Reinventing urban nature: the science of tree choice in a warming world

Francesco Ferrini – University of Florence , Plant Nursery District of Pistoia

Imagine created with AI by Francesco Ferrini, 2026

The strategic importance of the plant nursery industry in the present scenario

Ornamental plant production in Italy

verdir

VALHOR
TOUTES LES FORCES DU VÉGÉTAL

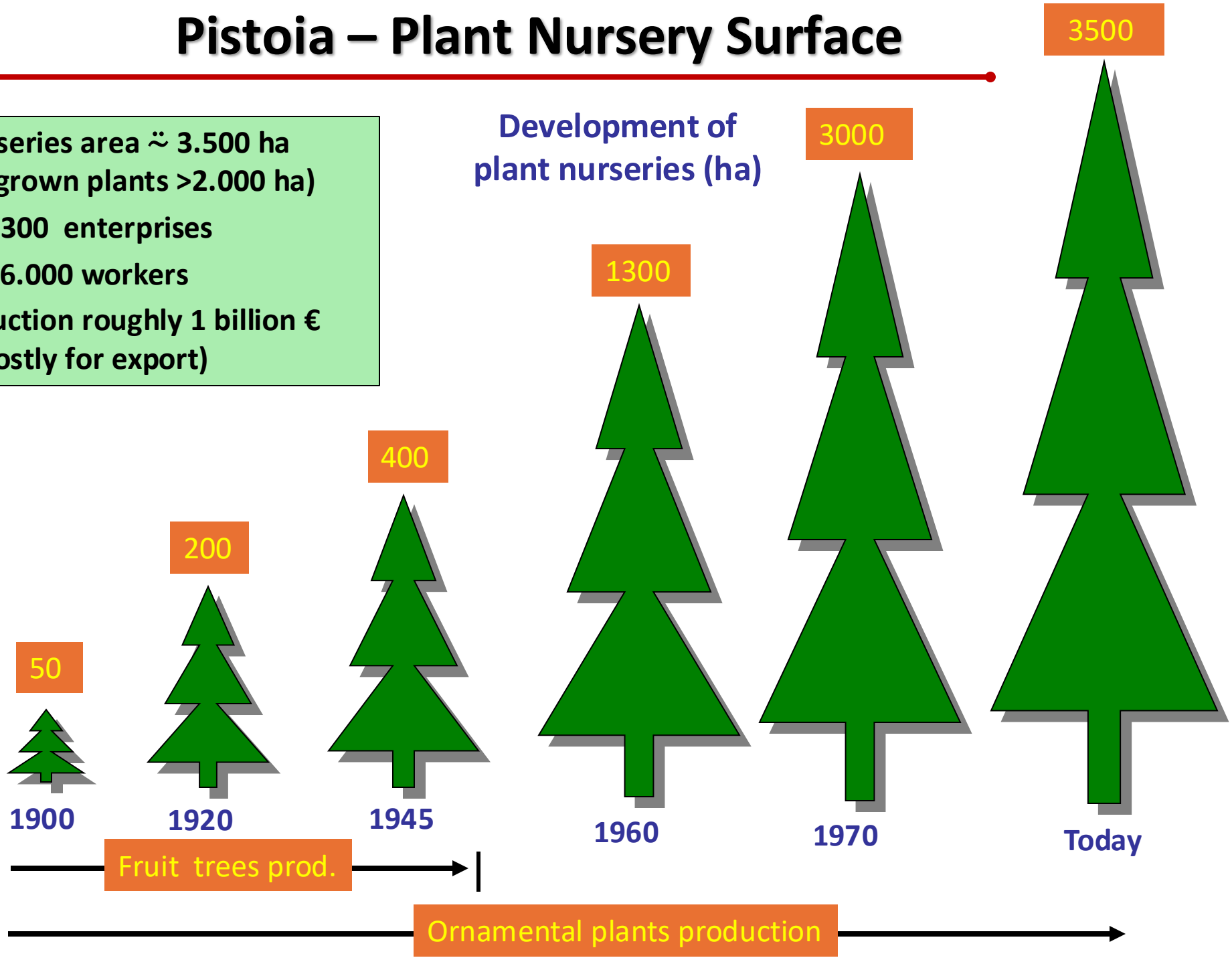
Pistoia – Plant Nursery Surface

Total nurseries area ≃ 3.500 ha
(container grown plants >2.000 ha)

≃1.300 enterprises

≃6.000 workers

Gross Production roughly 1 billion €
(mostly for export)



4 macro-trends of the sector

1 Focus on sustainability

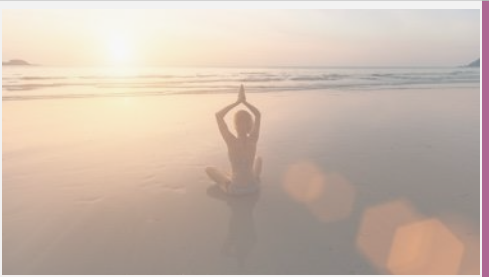
- Growing attention to sustainability (e.g. saving/reusing water), "plastic-free" pots and technical innovation (e.g. greenhouses 2.0)
- **Development of an innovative approach capable of replacing chemical fertilizers with organic or environmentally friendly products**
- **Use of renewable energy for crop management**

2 Innovation and digitalization

- **Digitalization of sales of horticultural products through new technologies and e-commerce with simplification of the user experience**
- **Emergence of a new commercial proposition with a focus on logistics and speed**

3 Globalization

- **Increase in platforms that digitally connect producers and retailers in the horticultural sector, increasing international exchanges**



4 Mental wellbeing

- The impact of the pandemic has influenced the increase in purchases of ornamental plants and flowers **to improve mental health** and **increase "mindfulness"**

STRENGTHS

✓High level of know-how of the operators;
✓Presence of highly specialized nurseries;
✓Favorable environmental conditions that allow open field cultivation;
✓Positive image of "Made in Italy".
✓Quality of productions

WEAKNESSES

✓Strong international competition;
✓Lack of competitiveness at company level (also due to small size).
✓**Limits to expansion**
✓Logistic problems
✓**Length of the production cycle**

OPPORTUNITIES

✓Cogent regulatory, social, economic and environmental constraints;
✓Dissemination of forms of environmental and ethical certification;
✓Change in lifestyles (⍰ new products and new consumption);
✓Valorization of indigenous genetic materials;
✓“Typicalisation” of productions;
✓New markets (e-commerce, etc.).
✓**Increase in demand**
✓Green tourism

THREATS

✓Cogent regulatory, social, economic and environmental constraints;
✓Dissemination of forms of environmental and ethical certification;
✓Self-referentiality of operators (primarily researchers);
✓Very aggressive and borderless competitiveness;
✓Absence of typical production brands.
✓**Production costs**

Da Romano e Ferrini, 2021

So many tree planting programs all over the world

Nurseries are not involved in the planning and design process

Well-being

Improving life quality

Urban Greening

Nurseries

Nurseries are the engine in the planning and design process

The Vision

Pistoia's plants for change: local roots for a global challenge.

- Pistoia doesn't just sell plants; it sells solutions to tomorrow's problems.
- Plant nurseries as a response to the climate crisis.

"We're not just growing trees. We're growing the future living infrastructures that will allow the world to breathe."

(Foto F. Ferrini, 2025)

Whether it’s material for reforestation…

Or big trees transplanting…


…Urban forestry must begin in the nursery!

Plant production

How much???

For who?

Where?

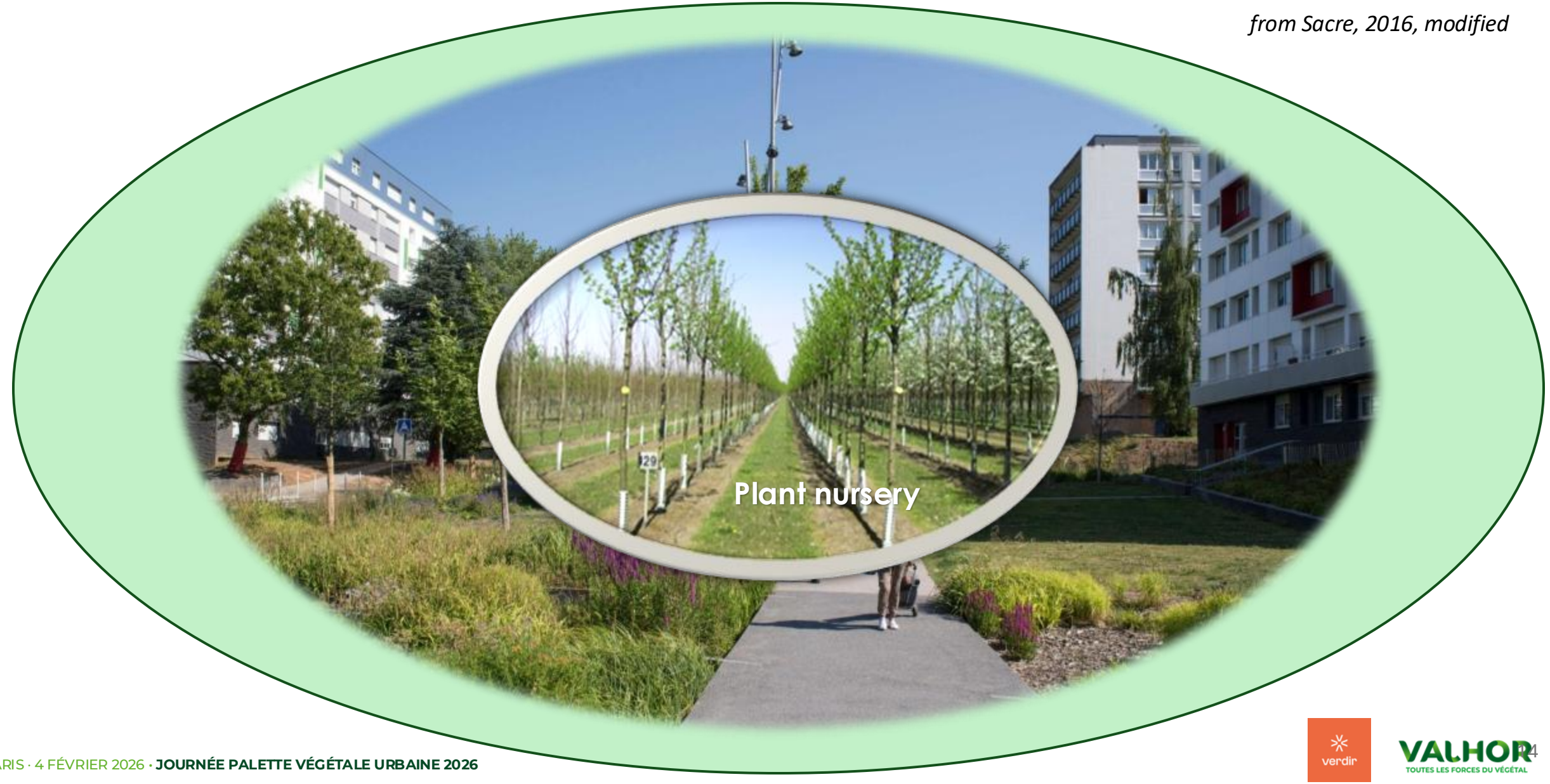
When?

What ???

What techniques and/or technologies to use???

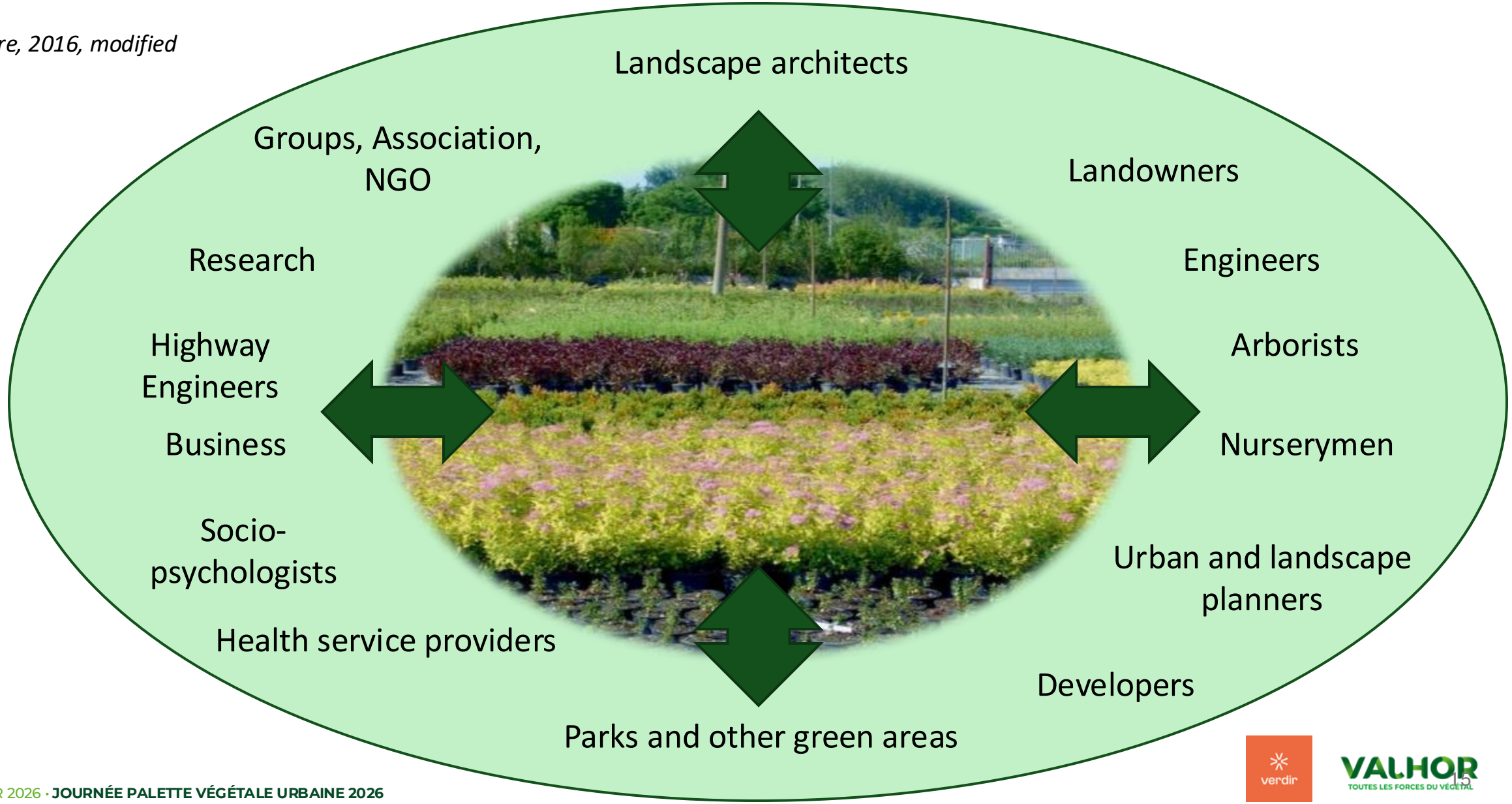
A differerent view: the nursery is central and is involved in the design and management of urban green

from Sacre, 2016, modified



So many professionals to be involved

From Sacre, 2016, modified




TIME
" And one day you discover that ten years have flown by: no one had warned you that you had to start cultivating the future»
(paraphrased from Time Pink Floyd, 1073)

Production plans

Strategic choices

they integrate structures and systems, medium and long-term effects

Tactical choices

include products and materials, short-term effects

Operational choices

management and commercial aspects, quick choices

Emergency choices

Unpredictability, instant and precise choices

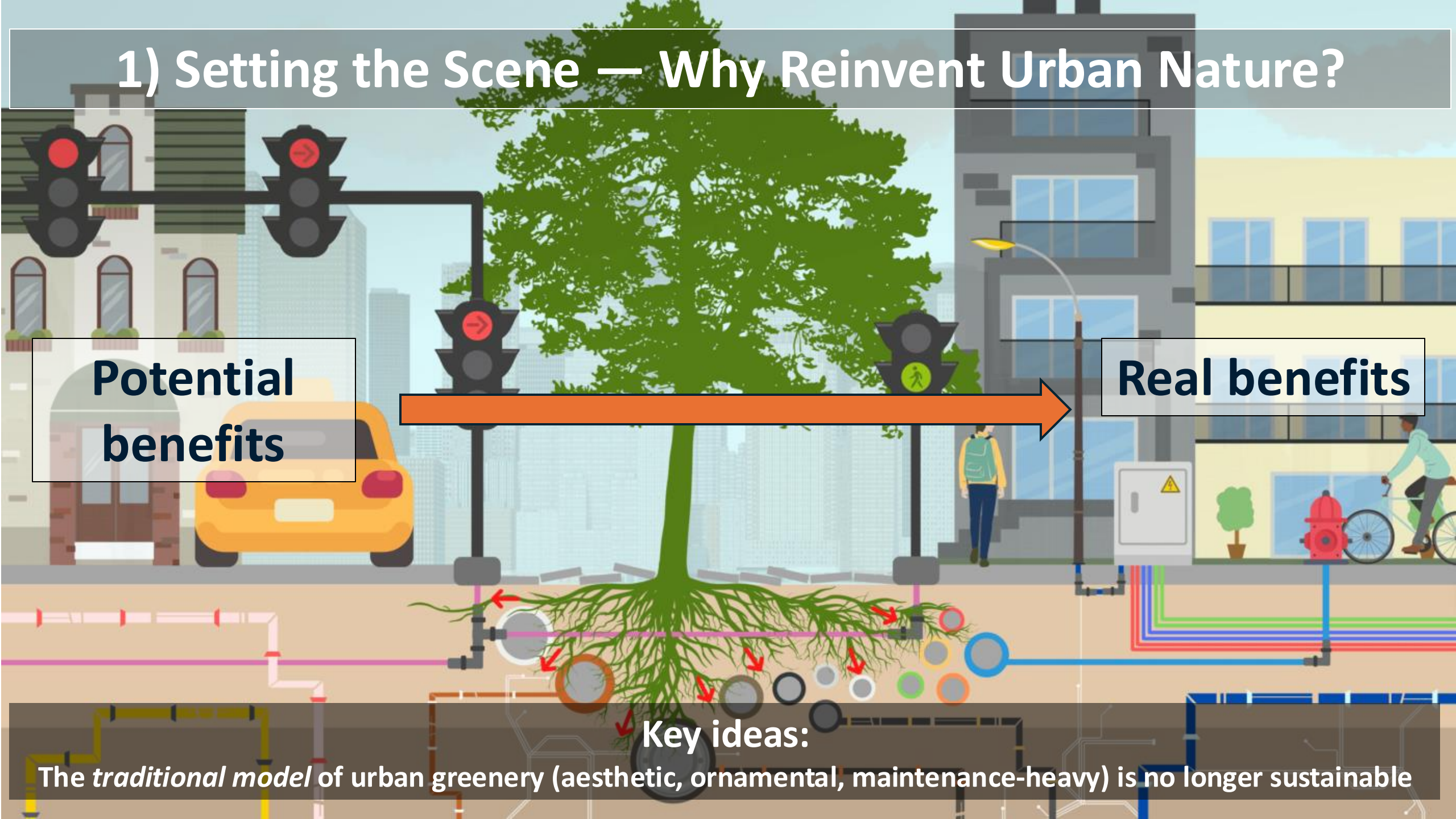
Reinventing urban nature

Need to change approach

Imagine generated by AI, Ferrini . 2025


Paris today
Paris 2070
•Urbanization has rapidly accelerated, particularly in arid regions
•Cities are hotspots for climate change presenting environmental challenges.
Imagine generated with AI
Adaptation or decline?

1) Setting the Scene — Why Reinvent Urban Nature?



Key ideas:

The *traditional model* of urban greenery (aesthetic, ornamental, maintenance-heavy) is no longer sustainable

1) Setting the Scene — Why Reinvent Urban Nature?

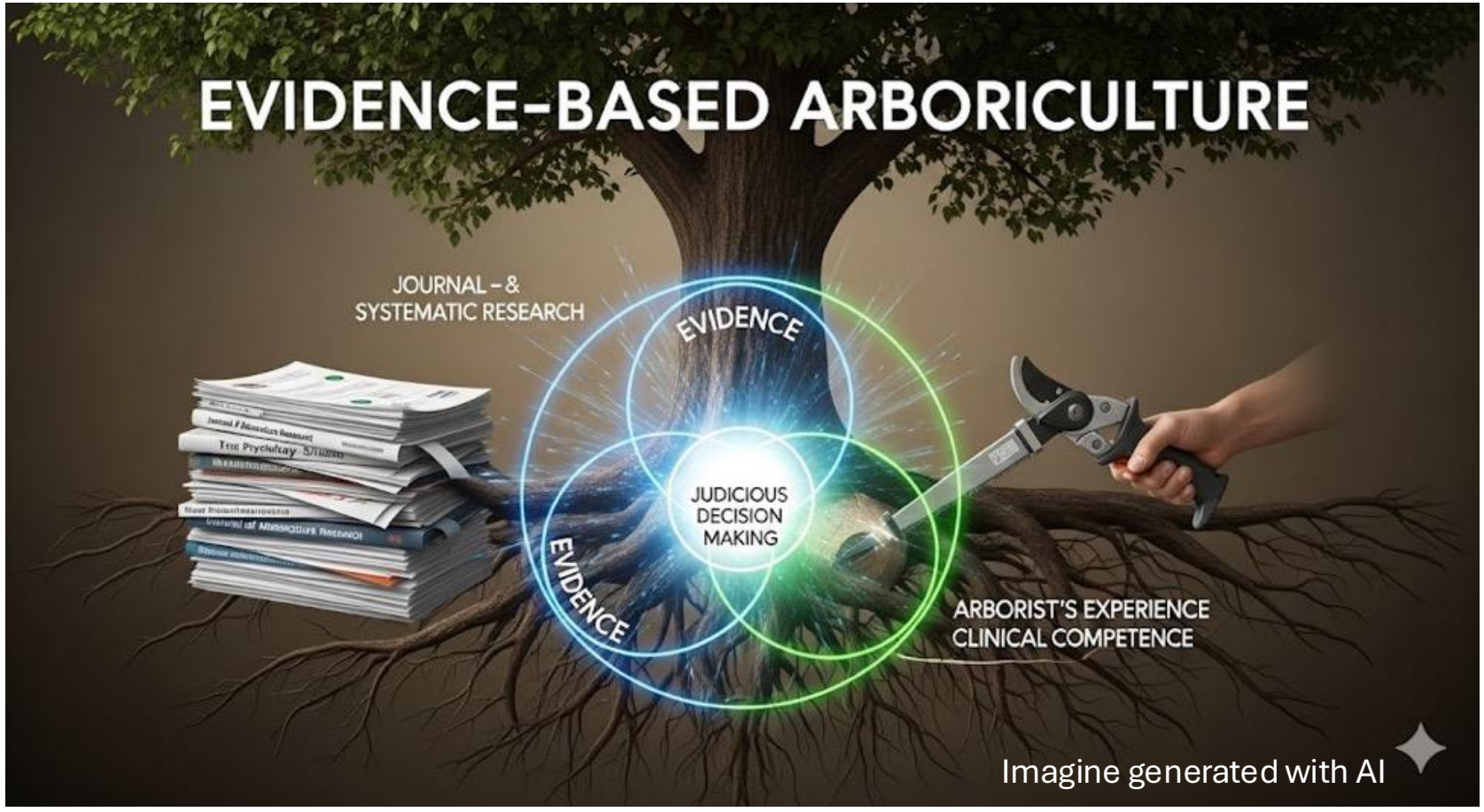
Key ideas:

•*Climate change*, *urban densification*, and *biodiversity loss* require a new paradigm: **functional, adaptive, living urban nature**.

Concepts that must be kept in mind

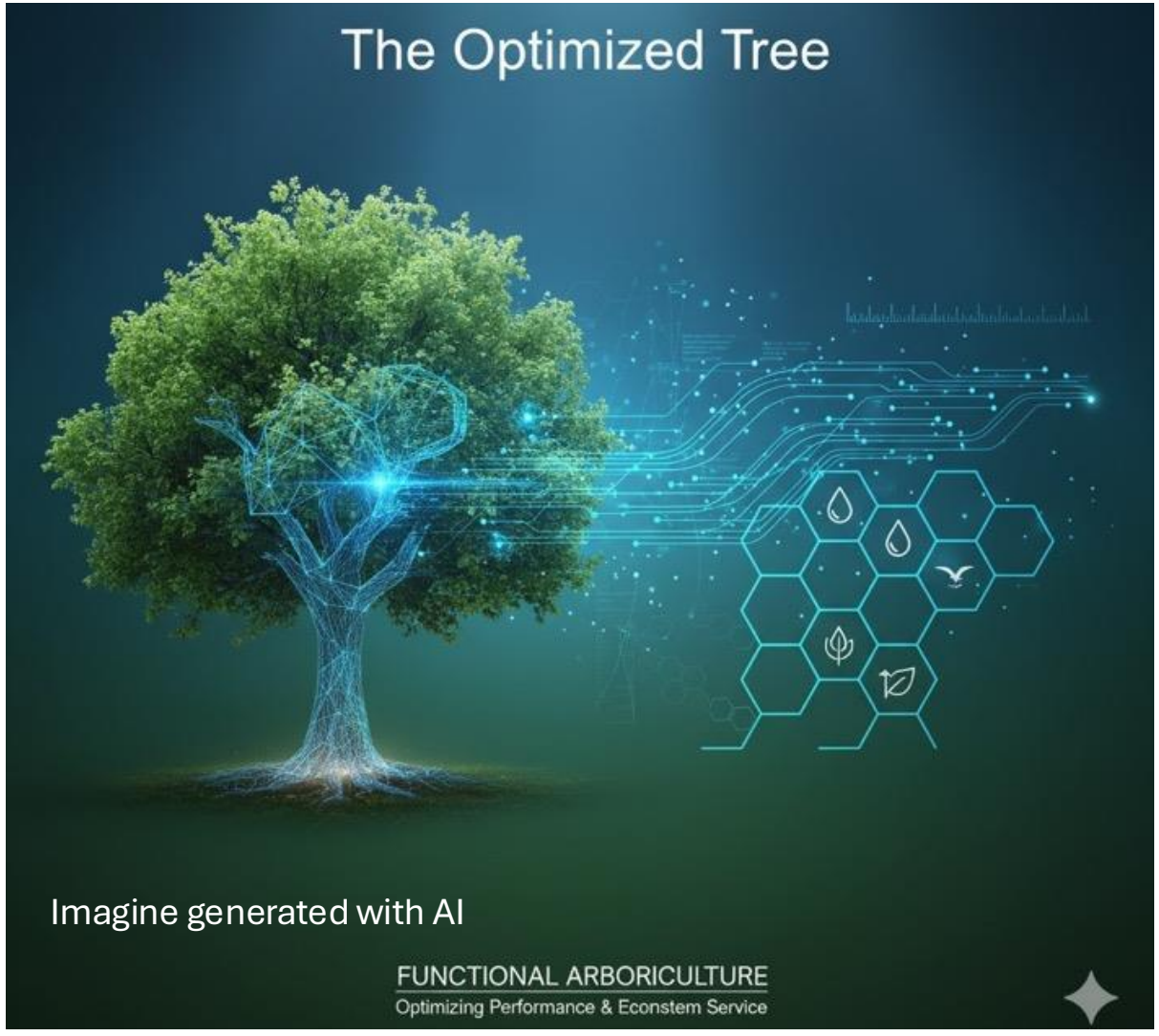
Evidence-based Arboriculture (EBA)
The conscientious, explicit, and judicious use of the best current evidence in the field of medical science—to the field of Arboriculture & Urban Forestry, calling it EBA (Francesco Ferrini, 2023)

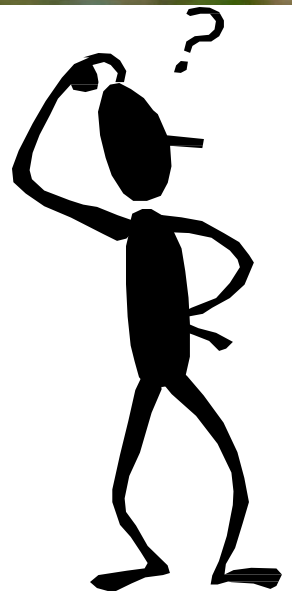
Definition:
EBA is defined as the **conscious, explicit, judicious, and reasonable** use of the **best and most modern research evidence** in arboriculture when making green areas and tree management decisions.



Functional arboriculture

Functional arboriculture is a technical-scientific discipline that deals with the cultivation and management of trees, focusing on their morphological and physiological characteristics **to optimize their performance and adaptation to the environment.** This approach includes the selection of tree species, their planting, care and management, with the aim of maximizing ecosystem services, while respecting environmental sustainability (Ferrini & Lo Piccolo 2025).





3. The Science of Tree Choice — Evidence-Based Selection

How do we currently select trees?

From Hirons, 2024

Do you currently source guidance from?

	Always	Mostly	Sometimes	Never
Dendrological literature	9%	20%	54%	16%
Online selection tools	3%	17%	58%	22%
Tree nursery catalogues	12%	48%	38%	1%
Recommendations from a tree nursery	4%	18%	67%	10%

Tree Nursery Catalogues dominated species selection decisions across all major professional groups (Landscape Architects, Arboricultural Consultants, Local Authority Officers).

From Hirons, 2024

3. The Science of Tree Choice — Evidence-Based Selection

Goal: Move from intuition to data-driven species selection.

Key ideas:

•Functional traits approach: drought tolerance, phenology, rooting patterns, canopy structure.

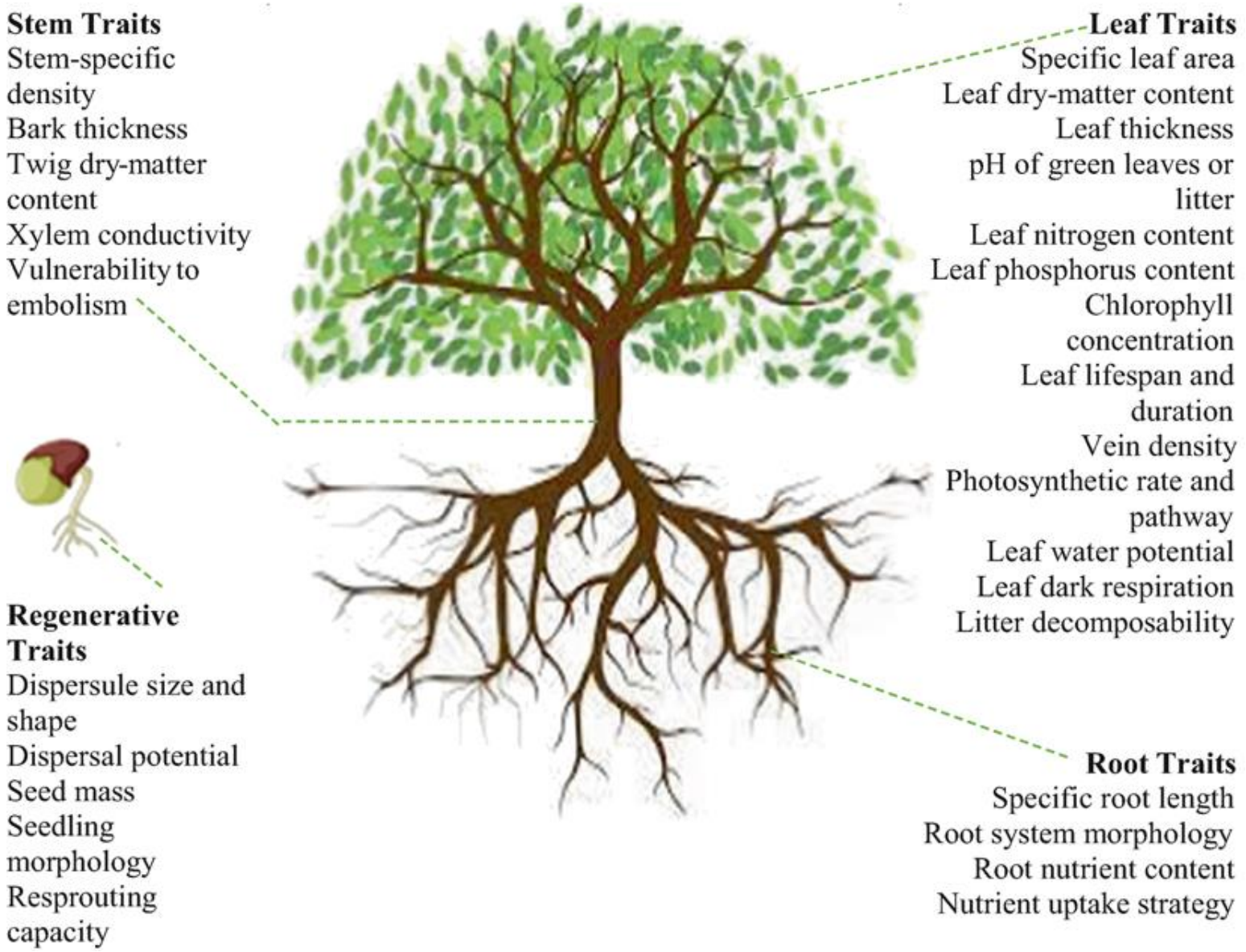


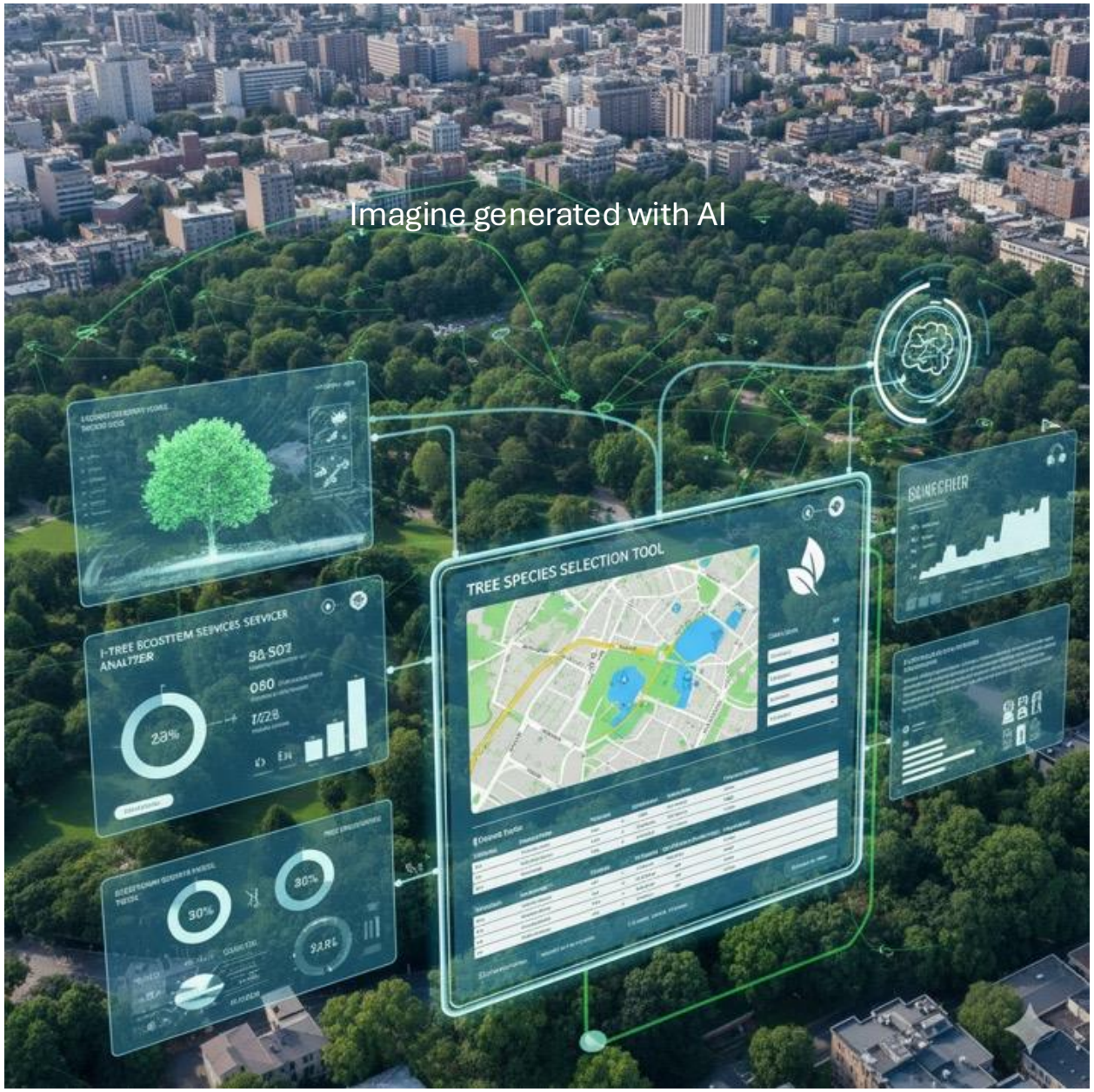
Image credits https://link.springer.com/chapter/10.1007/978-981-97-1510-7_1/figures/2 from Tyagi and Kumar, 2024

3. The Science of Tree Choice — Evidence-Based Selection

Goal: Move from intuition to data-driven species selection.

Key ideas:

•Databases, decision-support tools, and predictive models (e.g., Tree Species Selection Tools, i-Tree, etc.).



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Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug

Urban forests, provenance matters: Investigating its influence on growth and physiological responses to drought in *Quercus robur* and *Acer pseudoplatanus*

Ermes Lo Piccolo [a,b,*,1], Barbara Mariotti [a,b,1], Francesca Alderotti [a,c], Cassandra Detti [a], Andrea Scartazza [b,d], Silvia Traversari [b,d], Alessio Giovannelli [b,e], Maria Laura Traversi [e], Negar Rezaie [b,e], Antonella Gori [a,c], Cecilia Brunetti [a,c], Luisa Ghelardini [a,b], Alberto Maltoni [a,b], Fabio Salbitano [b,f], Francesco Ferrini [a,b,c]

3. The Science of Tree Choice — Evidence-Based Selection

Goal: Move from intuition to data-driven species selection.

Key ideas:

- Role of *provenance* and *intraspecific variation* (varieties, cultivars, seed sources).

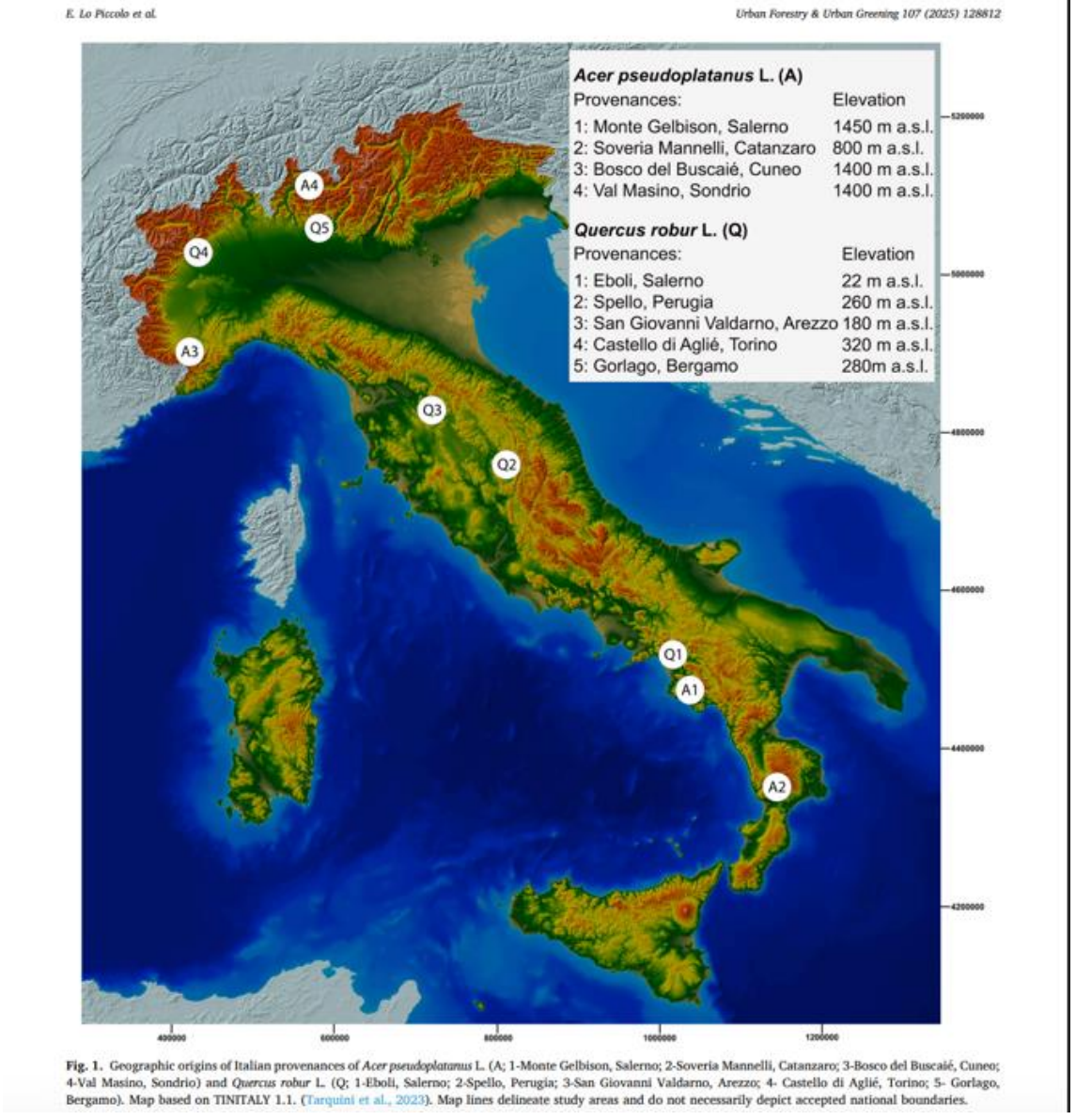


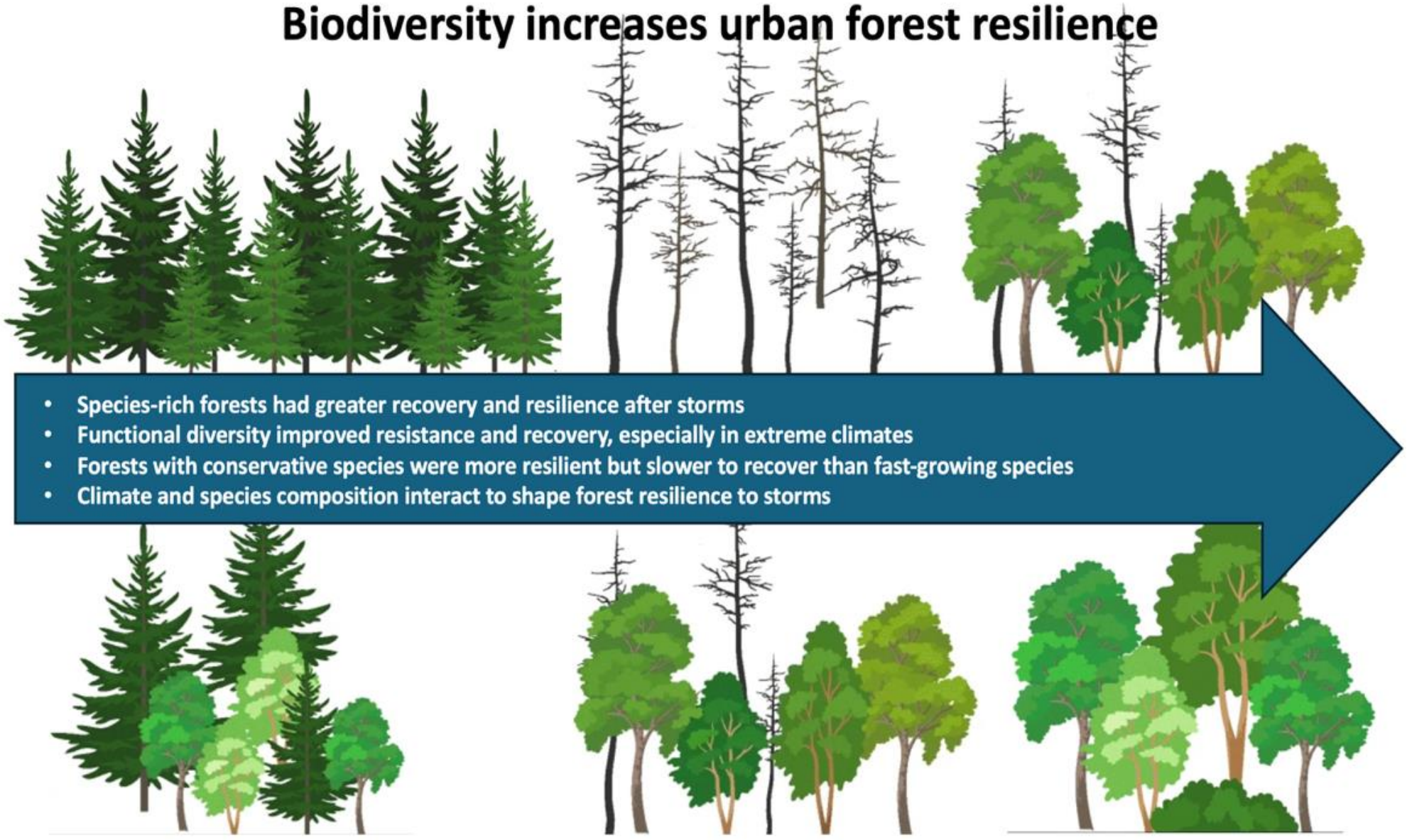
Fig. 1. Geographic origins of Italian provenances of *Acer pseudoplatanus* L. (A; 1-Monte Gelbison, Salerno; 2-Soveria Mannelli, Catanzaro; 3-Bosco del Buscaié, Cuneo; 4-Val Masino, Sondrio) and *Quercus robur* L. (Q; 1-Eboli, Salerno; 2-Spello, Perugia; 3-San Giovanni Valdarno, Arezzo; 4- Castello di Aglié, Torino; 5- Gorlago, Bergamo). Map based on TINITALY 1.1. (Tarquini et al., 2023). Map lines delineate study areas and do not necessarily depict accepted national boundaries.

3. The Science of Tree Choice — Evidence-Based Selection

Goal: Move from intuition to data-driven species selection.

Key ideas:

•The importance of genetic diversity and polyculture for resilience.

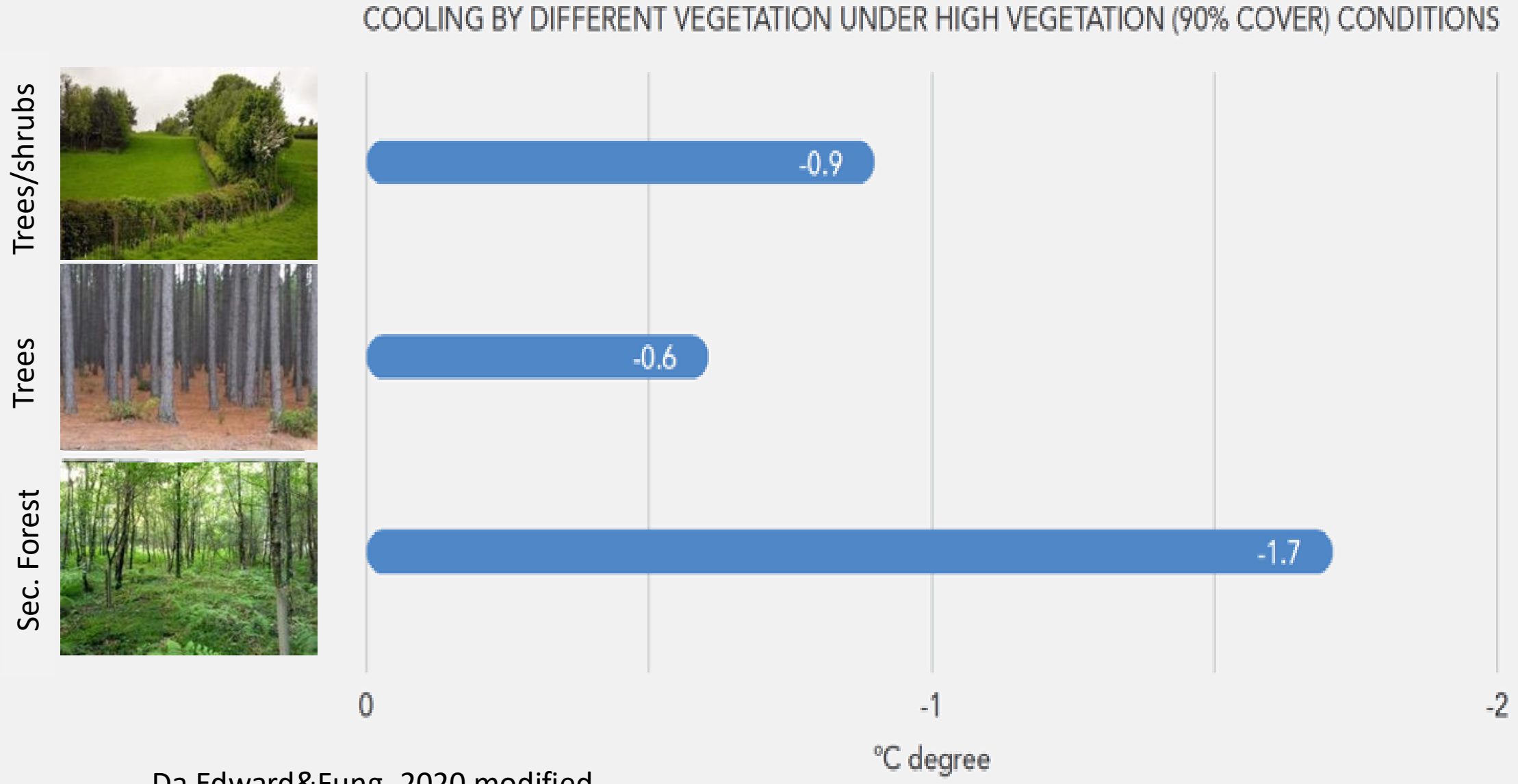


Biodiversity as a resource

Biodiversity in urban environments is a precious resource, particularly for species and structural diversity. Increasing the number of different plant species (species) and their complexity in terms of height and stratification (structural diversity) makes the urban ecosystem more stable, resistant to diseases and pests, and maximizes the provision of ecosystem services.

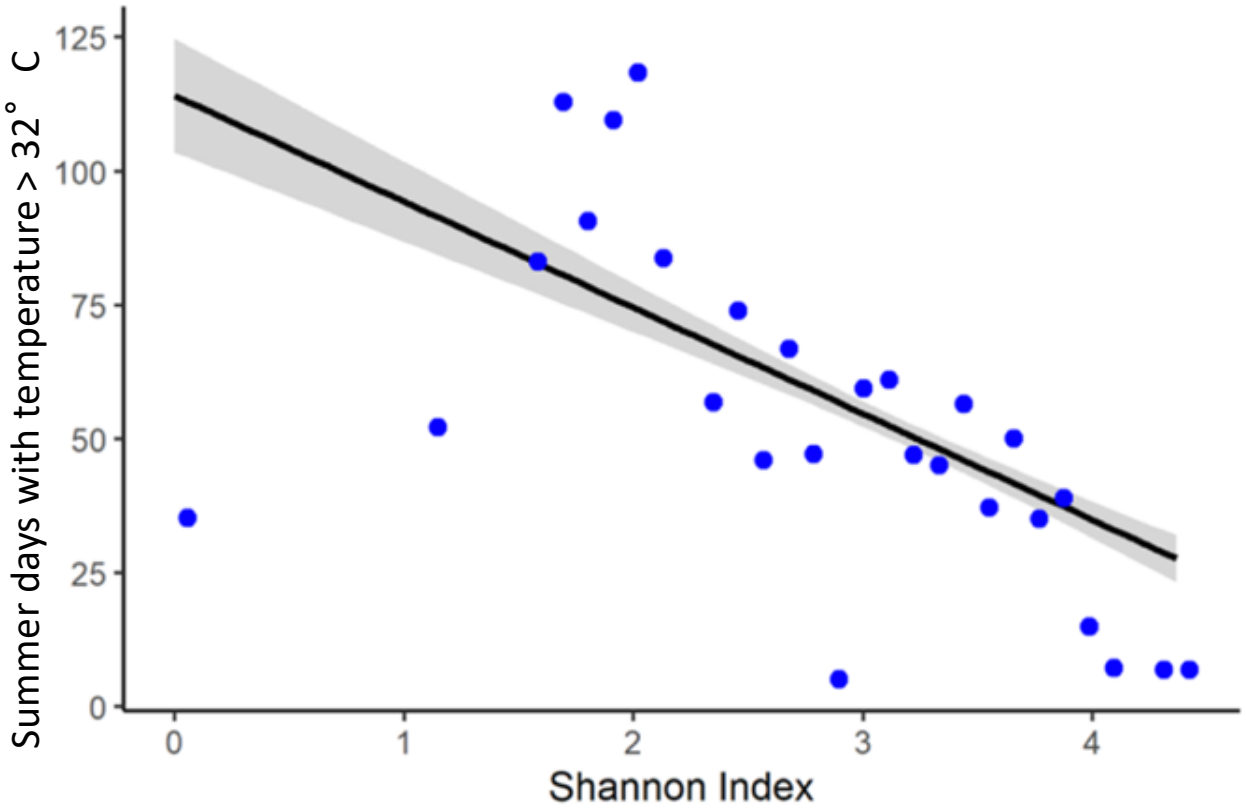
Imagine generated by AI, Ferrini . 2026

From Coutts&Tapper, 2017



Da Edward&Fung, 2020 modified

Weather Station Data



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Street tree diversity and urban heat

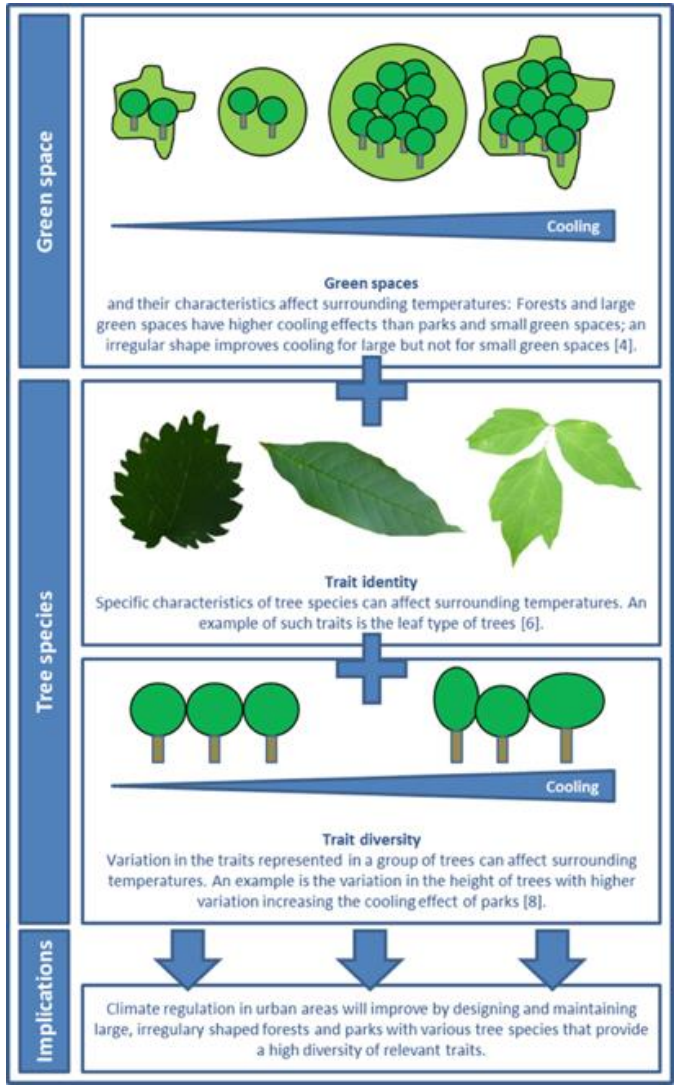
Paola Rendon, Natalie Love, Camille Pawlak, Jenn Yost, Matthew Ritter, Jacqueline Doremus *

California Polytechnic State University, San Luis Obispo, USA

- **Biodiversity and Urban Heat Island**: The study of 136 urban zip codes in California shows that **greater tree species diversity is associated with lower summer maximum temperatures** and fewer days above 32° C, helping to mitigate the urban heat island effect.
- **Impact independent of tree cover**: The results indicate that **the cooling effect of tree diversity is independent of tree canopy cover,** suggesting that species diversity plays a unique role in cooling urban areas.
- **Implications for urban planning**: The study suggests that **increasing tree diversity may be an effective strategy to reduce the impact of heat waves in cities**, especially in densely populated areas, providing equitable benefits to less affluent communities that cannot invest in artificial cooling systems.

Biodiversity of shapes

Summary of findings on the effects of green space configuration and tree diversity on climate regulation that should be considered when creating new urban green spaces (da Knapp et al., 2019)



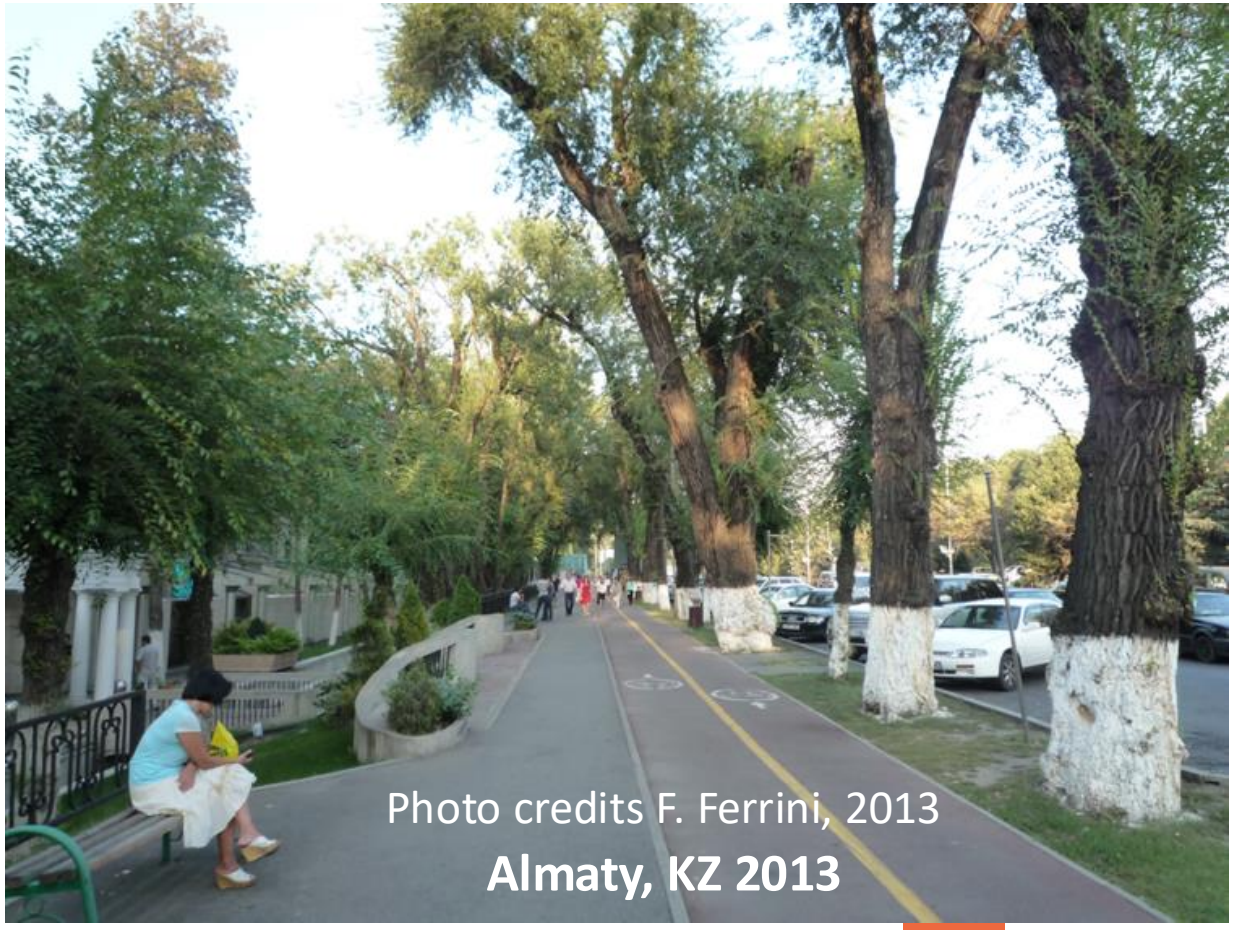


Photo credits F. Ferrini, 2013

Almaty, KZ 2013

Future green city planning:
Avoiding the unmanageable, managing the unavoidable

In urban tree planting this means taking care of what we already have, and planning for a resilient canopy that can truly endure.

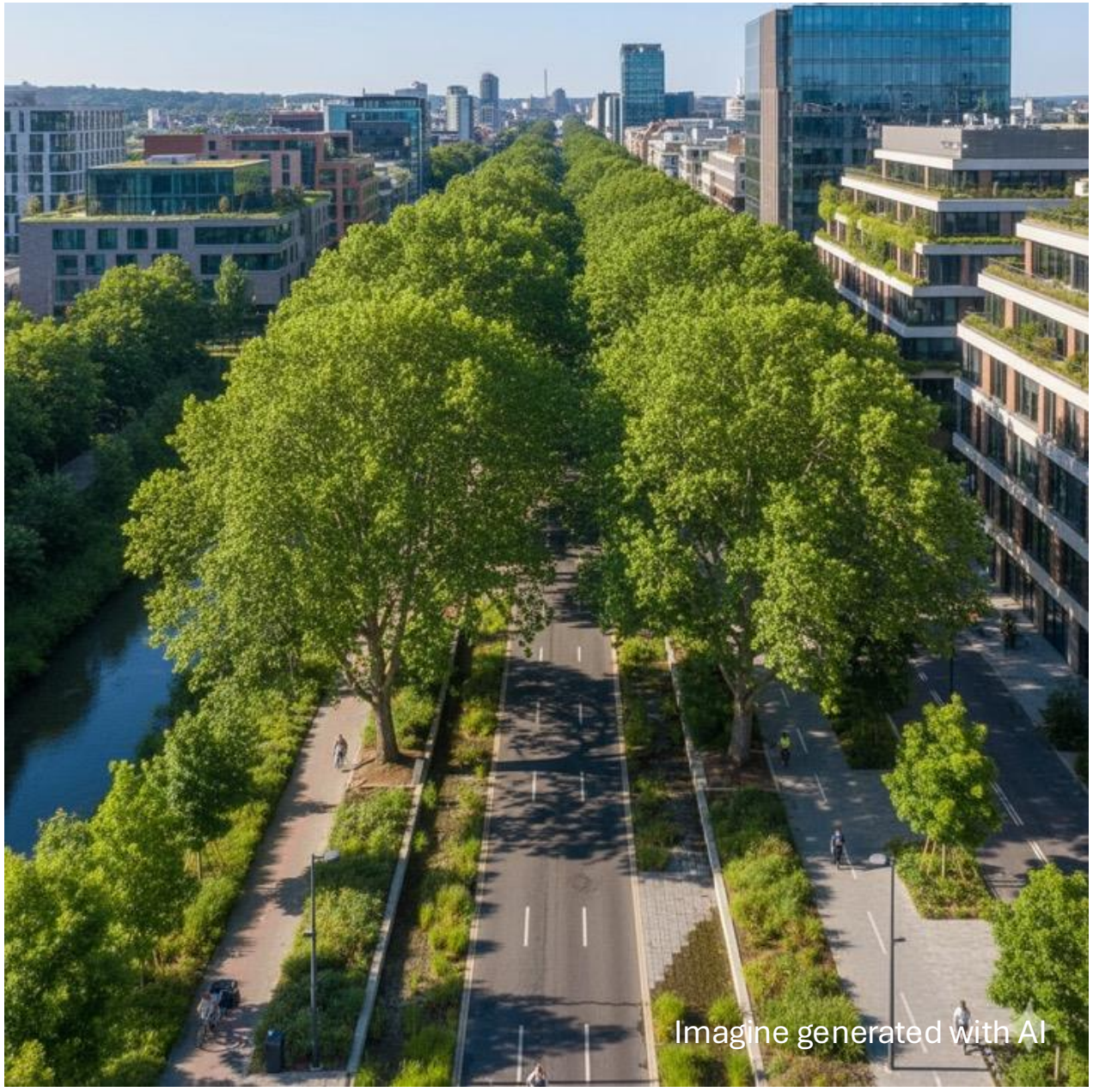
Image credits https://gbdinnovationclub.com/members-news/the-future-of-the-la-defense-esplanade-takes-shape-with-the-park-project/

4) Reinventing the Urban Landscape — Integrating Ecology and Design

Goal: Connect science with urban form and human experience.

Key ideas:

•Rethink spatial design: trees as *infrastructure*, not decoration.



4) Reinventing the Urban Landscape — Integrating Ecology and Design

Goal: Connect science with urban form and human experience.

Key ideas:

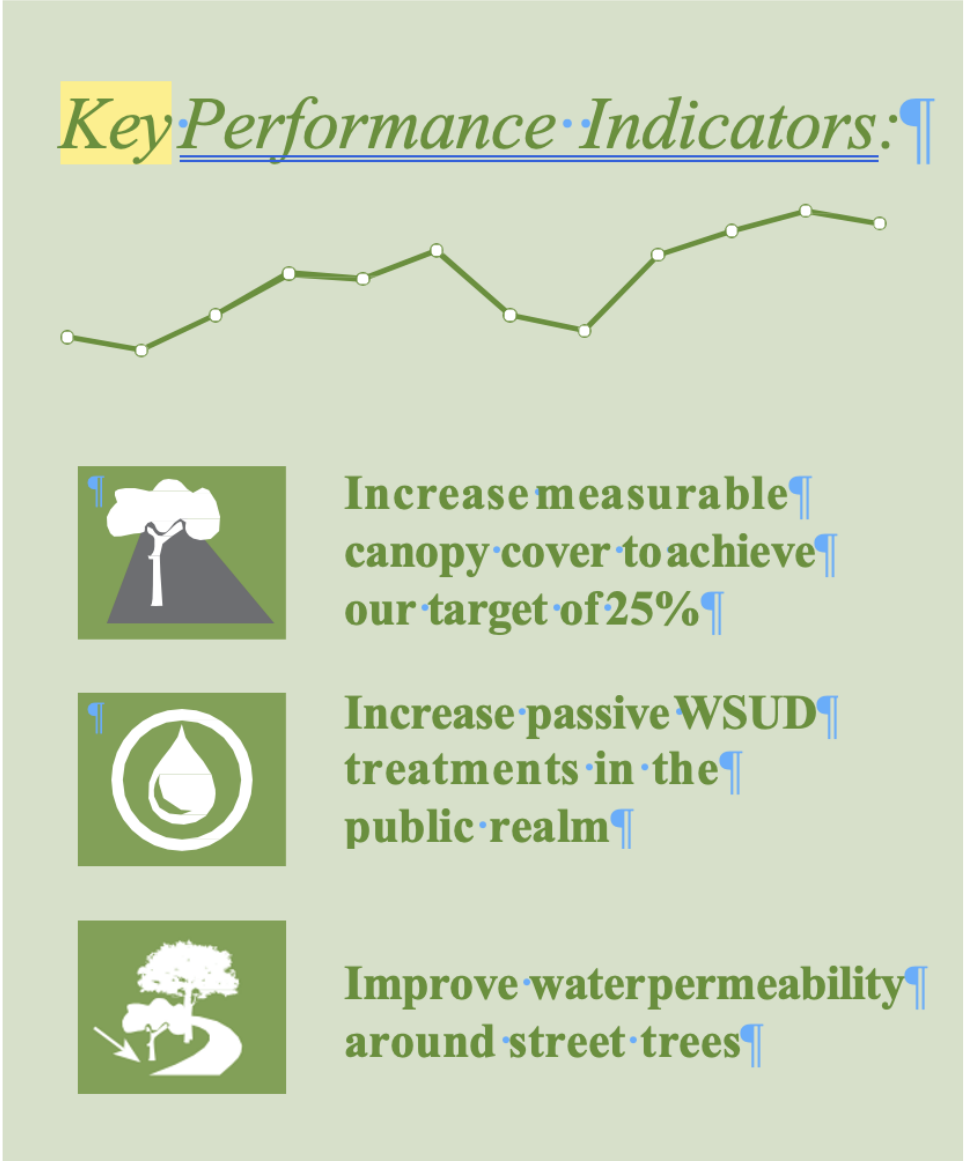
•Multifunctionality: shade, water management, biodiversity, well-being.

5. Measuring Success — Indicators of a Living Urban Nature

Goal: Emphasize accountability and feedback.

Key ideas and KPIs:

- **Canopy Cover Percentage (%)**
- **Green Infrastructure Performance for Water Management (GI-WM)**
- **Biodiversity Index (Bi)**
- **Air Quality Improvement (AQI)**
- **Social KPIs user satisfaction, equity in green access, community engagement**



https://www.geelongaustralia.com.au/urbanforest/article/item/8d30160f61d3725.aspx

The Science of Tree Choice in a Warming World

Imagine generated with AI

Urban forest expansion in drier climates

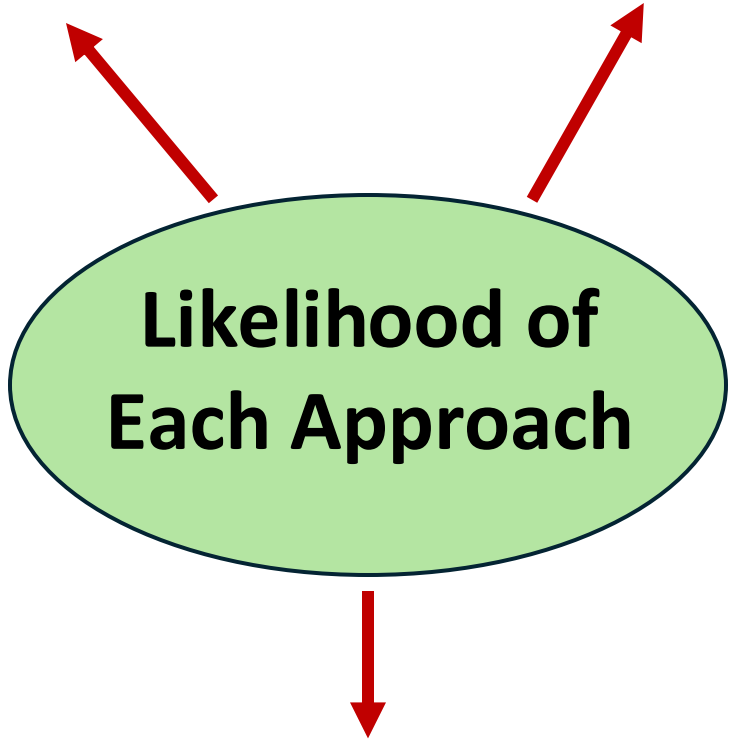
Challenges and Trade-offs:

1) While tree planting reduces urban heat, it increases irrigation needs
2) Improving soil quality (i.e use of different amending materials)
3) Need of selecting drought-tolerant species (native vs exotic)
4) Balancing tree canopy expansion with sustainable water use to irrigate new green spaces (i.e. treated wastewater)

Image credits https://www.alriyadhdaily.com/article/4d10a8f9f6c3481d9f9bf61ee7a886d8

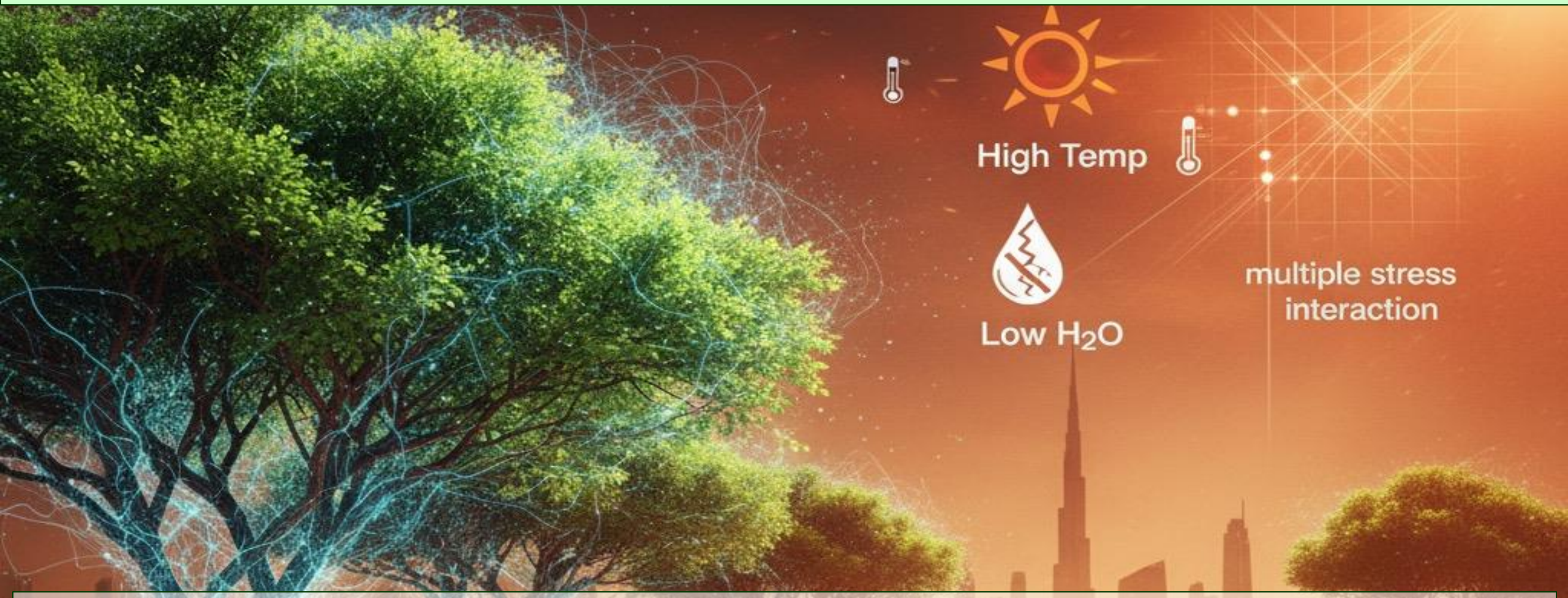
Breeding for Environmental Tolerance: This remains a foundational approach, as it leverages natural genetic variation and can produce new varieties over several generations. The integration of MAS (Marker assisted selection) accelerates this process and enhances its precision.

Selecting Species for Tolerance: This is a crucial strategy, particularly in regions facing severe climate impacts. Utilizing existing genetic diversity and resilient species **can provide immediate benefits**.



Cloning Observed Tolerant Plants: Cloning and genetic engineering are powerful tools, especially for rapidly propagating plants with proven tolerance. However, these methods may face regulatory, ethical, and economic challenges.

Drought is a multiple stress, involving the interaction of light, temperature and water availability.



Research directed to predict the effects of global change <u>is time and money consuming</u> and, at present, we mostly rely on predictions made on models……but we are sure that in the next future <u>drought, CO_2 levels and temperature might strongly affect tree health</u> and growth performances.

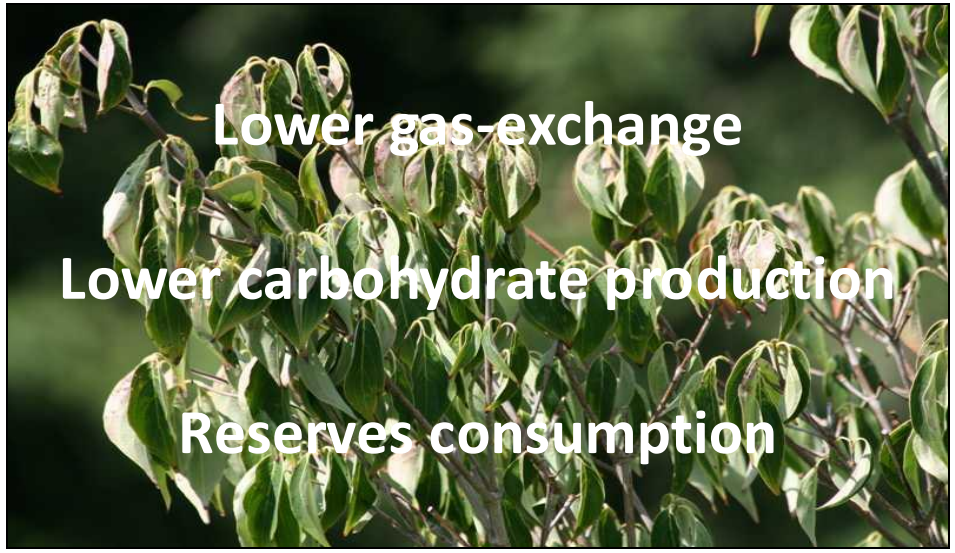
Imagine generated with AI

Drought stress

Short ← Drought → Prolonged

Short → Reversible

Prolonged → Permanent



Cellular dehydration

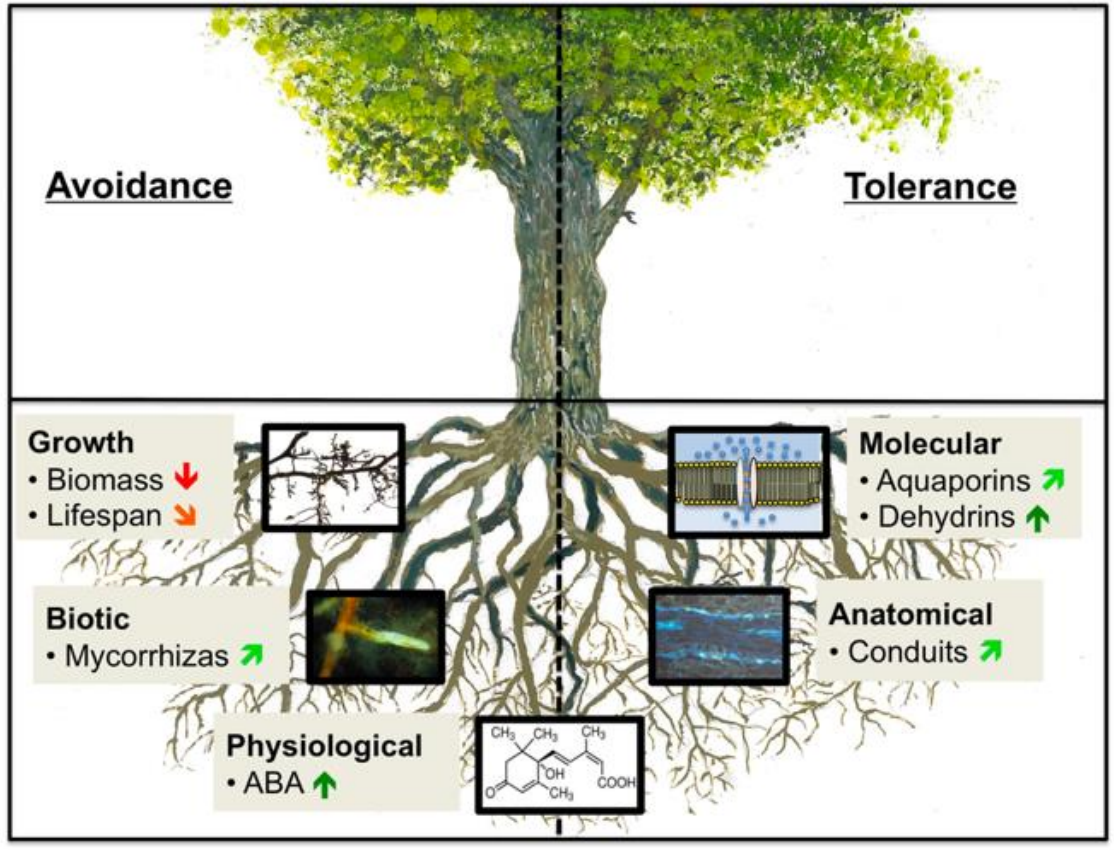
Enzymes inactivation

Biologic cycles alteration

Predisposition to secondary attacks

How can we improve drought tolerance?

Species selection	Nursery pre-conditioning	Planting and management



↑ indicates a positive effect, ↗ indicates a predominantly positive trend, ↓ indicates a negative effect and ↘ indicates a predominantly negative trend.

Mechanisms of drought resistance and selected examples of tree root traits that respond to drought with avoidance or tolerance. From Brunner I, Herzog C, Dawes MA, Arend M and Sperisen C (2015) How tree roots respond to drought. Front. Plant Sci. 6:547. doi: 10.3389/fpls.2015.00547

Hardening in the nursery – deficit irrigation

Deficit irrigation can reduce growth and yield in drought-avoider species (species which maintain a high RWC at decreasing water potential) as also reported by *Fini et al. (2013 J. Arid Environ.*), **but it may not be recommendable**, whereas it effectively improves post-transplant performances in drought-tolerant species

http://bmptoolbox.org/capturefactor/CF_Fact_Sheet_Page1-25-12_html_11466f2a.jpg

Imagine generated with AI

Species selection

Questions to be answered

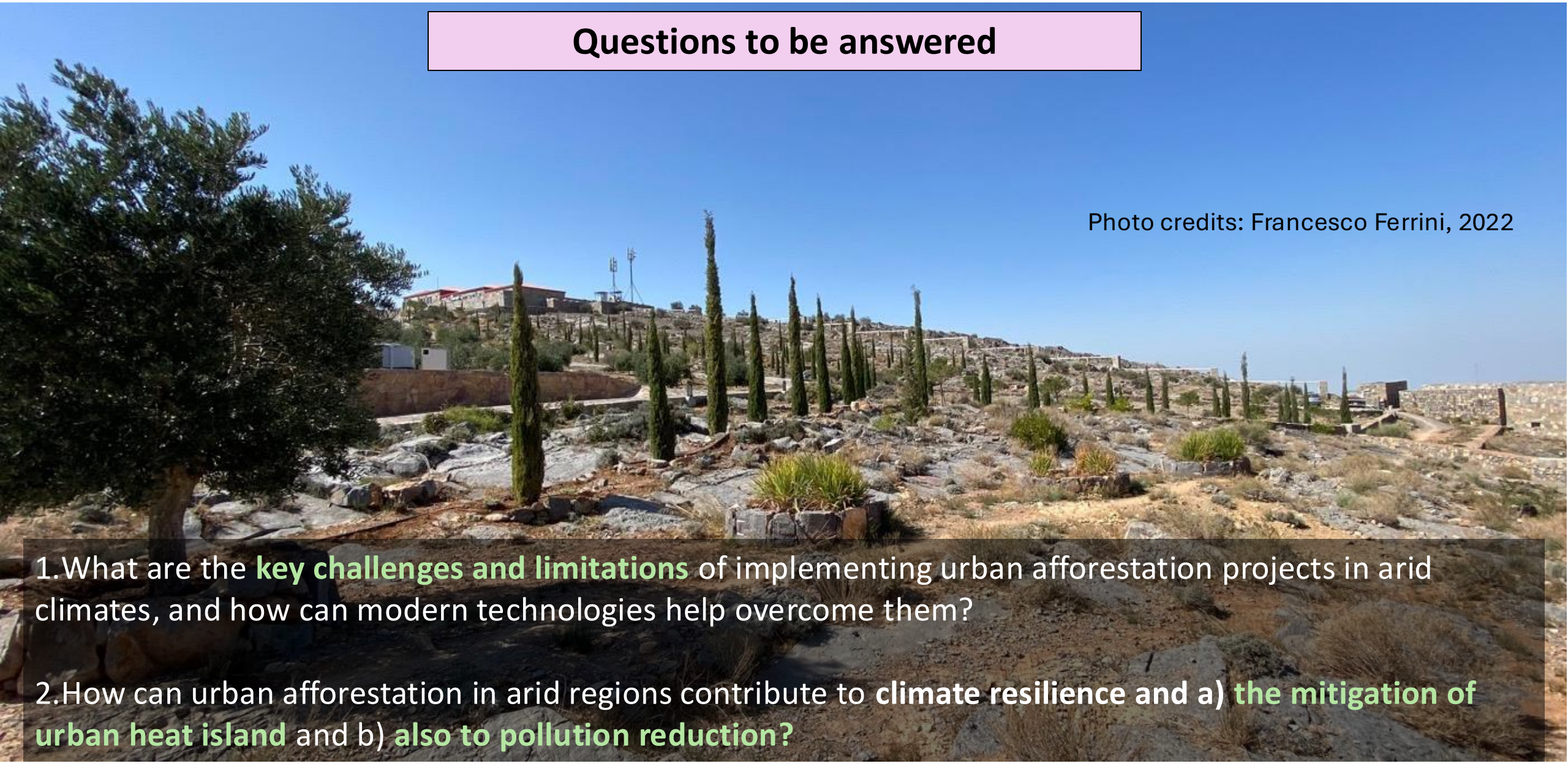


Photo credits: Francesco Ferrini, 2022

1.What are the **key challenges and limitations** of implementing urban afforestation projects in arid climates, and how can modern technologies help overcome them?

2.How can urban afforestation in arid regions contribute to **climate resilience and a) the mitigation of urban heat island** and b) **also to pollution reduction?**

ARBORICULTURE IS CHANGING

Past:

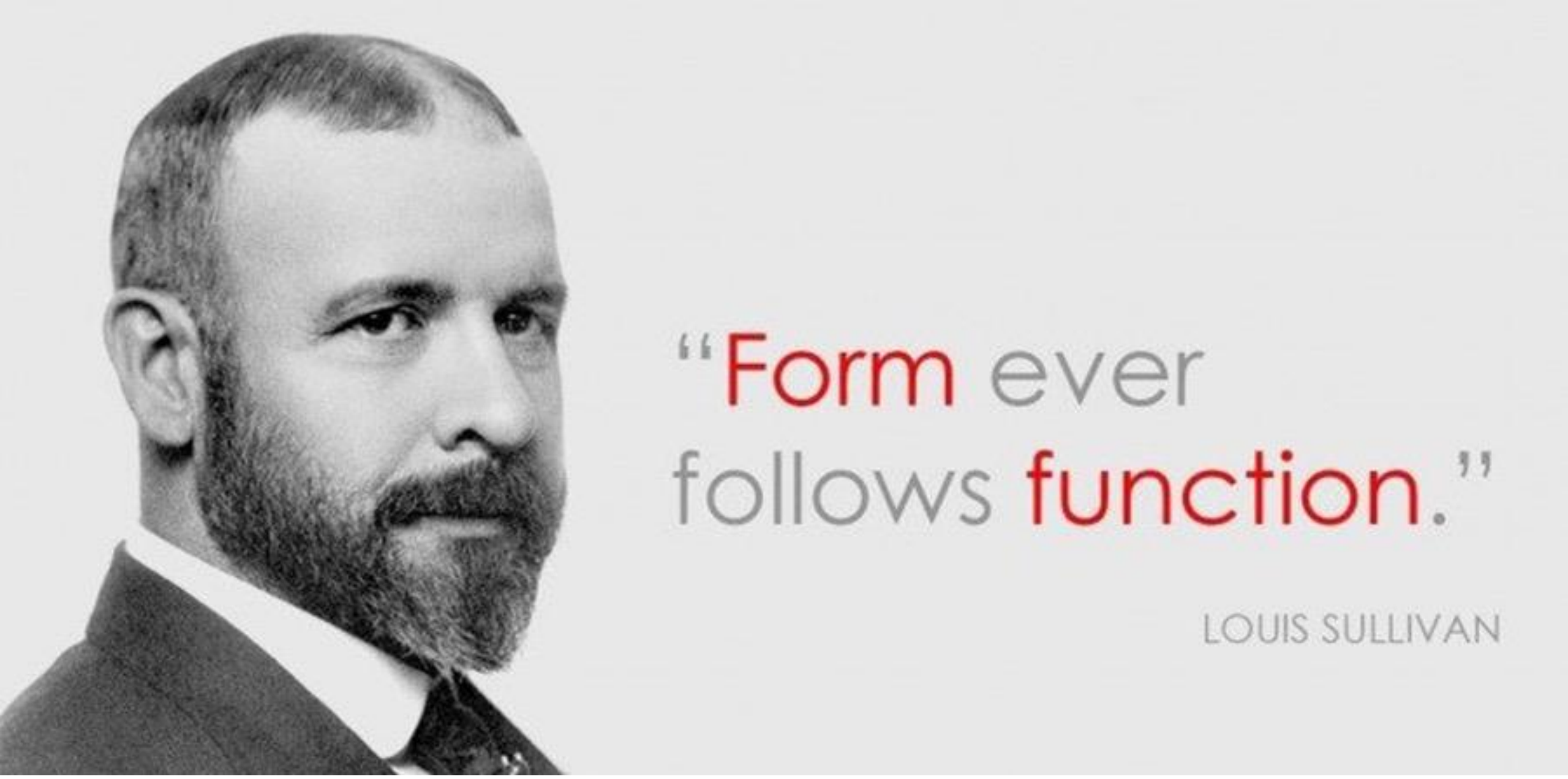
Few genera and species for urban greening (10 genera = 80% of the new tree planting in urban areas

Acer, Carpinus,

Aesculus, Fraxinus, Fagus, Populus, Platanus, Salix, Tilia, Ulmus

Present:

- More genera
- Tenths of species 80% with more cultivars available (more than 750 tested cultivars)


"Form ever
follows function."
LOUIS SULLIVAN

We must know the species that we use!

Ø	4-5 m	15-25 m	5-10 m	6-8 m	15-20 m	8-10 m
SPECIE	*Carpinus betulus*	*Platanus x acerifolia*	*Acer campestre*	*Betula pendula*	*Acer platanoides*	*Gingko biloba*
ALTA TOLLERANZA	inquinanti, compattazione	siccità, salinità, compattazione, sommersione inquinanti	siccità, salinità,compattazione inquinanti	sommersione, inquinanti	siccità, salinità, compattazione, sommersione inquinanti	siccità, salinità, compattazione, sommersione inquinanti
STOCCAGGIO CO_2	1644 Kg	6918 Kg	499 Kg	1644 Kg	1644 Kg	3606 Kg

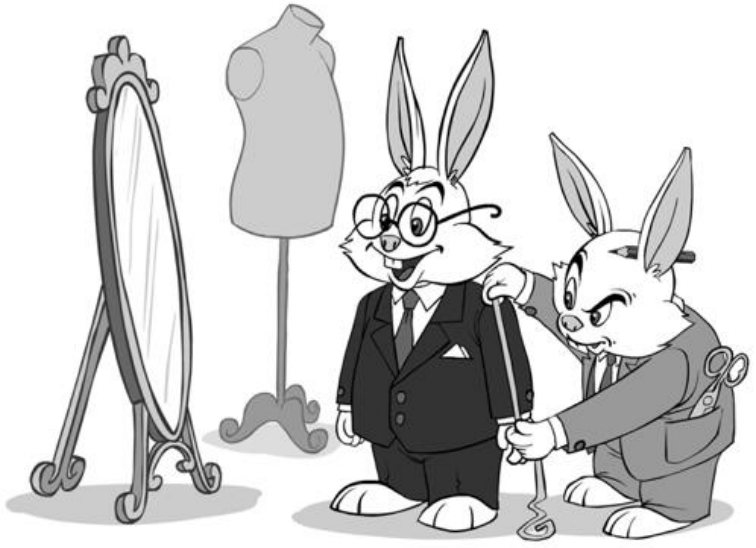
Fonte dati: Vivaistitaliani/qualiviva

And…we must know the place where we will plant them!!!

om Kwon C., accessed 14 set 20

Do we have a «one size fits all» solution??

ONE SIZE
FITS ALL



MADE TO
MEASURE

What these two cars do have in common?


/ACOlemans
#ACO

The importance of BIODIVERSITY

Biodiversity is not a trendy word, but what we must protect and increase in the city of the future

Image credits https://www.weforum.org/stories/2021/06/cities-ecosystems-biodiversity-climate-

Tree species most widely grown in our cities

Scientific name	Drought Tolerance (Med.)	Growth Rate	Maintenance Needs	Shade Potential	Climate-Change Resilience	Root Aggressiveness	Biodiversity Value	Notes (Mediterranean context)
Acer platanoides	Low–Moderate	Moderate–Fast	Moderate	High	Low–Moderate	Moderate	Low–Moderate	Performs poorly under prolonged heat and drought; declining suitability
Acer pseudoplatanus	Low	Fast	Moderate	High	Low	Moderate	Moderate	Sensitive to summer drought; better in cooler, wetter sub-regions
Aesculus hippocastanum	Low	Moderate	High	High	Low	Moderate	Low	Unsuitable for hot, dry cities; high pest pressure
Celtis australis	High	Moderate	Low	Moderate–High	High	Low–Moderate	Moderate–High	Excellent Mediterranean urban tree; heat, drought, and pollution tolerant
Fraxinus excelsior	Low–Moderate	Fast	Moderate	High	Low	Moderate	High	Drought stress + ash dieback severely limit use
Ginkgo biloba	High	Slow–Moderate	Low	Moderate	Very High	Low	Low	Extremely resilient but limited ecological interactions
Liquidambar styraciflua	Low–Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Requires irrigation and deep soils; heat stress common
Liriodendron tulipifera	Low	Fast	Moderate	High	Low	Moderate	Low–Moderate	Poor Mediterranean performance except irrigated parks
Platanus × acerifolia	High	Fast	Moderate	Very High	High	High	Moderate	Highly resilient but aggressive roots; careful siting required
Populus spp.	Low	Very Fast	High	High	Low	Very High	Moderate	High water demand and infrastructure conflicts
Quercus spp.	High	Slow–Moderate	Low	Very High	Very High	Moderate–High	Very High	Among the best climate-adapted, high ecological value
Robinia pseudoacacia	High	Fast	Low–Moderate	Moderate	High	High	Moderate	Drought tolerant but invasive; brittle wood
Styphnolobium japonicum	High	Moderate	Low	Moderate	High	Low–Moderate	Low–Moderate	Well adapted to heat and drought; low habitat value
Tilia cordata	Low–Moderate	Moderate	Moderate	High	Moderate	Moderate	High	Suffers under drought; important pollinator resource
Tilia × europaea	Low	Fast	High	High	Low	Moderate	Moderate	High water demand; declining Mediterranean suitability
Tilia tomentosa	High	Moderate	Low–Moderate	High	High	Moderate	Moderate	Best Tilia for Mediterranean climates
Ulmus spp.	Moderate	Fast	Moderate	High	Moderate	Moderate	High	New cultivars tolerate drought better; valuable for fauna

Tree species suitable for a drier climate

Scientific name	Drought Tolerance	Growth Rate	Maintenance Needs	Shade Potential	Climate-Change Resilience	Root Aggressiveness	Biodiversity Value	Notes (Mediterranean context)
Acer campestre	High	Slow–Moderate	Low	Moderate	Moderate	Low	Moderate	Good adaptability; suitable for small urban spaces; tolerates pruning
Acer opalus	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Native to Mediterranean mountains; prefers cooler sites
Acer cappadocicum	Low–Moderate	Moderate	Moderate	High	Low–Moderate	Moderate	Low	Sensitive to drought; produces suckers; limited Mediterranean suitability
Acer monspessulanum	High	Slow	Low	Moderate	High	Low	High	Excellent drought tolerance; native Mediterranean species
Aesculus indica / A. glabra	Low	Moderate	High	High	Low	Moderate	Low	Poor heat and drought tolerance; unsuitable for hot, dry cities
Brachychiton populneus	High	Fast	Low	Moderate	High	Low	Low	Very drought-tolerant; limited ecological interactions
Ceratonia siliqua (♀)	Very High	Moderate	Very Low	Moderate	Very High	Low	High	Iconic Mediterranean species; excellent for dry urban sites
Corylus colurna	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Tolerates urban conditions; prefers deeper soils
Fraxinus oxycarpa	High	Moderate	Moderate	High	Low	Moderate	High	Vulnerable to pests and climate stress
Gleditsia triacanthos (♂)	High	Fast	Moderate	Moderate	High	Moderate	Moderate	Drought tolerant but structural issues; use thornless cultivars
Ginkgo biloba (♂)	High	Slow–Moderate	Low	Moderate	Very High	Low	Low	Extremely resilient; limited biodiversity value
Gymnocladus dioicus (♂)	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Good heat tolerance; slow establishment
Koelreuteria paniculata	High	Moderate–Fast	Low	Moderate	High	Low	Moderate	Well adapted to Mediterranean cities; good ornamental value
Juglans nigra	Moderate	Moderate–Fast	High	High	Moderate	High	Moderate	Large size; allelopathic effects; needs space and water
Maclura pomifera (♂)	High	Fast	Low	Moderate	High	Moderate	Low	Very tough species; limited ecological and aesthetic value

Scientific name	Drought Tolerance	Growth Rate	Maintenance Needs	Shade Potential	Climate-Change Resilience	Root Aggressiveness	Biodiversity Value	Notes (Mediterranean context)
Melia azedarach	High	Fast	Low	High	High	Low–Moderate	Low	Heat-tolerant but invasive in some areas
Nyssa sylvatica	Low	Slow	High	Moderate	Low	Low	Moderate	Suffers transplant stress; unsuitable for dry climates
Phellodendron amurense (♂)	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Tolerates pollution; prefers cooler climates
Pinus halepensis	Very High	Moderate	Low	Moderate	Very High	Low	Moderate	Highly adapted Mediterranean pine; fire-sensitive management
Pistacia chinensis	High	Fast	Low	Moderate	High	Low	Moderate	Excellent drought tolerance; good autumn colour
Pyrus calleryana	High	Moderate–Fast	Moderate	Moderate	Moderate	Low	Low	Lifespan; limited ecological value
Quercus canariensis	Moderate	Slow–Moderate	Low	High	Moderate	Moderate	Very High	Requires some moisture; high biodiversity importance
Quercus cerris	High	Moderate–Fast	Low	High	High	Moderate	Very High	Well adapted; good resilience to heat and drought
Quercus frainetto	Moderate	Moderate–Fast	Low	High	Moderate	Moderate	Very High	Prefers deeper soils; valuable native oak
Quercus rotundifolia	Very High	Slow–Moderate	Very Low	High	Very High	Low	Very High	One of the best species for dry Mediterranean cities
Quercus trojana	High	Slow–Moderate	Low	High	High	Low–Moderate	High	Excellent drought tolerance; limited urban use so far
Quercus virginiana	Moderate	Moderate	Moderate	Very High	High	High	High	Excellent shade; needs space; aggressive roots
Robinia pseudoacacia	High	Fast	Low–Moderate	Moderate	High	High	Moderate	Drought tolerant but invasive; brittle wood
Styphnolobium japonicum	High	Moderate–Fast	Low	Moderate	High	Low–Moderate	Low–Moderate	Well adapted to heat; low habitat value
Tipuana tipu	Moderate	Fast	Moderate	Very High	Moderate	High	Moderate	Excellent shade; root conflicts common
Ulmus parvifolia	High	Fast	Moderate	High	High	Moderate	High	Good disease resistance; strong urban performer
Zelkova serrata	Moderate	Moderate–Fast	Moderate	High	Moderate	Moderate	High	Good structure; prefers some water availability

The “climate suitability” evaluation method

A. Species Distribution Modeling (SDM)

Based on:

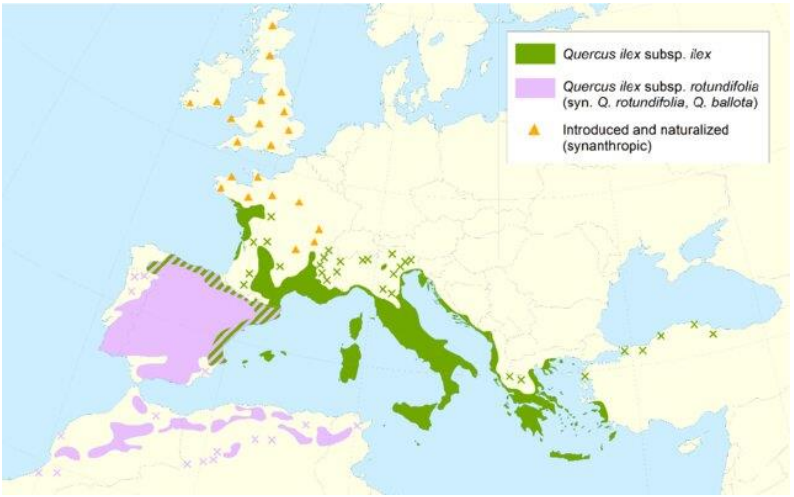
- global GBIF (Global Biodiversity Information Facility) data on species' natural ranges,
- CHELSA climate projections,
- key indicators:
  - **Mean Temperature of Growing Season (MTGS)**
  - **Climatic Moisture Index (CMI**), precipitation-to-potential evaporation ratio.

These indicators allow us to assess whether London's climate conditions in 2090 will be within, at the margins of, or outside the species' natural climate range.

Examples:

Betula pendula: outside the future climate range → **Vulnerable**.

Quercus ilex: fully within the range → **High suitability**.



B. Plant Trait Analysis

Three functional traits, from the TRY database and university studies:

- LDMC – Leaf Dry Matter Content (drought resistance)
- Wood Density (structural robustness, longevity)
- **Turgor Loss Point** (water stress tolerance)

These indicators help understand the "ecological personality" of species: acquisitive (fast but delicate) vs. conservative (slow but resistant).

C. Final Score (1–4)

The final value is the average of:

- climatic suitability (SDM)
- three plant traits

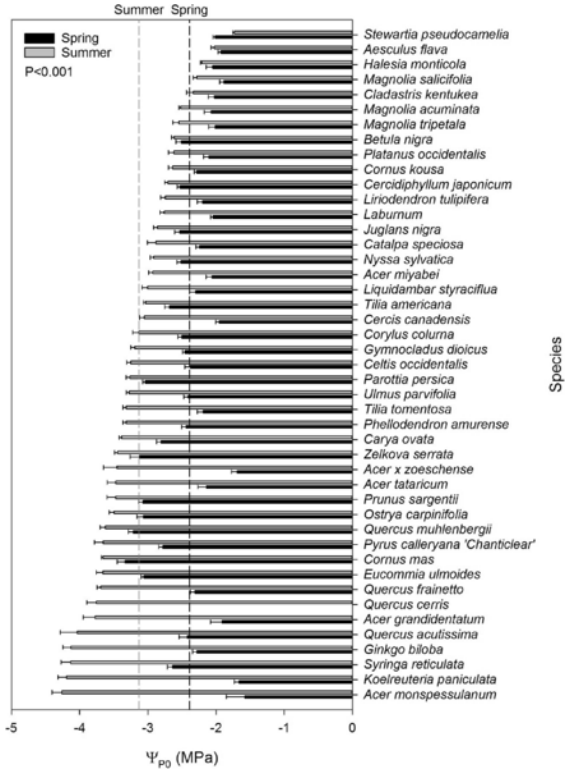
Final categories:

High Suitability (3–4)

Moderate Suitability (2–3, within range)

Low Suitability (2–3, but outside range)

Vulnerable (1–2)



Da Hirons, A. D. and Martin, K. W. E. (2025) Future climate suitability of London’s public realm trees. Urban Plant Lab.

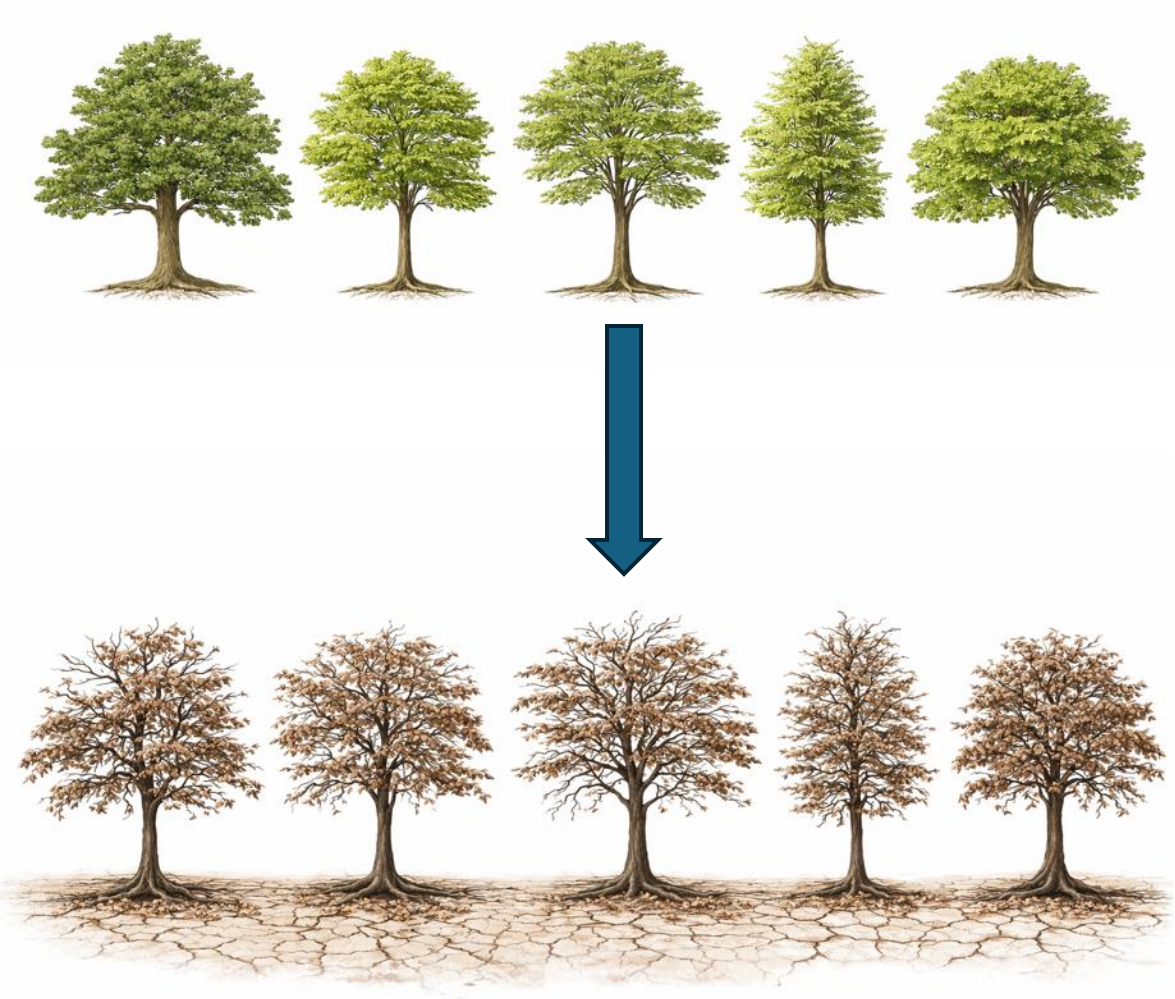
The main results: a critical but opportunity-rich scenario

Only 0.38% of London's trees are "highly suitable" for the 2090 climate.
Only two species emerge as fully compatible:
Quercus ilex (holm oak)
Parrotia persica

22% of trees are "moderately suitable."
Species that can function, especially if the optimal climate is selected:
Platanus × hispanica
Crataegus monogyna
Ginkgo biloba
Robinia pseudoacacia
several Asian birches

62% of trees are "low suitability."
Wide-spread species that will be severely stressed by the future climate:
Quercus robur
Acer platanoides
Acer pseudoplatanus
Carpinus betulus
Tilia × europaea

5.4% of species are "vulnerable."
Species at high risk of ecological failure:
Fraxinus excelsior
Prunus avium
Betula pendula
Tilia platyphyllos
Populus nigra



In total, 73% of London's public trees may not be suitable for the 2090 climate if nothing is done.

Species suited for the future

- The report offers a broad list of species with high or moderate suitability, many already present in London, others requiring further development.

Examples of promising species:

- ***Quercus ilex, Q. suber, Q. frainetto***
  - ***Arbutus unedo***
  - ***Ostrya carpinifolia***
  - ***Acer monspessulanum, Acer tataricum***
  - ***Gleditsia triacanthos***
  - ***Taxodium distichum***
  - ***Celtis australis***
  - ***Sorbus torminalis***

Tree species in urban environments

(Image created with AI – F. Ferrini, 2025)

A resilient selection is:

Climate-informed
Matching with climate analogues

Risk-assessed
Risk assessment

Climate-informed
Trait & provenance

1 CLIMATE ANALOGUES

Matching with climate analogues

Empirical selection of species / provenances suitable for the future climate

2 PROVENANCE / VARIABILITY

Genetic diversification to increase resllience

3 ASSISTED MIGRATION

Provenances better adapted to heat / drought

✔ Governance & risk monitoring

4 RISK ASSESSMENT

Invasiveness, phytopathologies, allergenicity

✔ EDRR estimates and programmes (Early Detection and Rapid Response)

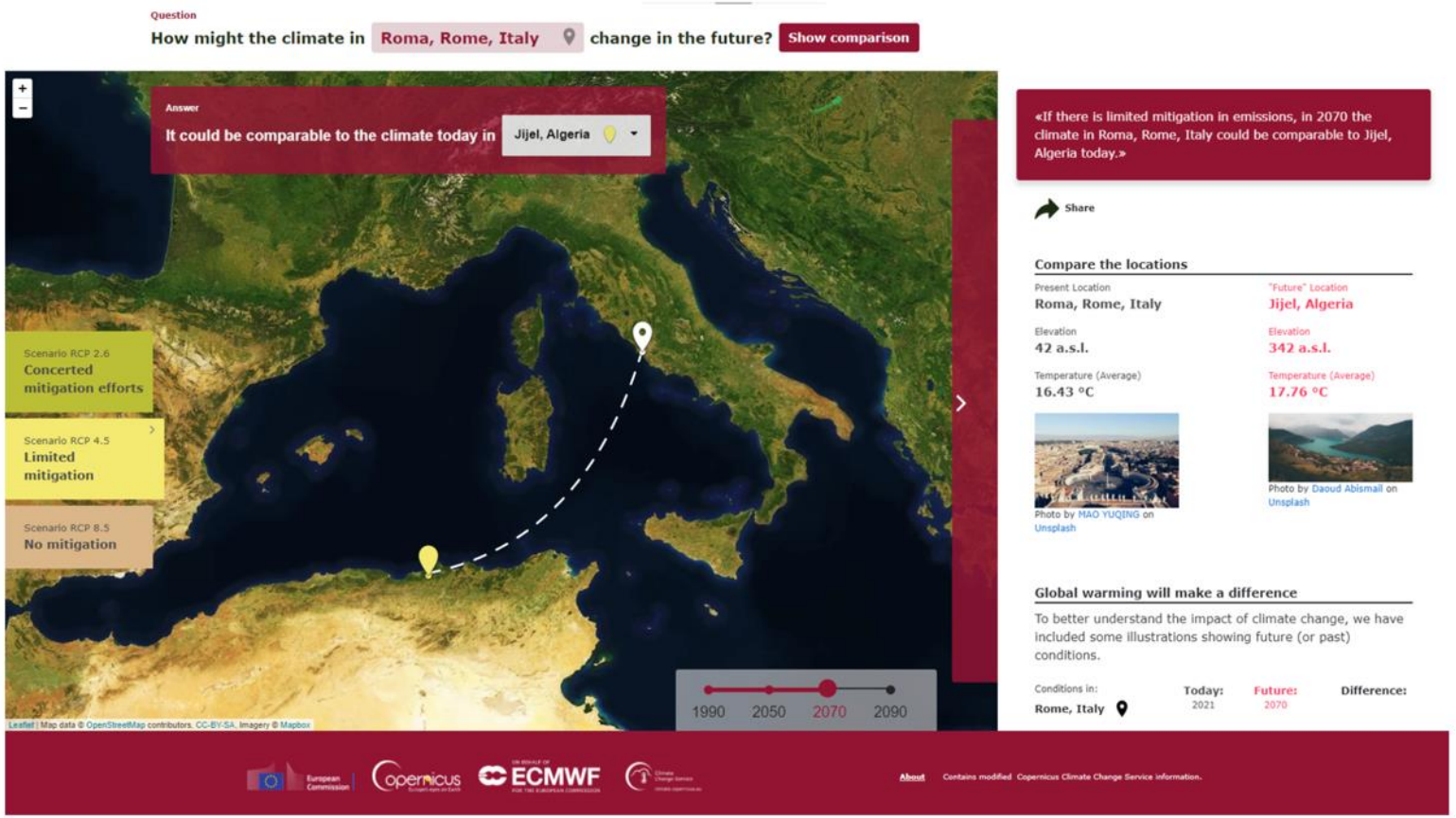
Decisions on tree species / provenience:

✔ Climate matching

✔ Traits & performance

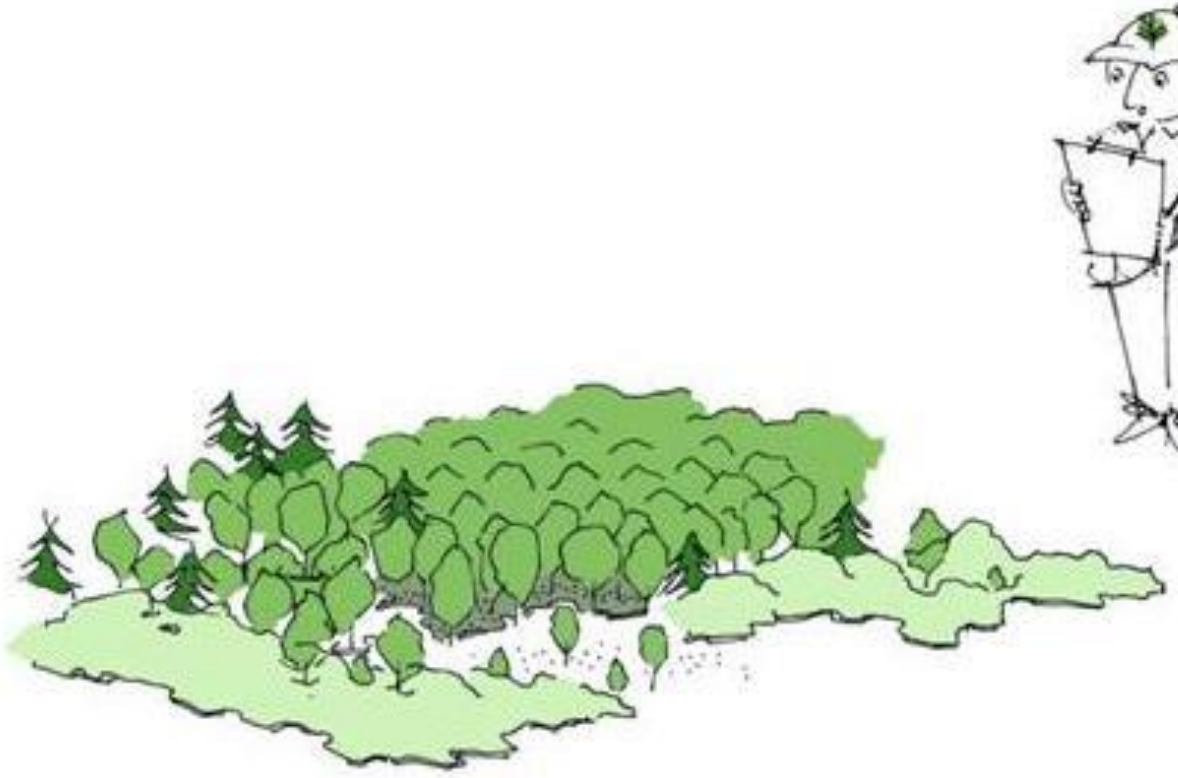
Future climate analogues for Italy

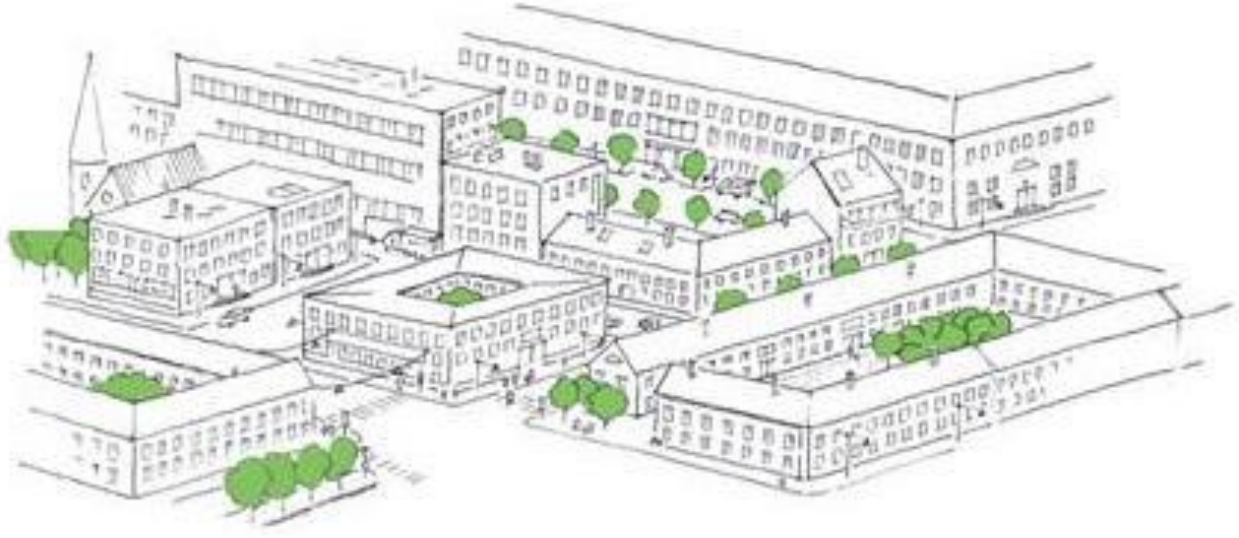
Current climates similar to those projected in Italy around 2050-2070*



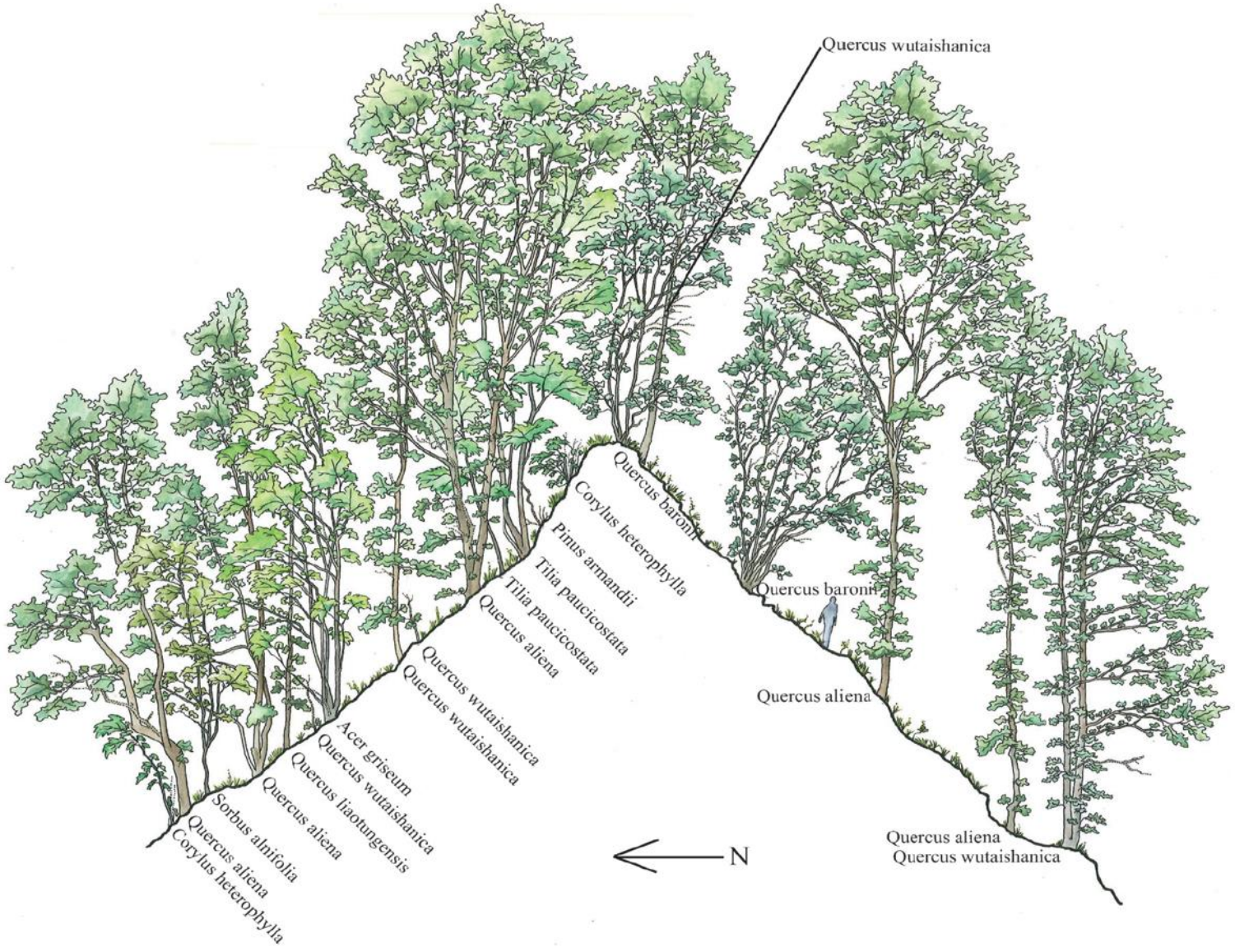
Screenshot from the Climate Analogues application, showing that in 2070, the climate of Rome (Italy) could be similar to the current climate of Jijel (Algeria).

Is knowing the original range of the species enough?





Profile illustrating the change in species composition and vegetation density from steep, south-facing slopes to shadier, wetter valley floor areas (from Sjoman, 2012)



Profile illustrating the change in species composition and vegetation structure between the south- and north-facing slopes (from Sjoman, 2012)

Carpinus betulus

Ostrya carpinofolia

Acer campestre

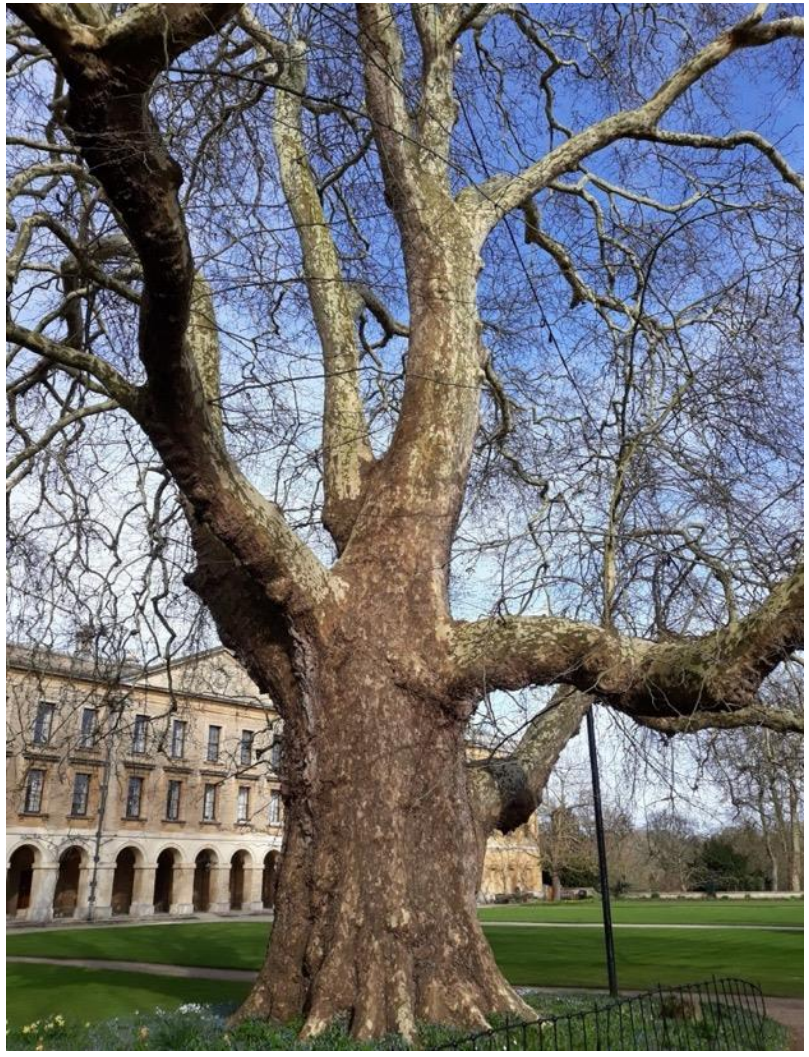
Acer monspessulanum

Platanus x acerifolia

Platanus mexicana

Quercus phellos

Nyssa sylvatica



Avoiding the unmanageable, managing the unavoidable

Avoiding the unmanageable, managing the unavoidable

Avoiding the unmanageable, managing the unavoidable

Avoiding the unmanageable, managing the unavoidable

https://www.regione.toscana.it/-/cocciniglia-tartaruga-a-pisa-aggiornato-il-piano-di-azione

https://www.alberosano.it/la-cocciniglia-tartaruga-un-grave-pericolo-per-i-pini/

https://www.parcoarcheologicoappiaantica.it/lavori-in-corso/il-parco-cura-i-suoi-pini-colpiti-dalla-cocciniglia-tartaruga/

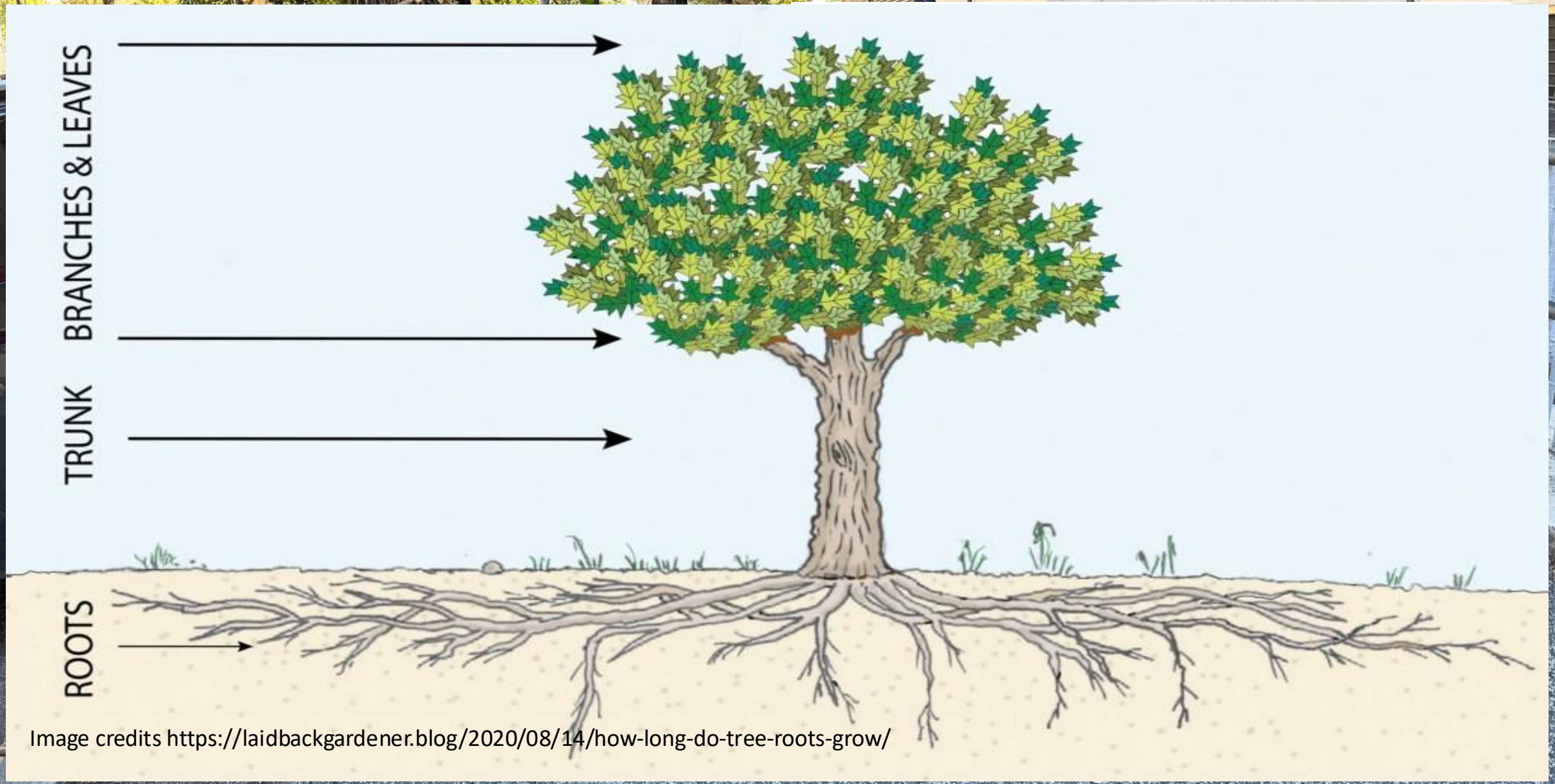
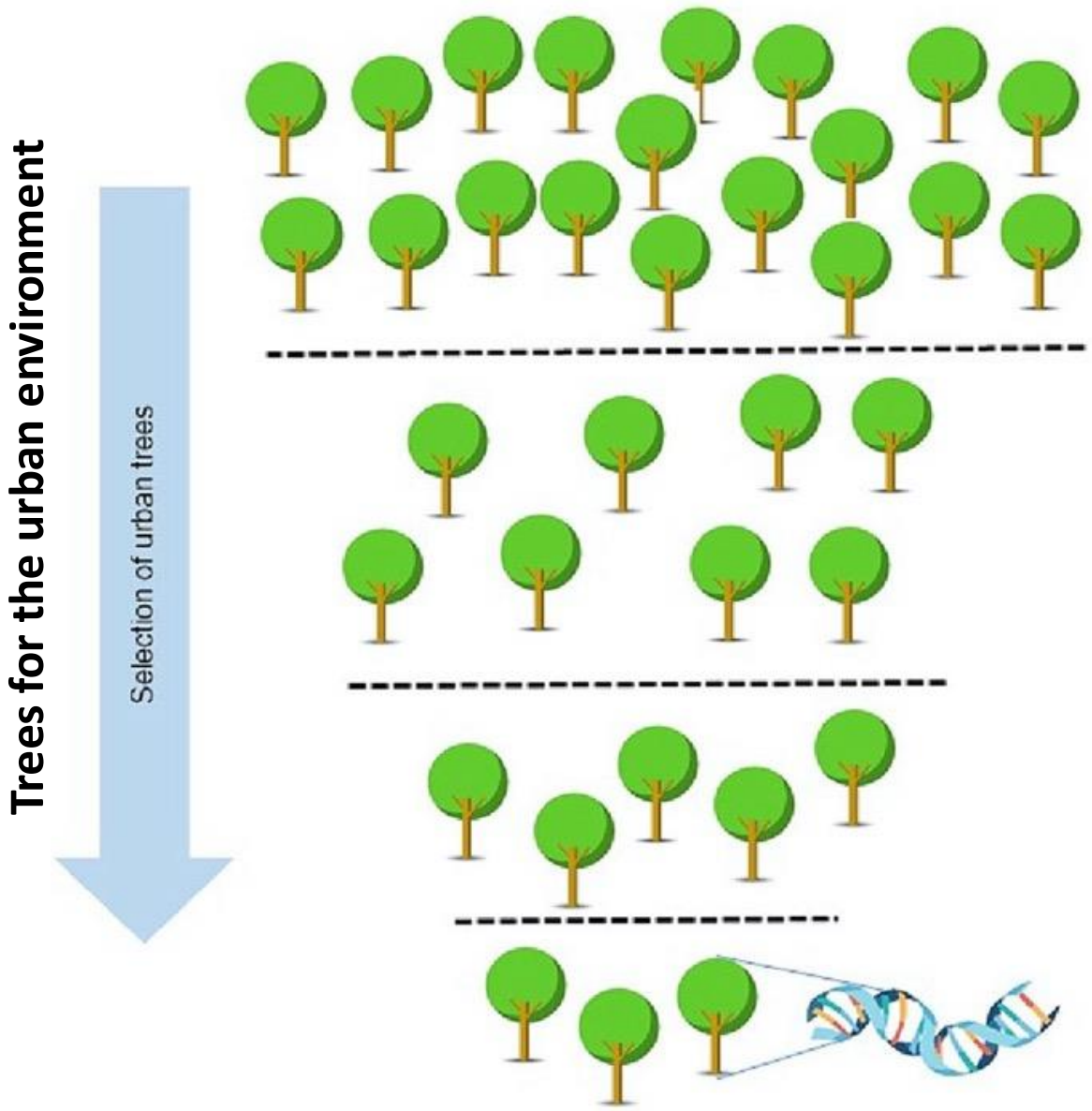


Image credits https://laidbackgardener.blog/2020/08/14/how-long-do-tree-roots-grow/

Avoiding the unmanageable, managing the unavoidable

Resilient trees for urban environments: the importance of intraspecific variation



Acer platanoides, Acer pseudoplatanus, Aesculus hippocastanum, Celtis australis, Fraxinus excelsior, Ginkgo biloba, Liquidambar styraciflua, Liriodendron tulipifera, Platanus x acerifolia, Populus spp., Quercus spp., Robinia pseudoacacia, Styphnolobium japonicum, Tilia cordata, Tilia x europaea, Tilia tomentosa, Ulmus spp.

Acer platanoides, Acer pseudoplatanus, Celtis australis, Ginkgo biloba, Liquidambar styraciflua, Liriodendron tulipifera, Populus spp., Quercus spp., Robinia pseudoacacia, Styphnolobium japonicum, Tilia cordata, Tilia x europaea, Tilia tomentosa

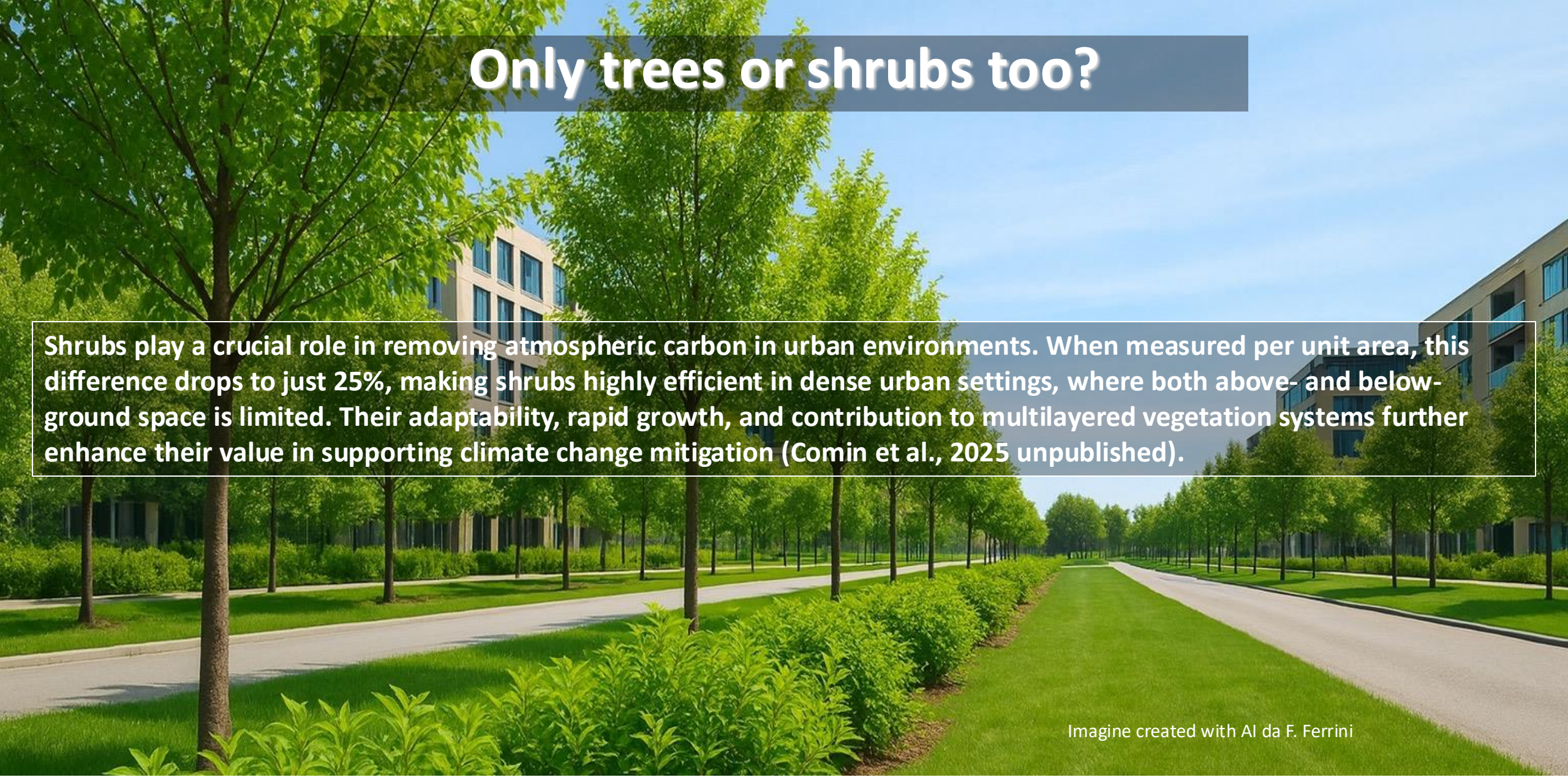
Celtis australis, Ginkgo biloba, Liquidambar styraciflua, Liriodendron tulipifera, Robinia pseudoacacia, Styphnolobium japonicum, Tilia cordata, Tilia x europaea, Tilia tomentosa

?

Fig da Sjöman et al., 2024, DOI: (10.1002/ppp3.10518)(modificata)

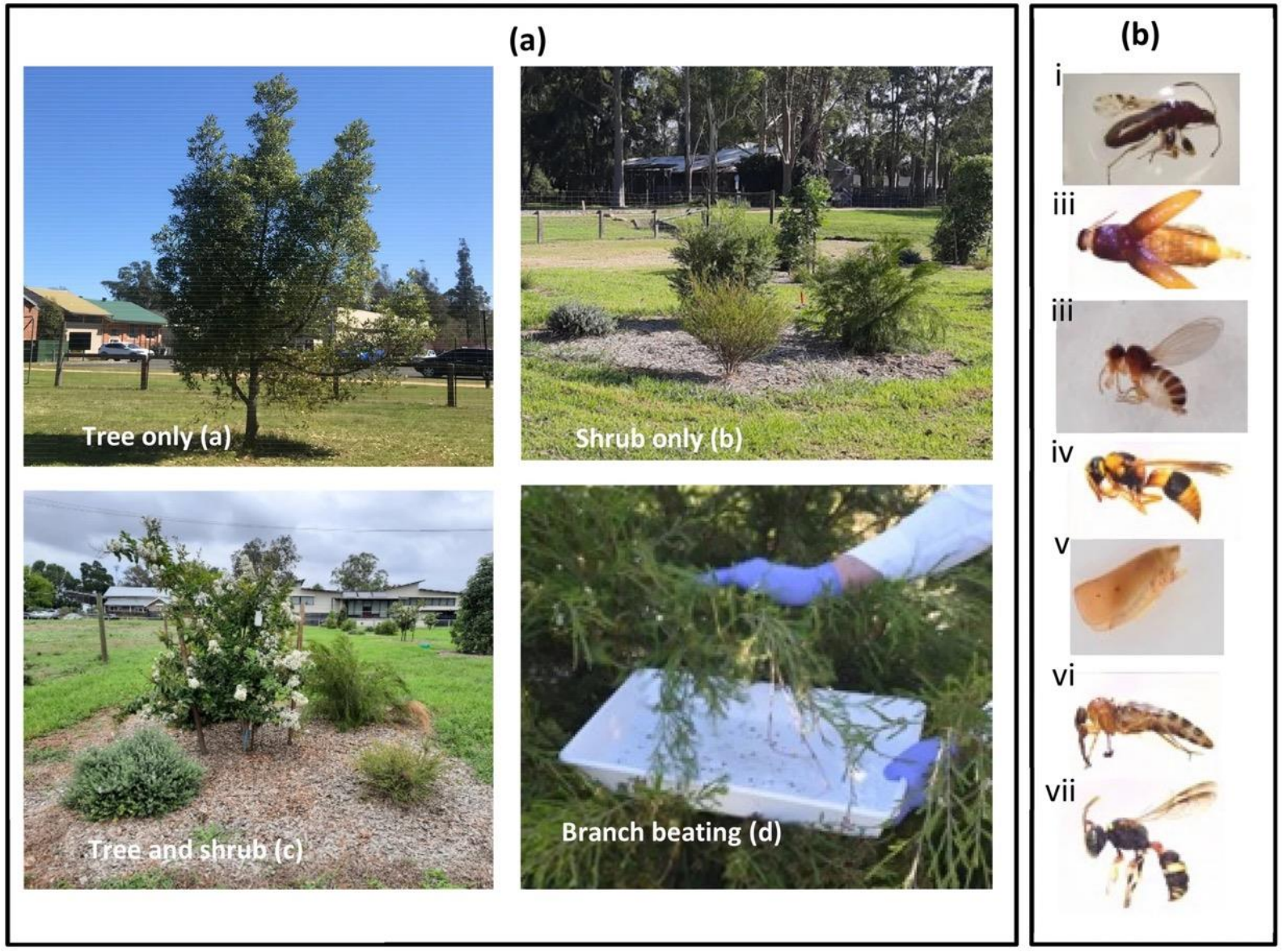
Only trees or shrubs too?

Shrubs play a crucial role in removing atmospheric carbon in urban environments. When measured per unit area, this difference drops to just 25%, making shrubs highly efficient in dense urban settings, where both above- and below-ground space is limited. Their adaptability, rapid growth, and contribution to multilayered vegetation systems further enhance their value in supporting climate change mitigation (Comin et al., 2025 unpublished).



Imagine created with AI da F. Ferrini

- **Shrubs, alone or combined with trees, support significantly more invertebrates** (both in terms of abundance and taxonomic richness) than tree-only plantings, thanks to their greater structural complexity and the presence of microenvironments closer to the ground.
- **Mixed tree-shrub plantings further increase the functional diversity of insects**, supporting groups such as herbivores, scavengers, predators, and pollinators; this is linked to greater canopy volume, greater leaf area, and a greater likelihood of flower availability.
- **The presence of shrubs creates vertical continuity between the ground and the canopy, facilitating invertebrate movement** and increasing access to trophic resources and refuges, with a positive effect on tree-associated communities as well (from Sharmin et al., 2024 - https://doi.org/10.1038/s41598-024-58909-8)

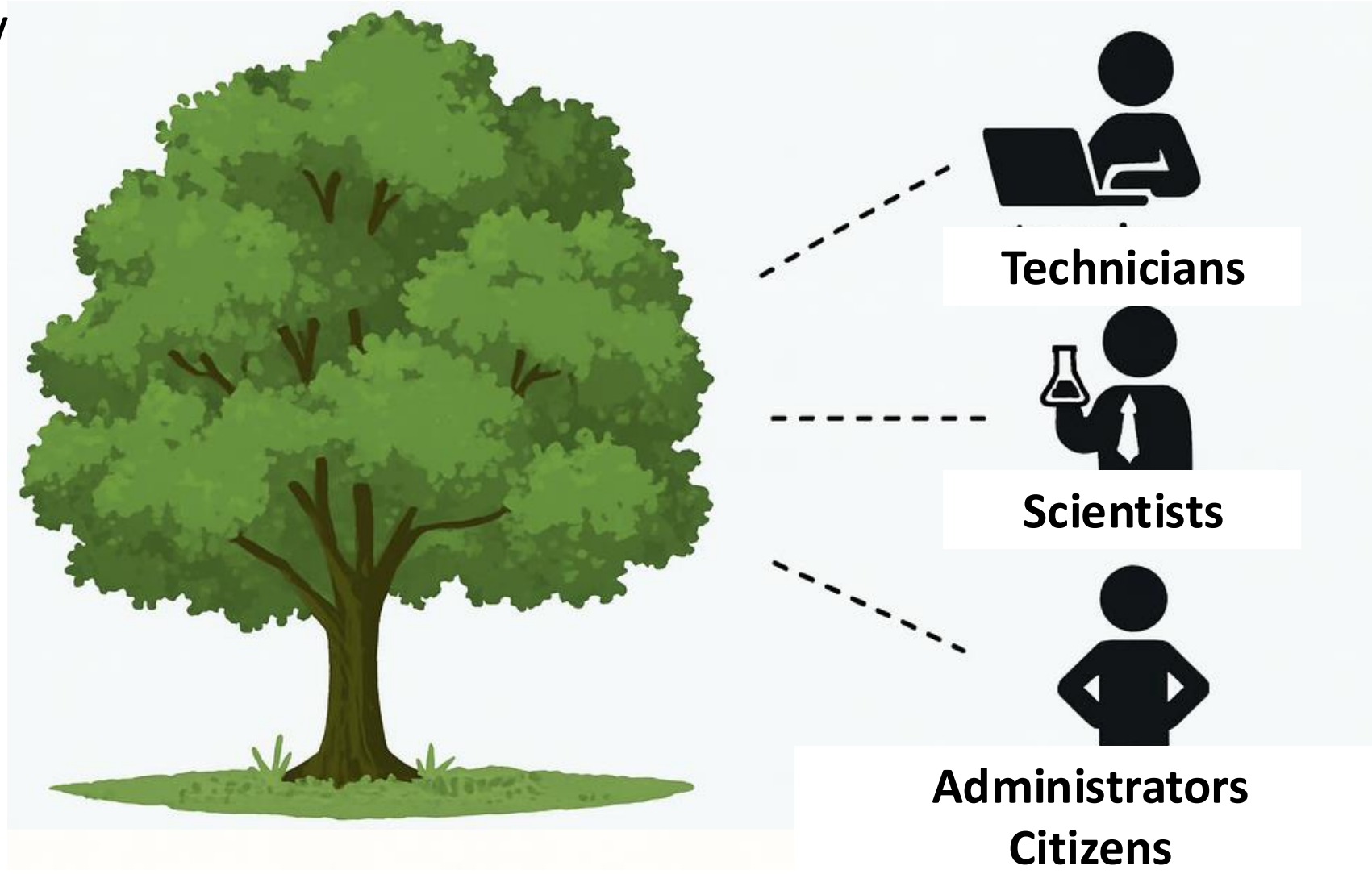


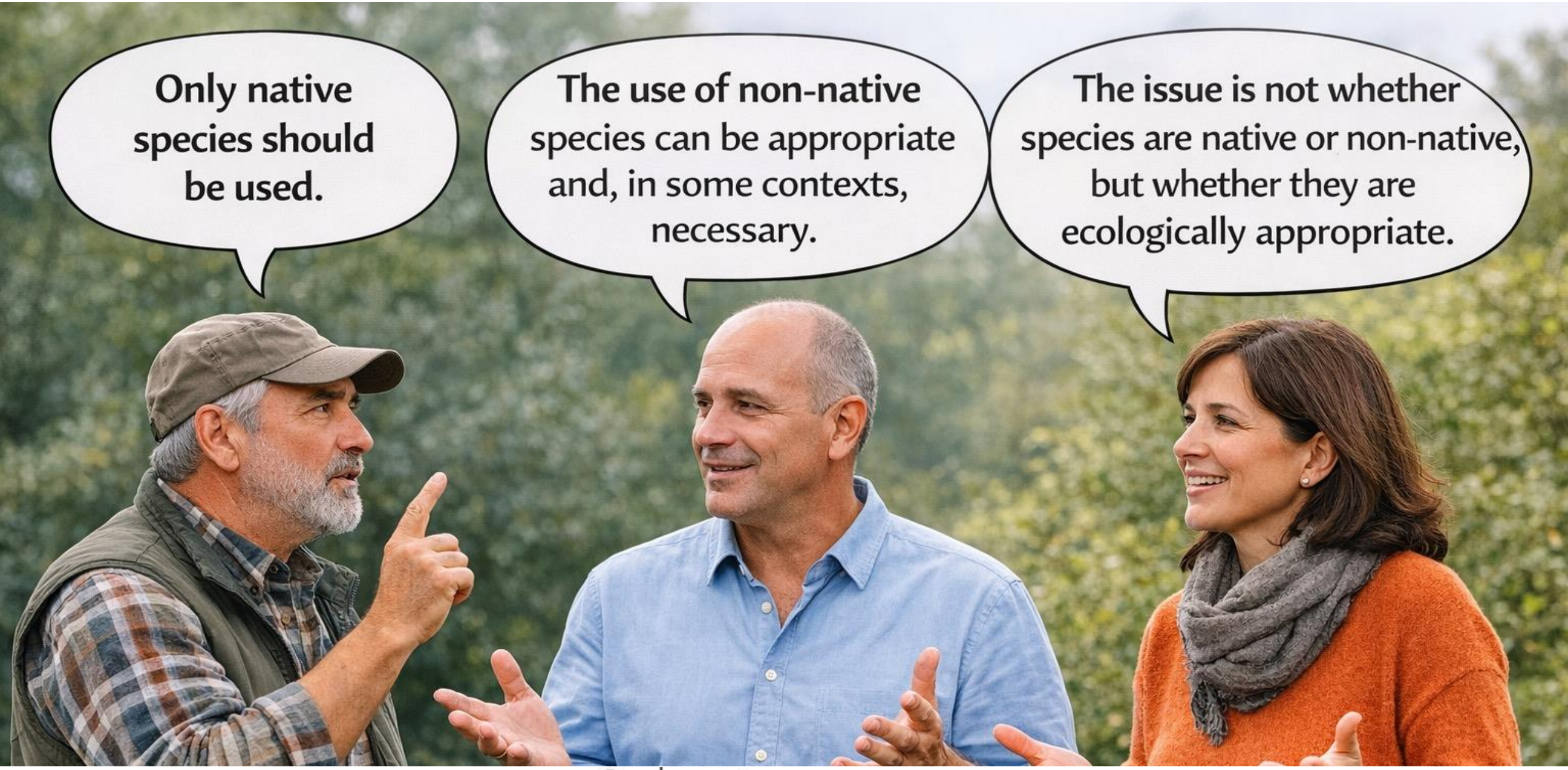
Conclusions and key messages

- Urban greenery as an ally for urban resilience.

- Need for an interdisciplinary approach (technicians, scientists, administrators, citizens).

- "Beyond paradigms": greenery not as a static image, but as a dynamic process.




Only native species should be used.
The use of non-native species can be appropriate and, in some contexts, necessary.
The issue is not whether species are native or non-native, but whether they are ecologically appropriate.