We can’t plant our way out of the climate crisis

TREEIB®

HOW TO MAKE URBAN TREES MORE RESILIENT

Ing. Martin Tušer

UTOI president, Chief Researcher and Business Development Director TREEIB®

October 3, 2022

RESILIENT CULTURAL LANDSCAPES - METHODS, APPLICATIONS AND PATTERNS

KRAKÓW

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Send your guess to chat:

HOW MANY TREES

do we have to plant
to replace

ONE LARGE TREE?

TODAY:

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LARGE TREES HOW TO HELP

HOW TO MAXIMIZE ECOSYSTEM SERVICES PRODUCTION

WATCH THE VIDEO ON THE CONFERENCE WEBSITE (2021):
Norbert Kühn, Technical University of Berlin, To a better Resilience of Urban Street trees in Central Europe: which trees will we plant in the future?

Today we celebrate the trees that we will not be able to grow in the future anymore.

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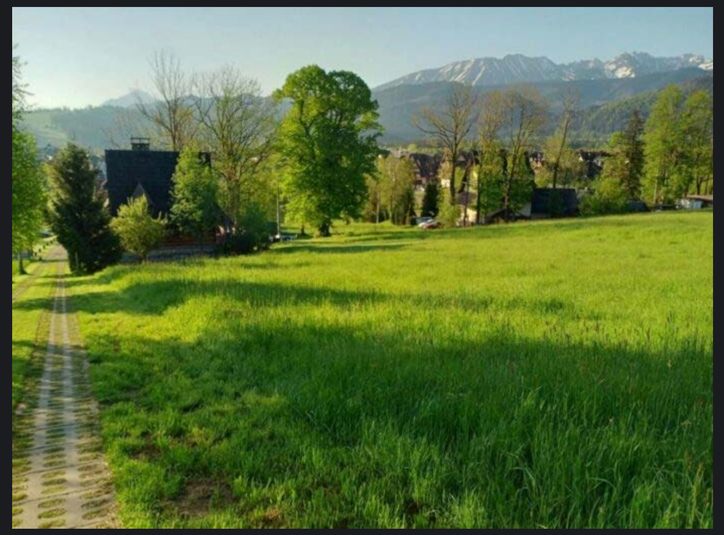
Dąb Dunin



Lipa w Zakopanem

EVERYONE MUST SHIFT THEIR PARADIGM

Large trees provide **significantly more ecosystem services** (including carbon sequestration) than small trees. This relationship is not linear, but rather **exponential.**

At the same time, we are no longer able to routinely grow large trees in cities.

In October 2020, a new study (1) was published by a team of world-leading scientists, including William R. Moomaw, Professor Emeritus of International Environmental Policy at the Fletcher School, Tufts University. He is the lead author of the Nobel Prize-winning Intergovernmental Panel on Climate Change. "A recent study examining carbon storage in forests in the Pacific Northwest found that although large-diameter trees (≥21 inches) account for only **3%** of the total number of stems, they contribute **42%** of the total above-ground carbon storage. The researchers stress the importance of protecting large trees and strengthening existing forest management policies so that large trees can continue to sequester carbon and provide valuable ecosystem services as a cost-effective natural solution to climate change in forest ecosystems worldwide."

Mildrexler David J., Berner Logan T., Law Beverly E., Birdsey Richard A., Moomaw William R. (2020). Large Trees Dominate Carbon Storage in Forests East of the Cascade Crest in the United States Pacific Northwest , USA. Frontiers in Forests and Global Change, 3/2020, PAGES=127, https://www.frontiersin.org/article/10.3389/ffgc.2020.594274
DOI=10.3389/ffgc.2020.594274 ISSN=2624-893X

According to various sources (2), the **lifespan of trees in cities is 7-28 years**, which is very short and does not give trees the chance to provide the ecosystem services they could. The annual mortality rate of trees in cities is estimated at a maximum of 9%, or an annual tree survival rate of more than 91%. This study does not include any information on how trees grow. Unfortunately, **most newly planted trees in cities grow very slowly**.

(2) Roman, Lara & Scatena, Frederick. (2011). Street tree survival rates: Meta-analysis of previous studies and application to a field survey in Philadelphia, PA, USA. Urban Forestry & Urban Greening - URBAN FOR URBAN GREEN. 10. 269-274. 10.1016/j.ufug.2011.05.008.
https://www.researchgate.net/publication/238003598_Street_tree_survival_rates_Meta-analysis_of_previous_studies_and_application_to_a_field_survey_in_Philadelphia_PA_USA

Dr. William Moomaw is one of the 5 authors of the **World Scientists' Warning of a Climate Emergency**

He defined a new term, **PROFORESTATION**, which points to the great potential for carbon storage and sequestration by allowing existing trees to grow to their full ecological potential.

A video explaining his philosophy, which we identify with, is here. It's interesting throughout, the link goes to the 18 minute mark when it refers to large trees.
https://youtu.be/Wl9Z_miGBNw?t=1093

Another interesting video:
https://youtu.be/Vru9MWE0drM

Planting new trees is very important but will not solve the climate emergency. A newly planted tree in a city is **carbon neutral after about 30 years.**
Moreover, there is **not infinite space** for planting trees in cities, and it is very common that trees can no longer be planted in place of a felled tree (conflict with utility grids).
Instead of large crown trees, smaller to small cultivars are planted whose supply of ecosystem services is already **genetically limited**.

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HOW MANY TREES

do I have to plant to replace

ONE LARGE TREE?

Time to review your answers from chat

CARBON STORED

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Red oak (Quercus Rubra)
Height: 30 m
DBH: 136 cm

DBH: 31 cm Height: 15,2 m Age: 29	DBH: 15 cm Height: 12,2 m Age: 16	DBH: 10 cm Height: 7,62 m Age: 10	DBH: 5 cm Height: 3 m Age: 7	DBH: 2 cm Height: 1,37 m Age: 3
OAKS NEEDED	OAKS NEEDED	OAKS NEEDED	OAKS NEEDED	OAKS NEEDED
35	150	465	3 068	48 061

WE WERE LOOKING FOR AN ANSWER TO THE QUESTION:

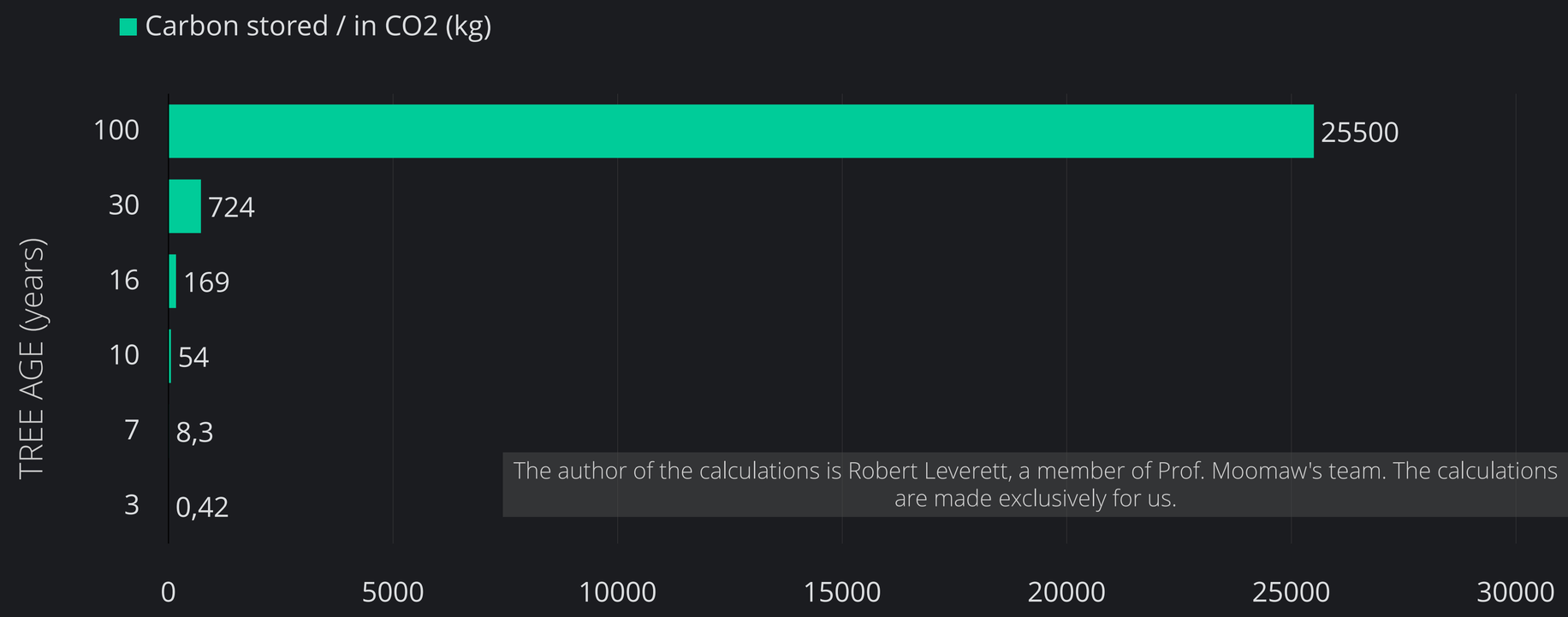
HOW MANY TREES DO I HAVE TO PLANT TO REPLACE ONE BIG TREE?

The whole article
www.treeib.com

Carbon stored in 1 tree by tree age, equivalent to CO2

TREEIB

The planting of about 3 068 seven-year-old trees (those planted in cities) or 48 061 three-year-old trees can be considered as a full replacement of a large tree.
If the wood of the initial tree is burnt, this figure must be doubled. If we include the carbon footprint of other associated activities, e.g. planting, etc., we can even get to a figure of 10 000 trees per large one.



The author of the calculations is Robert Leverett, a member of Prof. Moomaw's team. The calculations are made exclusively for us.

WE WERE LOOKING FOR AN ANSWER TO THE QUESTION:

HOW MANY TREES DO I HAVE TO PLANT TO REPLACE ONE BIG TREE?

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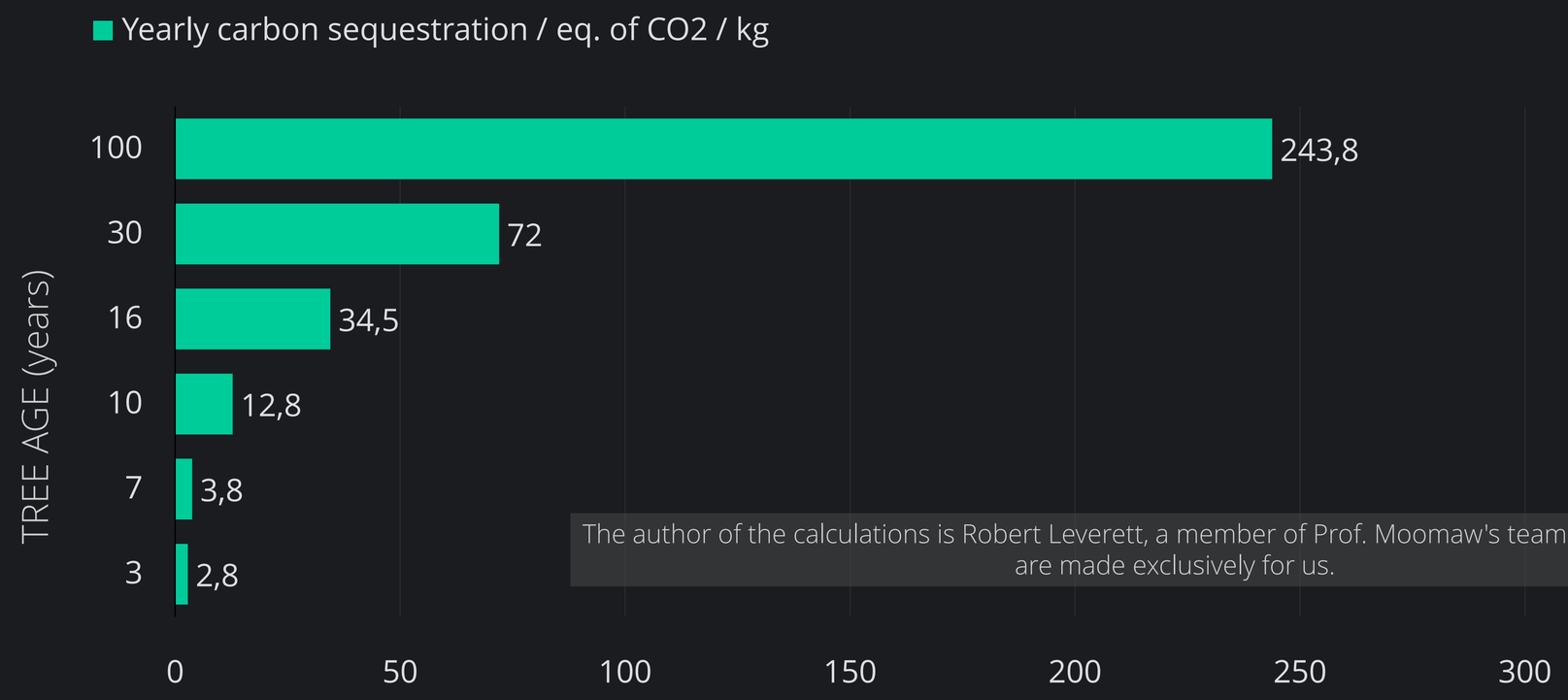
Annual carbon sequestration by tree age, converted to CO2

It no longer takes that many trees to fully replace a large tree in terms of carbon sequestration, but the numbers are still high. The point is that there simply isn't room for those numbers. It is often the case that we can no longer plant a new tree where there was a big old tree. Replacement planting is done somewhere outside the city. If we count on the trees to grow immediately after planting, which is usually not the case, we need, for example, 64 seven-year-old trees or 3.4 thirty-year-old trees.



The author of the calculations is Robert Leverett, a member of Prof. Moomaw's team. The calculations are made exclusively for us.

BUT: IT ALL DEPENDS ON THE GROWTH OF THE TREE.

This model calculation somewhat lowers the standard growth of a large tree (a conservative assumption) and increases the growth of a young tree. UTOI works on the basis of real data measured in the field. The above is a model case.

WHAT COULD BE THE RESULTS

if we start supporting our existing green infrastructure

The tables below show how the amount of carbon sequestered (converted to CO2) varies depending on how the tree grows. If we can significantly improve the growth of the tree, the carbon sequestered could be significantly higher than it is now without care.

Examples are given by calculating the first two largest trees from the previous graphs. Calculated based on the FIA-COLE model by Robert Leverett. Values from the previous graph are marked in purple.

It is important to note that each tree species sequesters carbon at a different rate. These calculations are all for red oak.

Oak tree, approx. 100 years old, height 30,5 m, trunk diameter 136 cm

Annual sequestration / CO2 equivalent/ kg	Annual increment of trunk diameter / mm	Annual height gain / m
101,50	1	0,03
243,79	2,413	0,07
364,10	4	0,07
390,20	4	0,1
477,10	4	0,2
728,10	5	0,4

Oak, age about 30 years, Height 15,2 m, trunk diameter 30,5 cm.

Annual sequestration / CO2 equivalent/ kg	Annual increment of trunk diameter / mm	Annual height gain / m
13,82	1	0,1
73,83	6,35	0,3
89,70	8	0,3
115,57	8	0,8
128,90	12	0,3
415,23	12	0,6

IS PLANTING NEW TREES IN CITIES A GOOD SOLUTION TO THE CLIMATE CRISIS?

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How Green Are Trees? — Using Life Cycle Assessment Methods to Assess Net Environmental Benefits

https://meridian.allenpress.com/jeh/article/34/4/101/80299/How-Green-Are-Trees-Using-Life-Cycle-Assessment

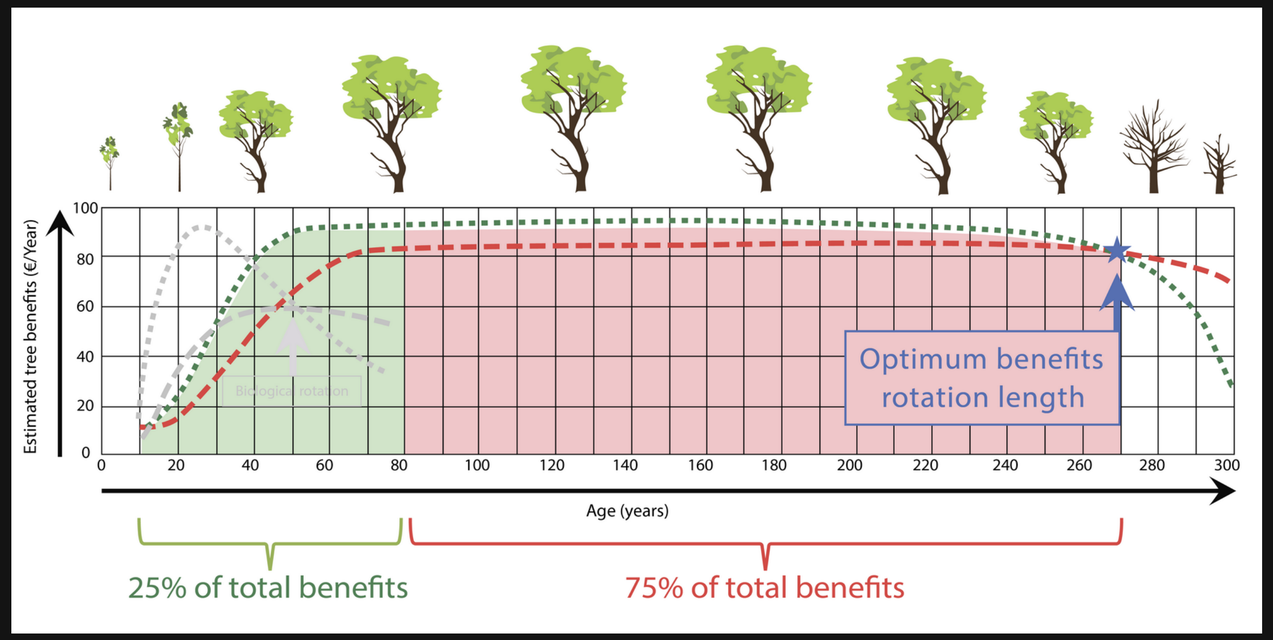
A newly planted city tree is CARBON NEUTRAL after

26-33 years

Aaron C. Petri, Andrew K. Koeser, Sarah T. Lovell, Dewayne Ingram; How Green Are Trees? — Using Life Cycle Assessment Methods to Assess Net Environmental Benefits. Journal of Environmental Horticulture 1 December 2016; 34 (4): 101–110. doi: https://doi.org/10.24266/0738-2898-34.4.101

CONCLUSION: **NOT REALLY A GOOD SOLUTION**

Our opinions are supported by others around the globe



JEREMY BARRELL

Jeremy has spent his entire career caring for trees and promoting a pragmatic approach to their conservation in the built environment. His passion is writing and he regularly gives talks and seminars to other professionals and enthusiasts around the world.

Jeremys BIO:
https://www.barrelltreecare.co.uk/assets/Uploads/J-Barrell-CV.pdf

barrell TREE CONSULTANCY

Simplified representation of one approach to estimating **the optimal rotation period of trees in urban environments**. It is based on the **financial benefits** that trees provide. It is a concept that is based on estimated values. It demonstrates the principle, the reality in different places may of course be different. Because of the different local conditions, it is therefore important to treat the illustration with caution and not to enforce it across the board, always and everywhere.

According to forest management theory, the optimum time to fell a tree/stand is the time when the curve of annual actual growth and average annual growth intersect (grey color). It is called **the clearing maturity** and in this example it is 51 years.

If we extrapolate this principle to the **urban environment**, ignoring timber production and focusing on other, more important benefits that trees provide to people in the city, the curves change. The current annual benefit (green) and the average annual benefit (red) intersect **at about 270 years** of age (blue arrow). **Felling an urban tree at age 80 will only deliver 25% of the total potential (potential) benefits (green area) that the tree could deliver if it were not felled. We can also say that 75% of the benefits that the tree can provide are lost due to premature removal.**

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70% of problems with city trees is caused by lack of water

Klaus Körber
Bayerische Landesanstalt für Weinbau und Gartenbau

POOR OR INEFFECTIVE WATERING TECHNIQUES FOR ESTABLISHED TREES

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NATURALLY DEVELOPED ROOT SYSTEM OF AN 8 YEAR OLD TREE

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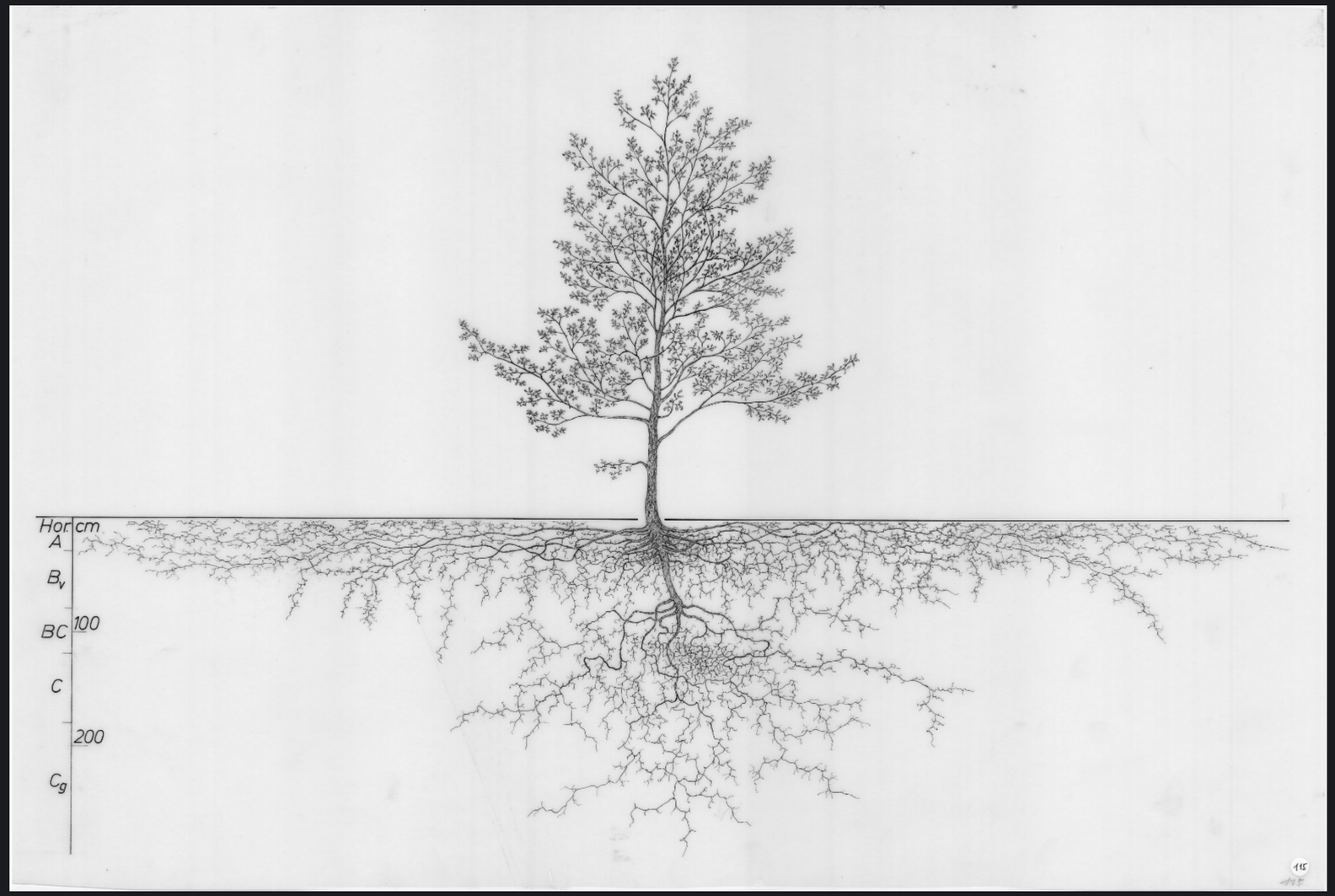

Quercus Robur:

Height: 3,8 m
Root diameter: 9,8 m
Root depth: 2,8 m

Kutschera, L.; Lichtenegger, E., Wurzelatlas mitteleuropäischer Waldbäume und Sträucher. - Graz, Stuttgart : Leopold Stocker Verlag, 2002 (2. Aufl. 2013). - 604 p.

Wageningen University & Research Image Collections

RESULTS OF BAD WATERING TECHNIQUES

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Salt Lake City lost 50 000 trees in the windstorm in September 2020 because of regular lawn irrigation, which caused shallow rooting

Confirmed by the local ISA ARBOR Chapter

WHY WE SHOULD WATER ESTABLISHED TREES IN DIFFERENT WAY?

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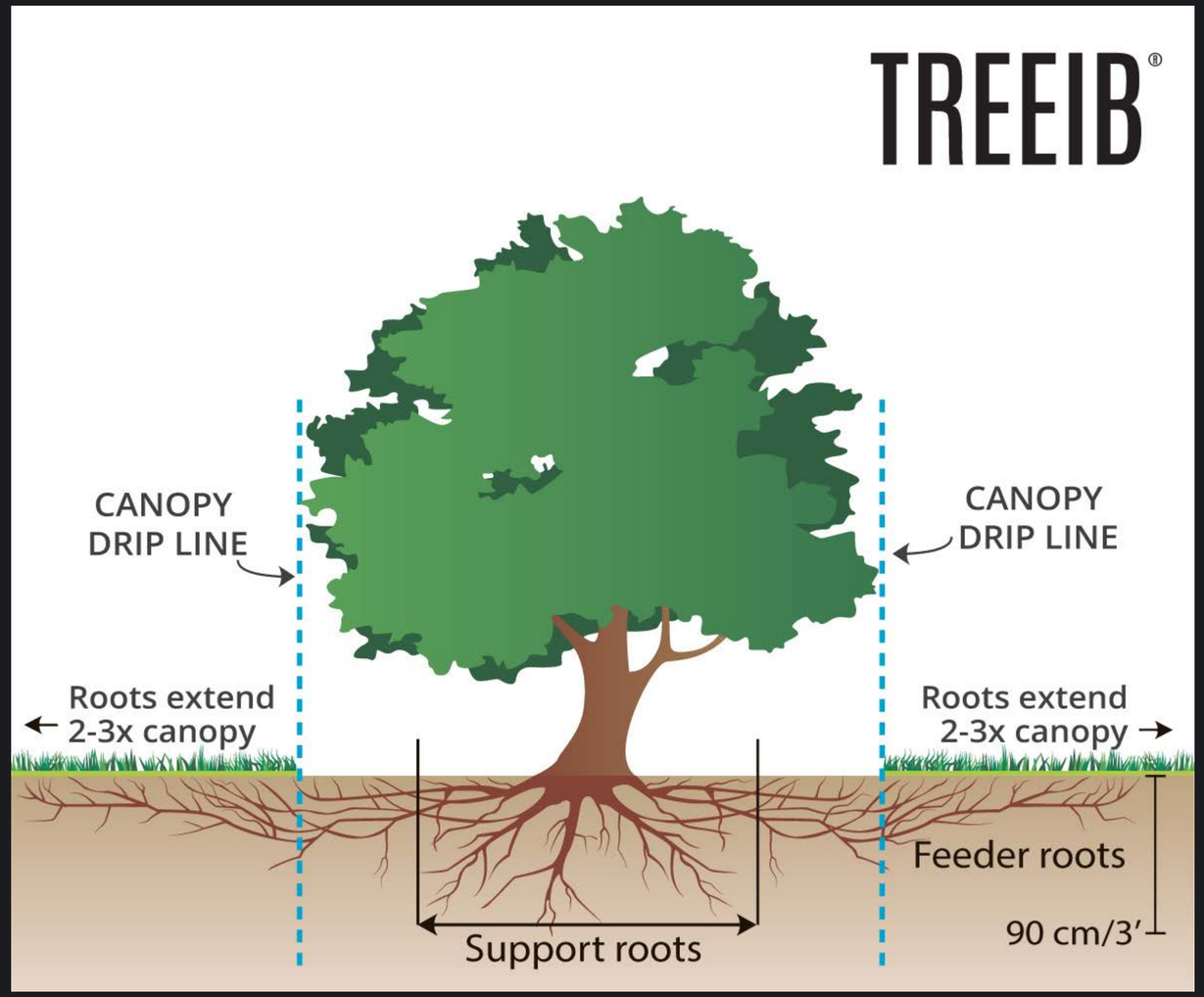

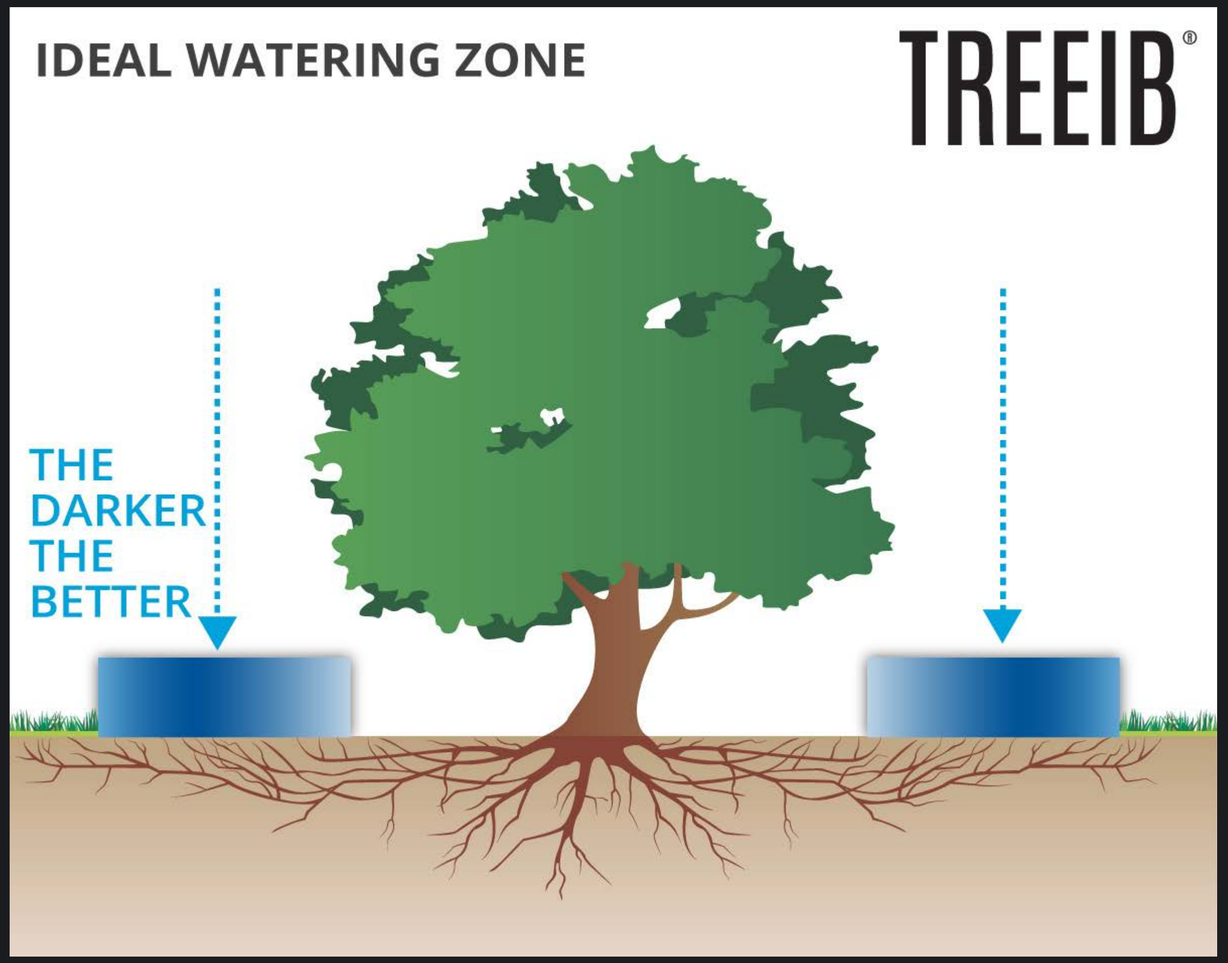

WHAT IS THE BETTER WAY OF WATERING?

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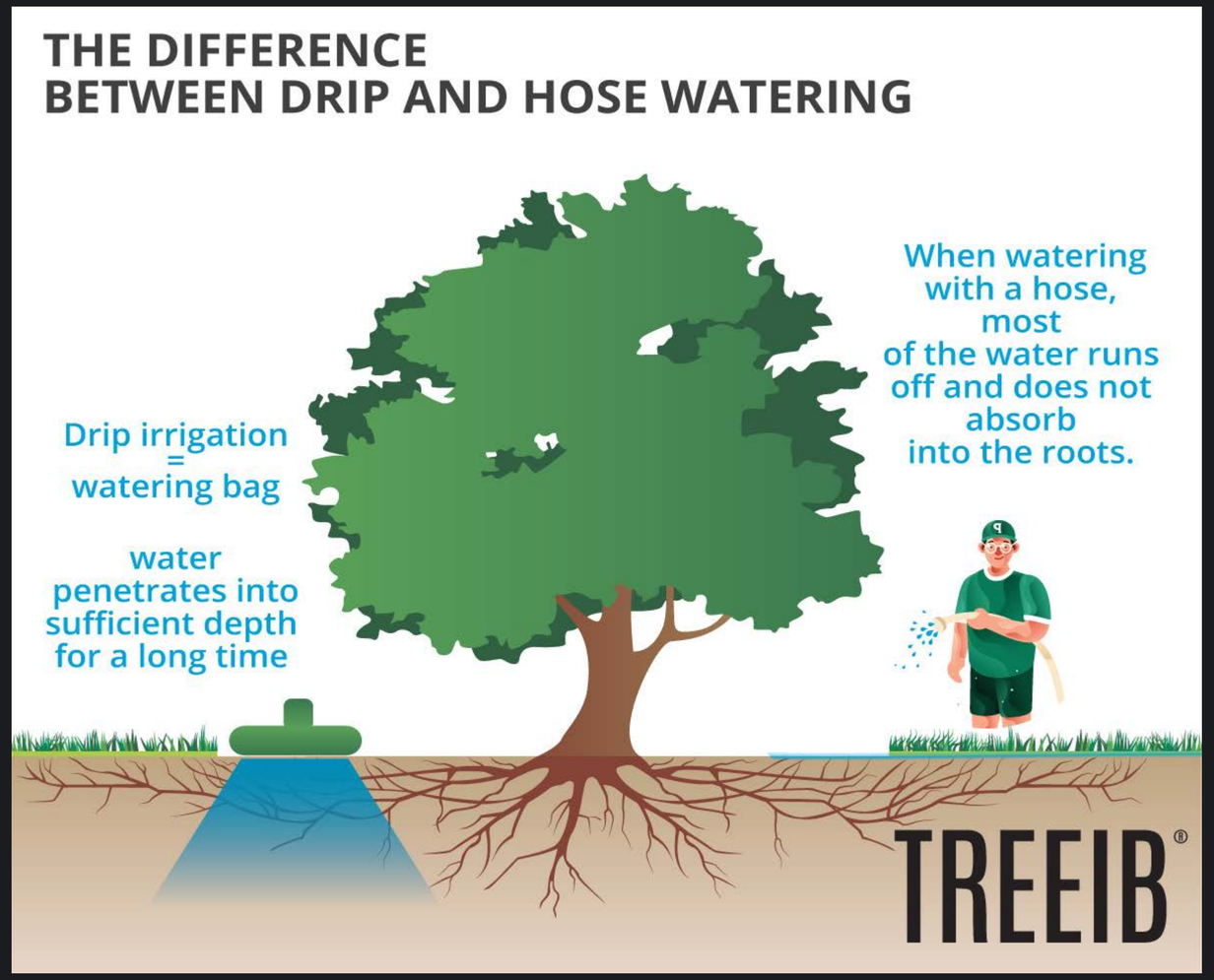

WHAT IS THE SHALLOW ROOTING?

TREEIB®

DANGEROUS!
Watering a large tree too often with a small amount of water, as when watering a lawn, e.g. with a sprinkler.

TREEIB®

TODAY
Tree with naturally shaped root system.

1-3 YEARS LATER:
A tree with a deformed root system, that roots just below the surface and not firmly anchored in the ground. It is susceptible to drought.

The root system of a tree can be extensively modified after just one year. Frequent presence of water only near the surface is a threat to the tree.

THE ROOT SYSTEM OF THE TREE CAN MOVED/BE DEFORMED VERY QUICKLY

TREEIB®

DANGEROUS!
Watering the tree near the trunk or under the canopy,
unless there is a legitimate reason to do so.

TODAY
Tree with naturally shaped root system.

1-3 YEARS LATER:
A tree with a deformed root system, that roots just below the surface and not solidly anchored in the ground. It is susceptible to drought.

3-5 YEARS LATER:
The tree loses its stability and is susceptible to uprooting by wind. It is not at all drought-resistant, if we stop watering.

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PROACTIVITY IS IMPORTANT!

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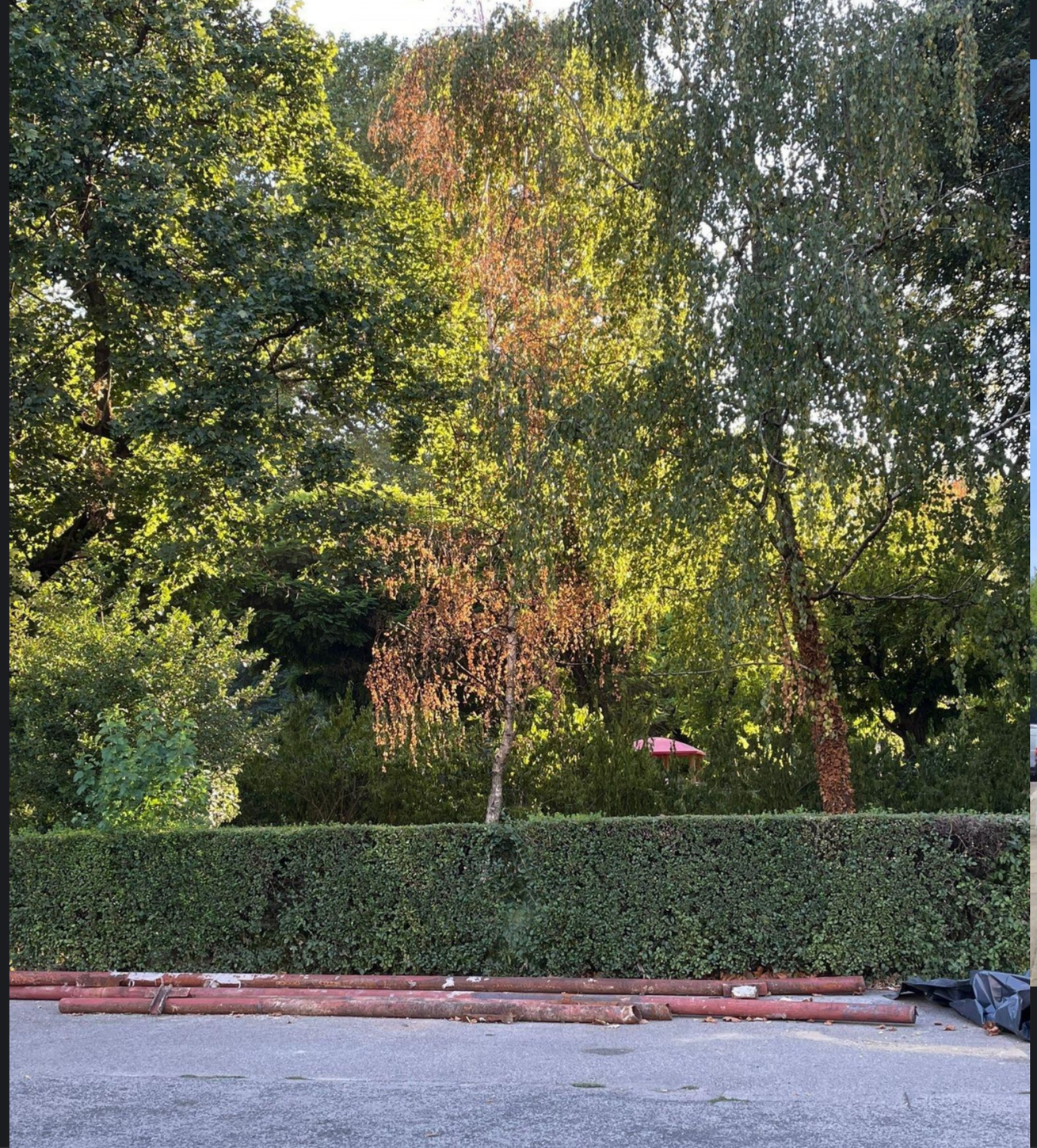


WE DEVELOPED
A SET OF TOOLS
for watering large/mature/established trees

TREEIB® is:

The only portable **non-invasive** watering system and method for mature trees in the world, which is usable **SAFELY** in large scale in the urban landscape.

the method and the product, which maximizes tree survival rate and, above that, **maximizes ecosystem services** provided by trees, based on science.

A patent pending method and product

TREEIB® STRATEGY

TREEIB®

Survival of mature trees is crucial, but it is not enough!

In drought periods, we try to keep the trees from dying. But this is only a partial solution to what we need in times of climate change:
TO MAXIMISE ECOSYSTEM SERVICES WHILE MAINTAINING THE TREE'S LONG-TERM PERSPECTIVE with reasonable costs.

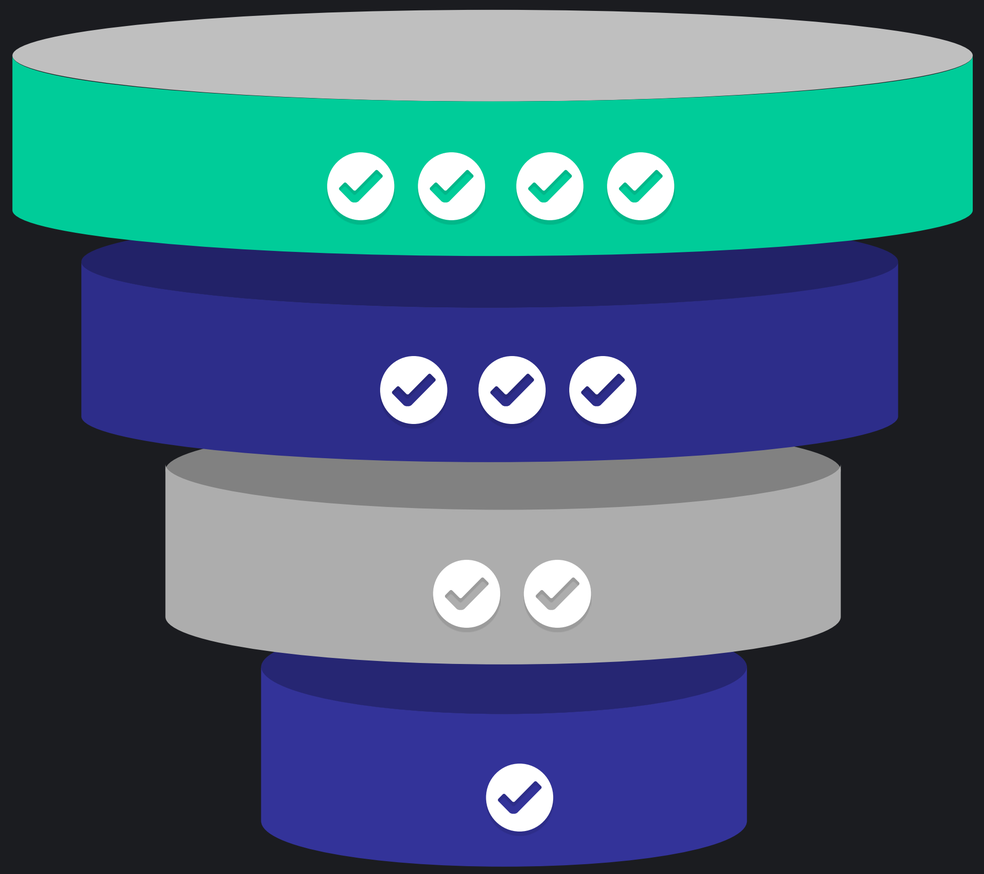
THIS REQUIRES A STRATEGIC APPROACH.

4 — MAXIMISING ECOSYSTEM SERVICES
Promoting the maximum benefits of trees.

3 — VITALITY
Maintaining and expanding the root system so that the tree has a long-term perspective, sufficient leaf area and is not susceptible to collapse due to any stress.

2 — SAFETY
Maintaining the tree stability by maintaining the correct shape and extent of the root system.

1 — SURVIVAL
Simple tree preservation.



THE RIGHT METHODOLOGY

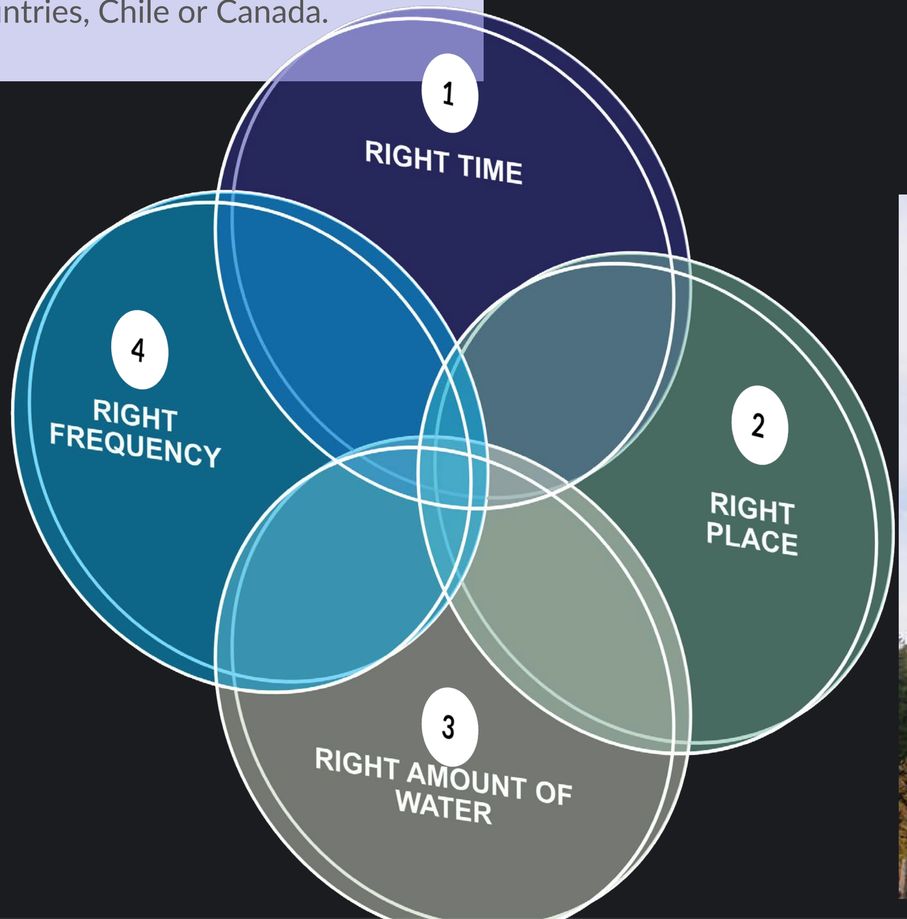
The right way how to water mature trees, based on the current science knowledge

TREEIB®

based on **tree physiology**

secures **trees long-term safety**

We gathered the latest scientific knowledge on tree physiology, developed our methodology and tested it for 3 years with very positive results.
Now this method is used in EU countries, Chile or Canada.



The results:

TREEIB® METHODOLOGY

TREEIB®

Whenever the substrate temperature is above

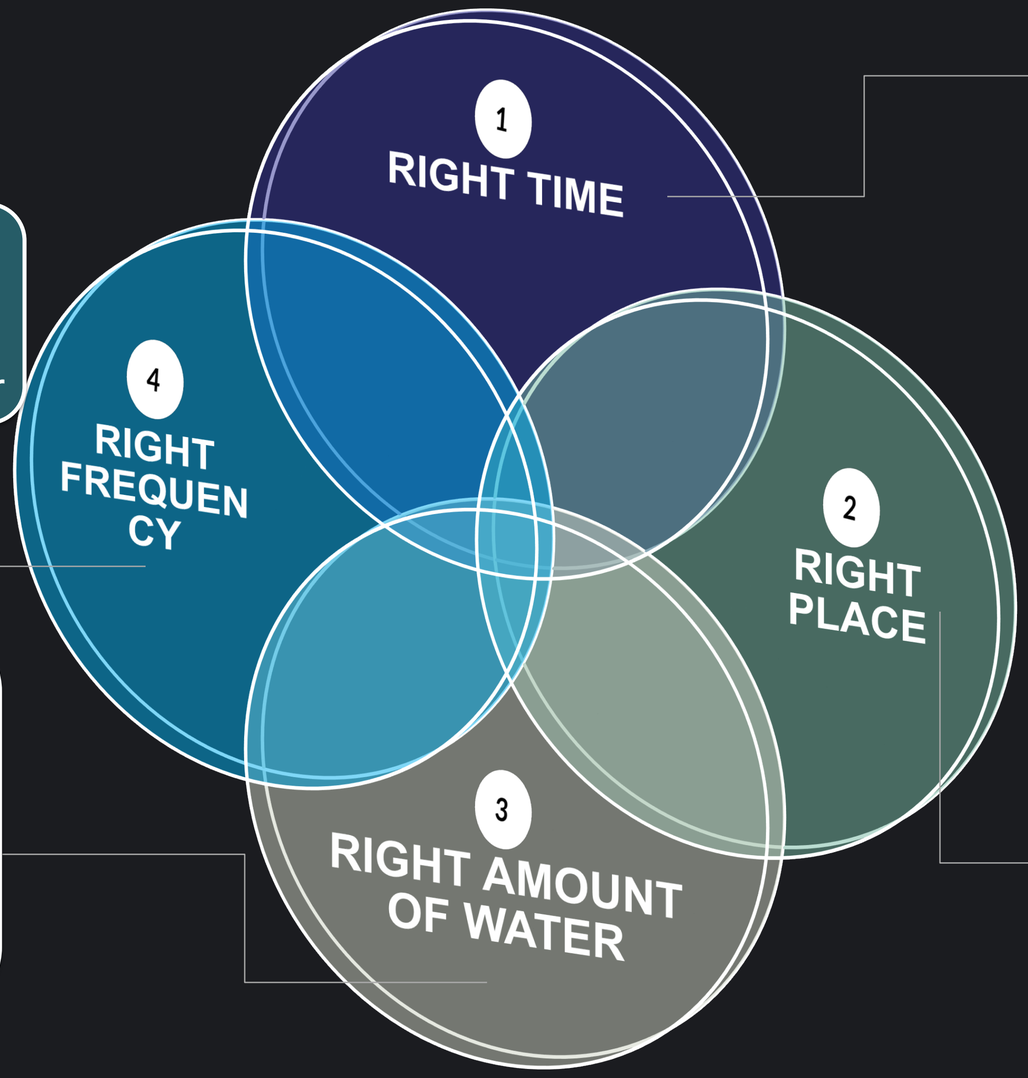
6°C/42°F

an adequate amount of water must be accessible to the tree with possible irregularity to prevent die off the feeder roots.

So that soil gas exchange is possible and shallow rooting of the tree is prevented.

4-5 times per year

The soil must dry out so that the root system does not become lazy. Vertical soil hydraulics is restored, as we cannot replace all the water the tree needs.



Enough to replace evapotranspiration volume for a minimum of 10 days

800-9,000 liters/

211-2,400 US gal.

A sufficient volume of water must reach a minimum depth of 60 cm / 2 ft.

Where we want the roots to be

On and beyond the canopy dripline

The extent and shape of the root system should be close to the natural shape of the root system of the taxon.

1

THE RIGHT TIME

When temperature of the soil is above

6°C/42°F

OBJECTIVE:

The tree has the largest root system as possible, including feeding roots. **Do not disrupt the growth cycle by root dieback and maximizing the tree growth.**

The biomass of the leaves corresponds approximately to that of the fine roots. If we want to generate enough nutrients over the growing season, we need to have as much fine root biomass as possible.

It is widely acknowledged that soil temperature is one of the primary factors affecting plant growth. In fact, soil temperature could be even more important than air temperature, because it usually lags behind (although it tracks) air temperature in spring (1). On the other hand is supports incorporate autumn mature tree irrigation into yearly tree management routine because vice versa soil temperature in autumn mornings is usually higher then air temperature.

The roots, unlike the leaves and other parts of the tree, grow all year round, especially in spring and in autumn (3). If the soil temperature drops below 41-42°F (1),(2), growth stops. The main condition of the tree roots grow in this period is water availability in the soil. If there is not enough water in the soil, the already grown fine roots die. The growth potential of the tree is lost, as well as the nutrients stored in the fine roots.

The root grow during spring has different function against root grow in autumn. When in spring the root system grows to secure enough nutrients and water for developing the tree foliage and blossoming, in autumn the root grow secure depositing of metabolites (like starches) to their tissue. This energy is saved for the spring grow spurt of tree in the next season.

Therefore, in general, we recommend watering in the following scheme:

- very early spring, before the leaves appear
- during the rapid growth phase in spring, at flowering period
- in summer to overcome dry periods (maximum once a month)
- in autumn to keep the feeding roots alive until the temperature drops

(1) Pregitzer, Kurt & King, John & Burton, Andrew & Brown, Shannon. (2000). Responses of tree fine roots to temperatue. New Phytologist. 147. 105-115. 10.1046/j.1469-8137.2000.00689.x.

(2) ALVAREZ-URIA, P. and KÖRNER, C. (2007), Low temperature limits of root growth in deciduous and evergreen temperate tree species. Functional Ecology, 21: 211-218. https://doi.org/10.1111/j.1365-2435.2007.01231.x

(3) Montagnoli, Antonio & Dumroese, R. Kasten & Terzaghi, Mattia & Onelli, Elisabetta & Scippa, Gabriella & Chiatante, Donato. (2018). Seasonality of fine root dynamics and activity of root and shoot vascular cambium in a Quercus ilex L. forest (Italy). Forest Ecology and Management. 10.1016/j.foreco.2018.06.044

2

THE RIGHT PLACE

Where we want the roots to be
On and beyond the canopy dripline

OBJECTIVE:

The tree has the largest a root system as possible, including stabilization roots. Safety and stability of the tree.

The tree root system is a dynamic system, which can move quite rapidly. Thats why we recommend watering trees on / beyond the canopy dripline.

- Longevity of the roots of the first order is relatively short (about 90% less than 1 year(1)) and the FO roots grow, where water and nutrients are available. It means that FO roots can move to the source of water or nutrients within one year. We have a documented observations of the fact.
- If the tree is watered near the trunk, within a short time the roots of the first order form close to the trunk and the others gradually disappear. As the FO roots form higher order roots that stabilise the whole tree, in the medium term the higher order roots further away from the trunk die and the stability of the tree is threatened.
- Deformation of the root system also occurs when the lawn and trees are watered together. This was well demonstrated, for example, in Salt Lake City during the September 2020 windstorm. The city lost tens of thousands of large trees in a matter of hours. According to a written statement from the local ISA-ARBOR chapter that we have access to, this was a direct result of lawn irrigation where trees rooted shallowly and became
- Watering close to the trunk or under the crown, as well as applying / injecting fertilizers to the same area, cause tree instability.
- This can be avoided if the tree is watered beyond the crown, where we naturally maintain/expand the root system similar to the natural environment. Even trees that are in a paved sidewalk should be watered beyond the canopy dripline.

(1) Huo, C., and Cheng, W.. 2019. Improved root turnover assessment using field scanning rhizotrons with branch order analysis. Ecosphere 10(8):e02793. 10.1002/ecs2.2793

3

THE RIGHT AMOUNT OF WATER

Enough to replace evapotranspiration volume for a minimum of 10 days
211-2,400 US gal.

OBJECTIVE:

Deep rooting. Safety and stability of the tree. Restoring vertical soil hydraulics.

Depending on their size, trees can evapotranspire up to 200 gallons of water per day. We recommend an irrigation rate of at least ten times the daily evapotranspiration volume.

- Although values may vary between taxons, as well as between individuals of the same species in different locations, it can generally be said that 90% of feeding roots are found at depths of up to 40 cm/16 inch (1).
- The soil must be moistened to at least this depth to prevent shallow rooting. There are not many ways to get water to such a depth, even in the dry season.
- The only way that is practically applicable is large irrigation doses applied by drip irrigation.

(1) Meinen, Catharina & Leuschner, Christoph & Ryan, Nicholas & Hertel, Dietrich. (2009). No evidence of spatial root system segregation and elevated fine root biomass in multi-species temperate broad-leaved forests. Trees. 23. 10.1007/s00468-009-0336-x.

4

THE RIGHT FREQUENCY

So that soil gas exchange is possible and shallow rooting of the tree is prevented.

4-5 TIMES a year

OBJECTIVE:

Maintaining the soil gases exchange. Making watering of trees economically accessible. Avoiding tree collapse in case of watering interruption.

- The presence of oxygen in the soil and the overall exchange of gases between the soil and the atmosphere is a factor that influences the growth and health of the tree. If the soil water content increases, the soil gas content decreases and vice versa. Overall, we should aim to keep the soil gas/moisture ratio as close to 'normal' as possible. This means that the soil substrate needs to dry out from time to time to allow the exchange of gases (1).
- ✓ We consider it completely pointless and dangerous for established trees to be watered every day or even once a week. This is appropriate for newly planted trees, not for the established ones.
- ✓ We have set an initial test frequency of 4-5 times per year for irrigation dose of mature trees in our test plot with minimum volume of 10x estimated evapotranspiration volume. After four years, we can say that this frequency has proven to be sufficient and very beneficial. We have verified experimentally that water applied with our product in heavy soil penetrates to a depth of 2-3 feet and moistens the entire soil profile.
- The above mentioned frequency minimizes the risk we lose the tree if the watering is not possible from any reason. The root system of the tree is still robust enough to get supply water and nutrients to the tree.

(1) Poorter, H., Niklas, K.J., Reich, P.B., Oleksyn, J., Poot, P. and Mommer, L. (2012), Biomass allocation to leaves, stems and roots: meta-analyses of interspecific variation and environmental control. New Phytologist, 193: 30-50. doi:10.1111/j.1469-8137.2011.03952.x

THE PRODUCT

TREEIB®

OBJECTIVE:

To develop a product range, which can provide tree watering according to the scientific evidence mentioned before. To develop a product, which is safe for the tree and for the investor, visually acceptable, durable and usable in large scale in urbanized environment.

- To start with product information click here: PRODUCT
- To see how the products look like in use click here: GALLERY
- To see our results and information of the testing plot click here: RESULTS
- To see how we solved security for the tree and the owner click here: SAFETY
- To see the custom design options click here: COLORS and CUSTOM PRINT

TREEIB®

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