tree syntax and tree architecture for climate-adaptive cities

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Associate Professor Landscape Architecture
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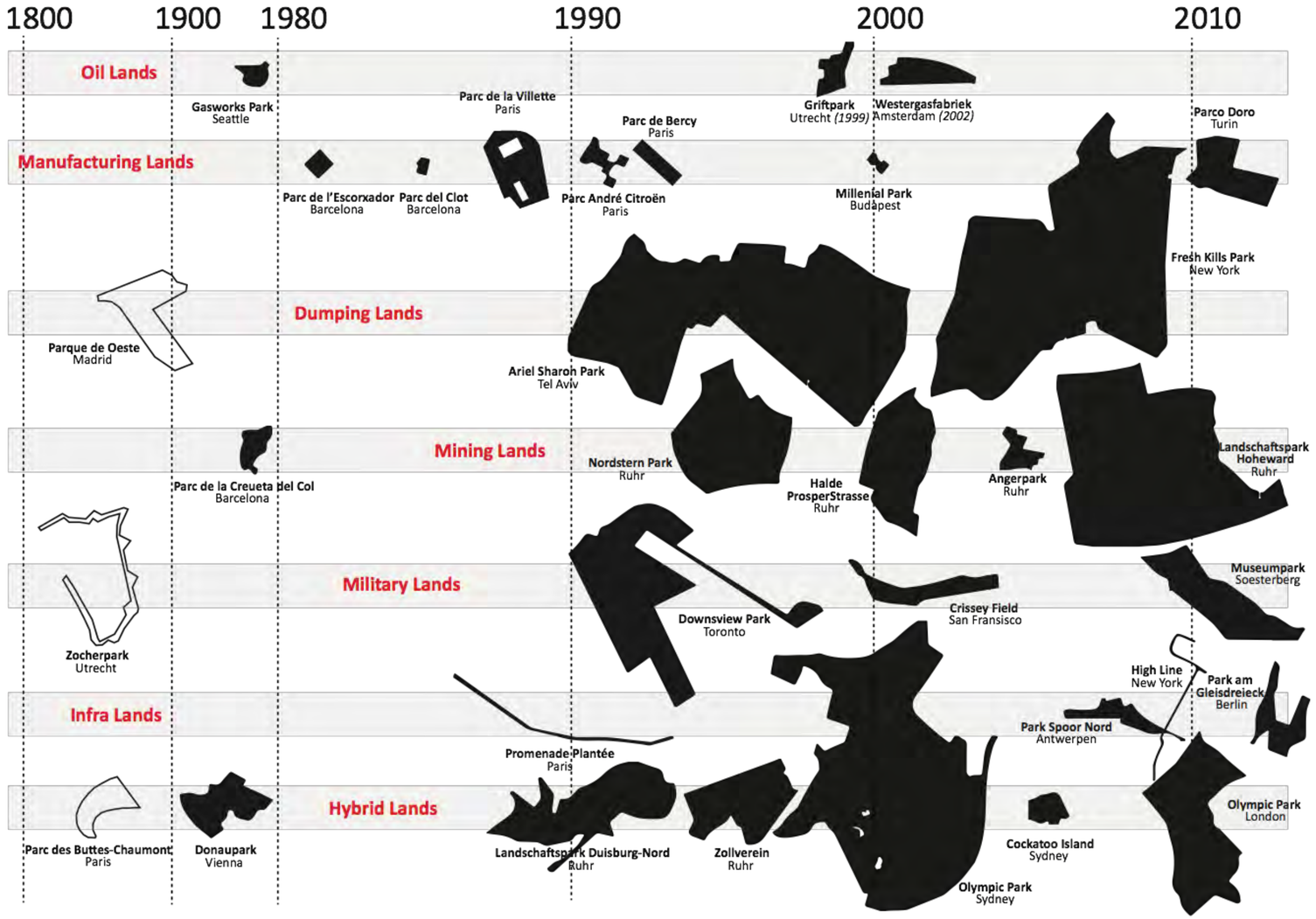
3 decades of (urban) trees - & green(ing) cities

climate trees symposium

spatial developments

climate trees symposium

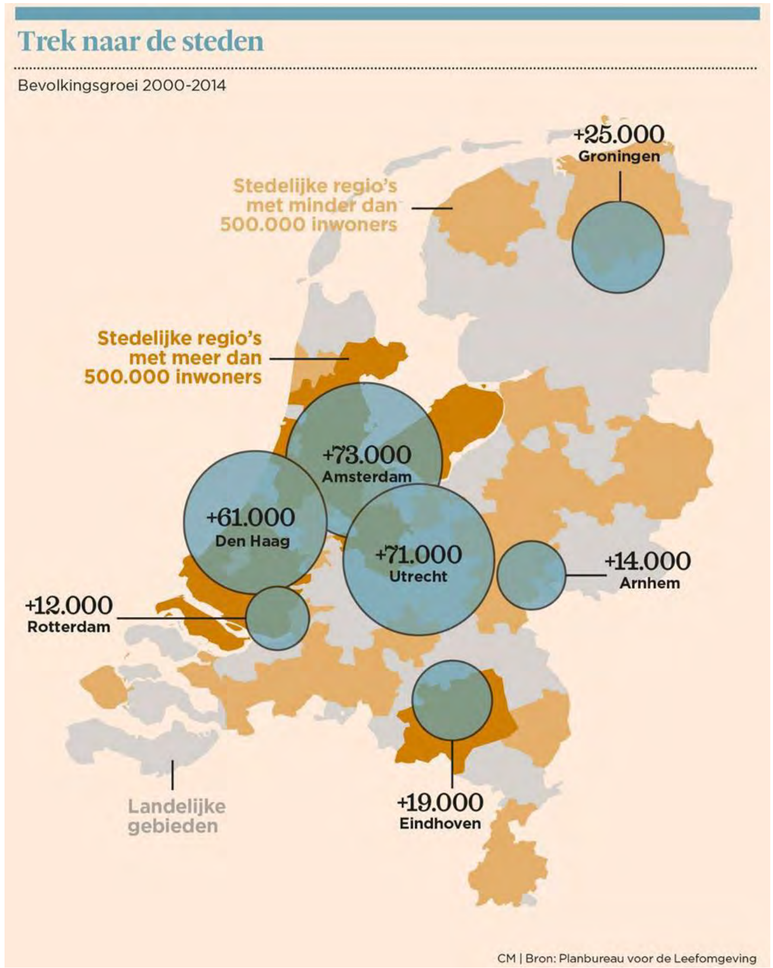


spatial developments

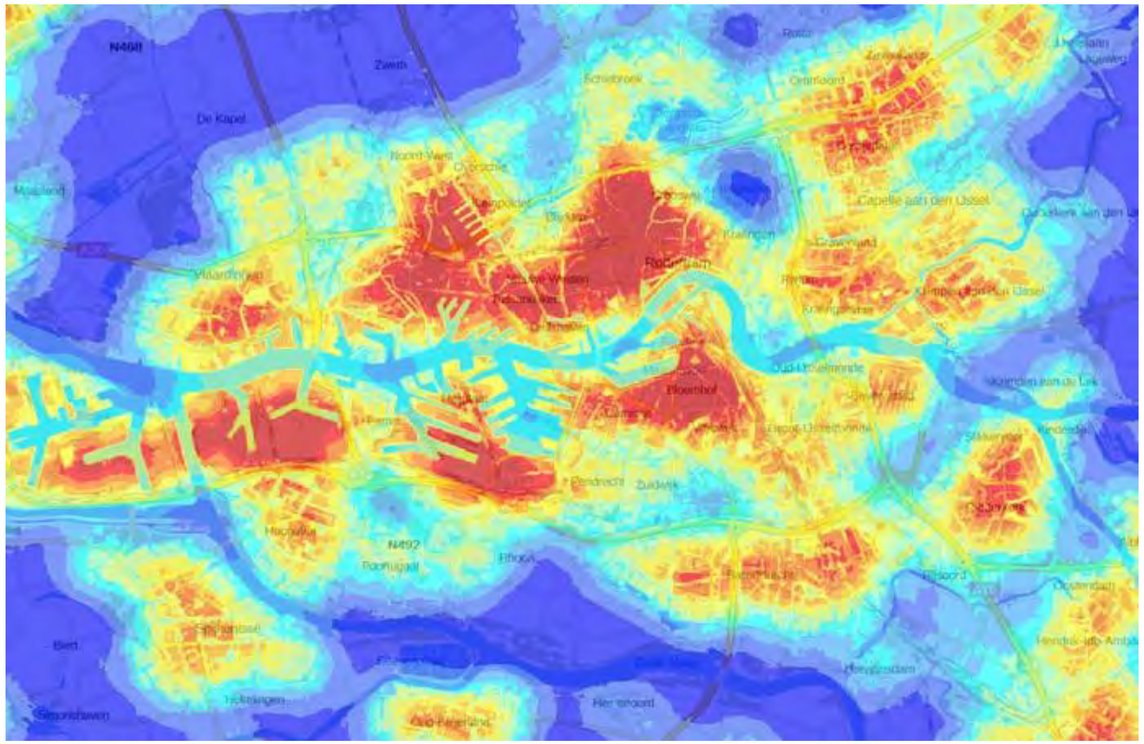
climate trees symposium

Landuse in
the Netherlands 1900

Landuse in
the Netherlands 2000

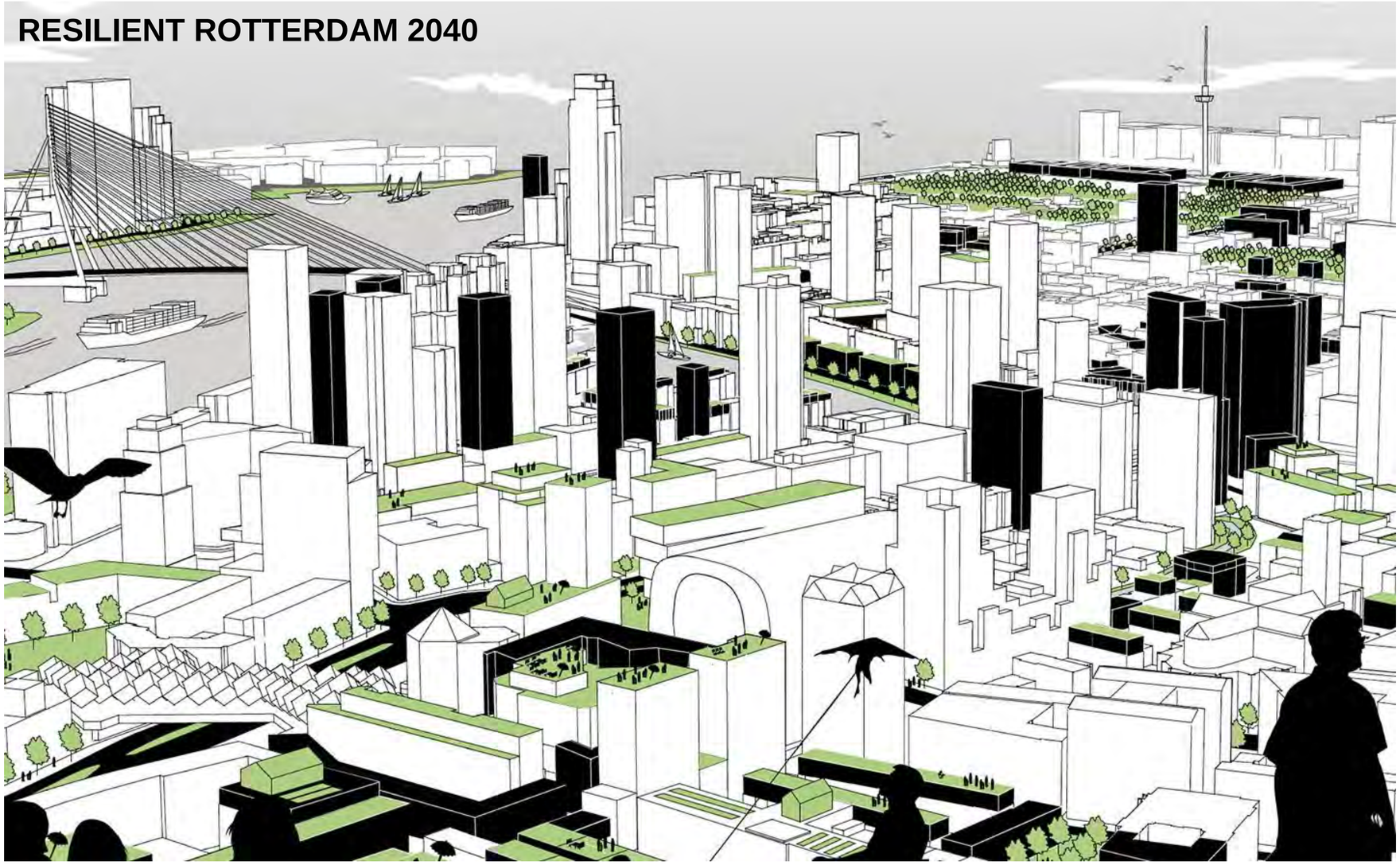


environmental developments



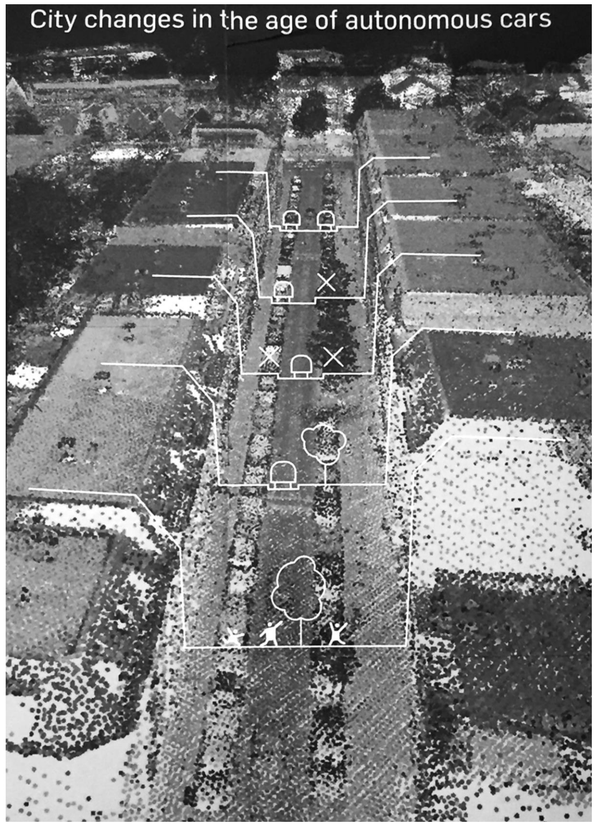
Urban heat islands **Rotterdam**

societal developments

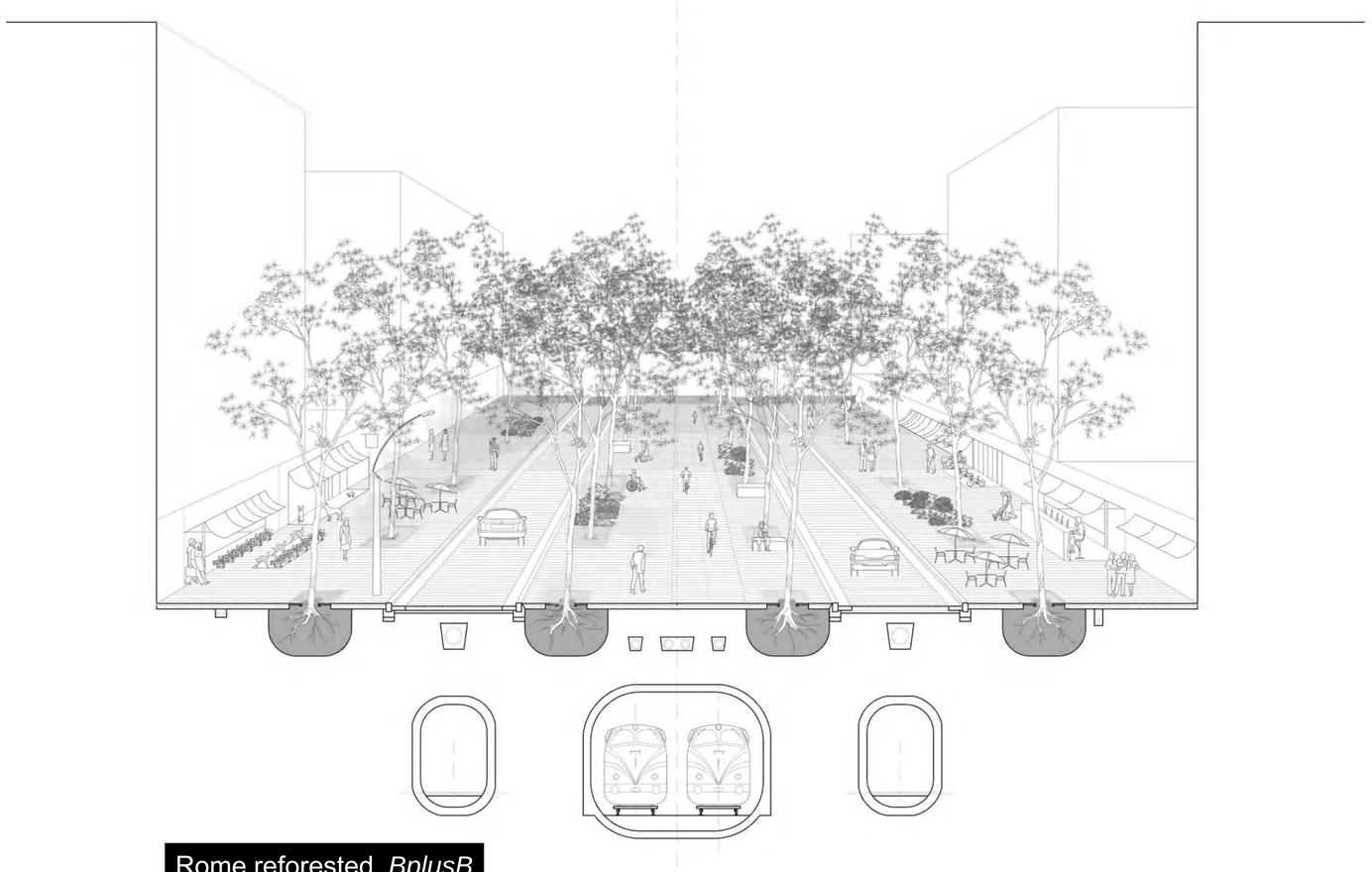


societal developments

climate trees symposium



Mobility revolution. Image: Anca Ionescu



Rome reforested_*BplusB*

urban forestry ‘infrastructure’ for *Garden Cities 2.0*

REALMS OF
URBAN FORESTRY

aboriculture/silviculture
selection, planting, training, fertilization, pest and pathogen control, pruning, shaping, removal

planning & policy
models, guidelines, land use plans, strategies, regulations, guidelines

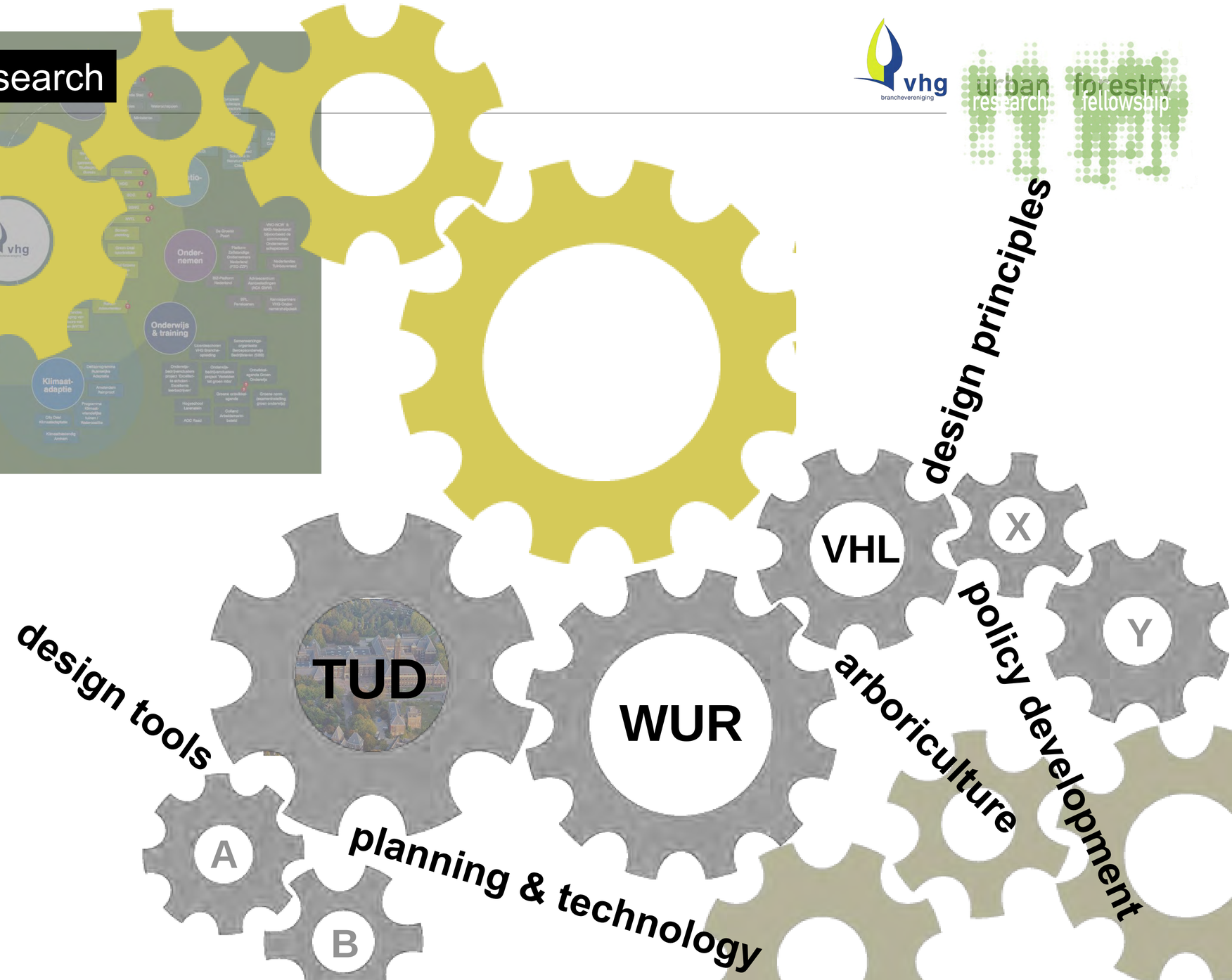
design
principles, solutions, plans, details

construction
technical detailing, construction techniques, methods

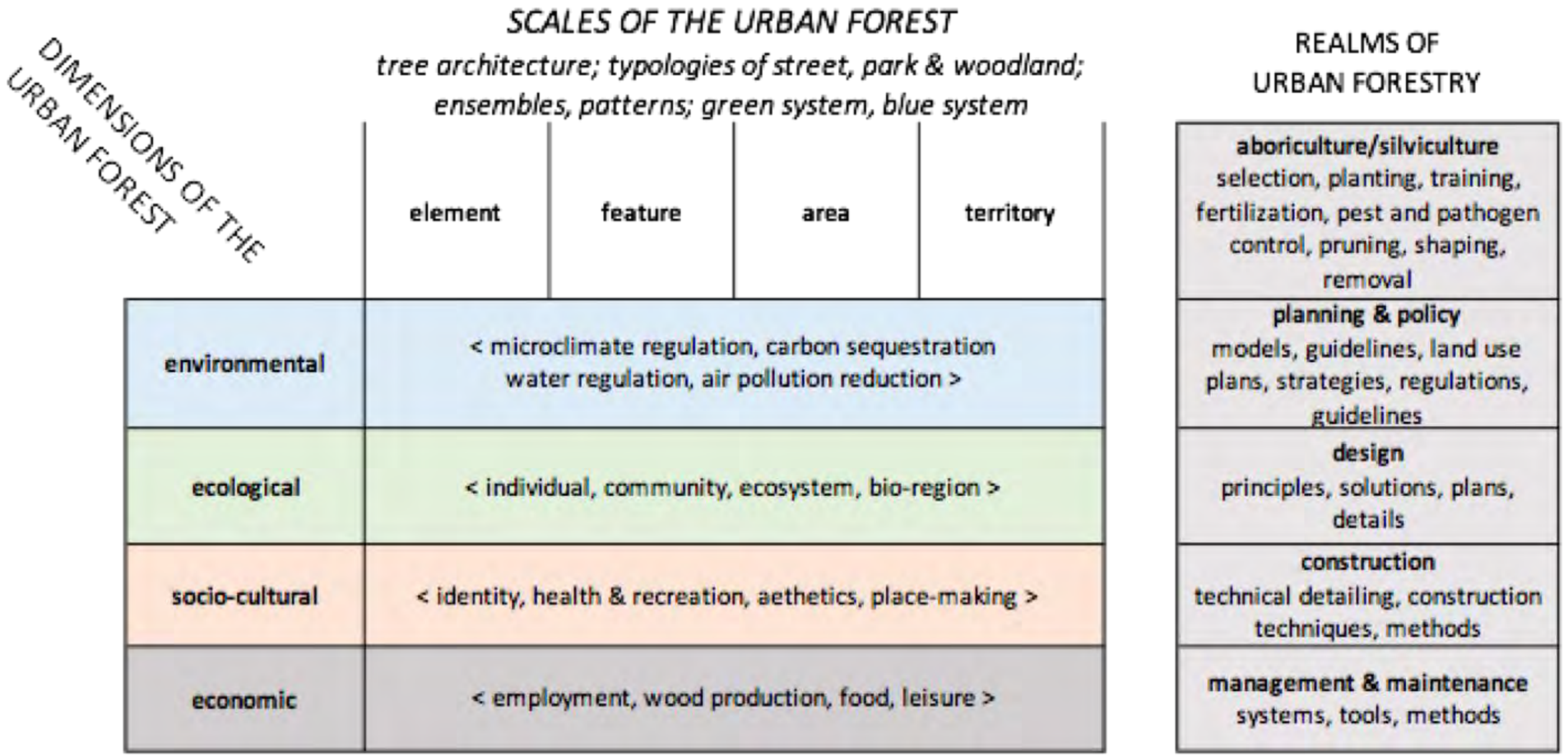
management & maintenance
systems, tools, methods

*Urban Forestry Matrix_*
Van der Velde, R. 2019

urban forestry research



VHG research fellow *urban forestry*



Urban Forestry Matrix_Van der Velde, R. 2019

VHG *research fellowship* urban forestry

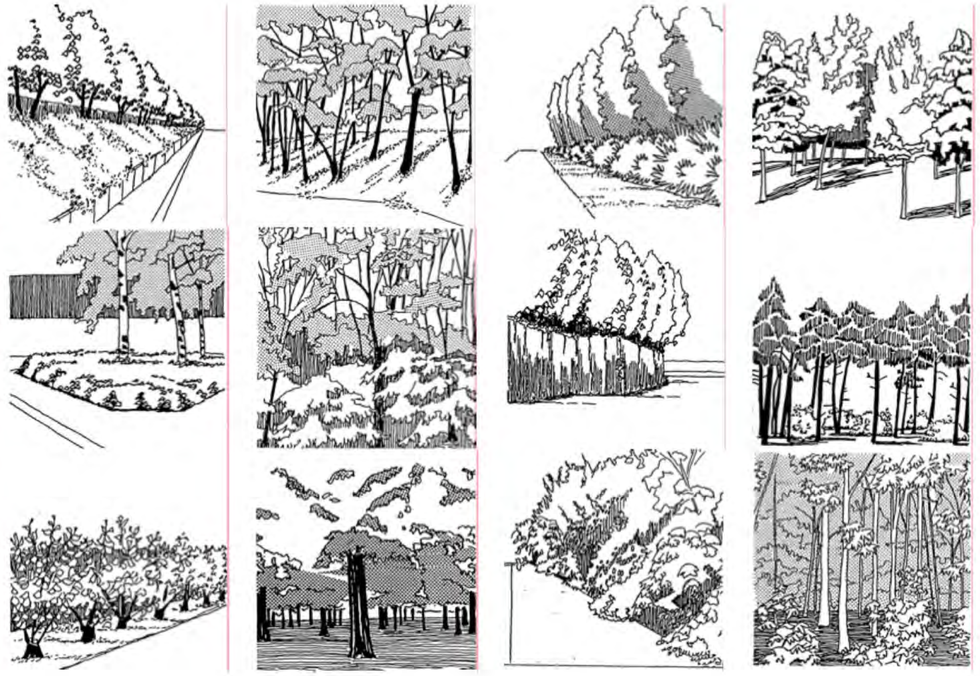
climate trees symposium

Hans Kaljee City of Amsterdam
Bob Ursem botanische tuin TU Delft
Hanna Hirsch Bomenstichting Nederland
Leendert Koudstaal City of Den Haag
Erik de Jong UVA
Olivier Copijn Van der Tol
Dirk Sijmons TU Delft
Harold Schoenmakers Anders Boomtechnisch Advies
Djorn Noordman City of Haarlem
Maarten Loeffen Vereniging Stadswerk Nederland
Marc Custers VHG

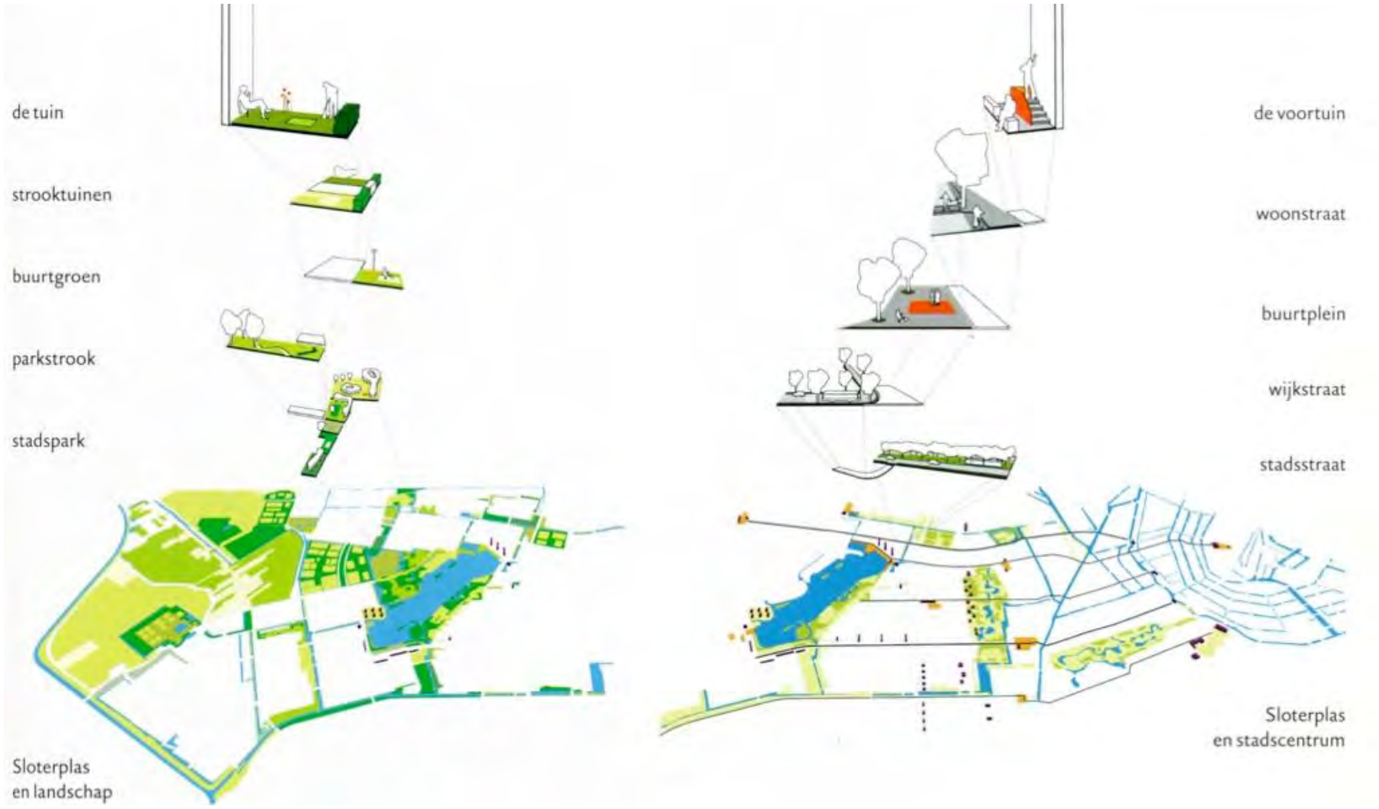
Saskia de Wit Chair of LA TU Delft
Gerdy Verschuure Chair of LA TU Delft
Lotte Dijkstra, Research Assistant

Jelle Hiemstra
Henry Kuppen
…

expand on the building design-landscape design idiom

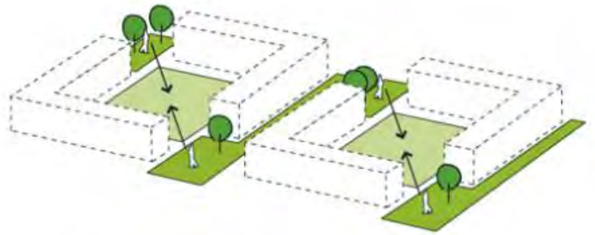


through: principles of integrated green-blue + grey-red systems

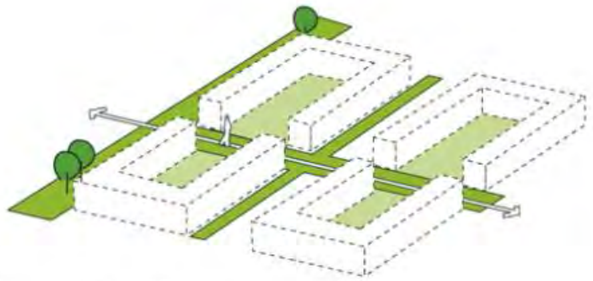


Veldhuis, W. (2006). Het ontwerp van de openbare ruimte.

Sun



Doorzicht bij het opengewerkt blok



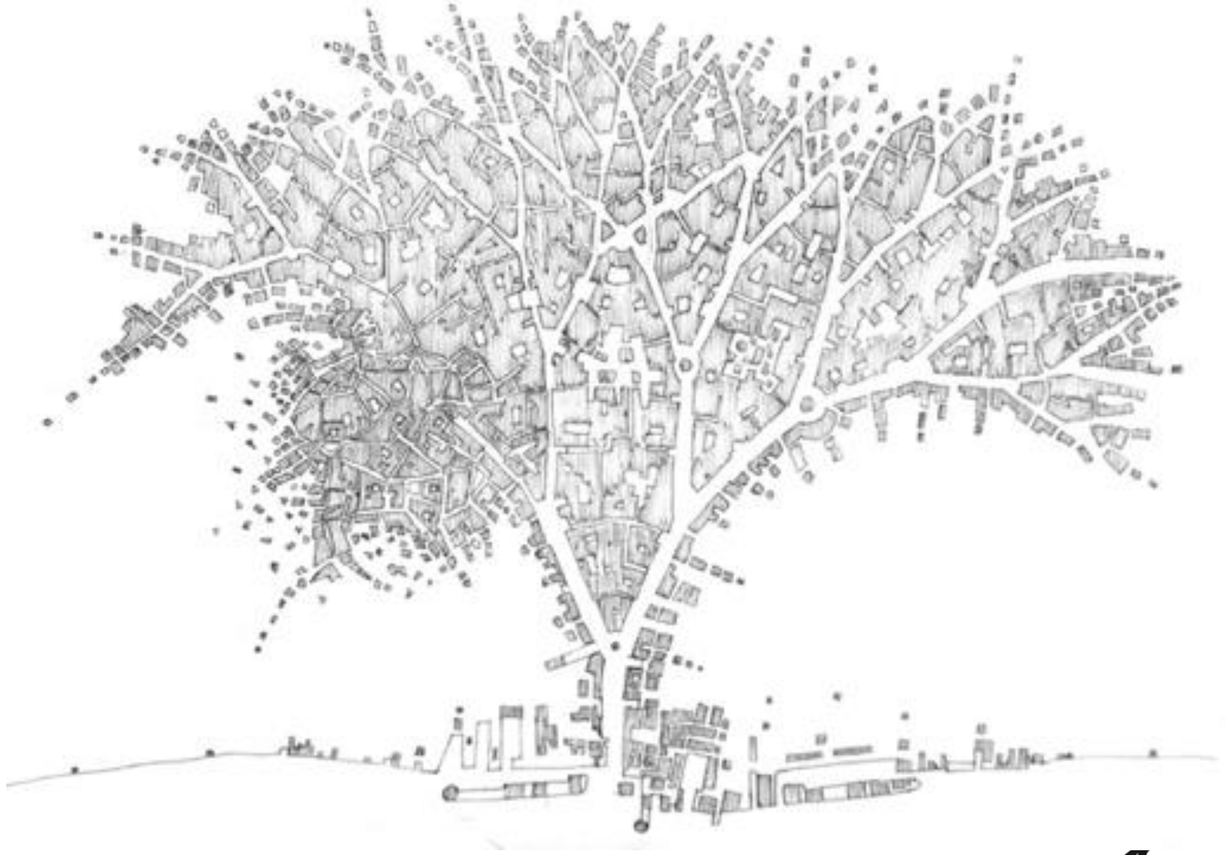
Dwarsroute door de hoven

Yttje Feddes et. al. (2010). De groene kracht

Transformatie van de Westelijke Tuinsteden, Amsterdam. Sun 2010

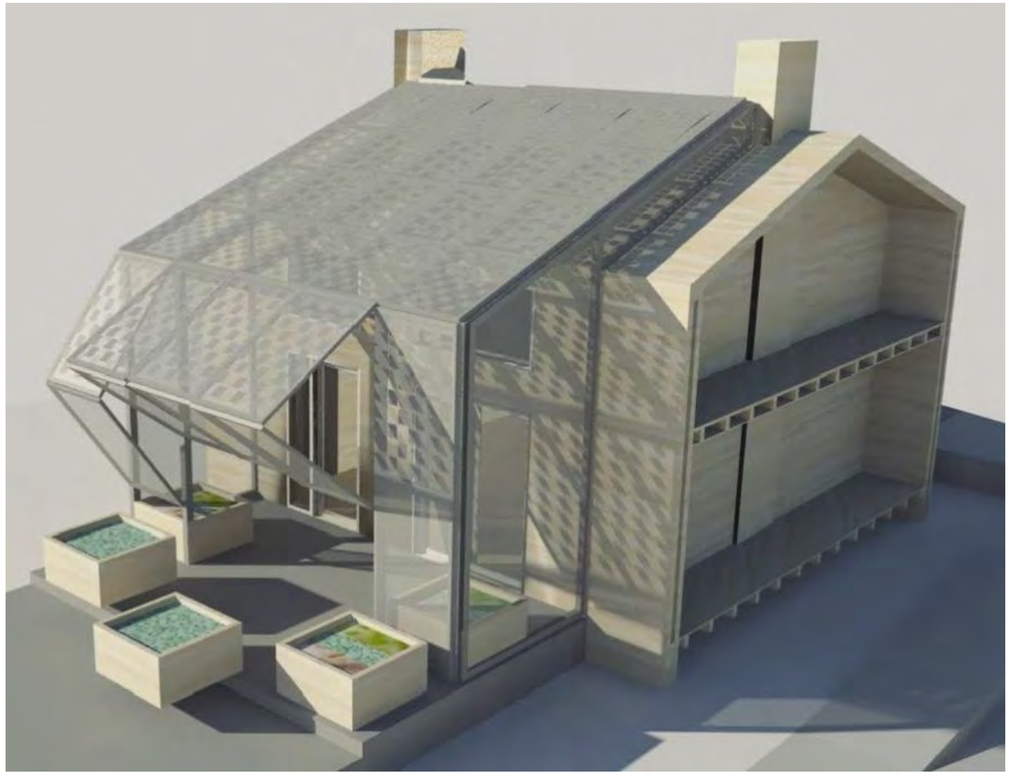
+ garden city 2.0 solutions_via design research & innovation

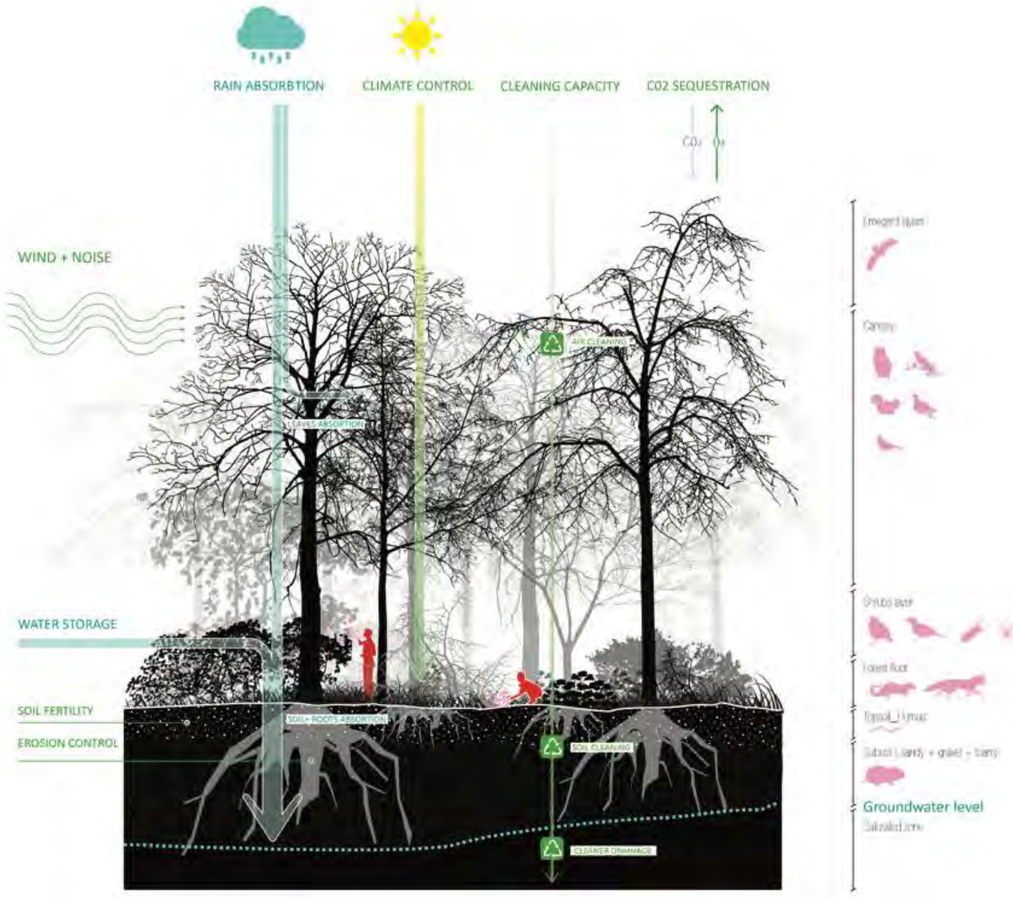
forest tower_Sou Fujimoto



Image_*Simeon Nelson Studio*

move from building sciences vs. life sciences to…

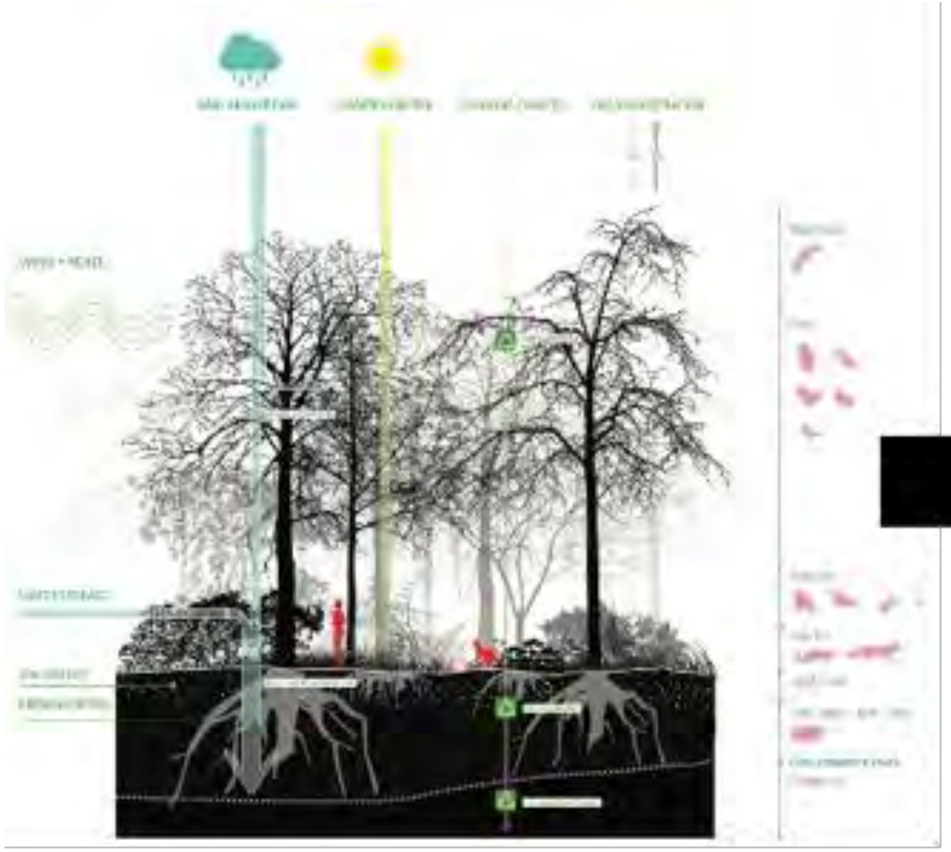


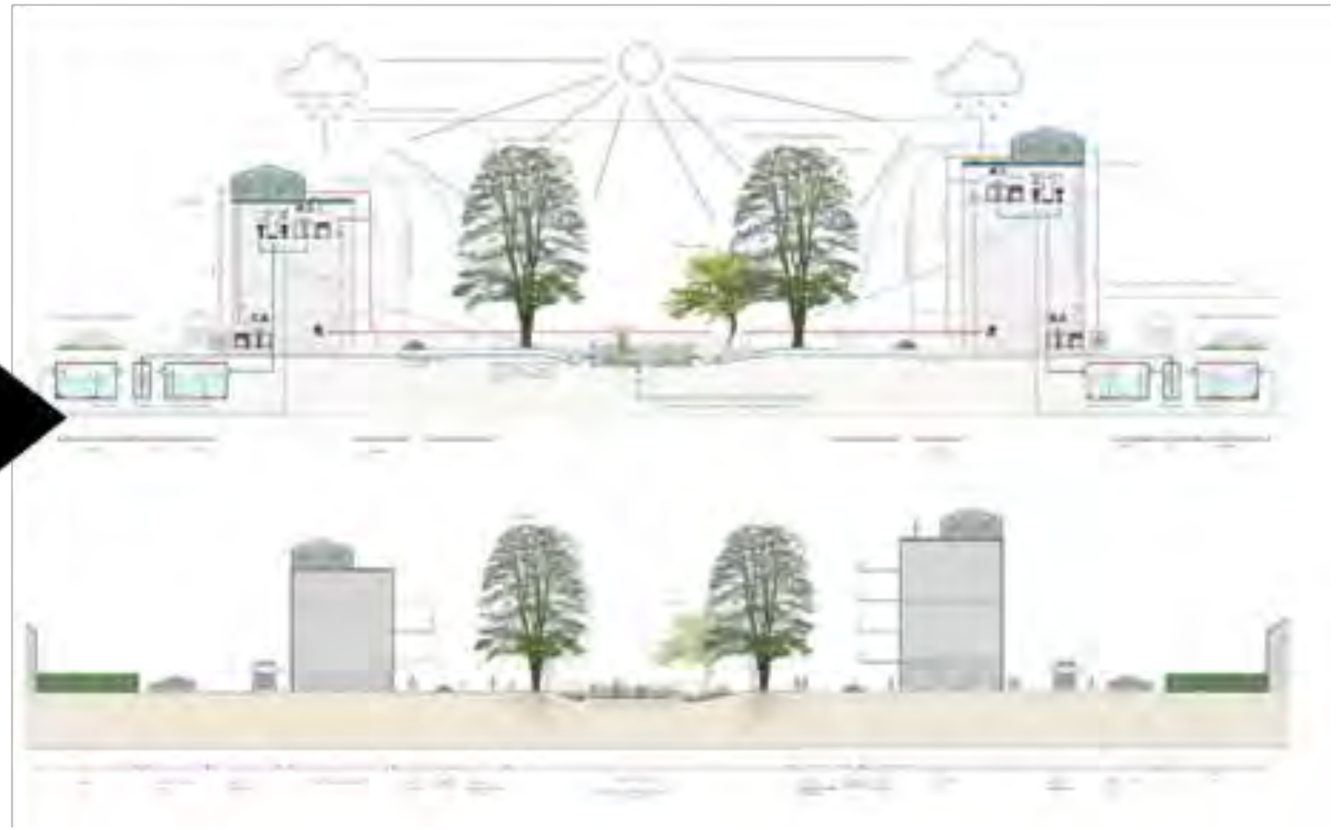


forest ecosystem services_*de urbanisten*

integrated sustainable environments

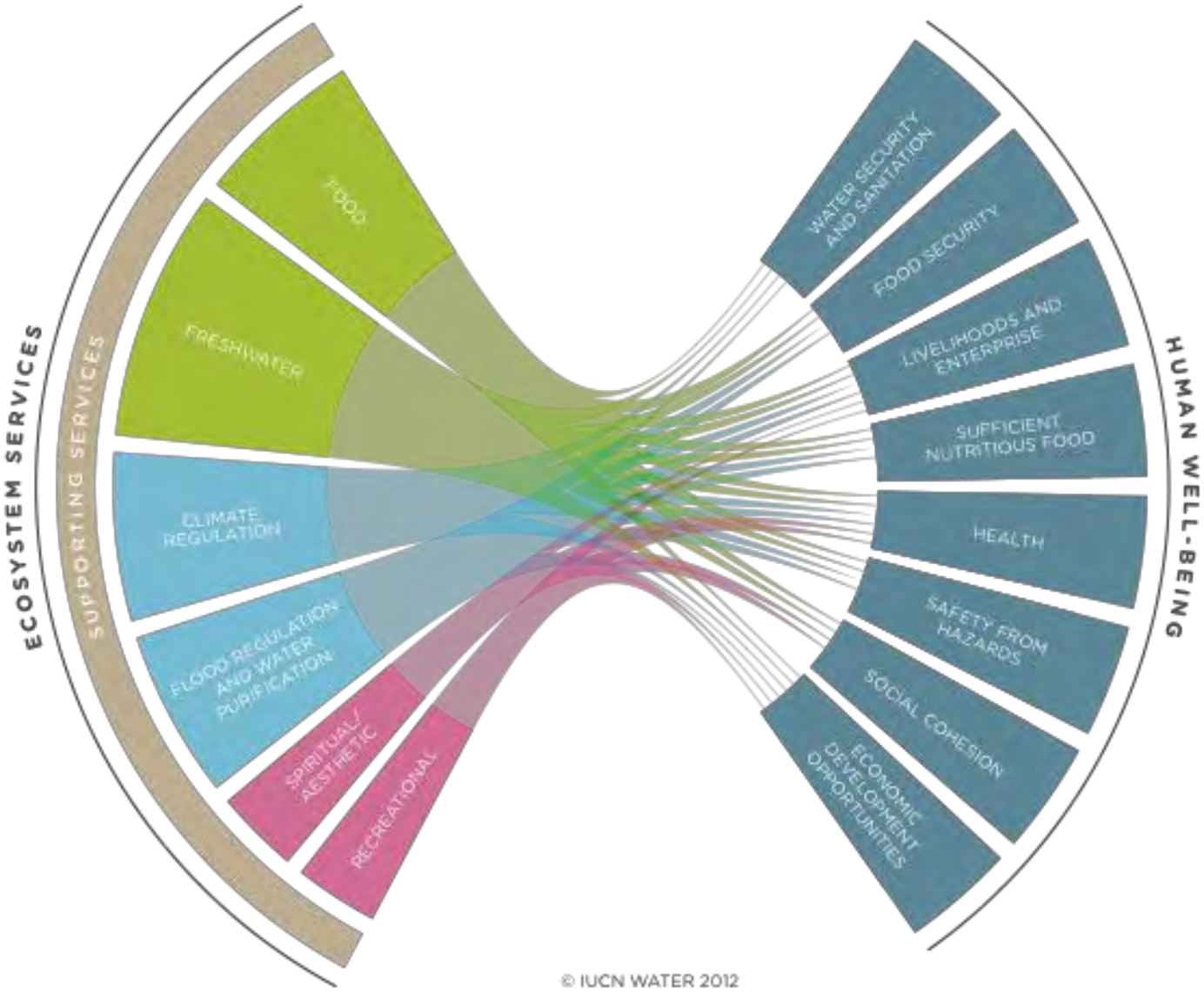
climate trees symposium



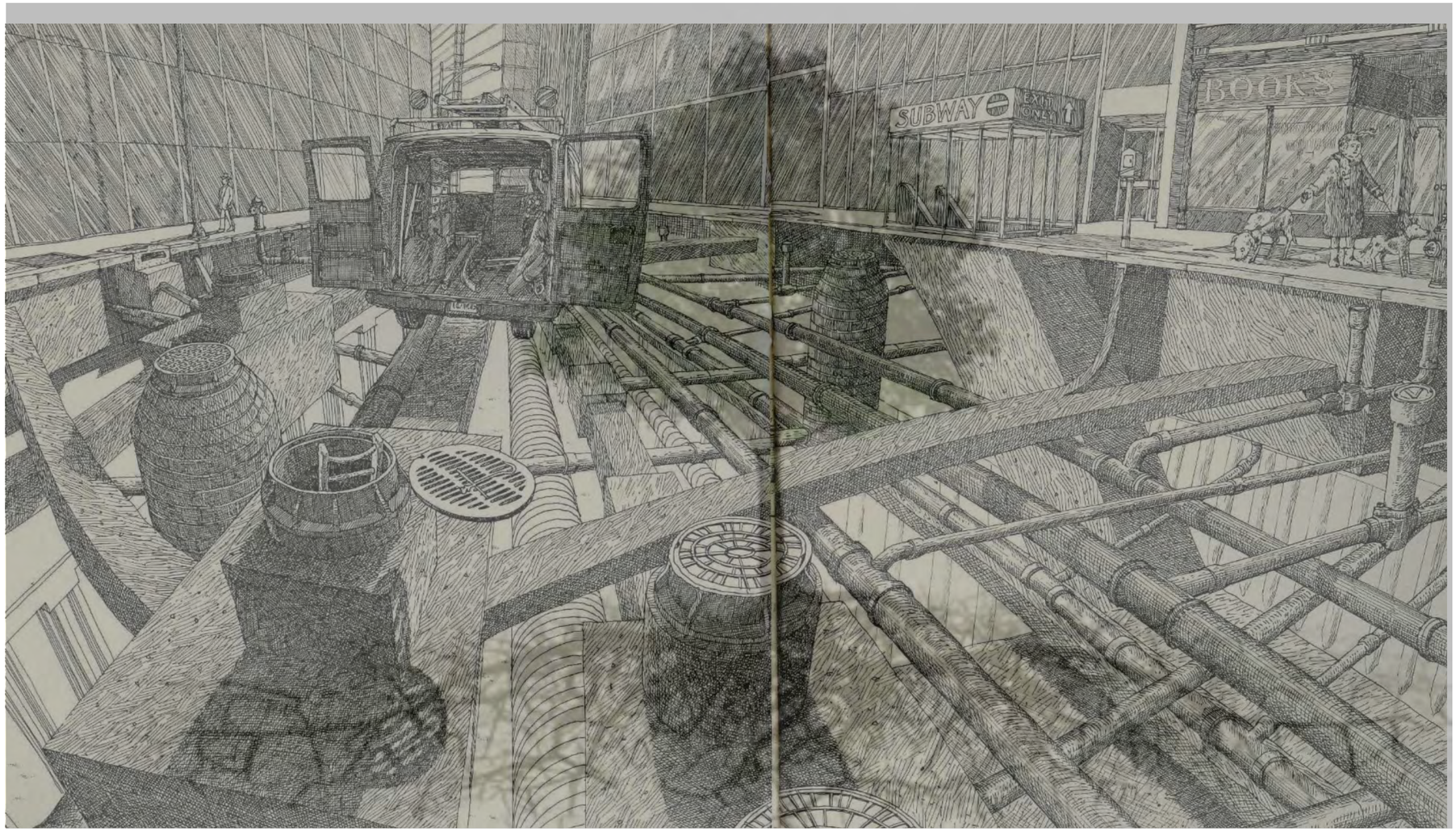


challenges for the green sector

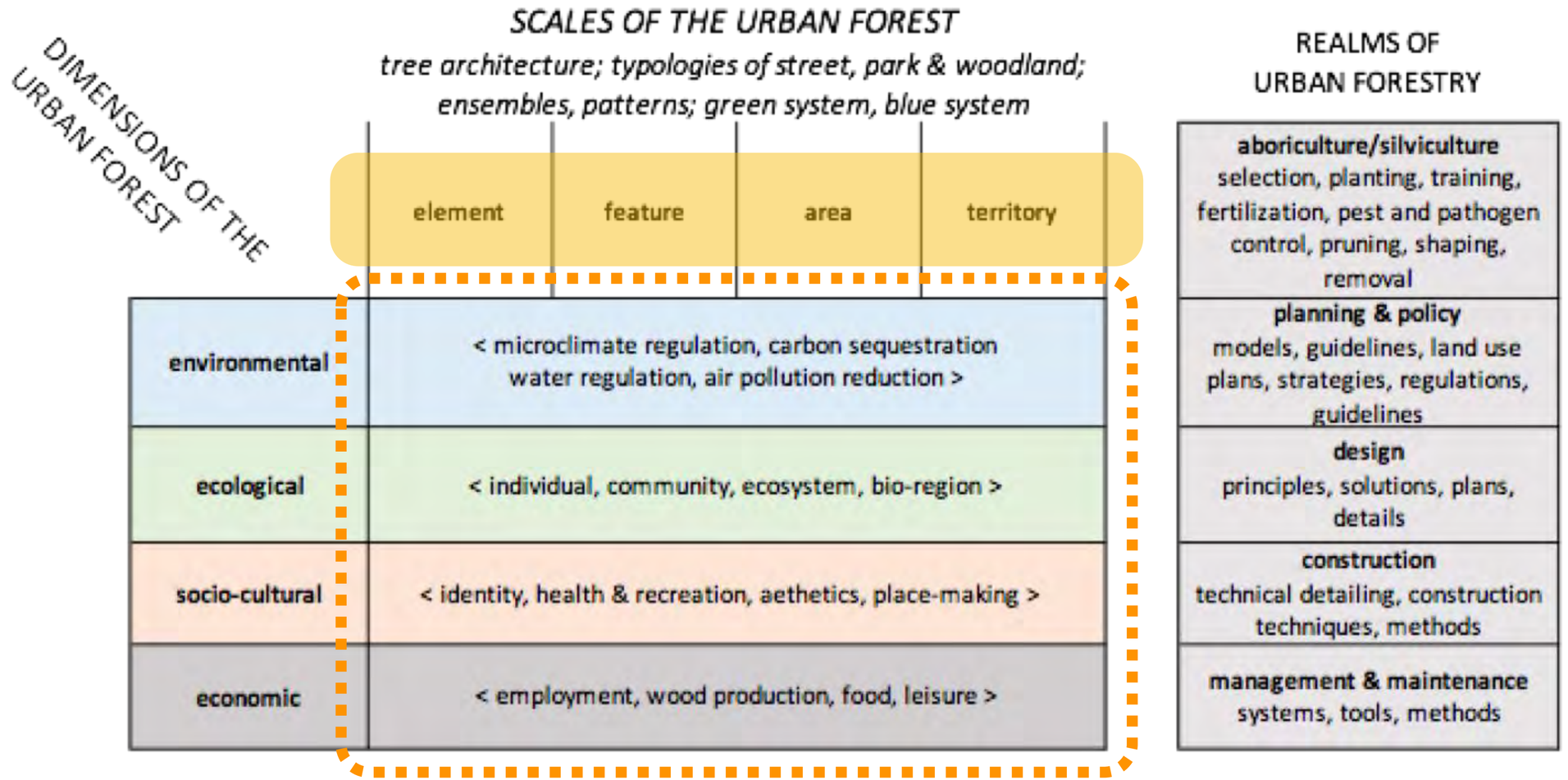
climate trees symposium



rule #1: it’s never just about the tree!



central research initiative: delta city tree syntax



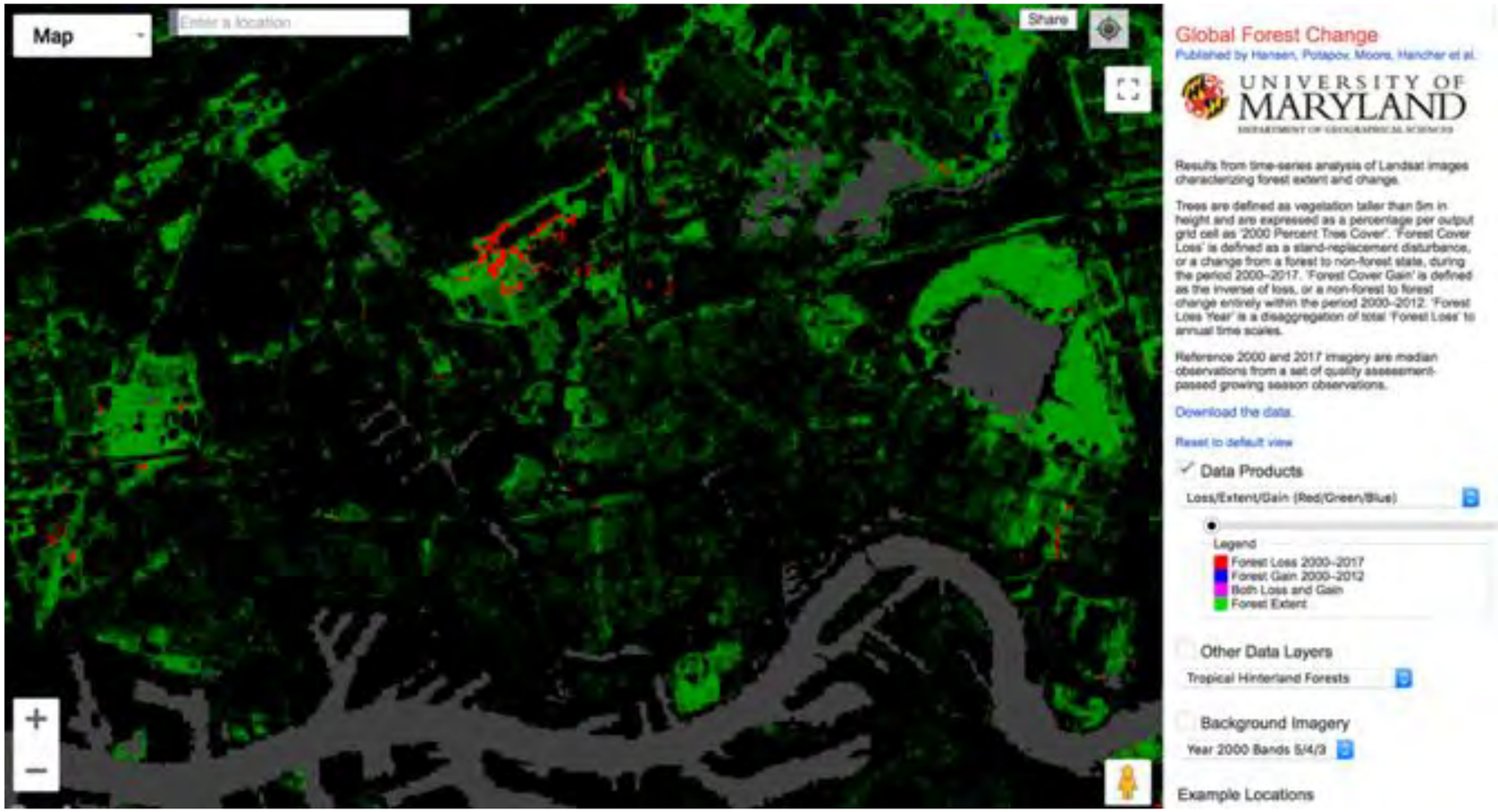
Urban Forestry Matrix_Van der Velde, R. 2019

central research initiative: delta city tree syntax

Gezicht op de Gouden Bocht in de Herengracht, 1671-1672
Gerrit Berckheyde

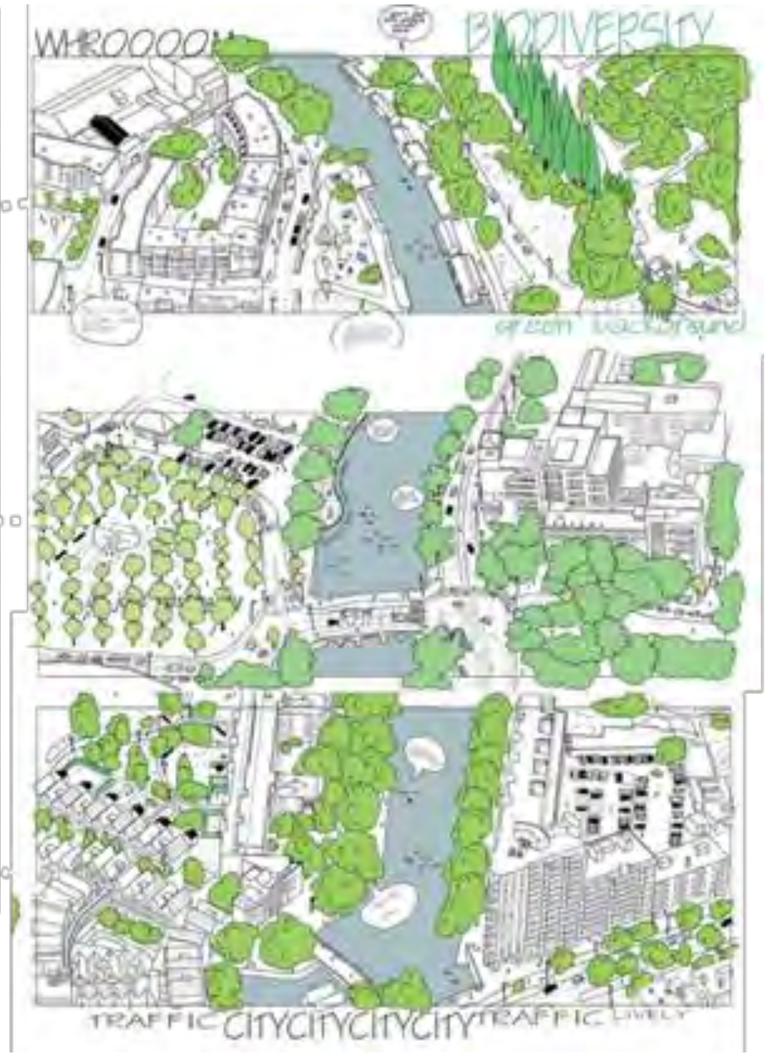
Gezicht op de Gouden Bocht (Herengracht), 1694
Jan van Call (1655-1703)

‘urban forest’ Rotterdam



‘urban forest’ Rotterdam

Rotte river forest, Q3 MScLA
Gaila Costantini, 2016



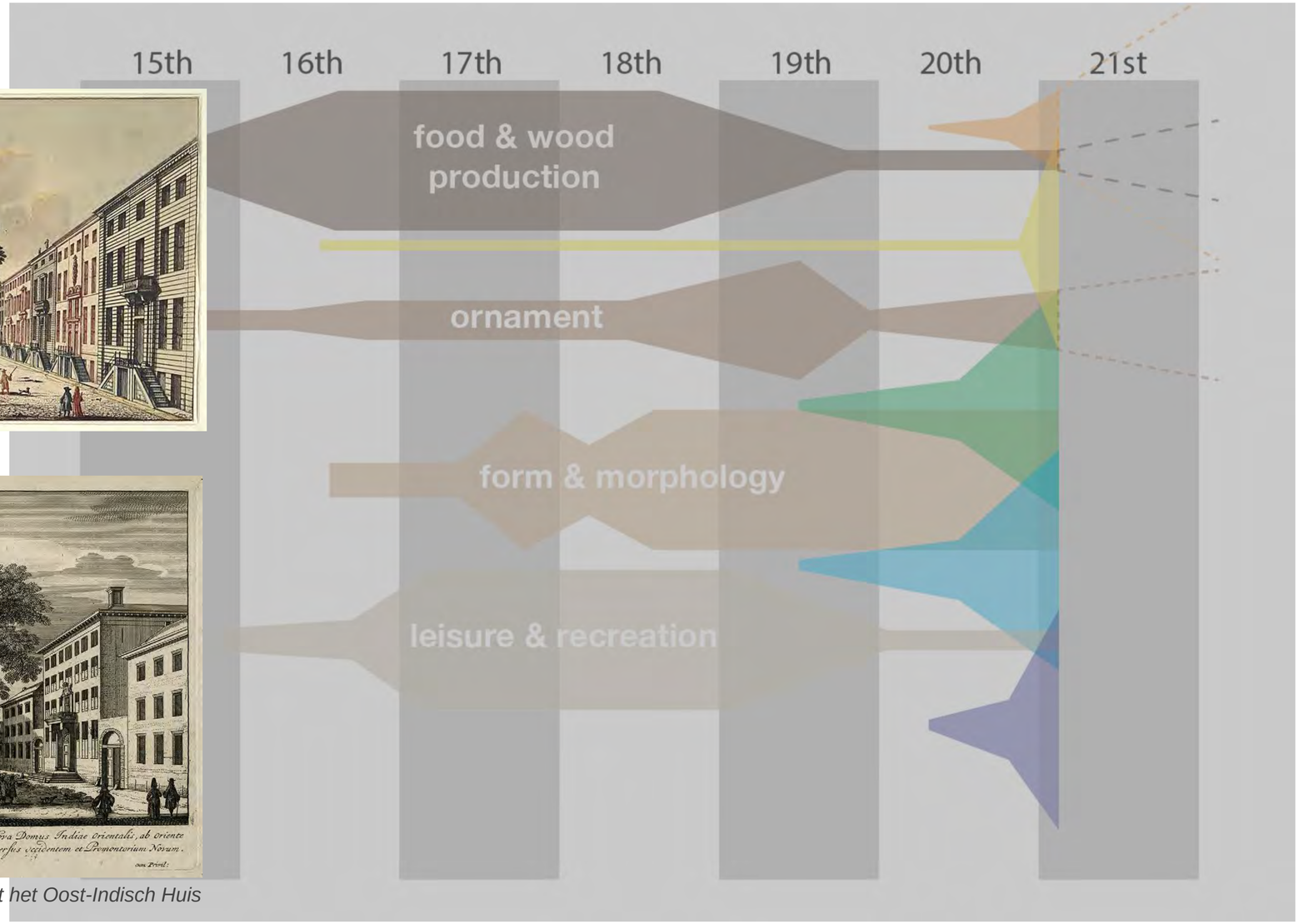
‘urban forest’ Rotterdam

climate trees symposium

base-line study: what do we have and how does it perform?

Jan van Call, 1655-1703

De Boompjes rond 1700, met het Oost-Indisch Huis



base-line study: what do we have and how does it perform?

historical developments (‘first words’)

Zicht op de Nieuwegracht (nu Servaasbolwerk) Utrecht
tekening Herman Saftleven, circa 1660

spp, practices and details (‘vocabulary’)

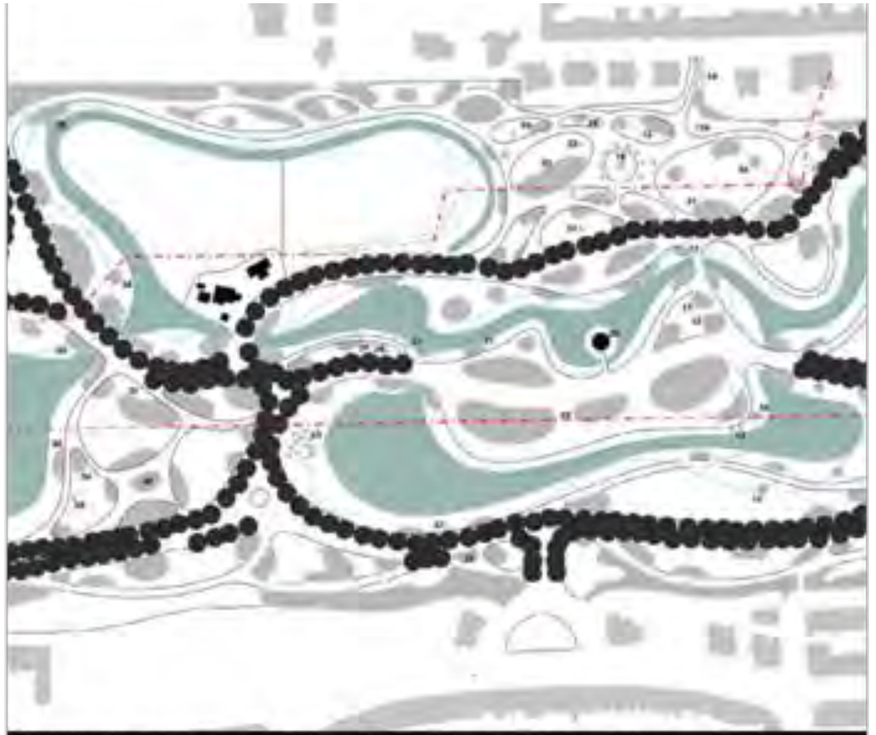
bestemmingsplan Oudegracht, Utrecht, 1970

base-line study: what do we have and how does it perform?

patterns of tree plantings (‘grammar’);

groenbeheer & naoorlogs erfgoed - de bomentaal van Pottenberg, *Jacqueline Verhees*

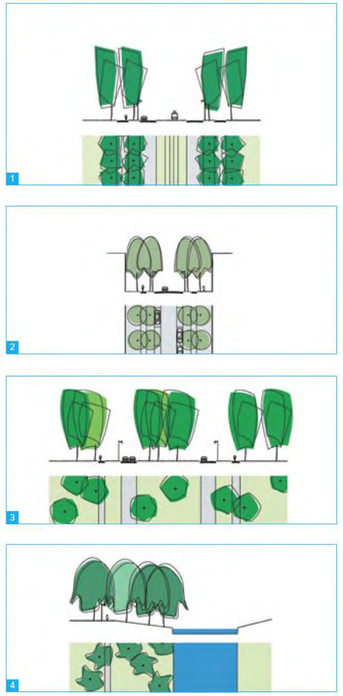
woodlands, parks (‘sentences’ & ‘stories’)



Planting detail of the Vondelpark in 1906.
From: Reh, W., Steenbergen, C., Metropolitan Landscape Architecture: Urban Parks and Landscapes (Amsterdam: Thoth, 2011)

base-line study: what do we have and how does it perform?

existing body of knowledge

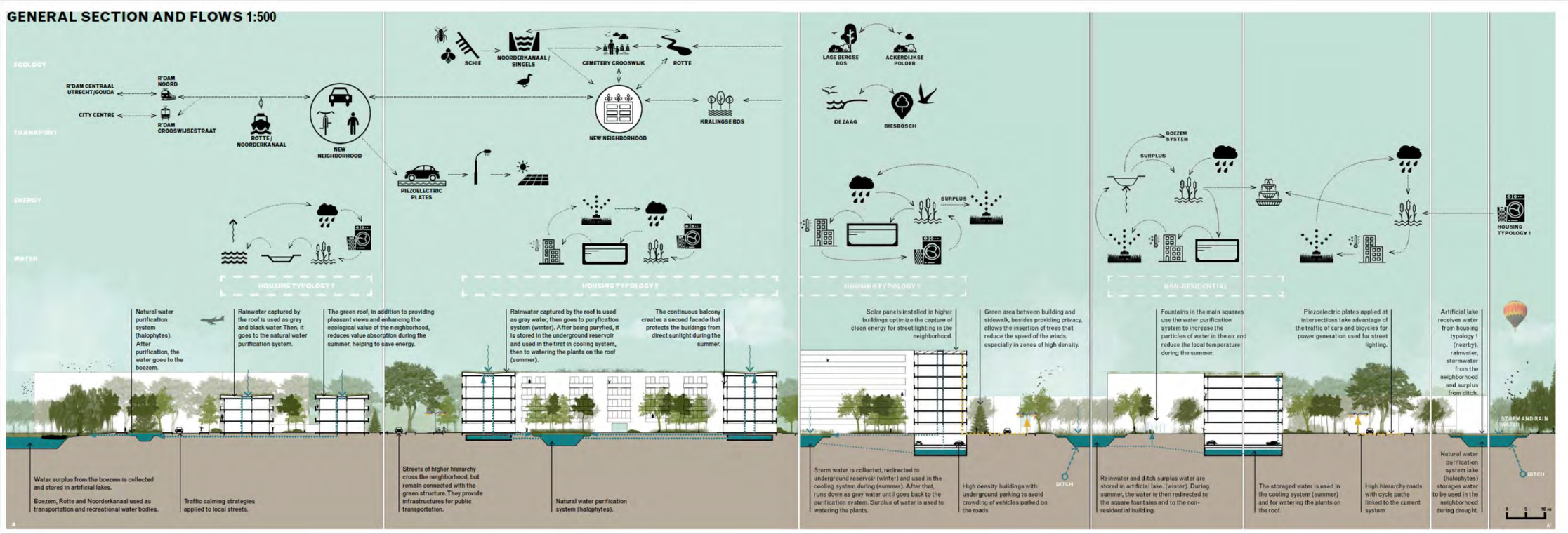


inventory & cataloging

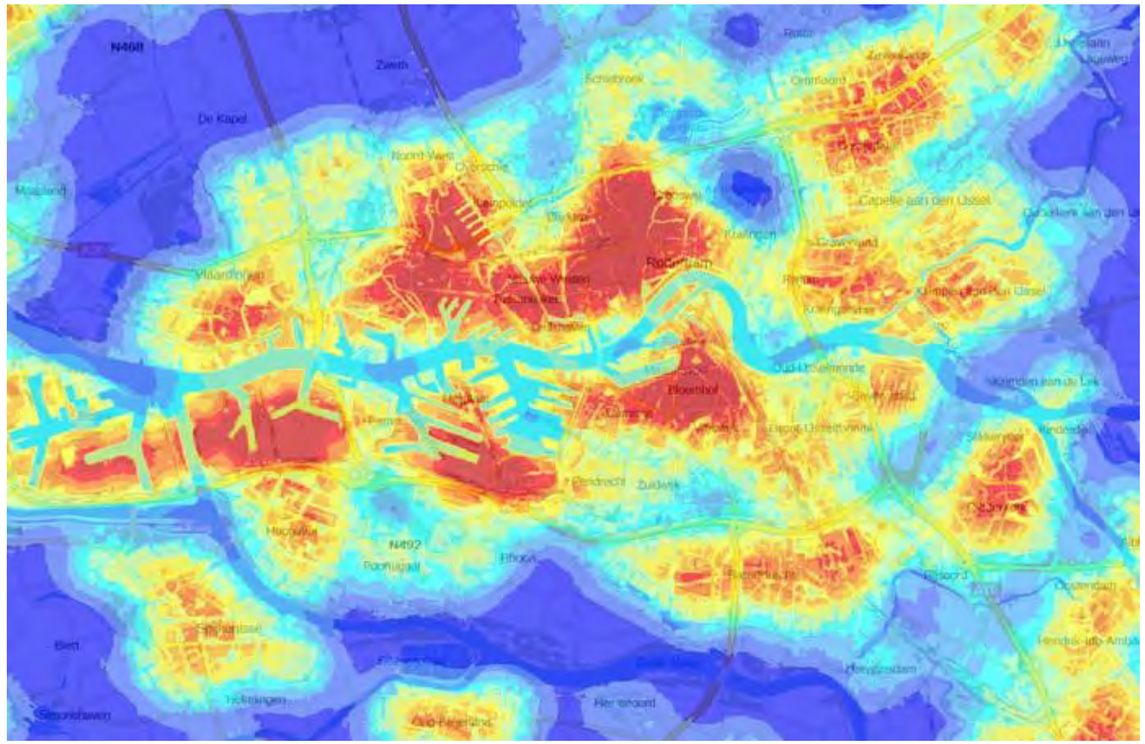
documentation, visualisations, calculations, simulations

documentation, visualisations

climate trees symposium



calculations, simulations



HITTE**KAART ROTTERDAM**

CONCEPT **GROENSTRUCTUURKAART ROTTERDAM**

studies & simulations at design scale





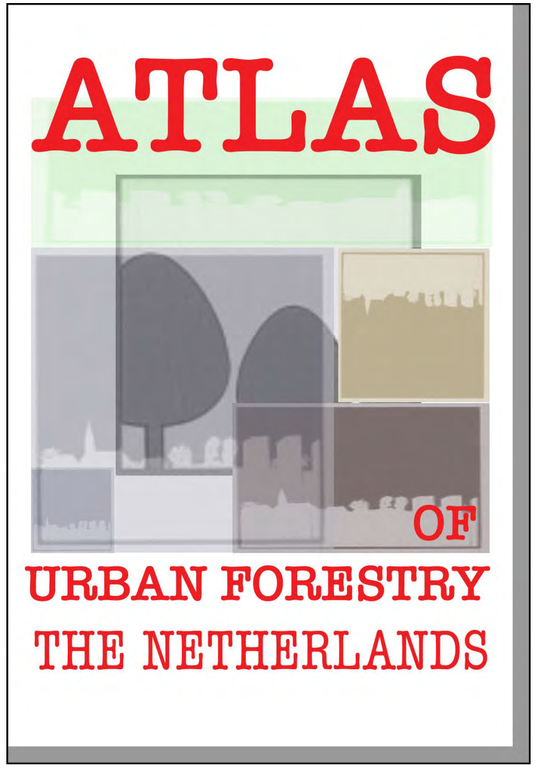


MSc studio landschapsarchitectuur TU Delft 2019

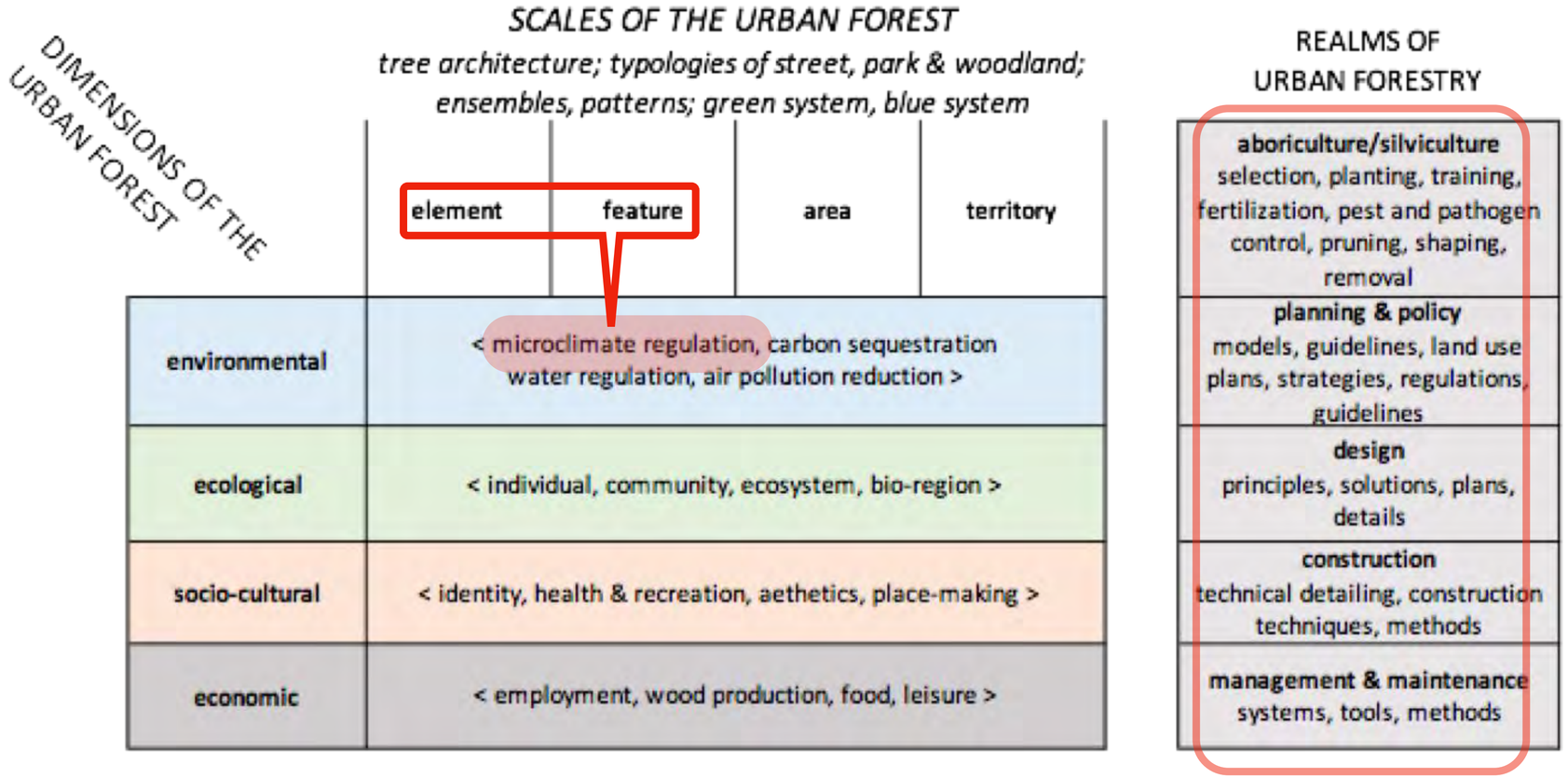
studies & simulations at planning scale

MSc studio landschapsarchitectuur TU Delft 2019

dissemination: Atlas of Urban Forestry *Netherlands*



tree architecture & the urban microclimate



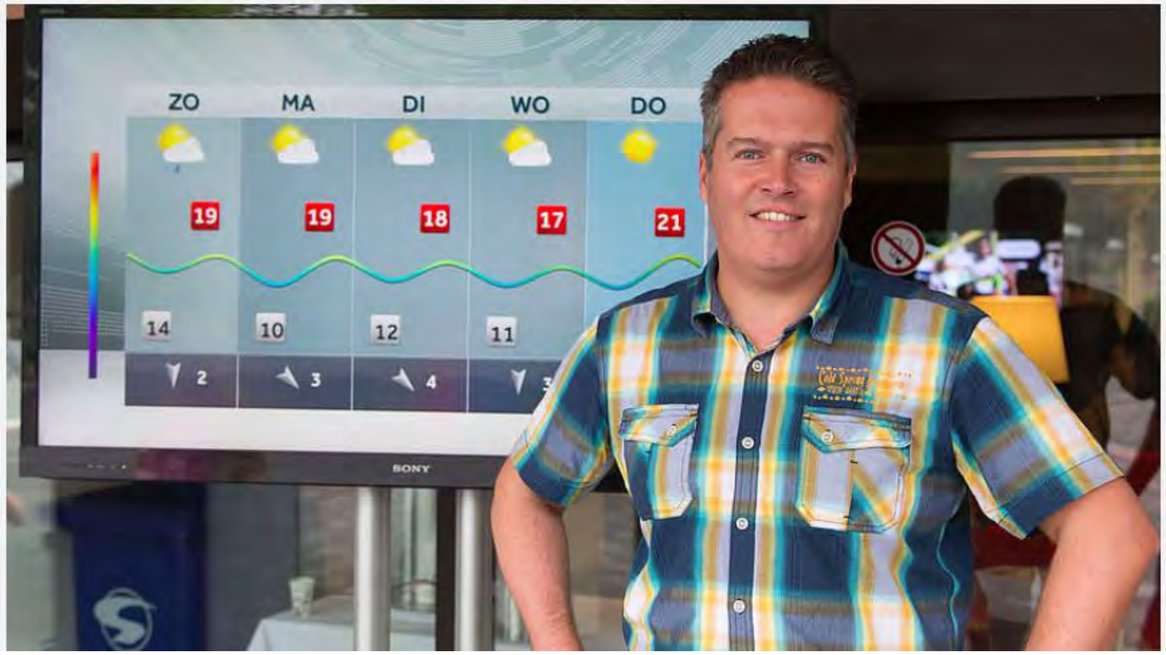
Urban Forestry Matrix_Velde, van der, R. 2019

Summer 2018

climate trees symposium

'Eén boom geeft net zo veel verkoeling als tien airco's'

30-07-2018 | Binnenland | Redactie: Bas Altena



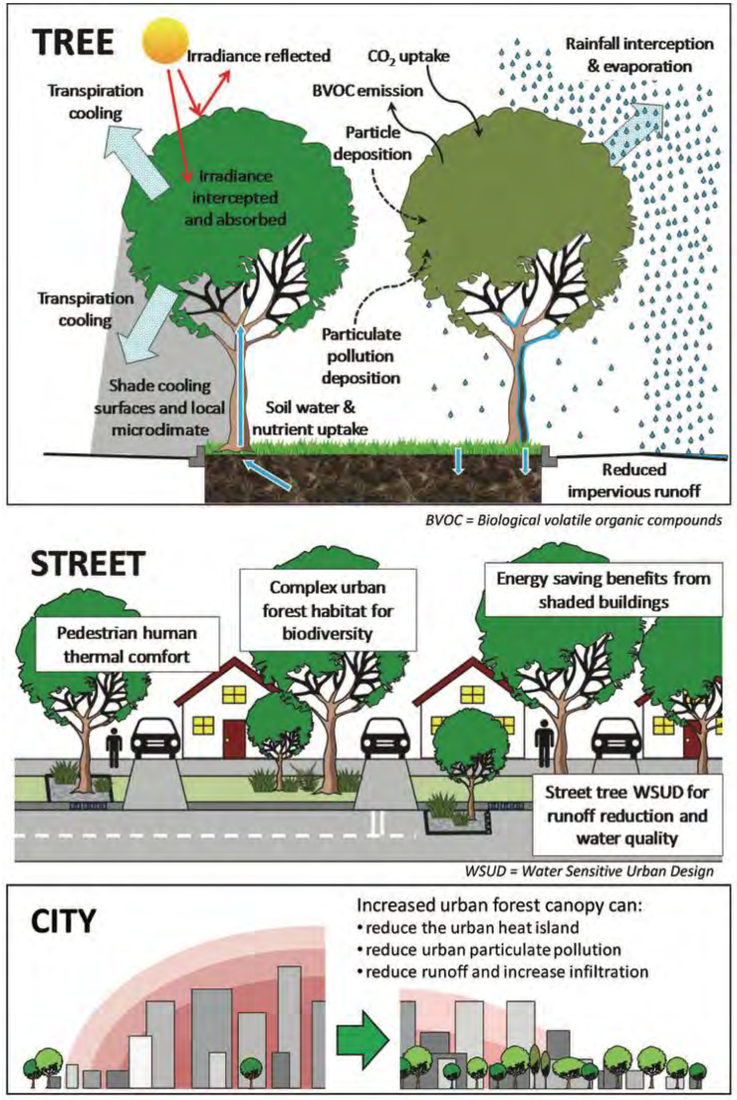
Gemeente Almere

Gemeente Den Haag

DORDRECHT

TU Delft

urban forest impacts on urban water, heat, and pollution cycles



Livesley, S. J., McPherson, E. G., & Calfapietra, C. (2016). The urban forest and ecosystem services: impacts on urban water, heat, and pollution cycles at the tree, street, and city scale. *Journal of environmental quality*, *45*(1), 119-124.

existing knowledge base

Koelende werking bomen

- Actief overdag door verdamping via bladeren (evapotranspiratie)
  - 1 boom op een zonnige dag heeft koelvermogen van 20-30 kW ≈ 10 airco's
- Passief overdag door beschaduwing
  - 1-5 graden vermindering luchttemperatuur
  - 10-25 graden vermindering oppervlaktetemperatuur
- Absorbeert weinig warmte i.t.t. verhard oppervlak

Effectiviteit

- Afhankelijk van soort en dichtheid van vegetatie, grootte en locatie
- Kennis beperkt (kwantitatief)
- Manchester (ASCCUE): 10% toename groen tot 2080 kan temperaturen constant houden
- Voldoende water beschikbaar essentieel!

Kennismontage Hitte_Climate Proof Cities

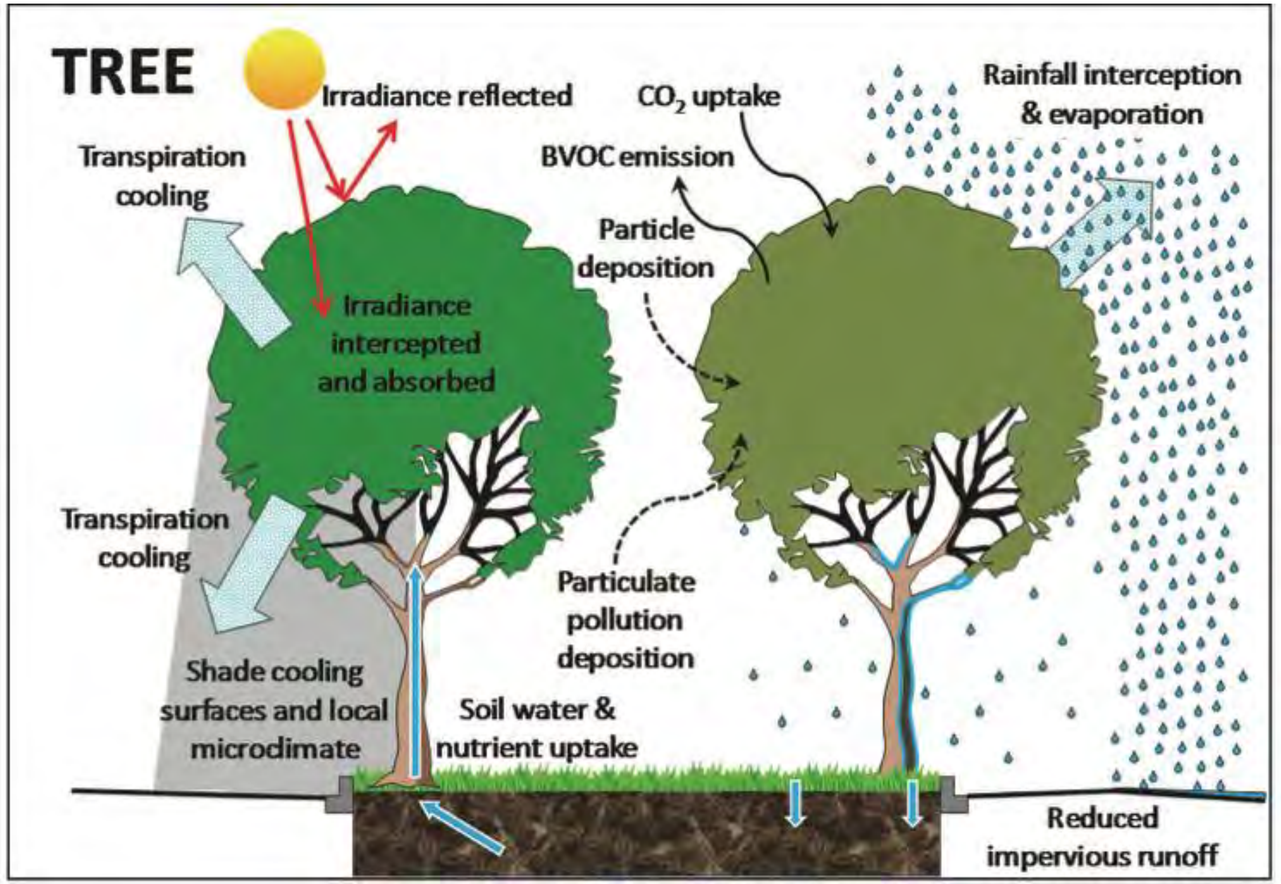
factors in temperature amelioration

Reflection

Evapo-transpiration

absorption of radiation

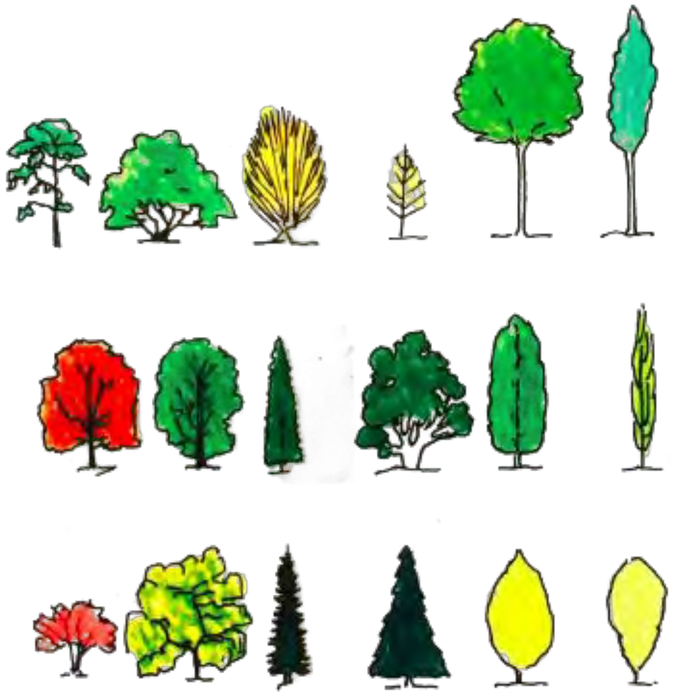
shade cooling



Livesley, S. J., McPherson, E. G., & Calfapietra, C. (2016). The urban forest and ecosystem services: impacts on urban water, heat, and pollution cycles at the tree, street, and city scale. *Journal of environmental quality*, *45*(1), 119-124.

tree architecture & the urban microclimate

ARBORETUM DE LA MARTINIERE, Loire Valley



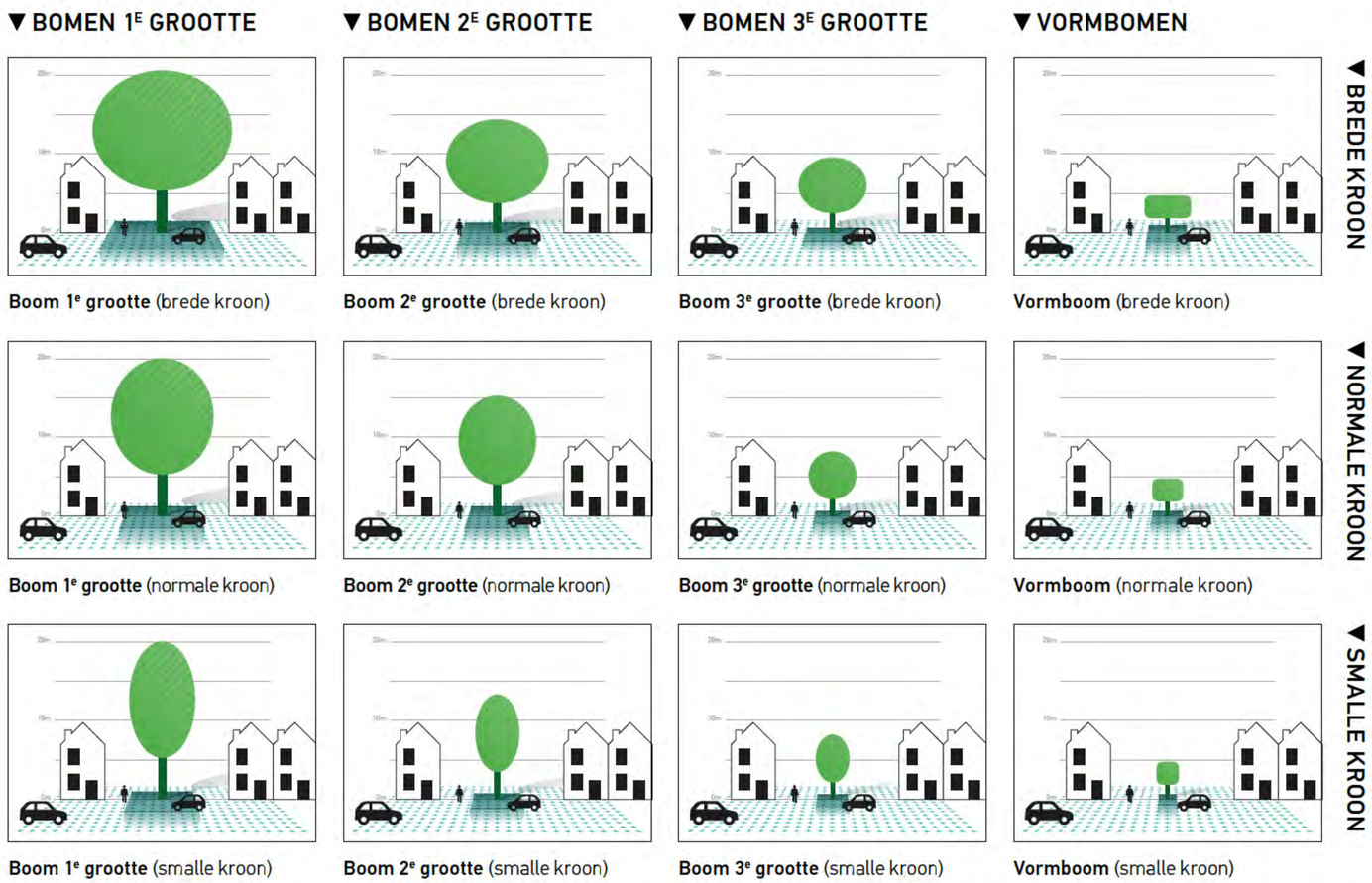
Boomvormstudie Regenboogbuurt alme
Hosper, A. 1992

spp. impacts on urban water, heat, and pollution etc

WETENSCHAPPELIJKE NAAM	GROOTTE	GROEN-BLIJVEND	WINTER-HARDHEID	TOLERANTIE DROOGTE	TOLERANTIE STROOIZOUT	BEPERKEN OPWARMING	INTERCEPTIE NEERSLAG	VERDRAAGT ZEER NATTE PERIODE	VERDR DRO
Acer buergerianum	★★★★		★★★	★★		★★★			
Acer campestre	★★★		★★★	★★★	★	★★	★		
Acer negundo	★★★★		★★★	★		★★★	★	★	
Acer platanoides	★★★★		★★★	★★		★★★	★★		
Acer pseudoplatanus	★★★★		★★★	★★		★★★	★★		
Acer rubrum	★★★★		★★★	★	☆	★★★	★		
Acer saccharinum	★★★★		★★★	☆		★★★	★★	★	
Acer tataricum ssp. Ginnala	★★		★★★	★★	★	★★	★★		
Aesculus hippocastanum	★★★★		★★★	☆		★★★	★★		
Aesculus x carnea	★★★		★★★	★	☆	★★★			
Alnus cordata	★★★		★★★	★	★	★★	★★		
Alnus glutinosa	★★★		★★★	☆	★	★★	★★	★★	★
Alnus incana	★★★		★★★	★★	★	★★	★	★	★
Alnus spaethii	★★★★		★★★	★★	★	★★			
Amelanchier arborea	★		★★★	☆	★	★			
Amelanchier lamarckii	★★		★★★	☆	★	★			

Hiemstra et al. (2017). Species-Specific Information for Enhancing Ecosystem Services. In: The Urban Forest, pp. 11
Springer.

based on size, crown shape and (in some cases) leaf area index



Handboek bomen_norminstituut bomen

research questions

~~do different tree spp have different cooling performances?~~

which physiognomic (architectural) factors influence these performances?

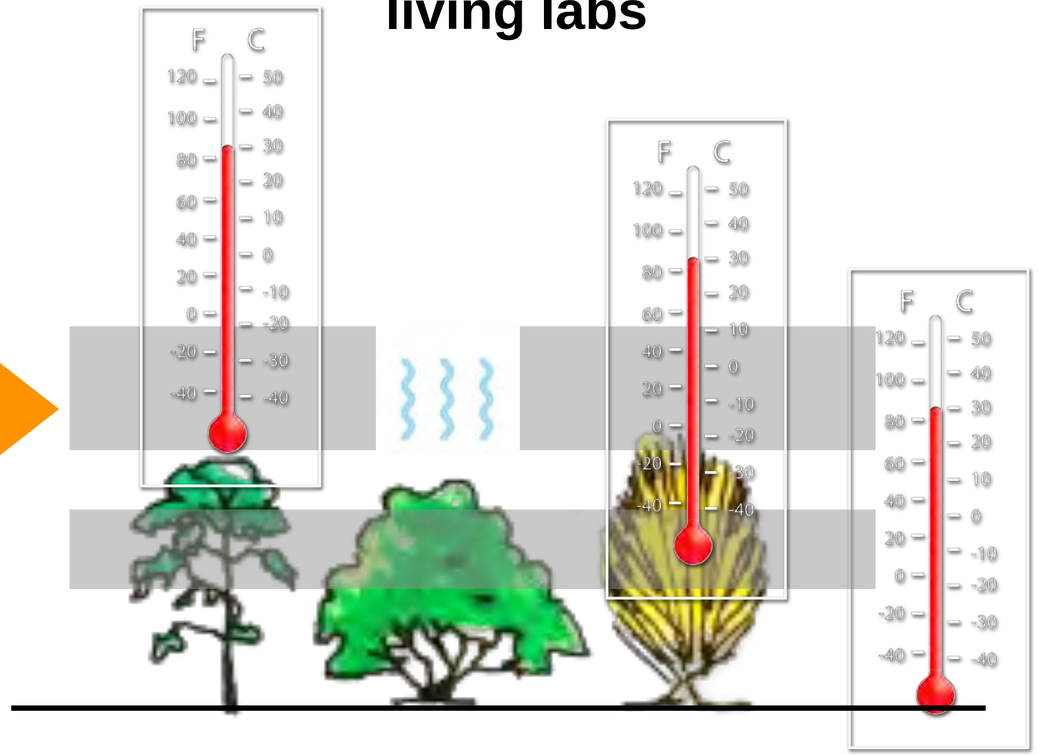
research design

climate trees symposium

analyse + categorize

modeling + simulations

living labs



Gemeente Almere

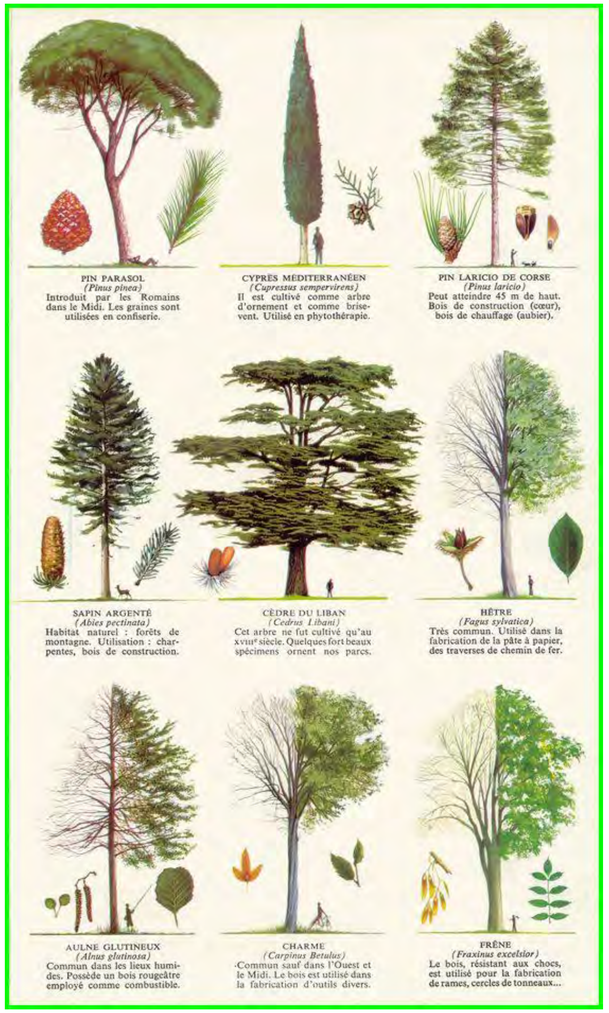
Gemeente Den Haag

DORDRECHT

TU Delft

analysis + categorisation

climate trees symposium



size

crown shape

transparancy

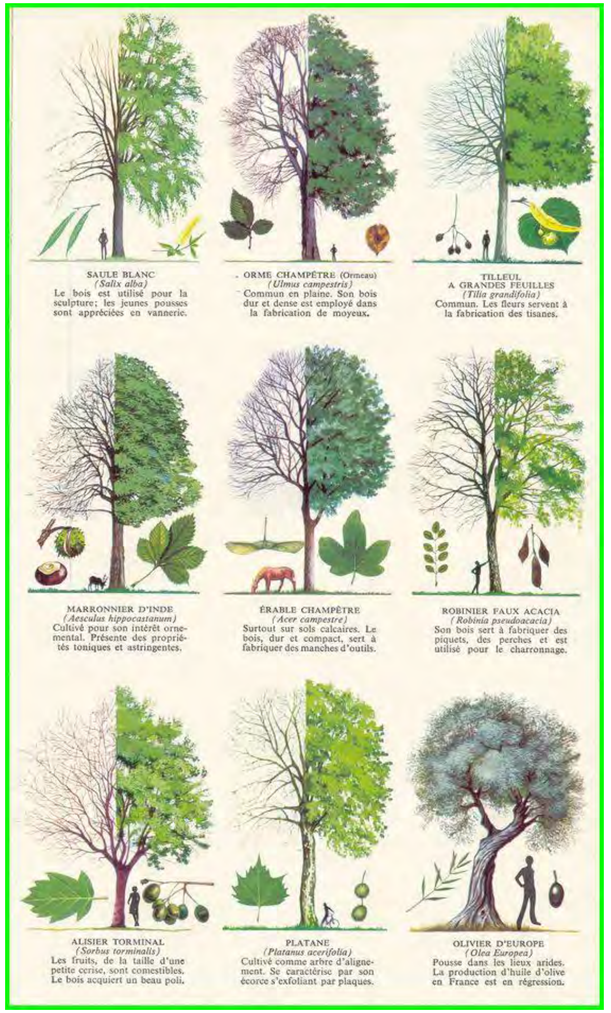
branch structure

leaf size/shape

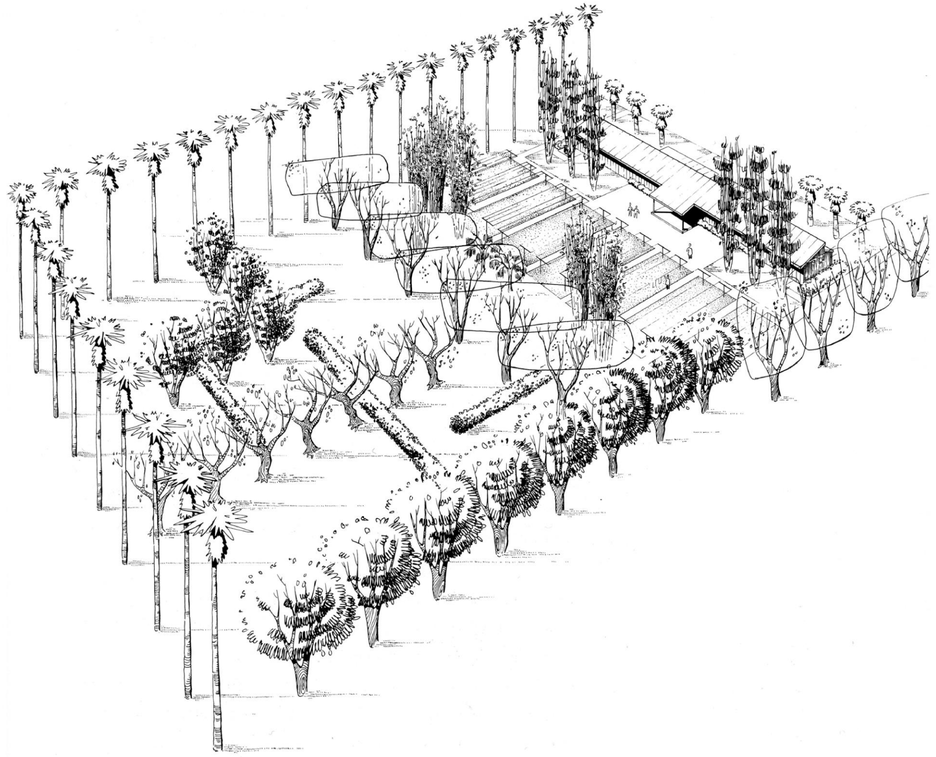
LAI

leafing period

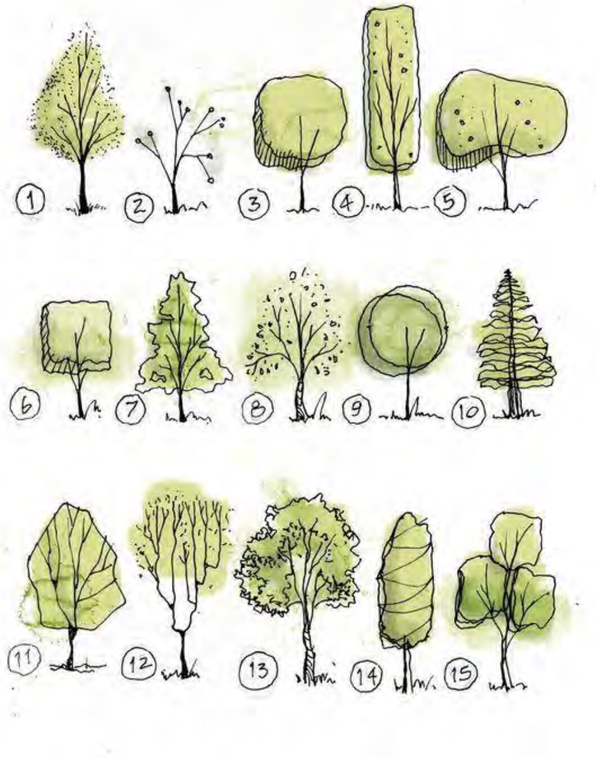
leaf colour



analysis + categorisation



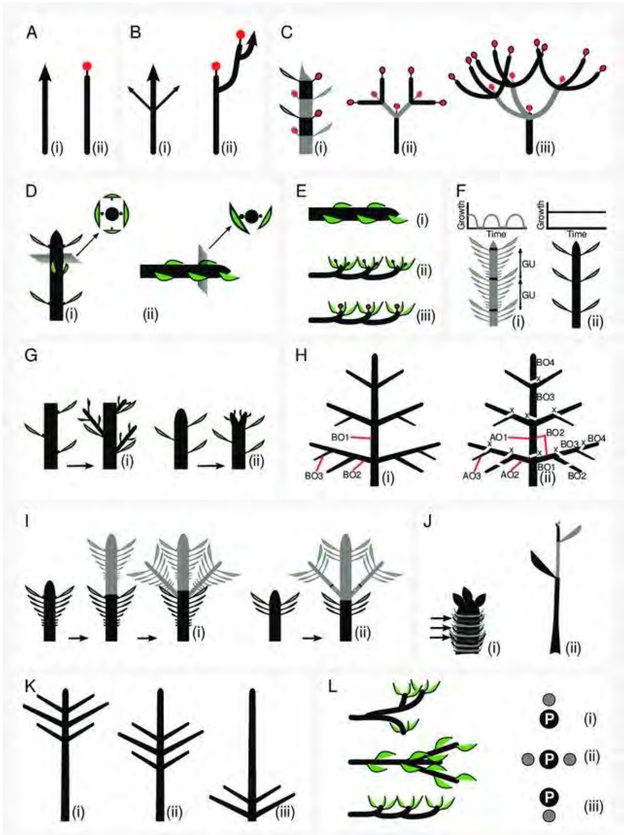
Park and community building. Harlingen, Texas, 1940. [Gareth Eckbo]



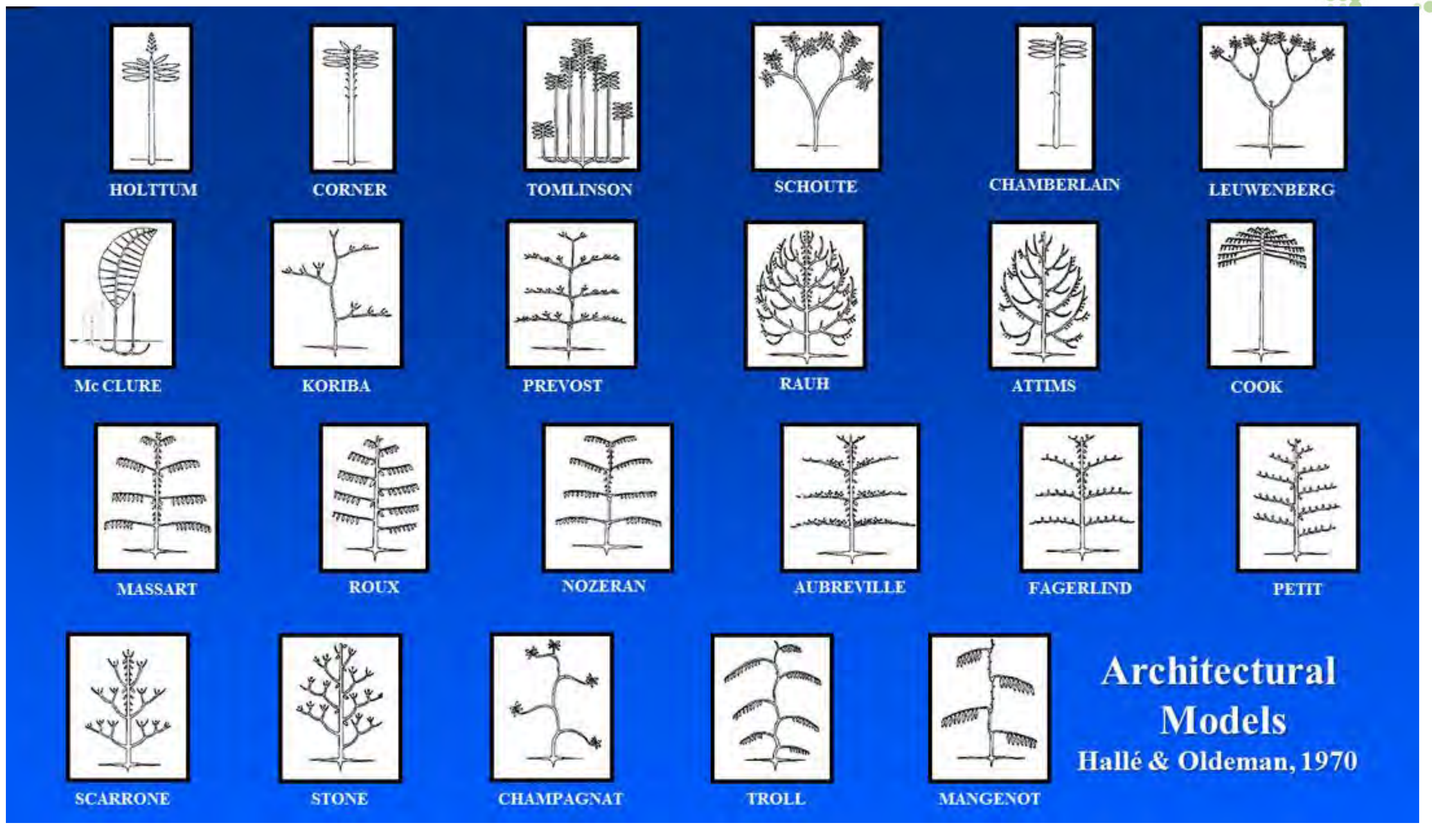
Common tree drawing principles

modelling + simulations

climate trees symposium



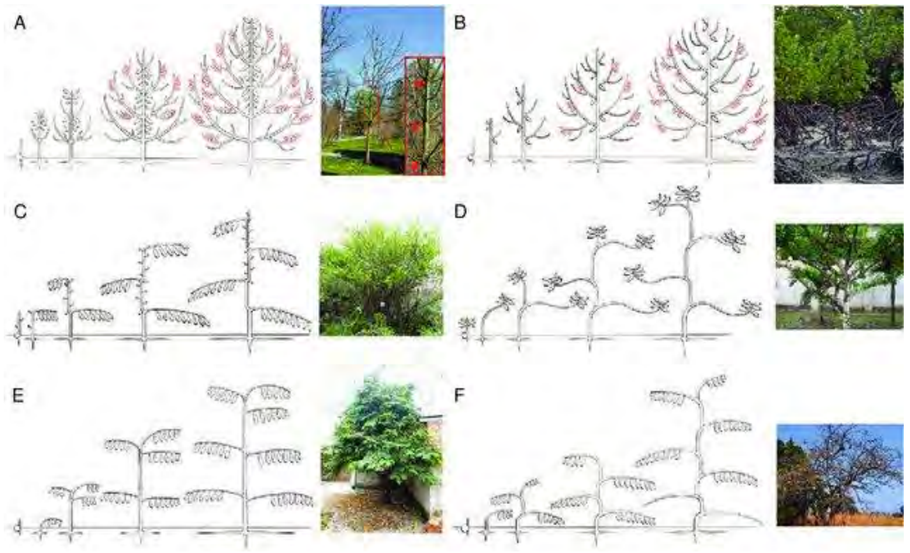
Main concepts in plant architecture.
Chomicki et. al. 2017



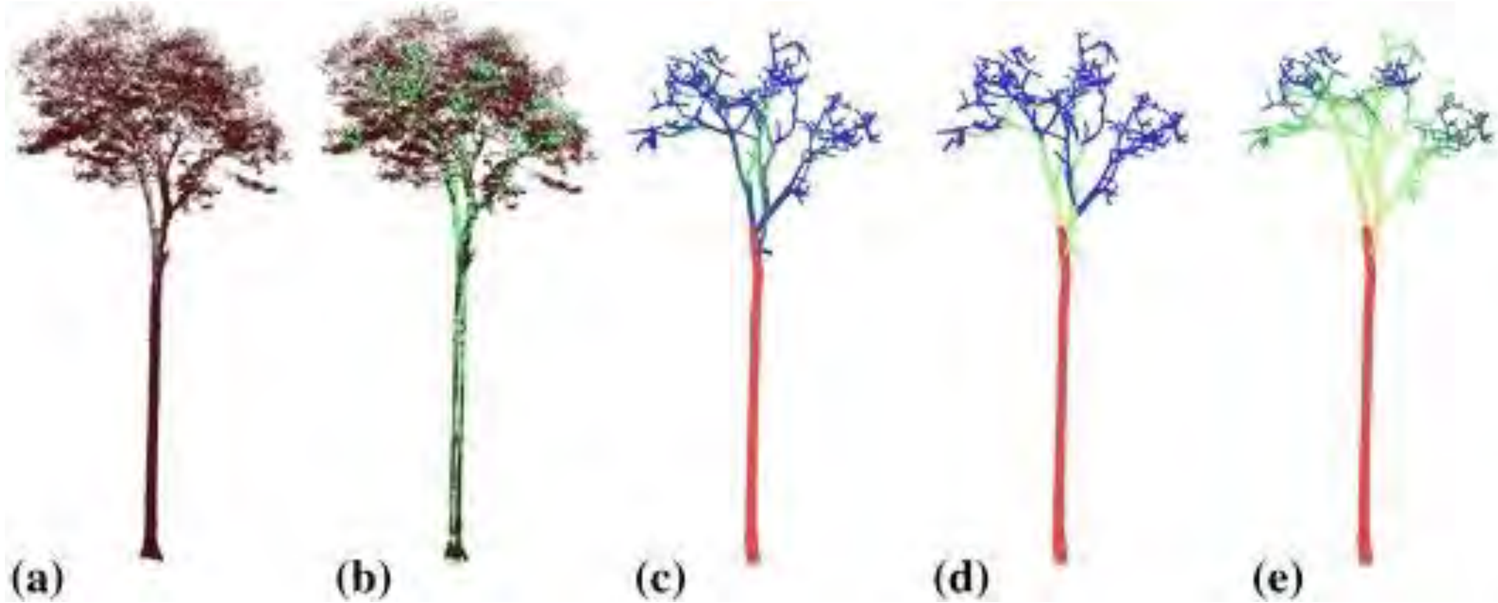
Tree architectural models, Hallé & Oldeman (1970)

modelling + simulations

climate trees symposium



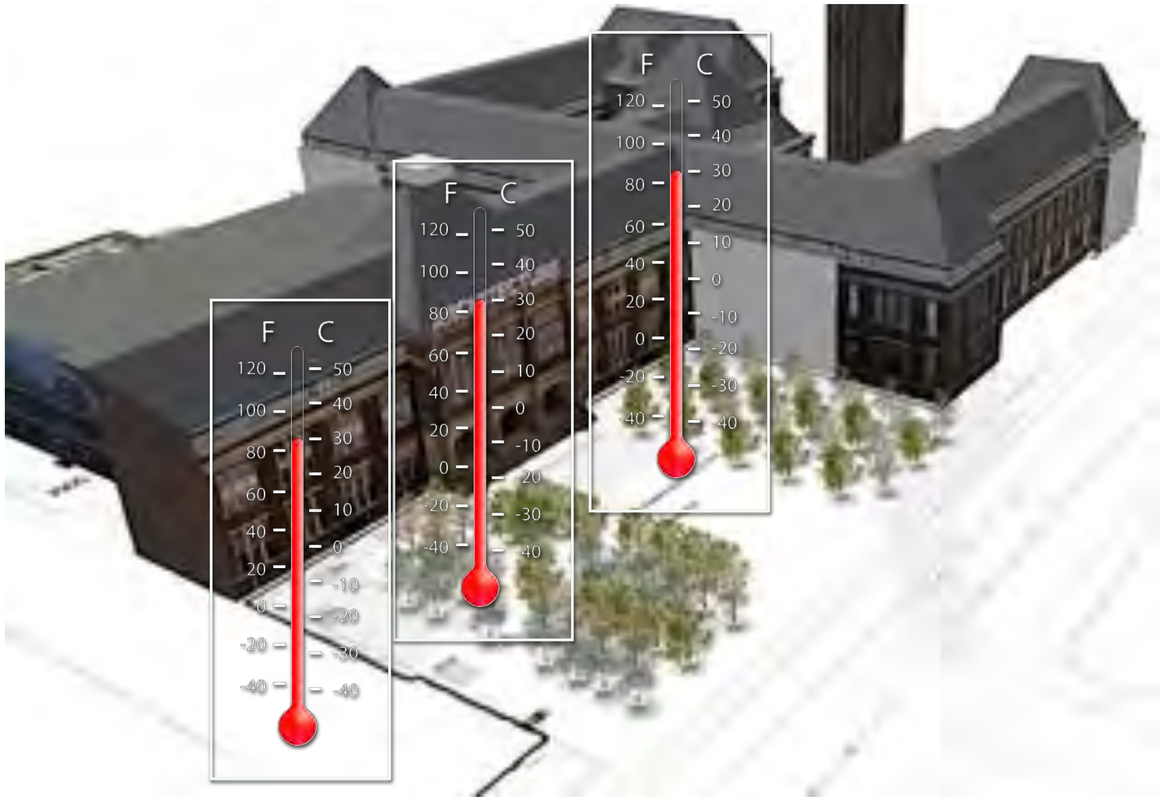
Tree architectural models_Chomicki et. al. 2017



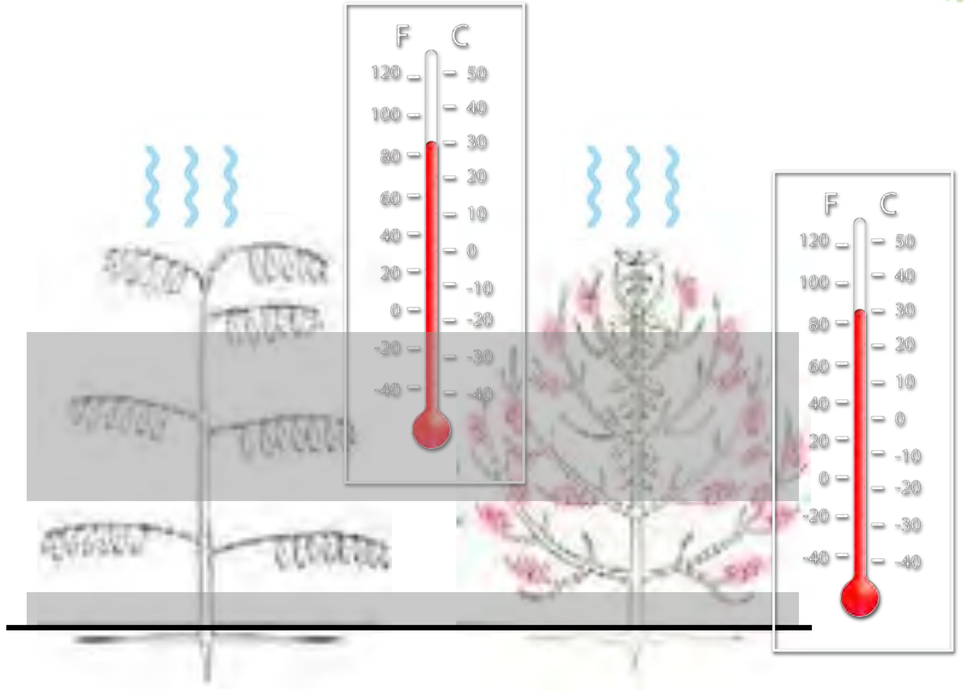
E. grandiflora tree point cloud, Lau A., et al. 2018

living labs

climate trees symposium



installatie en meetpunten



meetpunten bomen

living labs

impressie voorplein bk city, met arboretum_Lotte Dijkstra

vhg branchevereniging

Gemeente Almere

Gemeente Den Haag

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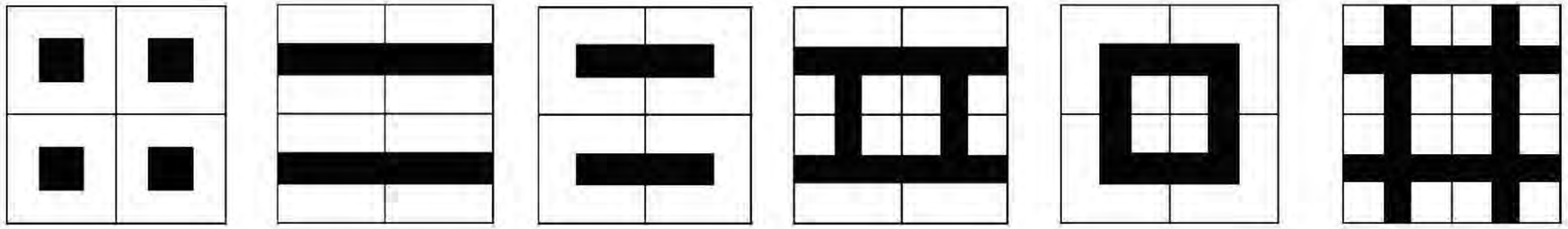
varying built environment situations



Urban forms studied by Ratti et al. (2003): pavilions, slabs, terraces, terrace-courts, pavilion-courts, and courts

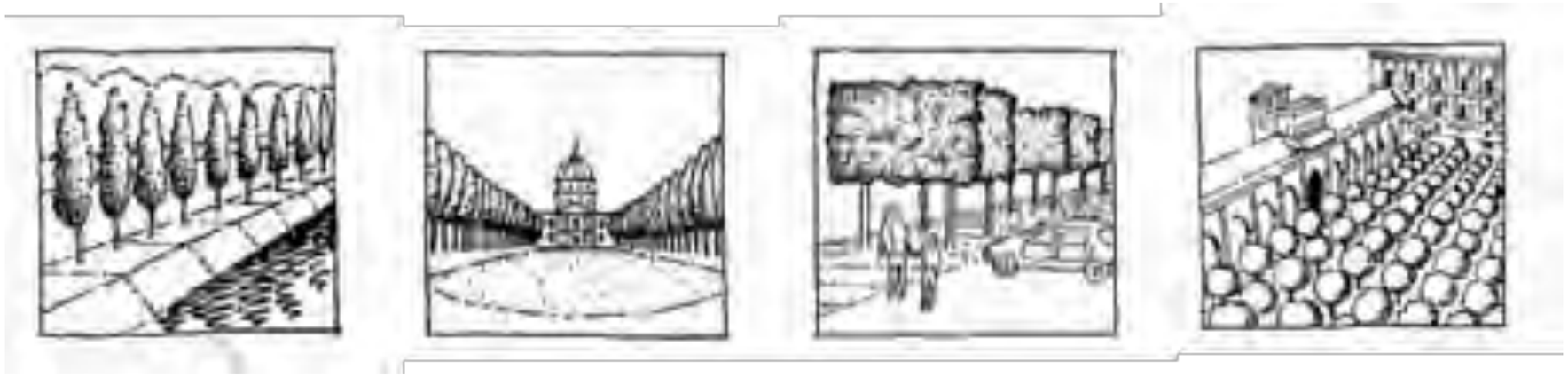
voorplein bk city, bestaande situatie

research questions

~~do different tree spp have different cooling performances?~~

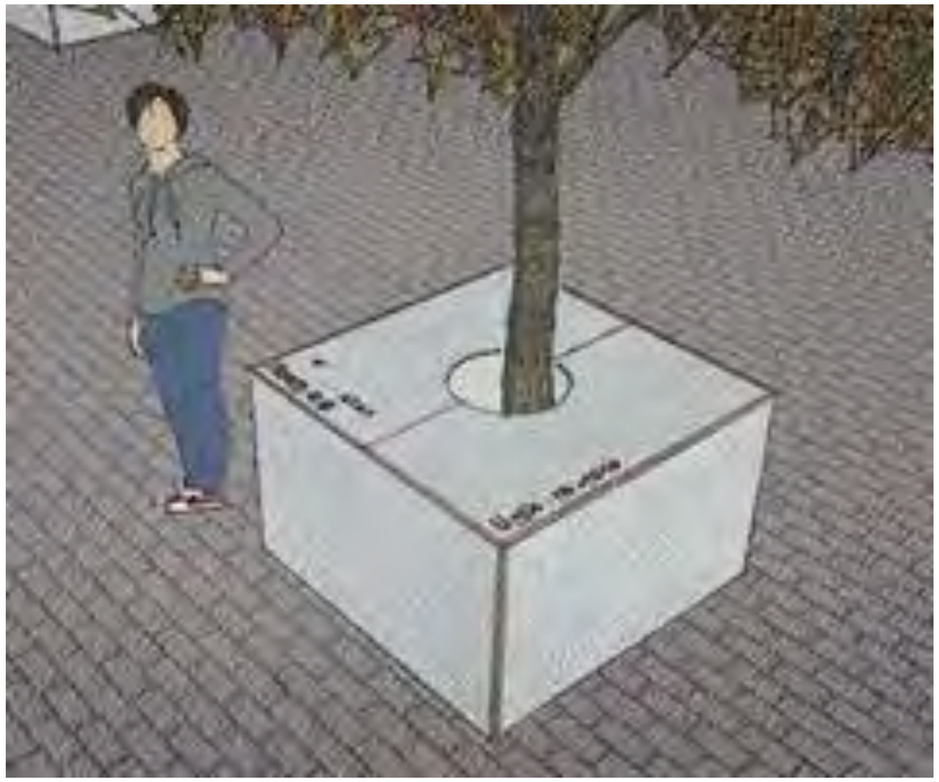
which physiognomic (architectural) factors influence these performances?

what is the performance of different configurations in various built environment situations?



Standard typologies of tree plantings in urban areas. (Images: Mader & Neubert-Mader, 1996)

basisopstelling (Image: Lotte Dijkstra)



Impression of tree containers (Image: Lotte Dijkstra)

drought tolerance

WETENSCHAPPELIJKE NAAM	GROOTTE	GROEN-BLIJVEND	WINTER-HARDHEID	TOLERANTIE DROOGTE	TOLERANTIE STROOIZOUT	BEPERKEN OPWARMING	INTERCEPTIE NEERSLAG	VERDRAAGT ZEER NATTE PERIODE	VERDR DRO PERI
Acer buergerianum	★★★★		★★★	★★		★★★			
Acer campestre	★★★		★★★	★★★	★	★★	★		
Acer negundo	★★★★		★★★	★		★★★	★	★	★
Acer platanoides	★★★★		★★★	★★		★★★	★★		
Acer pseudoplatanus	★★★★		★★★	★★		★★★	★★		
Acer rubrum	★★★★		★★★	★	☆	★★★	★		★
Acer saccharinum	★★★★		★★★	☆		★★★	★★	★	★
Acer tataricum ssp. Ginnala	★★		★★★	★★	★	★★	★★		
Aesculus hippocastanum	★★★★		★★★	☆		★★★	★★		
Aesculus x carnea	★★★		★★★	★	☆	★★★			
Alnus cordata	★★★		★★★	★	★	★★	★★		
Alnus glutinosa	★★★		★★★	☆	★	★★	★★	★★	★
Alnus incana	★★★		★★★	★★	★	★★	★	★	★
Alnus spaethii	★★★★		★★★	★★	★	★★			
Amelanchier arborea	★		★★★	☆	★	★			★
Amelanchier lamarckii	★★		★★★	☆	★	★			★

vhg branchevereniging

Gemeente Almere

Gemeente Den Haag

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research questions

~~do different tree spp have different cooling performances?~~

which physiognomic (architectural) factors influence these performances?

what is the performance of different tree configurations in various built environment situations?

what is the moisture usage of different spp./cultivars under various micro-climate conditions?

research team

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Senior dendrologist
Cobra Adviesbureau

Wouter Baack
City of Almere

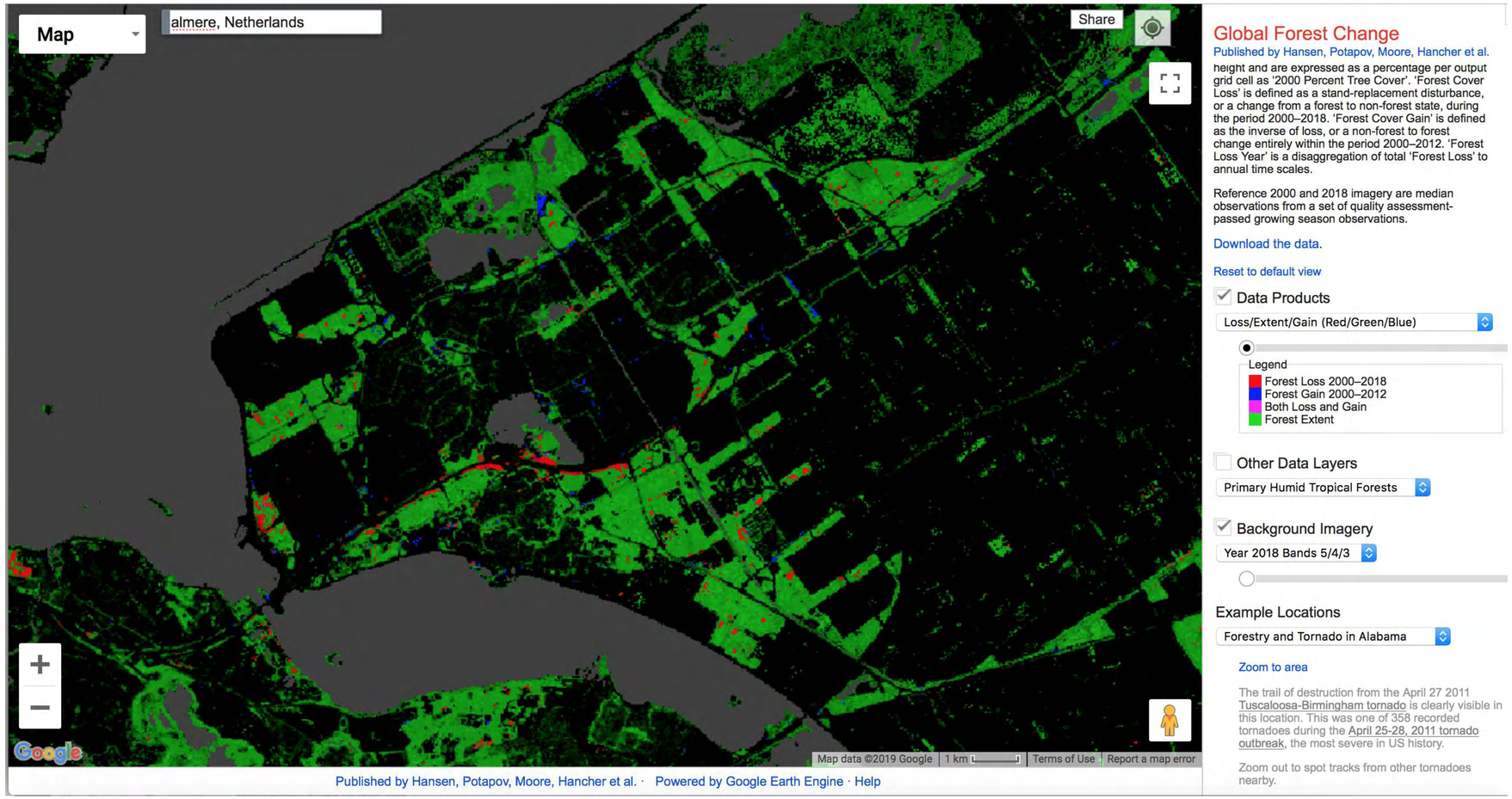
Leendert Koudstaal/Wiebke Klemm
City of Den Haag

Marit Janse/Rudy Scheper
City of Dodrdrecht

….

partner city arboreta

climate trees symposium



Almere NL_Global Forest Change index (Image: Hansen et. al.)

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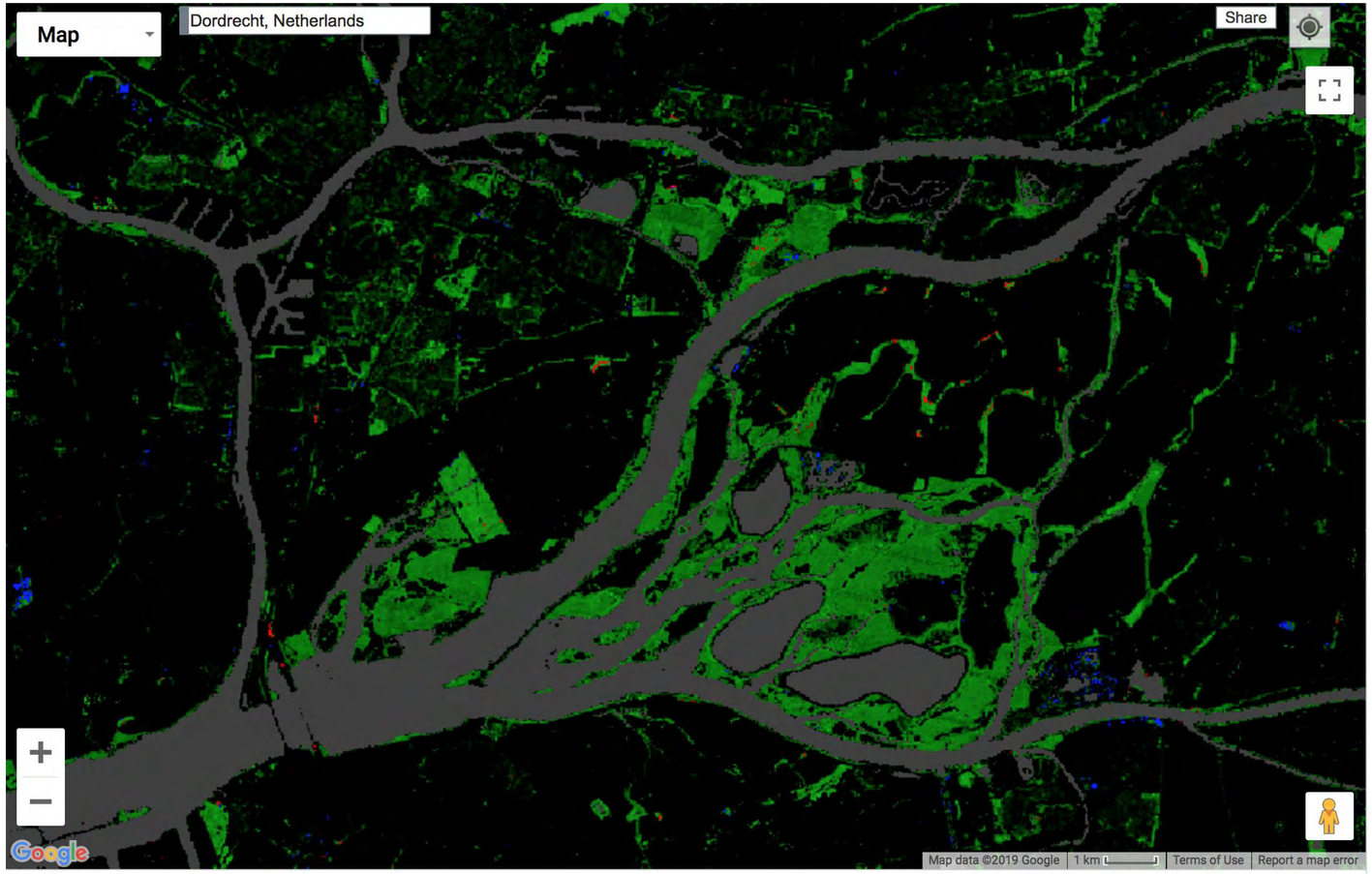
climate trees symposium

Den Haag_Global Forest Change index (Image: Hansen et. al.)

partner city arboreta

climate trees symposium



Dordrecht_Global Forest Change index (Image: Hansen et. al.)

alternative to taxonomic understanding of (urban) tree spp

Gemeente Almere

Gemeente Den Haag

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sharpening of performance values of individual spp.

WETENSCHAPPELIJKE NAAM	GROOTTE	GROEN-BLIJVEND	WINTER-HARDHEID	TOLERANTIE DROOGTE	TOLERANTIE STROOIZOUT	BEPERKEN OPWARMING	INTERCEPTIE NEERSLAG	VERDRAAGT ZEER NATTE PERIODE	VERDR DRO PERI
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Acer platanoides	★★★★		★★★	★★		★★★	★★		
Acer pseudoplatanus	★★★★		★★★	★★		★★★	★★		
Acer rubrum	★★★★		★★★	★	☆	★★★	★		★
Acer saccharinum	★★★★		★★★	☆		★★★	★★	★	★
Acer tataricum ssp. Ginnala	★★		★★★	★★	★	★★	★★		
Aesculus hippocastanum	★★★★		★★★	☆		★★★	★★		
Aesculus x carnea	★★★		★★★	★	☆	★★★			
Alnus cordata	★★★		★★★	★	★	★★	★★		
Alnus glutinosa	★★★		★★★	☆	★	★★	★★	★★	★
Alnus incana	★★★		★★★	★★	★	★★	★	★	★
Alnus spaethii	★★★★		★★★	★★	★	★★			
Amelanchier arborea	★		★★★	☆	★	★			★
Amelanchier lamarckii	★★		★★★	☆	★	★			★

Hiemstra et al. (2017). Species-Specific Information for Enhancing Ecosystem Services. In: The Urban Forest, pp. 111-144. Springer.

tree maintenance for climate adaptation

climate trees symposium

trialling of new spp. for climate adaptation

Acer cappadocicum
Alnus glutinosa Pyramidalis
Cedrus libanii
Celtis australis
Fagus orientalis Iskander
Ginkgo biloba Princeton Sentry
Juglans nigra
Koelreuteria paniculata
Parrotia persica 'Vanessa'
Paulownia fargesii
Phellodendron amurense
Populus canadensis Ellert
Prunus maackii
Quercus ilex
Quercus hispanica Waasland Select
Tetradium danielii
Tilia mongolica
Zelkova serrata

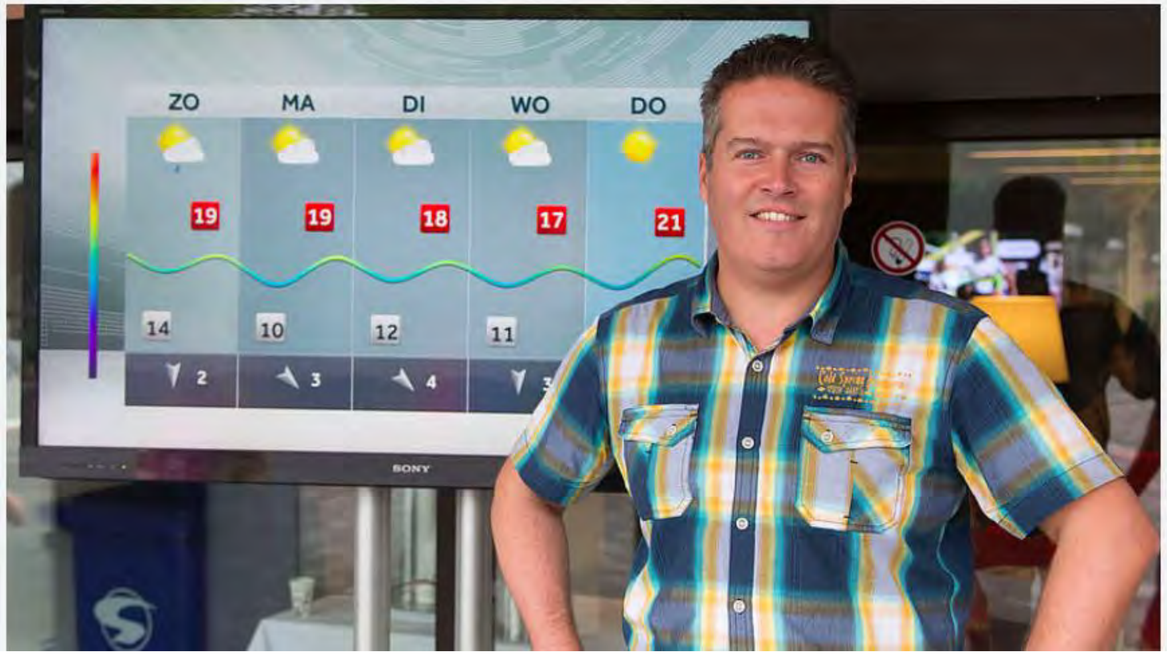
hybrid design & maitenance solutions

climate trees symposium

attention for climate change (amelioration) & advocacy for adaptation

'Eén boom geeft net zo veel verkoeling als tien airco's'

30-07-2018 | Binnenland | Redactie: Bas Altena



thank you

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Associate Professor Landscape Architecture
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