TECHNISCHE UNIVERSITÄT DRESDEN

Institut für Forstbotanik und Forstzoologie

Department of Forestry

Chair of Tree Biology

Decision tools for urban habitats considering climate change et al.

Climate-Species-Matrix (CSM) and Tree Selection Data Base CITREE – New approaches for tree species selection

Andreas Roloff

TU Dresden, Chair of Tree Biology

www.tu-dresden.de/forstbotanik

Amenity Conference Arb Ass at Exeter 9-12 Sept 2018

Introduction

Expected consequences of climate change

- Drought stress
- Damage by late frost

Suitability of urban trees for the future

- Climate-Species-Matrix (CSM)
- Urban Tree Selection Data Base CITREE

Conclusion

Introduction: Site conditions and tree selection criteria

Expected consequences of climate change

- Drought stress
- Damage by late frost

Suitability of urban trees for the future

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Conclusion


Mercure HOTEL
FITNESS
Zugang zur
Hbf. Nord
Strab.-Linien
3, 8, 9, 11
Taxistand
Zugang zur
Hbf. Nord
Strab.-Linien
3, 8, 9, 11


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SOMMERGARTEN

Urban tree sites ordered by decreasing naturalness / increasing stress/artificial conditions

Urban woodlands and forests
Parks, green spaces
Private gardens

Public squares and pedestrian precincts
Road-side areas
Roof terraces and roof gardens

Covered atriums
Buildings interiors

Specific Conditions for Urban Trees (in alphabetical order).

- All-day sunshine / radiation
- Artificial light
- Damage / injuries (crown, trunk, root)
- Dog / human urine
- Drought stress
- Dust impact
- Immissions / pollution
- Increased temperature
- Leaks from pipes, e.g. gas
- Nutrient deficiency
- Oxygen deficiency in soil / rooting area
- pH value neutral to alkaline (>7)
- Pruning / cutting
- Reflections from buildings
- Road salt impact
- Rooting space restrictions / limitations
- Single / solitary trees in focus
- Soil contamination (e.g. oil, cement, …)
- Soil disturbances
- Soil compaction
- Soil covering / sealing

Requirements and selection criteria for species nomination I

(in alphabetical order).

- Allergy risk (by pollen, hairs)
- Bark: colour, beauty, structure, thickness, drop of bark scales etc, potential uses (colouring, bast), sunburn sensitivity
- Benefits for animals (nesting, protection, food, …) (regarding birds, mammals, insects)
- Costs of planting, maintenance
- Crown size, shape
- Crown transparency (species specific)
- Drought stress tolerance
- Edible leaves, fruit, branches (also for animals)
- Effects on the psyche
- Features for bioengineering
- Flowers: colour, intensity, smell, time of flowering, annoyance (allergies, dust…)
- Fruits: number, size, colour, time of ripeness, edible, nutrient content (also for animals), annoyance (also caused by animals), dropping period / time
- Growth rate of young / mature trees
- Immission tolerance (SO 2 , NO x , O 3 , HF, …)
- Immission reduction potential (fixation / absorption)
- Invasiveness / spreading potential: problems

Requirements and selection criteria for species nomination II

(in alphabetical order).

- Late frost susceptibility
- Leaf colouration: intensity, period / time
- Leaves of evergreen / decidious, leaves stay brown on branches in autumn
- Leaves: shape, size, colour, time of flush / autumn colouration / leaf drop, potential uses (decoration, food), annoyance (leaf drop, shading), self cleaning / dust accumulation
- Life expectancy
- Light requirements (young, mature plant)
- Maintenance requirement / costs
- Mykorrhiza necessary?
- Nature conservation aspects (indigenous, introduced, rare species, tree for birds or other animals, biotope, habitat)
- Neighbourhood situation (leaf drop, fruit drop, shading, hanging branches)
- 'New' species (test, experiment)
- Nitrogen fixation by roots (symbiosis with bacteria)
- Noise reduction potential
- Pathogens / pests (current, future)
- Personal relationships / experience with specific species (childhood, life stages, house / family tree...)

Requirements and selection criteria for species nomination III

(in alphabetical order).

- pH value amplitude
- Pioneer features
- Poisonousness (leaves, fruit, branches)
- Potential for dust fixation / reduction
- Pruning / cutting tolerance
- Psychological effects
- Radiation tolerance (single trees)
- Risk of breakage (branches, trunk)
- Root suckers
- Rooting intensity
- Rooting type (flat, heart, tap root)
- Salt tolerance
- Shading
- Size of mature tree (small, large)
- Slow growth
- Soil requirements (water, nutrients, pH value…)
- Soil tolerance: drought, contamination, wetness, flooding, compaction, pH value …
- Spring sap

Requirements and selection criteria for species nomination IV

(in alphabetical order).

- Sunburn sensitivity (bark, leaves)
- Thorns, spines
- Trunk dominance (tendency to coppicing / root suckers)
- Use of firewood
- Use of wood (furniture), bark (dye), leaves (decoration), flowers (recipe), fruit (food), spring sap …
- Vegetative spread with root suckers, branch layering
- Visual barrier effect
- Water demand
- Wind protection
- Wind throw risk
- Winter frost hardiness

It may help a little sorting the mentioned criteria into

- aesthetic factors
- aspects of design
- ecological requirements of the species
- tolerance of the species
- positive effects on people
- possible annoyance
- ...

Introduction

Expected consequences of climate change

- Drought stress – avoidance vs. tolerance

- Damage by late frost

Suitability of urban trees for the future

- Climate-Species-Matrix (KLAM)

- Urban Tree Selection Data Base CITREE

Conclusion

Introduction

Expected consequences of climate change

- Drought stress

- Damage by late frost

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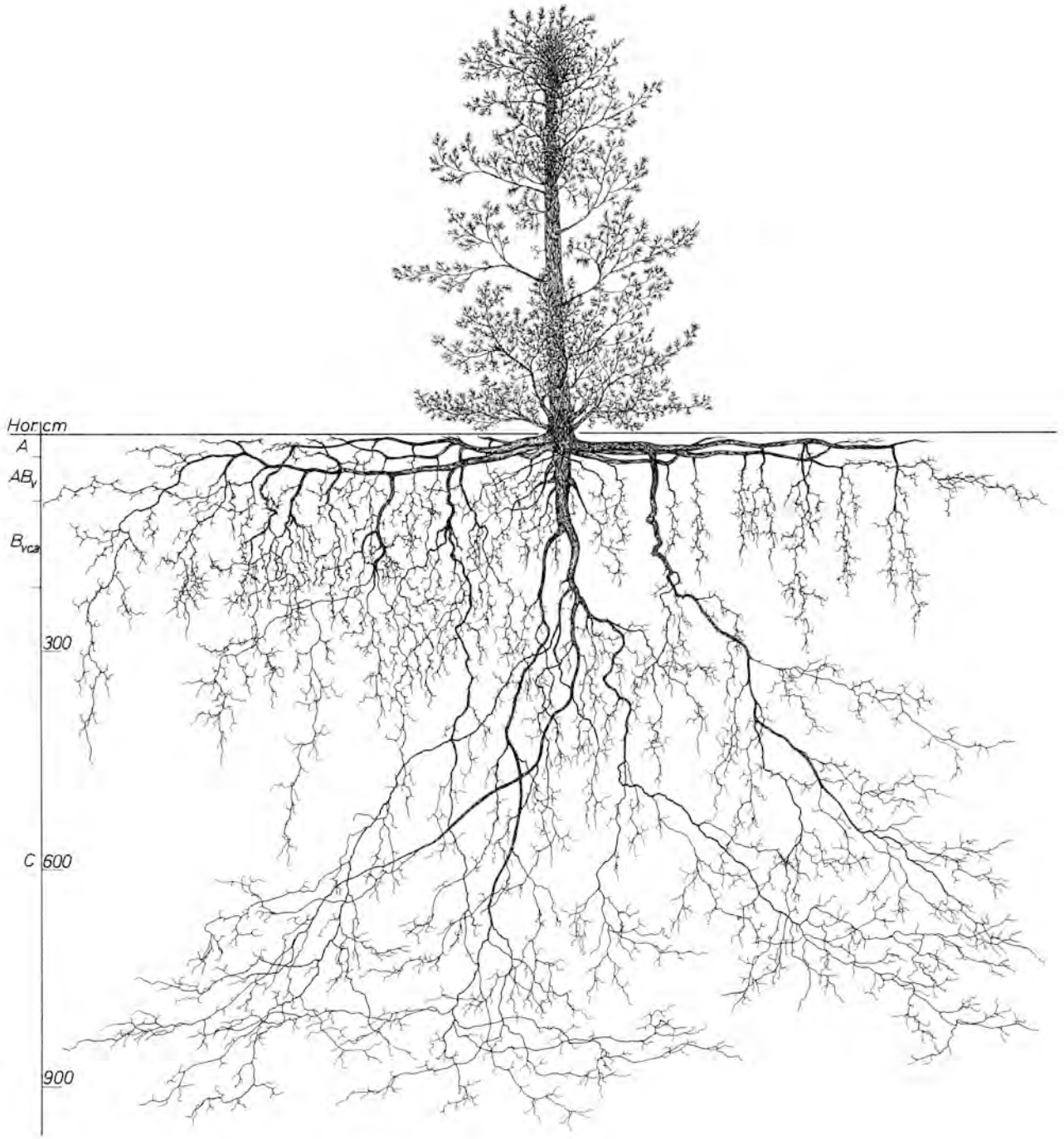
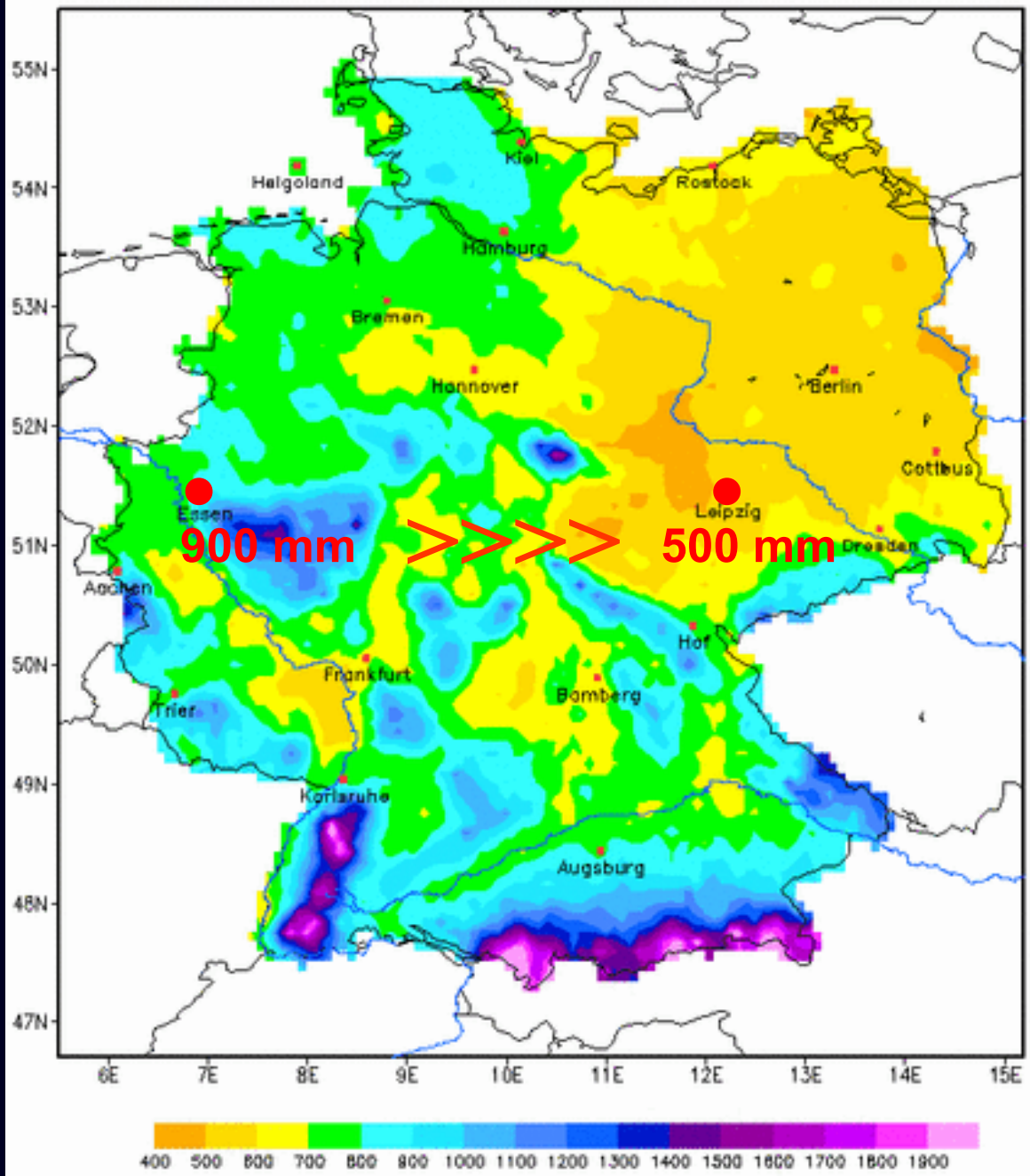
Conclusion



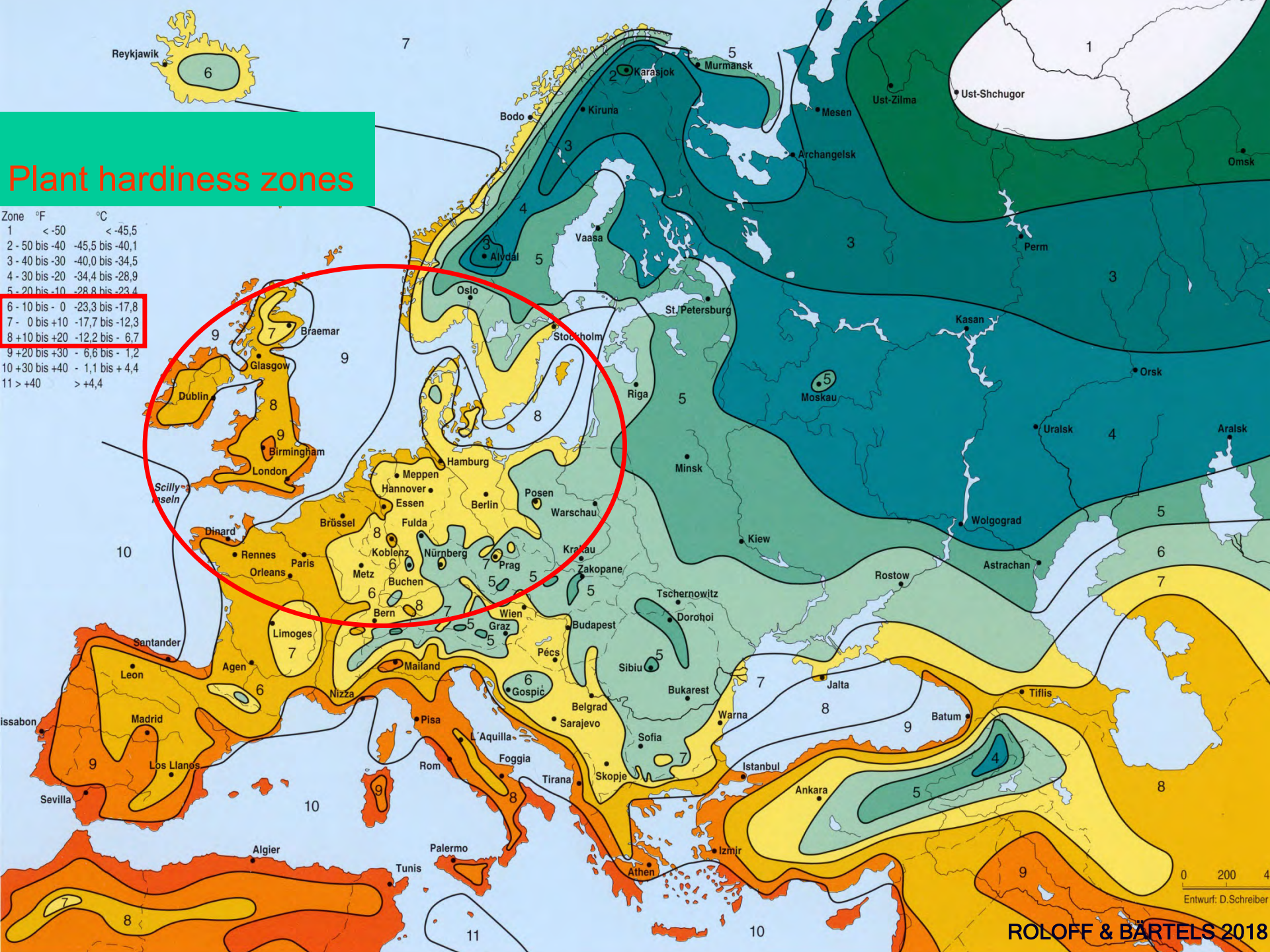
KUTSCHERA et al. 2002

average precipitation



DWD 2007

Plant hardiness zones



Grades for suitability to drought stress

1: very well suited
2: well suited
3: problematic
4: not very suitable

1: best
:::
4: worst

Frost hardiness degree

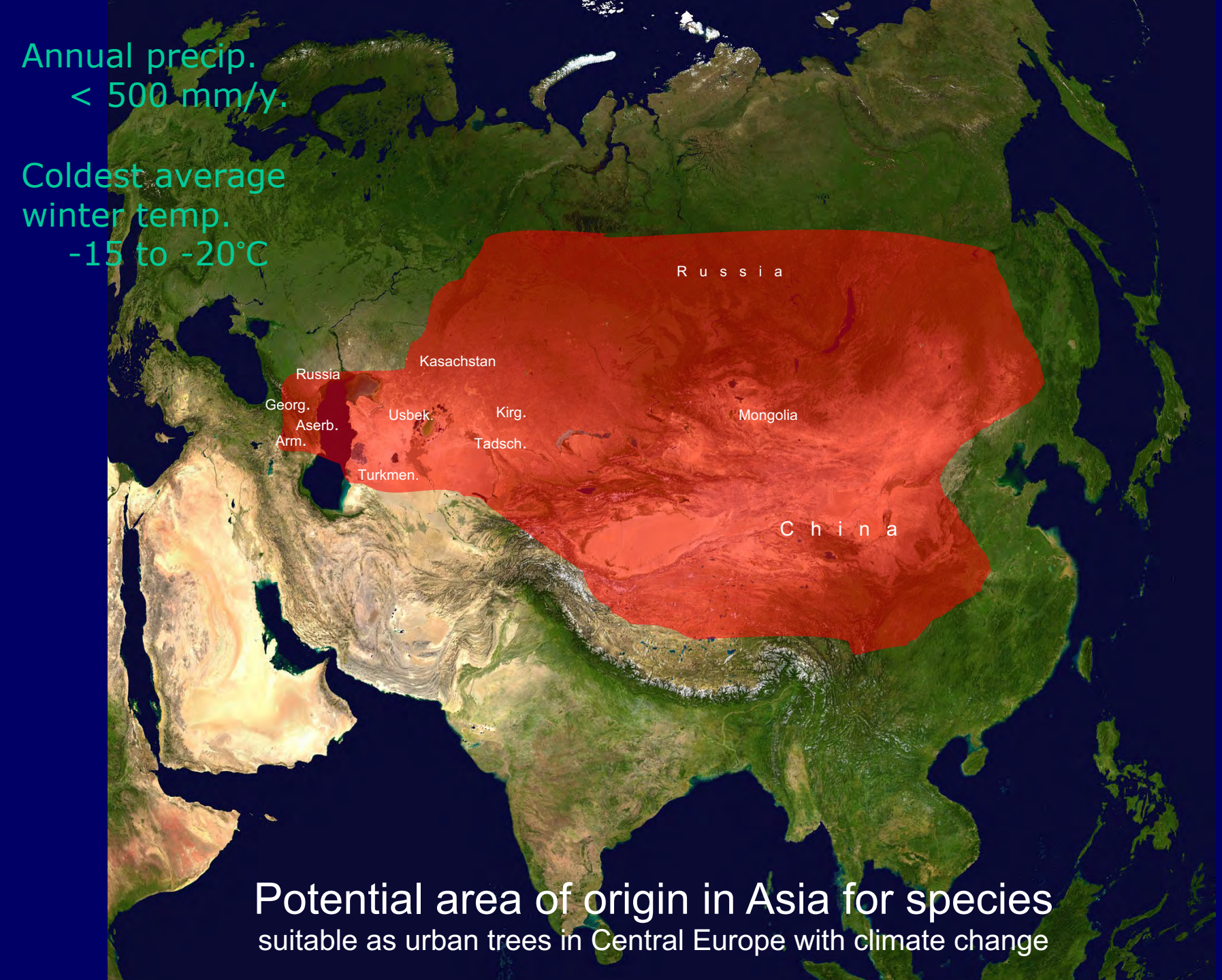
1: very well suited
2: well suited
3: problematic
4: not very suitable

Annual precip.
< 500 mm/y.

Coldest average winter temp.
-15 to -20°C

Potential area of origin in North America for species

suitable as urban trees in Central Europe with climate change



Potential area of origin in Asia for species

suitable as urban trees in Central Europe with climate change

Evaluation of drought tolerance and hardiness, using the example of Downy oak (*Quercus pubescens*)

	Drought tolerance			Hardiness							
	A	B	C	E	F	G	H	I	J	K	L
Assessment	6	3	2	6b		(x)	(x)	>20			
Individual grades	1	2	1	1	1	2	3				
Overall grades (final)			**1.3**				**1.7**		**1**	**1**	**h***
Grading (grade pair)						**1-2**					

* h = hardy

Explanation:

A Habitat
B Soil factors
C Climate factors
E Hardiness zone
F Frost sensitivity
G Frost resistance
H Resistance to late frost

► Based on reliable publications and own experience

'CSM' Climate-Species-Matrix

Hardiness

Drought stress tolerance

Grade	-1	-2	-3	-4
1-	49 1-1	59 1-2	9 1-3	14 1-4
2-	25 2-1	28 2-2	4 2-3	5 2-4
3-	17 3-1	14 3-2	3 3-3	3 3-4
4-	4 4-1	5 4-2	3 4-3	0 4-4

(very) suitable
with restrictions
not very suitable

'CSM' Climate-Species-Matrix

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4-	4 4-1	5 4-2	3 4-3	0 4-4

(very) suitable
with restrictions
not very suitable

Urban trees category 1-1: "very suitable"

Acer campestre
Acer negundo
Acer x zoeschense
Alnus incana
Cladrastis sinensis
Fraxinus pallisiae
Juniperus communis
Juniperus scopulorum
Juniperus virginiana
Ostrya carpinifolia
Phellodendron sachalinense
Pinus heldreichii
Pinus nigra
Pinus sylvestris
Prunus avium
Quercus bicolor
Quercus macrocarpa
Robinia pseudoacacia
Robinia viscosa
Sorbus aria
Sorbus badensis
Sorbus x thuringiaca
Tilia mandshurica
Ulmus pumila

'CSM' Climate-Species-Matrix

Hardiness

Drought stress tolerance

Grade	-1	-2	-3	-4
1-	49 1-1	59 1-2	9 1-3	14 1-4
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4-	4 4-1	5 4-2	3 4-3	0 4-4

(very) suitable
with restrictions
not very suitable

Favoured road-side trees

Acer campestre 1-1

A. platanoides 2-1

A. rubrum 1-2

Aesculus x *carnea* 2-1

Ailanthus altissima 1-2

Alnus x *spaethii* 2-1

Betula pendula 2-1

Carpinus betulus 2-1

Carya tomentosa 1-2

Celtis australis 1-3

Fraxinus angustifolia 1-2

F. ornus 1-3

F. pennsylvanica 2-1

Ginkgo biloba 1-2

Gleditsia triacanthos 1-2

Liquidambar styraciflua 2-2

Ostrya carpinifolia 1-1

Phellodendron sachalinense 1-1

Platanus x *hispanica* 1-2

Populus x *berolinensis* 2-1

Quercus cerris 1-2

Qu. frainetto 1-2

Robinia pseudoacacia 1-1

Sophora japonia 1-2

Sorbus intermedia 2-1

S. x *thuringiaca* 1-1

Tilia cordata 2-1

T. x *euchlora* 2-1

T. mandshurica 1-1

T. tomentosa 1-2

Ulmus pumila 1-1

Acer campestre (Field maple from Europe)

Ginkgo biloba (Gingko from China)

Liquidambar styraciflua (Sweet gum from N-America)

Acer buergerianum (Trident maple from China/Japan)

Koelreuteria paniculata (Golden rain tree from China/Korea/Japan)


Metasequoia glyptostroboides (Dawn redwood from China)

Fraxinus angustifolia (Narrow-leaved ash from S-Europe)


Styphnolobium japonicum (Pagoda tree from China/Korea)


Herbst-
blumen


Weingut Pesterwitz
Stein Castell Thorun


bäcker
café
drive in
GENAU DEIN GESCHMACK
ODER

'CSM' Climate-Species-Matrix

published in **'Urban Forestry & Urban Greening'** issue 4 in 2009, (ROLOFF et al.)

Hardiness

Drought stress tolerance: Grade	-1	-2	-3	-4
1-	49 1-1	59 1-2	9 1-3	14 1-4
2-	25 2-1	28 2-2	4 2-3	5 2-4
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4-	4 4-1	5 4-2	3 4-3	0 4-4

(very) suitable
with restrictions
not very suitable

Problem

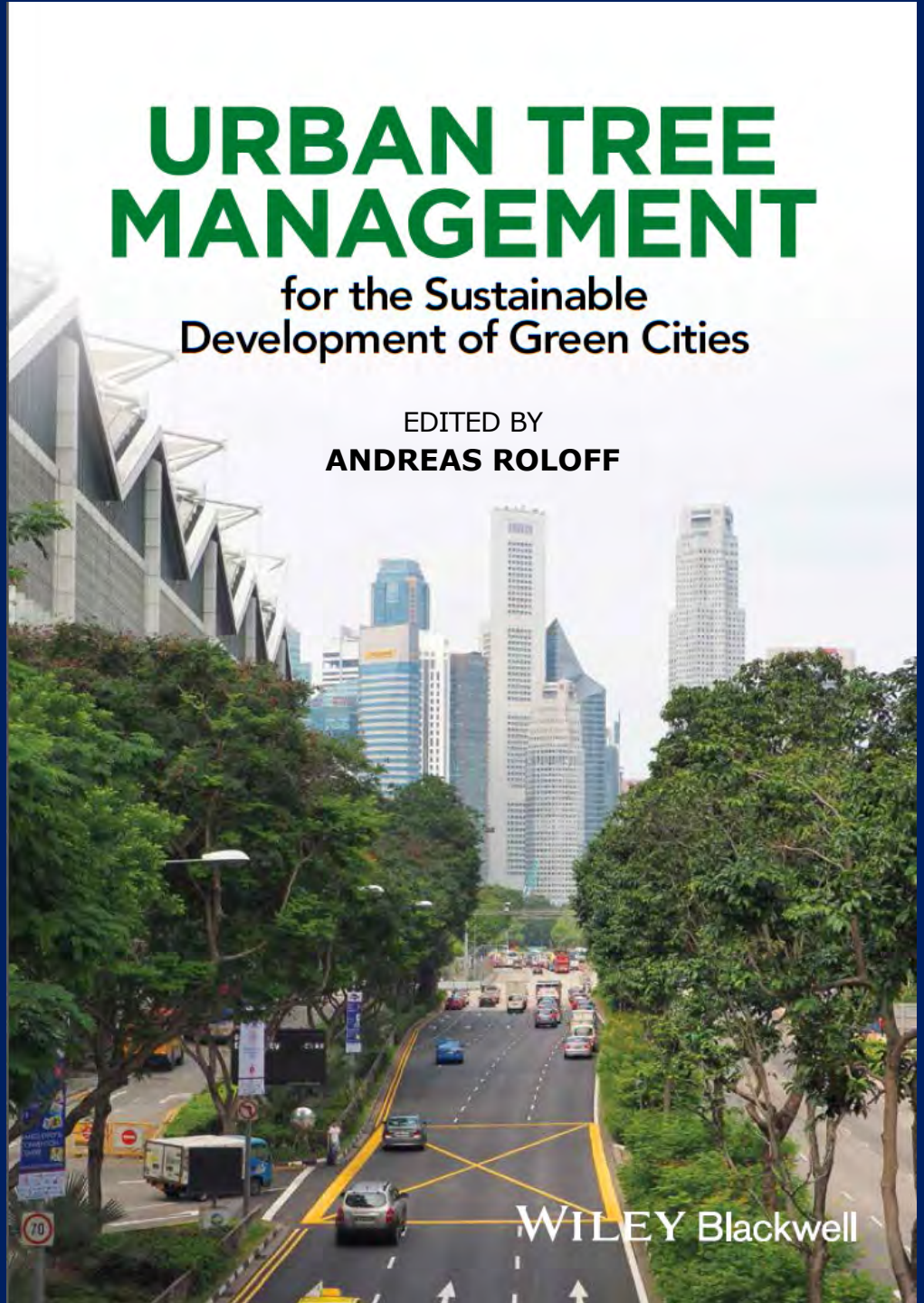
there were not included so far:

- cultivars

- possible risks posed by pathogens

- other special factors e.g. aesthetical criteria, tolerance for salt etc.

- site factors



Published in 2017

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'I like to be here.' Professor Andreas Roloff is head of the chair since 1.1.1994 and works with his team all over the spectrum of forest and urban tree topics (tree biology), botany of woods, successional development and parks. His favourite scientific interest is to understand trees in their complete broad life cycle and adaptation mechanisms, not only parts of it and some

STAFF

Members

RESEARCH FOCUS

Plants and in particular trees are fascinating. Past and recent knowledge of eco-dendrological research shows a wide range of functions, mechanisms and strategies of trees and shrubs. The focus of the chair lies on fundamental and application-oriented research.

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The Chair

What are woody species? How can trees and shrubs maintain their life processes over years, decades or even centuries resisting diverse changing environmental conditions? How can trees ensure supply of water and nutrients and which structures are involved? Is it possible to detect life history of trees from outer and inner structures? How do trees and shrubs reproduce and spread?

The chair of forest botany focuses on these and many more questions within research and study. This complexity and meshing of plant-physiological, ecological and genetic aspects are characteristic for our working practices. We have fostered relations with international, national, and regional research institutions, local authority boards and enterprises supporting our trans- and interdisciplinary work approaches.

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CITREE - Urban Tree Selection Database

- with >400 species and cultivars
- with >65 features you can choose

https://citree.de ► switch to English

citree

Woody species for urban spaces
Database planning tool

TECHNISCHE UNIVERSITÄT DRESDEN

Woody species for urban spaces

The database supports you in the selection processes of trees and shrubs for urban sites. Therefore, please characterize the site as detailed as possible and indicate additional requirements towards trees, such as certain appearances you desire or potential risks that are to be avoided. You may use preselected values for typical planting locations (displayed at the top of the front page) and modify them accordingly. If you need help, please refer to our additional instructions.

SELECTION

By selection criteria

You may use **preselected criteria** for typical tree location types or sensitive demographic groups or select single criteria individually.

By names

You may access detailed information on all species (**profiles**) by filtering by name. You may enter common or scientific names.

SPECIFICATION

RESULTS

Site characteristics and natural distribution

Climatic conditions

- Drought risk
- Light availability
- Heat risk
- Late frost risk
- Plant hardiness zone

Soil conditions

- pH value
- Substrate
- Soil depth
- Soil compaction risk
- Waterlogging risk
- De-icing salt stress
- Soil moisture

Natural distribution

- Origin
- Neophyte

Tree appearance

Habitus

- Maximum tree height

- Near-surface roots
- Average crown radius
- Habit

tree shrub

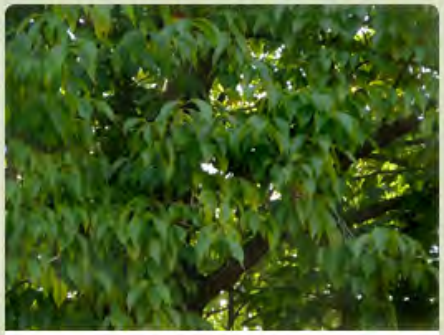
- Growth direction

upright squarrose overbent
overhanging corkscrew-like twisted
climbing ground-lying creeping

- Crown shape
- Leaf density
- Average tree height
- Growth speed
- Multi-stem development

Leaf

- Foliation



Gutta-percha-tree

Eucommia ulmoides Oliv.

Match 92 %

Netleaf hackberry

Celtis reticulata Torr.

Match 92 %

Dutch elm

Ulmus x hollandica Mill. **Sorte** Lobel

Match 87 %

Dutch elm

Ulmus x hollandica Mill.

Sorte Regal

Match 87 %

Dutch elm

Ulmus x hollandica Mill.

Sorte Plantijn

Match 87 %

Common hornbeam

Carpinus betulus L.

Sorte Frans Fontaine

Match 87 %

Ginkgo Ginkgo biloba L.

Sorte Fastigiata Blagon

Match 86 %

by cri ames

CHARACTERISTICS

Ginkgo Ginkgo biloba L.

Ginkgo

Ginkgo biloba L.

Sort: general

popularity 54%

SITE CHARACTERISTICS AND NATURAL DISTRIBUTION

Climatic conditions

Light requirement	sunny, half sunny
Drought tolerance	high tolerance
Heat tolerance	good
Llate frost tolerance	medium
Plant hardiness zone	5b

Soil conditions

pH value	5--8
Soil compaction tolerance	good
Waterlogging tolerance	sensitive
Salt tolerance	good
Soil moisture tolerance	medium, medium, low
Substrate	sandy, loamy, clayey, humous, porous, peaty, calcareous
Soil depth	deep (>3 m)

Natural distribution

Neophyte	yes
Origin	East Asia

TREE APPEARANCE

Habitus

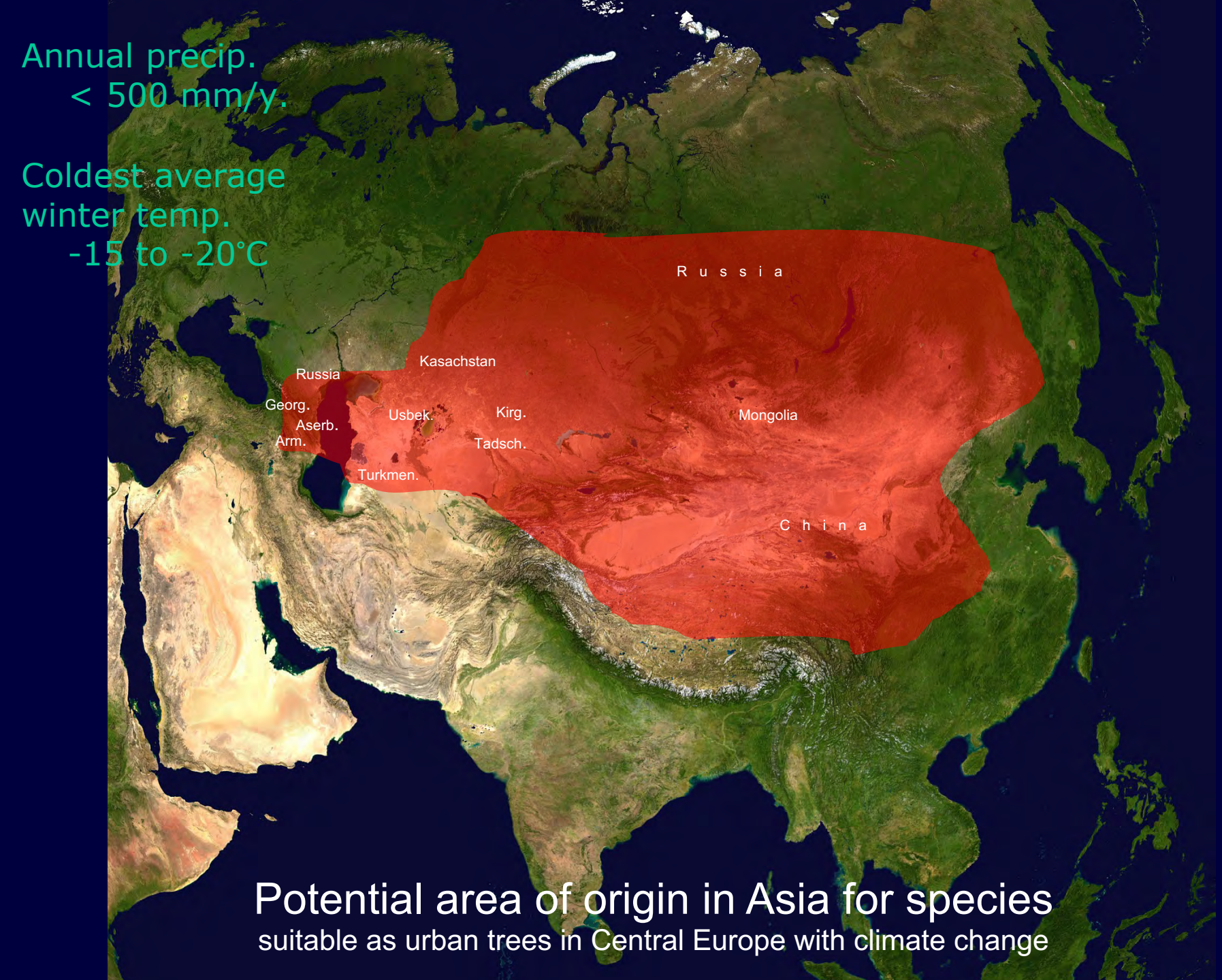
Multi-stem development	no
Growth speed	slow
Crown shape	broad and heavy, oval, conical, rounded, columnar, irregular
Growth direction	upright, squarrose, overhanging
Near-surface roots	yes
Leaf density	low
Habit	tree
Average crown radius	15 m
Average tree height	35 m
Maximum tree height	40 m

Leaf

Foliation	decidious
Leaf shape	single leaf
Autumn Coloring	yellow
Foliage	evergreen

Blossom

Blossom period	May



Potential area of origin in Asia for species

suitable as urban trees in Central Europe with climate change

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Street Trees from China for Central Euope?

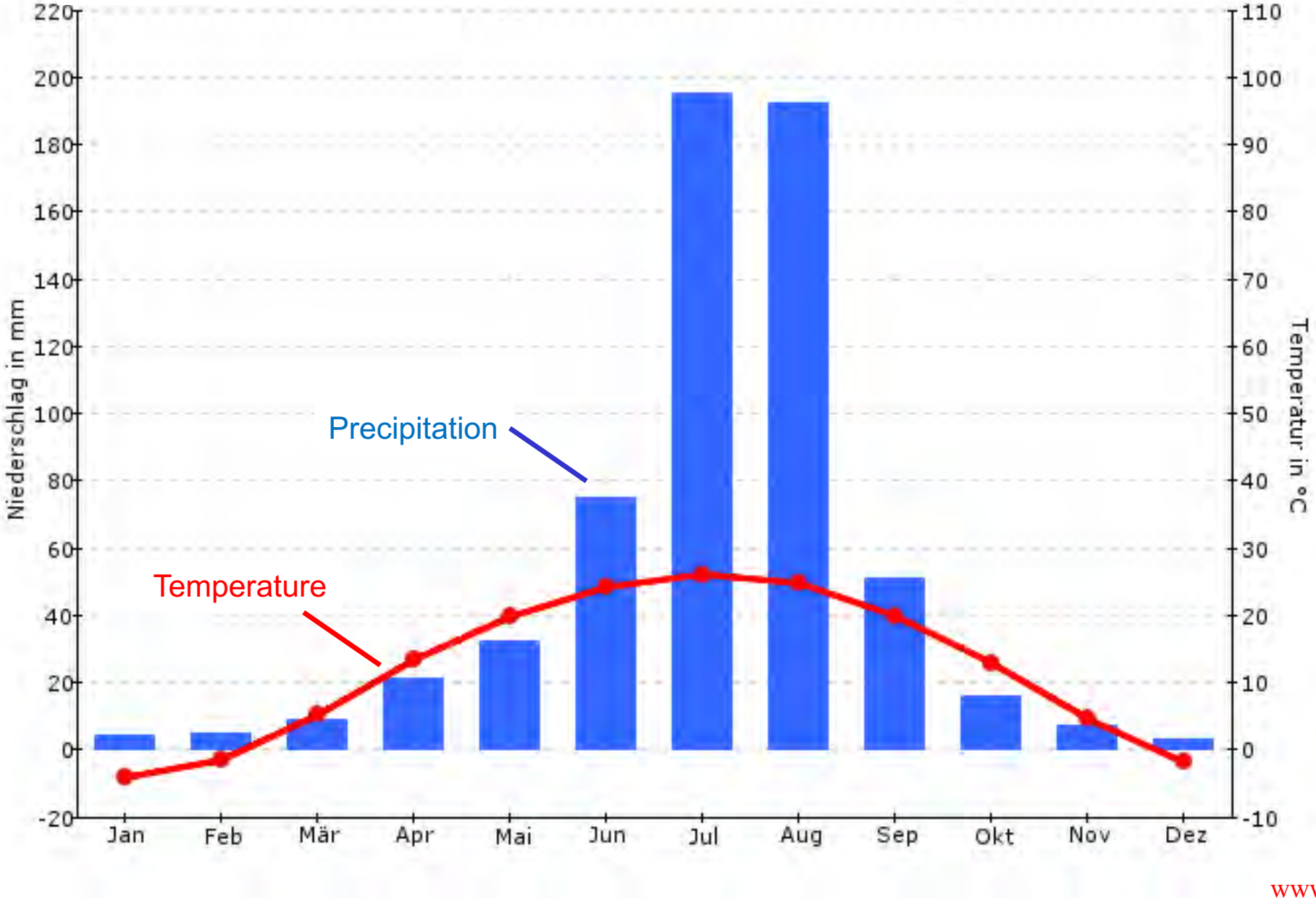
Andreas Roloff

TU Dresden, Chair of Tree Biology

www.tu-dresden.de/forstbotanik

Amenity Conference Arb Ass at Exeter 9-12 Sept 2018

Climate Diagram of Beijing




1. Sophora japonica – Pagoda tree


2. Fraxinus pennsylvanica – Green ash

3. Ginkgo biloba – Ginkgo

4. Populus tomentosa – Chin. white poplar


5. Ailanthus altissima – Tree of heaven


6. Koelreuteria paniculata – Golden rain tree

F1: Eucommia ulmoides – Gutta-percha tree

F2: Ziziphus jujuba – Chin. date


F3: Ulmus pumila – Sibirian elm


F4: Acer truncatum – Shandong maple

Acer truncatum	Shandong maple
Celtis bungeana	Bunge's hackberry
Eucommia ulmoides	Gutta-percha-tree
Fraxinus chinensis	Chinese ash
Pistacia chinensis	Chinese pistache
Platycarya strobilacea	Black dyetree
Populus tomentosa	Chinese white poplar
Quercus mongolica	Mongolian oak
Tilia mandshurica	Manchurian lime
Ulmus pumila (*U. mandschurica*)	Siberian elm
Ziziphus jujube	Chinese date


Thank you for your attention.