Integrating forest management planning at forest holding and single stand level

Jussi Rasinmäki, Simosol Oy
Christian Rosset, Bern University of Applied Sciences
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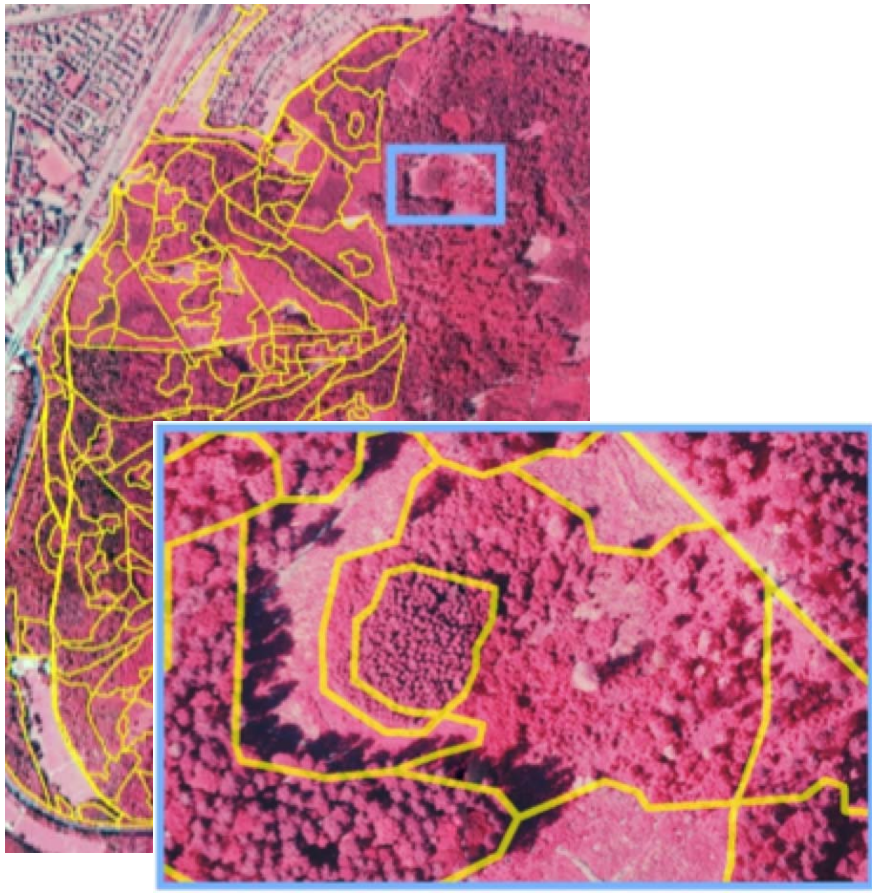
Forest management in Switzerland

- Commitment to sustainable forest management, multi-functionality and close-to-nature silviculture
- Forest clearance not allowed, no clear-cut, no chemicals (except for short term storage of timber)
- Harvesting not possible without permits issued from the forest service
- Forest freely accessible for everyone



Forest management planning in Switzerland – Canton of Zürich

- The concept presented here is being developed in the context of city of Winterthur in the canton of Zürich in Switzerland
  - The city owns around 2,000 ha of forest
- Two level planning system in the Canton of Zurich
  - **Authority level**: Focused on public needs / control of sustainable management / participation process / rational use of subsidies.
    - Main planning tool: Forest Development Plan (FDP)
  - **Forest owner level**: Focused on the owner strategy / success of forest management
    - Main planning tool: Forest Management Plan (FMP)

SiWaWa – the growth model behind it all

- The same growth model is shared between all planning levels
- Input: basal area per ha, number of stems per ha, site index or dominant height
- Model predicts:
  - stem diameter distribution (Weibull-function)
  - tree growth based on the cumulative basal area of each tree; i.e the basal area of all trees larger than the considered tree
  - maximal stand density > mortality
- Limitations: even aged and single tree species (spruce, beech, ash)
- Authors: Jean-Philippe Schütz and Andreas Zingg (Schütz and Zingg 2007)

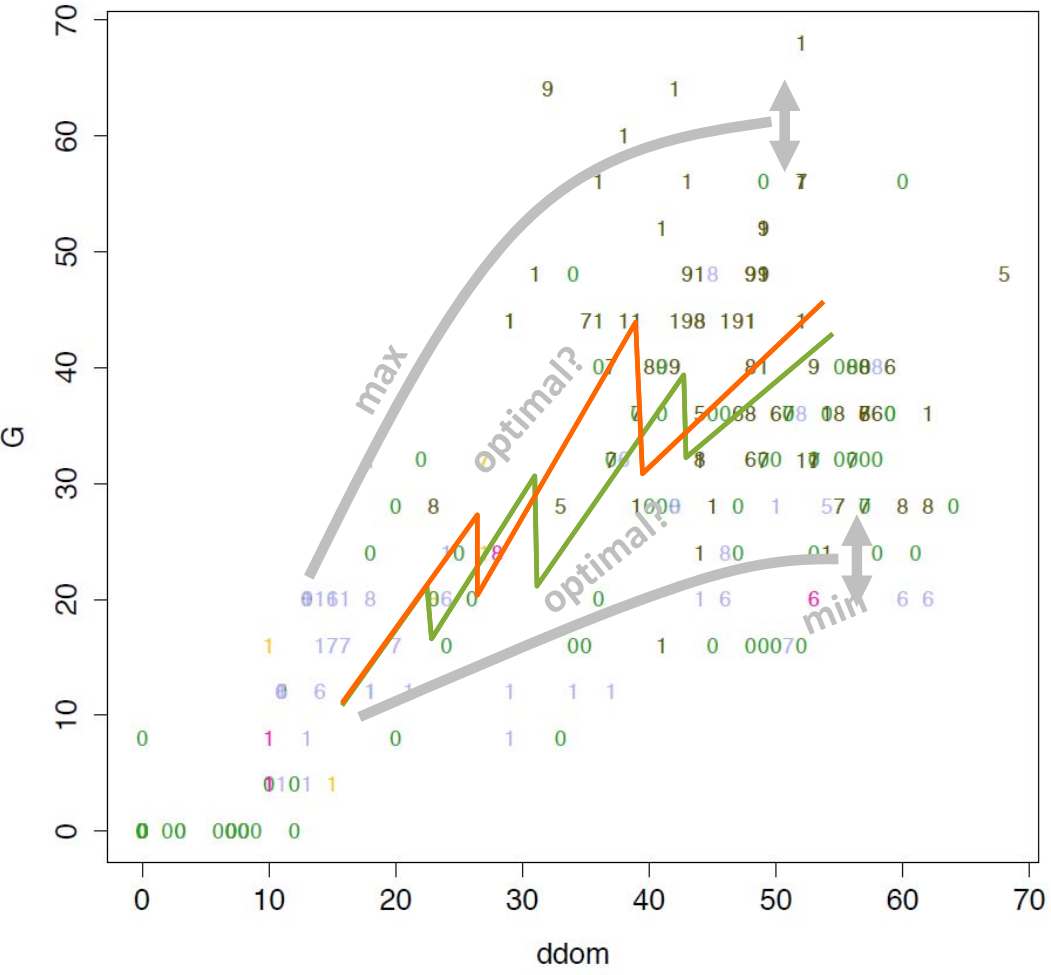
Long-term planning at forest estate level

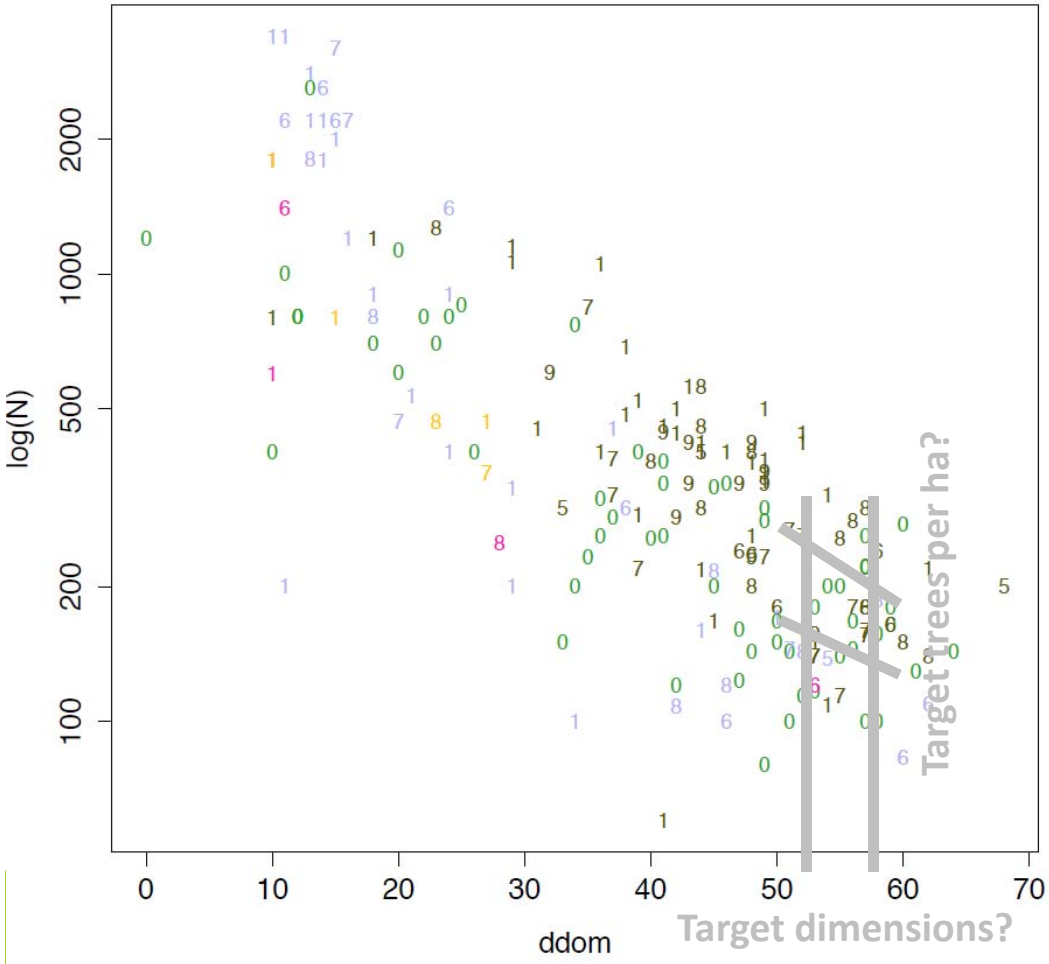
- The planning process starts with holding level long-term management planning.
- It is driven by the goals and constraints for the forest management, e.g. tree species composition development for the area under planning, and the targeted regeneration dimensions for different species.
- Mathematical optimisation is used to solve an intervention plan at individual stand level: the type and timing of the interventions.
- This step is supported with a desktop DSS application that allows analysis and comparison of different long term plans.

Defining stand management alternatives for long-term planning

- The long-term planning concept is based on the concept of simulating alternative development paths for each stand in the estate; i.e. simulating alternative intervention schedules and intensities.
- Estate level optimisation is then used to solve the plan out of these alternatives
- To guarantee that the plan is executable in practise, and to keep the simulation "burden" tolerable, the alternative paths are limited at the simulation stage
- Single stand optimisation over one tree generation rotation will be used to find the optimal management regime given the practical constraints and financial parameters defined by the user.
- This optimal management regime will then be the baseline solution for the stand for which deviations will be generated in the simulation for estate level plan

Search space for the single stand optimisation





Planning the next intervention actions at the single stand level

- The next step in the process is executed at individual stand level against the estate level plan having timing and intensity operations for each stand.
- In the forest:
  - inventory checks
  - planner's decisions about the future intervention schedule for the stand.
- This is supported with a smartphone application that
  - allows measurement of basal area, stem number and dominant height for the stand .
  - integrates a growth model system based on these attributes for the analysis of future states of the stand.

Tying the two together at a group of stands level

- The final step is integration of the stand level decisions and the forest holding level optimisation.
- The planner is supported on-site in the forest by showing:
  - The holding level effects for the alternative intervention decisions for the individual stand.
  - In the context of the neighbouring stands giving the planner an additional spatial planning level between the whole holding and a single stand.

The technology stack supporting this planning concept

- The technical development for this concept started with two existing systems, one for the forest holding level planning (Iptim) and one for the single stand level (MOTI).
- These systems are being integrated to provide planning support for the different spatial levels of estate – group of stands – single stand.

Iptim DSS – estate level planning

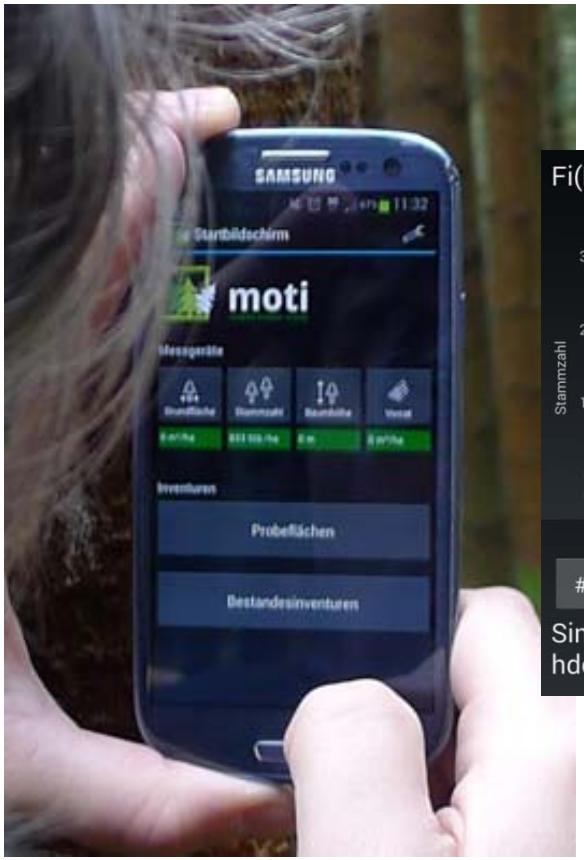
- Iptim is a strategic planning decision support system developed by Simosol Oy
- Supports defining your own forestry data model, inventory measurements, growth and taper curve modelling, forest management regime modelling and finally applying all these in long-term management planning based on mathematical optimisation
- Iptim has been applied in Finland, Sweden, Estonia, Latvia, Ireland, Mexico, Costa Rica, Panama, Colombia, Brazil, Ecuador, Uruguay, Argentina, Uganda, Kenya, Tanzania, Ghana, Mozambique, China

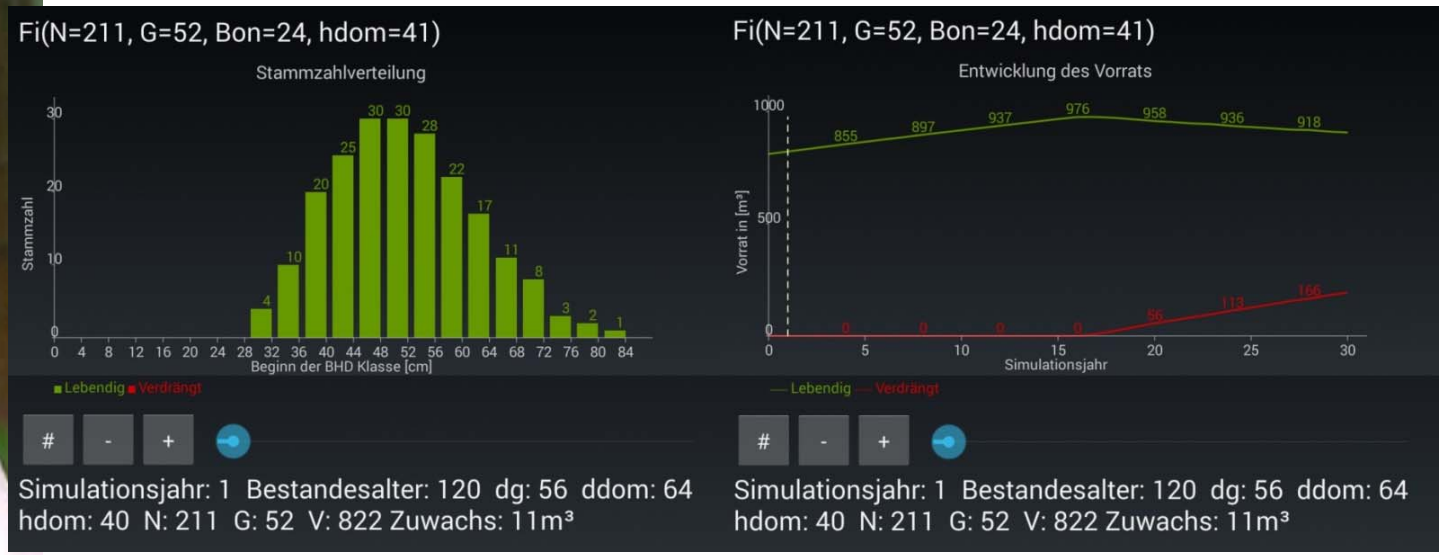
Iptim DSS – some screenshots

MOTI – intervention decisions at single stand level

- Smartphone app for measuring basal area, number of trees per ha and tree height
  - As a single measurement, combined in a sample plot, or at the level of a stand.
- Has an integrated growth model SiWaWa for predicting the stem distribution (dbh-classes), maximal stand density, development of the basal area, the growing stock, the increment and the dead wood

MOTI – some screenshots





FOCUS Mobile – bringing estate level and stand level together

- This work is part of the FOCUS (Advances in Forestry Control and Automation Systems in Europe) FP7 project (www.focusnet.eu)
- One of the components being developed in the project is a mobile application
- It will allow the forest manager to make stand level decisions on-site, while
  - Being aware of what is planned for the neighbouring stands
  - What the estate level consequences of the actions are

http://www.simosol.fi
jussi.rasinmaki@simosol.fi
Skype: jussi.rasinmaki