World Forum on Urban Forests
Mantova 2018

PS 3.3 Changing Environemnt

Mitigating urban climate change

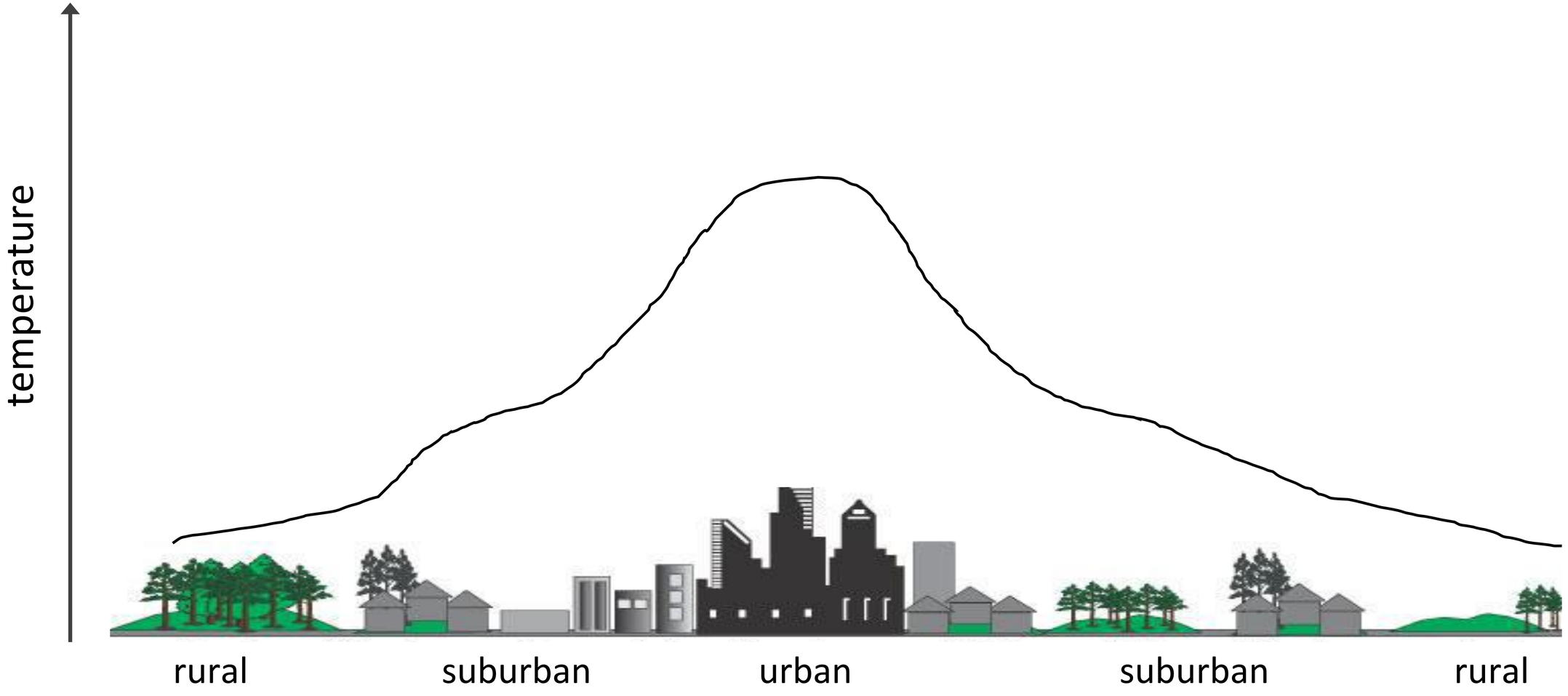
Simulating ecosystem services of urban trees under present and future climate conditions

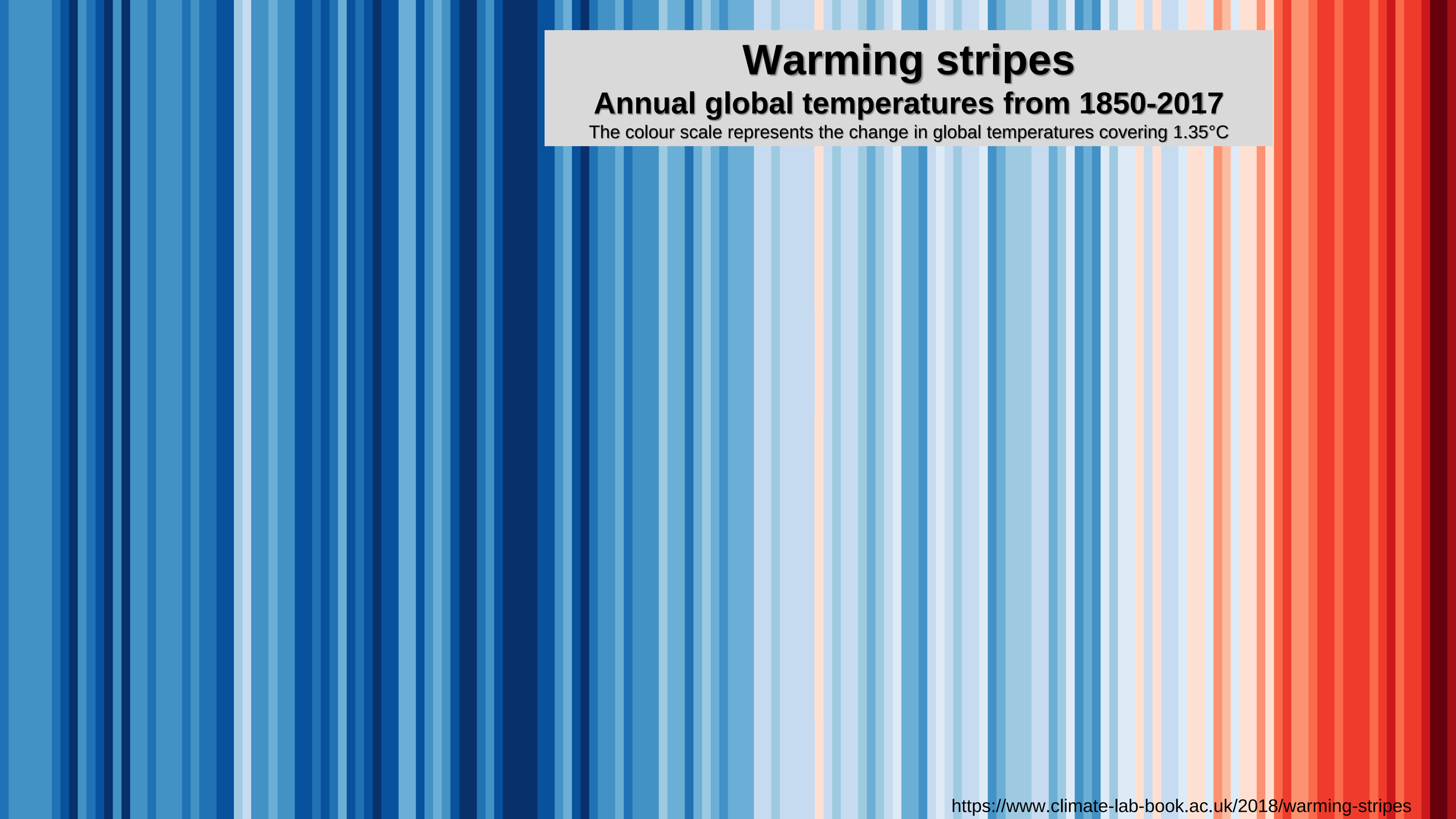
Thomas Rötzer, Mohammad A Rahman, Stephan Pauleit, Hans Pretzsch

Technical University of Munich, Germany
thomas.roetzer@tum.de

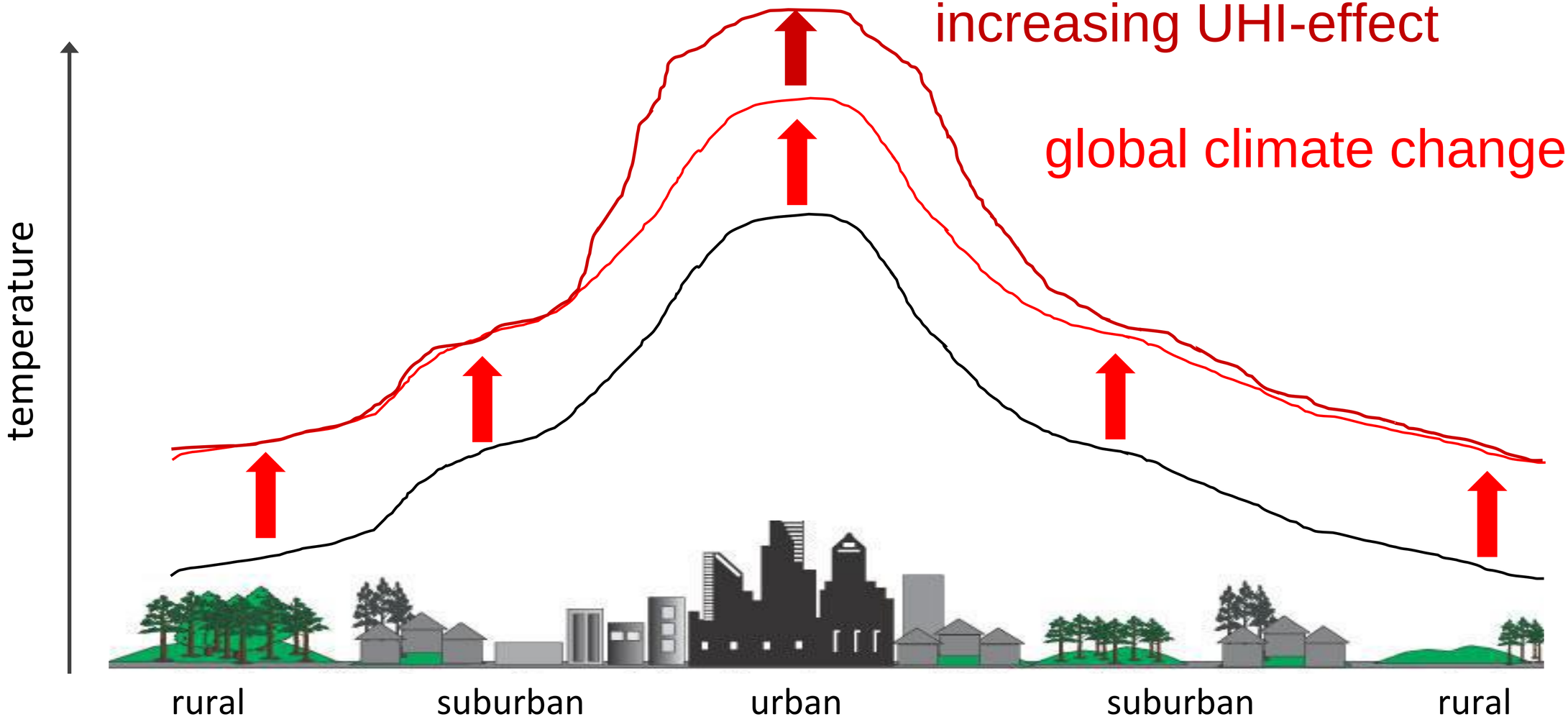
urban climate

The urban heat island effect (UHI)




Warming stripes
Annual global temperatures from 1850-2017
The colour scale represents the change in global temperatures covering 1.35°C
https://www.climate-lab-book.ac.uk/2018/warming-stripes

urban climate change

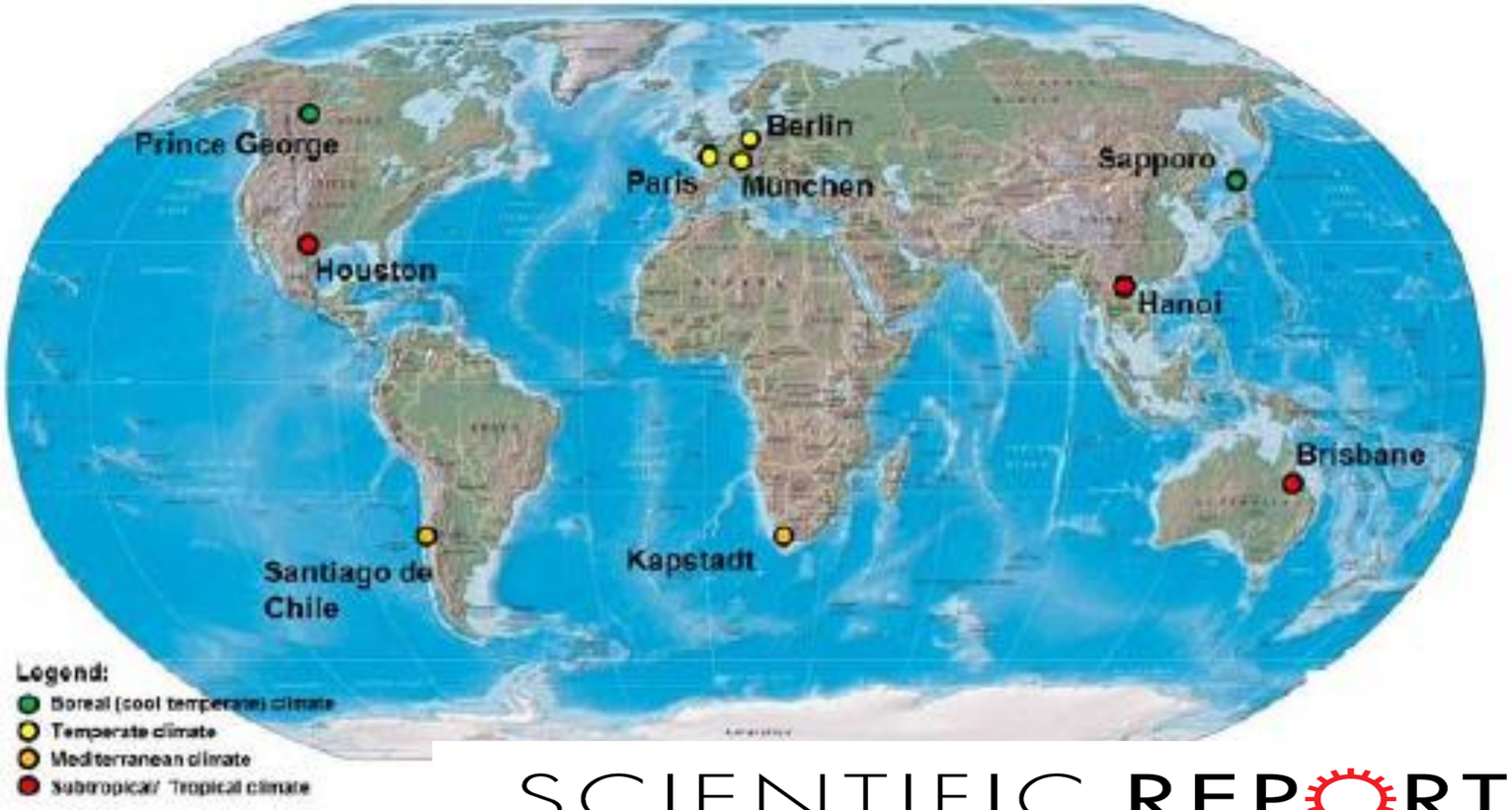


World Forum on Urban Forests
Mantova 2018

urban climate change and tree growth

Technische Universität München

Metropolis Project



SCIENTIFIC REPORTS

OPEN

Climate change accelerates growth of urban trees in metropolises worldwide

Received: 29 March 2017
Accepted: 17 October 2017
Published online: 13 November 2017

Hans Pretzsch[1], Peter Biber[1], Enno Uhl[1], Jens Dahlhausen[1], Gerhard Schütze[1], Diana Perkins[1], Thomas Rötzer[1], Juan Caldentey[2], Takayoshi Koike[3], Tran van Con[4], Aurélia Chavanne[5], Ben du Toit[6], Keith Foster[7] & Barry Lefer[8]

urban climate change and tree growth

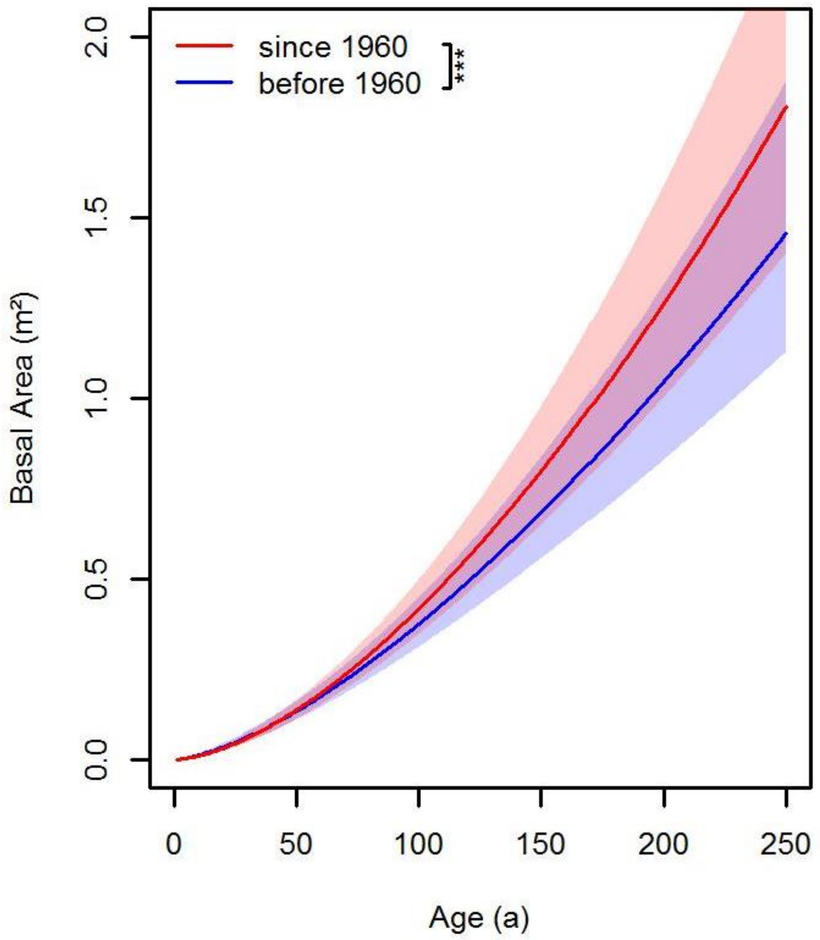
Metropolis Project

City (sampling year)	Species	Number of Sampled Trees	Diameter in Breast Height [cm]	Tree Height [m]	Height to Crown Base [m]	Crown Projection Area [m²]
Sapporo (2012)	*Abies sachalinensis* MAST.	110	33.4 (20.0 - 77.5)	17.5 (11.3 - 32.0)	6.3 (2.0 - 18.5)	28.4 (4.6 - 148.9)
Prince George (2012)	*Picea glauca* (MOENCH) VOSS	143	40.6 (27.7 - 56.5)	27.5 (17.7 - 36.8)	7.2 (1.8 - 16.6)	22.7 (4.8 - 61.2)
Berlin (2010-2013)	*Tilia cordata* MILL.	265	44.2 (16.5 - 81.1)	16.9 (8.1 - 29.1)	4.7 (1.8 - 15.1)	82.3 (19.8 - 286.4)
Munich (2013)	*Aesculus hippocastanum* L.	231	63.3 (19.6 - 117)	16.1 (7.4 - 27.2)	3.3 (0.5 - 9.7)	99.4 (25.6 - 256)
Paris (2013)	*Platanus x hispanica* MÜNCHH.	171	64.8 (40.3 - 144)	18.8 (6.8 - 34.5)	4.7 (2.5 - 10)	147.5 (23 - 648.5)
Santiago de Chile (2012)	*Robinia pseudoacacia* L.	136	41.4 (19.8 - 56.1)	15.3 (4.8 - 31.5)	2.7 (1.7 - 6.3)	14.6 (1.5 - 49.0)
Cape Town (2011)	*Quercur robur* L.	72	67.9 (40.3 - 112.9)	15.6 (9.7 - 22.8)	3.7 (2.1 - 7.3)	168.2 (56.9 - 341.7)
Hanoi (2012)	*Khaya senegalensis* (DESR.) A.JUSS.	163	73.4 (44.1 - 123.1)	22.6 (14.1 - 36.0)	5.6 (2.2 - 10.7)	136.9 (31.0 - 421.5)
Brisbane (2013)	*Araucaria cunninghamii* AITON ex. D.DON	126	40.7 (15.7 - 129.5)	17.3 (3.1 - 33.5)	3.2 (0.6 - 7.1)	45.5 (8.4 - 422.8)
Houston (2014)	*Quercus nigra* L.	183	59.9 (34.2 - 98)	16.2 (10 - 25)	3.8 (1.2 - 11.6)	162.6 (37 - 442)

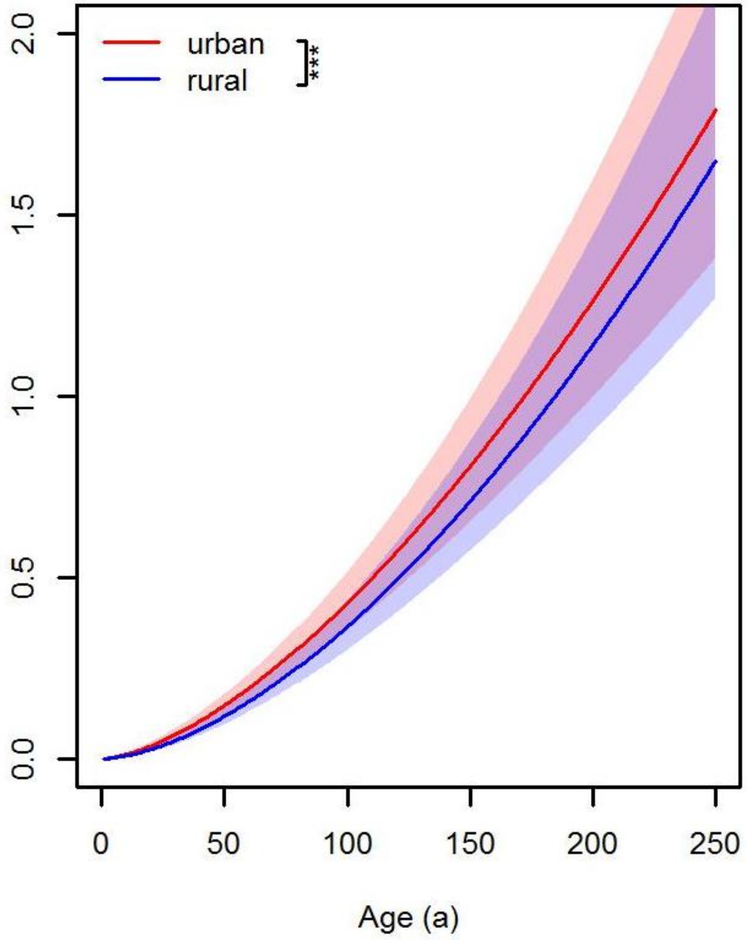
urban climate change and tree growth

Worldwide urban tree growth was faster …

…after 1960 than before 1960



… in city centres compared to periphery

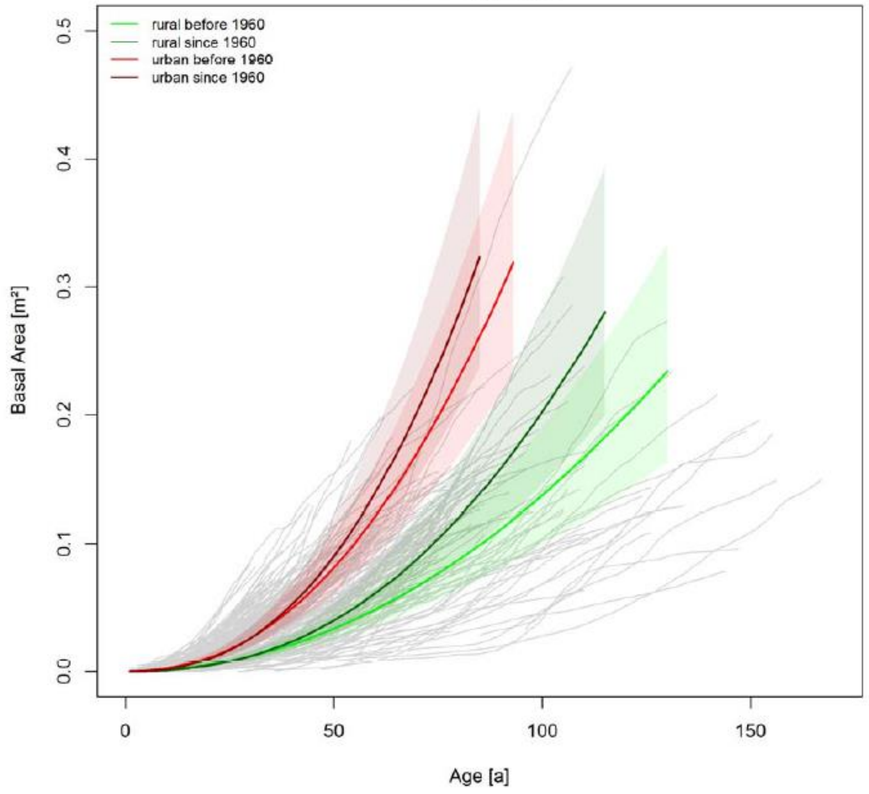


Pretzsch, Rötzer,… 2017 Scientific Reports

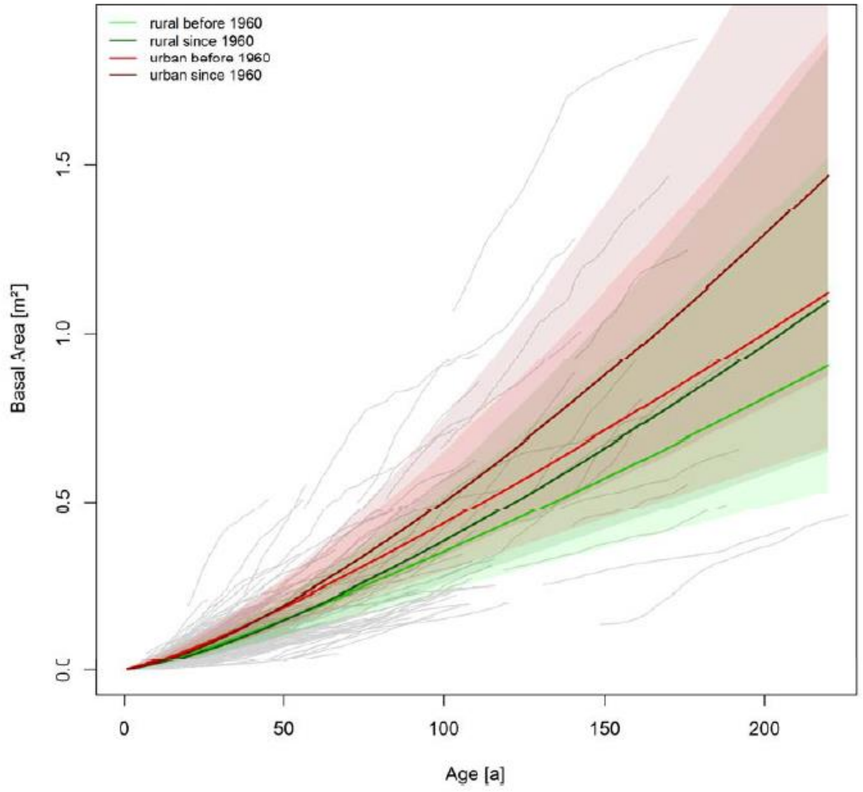
urban climate change and tree growth

…but varied from climate zone to climate zone

Boreal



Mediterranean



Pretzsch, Rötzer,… 2017 Scientific Reports

How can we mitigate urban climate change?

urban forests

and their ecosystem services

carbon storage (McPherson 1998, Nowak & Crane 2002)

cooling by transpiration (Pretzsch et al. 2015, Rahman et al. 2017)

reduction rainwater discharge (Xiao et al. 2000a, Xiao et al. 2000b)

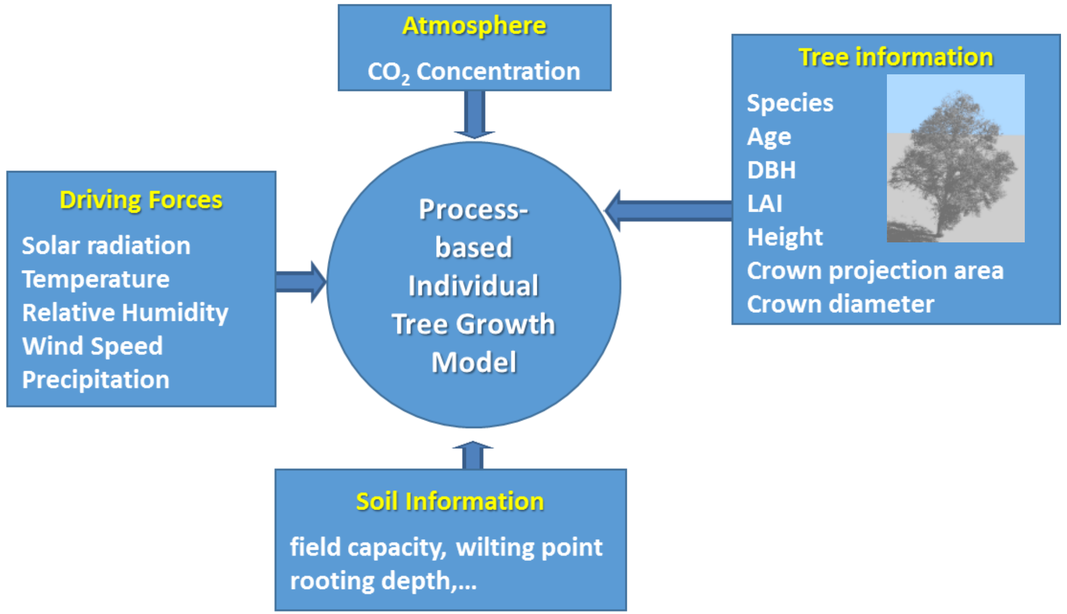
shading (Akbari et al. 2001, Dimoudi & Nikolopoulou 2003)

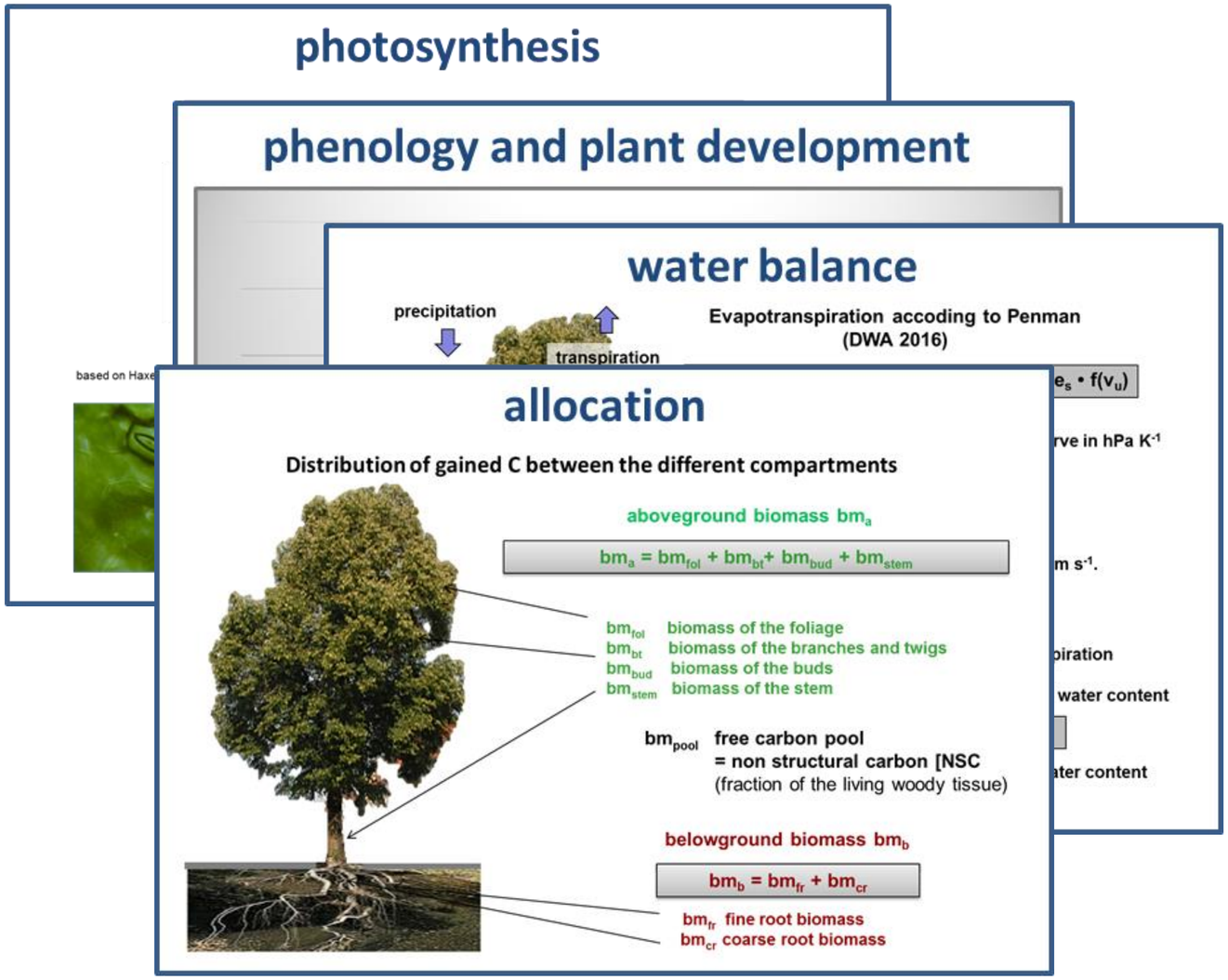
air filtering (McPherson et al. 1997, Pretzsch et al. 2015)

Quantity is depending on number of plants, species, age and dimension, vitality, climate and site conditions

simulation of growth and ecosystem services

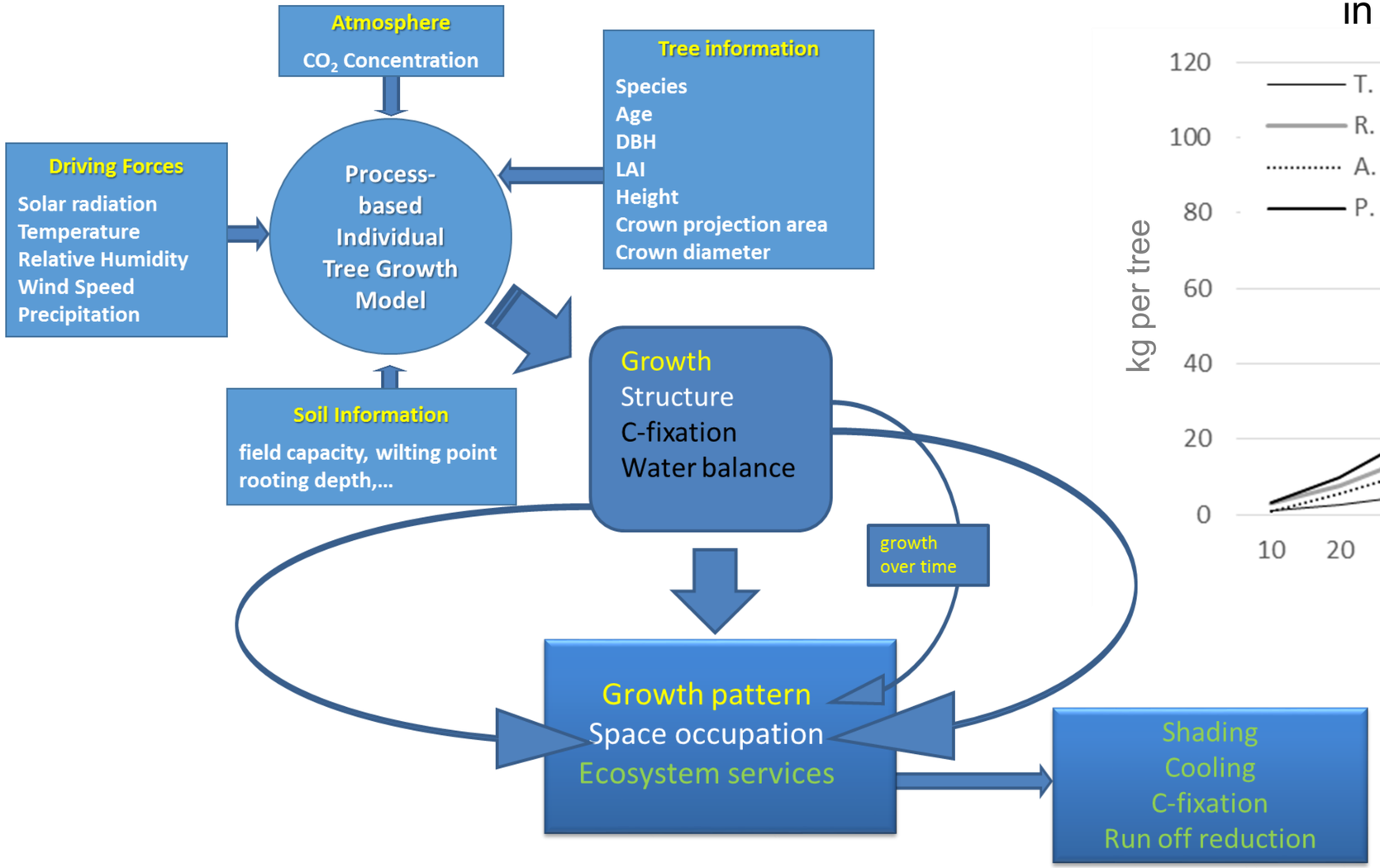
CityTree : a process-based individual tree growth model



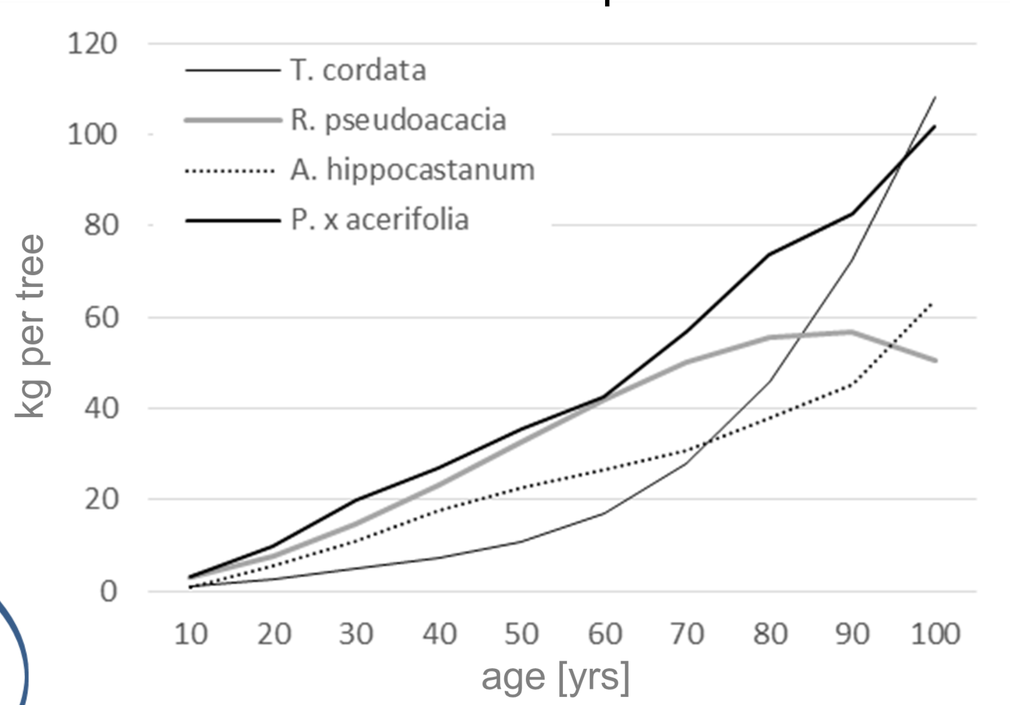


simulation of growth and ecosystem services

CityTree : a process-based individual tree growth model

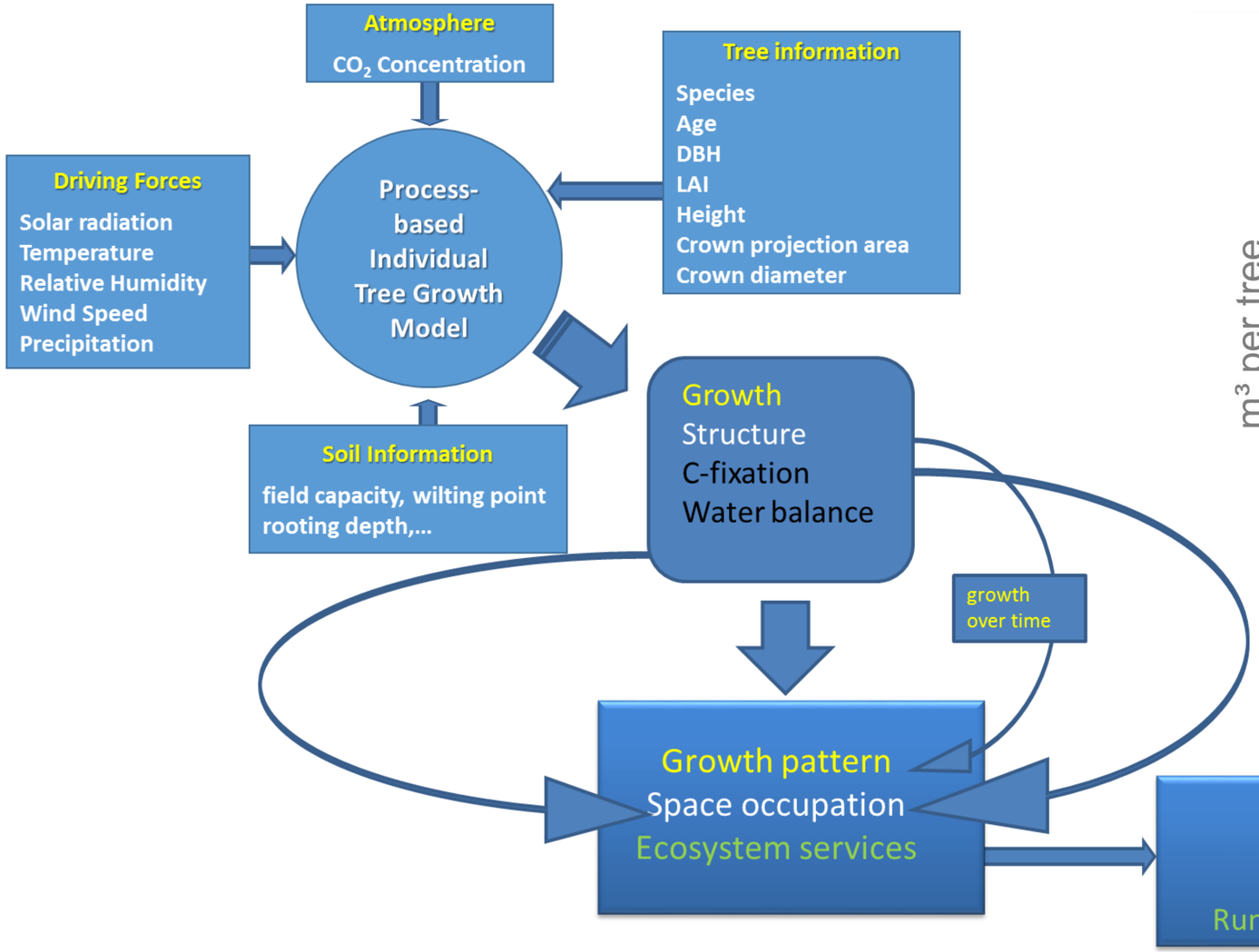


Mean biomass growth for individual trees in Central European cities

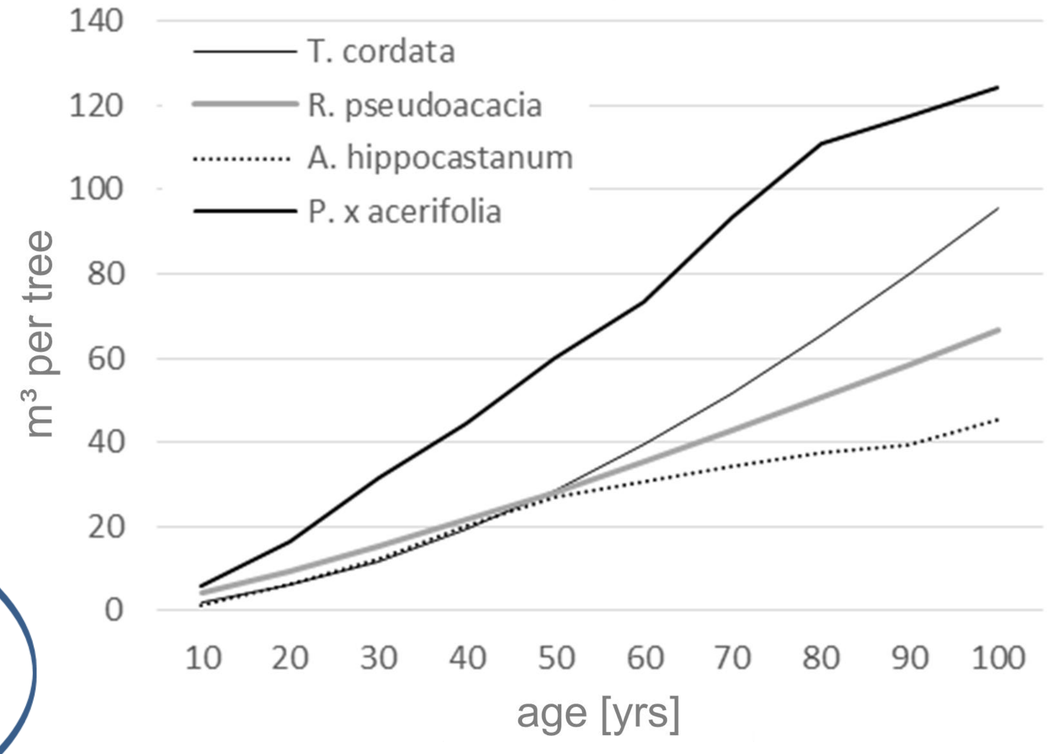


simulation of growth and ecosystem services

CityTree : a process-based individual tree growth model

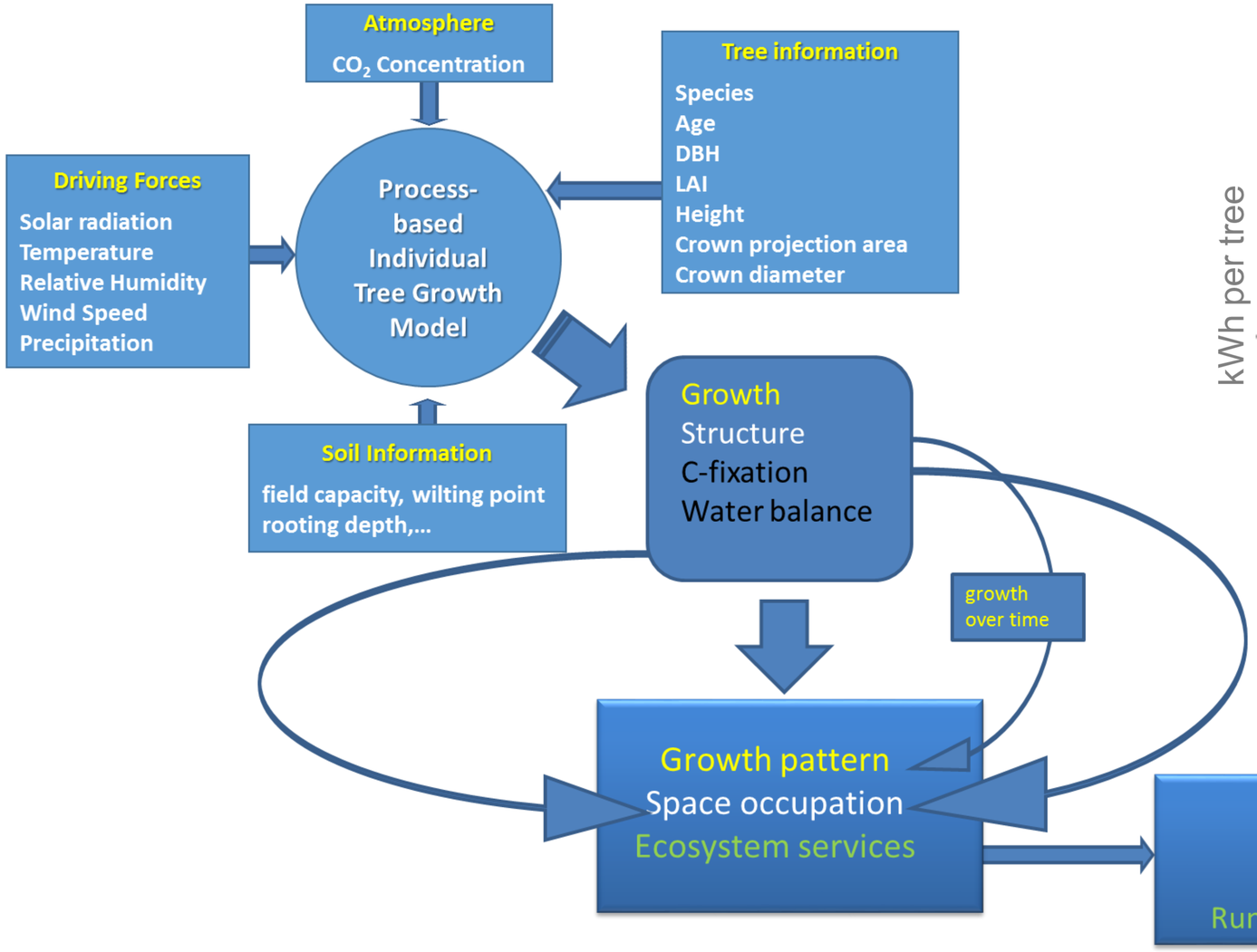


Mean annual transpiration of individual trees in Central European cities

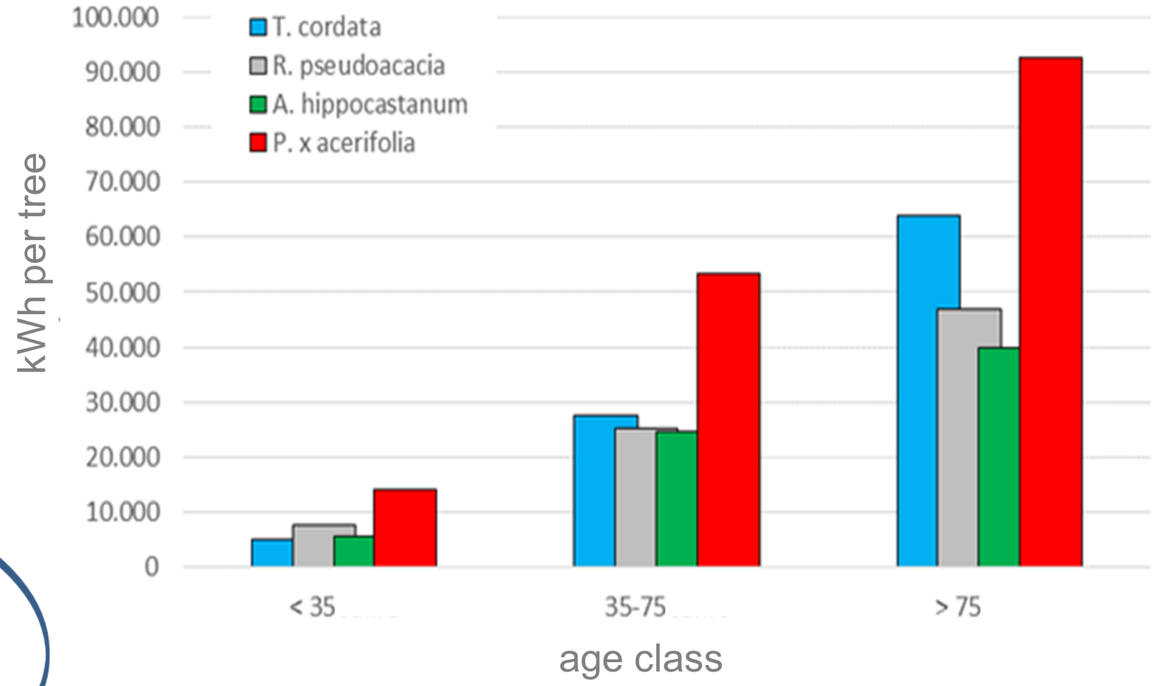


simulation of growth and ecosystem services

CityTree : a process-based individual tree growth model

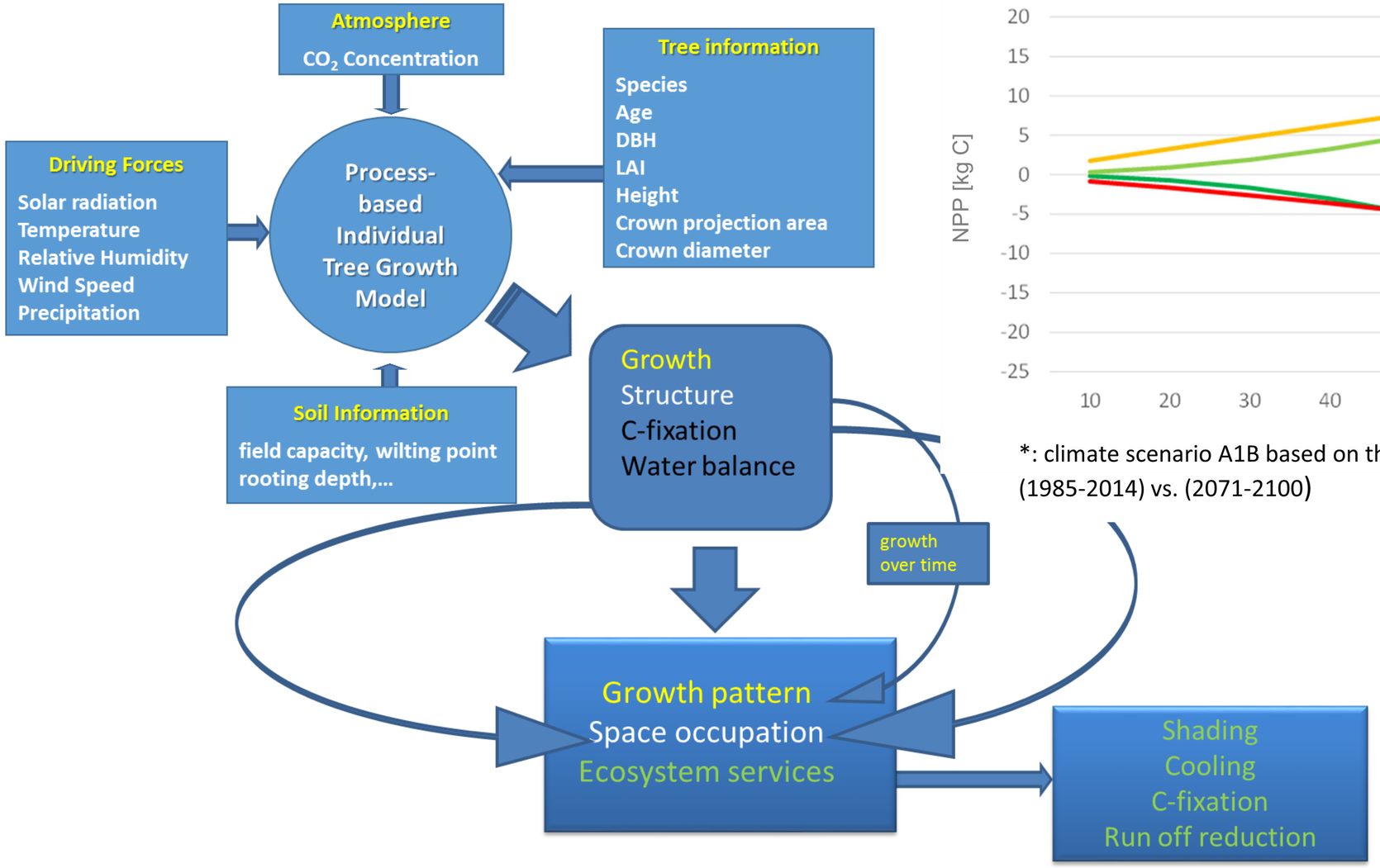


Mean annual cooling potential of individual trees in Central European cities

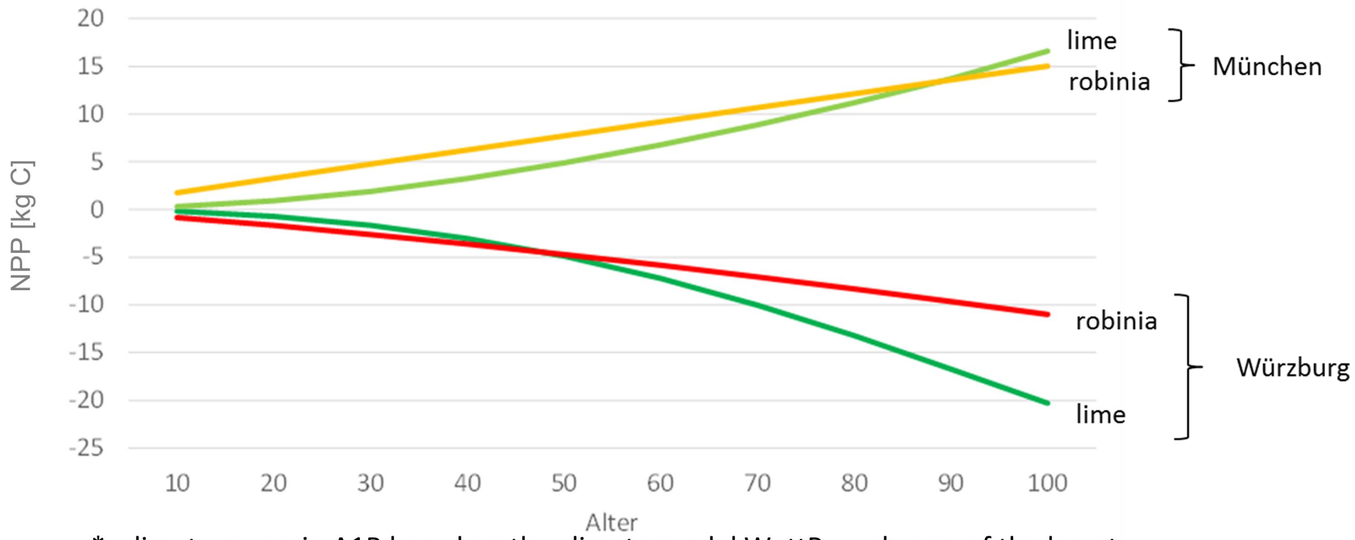


simulation of growth and ecosystem services

CityTree : a process-based individual tree growth model



change of productivity under changed future climate conditions*



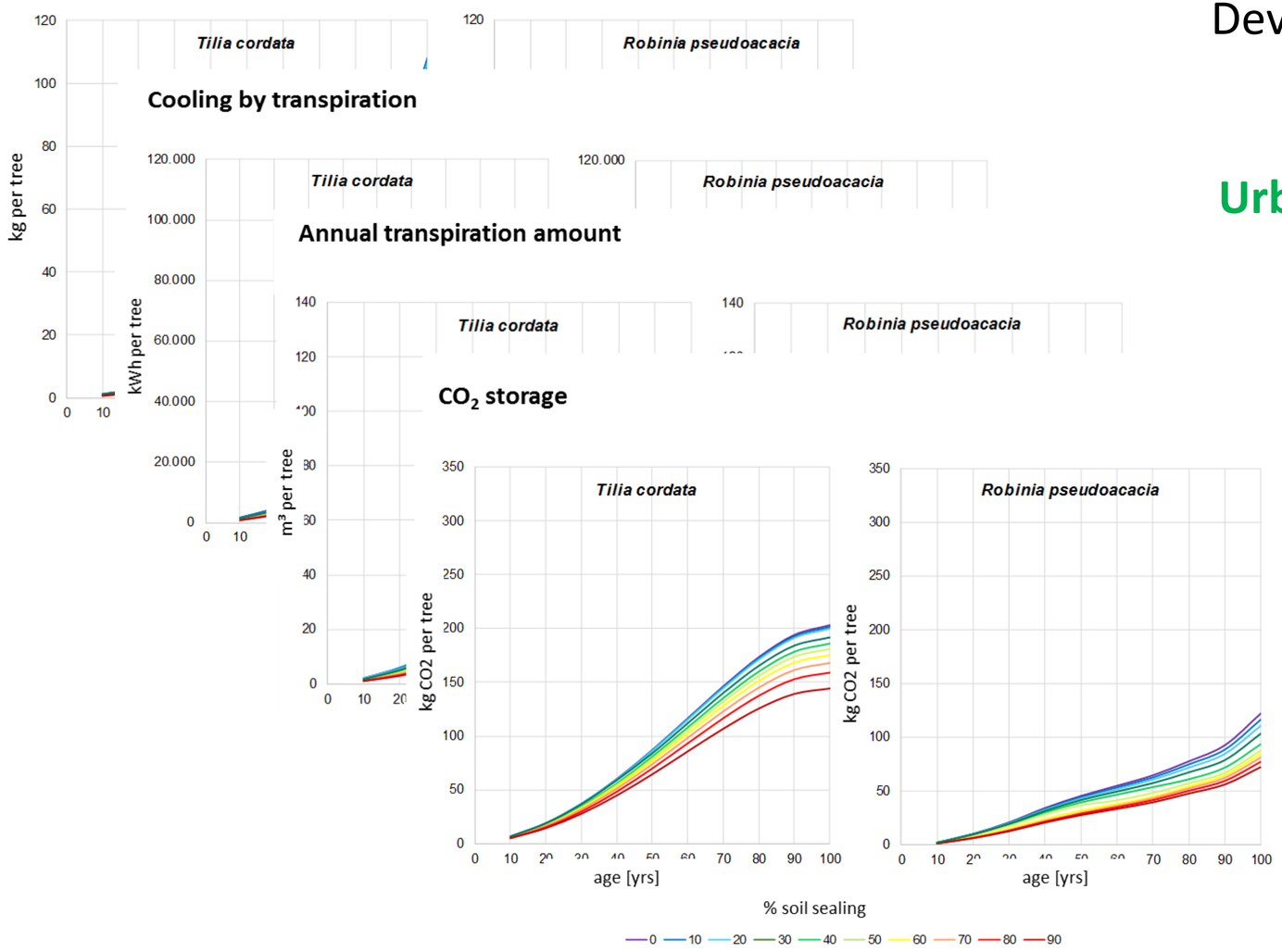
*: climate scenario A1B based on the climate model WettReg; change of the long term averages (1985-2014) vs. (2071-2100)

World Forum on Urban Forests Mantova 2018

manual for urban forestry planning

Technische Universität München

Annual biomass increment



Development of a manual for city planners, architects, landscape planners, scientists and landscapers:

Urban trees under climate change: Growth patterns, ecosystem services and perspectives

Figures and tables for
growth patterns
dimensional changes
ecosystem services
for Central European cities
under present and future climate conditions

Bayerisches Staatsministerium für Umwelt und Verbraucherschutz

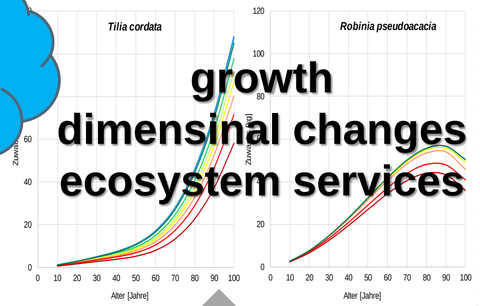
World Forum on Urban Forests
Mantova 2018

options to mitigate urban climate change

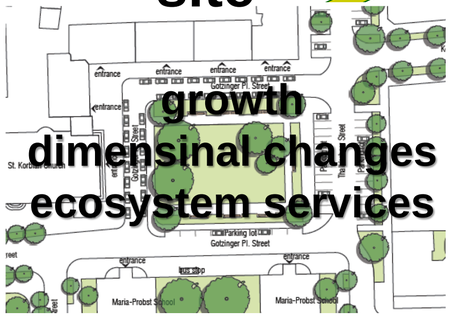
Technische Universität München

present climate

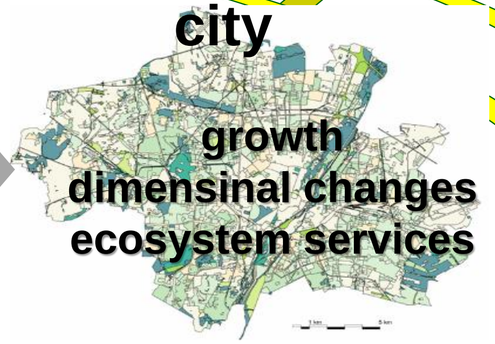
individual tree

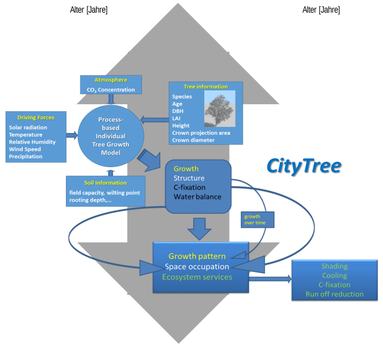


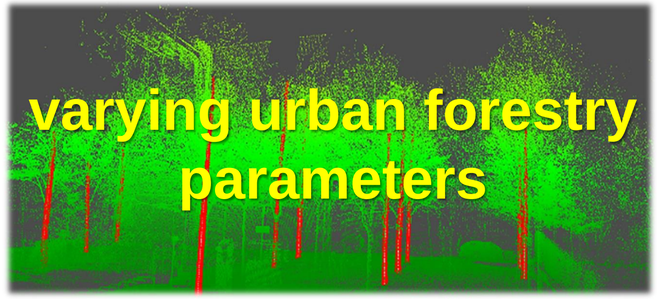
site



city



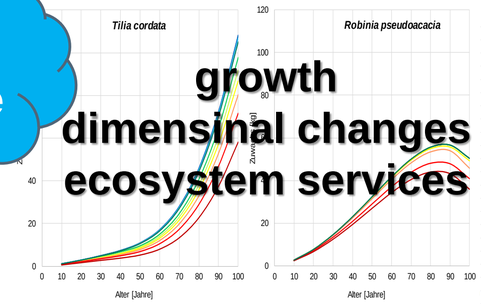




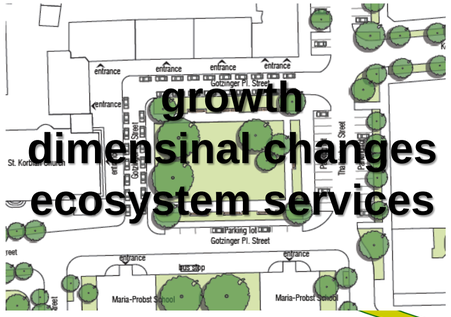
possibilites for adaptation and mitigation

future climate

individual tree



site



city

conclusion

- **Global climate change and the urban climate have a strong influence on tree growth and ecosystem services**
- **By using process based models, ecosystem services can be quantified, particularly for future climate conditions and for varying urban forestry measures**
- **Detailed information is needed about species and age dependent growth patterns and ecosystem services**
- **Thus, mitigation effects of the urban green on urban climate change can be simulated**
- **Information on species and age dependent ES can help landscape planners and architects to adapt our growing cities to climate change**

acknowledgement

Thank’s

… to you for your attention

… to the funding agencies

Audi Stiftung für Umwelt

Bayerisches Staatsministerium für Umwelt und Verbraucherschutz

… to the entire team of our research group

(A. Reischl, C. Hartmann, C. Zhang, F. Wiehler, H. Paeth, H. Pretzsch, J. Dahlhausen, L. Stratopoulos, M. von Strachwitz, Ni Ke, M. Rahman, R. Schelle, S. Pauleit, T. Limmer, T. Rötzer, T. Zölch)

Centre for Urban Ecology and Climate Adaptation (ZSK)
Technische Universität München

www.zsk.tum.de
info@zsk.tum.de

for a list of publications see

www.waldwachstum.wzw.tum.de www.zsk.tum.de