World Forum on Urban Forests
Mantova 2018

Your session here:
PS 3.2 Changing spaces and places

How does trees density affect air quality and temperature mitigation? The case study of Berlin

Rocco Pace*, Roland Stirnberg, Francesco De Fino, Rüdiger Grote*

*Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Atmospheric Environmental Research (IMK-IFU), Garmisch-Partenkirchen, Germany;

rocco.pace@kit.edu

Karlsruhe Institute of Technology

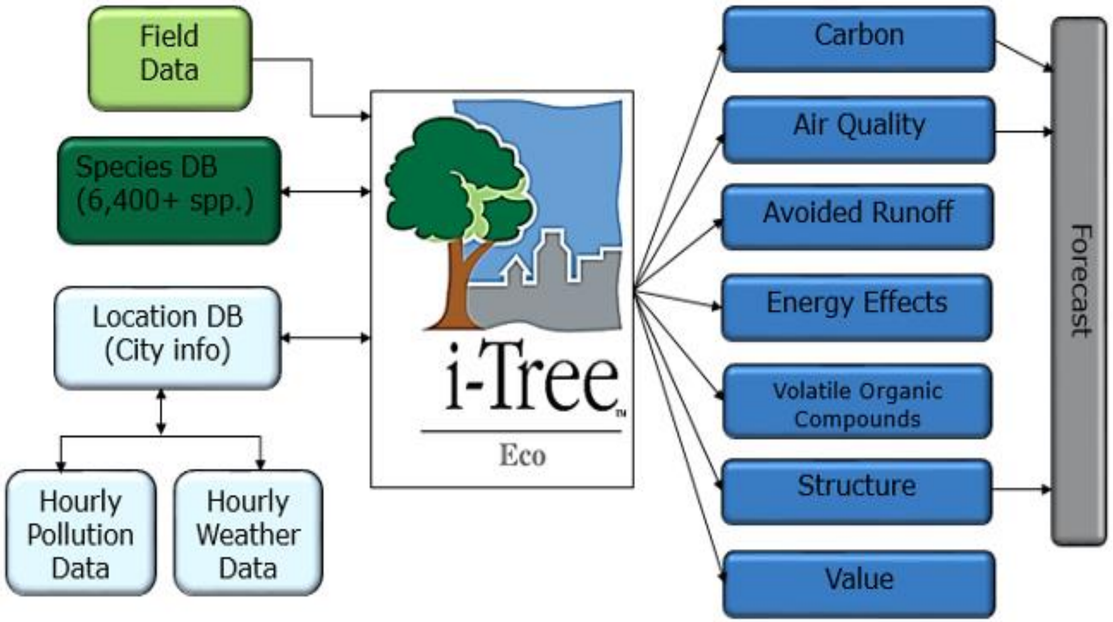
World Forum on Urban Forests
Mantova 2018

Green2Clean project

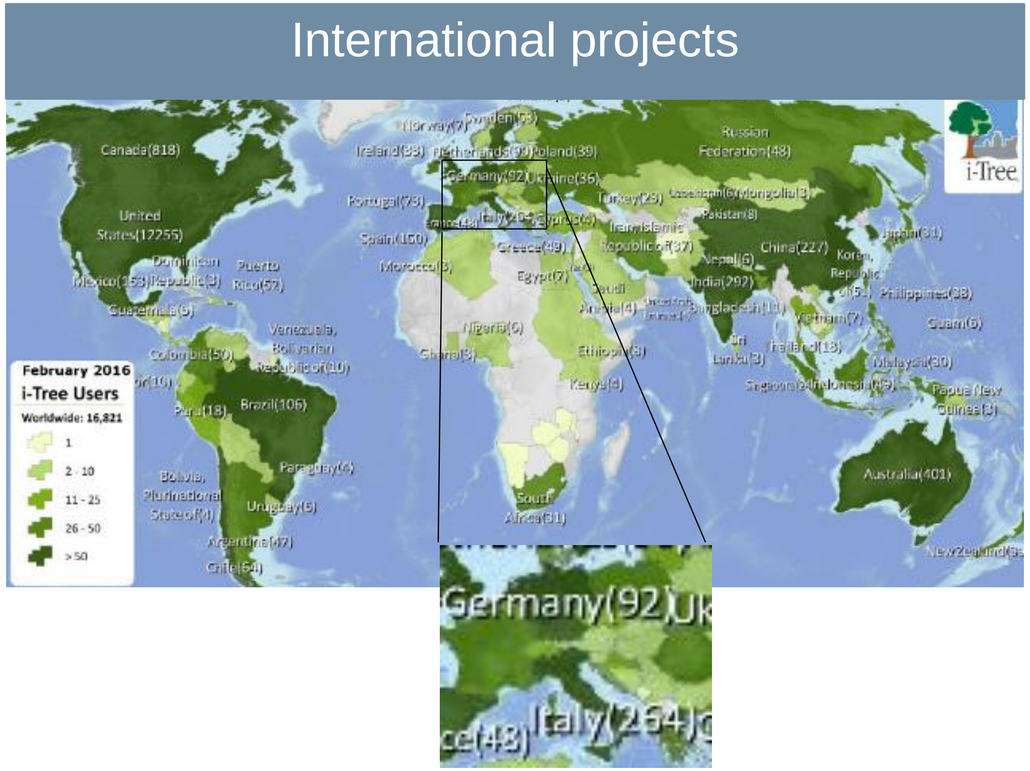
- Modeling ecosystem services provided by urban trees
- Air quality: pollution removal & BVOC emission
- Temperature mitigation: shading & cooling
- Influence of the light competition and tree properties on ES
- Model simulations of real cases in Munich and Berlin

World Forum on Urban Forests
Mantova 2018

i-Tree Eco



International projects



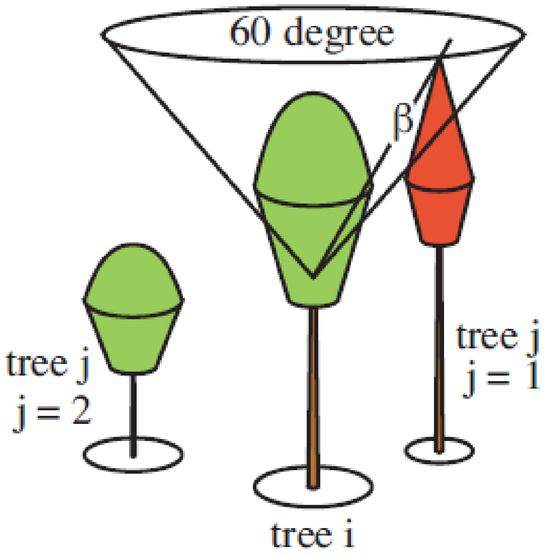
- **ArcGIS**
- **DSM**

Area solar radiation (W/m^2)

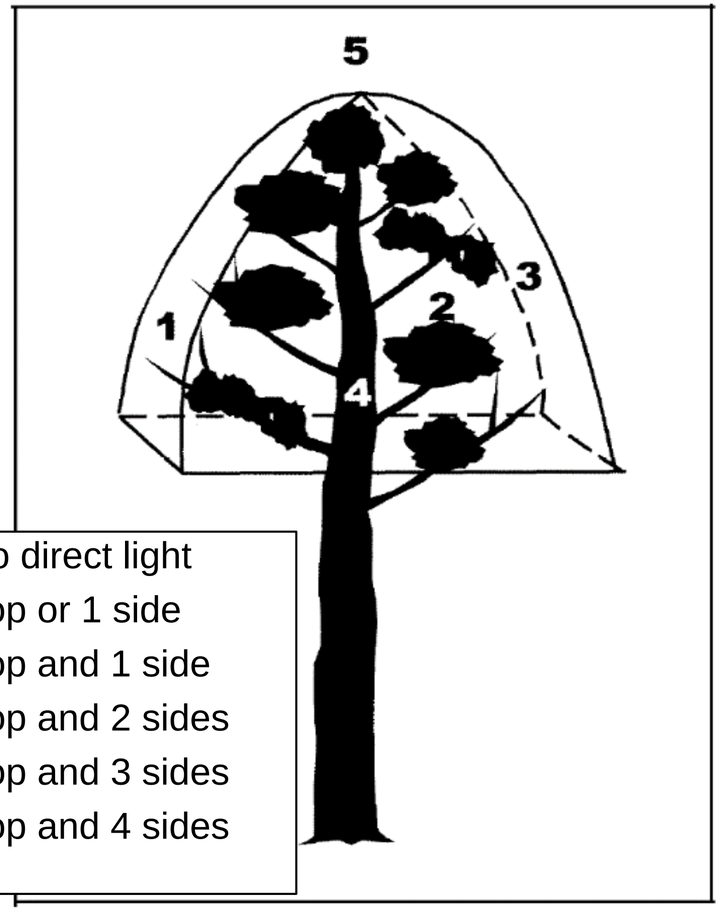
World Forum on Urban Forests
Mantova 2018

Light competition

SILVA competition index (KKL)

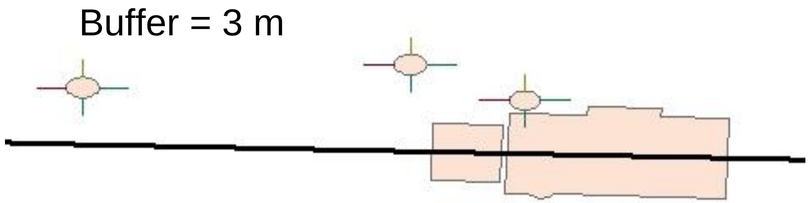


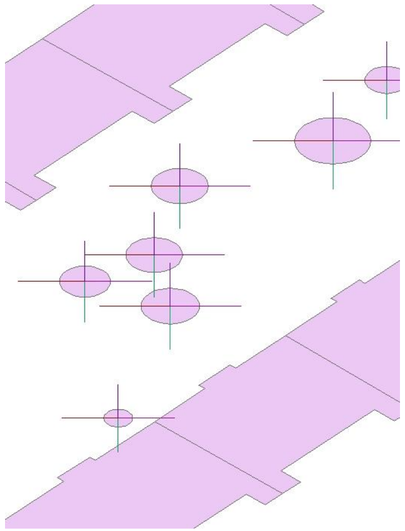
Crown light exposure (CLE)



0	No direct light
1	Top or 1 side
2	Top and 1 side
3	Top and 2 sides
4	Top and 3 sides
5	Top and 4 sides

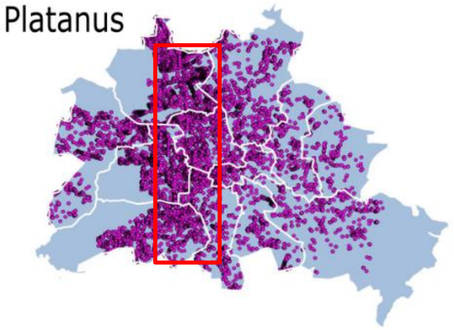
GIS calculation

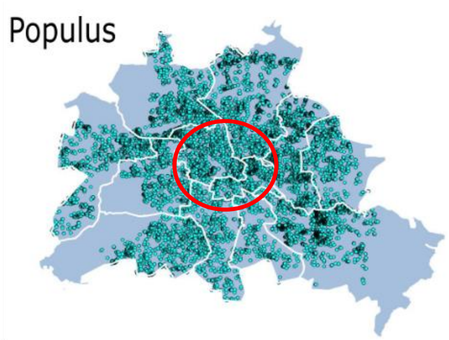


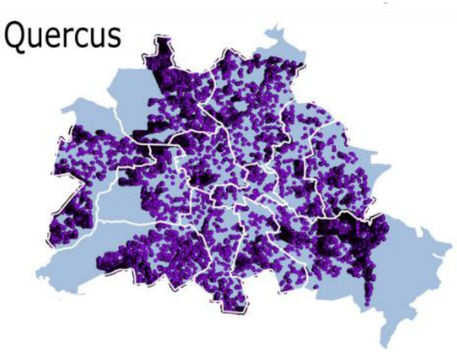


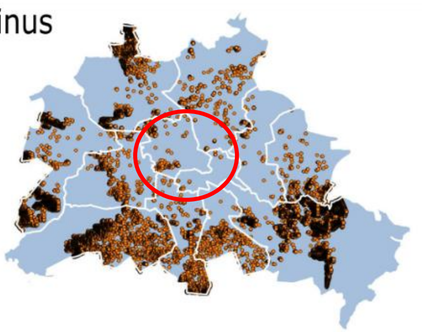
World Forum on Urban Forests
Mantova 2018

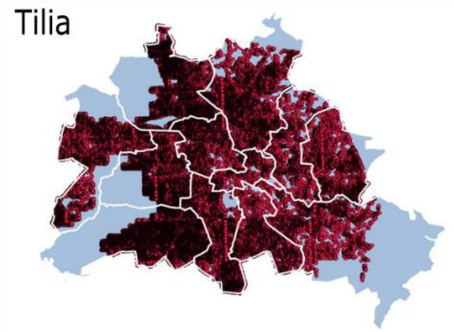
Urban trees in Berlin

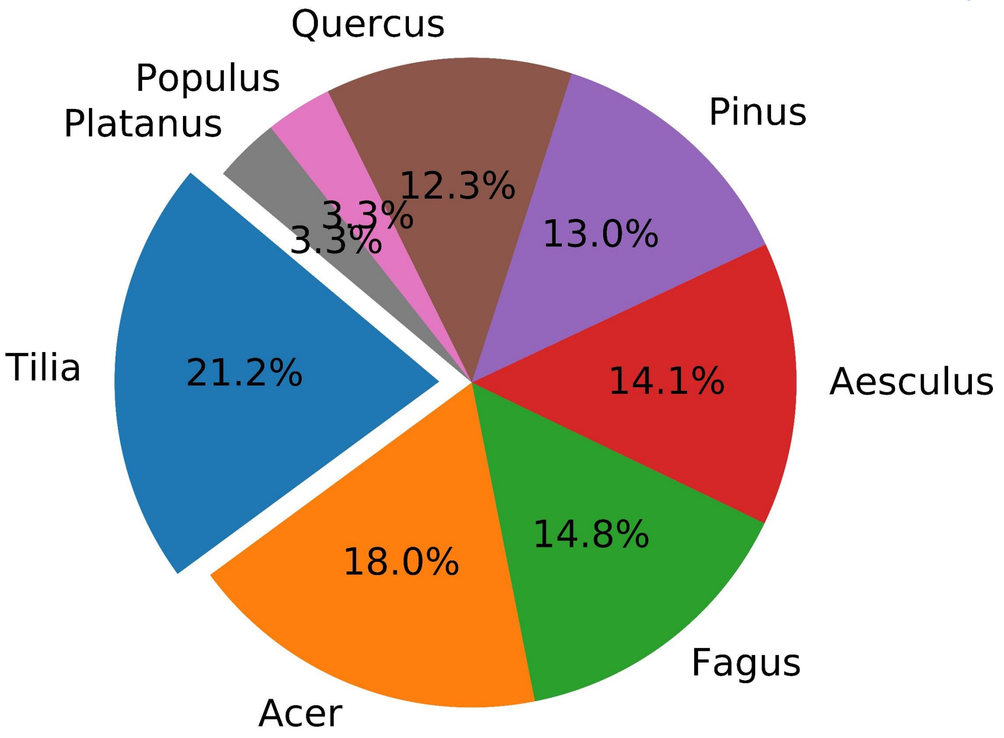


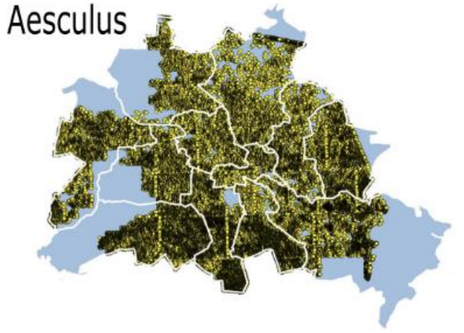


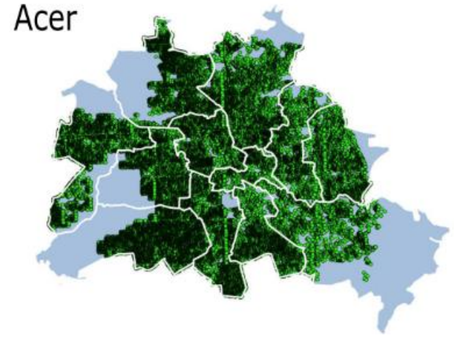


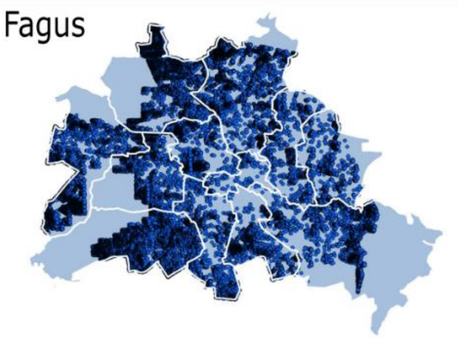










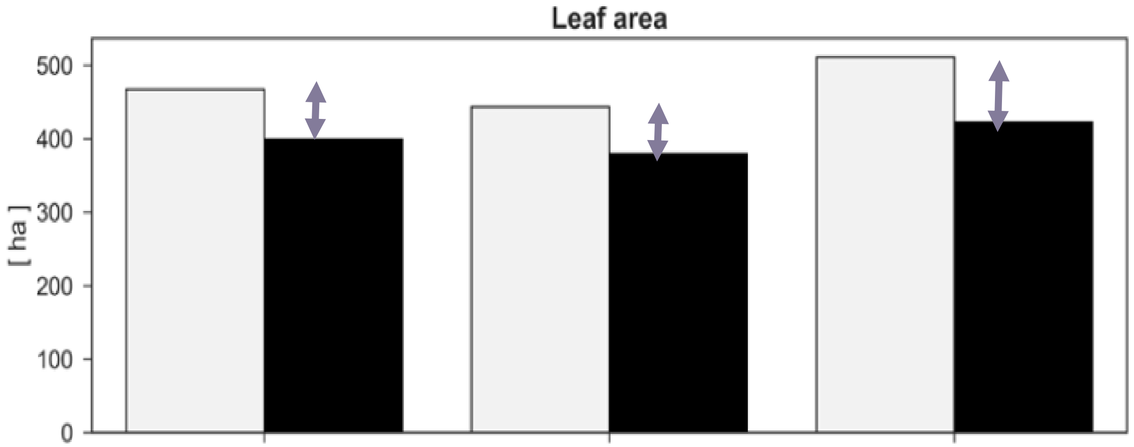


Inventory from Tigges et al. 2013; 2016

World Forum on Urban Forests
Mantova 2018

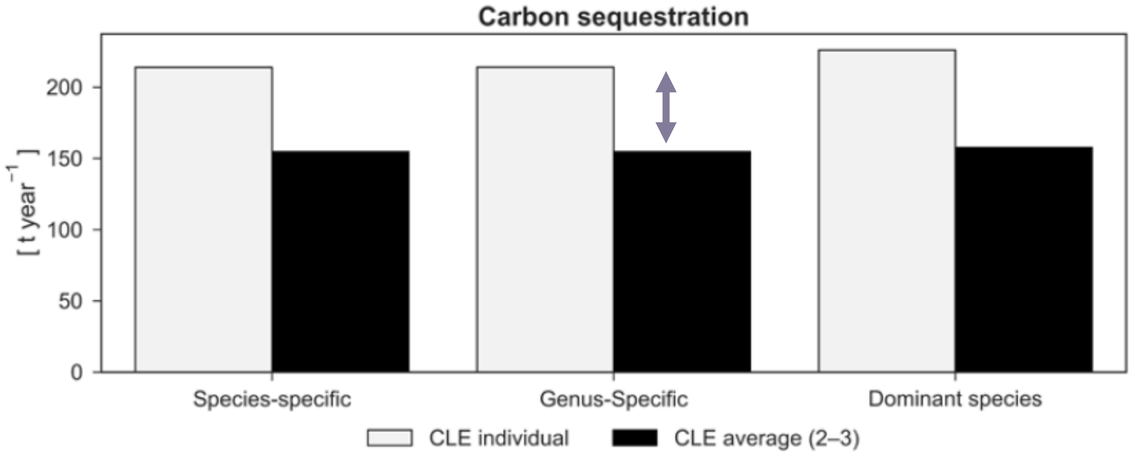
Light competition influence on ES

CLE Effect: +10%



- **Leaf area** was mildly affected by competition as well as species classification.

CLE Effect: +30%



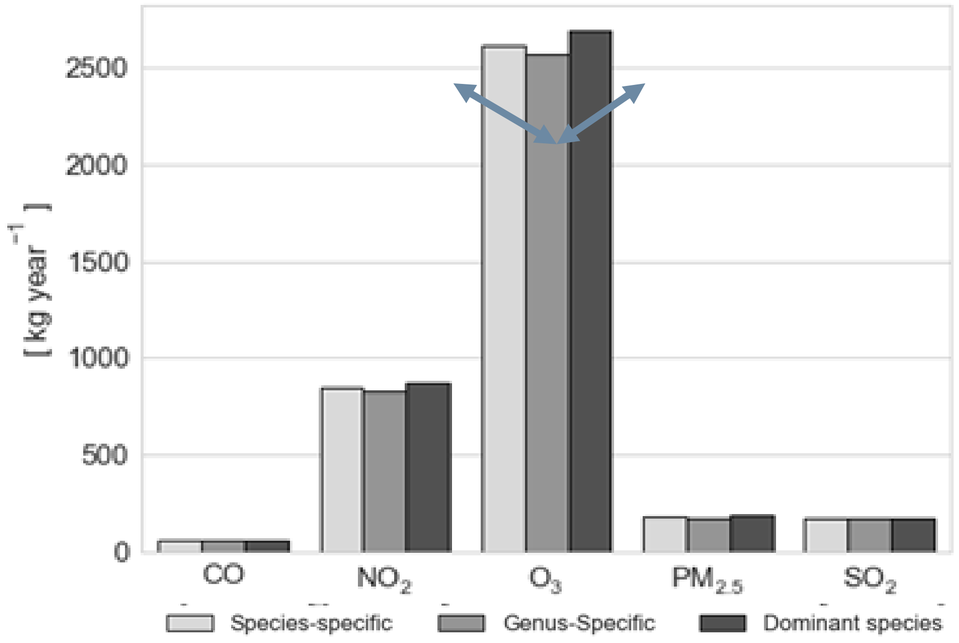
- **Carbon sequestration** depends strongly on competition but is independent of species-classification!

Pace et al. 2018 (Forests)

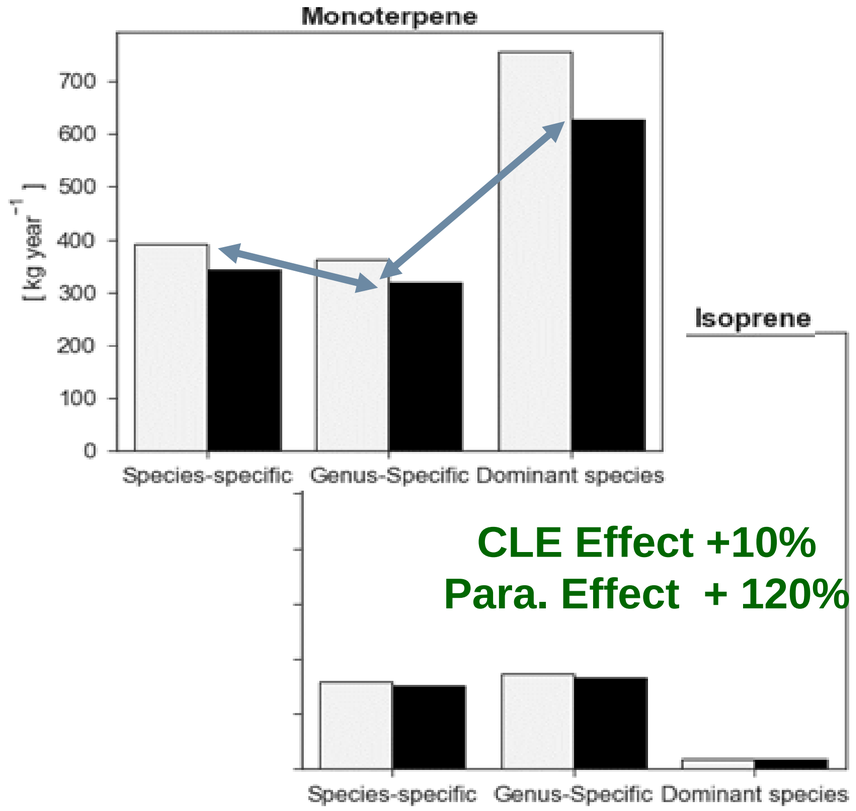
World Forum on Urban Forests
Mantova 2018

Species influence on ES

CLE Effect +10% (not shown)
Parameter Effect - 5%



CLE Effect +10%
Para. Effect - 90%



Pace et al. 2018 (Forests)

World Forum on Urban Forests
Mantova 2018

Simulations - Parks

Low density

- 111 trees
- 6.73 ha
- 16.5 trees/ha

Medium density

- 222 trees
- 6.41 ha
- 34.6 trees/ha

High density

- 340 trees
- 6.43 ha
- 52.9 trees/ha

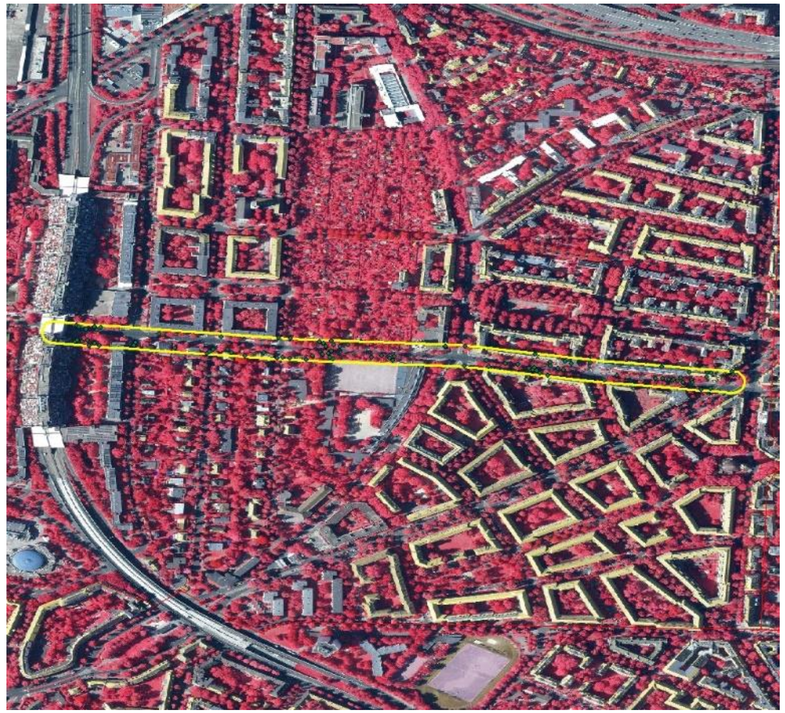
World Forum on Urban Forests
Mantova 2018

Simulations - Street

Low density

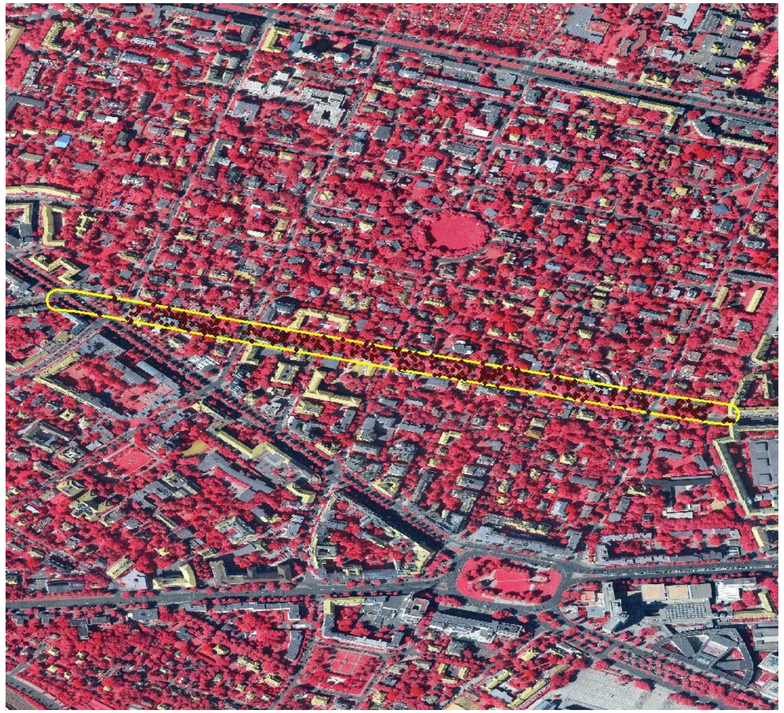
- 50 trees
- 6.6 ha
- 7.5 trees/ha

Medium density



- 100 trees
- 6.52 ha
- 15.3 trees/ha

High density



- 265 trees
- 6.9 ha
- 38.6 trees/ha

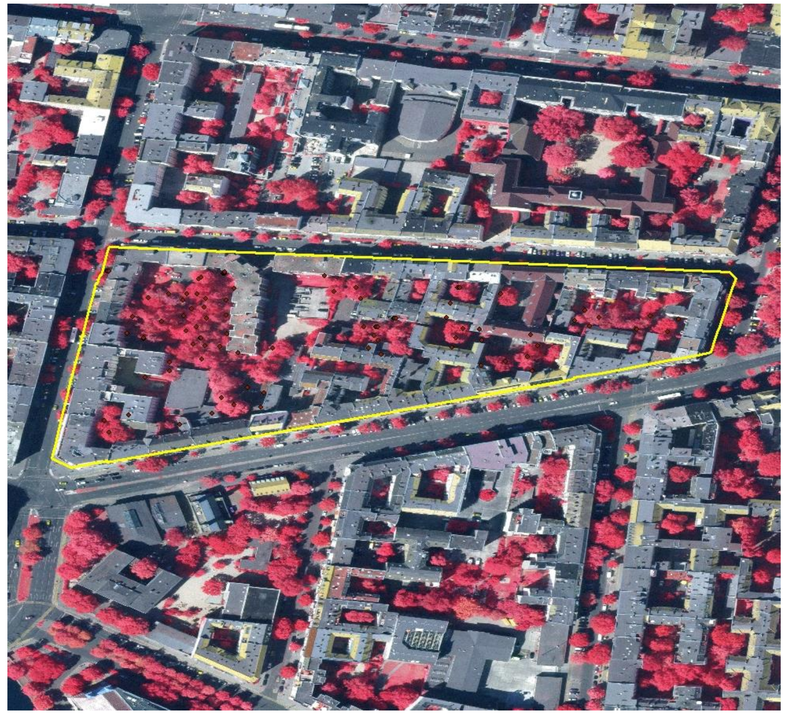
World Forum on Urban Forests
Mantova 2018

Simulations - Residential

Low density

- 20 trees
- 10 ha
- 2 trees/ha

Medium density



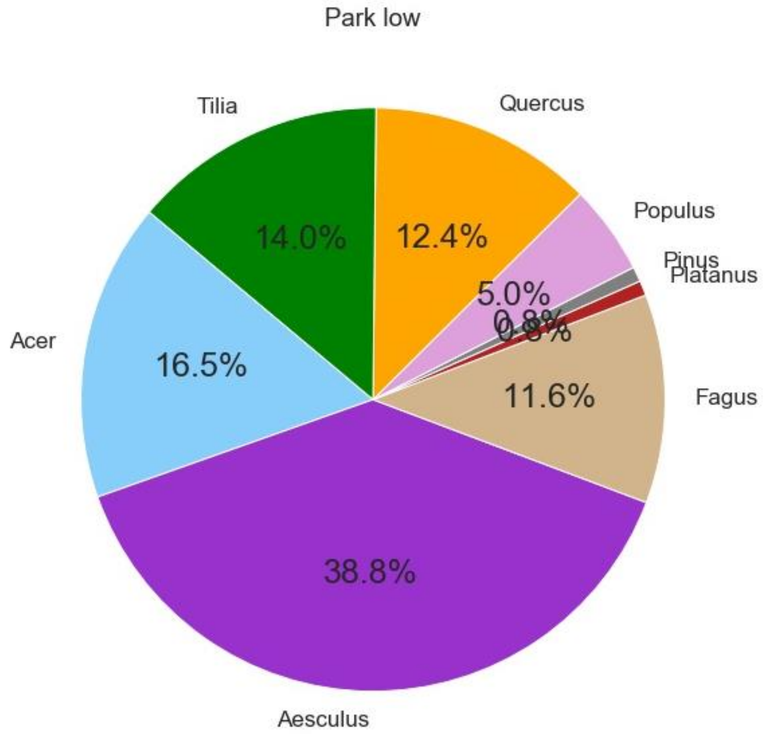
- 93 trees
- 10.4 ha
- 8.9 trees/ha

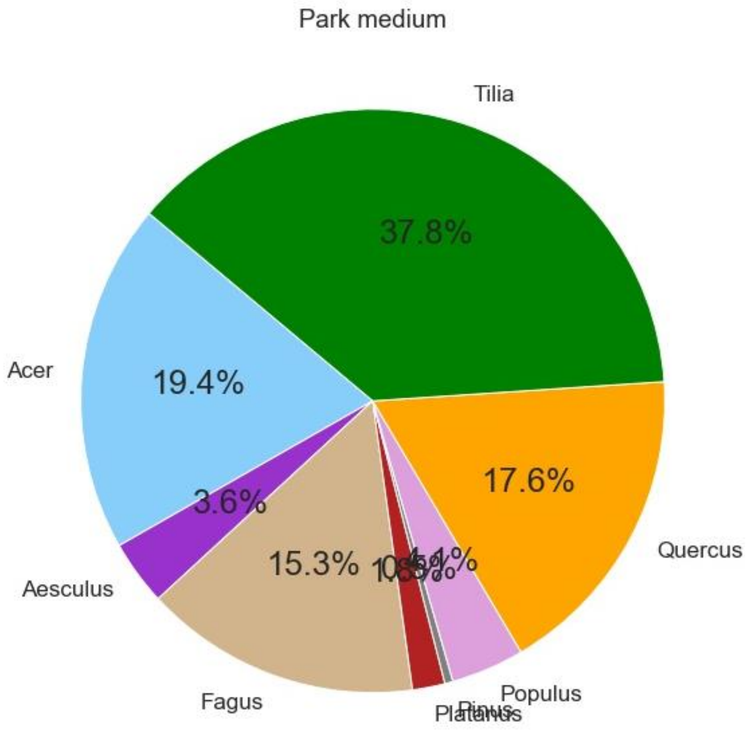
High density

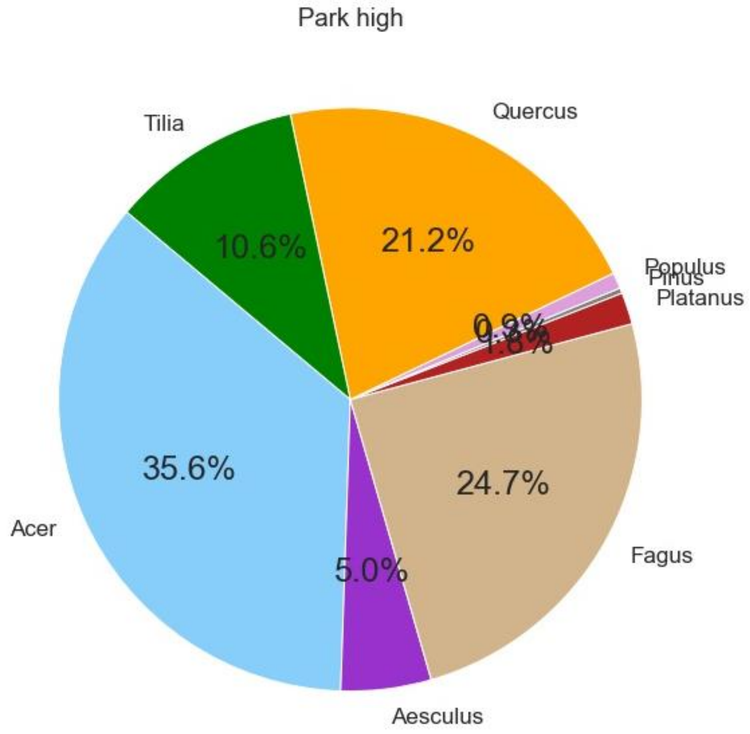
- 160 trees
- 10.6 ha
- 15.1 trees/ha

World Forum on Urban Forests
Mantova 2018

Species inventory - Park

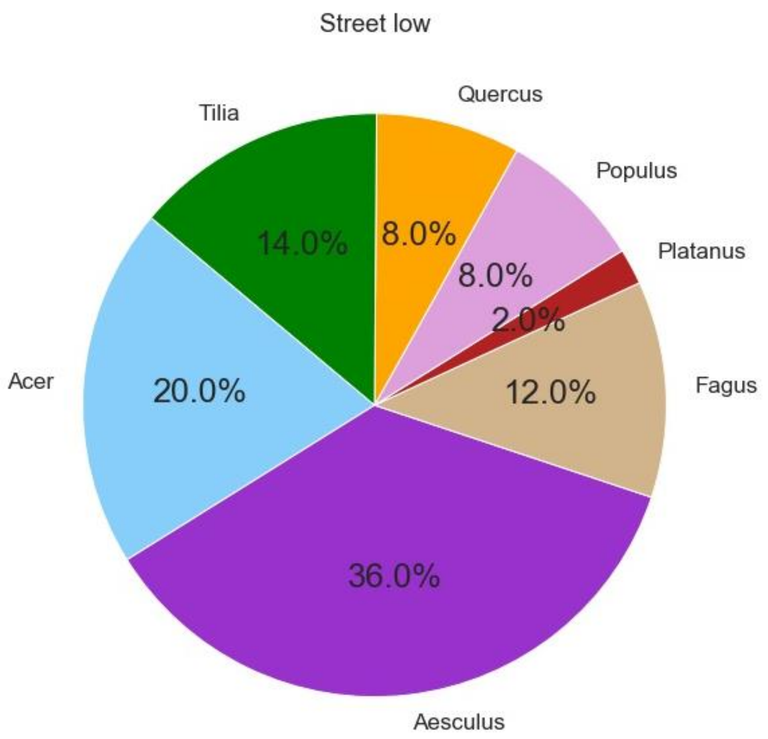


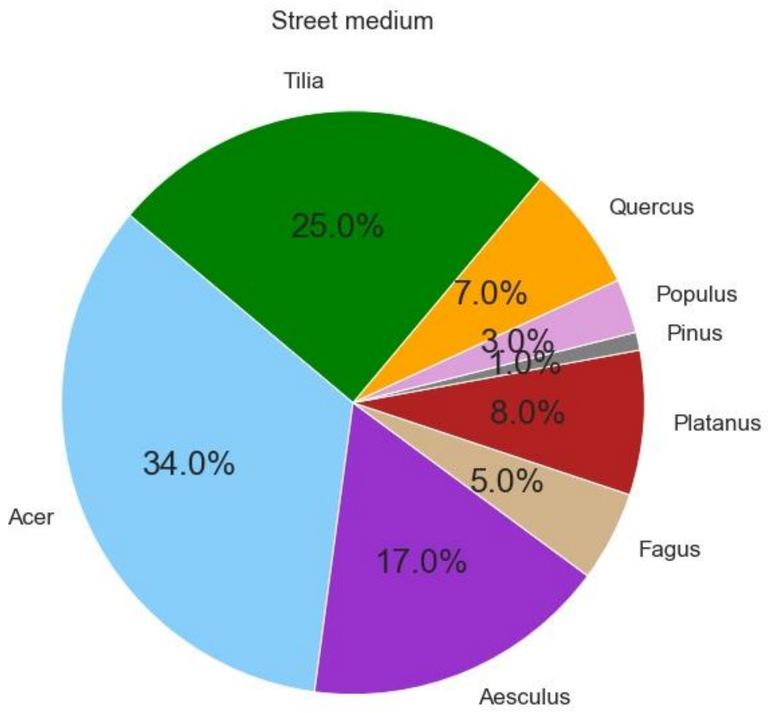


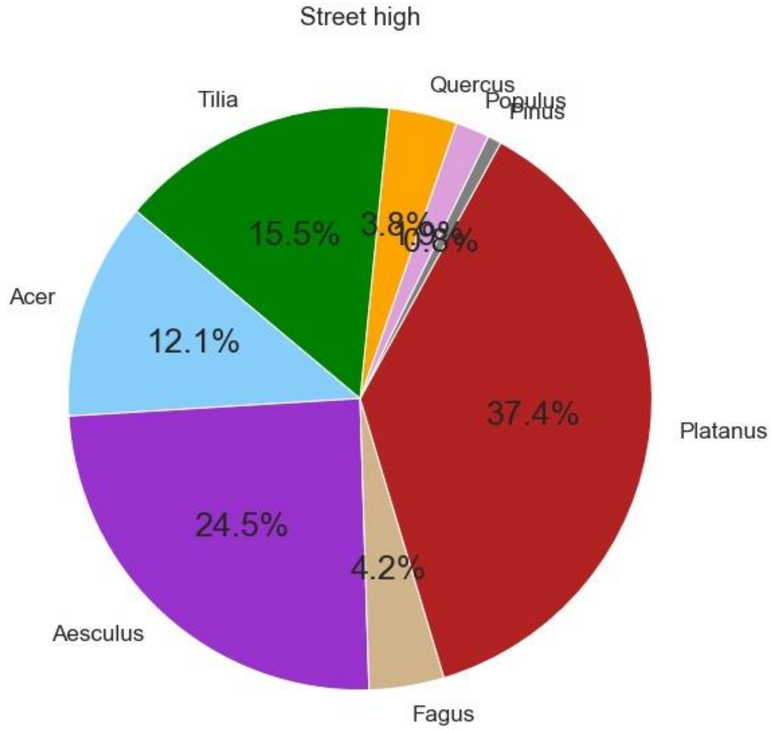


World Forum on Urban Forests
Mantova 2018

Species inventory - Street

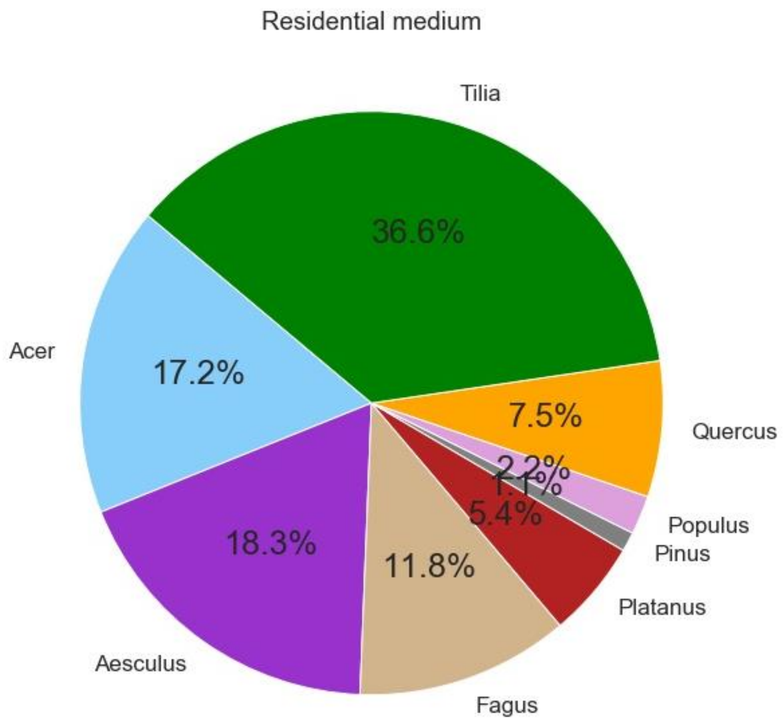


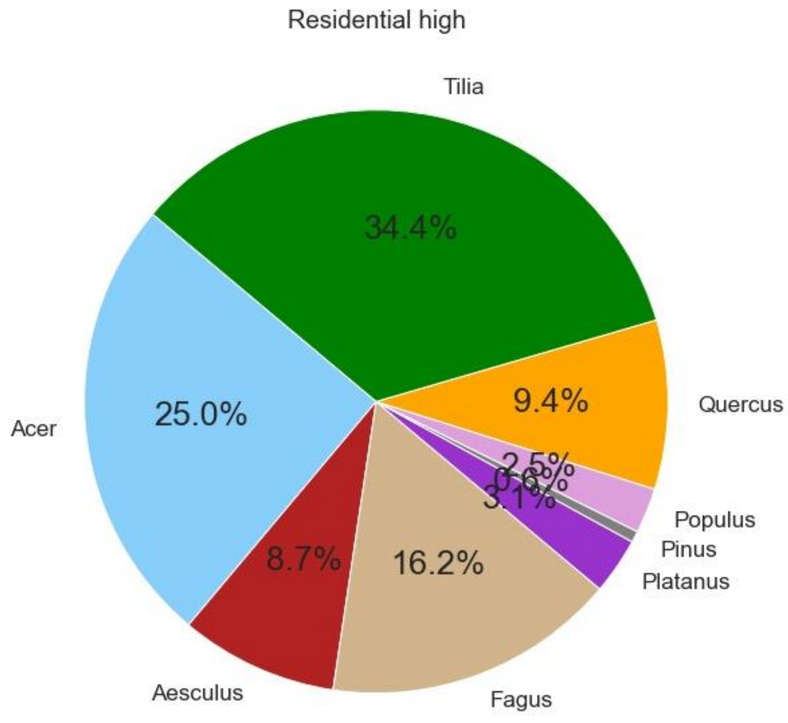




World Forum on Urban Forests
Mantova 2018

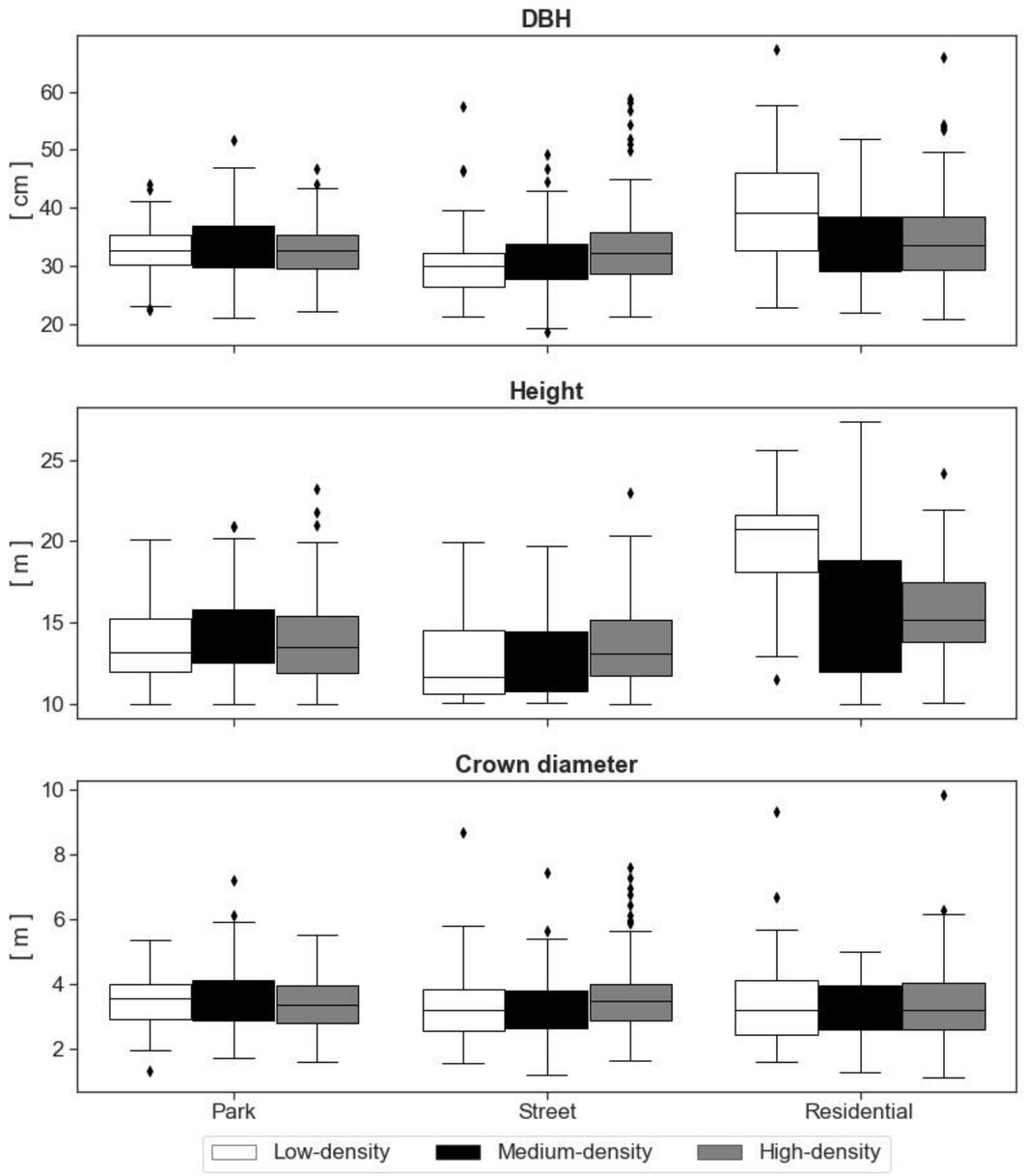
Species inventory - Residential





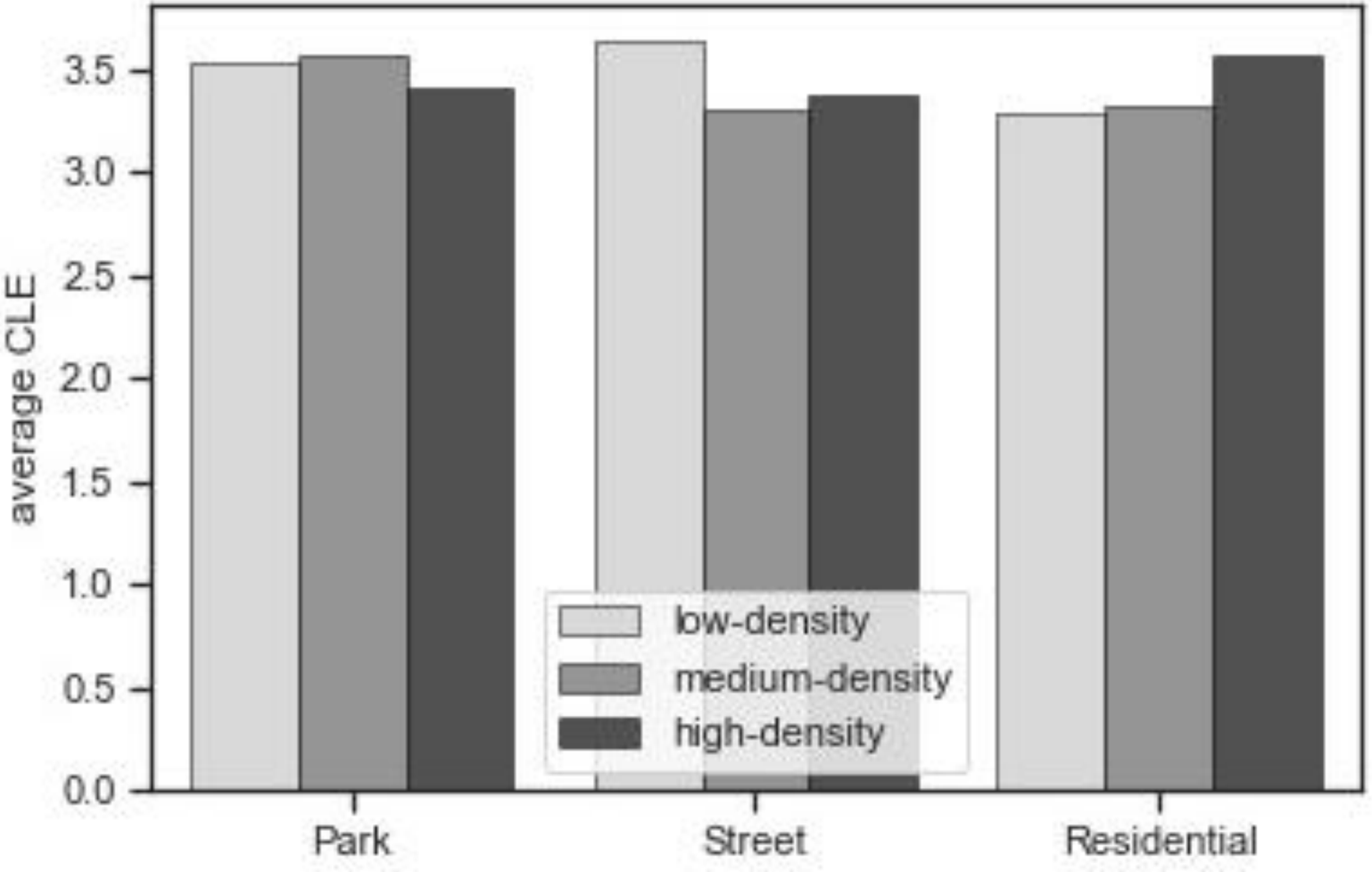
World Forum on Urban Forests
Mantova 2018

Trees information



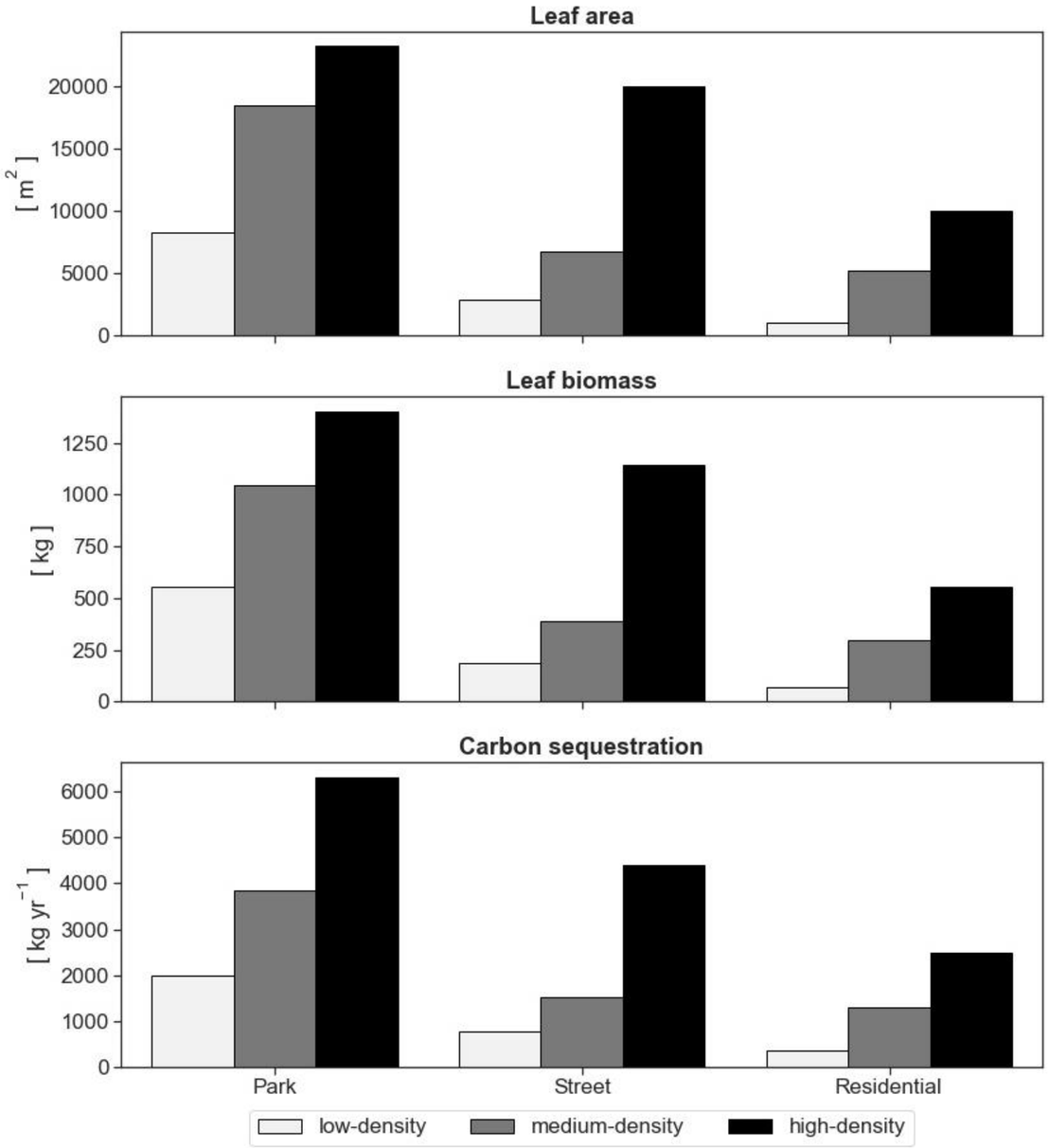
World Forum on Urban Forests
Mantova 2018

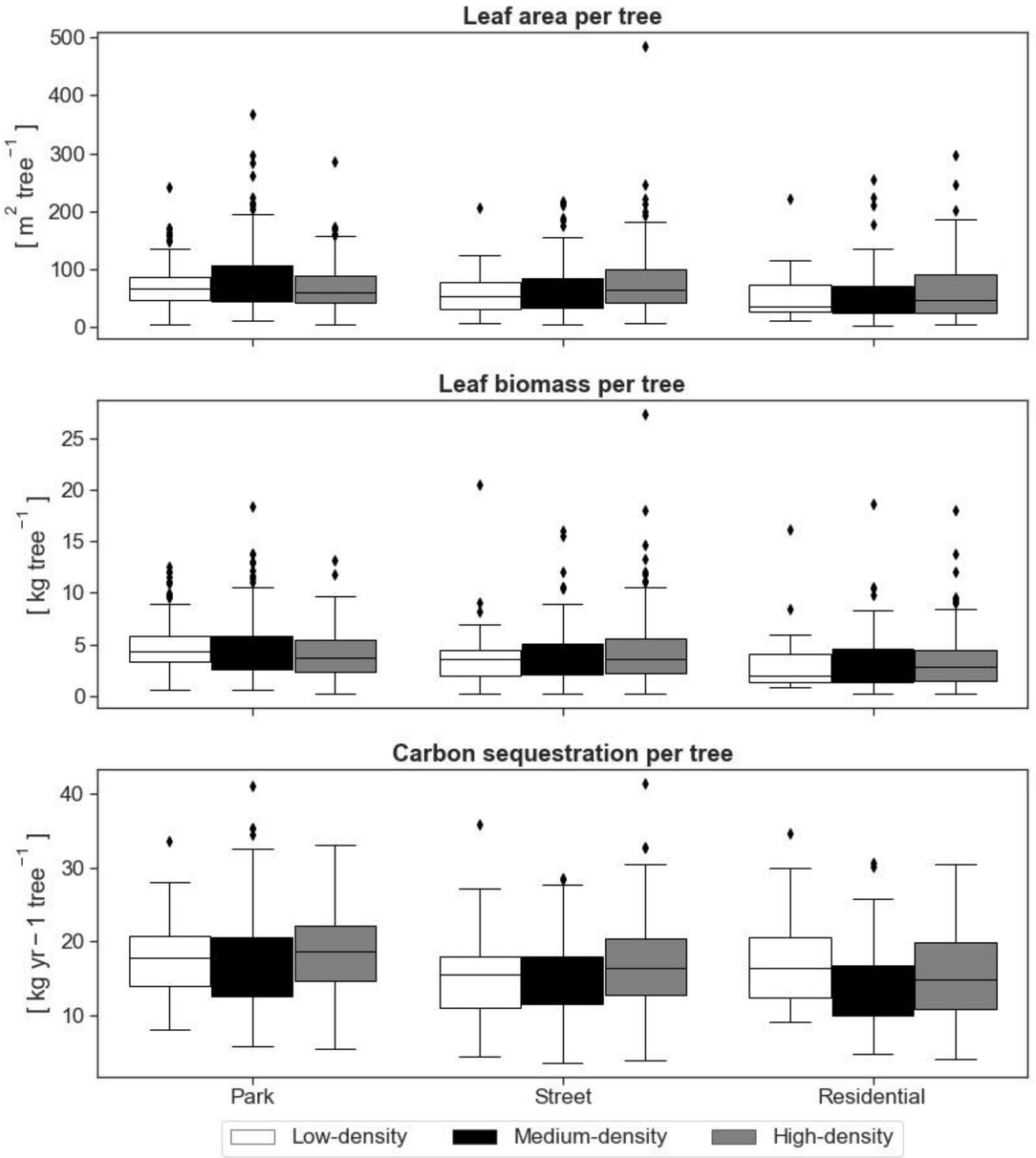
Crown light exposure



World Forum on Urban Forests
Mantova 2018

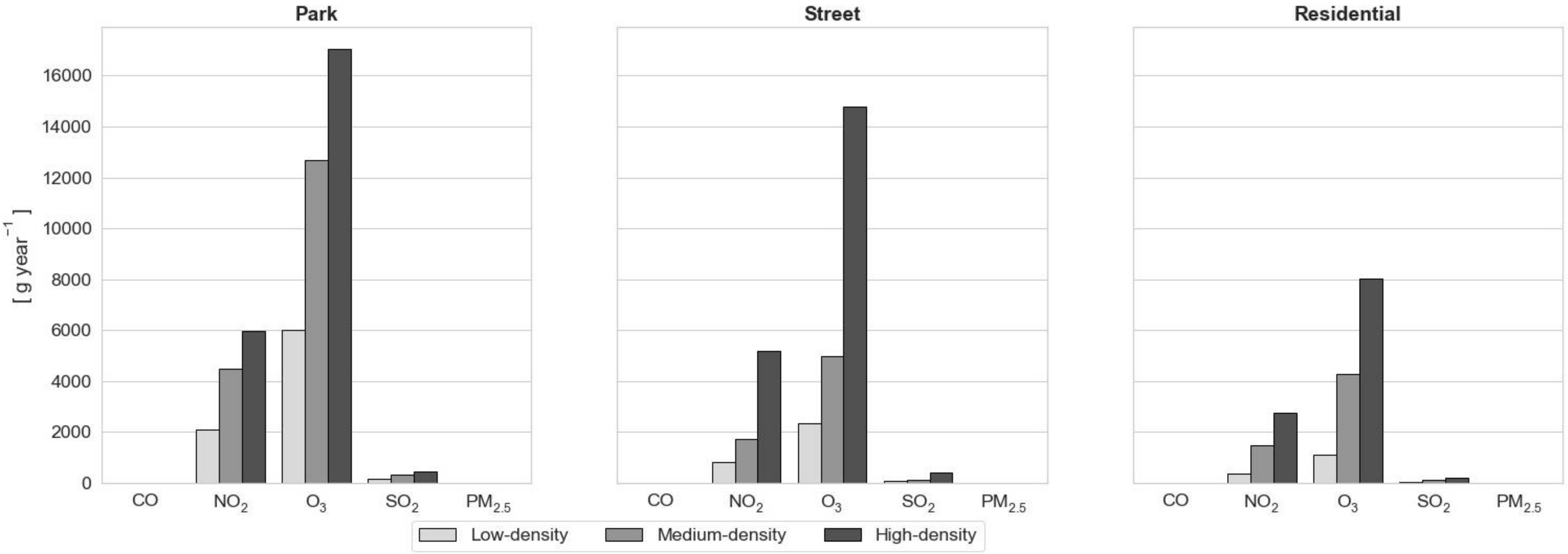
Trees calculation





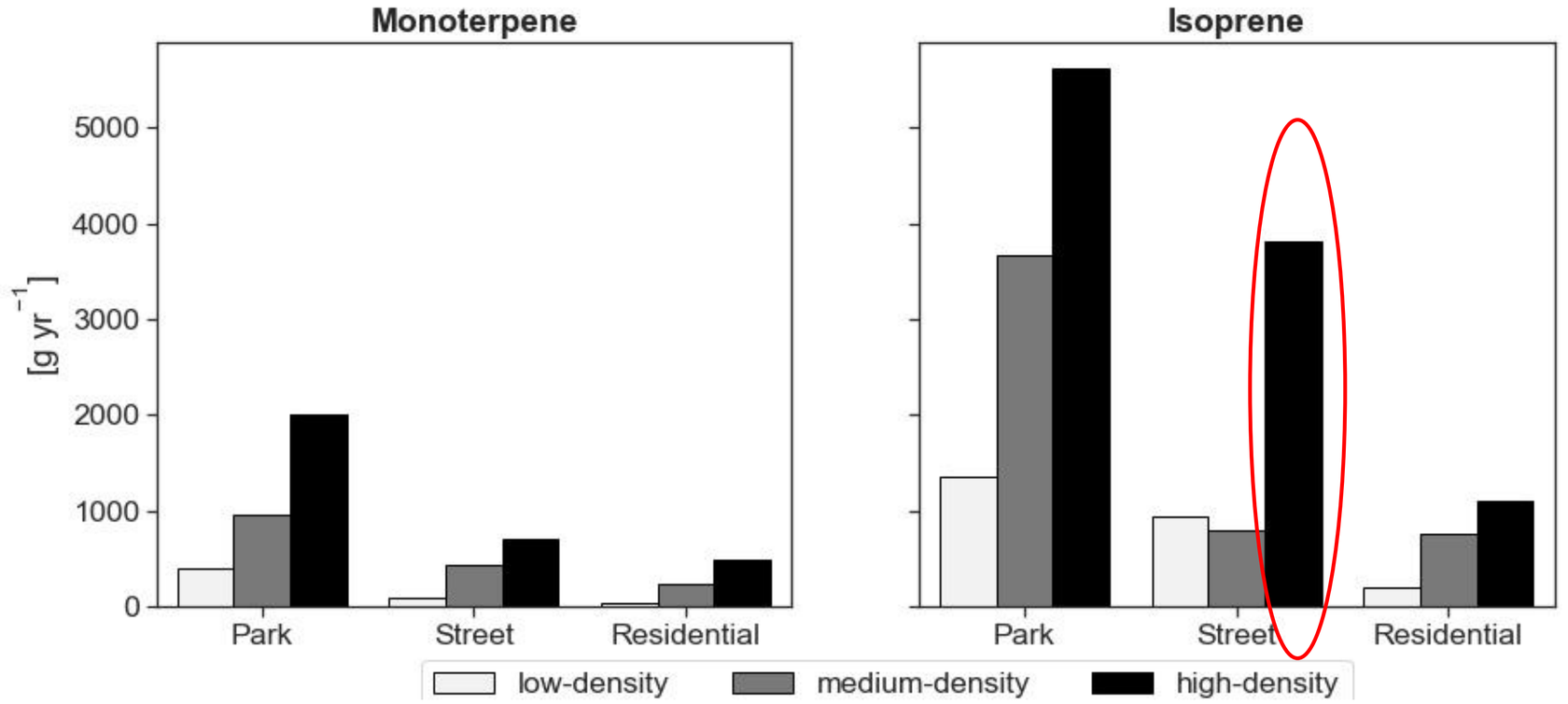
World Forum on Urban Forests
Mantova 2018

Air quality – Pollution removal



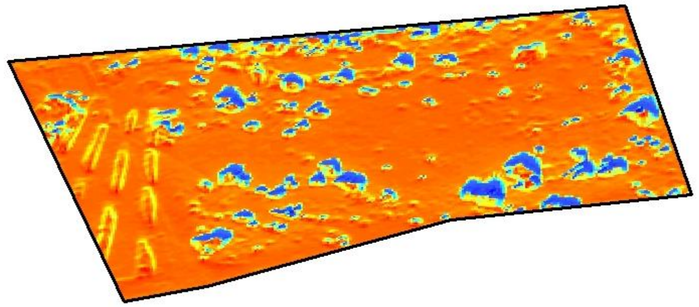
World Forum on Urban Forests
Mantova 2018

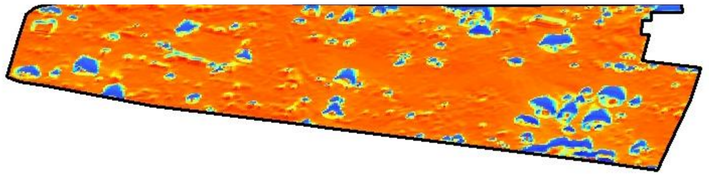
Air quality - BVOC

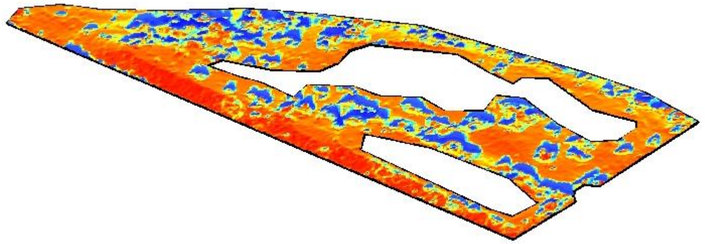


World Forum on Urban Forests
Mantova 2018

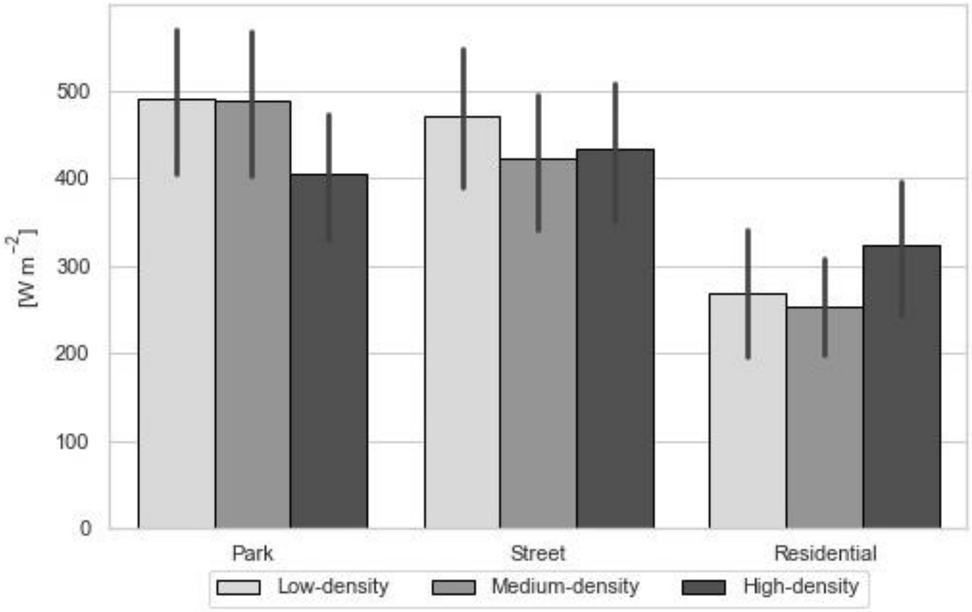
Shading

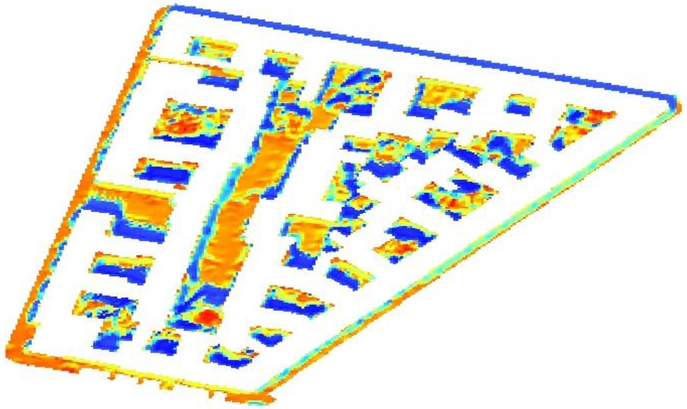


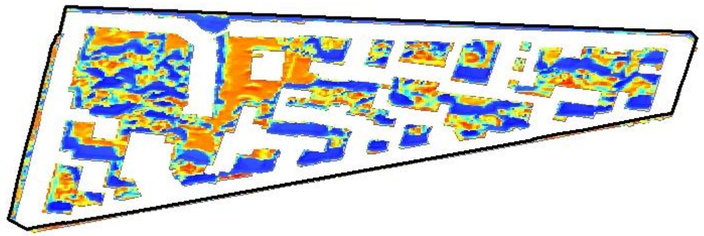


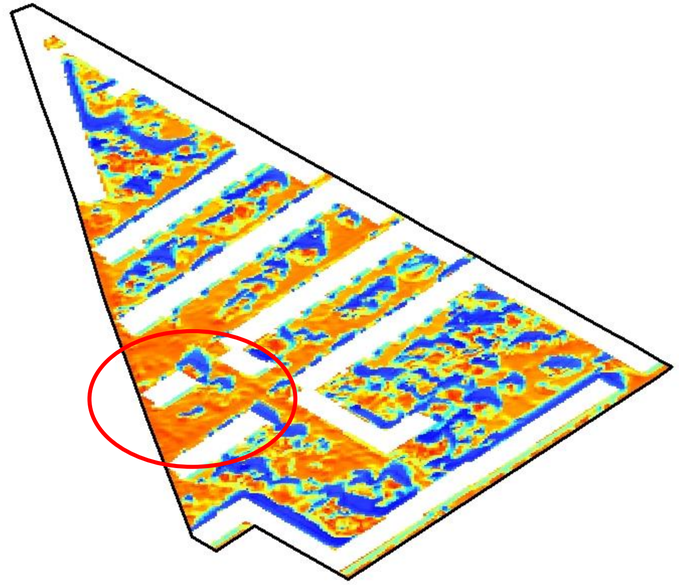


Solar radiation

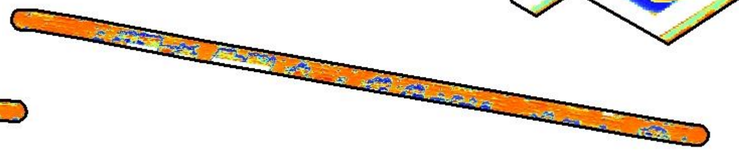








July 1st 12:00 - 15:00



World Forum on Urban Forests
Mantova 2018

Conclusions

- Increasing tree density:
  - Higher pollution removal but…
    - Light competition (contribute per single tree – LA)
    - Land use (space available – buildings)
    - Tree species (BVOC emission – ozone formation)
    - Tree canopy cover (shading – surface temperature)

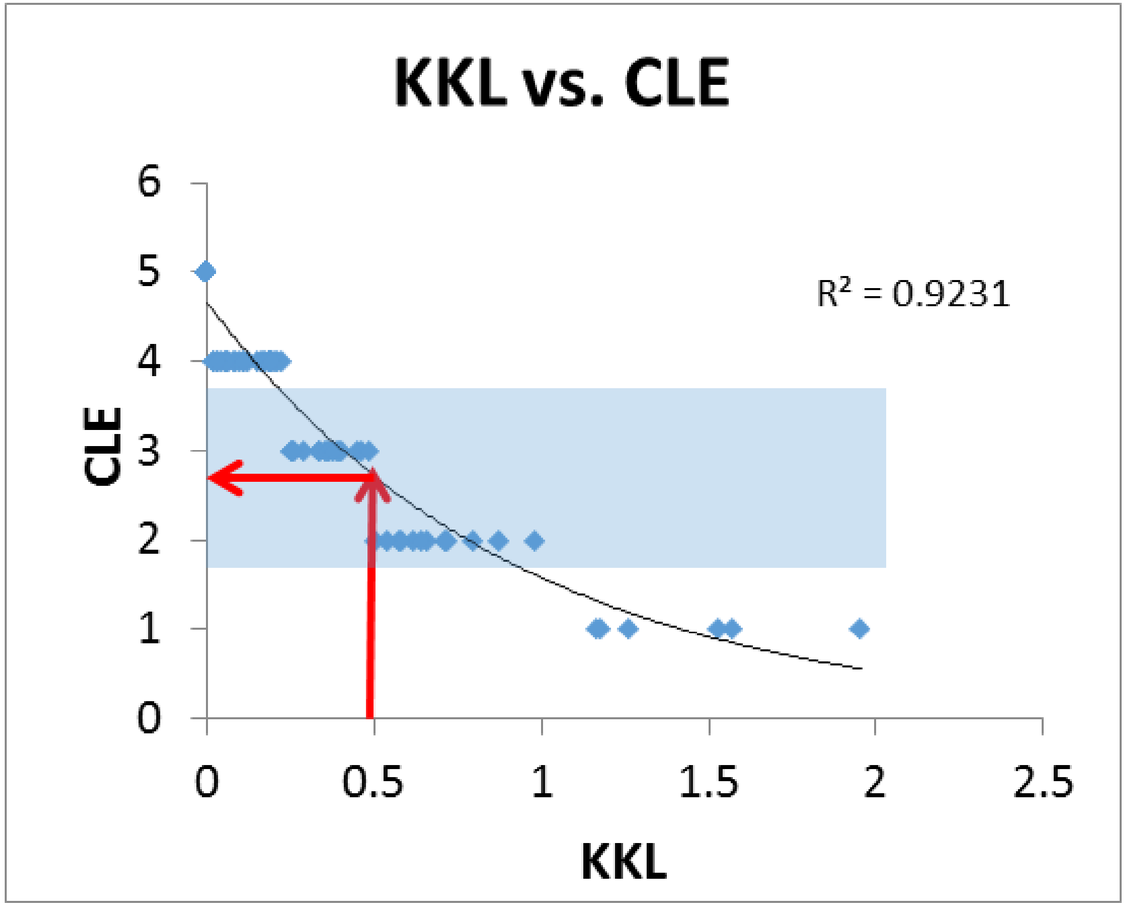
World Forum on
Urban Forests
Mantova 2018

Thanks for the attention!

World Forum on Urban Forests
Mantova 2018

Munich – Calculation of competition

- KKL vs. CLE (determined from 100 sample trees)



KKL	CLE
KKL<0.25	4-5
0.25<KKL<1	2-3
KKL>1	0-1