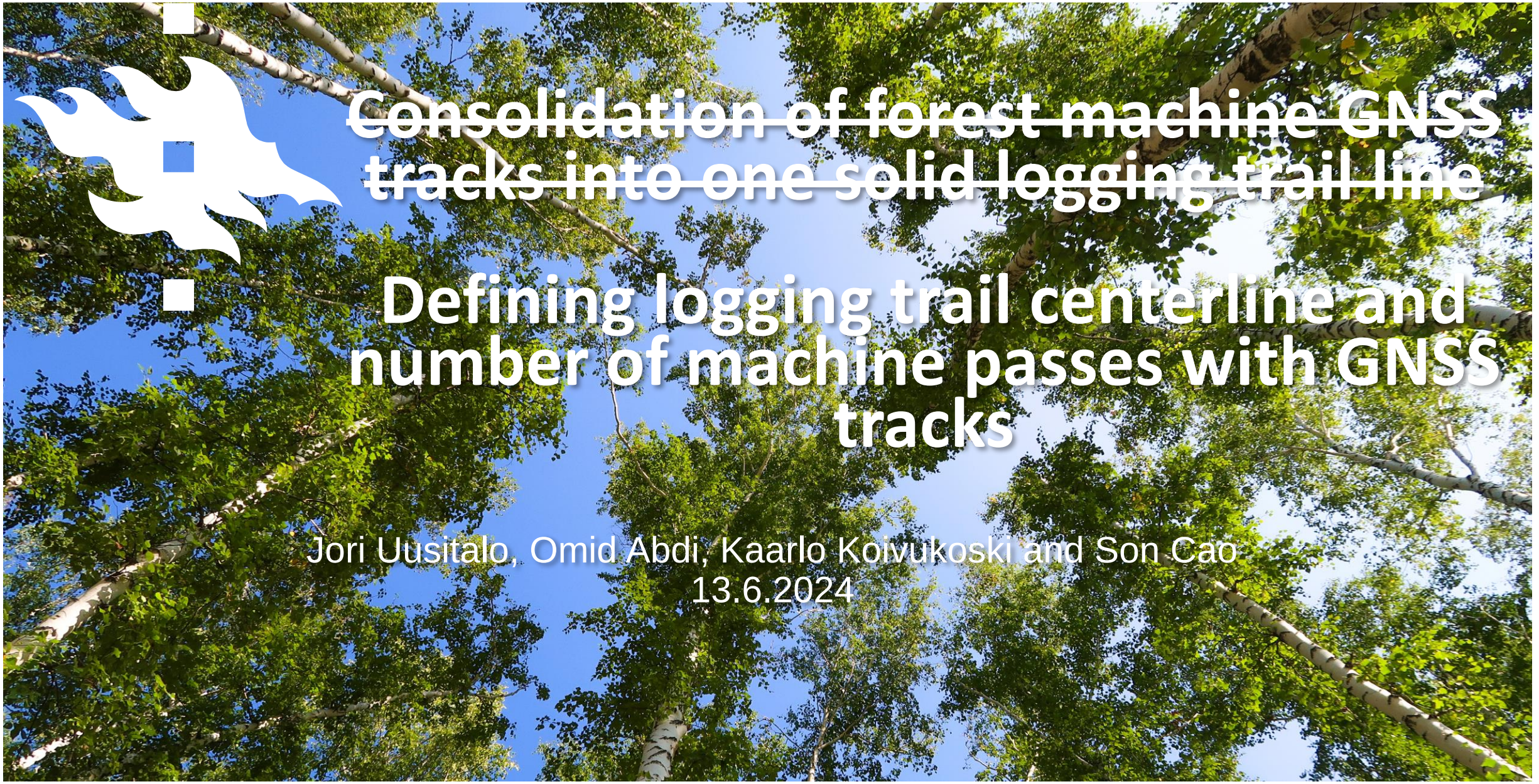


~~Consolidation of forest machine GNSS tracks into one solid logging trail line~~

Defining logging trail centerline and number of machine passes with GNSS tracks

Jori Uusitalo, Omid Abdi, Kaarlo Koivukoski and Son Cao

13.6.2024

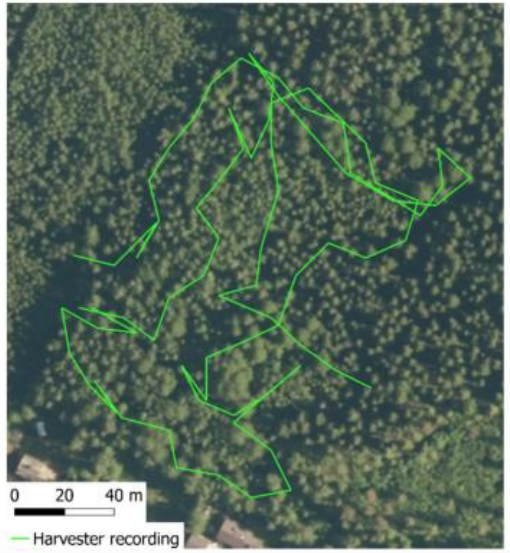
FOREST MACHINE GNSS DATA

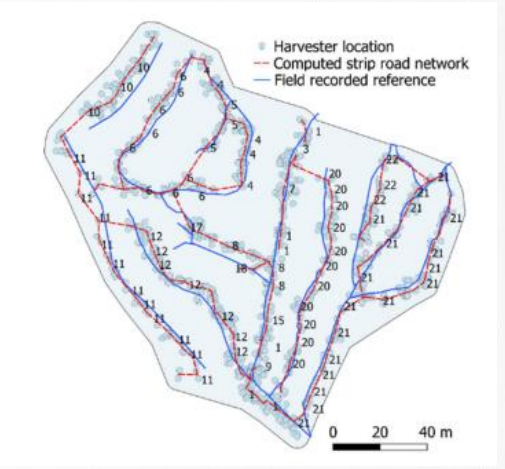
- Forest companies in Finland have already many years automatically collected GNSS tracks from harvester and more frequently from forwarders also
- The data is difficult to utilise since the data is very “fuzzy”

Source: Ovaskainen & Riekki 2022

FOREST MACHINE GNSS DATA

- Today forest machines employ almost 100% GNSS technology without RTK corrections
- Single points based on GNSS have an error of 2-10 m and polylines based on those points can not be directly utilised
- Recently, Ovaskainen & Riekki (2022) have introduced a method to draw logging trail network based on hpr-data (averaging locations of the base machine)





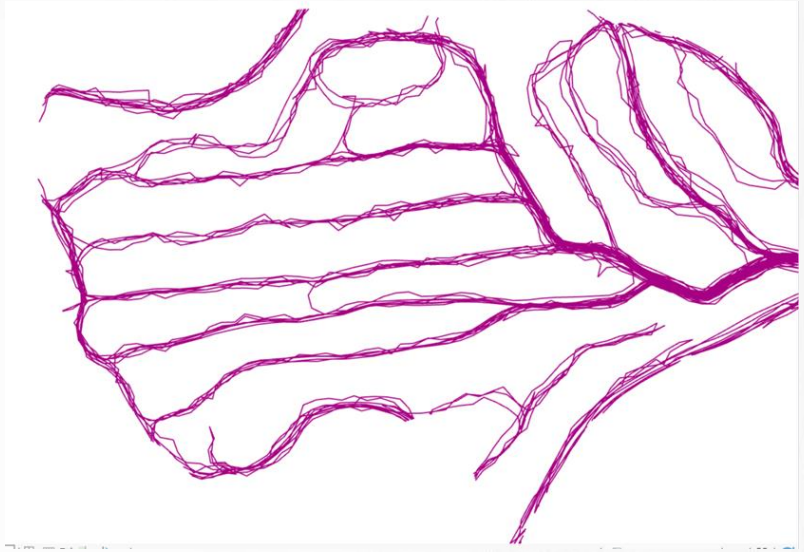
Source: Ovaskainen & Riekki 2022

AIM OF THE STUDY

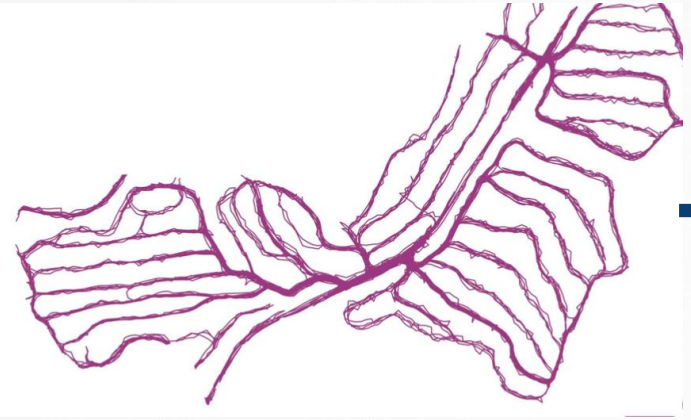
- Our aim was to develop a methodology that
  - utilize GNSS tracks both from harvester and forwarder
  - calculate logging trail center line and
  - calculate number of machine passes within each logging trail segment

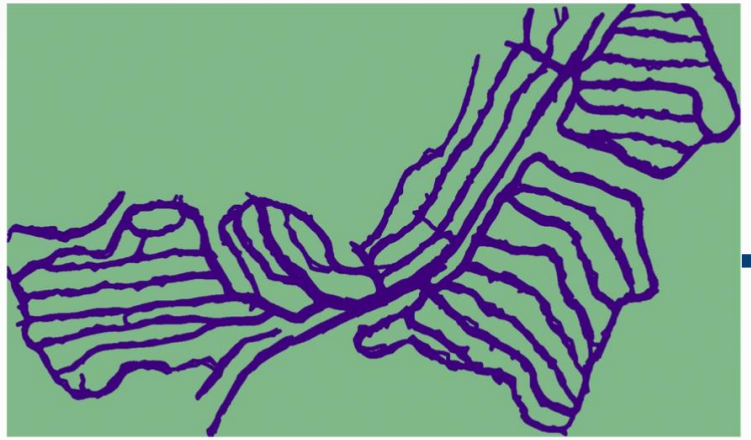
METHODOLOGY

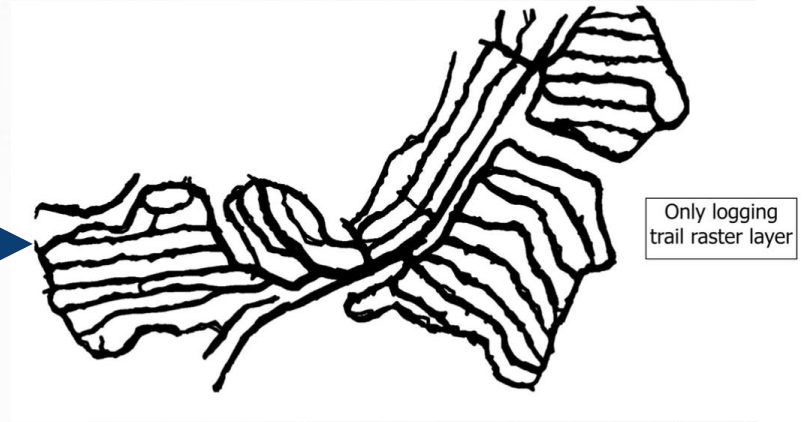
- The GNSS receiver produce first single points
- Next, a conversion program is needed to convert GNSS points to polylines (tracks)
- We received the original test files from a forest company that collects GNSS tracks from all their operations in vector format
- We have employed ArcGIS –procedures and linked them together with ArcGIS ModelBuilder -tool



PROCEDURES TO DEFINE CENTERLINE





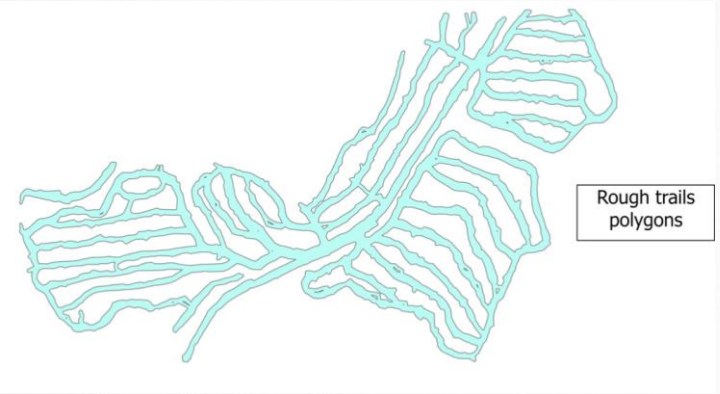


Kernel density-procedure

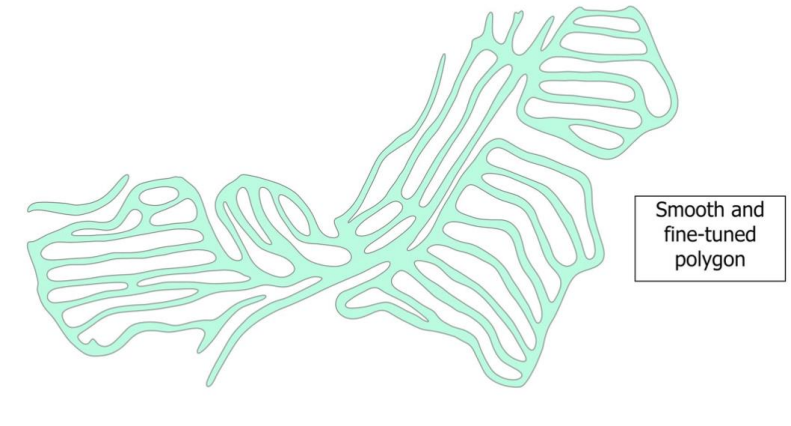
- Overlay density-function over the continuous surface based on observations
- Will place middle-point to the point with highest number of observations

Reclassify into binary value (trail/non trail)

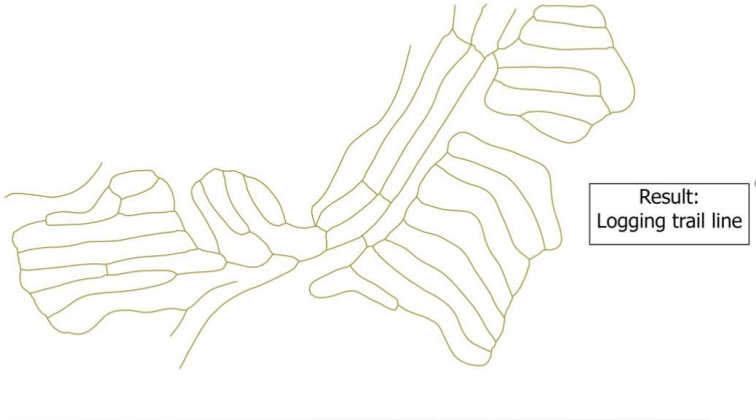
PROCEDURES TO DEFINE CENTERLINE (CONTINUE)



Convert raster to polygon



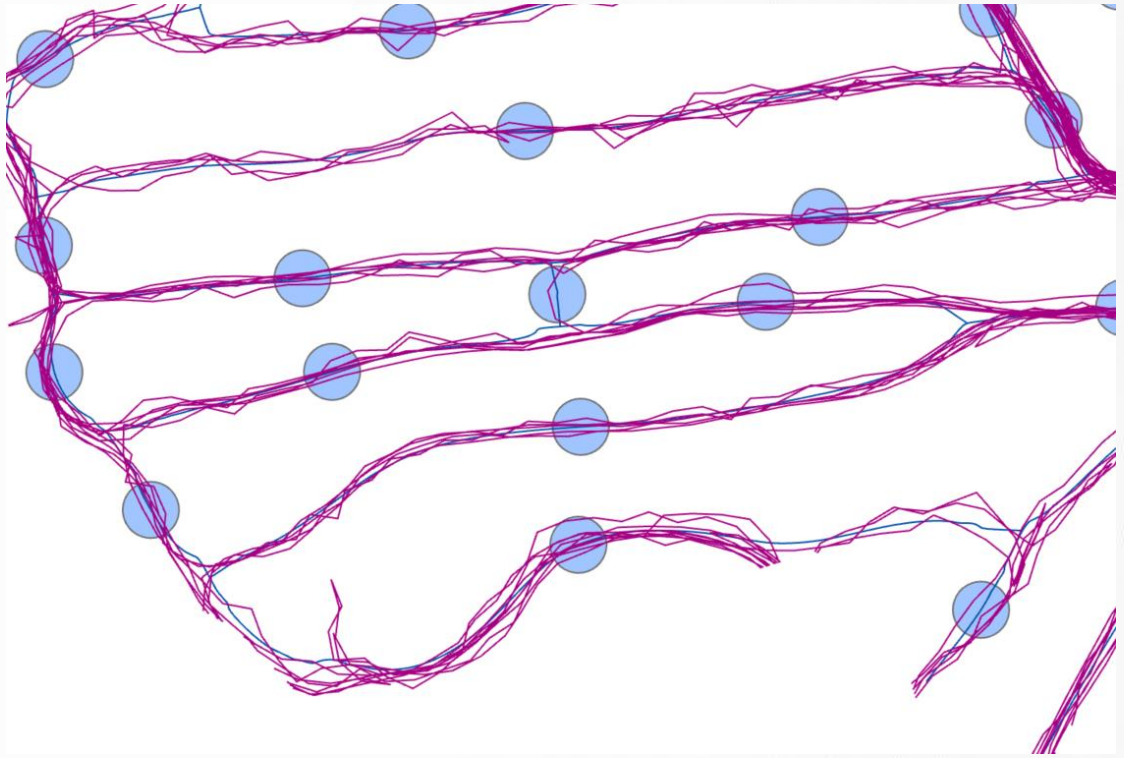
Smooth polygon



Polygon to Centerline

PROCEDURE FOR NUMBER OF PASSES

- Place checking points to the middle of each line segment (from one crossing to the next one)
- Use radius of 5m to calculate number of polylines (=machine passes) within each check point



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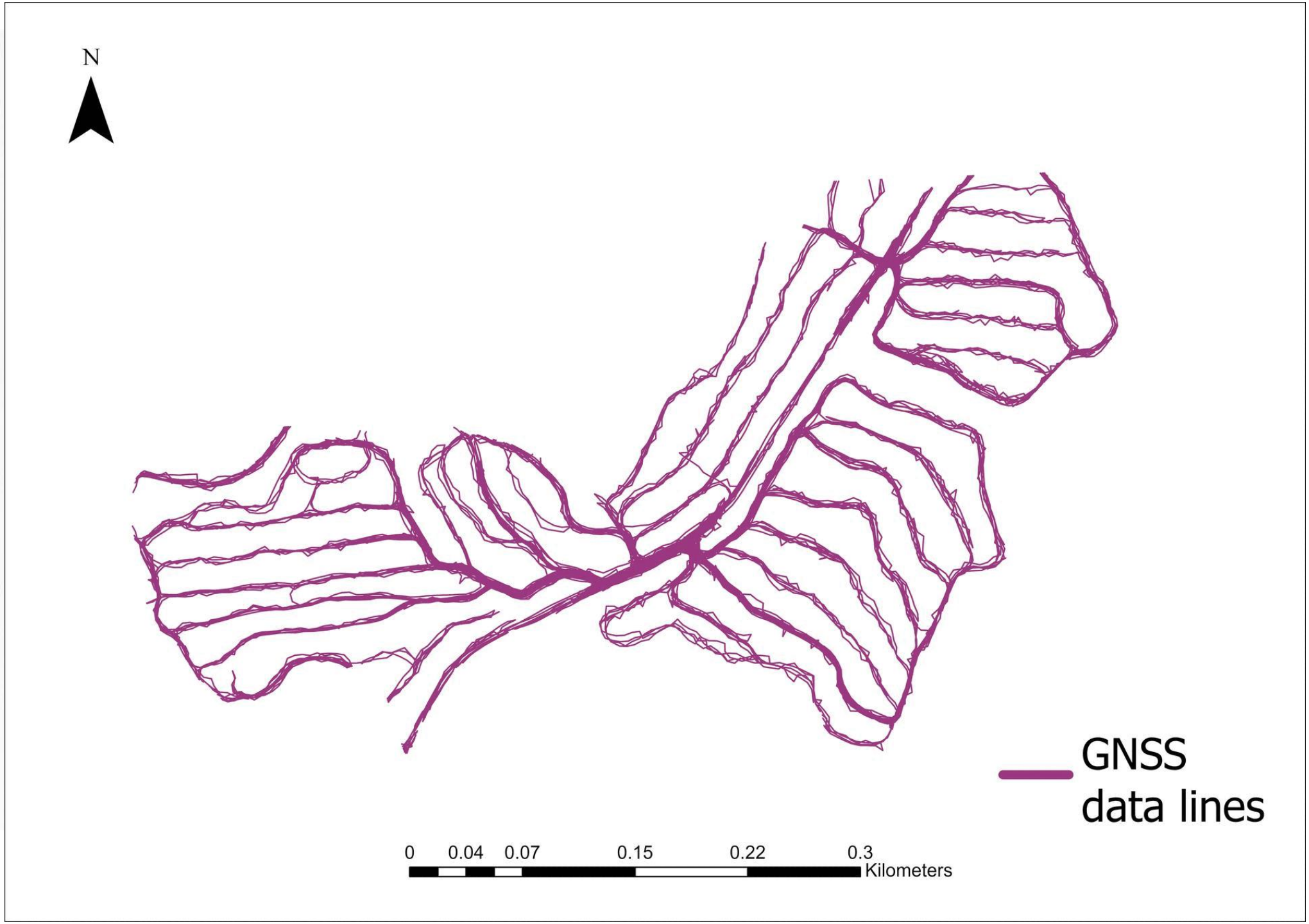
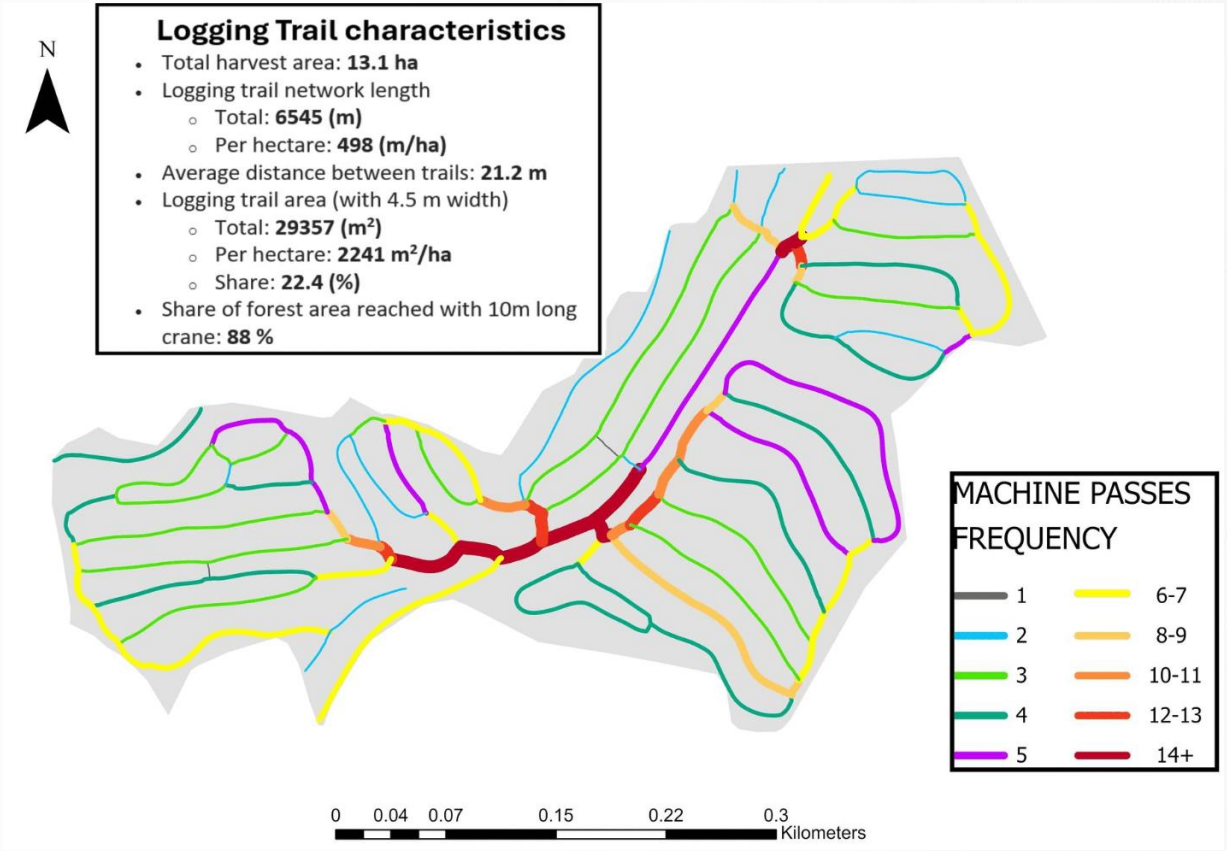


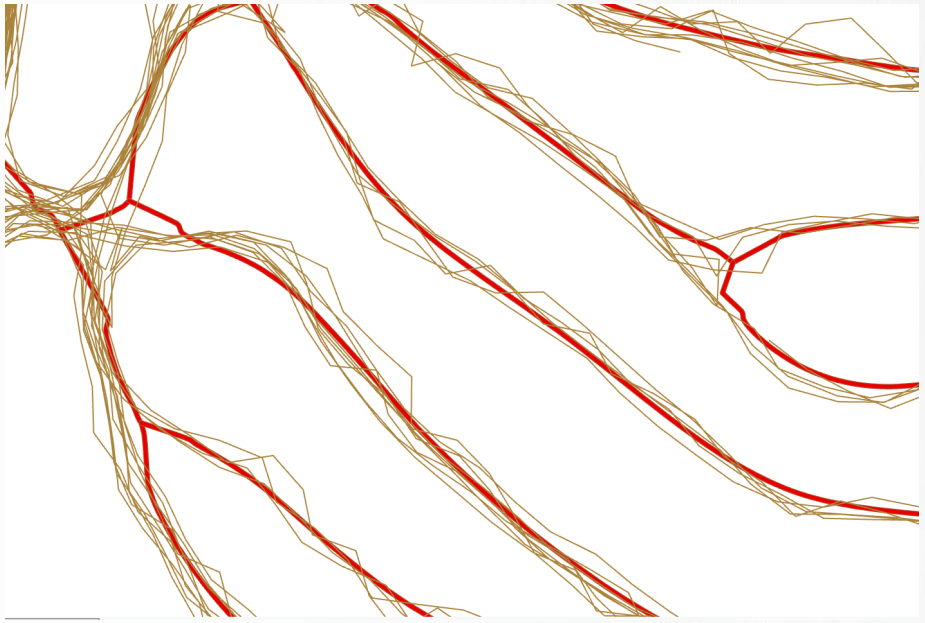
LOGGING TRAIL CHARACTERISTICS

- Link logging trail network with the stand boundaries
- You may now calculate the most important trail network characteristics
  - Density (m/ha)
  - Average interval between trails (m)
  - Efficiency metrics
    - Area covered by network
    - Overlap/gaps



NEXT STEPS

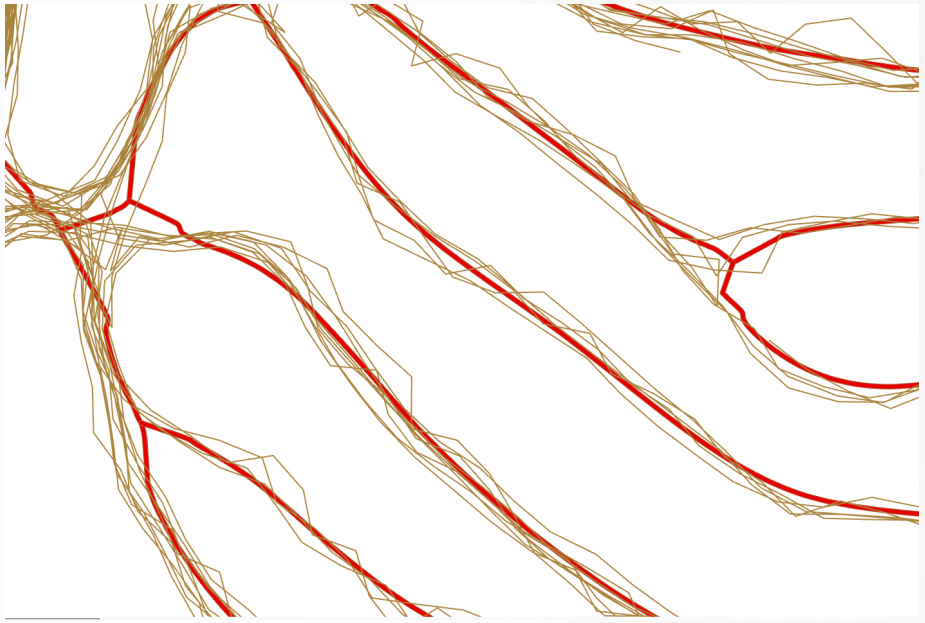
- Reference measurements in forests of 10 sites with RTK/GNSS (Kaarlo Koivukoski Master thesis)
- Converting the ArcGIS procedures into a version (Python-code) that works independently outside the ArcGIS –environment.
- Writing a scientific paper



Picture: Jori Uusitalo

CONCLUSIONS/EXPLOITATION OF THE PROCEDURE

- The procedure could be beneficial in following activities
  - Revisiting the site and utilisation of old logging trail network.
  - Post-harvest quality assessment of thinning operation (density of trail network (m/ha), average distance (m)
  - Operator feedback (metrics)
    - Efficiency of logging trail network
    - Forwarder routing efficiency
  - On-line feedback regarding the number of machine passes – avoidance of soil rutting and compaction
  - Reference data to improve logging trail network planning



Picture: Jori Uusitalo


THANK YOU!