Using city tree inventory data as a tool of planning, management and economic valuation of ecosystem services provided by urban trees

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**Urban trees**
- *Street and park trees, trees in yards, trees in built environment*
- *Trees owned and managed by the city*
  - *Trees that need input from the city*

**Finnish i-Tree project**
- *Cities of Turku and Helsinki*
- *Luke*
- *University of Helsinki*
Ecosystem services of urban trees

- Bind dust and gaseous air pollutants
- Use water, alleviate infiltration and improve stormwater management
- Reduce noise
- Bind CO₂ and release O₂
- Affect microclimate; alleviate heat island effect
- Give shadow, reduce UV-radiation
- Increase biodiversity
- Improve well-being and health by having various recreational and social effects
- Cultural and landscape values
- Economic benefits on housing prices
Do we need trees in this city? Can we afford them?

**Amount and value of ecosystem services**
- How much do our trees provide ecosystem services?
- What they are worth of?

**Structure and cost of tree population**
- What kind of trees and how many do we have now?
- How much does it then cost to plant and take care of our trees?

**Planning and management**
- Are there threats for our trees and their ecosystem services?
- How can we avoid them?
- What kind of trees and how many should we have in the future?
Goals of the project

To describe
• the structure of urban tree population in the city
• the economic value of some ecosystem services of urban trees
  ✓ dust and gaseous air pollution binding
  ✓ stormwater management
  ✓ CO₂ binding

To give tools for planning of sustainable city tree population that
  ➢ Provides ecosystem services in the future
  ➢ And is resistant
  ➢ and resilient in the face of new pests, diseases and climate change
i-Tree – a tool for modelling some ecosystem services

- Tool for calculating the amount and value of some ecosystem services of city trees, and to describe the city tree population

- Does not take into account all ecosystem services, eg. recreational, health and cultural values

- Developed by USDA Forest Service, David Nowak et al.
- 1st version released in 2006, has been developed for 25 years
- Versions to USA, Canada, UK and Australia
- European version will be released in 2018
- All modules are not applicable outside of USA
Ecosystem services of urban trees modelled with i-Tree Eco Module

i-Tree Eco provides data on the structure, function and benefits of urban trees, including:

**Ecosystem services**

- Pollution removal and value as avoided health care costs
- Carbon storage, sequestration, and value
- Avoided runoff and value as avoided treatment cost
- Volatile organic compound emissions
- Oxygen production
- Ultraviolet (UV) effects
Structure of urban tree population modelled with i-Tree Eco Module

i-Tree Eco provides data on the structure, function and benefits of urban trees, including:

**Structure**
- Number of trees
- Species composition
- Leaf area and biomass
- Canopy cover
- Species importance values

**Forecasting and management**
- Tree planting inputs
- Annual mortality adjustments
- Cost benefit analysis

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Data needed for modelling with i-Tree

1) Single tree inventory data
   • Available in the cities of Turku and Helsinki

2) Inventory of random research plots
   • Will be studied in Turku and Helsinki 2018

3) Tree inventory of a limited area, like a park or cemetery
   • Eg. Park of Kupittaa in Turku

Weather and air pollution data
   • From the nearest weather stations and measurement points

Coefficients
   • Eg. cost of CO₂-ton, cost of stormwater treatment
Urban Tree Databases in Turku and Helsinki

- Created as a tool for management and planning of green infra
- Embedded in the GIS-software with city infrastructure

Tree Register in Turku
- Trimble Locus

Available for viewing in guide maps of Turku:
- Tree species in Finnish and Latin

https://www.turku.fi/turku-tieto/kartat-ja-paikkatieto/opaskartta

- Pick Maastokartta
- Zoom +
Urban Tree Database in Turku

- Includes 33,000 trees in the green areas of the city
- Trees owned and managed by the city
- Data collection started in 2007
- Cycle of updating 6-8 years, risk trees every 1-3 years
- Tree measurements and condition assessments made by arborists
- Species (Finnish/Latin)
- Diameter at breast height (DBH 1.3 m)
- Height
- Condition 1-4
- Street/park tree
- Growing site info
- Mulching
- Equipment
- Lamp-posts, power lines etc. nearby
• Tree assessment, like risks, decay, decaying fungi, cracks, obliquity
• Maintenance so far
• Future needs of maintenance
• New plantings: plant species, size, pot quality, nursery, origin
Urban Tree Database in Helsinki

- PuuAtlas software
- Includes 48 300 trees in the green areas of the city
- Street trees 26 000, park trees 21 000
- Inventories started in the beginning of 21st century
- No planned cycle of updating, risk trees assessed every 3rd year
Urban Tree Database in Helsinki

- In addition, tree inventory data obtained by laser scanning
  Topi Tanhuanpää et al., University of Helsinki
  Abstract #10, session 5.
  'Producing tree maps for the park areas in Helsinki'
### Data needed for modelling with i-Tree

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
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<td>• $r = 11.3$ m, $n = \text{min. } 90/$city</td>
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Inventory of random research plots

**Tree data**

- Location
- Height
- DBH 1.3 m
- Crown width in two directions
- Height of the crown base
- % of canopy missing
- Crown condition, % of dieback
- Crown light exposure, 1-5
- Canopy cover, %
- Distance to the nearest buildings

Leaf area, leaf biomass, tree biomass

- Carbon storage
- Carbon sequestration
- Air pollution removal
- Avoided runoff
- VOC emissions
Inventory of random research plots
Shrub layer, other characteristics

**Shrub layer**
- Species
- Volume
- Cover-%

**Other plot characteristics**
- Land use category
- Ground cover
- Plantable space, %

**Shrubs, Ground cover**
- Carbon sequestration
- Air pollution removal
- Avoided runoff
Finnish i-Tree project in co-operation with the Nordic i-Tree project

Nordic i-Tree project coordinated by SLU, Sweden
• Coordinator Johanna Deak Sjöman
• Project built by Johan Östberg
• Project leader Thomas Randrup
• Post-graduate student Blaz Klobucar

In co-operation:
• Kenton Rogers, Treeconomy, UK  
  ➢ Workshops in Sweden
• David Nowak, USDA Forest Service

Finnish i-Tree project has been build in Luke in the frames of Urban Building with Wood and Green Infrastructure -project
Nordic project partners

In Sweden
SLU, Tukholma, Malmö, Hamlstad, Eskilstuna, Umea, Hassleholm, Lulea, Ystad, Uppsala, Kristianstad, Boras, Borlange Energi, Sveskakyrkan, arborist companies, housing companies

In Norway
• David Barton, Norwegian Institute for Nature Research (NINA)
• Ingjerd Solfjeld, Norwegian University of Life Sciences
• Oslo

In Denmark
• Oliver Bühler, Anders Busse Nielsen, Susanne Ogstrup, Institut for Geovidenskab og Naturforvaltning
• Copenhagen
The Finnish i-Tree Project

Coordinated by Luke
Project leader Eeva-Maria Tuhkanen
Researcher Sirkka Juhanoja, Prof. Erkki Verkasalo

The city of Turku: Aki Männistö

The city of Helsinki: Minna Terho, Juha Raisio, Katriina Arrakoski

The University of Helsinki: PhD student Miia Mänttäri
Anu Riikonen, Topi Tanhuanpää

Other cities?
The effect of tree species selection on ecosystem services of urban trees

• What are the factors that have led to the current tree population in Turku and Helsinki?
  ➢ Cultural and historical factors
  ➢ Development of city structure
  ➢ Practical reasons, eg. growing conditions, availability of plant material
  ➢ Planning guidelines
The effect of tree species selection on ecosystem services of urban trees

• What is the impact of tree species diversity in cities on ecosystem services?
  - Is diversity needed?

• What is the impact of tree species diversity on other species groups, like pollinators?

• What is the impact of tree diversity on resistance and resilience of tree population and provision of ecosystem services?
Thank you!