Biomonitoring of Urban Habitat Quality by Anatomical and Chemical Characteristics of Plant Foliage

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Introduction

- Urban Habitat Quality
  - Air/ Soil/ Water quality

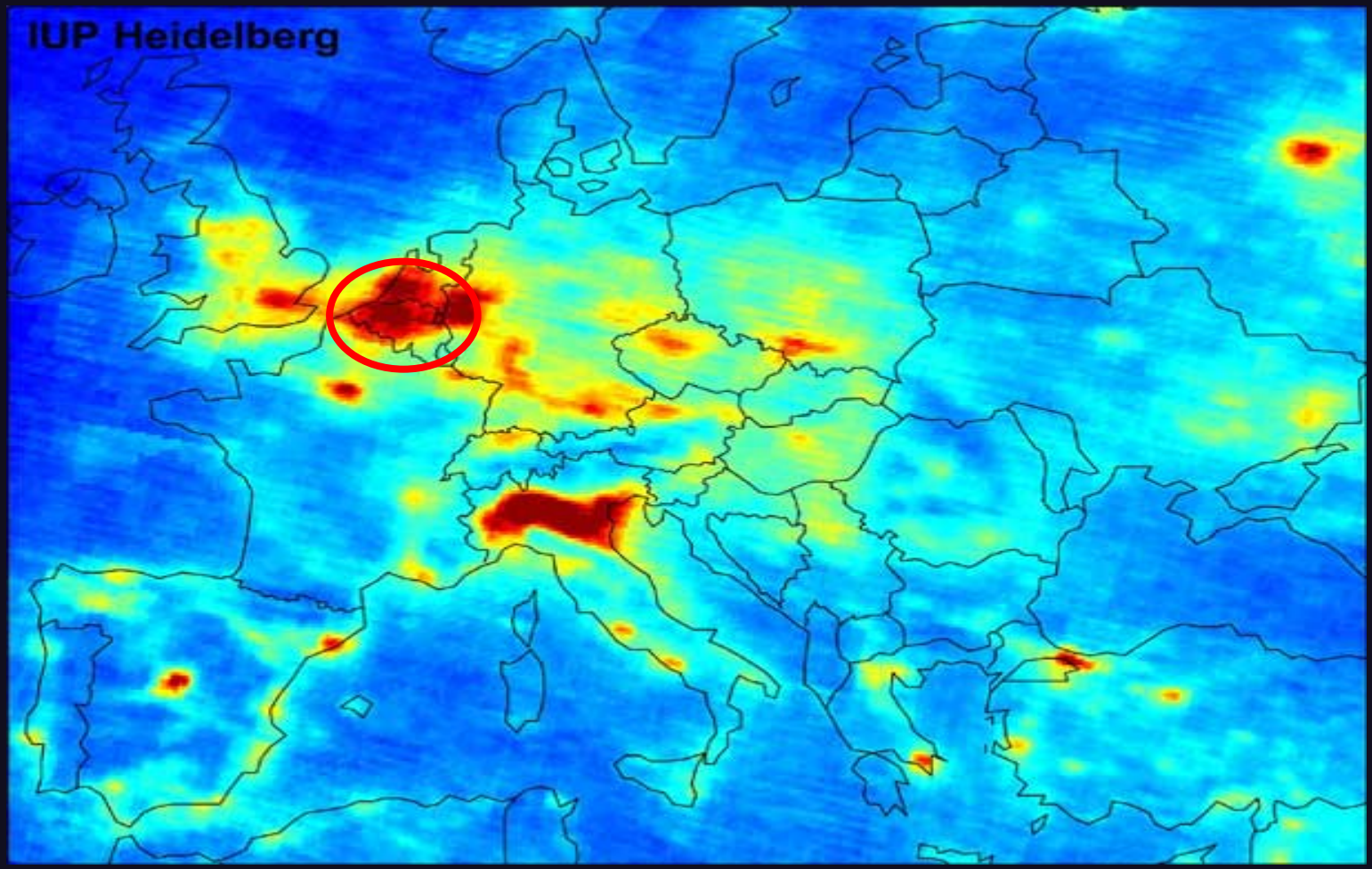
- Physico-Chemical Monitoring

  - High-tech equipment and methods
  - High cost
  - Based on single pollutants:

    SO_2, NO_x, O_3, CO_2, PM_{10},...
  - Eg: Flemish Environmental Agency (VMM)

Introduction contd..

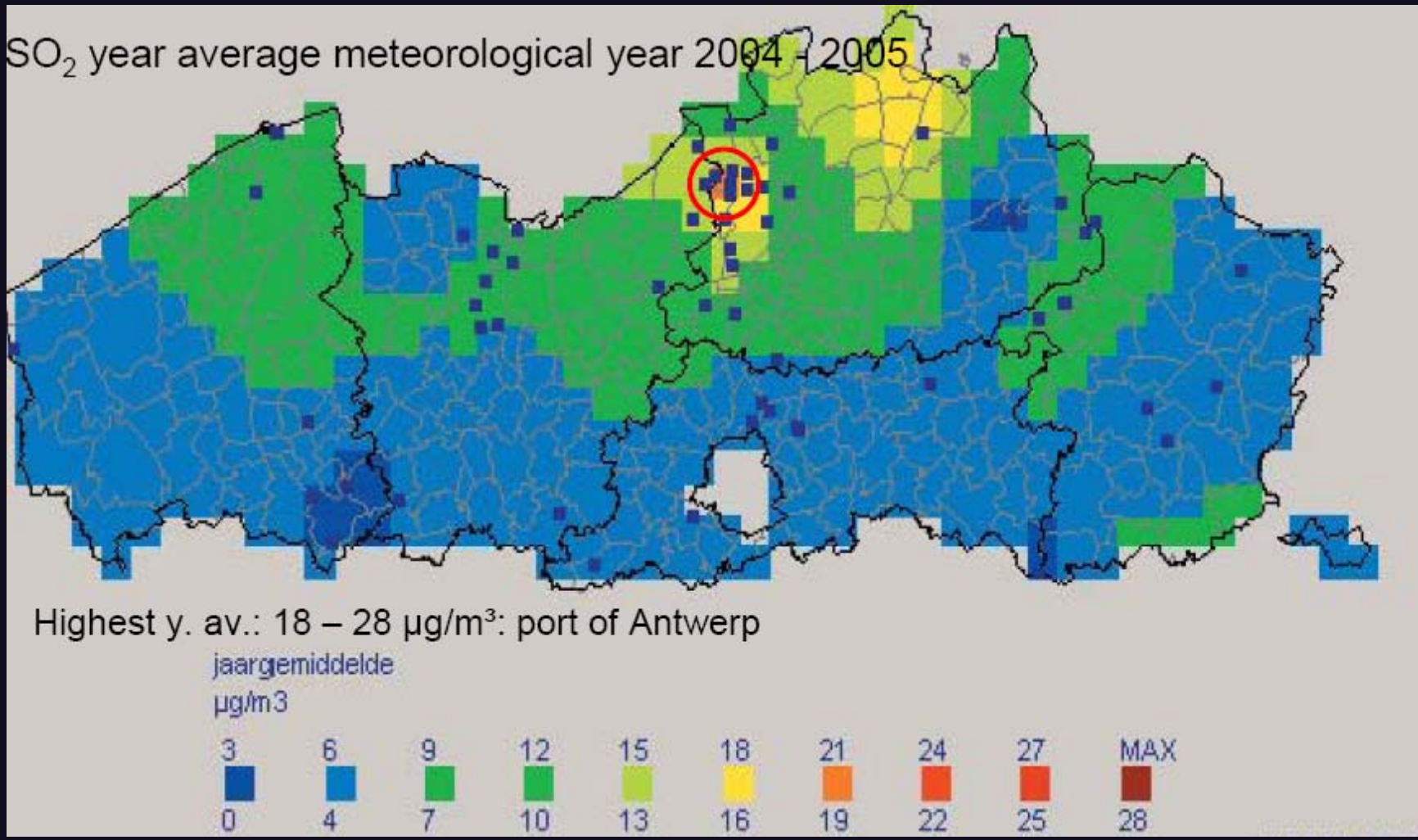
NO_2



WWW.esa.int

Introduction contd..

SO_2

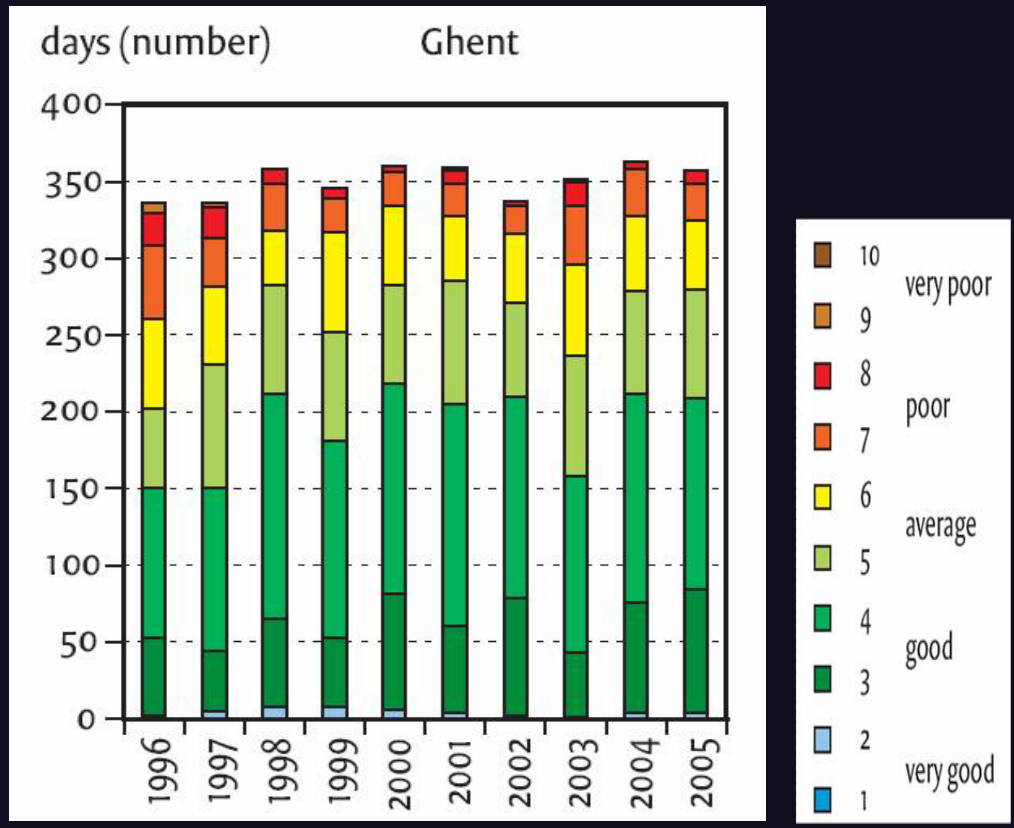


Source:IRCEL CELIN

Introduction contd..

Air Quality Index

-Calculated to integrate several pollutants



Source:IRCEL, WWW.vmm.be/mira

Introduction contd..

Biomonitoring

- combined effect – additive/synergistic/antagonistic
- low-tech equipment and methods
- less cost – large data base

- Bioaccumulation

Trace element accumulation : Lichens, *Quercus illex*

- Plant responses

Physiological responses

eg: photosynthesis and stomatal conductance

Morphological and anatomical characteristics

- Foliar injuries, leaf area
- Specific leaf area, stomatal density, stomatal pore surface

Objectives

To evaluate the potential of

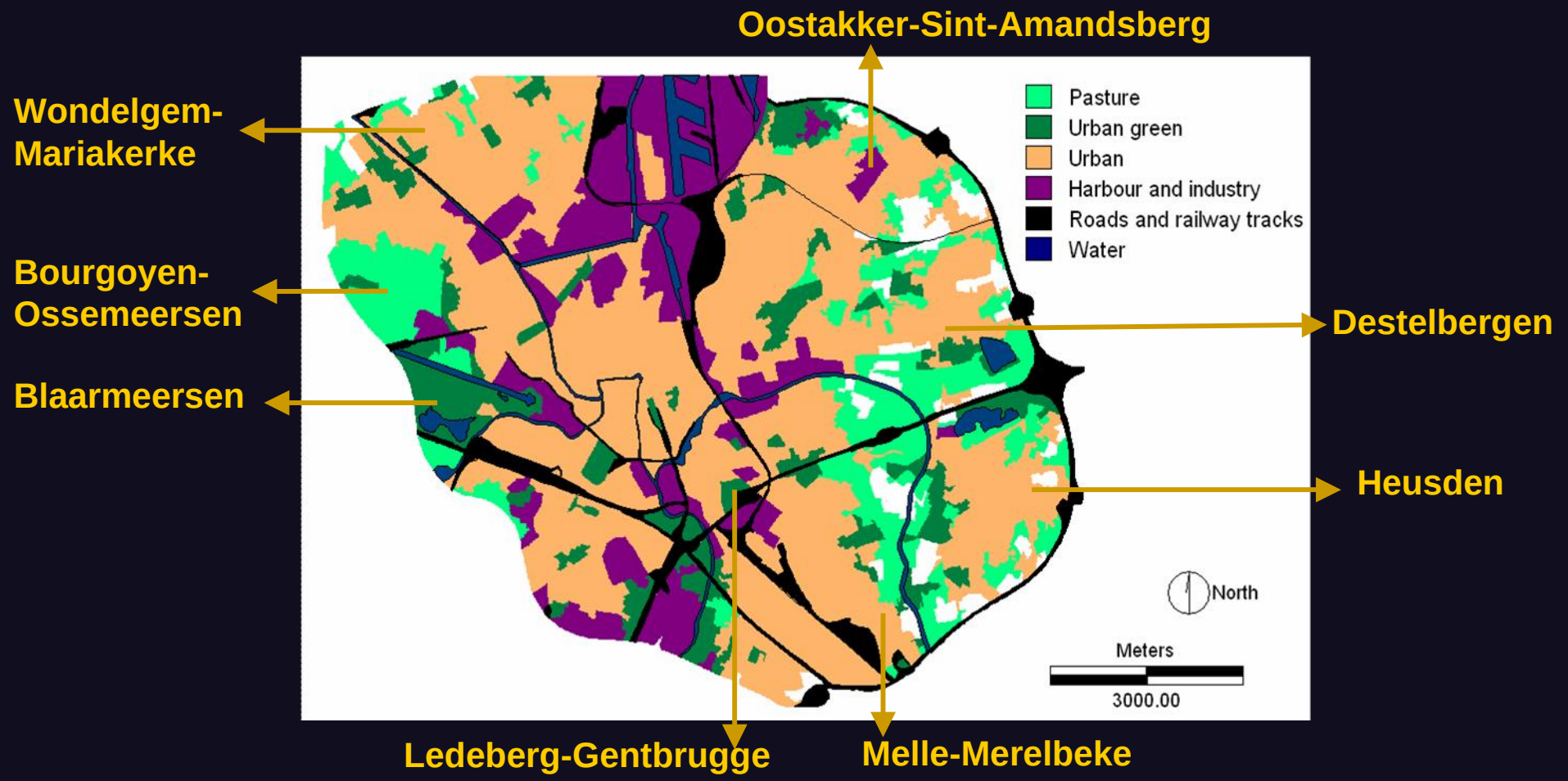
- Specific leaf area
- Stomatal density and
- Stomatal pore surface

as parameters in biomonitoring of urban habitat quality

Materials and Methods

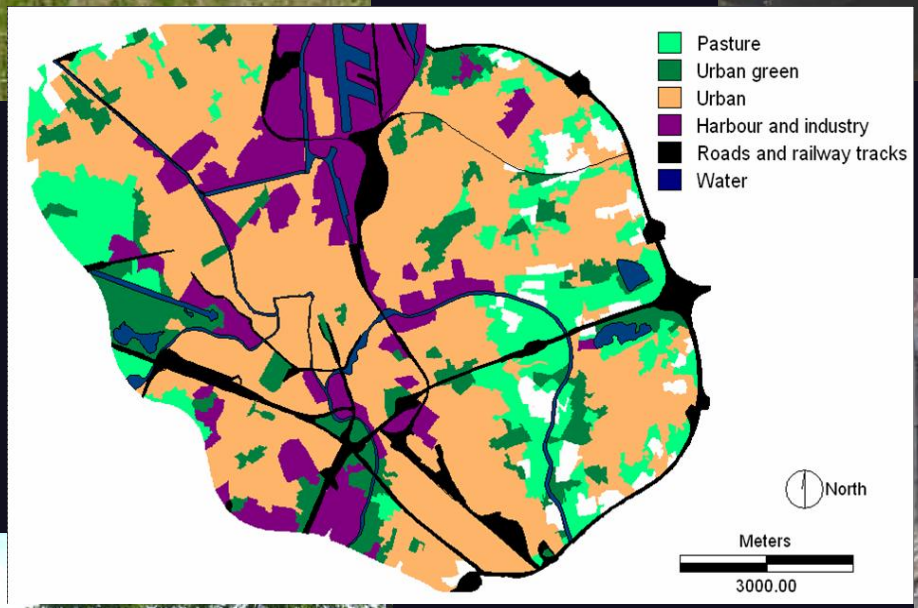
Study area

- City of Gent
- 81.5 km^2 area
- 4 land use classes



Bourgoyen-Ossemeersen

Gent-harbour



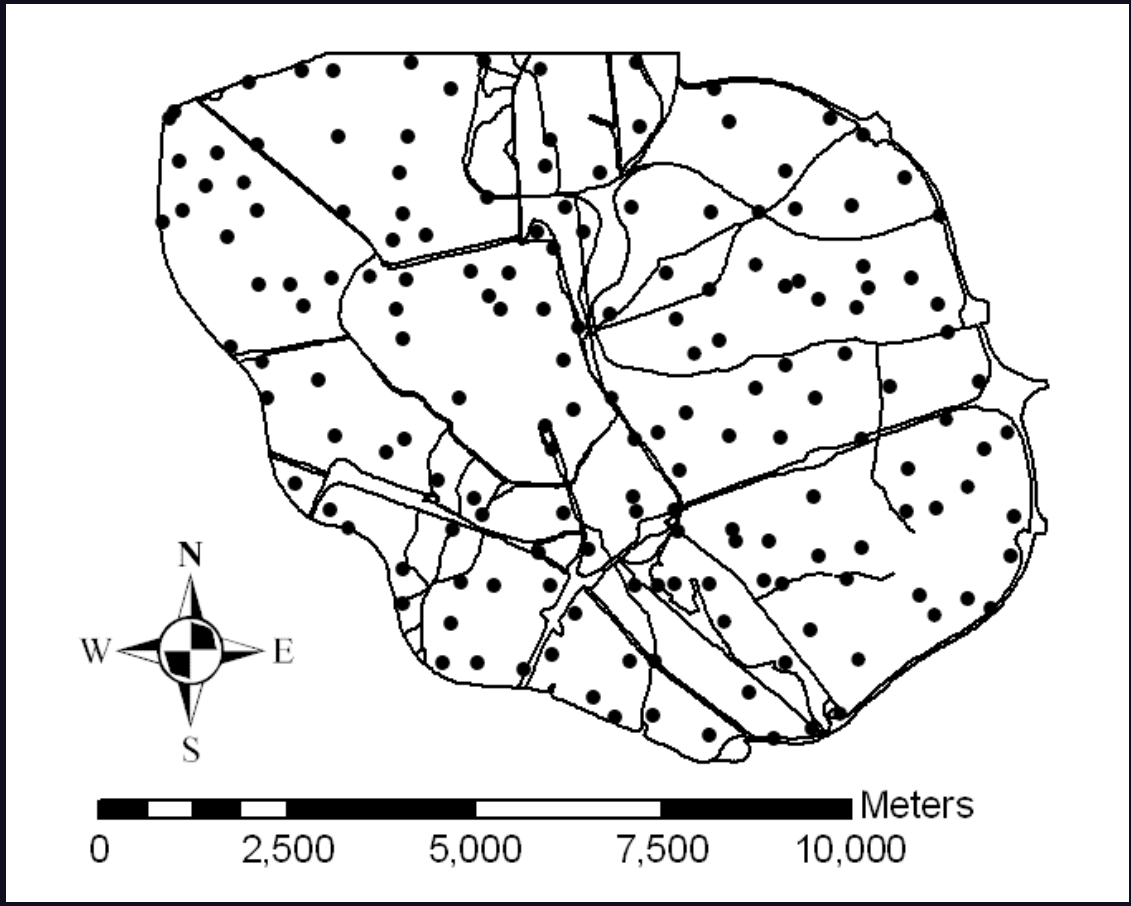
City Centre

Blaarmeersen

Materials and Methods contd..

Sampling Survey:

- Partially random & grid sampling design
- 169 sampling locations
- During 2005-2007



Materials and Methods contd..

Selection of species

- Widely distributed
- Perennial
- Easy to sample
- Sensitive/ tolerant to pollutants (literature)

Materials and Methods contd..

At each sampling location

- 4 sub-sampling points
- Leaf samples
- Stomatal imprints

Determination of bio-chemical parameters

(only for *T. officinalis*)

- Chlorophyll a and b
- C and N content
- $\delta^{13}C$ and $\delta^{15}N$ content

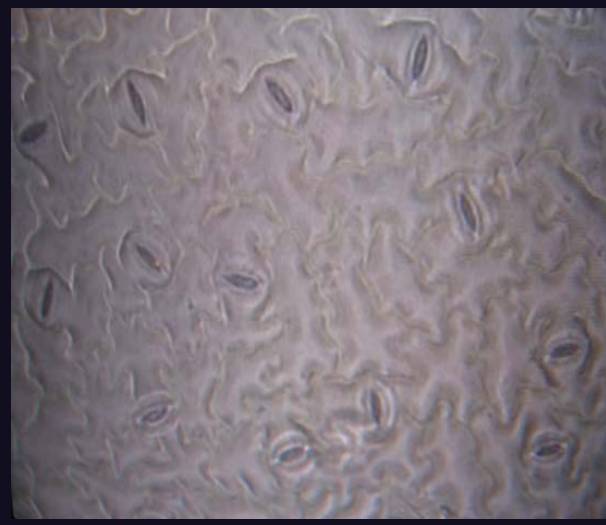
Determination of SLA (SLA, $m^2\ g^{-1}$)

- Measurement of leaf area and dry weight
- SLA = LA/DW

Materials and Methods contd..

Determination of stomatal characteristics

- 40 x 10 magnification under light microscope
- Stomatal density (SD, mm^{-2}) = No. of stomata per leaf area
- Measurement of pore length and width and calculation of
  - Stomatal pore surface (SPS, μm^2)
  - Theoretical stomatal resistance (Rs, sm^{-1})

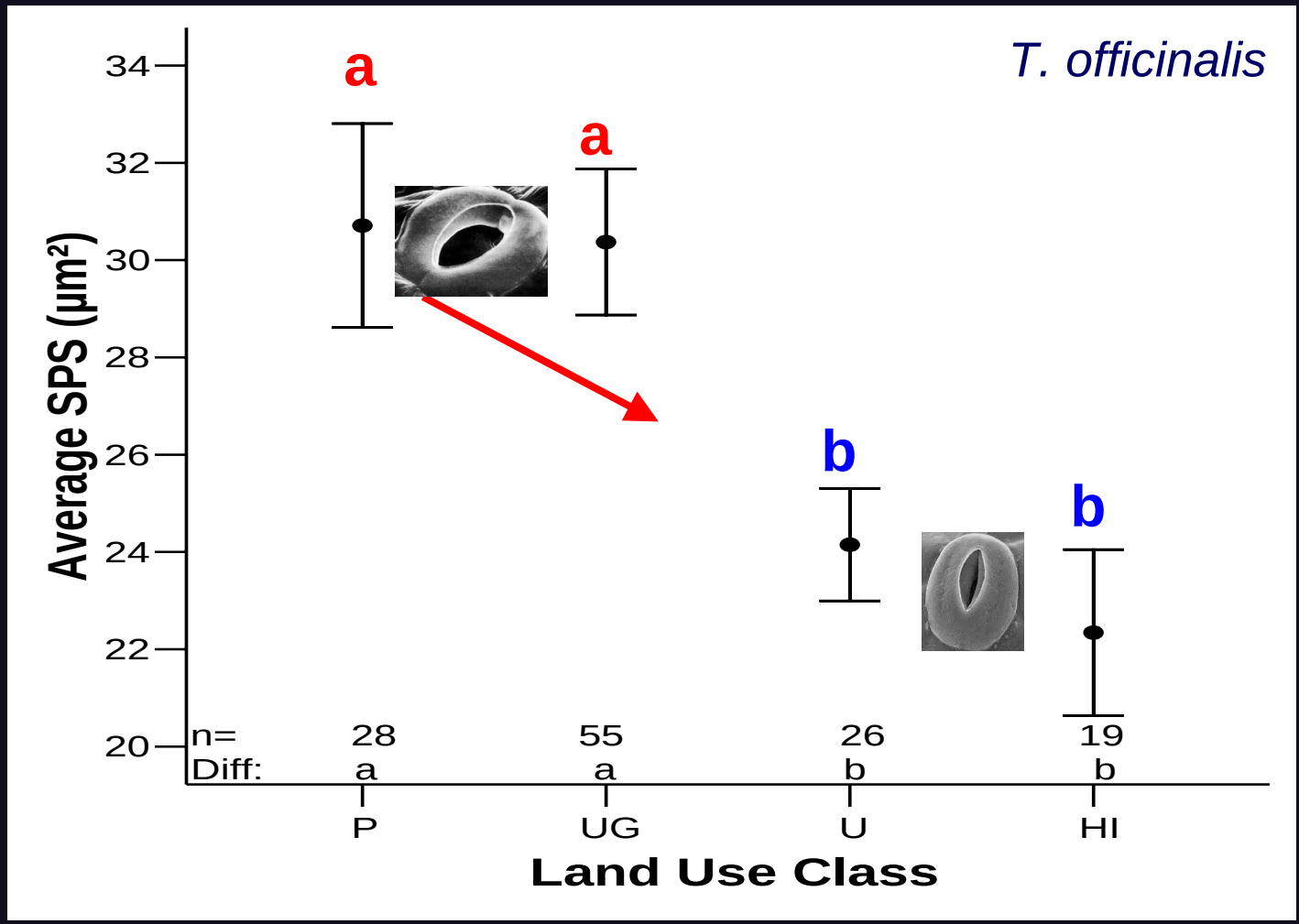


Data analysis

- ANOVA with Duncan test for differences between land use classes
- Geostatistical analysis - Ordinary Kriging and Simple Kriging with varying Local Means (SKLM).

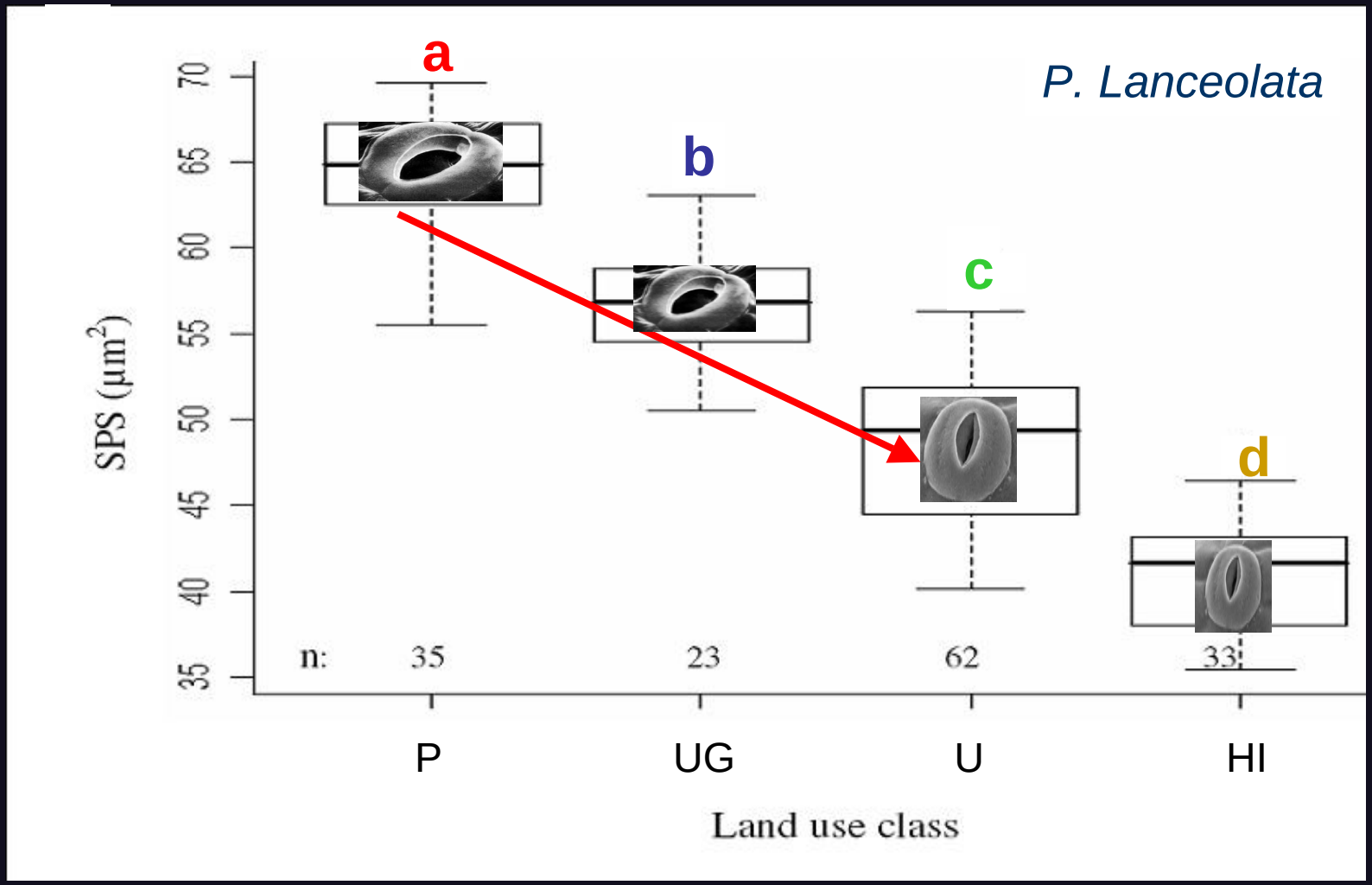
Results

SPS


T. officinalis
a
a
b
b
34
32
30
28
26
24
22
20
Average SPS (µm²)
n=
Diff:
28
a
55
a
26
b
19
b
P
UG
U
HI
Land Use Class

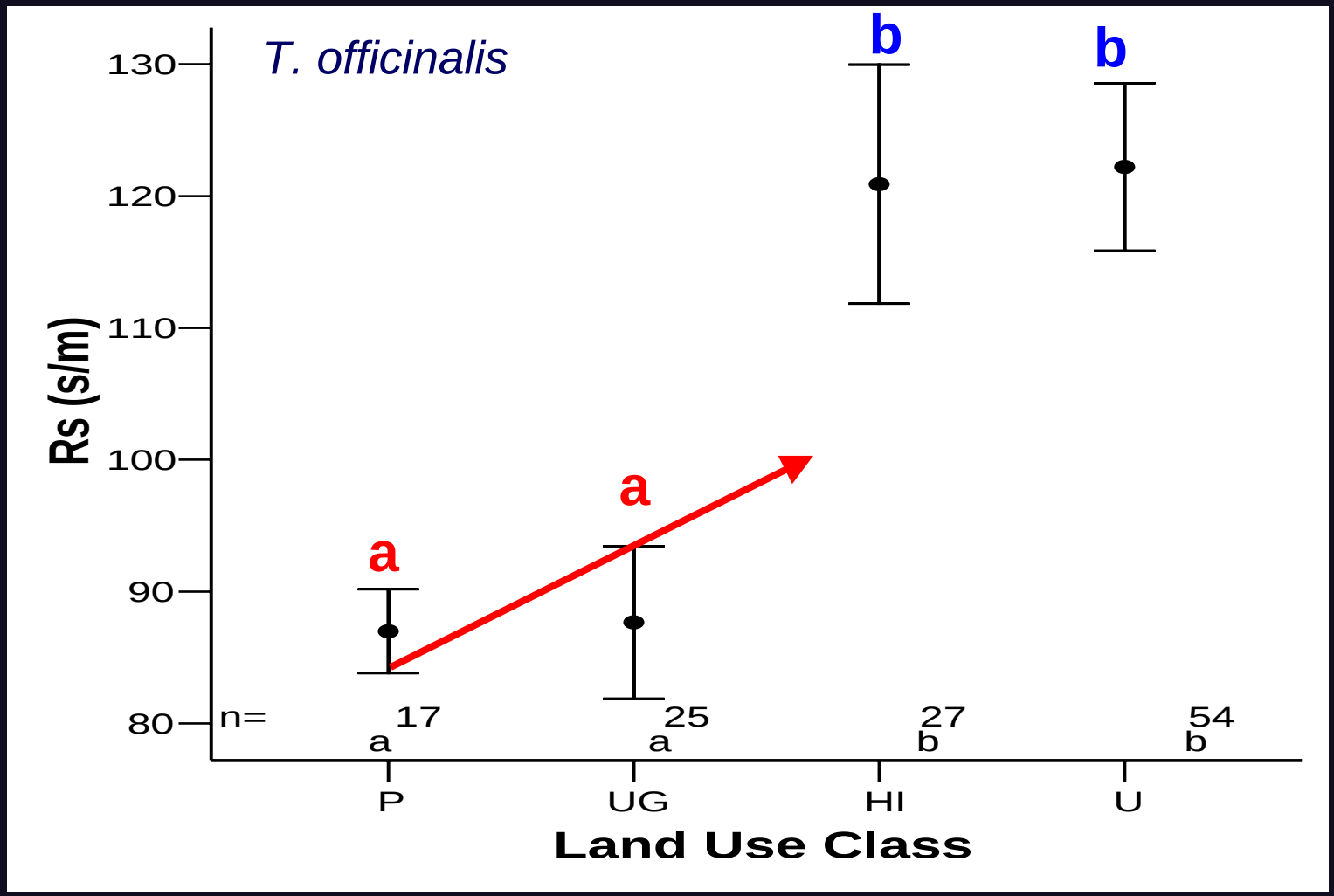
Results

SPS


a
b
c
d
P. Lanceolata
SPS (µm²)
70
65
60
55
50
45
40
35
n:
35
23
62
33
P
UG
U
HI
Land use class

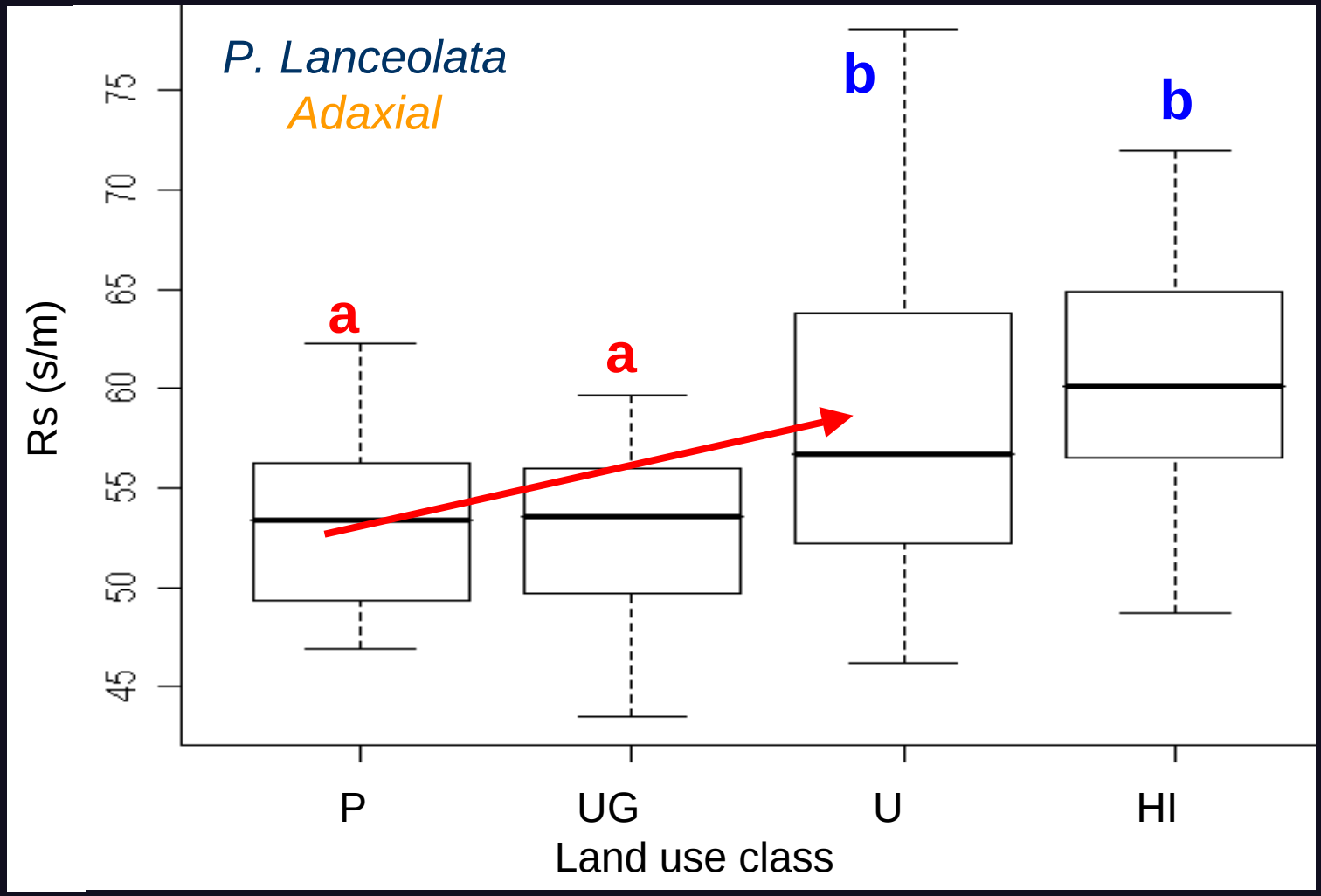
Results

Rs


T. officinalis
130
120
110
100
90
80
Rs (s/m)
b
b
a
a
n=
17
25
27
54
a
a
b
b
P
UG
HI
U
Land Use Class

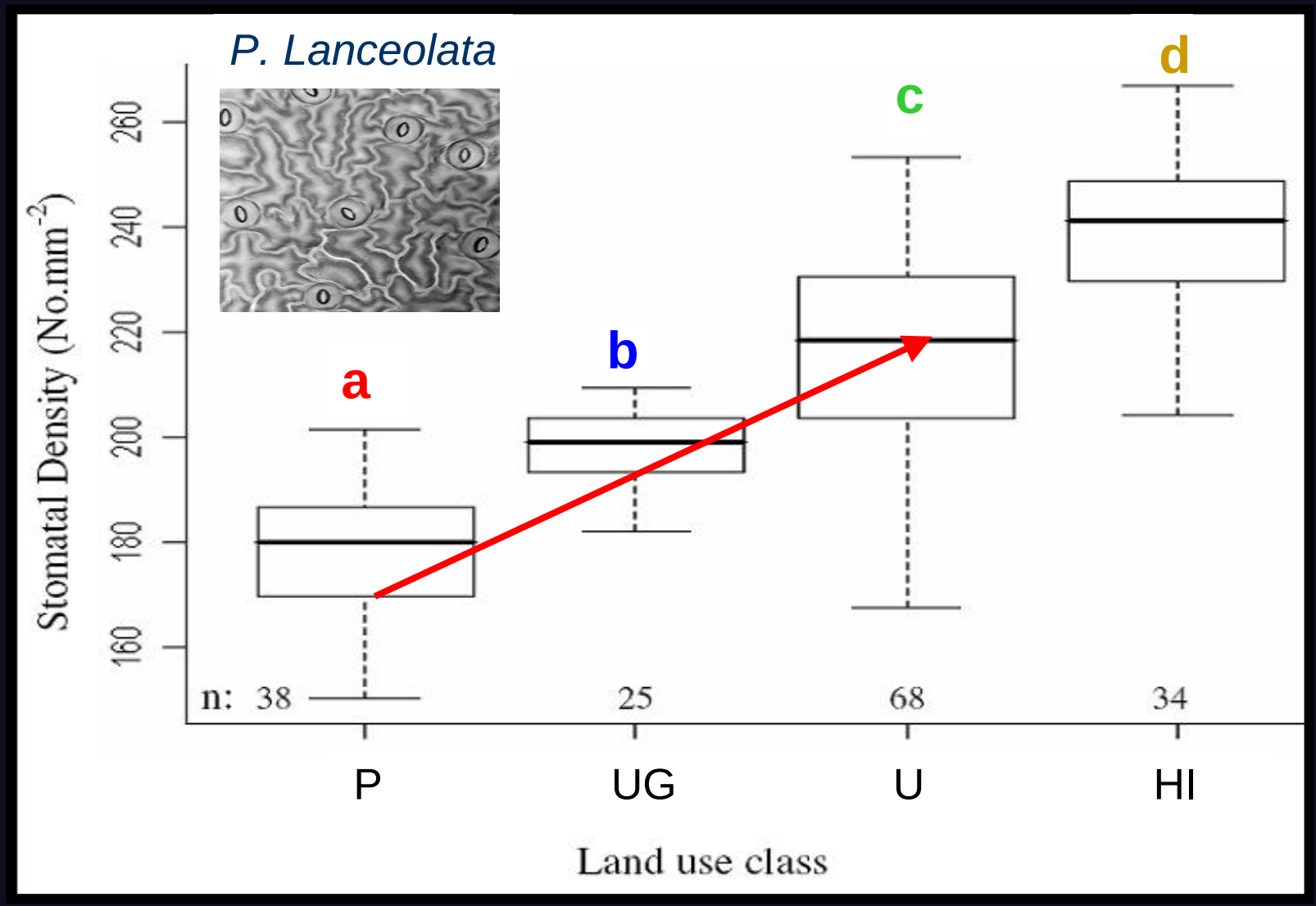
Results

Rs


P. Lanceolata
Adaxial
a
a
b
b
Rs (s/m)
45
50
55
60
65
70
75
P
UG
U
HI
Land use class

Results

SD


P. Lanceolata
a
b
c
d
Stomatal Density (No.mm-2)
160
180
200
220
240
260
n: 38
25
68
34
P
UG
U
HI
Land use class

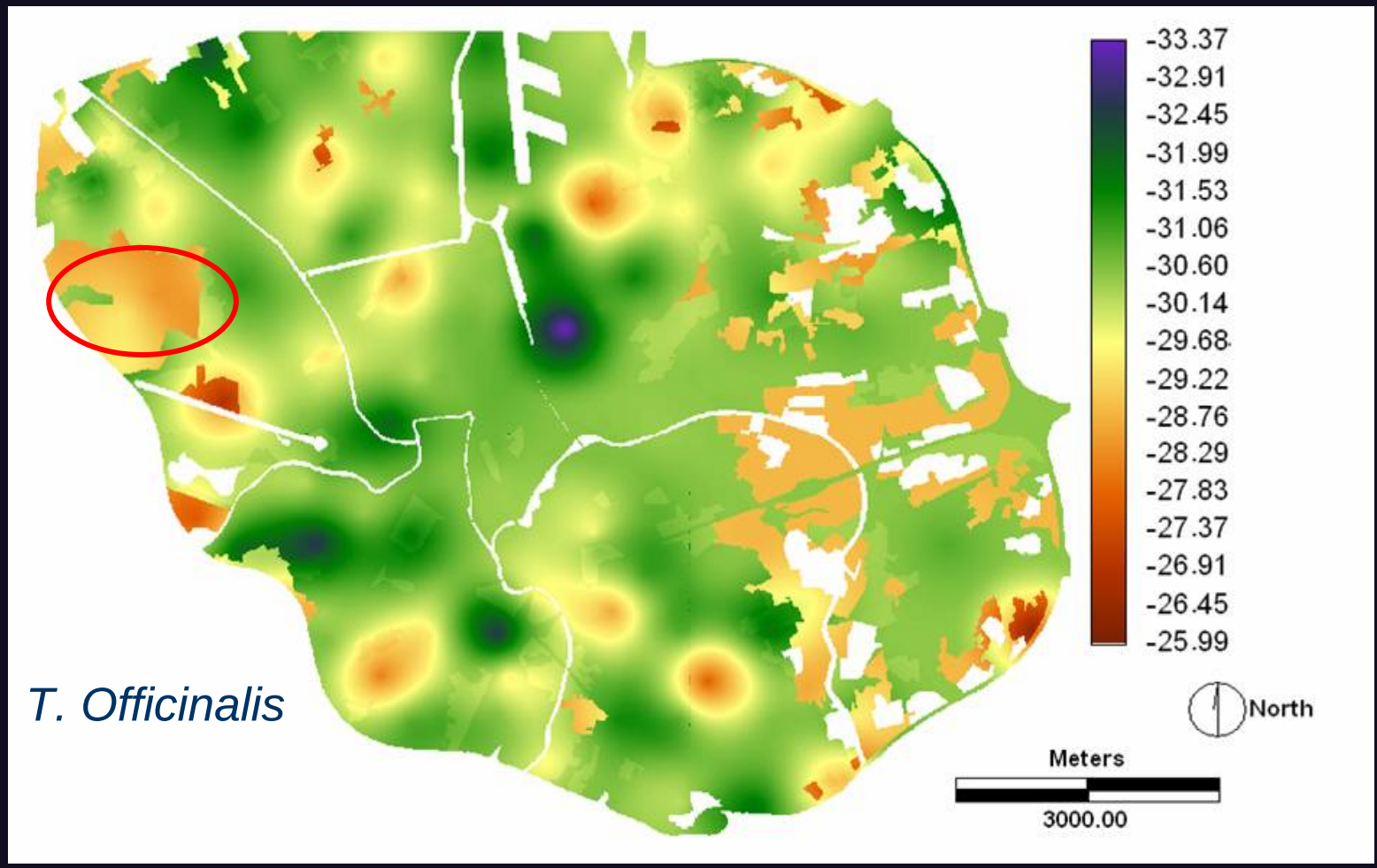
Results

Pearson's correlation matrix of all considered parameters for *P. lanceolata*

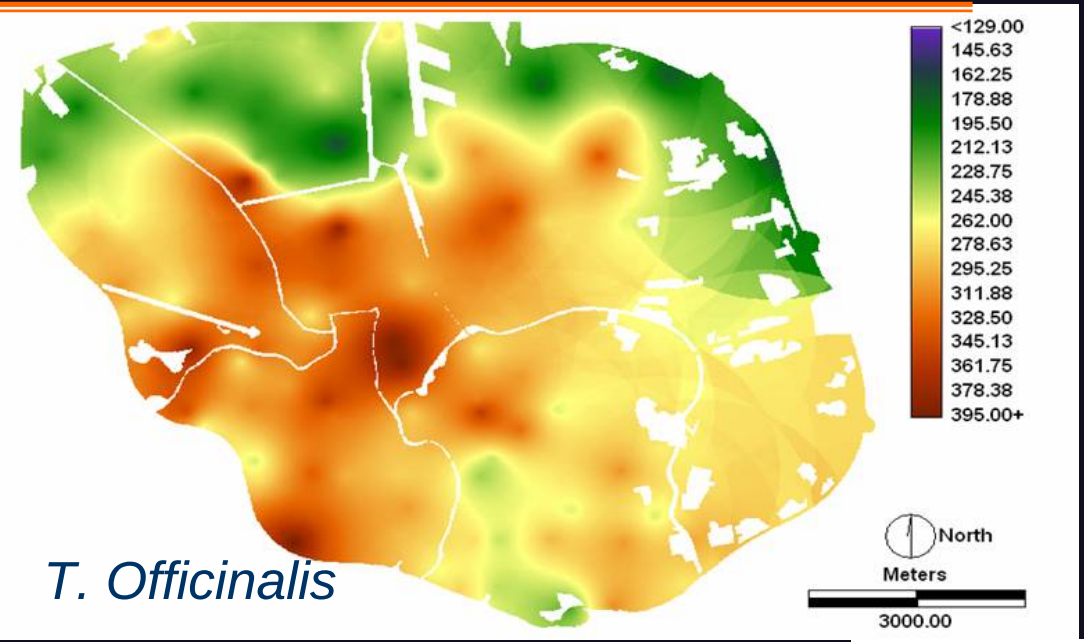
	SD_{AD}	SD_{AB}	SPS_{AD}	SPS_{AB}	$RSPS_{AD}$	$RSPS_{AB}$	Rs_{AD}	Rs_{AB}
SLA	0.16*	0.17*	-0.13	-0.16	0.02	-0.02	-0.06	-0.03
SD_{AD}		0.90**	-0.69**	-0.73**	-0.03	-0.15	-0.15	-0.03
SD_{AB}			-0.72**	-0.75**	-0.16	-0.09	-0.01	-0.09
SPS_{AD}				0.90**	0.74**	0.60**	-0.59**	-0.46**
SPS_{AB}					0.57**	0.71**	-0.43**	-0.57**
$RSPS_{AD}$						0.71**	-0.97**	-0.68**
$RSPS_{AB}$							-0.67**	-0.97**
Rs_{AD}								0.68**

Results

C13

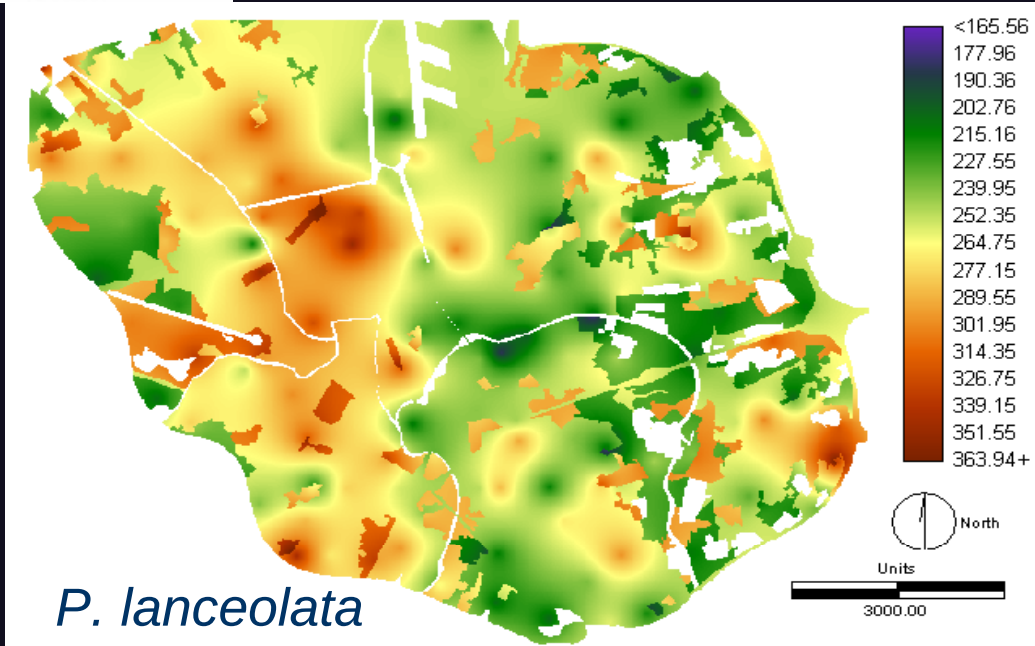

-33.37
-32.91
-32.45
-31.99
-31.53
-31.06
-30.60
-30.14
-29.68
-29.22
-28.76
-28.29
-27.83
-27.37
-26.91
-26.45
-25.99
T. Officinalis
North
Meters
3000.00

Results



T. Officinalis

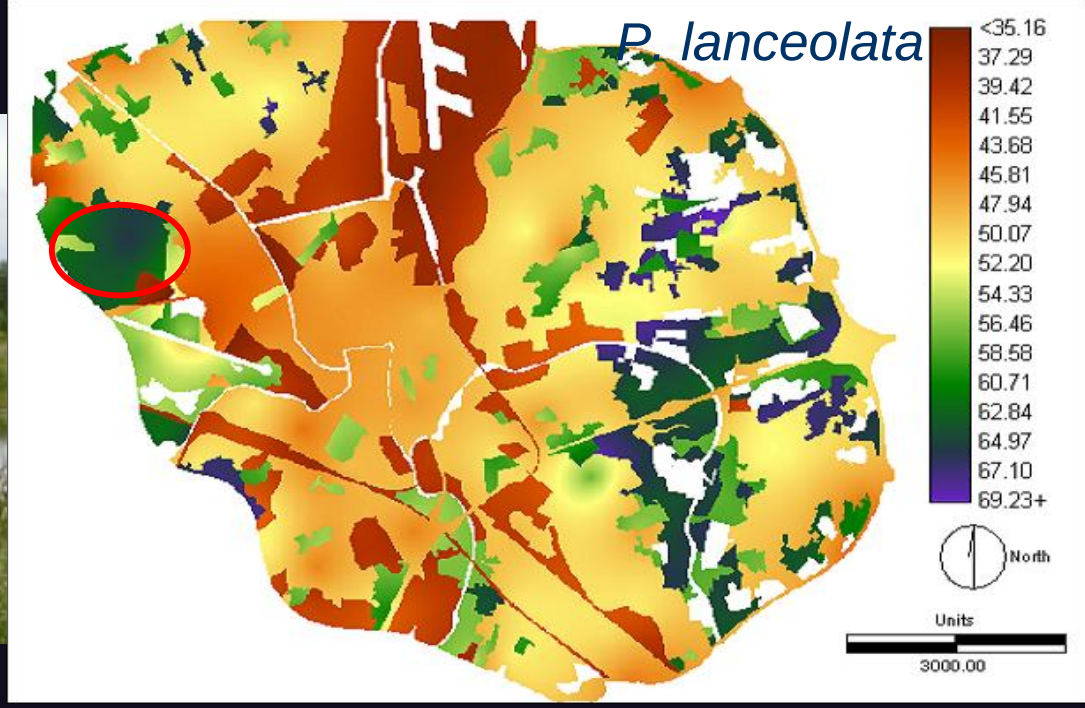
SLA

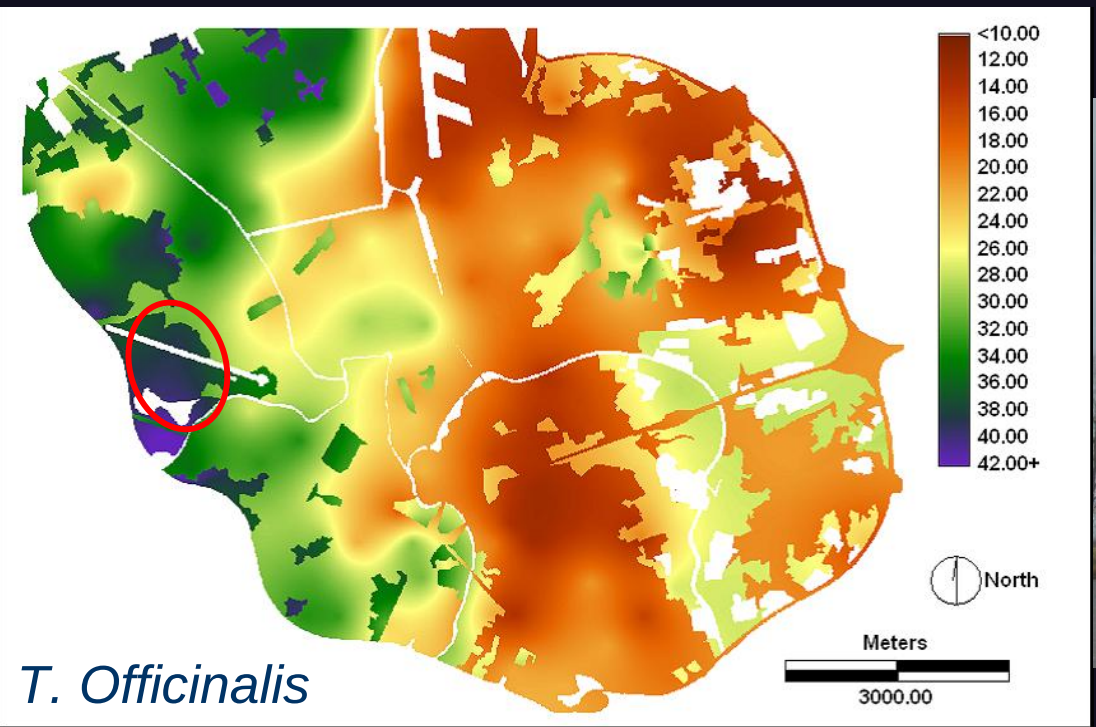


P. lanceolata

SPS

Bourgoyen-Ossemeersen

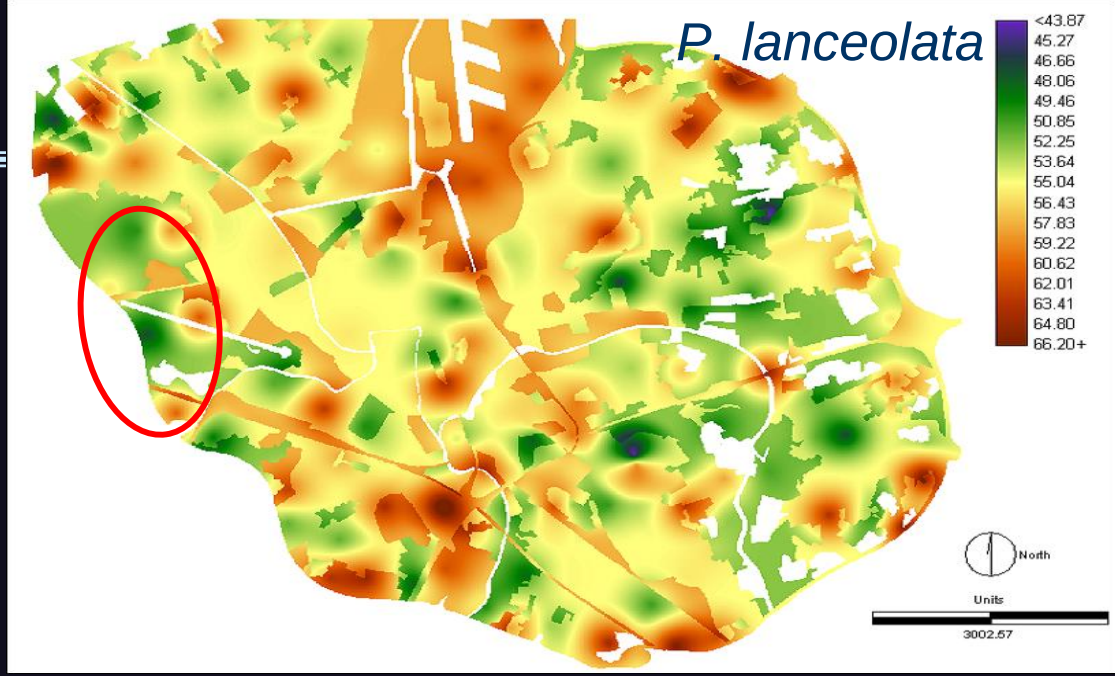


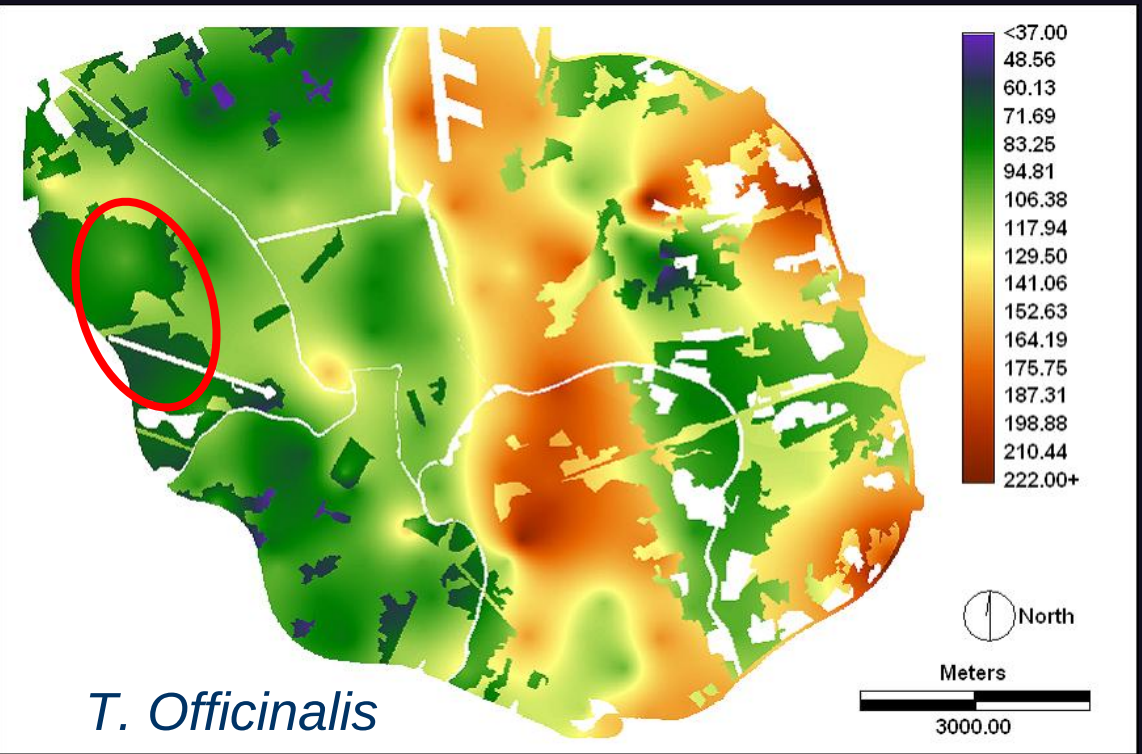


T. Officinalis

Rs

Bourgoyen-Ossemeersen



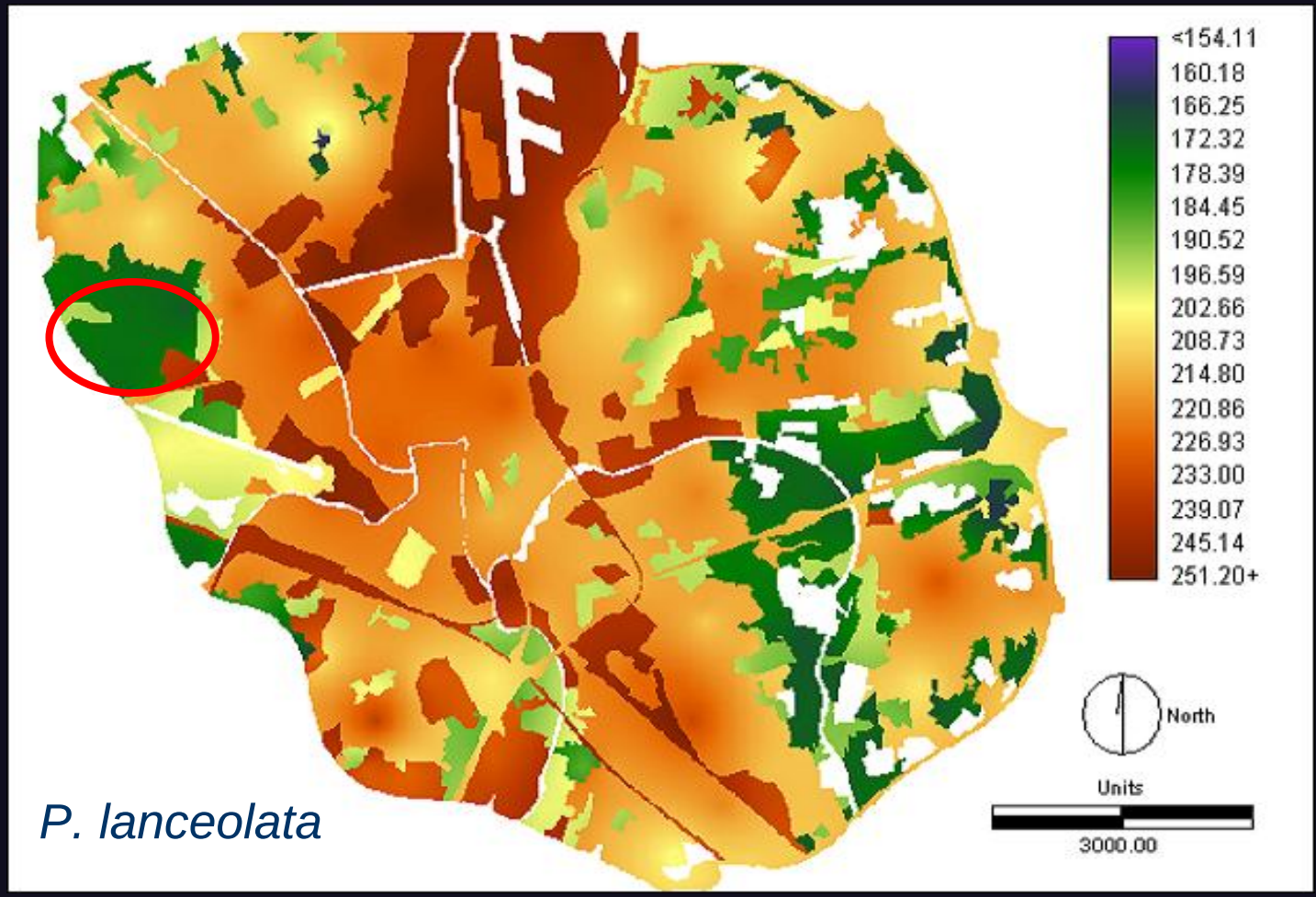


T. Officinalis

Gent-Harbour

Results

SD


<154.11
160.18
166.25
172.32
178.39
184.45
190.52
196.59
202.66
208.73
214.80
220.86
226.93
233.00
239.07
245.14
251.20+
North
Units
3000.00
P. lanceolata

Conclusions

- SPS significantly decreased towards more polluted areas
- Rs was higher in more polluted areas
- SD of *P. lanceolata* increased significantly towards more polluted areas
- Stomatal characteristics of *T. officinalis* & *P. lanceolata* are suitable bioindicators of urban habitat quality

Suggestions for future research

- Test in the different climatic regions
- A comparison of the different methodologies
- Use of image analysis software to replace the laborious microscopic analysis

Thank You