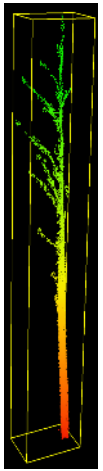
Opportunities

- Work on young stands management for people from abroad
- Knowledge sharing
- Continuous Cover Forestry
- Digitalization

Why do we need digital tree-wise forest management?

- Unmanned forest operations: automatization, robotization
- How we will manage the forests in nearest future? – via digital twins
- Market for ecosystem services (carbon price growth on 300% during last year)
- Continuous cover forestry
- Pests and diseases
- Convert volume to value

6% increase in investment return (McKinsey, 2020)



European Carbon Credit Market

Key forestry operations requiring quality control

Soil preparation

Planting young trees

Taking care on young trees

Is it possible to automate work quality control with drones, laser scanning, artificial intelligence?

Kuvat: Rekomendatsii po samokontrolju pri osuštšestvlenii lesohozjaistvennoi dejatelnosti. Saksa, Timo; Pölönen, Vesa; Haataja, Lauri; Sipilä, Kyösti (2022)
http://urn.fi/URN:NBN:fi-fe2022020818174

Novel tools to collect data for tree-wise inventory

Photogrammetry

Laser scanning

Laser scanner test in December 2020





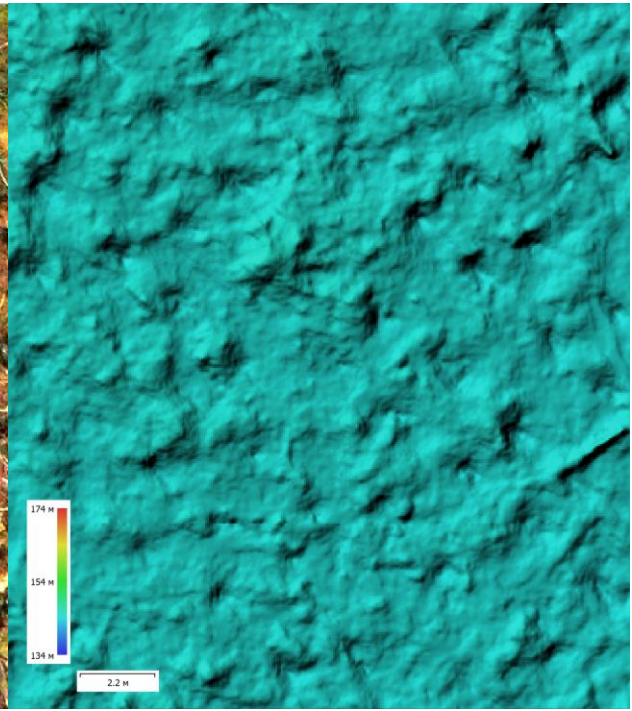
Data collection: night, cold, weather

Quality control on soil preparation

Orthophoto 20 ha

3D-model from point cloud

Orthophoto 2 cm/pix



Surface model 5 cm/pix

- Data collection: 20 hectares with a 15-minute drone flight, flight height 80 m
- Data processing: 20 min, deep learning (artificial intelligence, deep learning, CNN)
- Outputs: number of seedling sites (12986 pcs, accuracy 98%), site sizes (height, length, width)

Quality control on planting young trees

Is it possible to increase the resolution of the images to 5 mm per pixel?

1. New 61 megapixel camera: Sony A7R IV

2. Two-stage flight (altitude 120 meters to detect obstacles and then altitude 15 meters)

1 stage: height 120 m to produce an obstacle map

2 stage: "smart" drone flight at a height of 5 meters

Quality control on planting young trees

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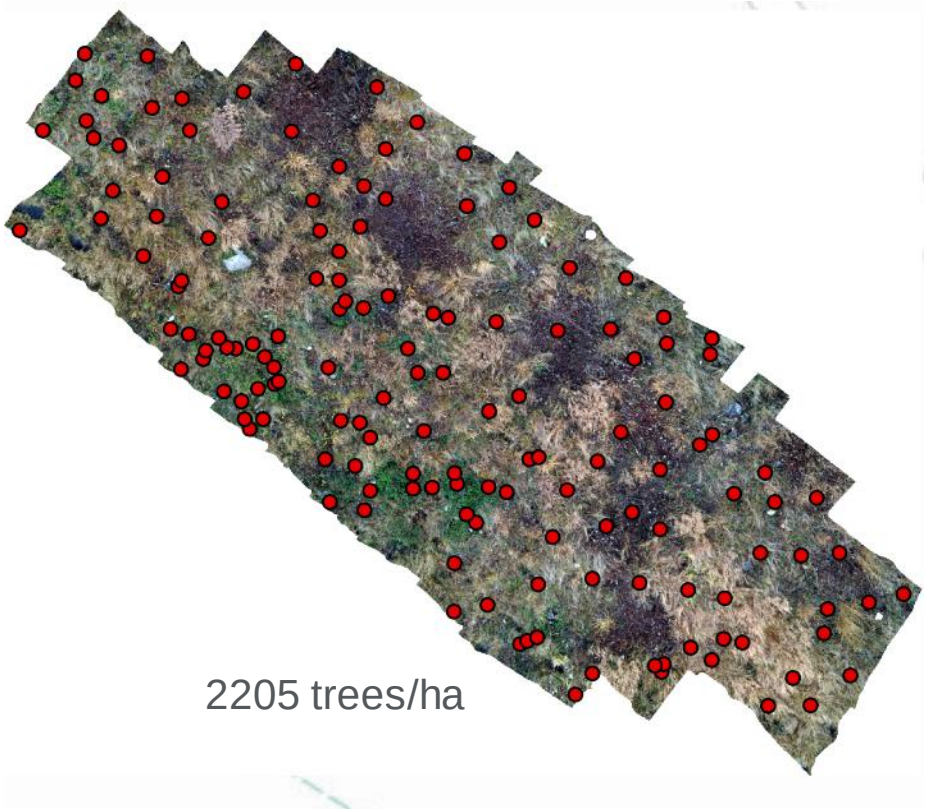
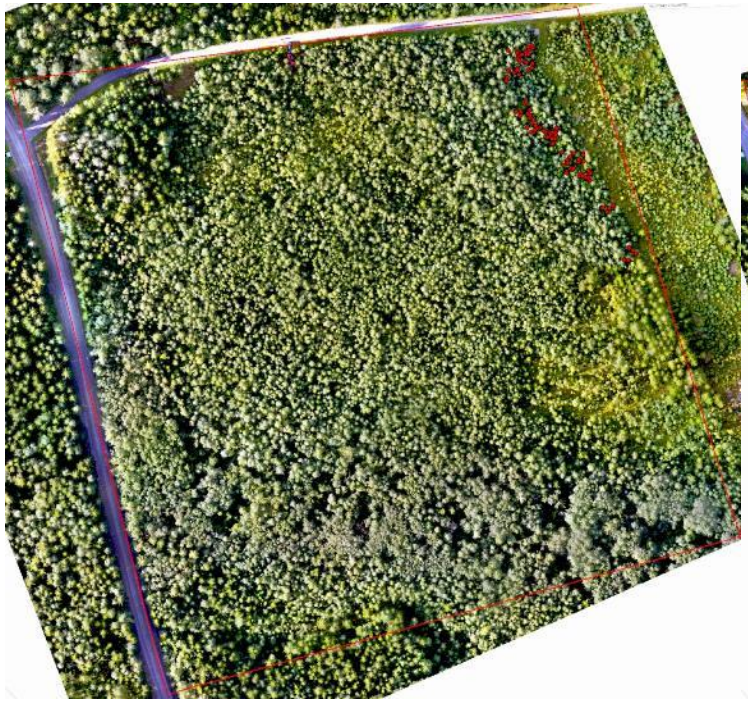
Quality control on planting young trees



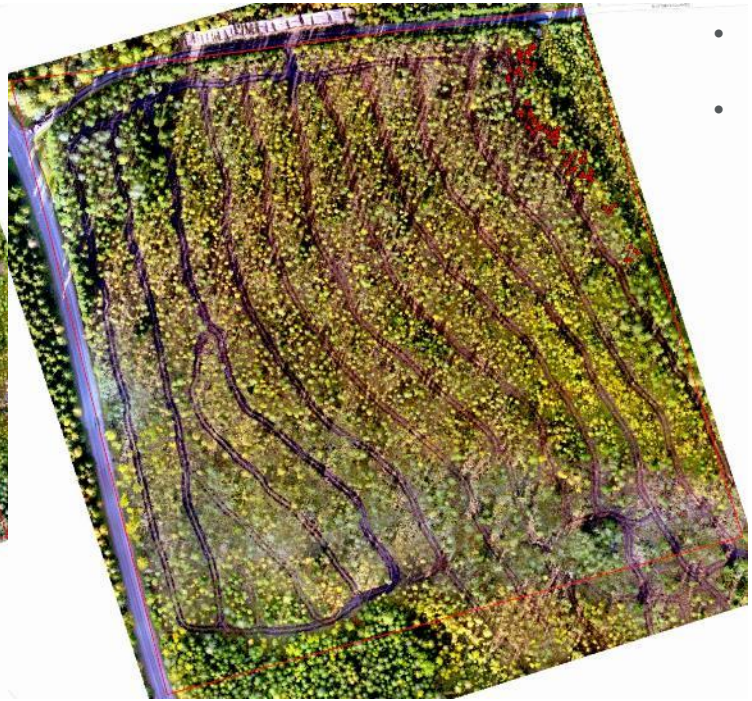
- 36 experimental plots were established and the position of 1300 seedlings was measured with an accuracy of 1 cm using high-precision GNSS
- Seedling identification accuracy was 96%
- The method tends to underestimate the number of seedlings
- The accuracy of the height measurement was 2 cm
- The best time for data collection is early spring or late fall to minimize false identifications caused by turf

Quality control on cleaning young stands

Collection of energy wood in harvester thinning



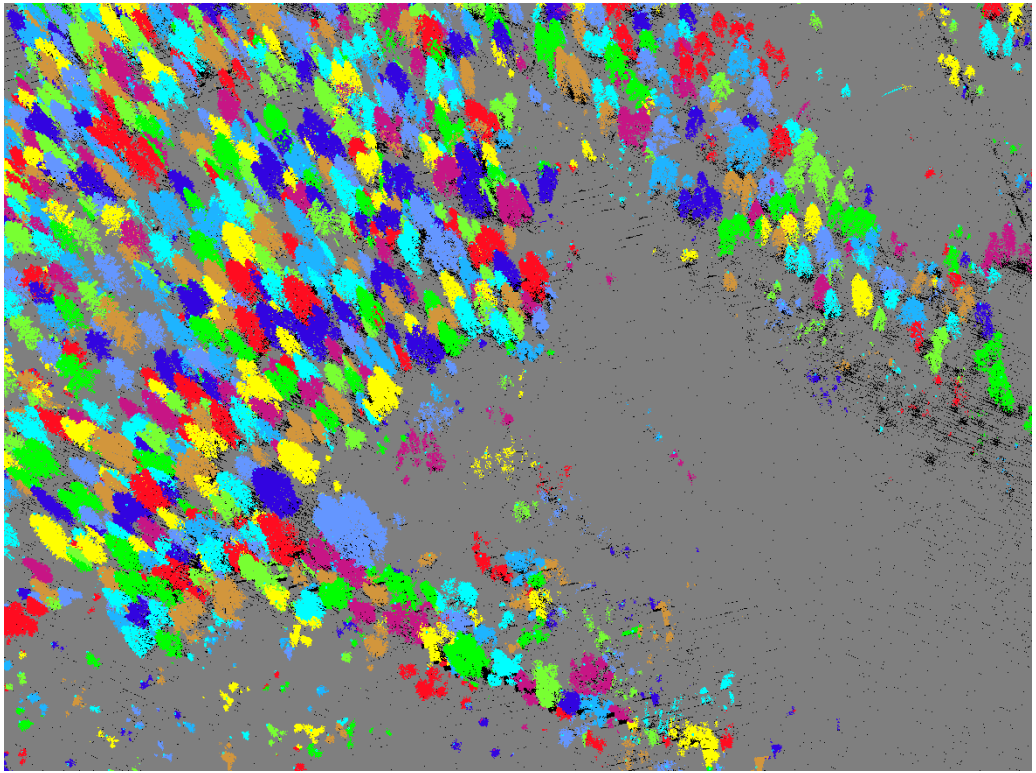
17.08.2020



18.09.2020

- Single tree detection rate by photogrammetry 92%
- Single tree detection rate from laser scanning 98%

Forest inventory from mobile laser scanning

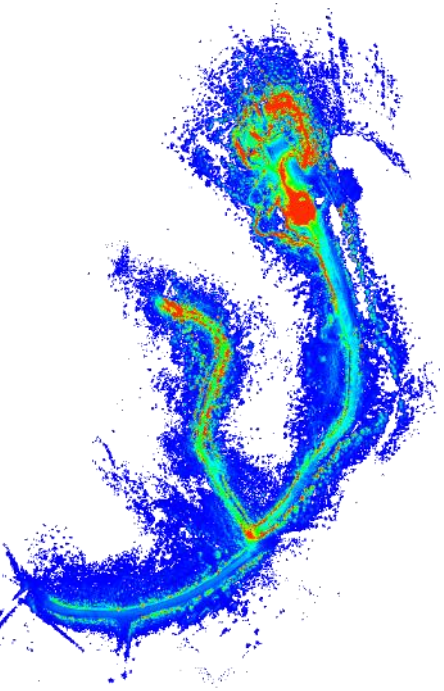


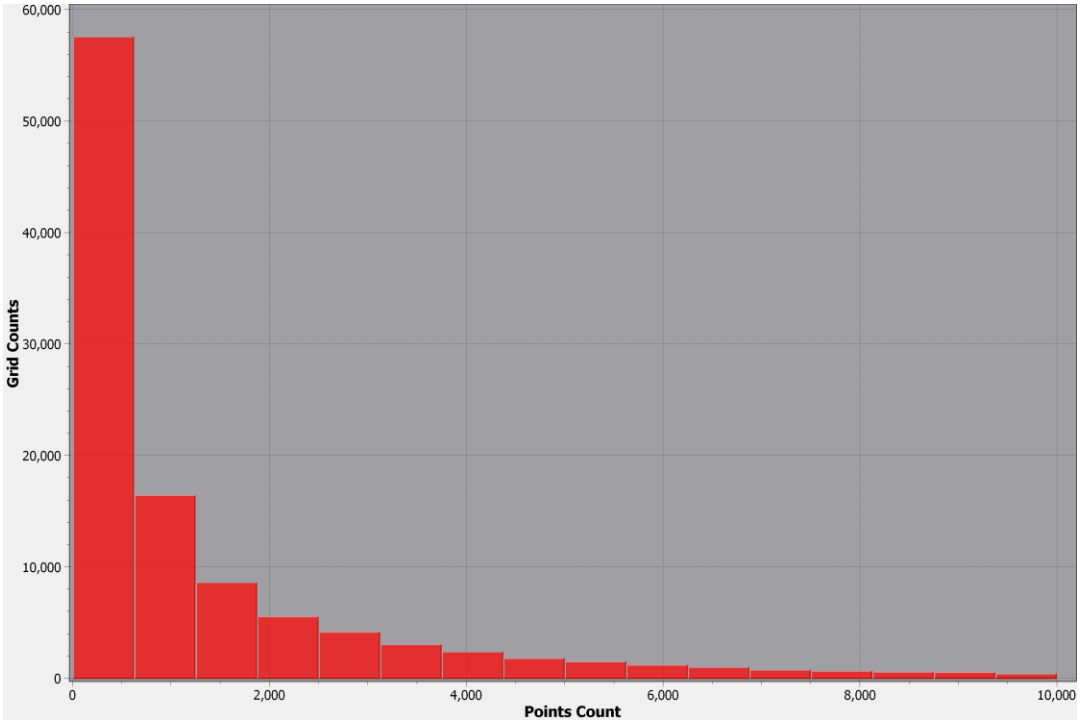
- Trees (smallest 3,5 m): 357 389
- Crowns
- Tree height
- Crown diameter
- Crown area

TreeID,TreeLocationX,TreeLocationY,TreeHeight,CrownDiameter,CrownArea,CrownVolume,PreviousID
1,650108.520,6964507.489,23.643,4.835,18.359,124.169,1
2,650079.407,6964543.813,23.898,7.563,44.924,413.306,22
3,650103.848,6964521.666,23.250,5.921,27.532,120.543,3
4,650113.066,6964528.864,22.644,5.299,22.057,131.928,5
5,650107.614,6964518.643,21.572,4.132,13.411,77.037,13
6,650110.379,6964515.110,22.150,5.889,27.241,170.500,8
7,650105.800,6964514.886,19.075,3.347,8.796,21.773,17

Terrestrial laser scanning from quad bike

Number of points

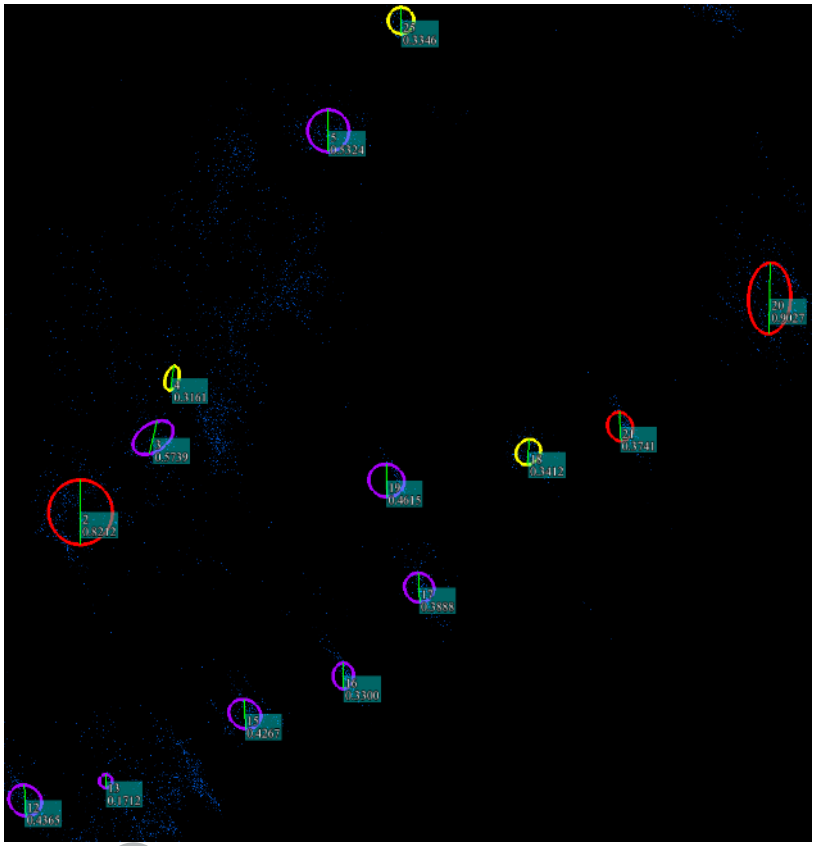


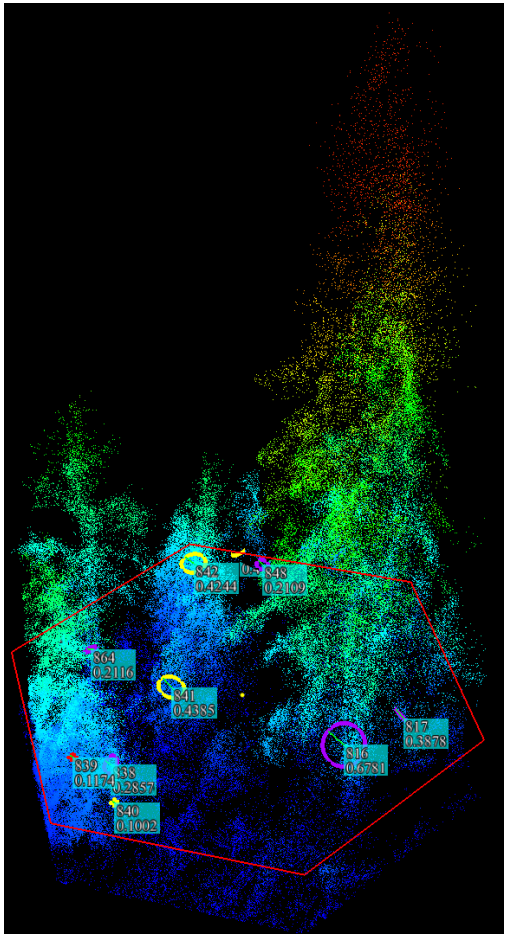


- 500 – 10 000 points/m2
- Slower the movement higher point density
- On average 2 times higher then aerial
- Proper angles for diameter measurements

Next step to increase the coverage:

Results of terrestrial point cloud processing

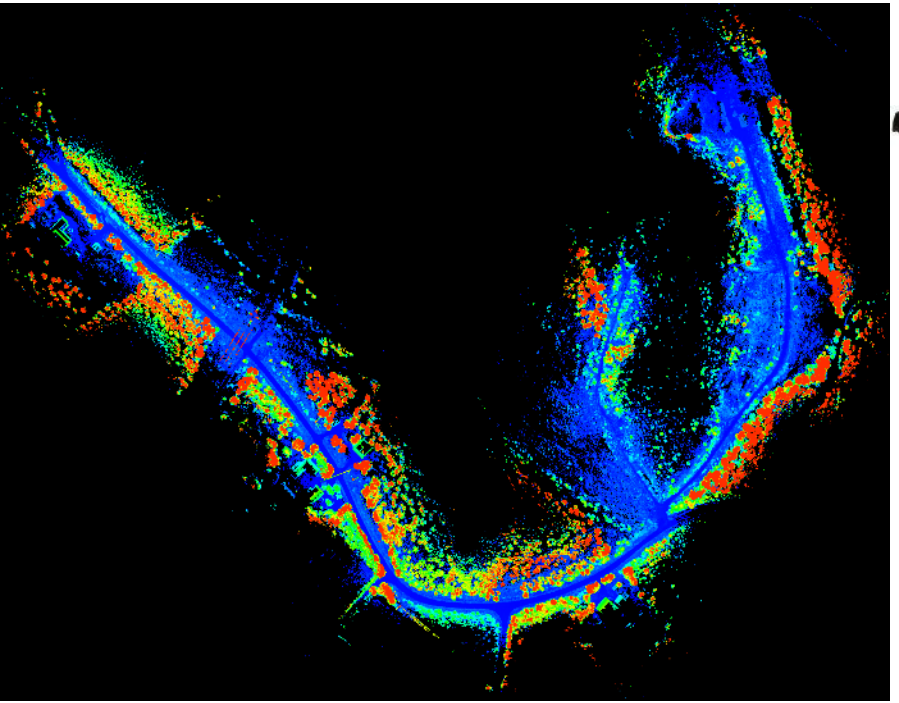




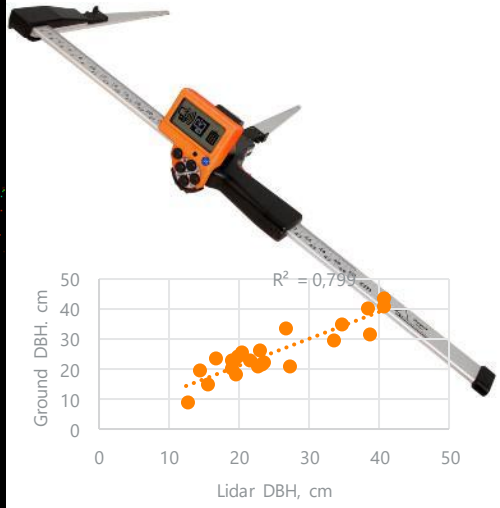
- Trees (smallest 1 m): 4169
- Crowns
- Tree height
- Crown diameter
- Crown area
- **Tree diameter**

To measure the same amount of trees manually using traditional methods it will take 138 man hours (17 days), we spend 0.5 hour to drive on quad bike

Accuracy assessment of the diameter estimation from terrestrial laser scanning

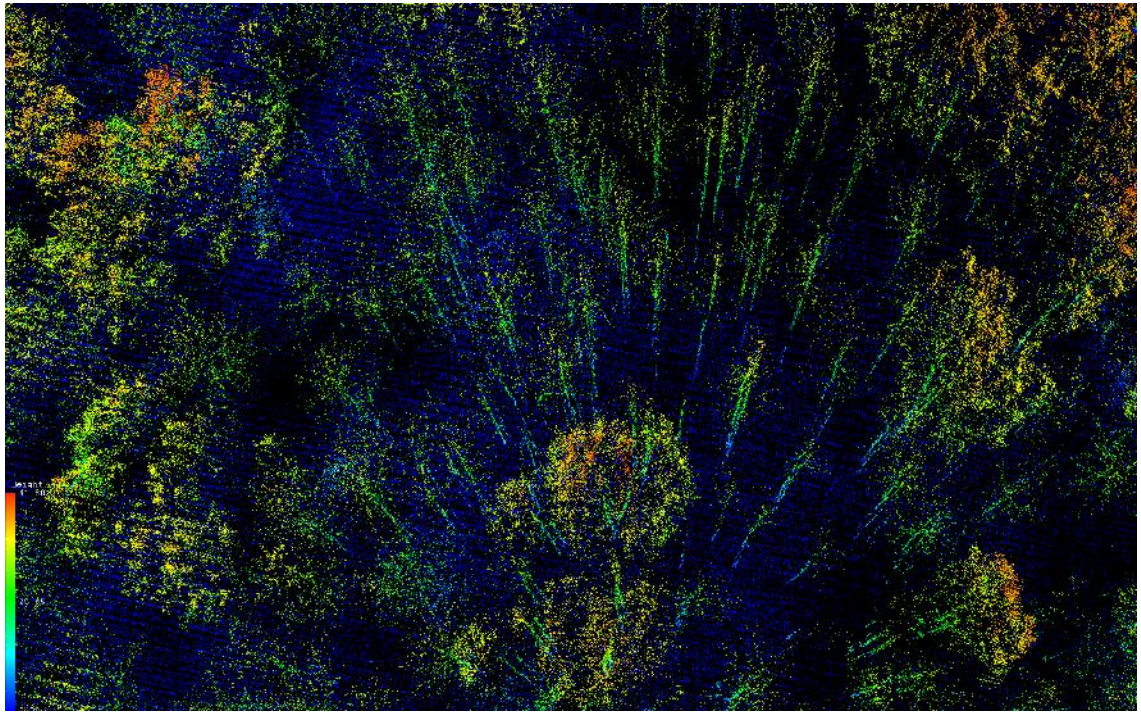


162 trees, diameter from 4 cm to 45 cm, 5 tree species



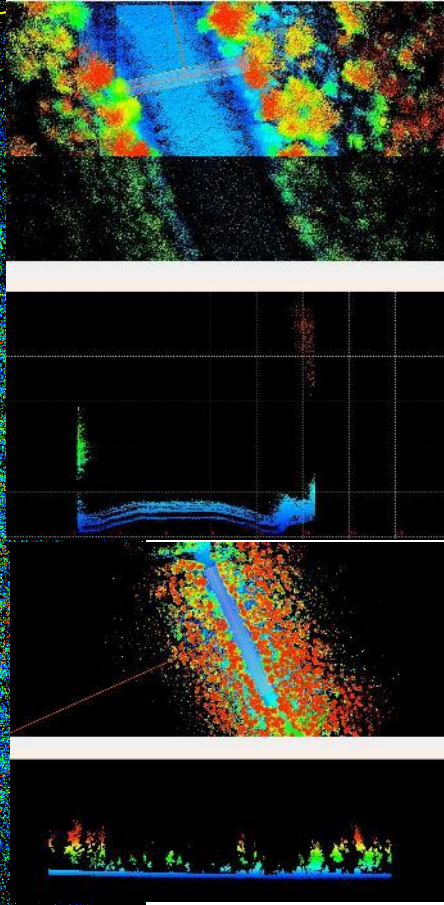
- Terrestrial laser scanning is reducing breast height diameter on 1.2 см.
- RMSE 3.94
- The error is increasing w ith the size of the tree stem and could be reduced by modelling

New approach: complete tree-wise forest inventory from air



- Mapping every single tree
- Measure height
- Measure DBH for at least 25% of the trees
- Recognize tree species
- Estimate DBH for the trees with low points at 1.3 m

Digital twin of forest road



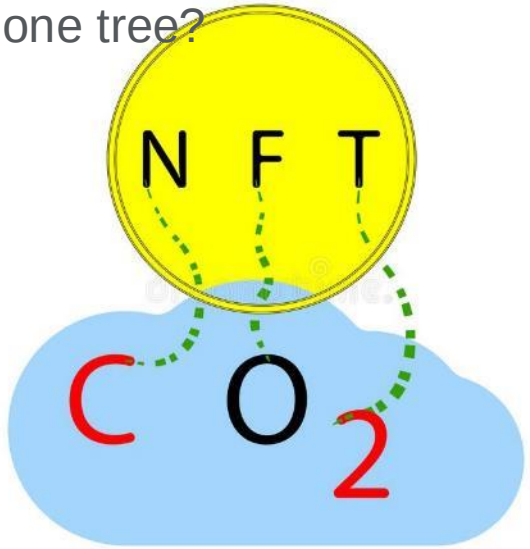

Digital actual carbon accumulation inventory using 2 drone flights per year

Tree-wise carbon accumulation

Baseline:
- 3D copy of the area (suitable for VR/AR)
- Trees: exact coordinates, height, species, diameter, volume, amount of carbon
- Total amount of carbon at the base line

Actual carbon accumulation:
- The same data as baseline
- + height increment, + diameter increment, -tree number loss
- Total amount of accumulated carbon during 5 month, kg

How to sell annual carbon sequestration function of one tree?



A non-fungible token (NFT) is **a financial security consisting of digital data stored in a blockchain, a form of distributed ledger**.

How the tree-wise data will be utilized in nearest future?

- Unmanned forest operations (harvesting, thinning, planting)
- Smart tree-wise forest management planning
- Sales of ecosystem functions as single tree NFT (for ex. carbon accumulation, birch sap, landscape attractiveness, stress removal)
- VR in thinning operations
- GNSS in planting tubes and thinning saws

Source: https://milremrobotics.com/

Source: https://forestry.ubc.ca/research/how-virtual-reality-can-aid-forest-operations/

Future outlook

- Training materials developed for Russian Karelia could be used in Ukraine
- Capitalization of projects results and future development within Aurora and NPP
    - Preparing application for 28.03.2023