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Background

Monsu = Forest planning system for multi-functional forestry

Uses

- Education: Several methods included
- Research: New methods and models
- Planning: Easy enough to use, visual
Structure

- Database manager
- Present state calculator
- Simulator
- Optimization tools
- Visualisation tools
Planning with Monsu

Decision maker

Preferences

Objectives and constraints

Forest ecosystem

Inventory data

Information about alternatives

Models

Comparisons

Decision

Simulation tool

Optimization tools

Vizualization tools
What is simulated

- **Initial stand**
  - stand-level data, tree-level growth models
  - diameter distribution predicted
  - calibrated using GP

- **Stand development**
  - regeneration
  - growth
  - mortality

- **Treatments**
  - cuttings, growing stock treatments
  - site treatment

- **BA** = 25
  - **Dmean** = 25
  - ...
Even vs. Uneven-aged management

Continuous cover forestry (CCF) is currently a global megatrend

In Monsu, the user can select

- CCF nowhere
- CCF in specified stands
- Only CCF in every stand
- Both CCF and RF in every stand
  - Optimization selects either CCF or RF for each stand
What is calculated in simulation

- Stand development
  - Volume etc.
  - Biomass
  - Mortality
  - Litter yields
  - Removals
  - Residues
  - Incomes
  - Costs

- Multiple-use things
  - Berry yields
  - Recreation scores
  - Scenic scores

- Habitat suitability indices
  - For > 40 species

- Risk indices
  - Vulnerability to wind damage
Four (!) parallel simulators

1. **Living biomass (= trees)**
   - Initialized with inventory data & models

2. **Dead (soil) organic matter (for CO2 balance)**
   - Initialized with models
   - Inputs: dead trees, harvest residues, litter
   - Decomposition simulated with Yasso07 model

3. **Products (for CO2 balance)**
   - Initialized with models
   - Inputs: harvested trees
   - Divided into end product categories
   - Decomposition simulated with product decay models

4. **Dead tree simulator (for ecological indices, HSIs)**
   - Initialized with models
Alternative schedules for a stand
Optimization tools

- Linear programming
  - LP & GP formulations
  - Lindo used as a solver

- Heuristic methods
  - Simulated annealing
  - Tabu search
  - Genetic algorithm
  - Great deluge
  - Threshold accepting

- Decentralized methods
  - Cellular automata
  - Spatial version of the reduced costs method (Hoganson & Rose)
Spatial optimization

- Adjacency information required (from text file)
- Aggregate treatments or features
- Form dynamic treatment units

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Visualization tool 1: Line graphics
2: VRML
3: Google Earth
Carbon balance example

- Low-thinning RF
- High-thinning RF
- CCF
- Any-aged management
Carbon balance map
Ecological spatial planning example

Dark: High HSI for flying squirrel
Siberian jay example

Maintain habitats IN THE SAME PLACE (red = BAD, green = GOOD)
Solution: Maximize location-weighted mean HSI of jay in 2042

Harvest equals growth
Cutting aggregation (SA, CA, RC)
Dynamic treatment units (right)
Wind risk example

- White: Mean tree height = 0 m
- Black: Mean tree height = 30 m

Initial

After 30 years
Maximize risk

After 30 years
Minimize risk
One easy question would be welcome