# Thematic urban ecosystem accounts: asset value of the regulating services from trees in Oslo

MAIA
Mapping and Assessment for Integrated ecosystem Accounting

NINA
Norwegian Institute for Nature Research

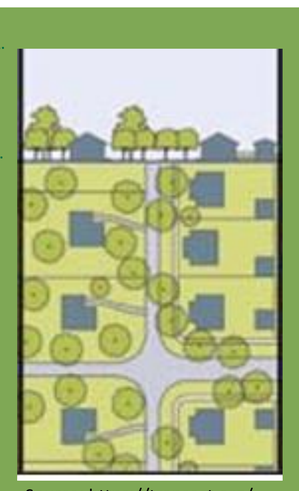
## Objectives

Demonstrate the integration of extent-condition accounts for urban trees with modeling of regulating ecosystem services and their asset values for different urban planning and policy purposes

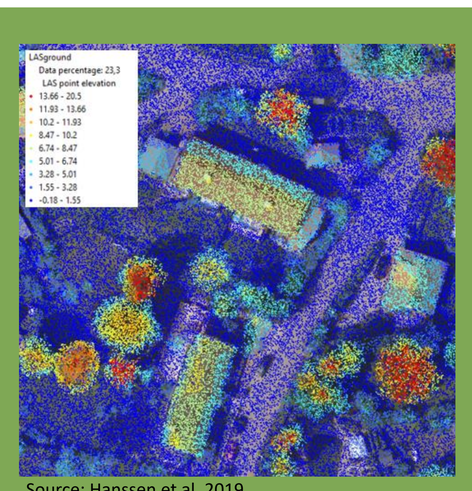
Test value generalization in urban ecosystem accounting - infer asset value for a whole city accounting area with only partial asset condition data, using machine learning and Bayesian networks

**Condition (tree height)**

**Extents (crown cover)**

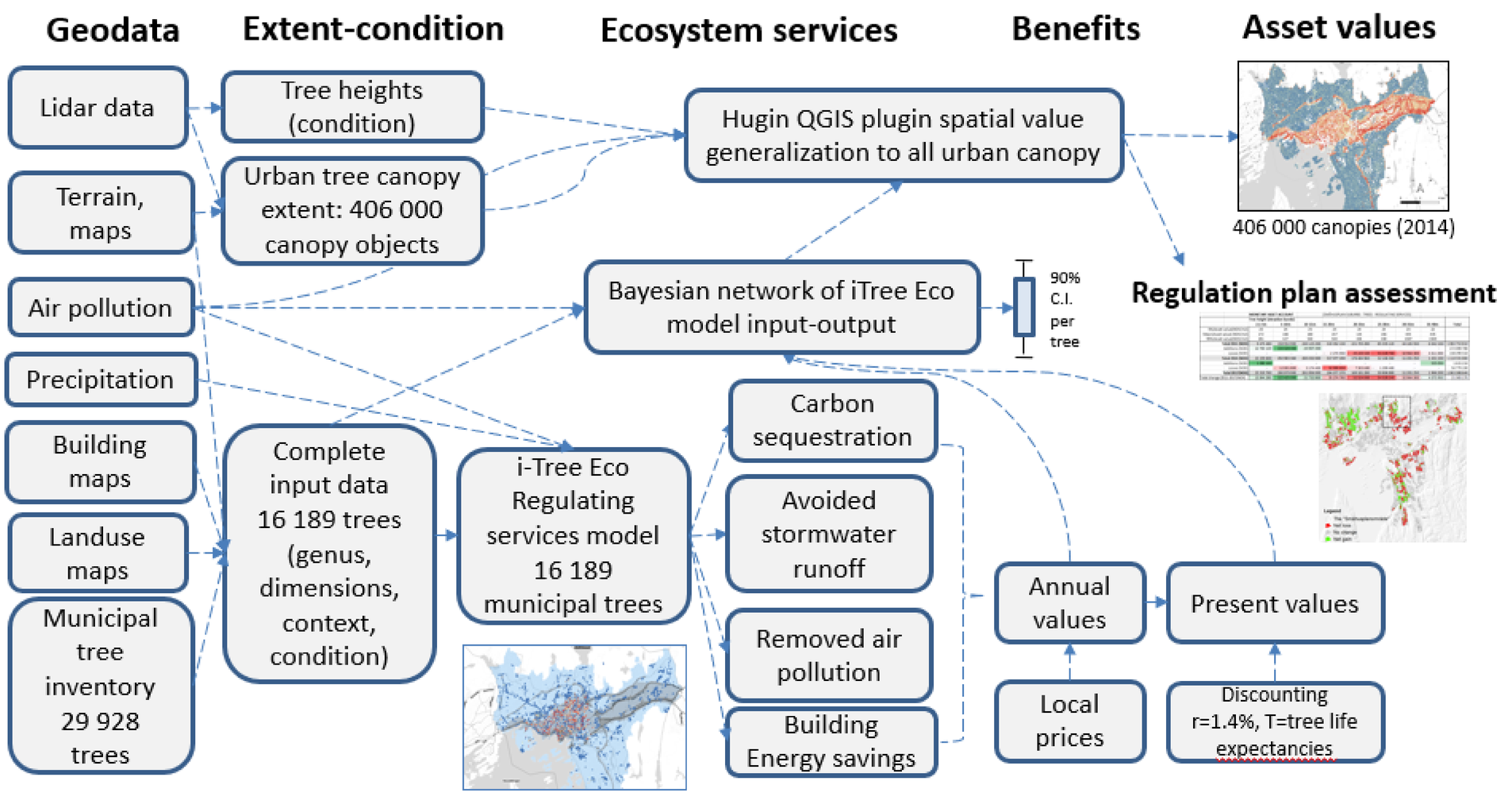


Source: https://transect.org/




Source: Hanssen et al. 2019

## Methods

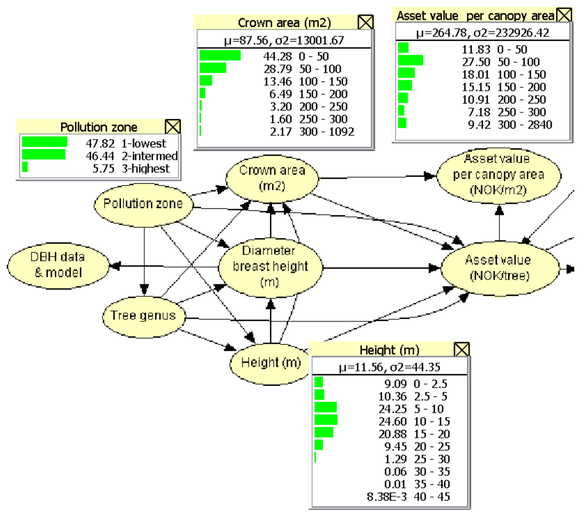



**iTree Eco regulating services model estimates per tree**

| | Average ES supply per tree | Average monetary value per tree |
|---|---|---|
| **Removed air pollution** | 0.8 kg/year | 200 NOK/year |
| **Avoided stormwater runoff** | 1 m3/year | 9 NOK/year |
| **Sequestrated carbon** | 8 kg/year | 3 NOK/year |
| **Stored carbon** | 385 kg | - |
| **Building energy savings** | 1 kWh/year | 2 NOK/year |
| **Total annual mon. value** | - | **220 NOK/year** |
| **Mean asset value (NPV)** | - | **12 414 NOK** |

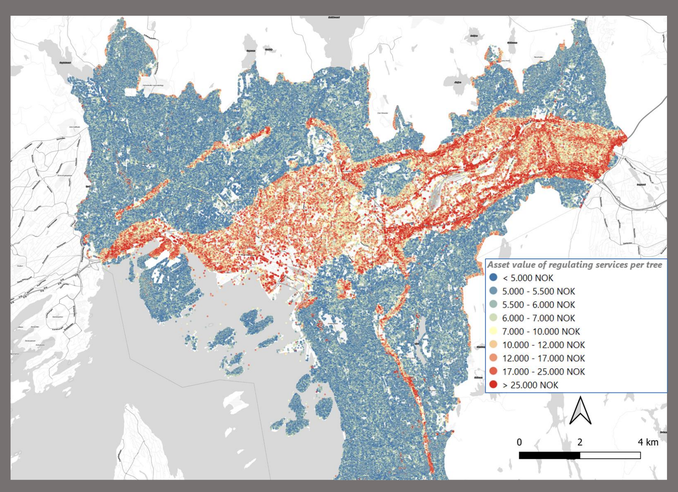
Source: Cimburova and Barton 2021

**Bayesian network emulation of iTree Eco model input-output variables**




## Results

**Awareness raising**
Estimated median asset value of regulating services provided by all tree canopy of Oslo's built zone ca. NOK 5,4 billion (2014)
(€ 635 million, or equivalent to ca. 0.4% of total residential asset value in Oslo)




**Regulation plan assessment**
Insignificant net loss in tree canopy extent in suburban plan area 2011-2017 due to loss of taller trees being compensated in extent (but not condition) by smaller tree plantings. Municipal regulation of suburban infill and tree felling permits were insufficient to avoid the loss of greenviews from large trees, while the net effect on regulating services was negligeable.

| | MONETARY ASSET ACCOUNT (SMÅHUSPLAN SUBURBS - TREES - REGULATING SERVICES) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tree height (elevation bands) | | | | | | | | |
| | 2.5-5m | 5-10m | 10-15m | 15-20m | 20-25m | 25-30m | 30-35m | 35-40m | Total |
| Expected Asset value (NOK/m2) | 170 | 146 | 121 | 132 | 121 | 123 | 281 | 433 | |
| **E(Total 2011)(NOK)** | 9 000 000 | 139 000 000 | 182 000 000 | 268 000 000 | 186 000 000 | 67 000 000 | 29 000 000 | 6 000 000 | 887 000 000 |
| E(Additions) (NOK) | 14 000 000 | 118 000 000 | 19 000 000 | - | - | - | - | 1 000 000 | 151 000 000 |
| E(Losses) (NOK) | - | - 11 000 000 | - 2 000 000 | - 30 000 000 | - 44 000 000 | - 43 000 000 | - 21 000 000 | - 5 000 000 | - 156 000 000 |
| **E(Total 2017(NOK)** | 23 000 000 | 247 000 000 | 198 000 000 | 239 000 000 | 142 000 000 | 24 000 000 | 7 000 000 | 2 000 000 | 883 000 000 |
| E (Change 2011-2017)(NOK) | 14 000 000 | 108 000 000 | 16 000 000 | - 30 000 000 | - 44 000 000 | - 43 000 000 | - 21 000 000 | - 4 000 000 | - 4 000 000 |

## Conclusions

- Combined ecosystem extent-condition accounts can represent vegetation's 3D structure needed to predict regulating services using iTree Eco.
- Machine learning and Bayesian networks (BN) can be used to tackle missing data in value transfer / generalization from a known sample to partial data on assets in a wider accounting area. BNs provide documentation of inference uncertainty in ecosystem accounting.
- Small net aggregate changes in ecosystem extent during an accounting period may conceal large variation in ecosystem condition affecting the spatial distribution of ecosystem services and their benefits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