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THE IMPORTANCE OF TREES IN URBAN ALIGNMENTS. STUDY OF VEGETATION ON KISELEFF BOULEVARD, BUCHAREST

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Abstract

Tree alignment plays an important role in shaping the busy urban roadways. These types of trees play a crucial role in rendering ecosystem services, while, at the same time, imparting a characteristic image of the place. The sustainable management of the species used in these alignments as well as the process of replacing them with other species are two of the major issues which fall under the scope of specialists concerned with ensuring a high quality urban environment. In light of the constantly changing climatic factors and an increasingly polluted urban environment, the studies on the alignments from Kiseleff Boulevard give rise to discussions on the choice of the most suitable tree species for an urban area with high traffic. Moreover, the use of species must be done after a rigorous selection and after studying the local environmental conditions. Apart from that, in order to preserve the efficient ecosystem services, it is essential to properly manage the trees that are currently found in the previously mentioned alignments. The tree's health, its visual impact, the shading capacity, the age are just a few basic elements that shape and restore the image of a boulevard that is a landmark of the urban area of Bucharest. Dendrometrical studies have brought forward the direct link between the age and the state of the tree (its health) on the one hand and the ability to adapt of the studied species to the specific conditions of the Bucharest urban environment on the other.

Keywords*: Kiseleff Boulevard, urban environment, ecosystem services, dendrometrical studies.*

INTRODUCTION

Over the centuries, trees have had a great importance in the formation and shaping of the public space, sketching and giving life to promenades, alleys, avenues, squares, gardens and parks (Forrest and Konijnendijk, 2005). Planting trees in alignment in public spaces from the European area was one of the key elements in the cities in terms of building a certain image and raising the quality of urban areas.

If at the beginning, the trees were elements that contributed to the design and organization of the urban space, they've gradually become key elements of the site's identity. Depending on the geographical typologies, local and European influences, personal affinities or preferences, boulevards have always had various species in the alignment which provided a special image. Ever since the sixteenth century, European cities have paid attention to the trees, using them to mark the way to cathedrals and churches. One example is Paris where, during King Henry II of France, it was mandatory to plant and take care of trees, and also design and organize any other aligned planting of trees (Forrest and Konijnendijk, 2005).

Starting with the second half of the 19th century, promenades and boulevards from all around Europe transformed into favoured places where people gather to socialize. The indiscriminate popularity of the walks in these places revealed the vegetation's role in producing oxygen (Pellegrini, 2012), and the middle of the nineteenth century allowed the appearance of a true fact of society: healthy trees, sidewalk and pedestrians (Pellegrini, 2012). With the opening of walks for everybody, sidewalks are charged with the role of protecting pedestrians from carriages with horses and sidewalks are also the ones that will enable the introduction of tree alignment. One such example is the 19th century Paris during the transformation of the Haussmannien urbanism, when alignments of trees were made depending on three main characteristics: hygiene, comfort and aesthetics (Pellegrini, 2012). In the haussamannian Paris, the trees which most often encountered in road alignments are plane trees and chestnut trees,

but also other species (Pellegrini, 2012) which could be found sporadically on avenues. Their planting was determined by the fashion of that time or certain preferences.

The situation in Bucharest proved to be similar to that of other European cities. Located in the northern part of Bucharest, the Kiseleff Boulevard is a historic roadway, which was built in the 1840s, at the same time with the urban changes Bucharest went through in the early nineteenth century (Fezi, 2010). Kiseleff represented the beginning of the road between Bucharest and Brasov, and at the same time the place outside the city where Mogoșoaia road ended (what we call Victoria Avenue after 1878). The documents which required the presence of this place where people were supposed to relax and socialize are the organic regulations (Toma, 2001). The place has been known since 1833 when the Great Steward (Romanian title assigned to the noble who was in charge of supervising the court) G. Filimon mentions it in a letter to General Kiselev. The alley was to be covered with sand and designed by "replanting the trees on the sides" (Toma, 2001). It was originally planted with *Tilia* sp. chosen for their shading capacity, and quickly enriched with *Robinia* sp. plantations. Thus, after 1846 Meyer proposes the extension of the *Tilia* sp. alley from Mogoșoaia road to the first round. From here until the second round (nowadays Arc de Triomphe) and further to Baneasa alley, it was overshadowed by an alignment of two rows of *Robinia pseudoacacia*. After 1851 the boulevard was extended to the third round (currently Press Square).

Due to the newly improvements that had been added to the street (mostly trees and gravel), it quickly became "the usual place of promenade" (Fezi, 2010) and of walking of the high society from Bucharest, offering opportunities to meet and socialize with other people, images which remained forever in the memory of the inhabitants (Toma, 2001). *Tilia* sp. were chosen as alignment trees and were planted in four rows. Their number was initially over 2000 (Vătămanu, 1973). Following the changes undertaken since the twentieth century, the boulevard increased and was enriched with new species of trees.

Based on these considerations, the study aims to establish the state of the inventoried trees, taking into account the fact that over time the trees used initially were replaced. If at the beginning the space chosen for this research was planted with *Robinia pseudoacacia* displayed in four rows, the boulevard contains nowadays alignments of *Fraxinus excelsior, Platanus hybrida, Aesculus hippocastanum, Tilia* sp., and other species used in urban areas now.

The role of the study is to present an inventory of plant material found in section A from the Press Square to the Arc de Triomphe and to establish after careful dendrometrical measurements the health of the inventoried species. This research started from the need to determine the steps to replace the species of trees after a certain period of time and also to find effective methods for using the species that will replace the damaged trees or those which are at the end of life.

The prevention of the physiological decline of the alignment leads to the maintenance of the urban image. Various studies have shown that trees which are in poor health affect the urban image and lead to a reduction of the space's social role and especially the ecological role.

MATERIALS AND METHODS

The inventory of species on Kiseleff Boulevard aimed trees throughout the entire chosen section, from Victory Square to the Press Square. This street is most certainly a historical landmark for urban transformation of the city. To improve the results of the research, the boulevard was divided into two sections. Section A from the Press Square to the Arc de Triomphe and section B from the Arc de Triomphe to Victory Square. But this article only regards section A, the remaining inventory thus contained in a larger study. The tree inventory was conducted using mixed teams made up of landscape architects and horticulture experts.

The working method in the inventory was to create sheets that contained both quantitative criteria such as: size, health, tree circumference at 1.3 m, but also qualitative criteria: aesthetic image, maintenance cutting or regeneration. The chosen qualitative and quantitative criteria

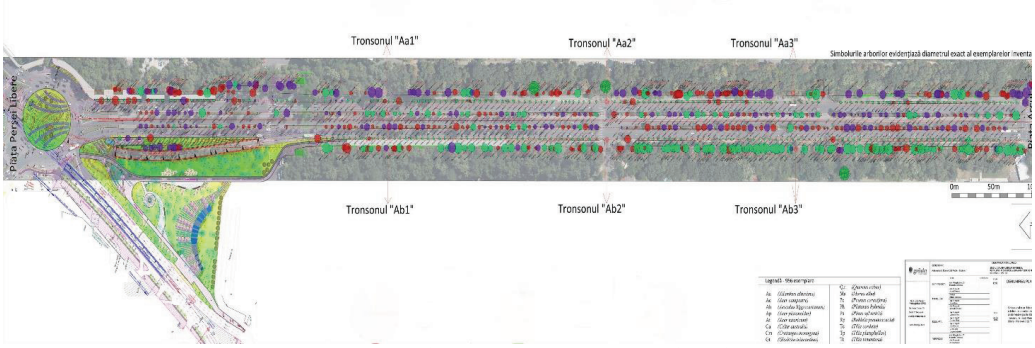

Figure 1. The section A of Kiseleff Boulevard

will complete the information about ecosystem services such as shading, carbon storage, storage of dust particles etc.

The cultural importance is also a criterion that is worth taking into account, because the species of trees from Kiseleff Boulevard have been replaced over time, and the newly planted species were not always adapted to Bucharest's urban environment. Thus, the selected criteria fall into four main groups:

- General features of the trees (the identification number of each tree, the circumference of the trunk, the trunk diameter, the insertion height of the treetop, the treetop diameter and the total height of the tree).
- The health of the tree (excellent, good, bad or very bad, dry) - which is determined only by the appearance of the tree and / or by determining diseases and pests that cause visible damage.
- The aesthetic value - relevant for determining the image of the boulevard as well as the possibility of decorating the chosen species. The argument for the introduction of this criterion is a qualitative one since cultural services are important for any recreation area. By determining aesthetic value, we can deduce the attractiveness or the monotony that can be induced by an alignment along a boulevard.

The maintenance status is justified by the need to intervene, types of interventions: cuts and treatments that can be performed on site depending on the chosen management plan.

The alignment referred to with the numeral 3 is actually the first line of trees which border the boulevard. In these generous green spaces, the number of trees and the number of trees species are various and bring an extra ecological value to the boulevard (Figure 1).

The chosen criteria are closely linked to the health of the trees, but also their aesthetic value, due to the fact that proper caring for urban trees provides an extension of their lives and also add value for the recreation component. For the inventory of the alignment of the avenue trees as well as a more careful study, each section was subdivided (Aa1, Aa2, Aa3 etc.) depending on the position of the alignment in the plan. Section A has four well established alignment sections.

RESULTS AND DISCUSSIONS

In the crowded cities where there are densely designed alignments, studies have shown that it is necessary to maintain and continuously restore a healthy environment to ensure a better quality of life. All this can be possible with the help of urban green spaces that, aside from their environmental qualities, help build a unique identity to the respective areas (Heidt and Neef, 2008).

If it base our research on the idea that trees play a crucial role in preserving a healthy environment, their importance is clear from both the absorption and storage of carbon dioxide and other polluting compounds, but also from the way they help reduce density of the ground by preventing flow (Merse et al., 2009). Planted near busy highways, trees can cut down the sound by reducing noise and pollution. It is known that small spaces with trees and shrubs can absorb or neutralize 68 tonnes of dust per ha / year and streets, squares and small parks with trees can absorb between

20% and 25% of the amount of dust that is found in the areas free of trees (Heidt and Neef, 2008). Thus, on green areas 50-100 m wide, they affect air quality up to a distance of 300 m (Heidt and Neef, 2008). Small spaces with trees (Merse et al., 2009), especially street alignment and boulevards cause a slower growth and lower life expectancy, especially when planted in crowded areas (Merse et al., 2009). The effects of urban pollution on vegetation and trees are the decrease of the default period of life, a slower development and an unattractive and sad appearance of the green elements. In the case of the Kiseleff Boulevard, trees have always played an important role for the spatial configuration and for providing ecosystem services. Its embellishment proved to be quite costly. The boulevard was in a continuous change over time (Potra, 1990). Thus, after the inventory conducted in mixed teams, section A with its subdivisions Aa1-Ab1, Aa2 - Ab2, Aa3 - Ab3 has a total of 956 specimens of 18 species out of which only one species of coniferous wood: *Pinus sylvestris*, the remaining 17 species belonging to the group of deciduous trees.

The middle layout Aa1 - Ab1, which has an alignment of *Fraxinus excelsior*, we have a number of 283 trees and for Aa2 and Ab2 *Platanus hybrida* alignments, with a total of 324 trees. In the case of Aa3 and Ab3 alignments, where we took stock of the trees from the first row, their total number is 349 (Figure 2).

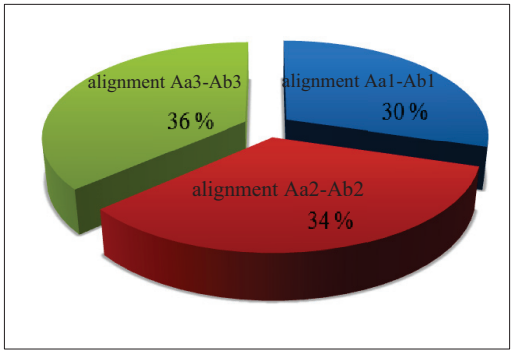

Figure 2. Total of the trees of the section A

As a result of the analysis of the three types of alignment, it was discovered that the diversity of species and volumes is mostly found in the boulevard's sides, in the portions numbered Aa3 and Ab3.

The alignment Aa1 - Ab1 has 283 tress, out of which 278 are *Fraxinus excelsior* and only 5 specimens of *Platanus hybrida*. In percentage, for a clearer image of the make-up of the alignments, 98.23% are part of the *Fraxinus excelsior* and the remaining 1.77% trees are *Platanus hybrida*. Note that this middle alignment consists of trees that have almost reached maturity, a result of the measurements carried out. Therefore, depending on the height of the specimens they may be classified into three distinct categories 2 m – 6 m (23%), 7 m - 9.5 m (39%) and 10 - 12 m (38%).

Following evaluation, it has been determined that out of all trees from the species *Fraxinus excelsior*, a percentage of 17.67% are in a state of good health, while the majority of specimens, 45.58% are in a mediocre state of health. Trees with a poor health condition or even dried specimens are found at a rate of 36.74%. This means that for more than one third of the inventoried specimens, more frequent cutting actions need to be applied to allow them to regenerate and recover. The state of the trees is a reflection of the way we manage all maintenance processes as well as a picture of the way trees and other plants are chosen and whether they are adequately matched to the environmental conditions and requirements.

But no species is totally resistant to pollution, because pollution resistance can be determined by several indicators that are constrained by certain characteristics of pollutants, the plant's growth stage, health status, location (Sieghardt et al., 2005).

For the following two alignments Aa2 and Ab2, the dominant species is *Platanus hybrida*. It must be noted that the alignment Aa2 is made up mostly of *Platanus hybrida* trees (88%). Also, in this alignment, *Fraxinus excelsior* is located in a proportion of 10%, as well as other species 2%. There are 154 trees on the alignment Aa2 that are between 4 meters and 7.5 meters high and only 17 trees between 8 and 16 meters high. 96% of them are young trees (148 trees) in good condition and only 4% are not in a very good condition or they are dry. The majority (70%) of the 17 trees between 8 meters and 16 meters high are in poor

conditions or very dry and only 6% are in good health.

It is easy to observe that most trees of *Platanus hybrida* are young specimen that were planted recently (the year of planting is usually 2013). It appears that trees are becoming increasingly fragile and their health status changes as they adapt increasingly difficult to urban pollution and its consequences.

In alignment Ab2 among the 153 trees we find species of *Platanus hybrida* - 145 trees with heights between 4 meters and 7 meters, 5 trees *Fraxinus excelsior* with heights of 8 meters and 12 meters and 3 specimens of *Aesculus hippocastanum* heights of 8 meters and 10 meters. Specimens of *Platanus hybrida* and those of *Aesculus hippocastanum* are young trees, while those of *Fraxinus excelsior* have almost reached maturity.

The health criteria reflects about the same situation as in alignment Aa2. The young species of *Platanus hybrida* (145 trees) are in good health, being planted throughout 2013, but specimens of *Fraxinus excelsior* and *Aesculus hippocastanum* are in bad health condition. Again, we can conclude that at the time of this study, namely in 2015, the majority of trees from the alignments Aa2 and Ab2 are newly planted ones and that they are trying to adapt to a boulevard with dense traffic conditions. But as they get older, their health deteriorates as well.

In section A, the last subdivisions Aa3 and Ab3 are actually the first lines of trees from the massive edges which complete this avenue's image. The trees inventoried in both Aa3 and Ab3 are mostly quite diverse, part of a large number of species and are found either in good health or in a bad condition.

Thus in Aa3, there are 175 trees of 16 of hardwood as *Acer* sp., *Tillia* sp., *Robinia pseudoacacia* etc.

For the Ab3 alignment, most of the 171 trees are *Tillia* sp., *Fraxinus excelsior* and *Aesculus hippocastanum*, but with a higher procentage regarding their condition (70% of them are in a good health state).

One of the results of the study show that the diversity encountered in certain areas has helped the adaptation process of the trees and generally speaking, the majority of them has reached maturity in good conditions.

An important role in urban areas is played by this diversity of species which helps to create and maintain a stable urban environment. Therefore species diversity in urban ecosystem management is one of the most important elements that should been encouraged as it is desirable to have a balance between biological diversity and production and maintenance costs of the plants (Heidt and Neef, 2008).

Depending on the adaptability of each tree, there could be a significant growth rate in the first years. However, there could also be trees which grow more slowly after they were planted and then, in a few years, they dry out and die (Bradshaw et al., 1995). Therefore, in the case of the species used for alignment, the criteria behind their management refers primarily to the possibility of survival and the selection of the best adapted trees, depending on the site's characteristics (Heidt and Neef, 2008). Managing the trees on Kiseleff Boulevard, section A, which was presented in this article also provides an updated and correct choice of tree species that are most suited to the conditions of urban pollution. The study observed that age and health are related and that most mature specimens identified at the site are in a poor state of health. This situation is caused not only by the characteristics of the urban environment, but also by the poor management from stakeholders.

CONCLUSIONS

It is therefore necessary to establish a vegetation management plan to anchor the current conditions of a polluted urban environment. Newly taken actions on trees alignment in European cities seek a closer study of the relationship between the area where the tree will be planted and the stresses to which specimens are exposed. It has been found that the life of trees is shorter in urban areas because of the high stress levels they face (Sæbø et al., 2005). Experts have identified many stress factors: from pollutants, physical damage, excessive cuts of treetops and the very small space for root development, to a soil that is poor in nutrients and is unable to absorb the water and oxygen needed for the roots (Sæbø et al., 2005).

For a better determination of the species which are well adapted to a particular local context, one can use the numerous studies that rely both on species selection and a more careful selection of genotypes. So the selection of urban trees is made after three criteria determining: the species' adaptation to environmental conditions of the site, the way its ecological functions adapt to urban conditions and a low cost of production and management (Sæbø et al., 2005).

The trees from street alignments must have several physical characteristics that recommend them for this type of use: they must have a strong growth of ramifications, well defined branches, with a steady and predictable growth and with a long life in order to lower or remove successive costs and a certain aesthetic value (Sæbø et al., 2005).The present study showed that a large proportion of all inventoried trees reach maturity in a mediocre state of health.

A tree that is in a poor or mediocre health state loses its environmental, social, cultural and economic benefits (Bradshaw et al., 1995). Therefore, encouraging a quality management which has among its concerns urban trees is desirable. Selecting and managing tree by tree translates into a better quality of life and reduction of urban pollution

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MISCELLANEOUS


EX·TERRA·AVRVM