GIS in forest planning
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Centre for Bioeconomy
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Contents

- Introduction
- Inventory
- Tactical planning
- Operative planning
- Spatial forest planning
What is planning?

- Methods for coordinating the factors of production in order to obtain utility
- Presenting the options for future decisions
- Presenting the options for future actions
- Presenting the consequences of future actions
- Preparation for future decisions and actions
- Planning uses the information of inventory
- Planning produces information for decision making
Reasons for planning

- Concern of forest resources
- Concern of sustainability
- Concern of nature biodiversity
- Wood supply for forest industry
- Profitability of future investments
- Planning decreases the uncertainty of future
- Planning helps to make better decisions
- Planning is a way to learn
### Forests available for wood supply in the European Union

<table>
<thead>
<tr>
<th>Country</th>
<th>Forest area (mil. ha)</th>
<th>Growing stock (mil. m³)</th>
<th>of which conif. %</th>
<th>Increment in mid-1990s (mil. m³/yr)</th>
<th>Removals (mil. m³/yr)</th>
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<td><strong>19 668</strong></td>
<td><strong>63</strong></td>
<td><strong>616.4</strong></td>
<td><strong>351.4</strong></td>
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</tbody>
</table>

*Source: The UN-ECE/FAO Forest Resources Assessment 2000*

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**Forest Finland in brief 2007**
Measurement

Calculation

Planning

Decision making

Inventory
Inventory

- **Standwise inventory**
  - Each forest stand is measured in the field

- **Plot inventory**
  - Based on sampling

- **Remote sensing**
  - Airborne Laser Scanning (ALS)
  - Ground inventory based on sampling
Random sampling
- Estimators for reliability
- Sample plots difficult to locate in field

Systematic sampling
- Can be used in forest inventory
- More reliable than random sampling

Cluster sampling
- Efficient in large areas
- Disadvantage is loss in precision

Stratified sampling
- Efficient sampling method
- Strata should be homogenous
- Pre-information required
Airborne Laser Scanning

- Equipment which measures the height and location of the trees is attached to an aeroplane.
- The data is combined with the aerial photographs and field measurements.
- The field data is measured from certain GPS-located sample plots.
- Field measurements are needed in modelling and interpreting the LiDaR data.

Maltamo et al. 2008
Stand characteristics

Simulation with stand models

Stand characteristics

Prediction of diameter distribution

Simulation with tree models

Measured trees

Simulation with tree models
Tactical planning

- Tool for forest owner’s decision making
- Ensure sustainable forest management
- Promote and maintain wood production
- Maintain biodiversity and water protection
- Provides also data for the supervision of forest legislation
- Key question – What to do in order to reach the aims?
Factors of production

Laws and restrictions

Objectives of forest owner

Forest resources

Planning process

FOREST PLAN

www.karelia.fi
Operative planning

- Short time period
- Operation at forest stand scale
- Cutting order of stands and specific methods
- Key question – How is it done?
Metsäliitto timber procurement system

www.karelia.fi
TAAKA system for Forest and Park Service, Arbonaut Ltd 2009
Spatial decision-making

- A large number of decision alternatives
- The outcomes or consequences of the decision alternatives are spatially variable
- Each alternative is evaluated on the basis of multiple criteria
- Some of the criteria may be qualitative while others may be quantitative
- There are typically more than one decision maker involved in the decision-making process
- The decision makers have different preferences with respect to the relative importance of evaluation criteria and decision consequences
- The decisions are often surrounded by uncertainty

Malczewski 1999
Spatial forest planning

- Shape and distribution of patches or management units
- Adjacency or green-up constraints
- Maximum and minimum opening size considerations
- Patch-size distributions
- Connectivity
- Fragmentation
- Development of the interior habitat patches of various sizes
- Road considerations

Baskent & Keles 2005
Conservation planning

- A tool for large-scale high-resolution spatial conservation prioritization using raster data
- Links species distribution modelling to quantitative reserve planning

University of Helsinki 2012
Multiple use of forests

- Maintaining the diversity of some threatened species
- In the map amount of production forests of ecological-economical simulation area are shown by green and protected areas by red color

Kouki & Tikkanen 2007
Multiple use of forests

- Surface of production possibilities in effective combinations of timber production, recreation value and species value (colored area)
- Circles indicate locations of different management scenarios on the surface

Kouki & Tikkanen 2007
Non-timber products

<table>
<thead>
<tr>
<th>Nykyarvo (2%)</th>
<th>18,4 milj. €</th>
<th>NPV</th>
<th>Old forests</th>
<th>Nykyarvo (2%)</th>
<th>16,5 milj. €</th>
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<tbody>
<tr>
<td>Vanhaa metsää</td>
<td>23 %</td>
<td></td>
<td></td>
<td>Vanhaa metsää</td>
<td>48 %</td>
</tr>
</tbody>
</table>

Spatial constraint?

Pukkala 2006
Spatial optimisation

A
- Maksimoi nykyarvoa (2%)
- Hakkaa 150 000–200 000 m³/20 v
- Uudistushakkuita < 450 ha/20 v

B
- Maksimoi nykyarvoa (2%)
- Hakkaa 150 000–200 000 m³/20 v
- Uudistushakkuita < 450 ha/20 v
- Keskitä hakkuita

NPV
Cutting removal
Regen. cutting

Nykjarvo 18,5 milj. €

Nykjarvo 17,1 milj. €

Spatial constraint

Pukkala 2006

www.karelia.fi
Spatial optimisation

- Maksimoi nykyarvoa (2%)
- Hakkaa 150 000–200 000 m³/20 v
- Uudistushakkuita < 450 ha/20 v
- Keskitä harvennushakkuita
- Hajauta uudistushakkuita

NPV
Cutting removal
Regen. Cutting

Maksimoi nykyarvoa (2%)
Hakkaa 150 000–200 000 m³/20 v
Uudistushakkuita < 450 ha/20 v
- Keskitä hakkuita
- Valtā laajoja pyöreitä aukkoja

Spatial constraint?

Pukkala 2006
- Arbonaut 2009. TAAKA. http://www.arbonaut.com
- Forest Finland in brief 2007. Finnish Forest Research Institute
- Malczewski, J., 1999. GIS and Multicriteria Decision Analysis
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