



## Digital Analytics and Robotics for Sustainable Forestry

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### **DELIVERABLE 5.2**

#### Logging Planner and Interface

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## 1 Introduction

This deliverable presents the design and purpose of the logging planner developed within the project. The planner is conceived as a desktop-based application that supports users in planning logging operations in an intuitive and data-driven manner.

The application provides a GIS-based interface that integrates a variety of spatial and tree-level datasets, including terrain characteristics (such as soil type, terrain, elevation and wetness), biodiversity indicators, and other relevant environmental and operational information. Through this interface, users can visualise detailed individual tree data and assess site-specific conditions relevant to the planning process.

To support decision-making, the system generates automatic suggestions of trees to be harvested. These proposals take into account the size and structure of a tree, as well as the selected type of logging operation. Users retain full control and can adjust the recommendations at the level of individual trees directly through the interface.

The planner interacts with other project components to enable the operational aspects of mission planning. Traversability data generated in Task 4.3 is planned to be retrieved by the user interface to inform routing. The resulting routes are designed to minimise impacts on sensitive areas and to avoid unnecessary damage to surrounding trees. These optimised paths are then presented to the user as part of the planning workflow.

## 2 Logging Planner

The application will be a tool for preparing and designing logging operations performed with the SAHA robot. Planning is done with a web-based user interface. The tool will create an instruction package that contains all information for the SAHA robot and its operator to perform the operation. Instruction package will consist of tree locations in the point cloud reference frame, tree species, tree diameter, boolean for whether the trees is thinned and order of the trees to be removed.

The goal is to create an automated router for the tracks in the stand to be thinned. In the first phase, this router will decide on traversability based on a high resolution digital surface model of the ground, and soil type and wetness. Currently also addition of large rocks detection from collected point cloud data is in progress, that will serve as additional layer for manual drawing of the cutting tracks for the harvester, which is in this case SAHA robot. Selection of trees to be harvested during the operation will be done utilizing the manually drawn tracks and information about the used machine, so feasible trees for reaching with the logging arm are chosen. Selection is refined further with utilizing spatial competition indices, so that density after thinning is according to the law, and growth of the forest is optimized for future logging operations and increased benefits for the owner, measured by monetary income.

The map of trees to be removed is a suggestion, and the operator has the final say in which trees will actually be removed. This is done because all the defects can't be detected from the point cloud data, and there can be several months between scanning of the forest and when implementing the thinning operation.



Figure 1: Logging planner UI prototype with predefined harvester logging roads and intermediate storages. Circles are presenting individual trees (pine, spruce, birch).

### 3 Current Status

The development of the logging planner UI has begun during the latter half of 2025. Currently, most of the work is focused on creating the background layers to support the decision making of logging planner on how to optimise the routes. Addition of the features to the logging planner UI has been delayed primarily due to limited availability of staff with the required expertise during the reporting period, which affected the timeline for completing specific tasks such as addition of terrain and biodiversity background maps for assisting in the planning phase. As of writing a prototype of the UI has been created that supports manual drawing of logging routes and positions of intermediate storages for different assortments of logs.

Initially logging planner was designed to utilise the common mission planning backend developed by project partner NTNU. However the original concept that was designed to incorporate navigation from tree to a tree, was dismissed because of practical obstacles. Standard procedure in Finnish logging industry is to have logging tracks with a predefined width of 4 to 4.5 meters and distance between tracks around 20 meters. During first thinning these areas are removed from all the trees and consultation with logging operators from the industry suggested, that doing otherwise would not be feasible, since the second thinning also requires same paths for doing the thinning operations and loading the trees out of the forest. Doing logging operations with robotic platforms, that will cut down trees and do the loading at the same time was not supported also, because of the various assortments by species, that should have been sorted during the loading and unloading phase.

Integration of traversability mapping developed in the Task T4.4 lead by University of Bonn, has not been implemented. This deviation also originates from the practical obstacles caused by industry logging standards together with commercialization plan. Mapping of traversability is mainly feasible from terrestrial datasets, and the current system is currently designed to run online. In the current concept of adapting technologies for commercial thinning operations, logging roads are first thinned, that enables easier autonomous operations of forwarder inside a forest. Defaulting

assumption is that the harvester operator is first hand verifying the planned logging route, which will then needed give needed information for the forwarder operation.

The development of the logging planner will go hand in hand with the commercialization efforts of the SAHA robot, where industry partners are giving constraints for the implementation together with enforced law regulations. Because of this, details of the plans for the UI and the functionality might change at any time. However, the basic idea of automatically routing the logging roads and selecting the trees to be cut will not change.

## 4 Discussion

The work carried out in this deliverable has established the foundation for the logging planner as a key component of the project's decision-support and mission-planning ecosystem. The concept and initial implementation demonstrate how a desktop-based GIS interface can integrate individual tree data, terrain information, biodiversity metrics, and other environmental layers to support informed planning of logging operations. The user-centric design approach ensures that the system is intuitive, while still capable of handling complex datasets and site-specific conditions.

A key technical outcome is the definition of how automated tree selection will operate, based on tree health, vigor, and the selected logging strategy. The planner also enables user-level editing at the scale of individual trees, ensuring that automatic suggestions remain transparent and adjustable.

Although several elements are still under development—notably real-time traversability input, refinement of the tree selection logic, and field-based testing of routing performance—the results to date confirm the feasibility of the overall approach. The remaining uncertainties, particularly in defect detection and accurate retrieval of terrain constraints, will be addressed through planned iterations of the software.

In the next phase, efforts will focus on integrating external datasets, validating the user interface in realistic use-case scenarios, and improving the underlying algorithms. Feedback from end users will help refine the practical functionality and ensure that the planner aligns with operational needs and on-site conditions.

Overall, the logging planner is on track to become a central element in enabling low-impact data-driven forest operations within the project. Its expected contribution extends to both ecological performance, through better planning of harvesting routes and protection of sensitive areas, and operational efficiency via automation and targeted decision support. Continued development in the subsequent testing will further strengthen its maturity, robustness and readiness for use in field demonstrations and future commercialization activities.