



ADAM MICKIEWICZ  
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# Monitoring and assessment of NBSs' environmental impact in Poznań.

Iwona Zwierzchowska, Piotr Lupa, Lidia Poniży, Katarzyna Fagiewicz,  
Łukasz Mikuła, Andrzej Mizgajski, Tomasz Szelaąg, Dawid Gałęza

Department of Integrated Geography  
Faculty of Human Geography and Planning  
Adam Mickiewicz University in Poznań

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Bringing  
cities to life,  
Bringing life  
into cities.



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# NBS Monitoring Plan for Poznań

- ✓ NBSs in Poznań: Nature-oriented playgrounds at preschools, open garden and pocket parks
- ✓ The Nature-Based Solutions Monitoring Plan for Poznań covers the environmental, social & health and economic indicators
- ✓ NBSs Impact Monitoring and Assessment were conducted at three scales:
  - ✓ local scale (selected case studies)
  - ✓ intermediate scale (neighborhood, all preschool gardens)
  - ✓ city scale (long-term assessment of urban transition).

Pocket parks



Natural playgrounds



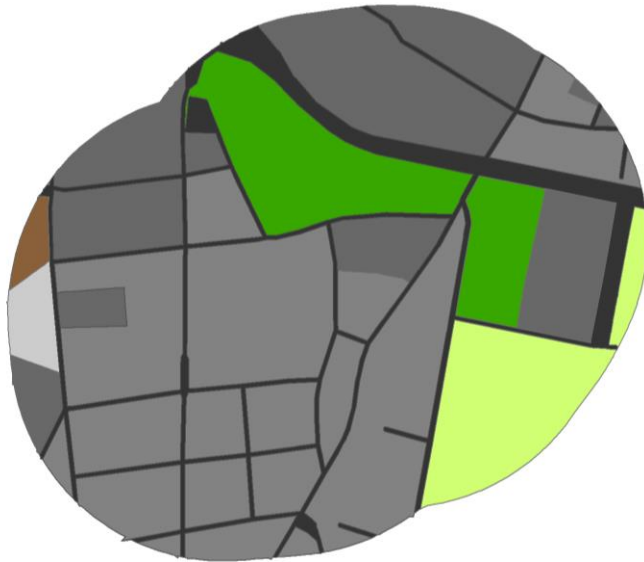
Open garden



# Green space area and its distribution

City scale

Site scale



**Urban Atlas**

**Polish Official Database  
of Topographical Objects  
(BDOT10k)**

**Land cover field mapping**

Geometric resolution 1:10 000  
Minimum surface area of unit 0,25 ha

Geometric resolution 1:10 000  
Minimum surface area of unit 0,1 ha\*

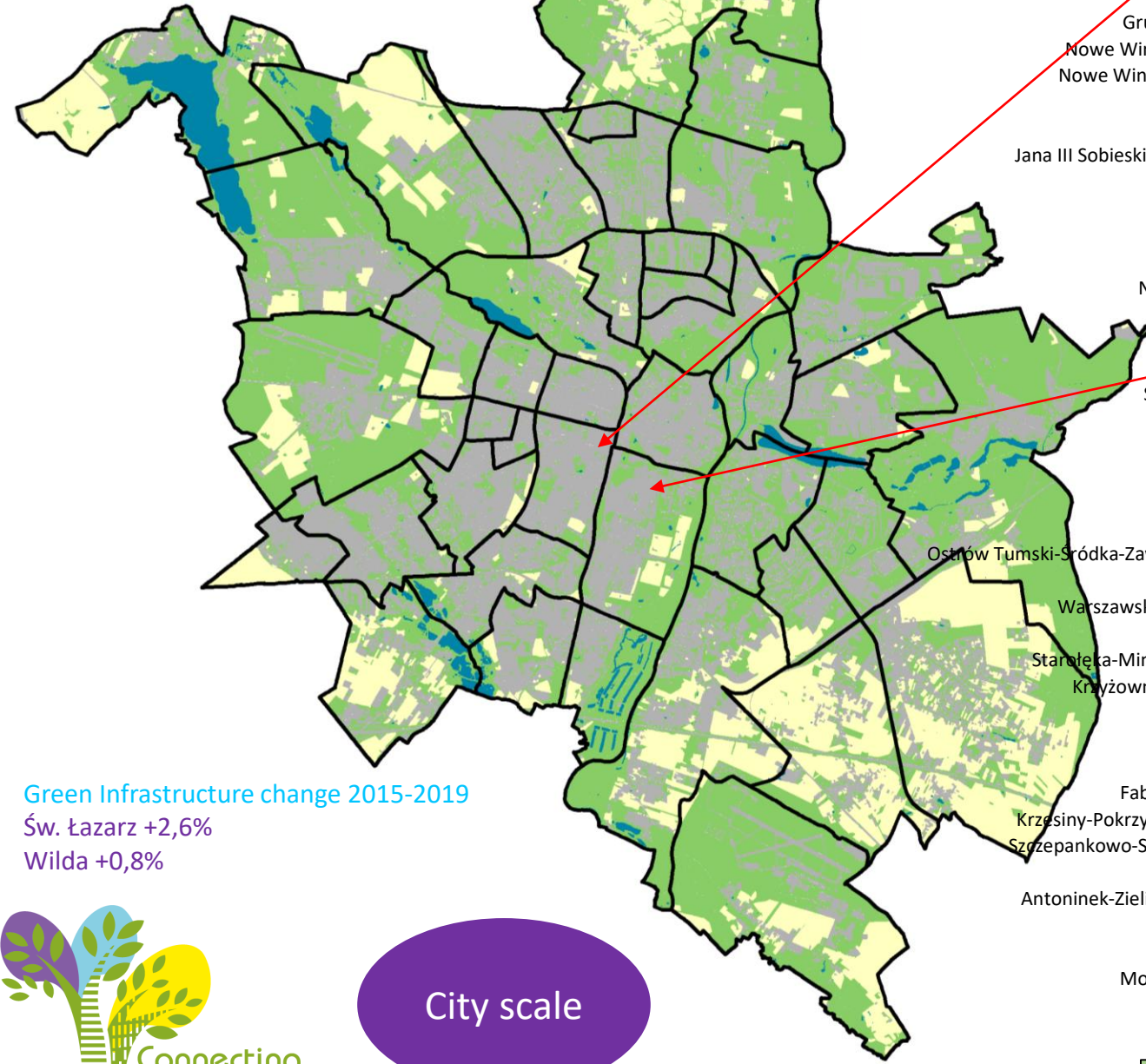
Minimum surface area of unit 1m<sup>2</sup>

\* unless the specific rules provide otherwise



# Green Infrastructure

2019



Stary Grunwald	8,3				91,7
Jeżyce	13,5	0,1			86,3
Grunwald Północ	14,7				85,3
Św. Łazarz	16,4	0,1			81,7
Stare Miasto	25,7	2,2			72,0
Grunwald Południe	23,6	0,2	25,4		70,8
Nowe Winogrody Wschód	32,2				67,8
Nowe Winogrody Południe	31,4				68,6
Ogrody	32,3	0,1	1,9		65,6
Podolany	29,7	0,2	3,5		67,5
Jana III Sobieskiego i Marysiewski	33,9	0,1			66,1
Górczyn	28,3	3,5	3,4		64,8
Piątkowo	33,2	0,2	0,7		64,1
Winiary	33,9	2,7			63,4
Świerczewo	26,9	3,8	11,4		57,9
Nowe Winogrody	38,6				61,4
Os. Kwiatowe	11,9	0,0	32,3		55,8
Głuszyna			65,7	0,2	21,2
Wilda	41,6	1,7	9,8		46,8
Stare Winogrody	48,6		1,1		47,4
Junikowo	35,4	0,2			63,4
Rataje	45,9		6,4	0,3	47,4
Wola	41,7	0,1	12,6		45,6
Chartowo	55,0		2,4		42,6
Żegrze	44,5		12,8		42,6
Ostrów Tumski-Sródka-Zawady-Komandor	52,4		10,0	2,8	34,8
Główna	54,6		0,7	7,8	39,9
Warszawskie-Pomet-Mała	41,9		3,6	7,2	47,3
Ławica		64,6		0,1	13,2
Starołęka-Minikowo-Marlewo	36,5	2,9		28,9	31,7
Krzyżowniki-Smochowice	54,2		8,0	7,6	30,2
Naramowice	62,8		2,6	3,4	31,1
Zielony Dębiec	55,1		13,7	3,9	27,4
Sołacz	55,4		7,5	7,6	29,5
Fabianowo-Kotowo	33,9	6,6		31,1	28,5
Krzyszyn-Pokrzywno-Garaszewo	23,5	0,2		56,0	20,2
Szczepankowo-Splawie-Krzyszynki	25,0	0,2		49,8	25,0
Umułtowo		71,0		2,7	4,8
Antoninek-Zieliniec-Kobylepole		73,4		2,8	6,1
Strzeszyn	50,7	3,8		30,3	15,1
Kiekrz	42,3		22,3		23,5
Morasko-Radojewo		56,7	1,1		33,2

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Green infrastructure Blue infrastructure Agriculture area Built-up area

Green Infrastructure change 2015-2019

Św. Łazarz +2,6%  
Wilda +0,8%

City scale





# Mapping green space with Urban Greening Factor (UGF)



$$UGF = \frac{\text{Area of land cover type with tree crown cover} * \text{ecological value factor}}{\text{Total area}}$$

Current state (with NBSs impact)

LC/LU classes	UGF_value	Area (m2)	UGF x Area
semi-natural vegetation	1,00	7436,89	7436,89
hedges	0,60	2255,05	1353,03
groundcover planting including long grass and her*	0,50	19041,59	9520,79
grass (lawns)	0,40	104693,36	41877,34
extensive green roofs (thin substrate)	0,30	921,61	276,48
bare ground	0,25	21050,81	5262,70
permeable paving	0,10	82101,73	8210,17
sealed surfaces	0,00	283818,24	0,00



- ✓ Share of green area in the NBS and its neighborhood is 26%
- ✓ NBS (preschool garden) is 2% of green area
- ✓ UGF (without tree canopy) = 0,14!
- ✓ UGF (with tree canopy) = 0,26!

## Urban Greening Factor



Intermediate scale



# Urban Green Factor – NBS intervention of Preschool 42

$$UGF = \frac{\text{Area of land cover type with tree crown cover} * \text{ecological value factor}}{\text{Total area}}$$



- ✓ Concrete surface reduce from 921 m<sup>2</sup> to 39 m<sup>2</sup>
- ✓ Share of concrete surface reduced from 24% to 1%
- ✓ Decrease of concrete surface 96 %
- ✓ UGF (without tree canopy) increased from 0.27 to 0.32
- ✓ UGF (including tree canopy) increased from 0.63 to 0.73

Site scale

Land cover and tree canopy cover in Preschool no. 42

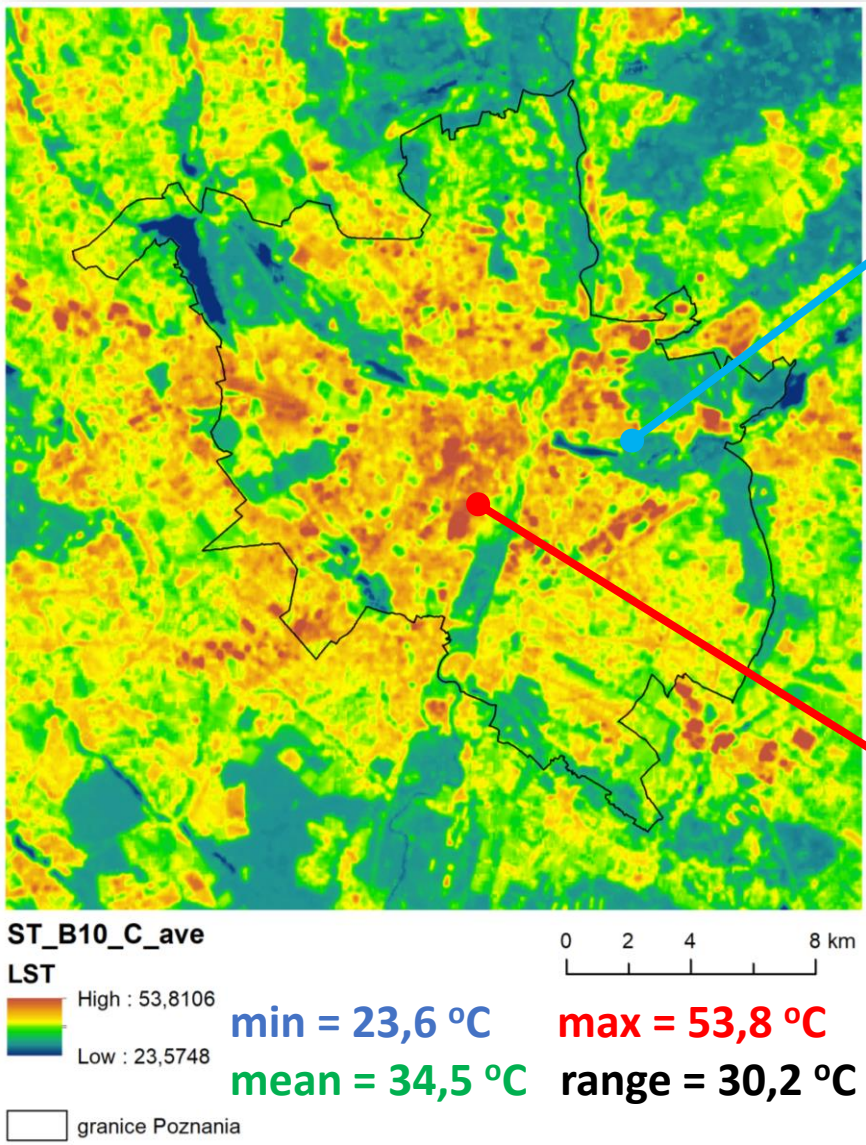


# Average land surface temperature

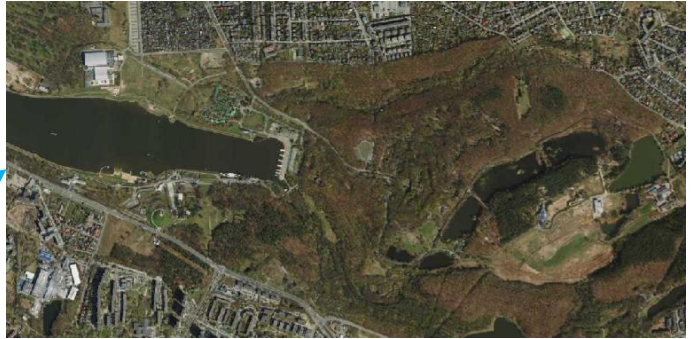
## City scale



Landsat 8 thermal satellite images  
5 scenes (2018-2020)



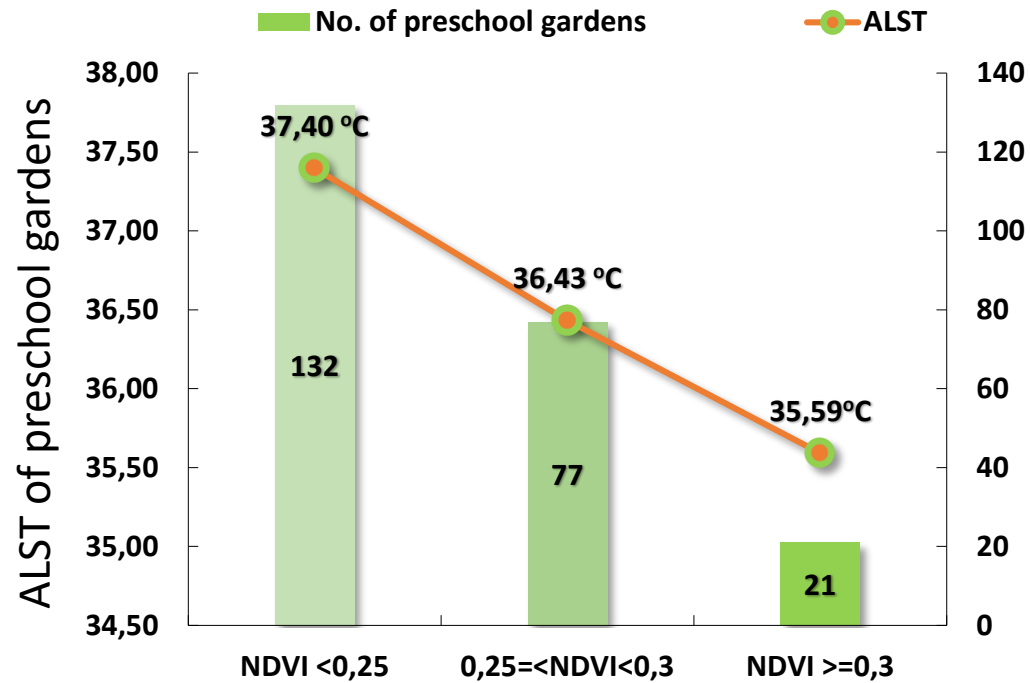
Mapping average land surface temperature (ALST)



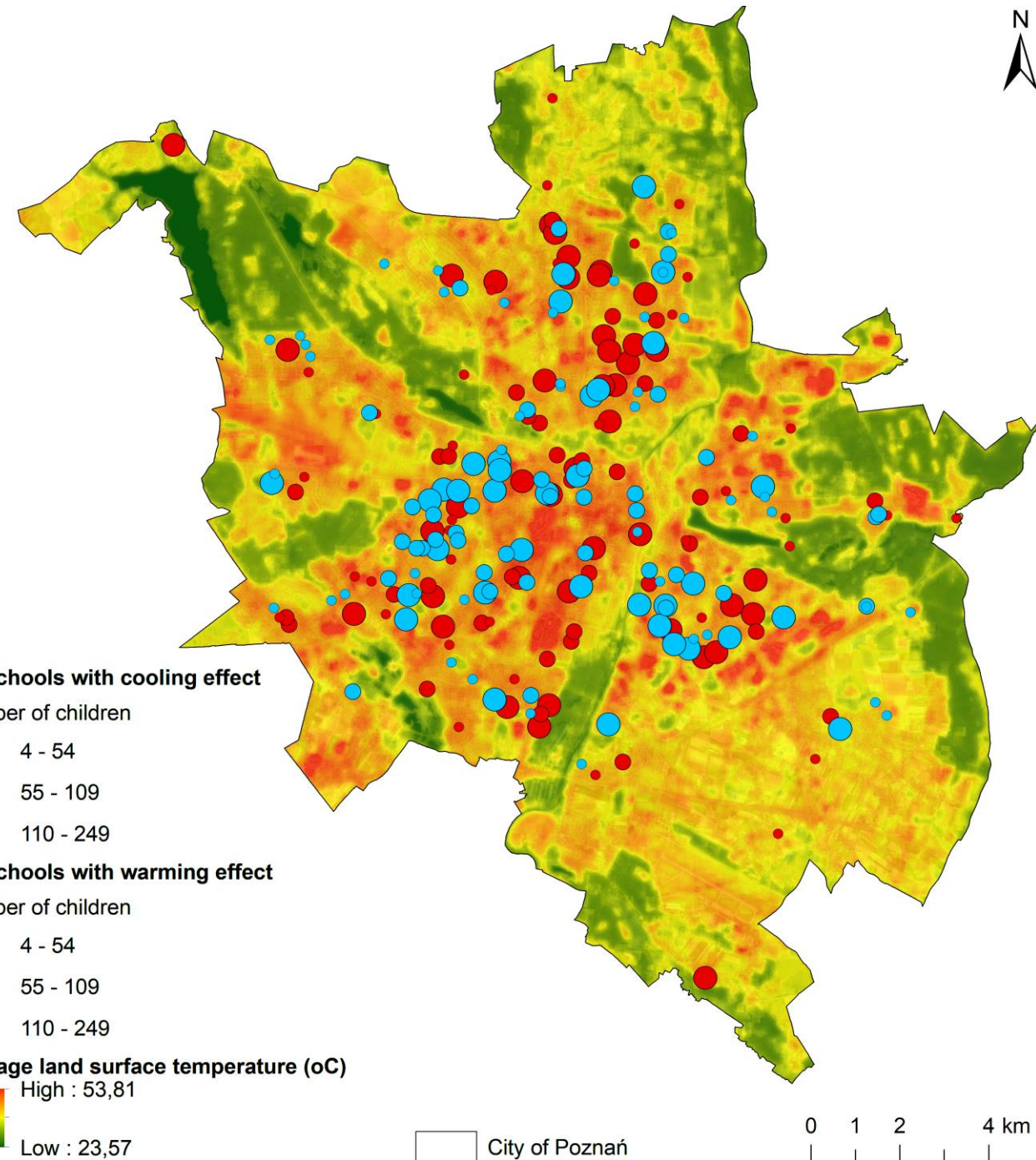
Identification of hot and cold-spots



# Preschool gardens cooling effect



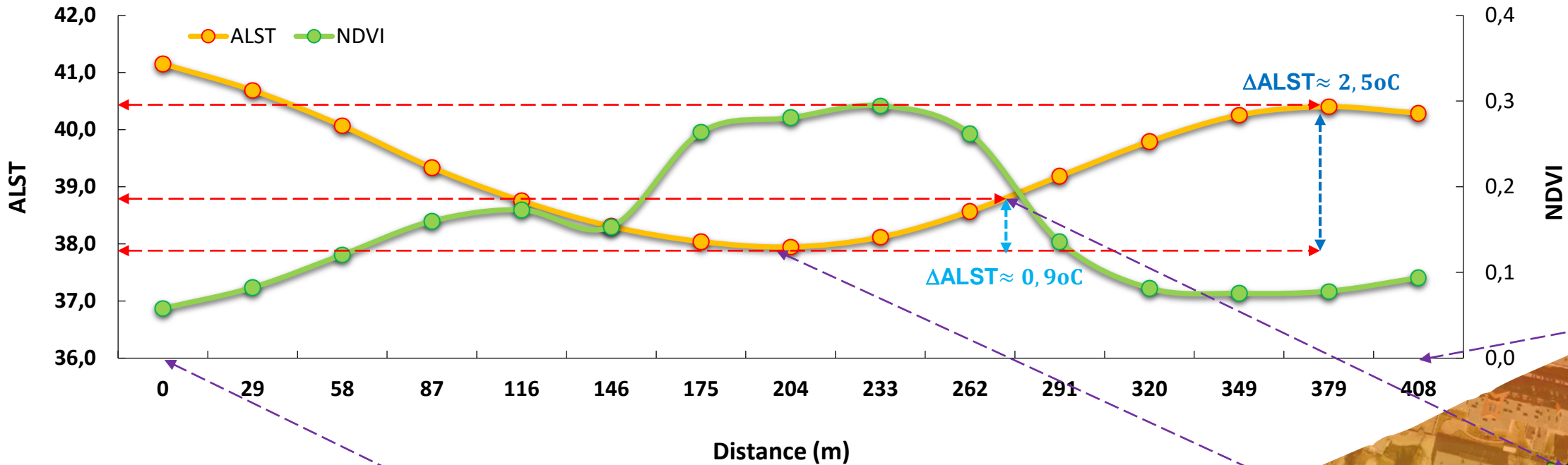
Preschool garden cooling effect in the neighborhood  
 Lower ALST (mean 0,15 °C; max 0,51 °C)



NDVI – Normalized Difference Vegetation Index  
 ALST – Average Land Surface Temperature



# Case study of Preschool No. 42 – thermal profile



The cooling effect of the preschool garden is **0,9-2,5°C!**

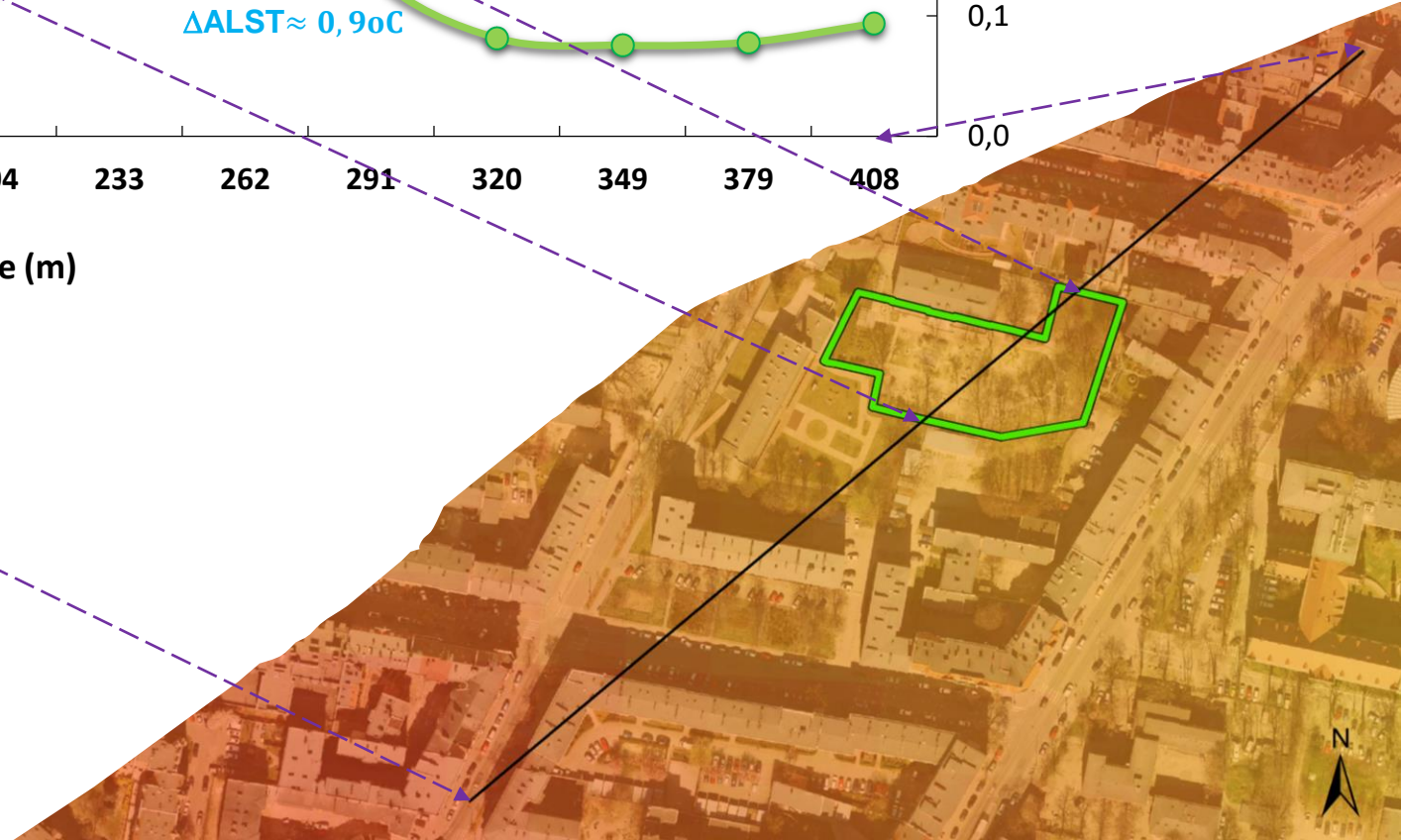
— ALST & NDVI profile range

▭ preschool garden

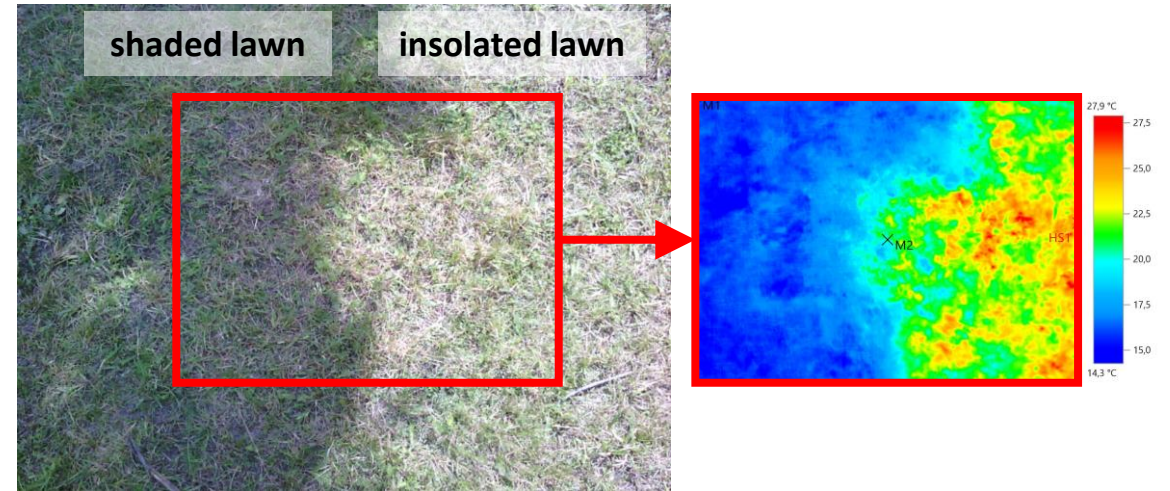
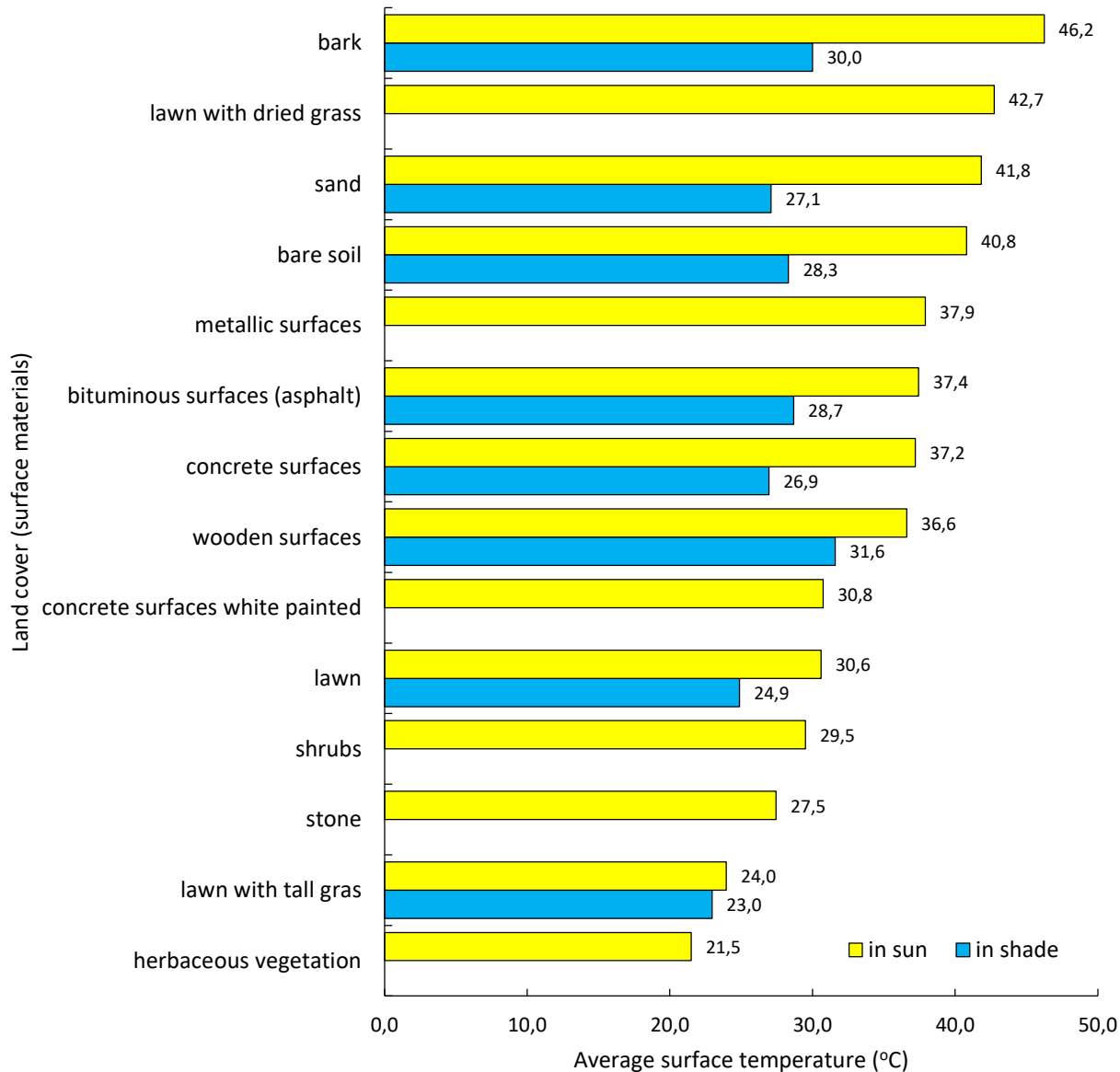
ALST (°C)

High : 53,81

Low : 23,57



# Tree shade for local heat reduction



Testo 871 Thermal Camera

Average temperatures in pocket parks and their surrounding - mean values based on measurements at  $T_{air} \geq 25^{\circ}C$



# Change in ecosystem service provision

## 1. Measurement of ecosystem services provided by trees in pocket park:

- ✓ air pollution removal (CO, NO<sub>2</sub>, O<sub>3</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>)
- ✓ carbon storage and sequestration
- ✓ oxygen production
- ✓ avoided runoff

## 2. i-Tree Eco free software (<https://www.itreetools.org/>)

## 3. Required input data:

- ✓ tree measurement data
- ✓ precipitation data and air pollution data

## 4. Trees measurements using rangefinder and measuring tape



Tools for Assessing and Managing  
Forests & Community Trees





# Change in ecosystem service provision: i-Tree results

Number of trees: **108**

Most common species of trees:

- ✓ **Tilia tomentosa,**
- ✓ **Celtis occidentalis,**
- ✓ **Robinia pseudoacacia 'Frisia'**

Site scale  
Pilot  
assessment

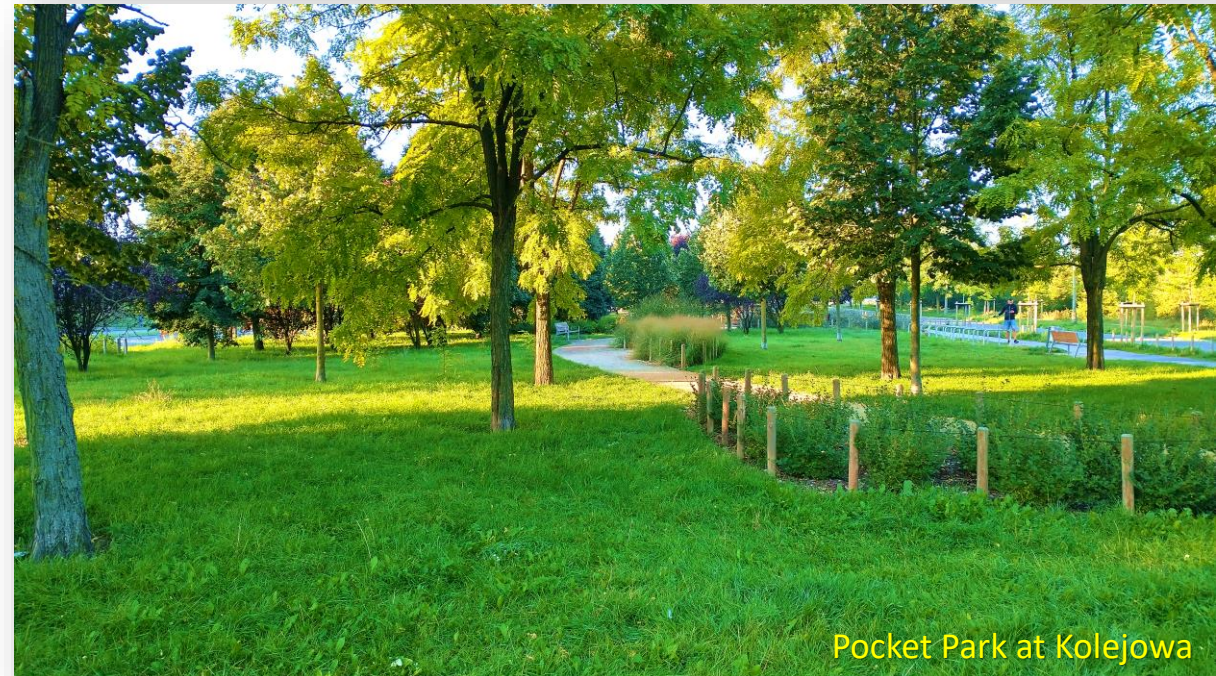
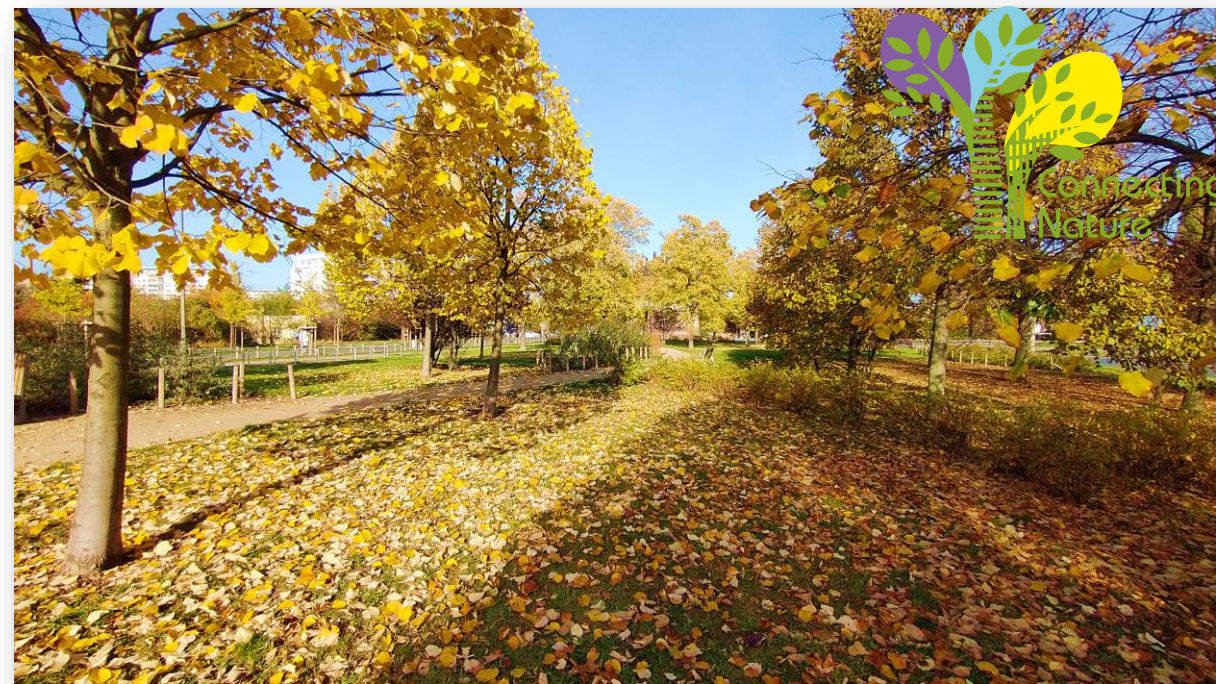
Pollution Removal: **11,31 kg/year**

Carbon Storage: **114,8 t**

Carbon Sequestration: **1,661 t/year**

Oxygen Production: **4,43 t/year**

Avoided Runoff: **30,47 m3/year**





# Conclusions

- ✓ **Monitoring the NBS is fundamental to support and evaluate decision-making process.**
- ✓ **Relevant data is a key challenge to monitor the impact of interventions at the site scale.**
- ✓ **On-site measurements allows for generating a local library of values that can be used as a base for the recommendation of the most appropriate solutions.**
- ✓ **City-wide monitoring can show the direction of urban transition from a long-term perspective and give evidence for local policy impact.**
- ✓ **Decision-making is a complex process from a legal and organizational perspective, in which environmental aspects are not always sufficiently captured. We showed how it can be improved.**
- ✓ **Science-practice interaction supports cities through evidence delivery and translation into feasible indicators.**





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