Examination of the condition of the oldest trees in the Buda Arboretum

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1. Abstract

The Buda Arboretum is one of the richest plant collections in Hungary, located in the heart of Budapest, at the southern foot of Gellért Hill. The arboretum was initiated in 1893-94, now the garden covers 7,5 hectares and it surrounds the buildings of Buda Campus of the University of Agriculture and Life Sciences. The yearly precipitation is about 600 mm, to which 150-200 mm of irrigation water is added during the vegetation period. The soil is a strongly eroded humus carbonate or brown forest soil and contains lime and clay. The content of active calcium is high, the pH is alkaline, around 8.

Our study aimed to examine the old trees in the garden, understand their overall health, and develop optimal tree care recommendations to ensure their long-term life. The ecosystem services of the old tree individuals are far higher than that of young trees. A mature, more than a hundred-year-old tree with a large crown brings us as much benefit as 200-400 young individuals. The oldest trees in the arboretum are 120-130 years old. Among these champion trees, the following three species appear *Carya cordiformis* (Wangenh.) K. Koch, *Fagus sylvatica* L. 'Pendula', *Parrotia persica* C.A. Mey. We examined one individual of each three species with the following method: measuring the physical parameters of the trees (the size and height of the trunk and the crown); investigating the health condition of the trees with an instrumental wood investigation with Arborsonic 3D Acoustic Tomography (Fakopp 3D). We evaluated the results by applying a five-step tree condition assessment method of the European Union, especially concerning the effects of climate change.

We found that most of the examined trees are in relatively good condition, but they have more dry branches in their crowns and more lairs in their trunk.

Maintaining the garden's tree population is a priority, and this is helped by the fast and professional tree care interventions, which is also due to the fact that the garden is also the practical site for tree care training. 2021 was a record year for detailed instrumental tree surveys, with 11 3D acoustic tomographs measuring at the same time. Accurate analyses will help to determine precise treatments in the long term.

Keywords: arboretum, maintenance of old trees, visual tree examination, instrumental tree examination, climate change

2. Introduction

The oldest trees in the Buda Arboretum have gone through storms of change in history and the environment during their long lives. They suffered a lot from the Second World War, as the garden was the scene of severe fighting during the siege of Budapest, traces of bullets and fragments can be found on many old tree trunks, and many of them carry shards of war, bullets, and pieces of metal.

The old trees have also undergone a change in their environment over their long lives as our summers have become warmer and drier, with very little winter rainfall in the last 10 years.

In the course of our work, we examined the health status of the oldest trees of the Buda Arboretum, how they react to environmental changes, what interventions and tree care work we can use to prevent possible injuries and damage and to preserve the life of the trees to decorate our garden as much as possible. We selected three old trees from the champion trees, these are: *Carya cordiformis* (Wangenh.) K. Koch, *Fagus sylvatica* L. 'Pendula', *Parrotia persica* C.A.Mey. An important aspect of the trees selected for the study was to choose from the oldest specimens and, if possible, species or varieties from which similarly old specimens are rarely found in Hungary: for example, the examined *Parrotia persica* is the oldest specimen of this species living in Hungary. Examination of the hanging-branched *Fagus sylvatica* 'Pendula' also yielded data for a variety that, in spite of its hanging habitus, was grafted into the root collar.

The role of trees in the urban environment is significant because of their climatic effects, they are also important in ecological and townscape ways. Alleys are linear elements that connect green spaces in urban areas, creating a multi-level green infrastructure. In addition to their conditioning effects, tree-lined areas also have an important ecological role, as they act as habitats and ecological corridors for urban fauna, especially insects and birds. As equally spaced elements, tree-lined streets have a strong architectural character and have a major impact on the townscape and streetscape as well.
However, there is a measurable and significant difference in the positive effects of urban trees at all levels between young and old trees. The fundamental objective is to keep old trees alive as long as possible, which provides a significant ecosystem service. Several rates are available in the literature for replacing over 100 years old climax species with young species (greenmax.hu, MFE), but due to the built-up areas, they cannot actually be replaced with a sufficient number of young species. However, the safety risk is significantly increased with older trees. Thus, one of the bases of our research is to retain old trees with adequate static safety and to ensure the timing of optimal tree maintenance based on a full mapping of the problems detected.

We examined one individual of each three species with the following method: measuring the physical parameters of the trees (the size and height of the trunk and the crown); investigating the health condition of the trees with an instrumental wood investigation with Arborsonic 3D Acoustic Tomography (Fakopp 3D). We evaluated the results by applying a five-step tree condition assessment method of the European Union, especially concerning the effects of climate change. Our study aimed to examine the old trees in the garden, understand their overall health, and develop optimal tree care recommendations to ensure their long-term life.

3. Background and Literature Review

3.1. Presentation of the Buda Arboretum

The Buda Arboretum is situated on the southern slope (near the foot) of the 235 m high Hill of Gellért. The garden was initiated in 1983-94, on 3 hectares of the premises of the Royal Horticultural School, it was one of the predecessors of the present university. Now it covers 7,5 hectares and is surrounded by the constantly growing city of Budapest.

The designer and first leader of the arboretum was Károly Räde, a horticultural dendrologist of German origin. 1,000 species of trees and shrubs and 90 perennial species were housed in the 3-hectare area surrounding the then Royal Hungarian Institute of Horticulture. So some of the plants here — some oak, walnut, sycamore, fern above the 'F' building — are almost 120-30 years old, such as the country's oldest *Parrotia persica*, *Platanus occidentalis*, *Platanus orientalis*, *Fagus sylvatica* 'Pendula, *Carya cordiformis*, *Quercus libani*.

A landscape garden was designed, with plants grouped according to their taxonomic affiliation. This grouping, in keeping with the demonstrative nature of the garden, served education (Honfi et al. 2012).

The garden is located on the border of the lowland and mountainous climates. The local climate is slightly dry, the yearly precipitation is about 600 mm, to which 150-200 mm of irrigation water is added during the vegetation period. This is further modified by the southern location, the urban climate (greenhouse effect), and the microclimate-creating effect of tall buildings. The soil is a strongly eroded humus carbonate or brown forest soil and contains lime and clay. The soil-forming bedrock of the area is partly limestone and dolomite, but most often the calcareous, clayey, calcareous, sedimentary rock (clay, Buda marl) settled on it. The content of active calcium is high, the pH is alkaline, around 8.

The arboretum has a unique microclimate in the country, the design of the southern slope, the system of fencing and retaining walls, and even the urban environment make it one of the warmest areas in Hungary. The late frosts in May and early freezes in October, so typical for most of Hungary, are not present here, which means a prolongation of the growing season with 3-5 weeks both in the spring and in autumn. So the garden has an extremely rich Mediterranean and unique subtropical open field collection.

The original vegetation was probably a mixed karst wood forest (*Ceraso mahaleb-Quercetum* and *Orno-Quercetum*) occupying the southern slopes of similar hills, with some elements of mixed floodplain hardwood forest (*Fraxino pannonicae-Ulmetum*) coming up from the former floodplain of the Danube at the foot of the hill.

At present, the plant material includes nearly 2000 woody species, more than 250 kinds of bulb flowers, and 300 different perennials. Besides all woody ornamentals available from nursery production in Hungary, most of the Hungarian-bred cultivars and many clones are represented, the latter being selected for the toleration of extreme (dry and polluted) environmental conditions. The unique microclimate offers possibilities for growing plants of subtropical origin, which not only successfully overwinter in the open but also produce flowers and viable seeds (Schmidt 1994).

As a green area in good ecological condition and developing, it is of great value in the center of Budapest, it provides an opportunity for researchers and students to acquire and expand their knowledge, and for the population to relax and unwind. The environmental education of the arboretum is also significant, as it provides space for the students of lower, secondary, and higher education institutions in Hungary to get to know the plants, animals, the living environment, and the diversity of the living world during their study walks.

The Buda Arboretum is a demonstration garden, its most important function is to provide the basic conditions for higher education in horticulture and landscape architecture, and the plant material of the arboretum serves as a living textbook.

Particular attention is paid here to Hungaricums: the treasures of the Hungarian dendroflora or the results of Hungarian breeding, such as the Hungarian rowan, such as *Sorbus rotundifolia, Sorbus balatonica*, the Hungarian varieties of silver linden (*Tilia tomentosa*), or the world-famous Mecsek round ash (*Fraxinus ornus* 'Mecsek').

Dendrological naturalization is also a significant task of the arboretum. Among other things, woody plants that are newly introduced to Hungary are planted here for the first time, and in case of favorable results, the experience of the arboretum will help them to propagate and spread them more widely (Schmidt 1994, Honfi et al. 2012).

3.2. Botanical description of the examined trees

Carya cordiformis (Wangenh.) K.Koch – Bitternut Hickory
This species usually reaches 20-30 m or more in height. It is usually a slender tree with a rather irregular, cylindrical crown and thin, scaly bark. The young twigs are at first rust-brown pubescent, later bright reddish-brown, the buds are sulfur-yellow grandular. The 8-15 cm long leaves are 5-9, but mostly 9-leafed, oblong-ovate or lanceolate, with long pointed serrated tips, pale green at the top, bald and hairy at the back. The round or ovate thin crops are 2-3, 5 cm long, 4 ribs, abruptly pointed, with smooth, thin skin and a bitter taste. The leaves are standing alternate.

Its homeland is the eastern and middle part of the USA. Its typical natural habitats are wetlands of riversides, so it prefers loamy, nutritious, fresh soil, and sunny conditions. It is an excellent solitaire tree, owing to its characteristic shape, fast growth rate, and golden or brownish-yellow autumn foliage (Krüssmann 1985, Dirr 1998, Schmidt and Tóth 2006, Tóth 2012).

Fagus sylvatica L. 'Pendula' – Sad Beech

This is a beautiful weeping form of the European beech, which has almost the same size as the main species, has a conical crown with a waving surface of 20-25 meters, the main branches of which grow irregularly upwards and laterally. The thinner side branches hang downwards, creating a picturesque crown shape. Long-lived trees have smooth, light gray bark, glowing dark green foliage that turns into yellow, then rust-brown in autumn, they are among the most beautiful park trees. The 'Pendula' variety requires a deep layer, medium or good water supply, calcareous soil and humid air (Krüssmann 1985, Dirr 1998, Schmidt and Tóth 2006, Tóth 2012).

Parrotia persica C.A. Mey. – Persian Ironwood

Initially a slow-growing, conical bush, it develops into a multi-trunked shrub tree, reaching 8-12 meters, and its width usually exceeds its height by its old age. Just like sycamore, at its mature state its grey-brown bark peels in small flakes leaving creamy patches (Coombes and Debreczy 2010). Its 6-10 cm long, 4-6 cm wide scattered, simple leaves are undivided, characterized by ovate or oblong shape, and a light stellate pubescence on both sides. The dark green leaf blade that turns gorgeous golden-yellow, purple, or scarlet-red in autumn have roughly serrated edges from the middle up, lacy-toothed, and slightly wavy. The tree has one of the most beautiful foliage effects. It's velvety brownish-red, tiny flowers that open before sprouting are not conspicuous. The flowers without the party have bright red, crimson protruding stamens that seem unusual. Its fruit is 1 cm long, ending in a horn, woody, with an ovoid stalk and bright brown seeds.
It is from the southern Caucasus, from the historic Persia, present-day northern Iran. Its autumn foligae becomes even more vibrant in protected, warm, and sunny locations. This tree is a plant of large green areas and parks. It adapts well to soil and climate conditions (Krüssmann 1985, Dirr 1998, Schmidt and Tóth 2006, Tóth 2012).

3.3. Possibilities of condition assessment of the old trees

Old trees may weaken in their late, aging stages of life, mainly due to the climate change experienced today, the long rain-free periods, the summer drought, the atmospheric drought, and the urban air pollution. We need to restore and maintain their health, prolong their lives, and eliminate potential hazards.

Before the tree protection and tree care intervention, it is essential to assess the condition of the trees with the method of full tree examination. Woodcare is based on the following inspection sequence: visual inspection of the wood, recognition of changes in the wood, determination of their effects and treatment, and accurate documentation. At this time, lesions, abnormalities, disease symptoms should be recognized, analyzed, evaluated and to propose further tests - instrumental examinations – if necessary. In the case of instrumental testing, the choice of the right instrument is essential to detect the critical problem.

Avoiding or minimizing the possible damage to the wood during testing is a priority. Testing methods with technical tools are evolving rapidly, so their introduction and application are constantly developing (Schmidt and Tóth 2006, Lukács et al. 2017, Lukács 2020).

4. Methods and Data

The tree stock's measurement and evaluation in gardens used the Hungarian Association for Tree Management's (MFE) method and criteria (Lukács et al. 2017). The dendrological survey is the overall tree recording, where the dendrometric characteristics express the full tree height, trunk height, trunk circumference size, trunk diameter, and crown diameter in numbers. Trunk diameters come in two ways: average diagonals' measured values or the trunk circumference size calculation. All trees are unique and form a physiologically coherent whole. A detailed examination is necessary because the habitat condition is often different from ideal, which affects the whole tree's life chances. During the visual inspection, the general state of the roots, trunk, and crown are essential. We applied the EU conform method developed by MFE, which uses five parts and values:

A – Root system including roots and collars and the type and condition of tree's plantation site; B – Trunk condition; C – Crown condition, including the crown base and the full crown (branches, branchlets, twigs, and shoots with leaves); D – Assessment of viability; E – Degree of care, maintenance.

The general condition indicator (EU method value) for the trees surveyed is the % value derived from the above figures, which refers to the general value of the trees (Lukács et al. 2017). The calculation formula (as proposed by the MFE) is (A+B+C+D+E-5)/20.

In cases where the extent of the lesions detected by visual examination needs to be clarified, **instrumental examinations** are justified. In the present case, we have also carried out an examination to obtain a more precise picture of the lesion of the trunk. Acoustic tomography: a Fakopp 3D (Divós et al. 2006) instrumental examination is used to detect and determine the size of the lesions and aging within the trunk. The scan provides a colour image of the condition of the cross-section of the tree by measuring the time of sound propagation in the tree. The measurement diagram clearly shows the cavities and hollows in the tree. The procedure does not cause any damage, so trees with diseased trunks can be examined safely. The data from the cross-sectional image can be easily interpreted by the colours: green indicates healthy, yellow to red indicates decayed, blue indicates hollow tissue. The test involves inserting the sensors of the instrument into the bark of the tree. The sensors are connected to a computer and scanned. The computer collects the time it takes for the sounds to reach the target. The result of the evaluation of the data is a relative sound velocity map of the cross-section under test. Thanks to this analysis, we can "see" inside the tree.

5. Results

5.1. Dendrometrical and other important data of selected old trees in Buda Arboretum

Table 1. The most valuable old tree individuals' important dendrometrical data

	Fagus sylvatica 'Pendula'	**Parrotia persica**	**Carya cordiformis**
Tree height (m)	15	14	22,8
Trunk height (m)	0,4	-	2,7
Trunk circumference (cm) / trunk diameter (cm)	348/110	app. 15 trunks (120, 68, 36, 38, 39, 60, 12, 45, 37, 86, 107, 77, 78)	219/70
Crown diameter (average) (m)	16	20	18
Age (year)	110	130	130
Dendrological value	valuable	valuable	valuable
GPS altitude	155155	144144	138138
GPS longitude	47°28'56.796"N	47°28'57.088"N	47°28'55.516"N
GPS latitude	19°2'23.438"E	19°2'21.540"E	19°2'26.304"E

5.2. Detailed evaluation of trees

5.2.1. *Fagus sylvatica* L. 'Pendula'

The tree can be found in the upper garden of the Buda Arboretum, next to one of the main promenades. Its surroundings are well-kept. The tree was planted in 1914 under the design and

supervision of Károly Räde, making it one of the oldest plants in the Buda Arboretum. It is a broad, undulating tree with a conical crown and branches that are mostly horizontal and then have a characteristic drooping tip (Fig. 1a-c). During the heavy fighting of the Second World War, the tree was hit several times, and its trunk contains bullet and shrapnel fragments, which can be detected with a metal detector. The beech with its curly shoots is one of the most impressive specimens in the garden. Its health is good for its age, with a crown of nearly full value, and it is a favourite tree with students and visitors. There are several dry branches in the crown, significant bark damage above the root collars, and limited root growth on the side facing the walkway. There are few (1-2) built elements in the tree's environment. The habitat conditions of the tree are still adequate. The tree may occasionally pose a threat to its surroundings.

a. Nice pendulous habit

b. Short trunk, crown base

c. Main branches, lower part of crown

Figure 1a-c. The only old beech tree in the Buda Arboretum with a drooping crown, more than 100 years old, Photo: B. Szabó, 2021

(A) Root characteristics: root system exposed, root system damages.
Root collar characteristics: lamellar thickening, bark damage, collar damage
There is a casing running within half a meter of the Northside which is restrictive to root growth.
Numeric value (based on Radó, harmonized by EU): 3 = minor wound damage on roots/root collar, minor defects in the site.

(B) Trunk characteristics: bark injury, bark detachment.
Very short trunk, the trunk circumference given is measured below the branching. The trunk circumference of large branches at 1.3 m: 158, 90, 64, 80, 81, 125 cm.
Numeric value (based on Radó, harmonized by EU): 3 = clear lesions (surface wounds, rotting sites)

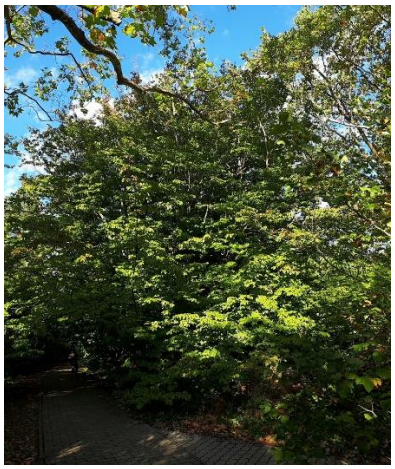
(C) Crown basic characteristics: loaded, water bag.
Crown characteristics: stump, damaged skeleton, hollow skeleton, dry branches.
The southern branch is hollow to knock, with a crown base damaged to the wood body. Healed cracks visible. More dry twigs in the upper part of the crown. The branching from the northern branch is rotten, with a flow from the branch colouring the trunk. Scratches from vandalism occur on the lower part of the skeleton branches. The foliage is healthy.

Numeric value (based on Radó, harmonized by EU): 5 intact, max. 10 % foliage loss
(D) Vitality: 4 = interventions to reach maximum lifespan

(E) Tree care: 4 = slight deficiencies

General assessment: Regular tree inspection. The deterioration of the tree can be slowed down by tree care. Closure of water bag. Fixing of spreading branches may be necessary over time.
The general condition indicator is 70 %.

5.2.2. *Parrotia persica* C.A. Mey.
The tree is located along the main promenades of the upper garden of the Buda Arboretum. Its surroundings are well-kept. The tree is among the oldest plants in the Buda Arboretum and the oldest Persian magic tree in Hungary, it was planted in 1894 under the design and supervision of Károly Räde. During the Second World War, its leader was hit, and it has developed into a beautiful, branching shrub from its base, with several shrapnel and bullet wounds in its branch system, which can be detected with a metal detector. With its crown, reminiscent of a small forest, its bark falling off in sheets and its foliage is golden yellow in autumn, it is a preferred destination for visitors. There are few (1-2) built elements in the proximity of this protected tree. The habitat conditions of the tree are still adequate. The tree may occasionally pose a threat to its surroundings (Fig. 2a-c).



a. Habit with dense branches and branchlets

b. Multitrunked brush-like tree

c. Cell proliferation on the trunk

Figure 2a-c. One of the most beautiful old trees in the garden, with a military patterned trunk, Photo: B. Szabó, 2021

(A) Root characteristics: root system exposed, root system damaged.
Root collar characteristics: intact, sparse thickening.
On the north-western side, there is a 1 m pavement to limit root growth. A choke root has developed at the root collars. Numeric value (based on Radó, harmonized by EU): 4 = root development slightly inhibited, growing medium acceptable, root collar not damaged.

(B) Trunk characteristics: intact, creeper, healed wound.
No evidence of scarring on the surface of the trunk. Slightly tilted (5 degree).

Numeric value (based on Radó, harmonized by EU): 5 = intact.
(C) Crown basic characteristics: intact.
Crown characteristics: stumps, damaged branches, hollow branches, dry branches.
The crown is irregular, with a strongly protruding branch. A small percentage of dry branches, hollow, damaged skeleton branches occur.
Numeric value (based on Radó, harmonized by EU): 4, 11-25%foliage loss.

(D) Vitality: 4 = interventions to reach maximum lifespan

(E) Tree care: 3 = medium deficit

General assessment: It is recommended to remove dead branches/trunks and to remove upward-growing crowning plants. The deterioration of the tree can be slowed down by tree care.
The general condition indicator is 60 %.

5.2.3. *Carya cordiformis* (Wangenh.) K.Koch

The tree can be found in the upper garden of the Buda Arboretum, next to one of the main promenades. Its surroundings are well-kept. The tree was planted in 1894 under the design and supervision of Károly Räde, making it one of the oldest plants in the Buda Arboretum. With its broad crown and golden yellow foliage in autumn, it is one of the most beautiful trees in the garden (Fig. 3a-c). It grows regularly and its interesting, pointed but inedible, thin-skinned fruits are regularly admired by visitors. Tree protected, standing in the area. There are few (1-2) built elements in the tree's environment. The habitat conditions of the tree are still adequate. The tree may occasionally pose a threat to its surroundings.

a. Habit, a branch bursting from the crown | b. Slightly inclined trunk | c. Dry branch ends in the crown

Figure 3a-c. Old specimen of bitter hickory with a slightly asymmetrical crown Photo: B. Szabó, 2021

(A) Root characteristics: root system exposed, root system damaged.
Root collar characteristics: lamellar thickening, bark damage, collar damage
There is a casing running within half a meter of the N side which is restrictive to root growth.

Numeric value (based on Radó, harmonized by EU): 3 = minor wound damage on roots/root collar, minor defects in the site.

(B) Trunk characteristics: bark injury, bark detachment.
Very short trunk, the trunk circumference given is measured below the branching. The trunk circumference of large branches at 1.3 m: 158, 90, 64, 80, 81, 125 cm.
Numeric value (based on Radó, harmonized by EU): 3 = clear lesions (surface wounds, rotting sites)

(C) Crown basic characteristics: loaded, water bag.
Crown characteristics: stump, damaged skeleton, hollow skeleton, dry branches.
The southern branch is hollow to knock, with a crown base damaged to the wood body. Healed cracks visible. More dry twigs in the upper part of the crown. The branching from the northern branch is rotten, with a flow from the branch colouring the trunk. Scratches from vandalism occur on the lower part of the skeleton branches. The foliage is healthy.
Numeric value (based on Radó, harmonized by EU): 5 intact, max. 10 % foliage loss

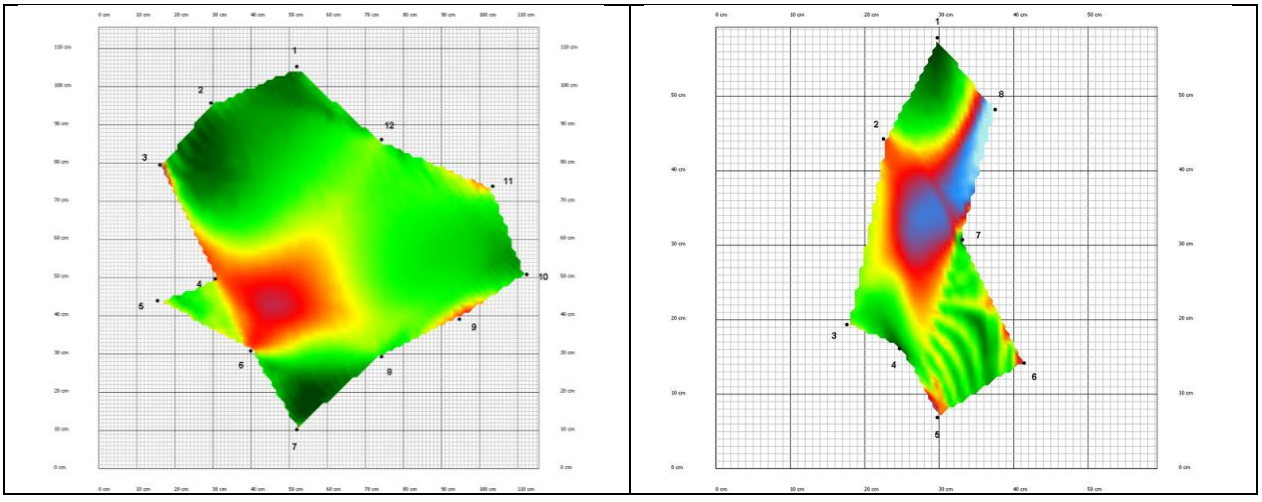
(D) Vitality: 4 = interventions to reach maximum lifespan

(E) Tree care: 4 = slight deficiencies

General assessment: No serious deterioration, crown care required.
The general condition indicator is 80 %.

5.3. Results of 3D Fakopp evaluations

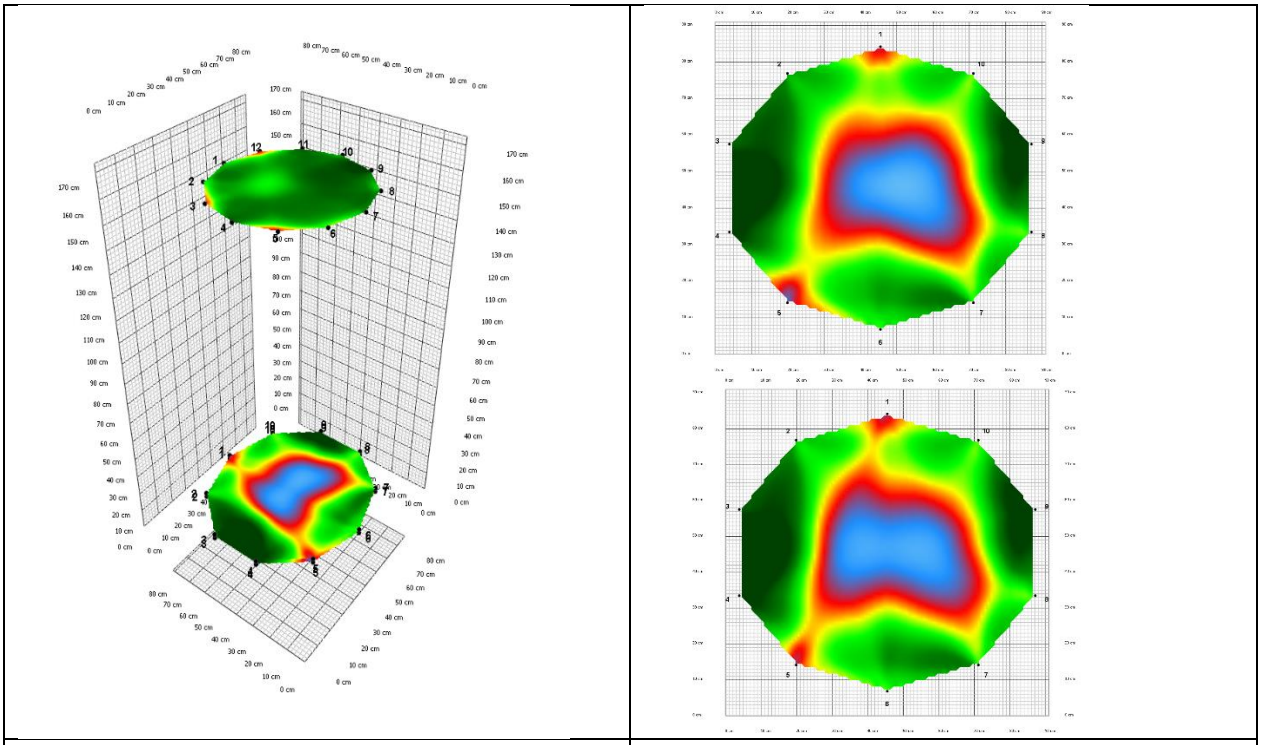
In the case of weeping beech (*Fagus sylvatica* 'Pendula') we could not measure the trunk due to low branching, so we performed an instrumental measurement on a skeleton considered critical based on visual assessment, at 10 cm from the branching, which showed 18% aging with low risk. The measurement was performed in an irregular positional scheme with 12 sensors. We encountered a similar situation, although for different reasons in the case of Persian ironwood (*Parrotia persica*), where we measured some of the trunks, we obtained different values of decay and rot (Fig. 4).



a. Fagus sylvatica ‘Pendula’	b. Parrotia persica

Figure 4a-b. 2D acoustic tomoraph results for some main branches

In the case of *Carya cordiformis*, there were 3 measurement levels (165, 22, 20 cm), 12 sensors, and an elliptical position scheme. The 3D Fakopp test gave low-risk scores at all three levels of measurement. The area of decay decreases up the trunk, with 37-42% of the trunk decayed at 20-22 cm, and only 2% at 165 cm (Fig 5).



a. Slight rotting in the upper part of the trunk	b. Similar rotting % at the near measurement levels (20, 22 cm)

Figure5. 3D acoustic tomoraph results in 3 levels of the trunk of *Carya cordiformis*

6. Discussion and Conclusion

In summary, the condition of the examined old trees, despite their significant age, is satisfactory. Of course, according to the results of the study, the recommended tree care interventions should be carried out as soon as possible to further increase the life expectancy of the trees and, as each specimen is located on the sidewalk, to reduce the potential risk of accidents. It is recommended to carry out a full annual examination of the trees. Based on our studies, we assessed that the roots of old specimens are likely to still provide water and nutrients to trees, and that the drought periods of the last decade have not affected them as much as young trees in urban areas.

Old trees are the defining feature of our parks and gardens. Trees also play an important environmental role, as they produce oxygen through their vital functions, sequester carbon dioxide, increase air humidity by evaporation, shade and cool their surroundings in the hot summer months, and reduce noise and vibrations caused by traffic.

To provide us with these benefits, it is important to maintain their health. In maintaining parks and gardens, we should strive to maintain and improve their condition, for example by watering, replenishing nutrients, aerating compacted soil where necessary, and by professional tree care at the right time.

In order to determine the necessary tasks, it is essential to regularly assess and monitor the condition of the trees, an excellent tool for this is the Radó five-step condition assessment method, which is a visual condition assessment method adapted to the conditions in Hungary and used by the European Union. In some cases, the body language of the tree can also be used by the tree inspector to infer possible hidden defects, in which case non-destructive instrumental tree inspection, such as acoustic tomography, can provide significant assistance in identifying damaged trunk or branch parts.

7. References

Coombes, A.J., Debreczy, Zs. 2010. The Book of Leaves. The University of Chicago Press. Chicago

Dirr, M.A. 1998. Manual of Woody Landscape Plants. Champign, Illinois: Stipes Publishing L.L.C.

Divós, F. et al. (2006) ArborSonic 3D Akusztikus Tomográf. Fakopp Bt. Ágfalva

Honfi, P., Czigány, K., Kohut, I., Schmidt, G., Sütöri-Diószegi, M. 2012. A megújult Budai Arborétum [*The renewed Buda Arboretum*]. Budapest: Budapesti Corvinus Egyetem Dísznövénytermesztési és Dendrológiai Tanszék [*Corvinus University of Budapest, Department of Floriculture and Dendrology*]

Krüssmann, G. 1985. Cultivated broad-leaved trees and shrubs. Portland, Oregon: Timber Press

Lukács, Z. 2020. Faápolás. Budapest: Garden Kft.

Lukács, Z., Szaller, V., Divós, F., Kelemen, G. 2017. Útmutató a vizuális és műszeres favizsgálatok elvégzéséhez és dokumentálásához [*Guidelines for performing and documenting visual and instrumental tree evaulation*]. Magyar Faápolók Egyesülete, Fadiagnosztikai Munkacsoport [*Association of Hungarian Arborists, Tree Diagnostics Working Group*]

Schmidt, G. 1994. Buda Arboretum. Budapest: University of Horticulture and Food Industry

Schmidt, G., Tóth I. 2006. Kertészeti dendrológia [*Horticultural Dendrology*]. Budapest: Mezőgazda Kiadó

Tóth, I. 2012. A lomblevelű díszfák, díszcserjék kézikönyve [*Handbook of Deciduous Ornamental Trees and Ornamental Shrubs*]. Dunaharaszti: Tarkavirág Kereskedelmi és Szolgáltató Kft.