

Research on urban greenery of representative types in the avenues of a big city

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Abstract

The aim of this study is to record the existing situation and to evaluate the trees of three representative types in the avenues chosen by their density of greenery, in the Municipality of Thessaloniki. The aim also included the formulation of proposals in order to make some improvement in the choice of species so as to increase the amount of spaces in the city. The results of the research showed that the most important problems the trees had in the three roads were the attack on the leaves by insects and fungi as well as the dry and broken branches of the crown. It was also realized that the majority of trees are in a moderate condition. The values of the surface indicator and volume indicator that were calculated depend not only on the number of trees but also on the average volume of their crowns. Finally, it was estimated a linear model for the volume indicator for which there is a physical explanation.

Keywords: Urban greenery; surface indicator; volume indicator; problems of urban trees; suitable species.

1. INTRODUCTION

The 20th century was the century of urbanization. Nowadays, it is calculated that above half of the world population lives in urban regions while by 2030 the urban population is expected to be twice as large as the corresponding rural [1,2,3,4,5]. Urban greenery is of fundamental importance for the quality of life on our ever increasingly urbanized societies [6,7]. More specifically, this term refers to open spaces that are located in the urban web and which include parks, avenues of trees and other garden areas [8,9,10].

The urban environment constitutes a difficult biotope for the trees. The environmental pressures decrease the vitality of many species and increase their sensitivity to diseases and parasitic attacks. The trees that are developing in the cities suffer from the effects of various negative factors, such as poor soils (compressed and with insufficient or low proportion of humidity and nutrients), the polluted atmosphere and vandalism. These problems can only be faced by choosing the proper species [11,12,13,14,15].

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- What problems do these trees face now, and will face in the future?
- Do the characteristics of the trees influence the density of greenery?
- Is there a linear model to correlate the volume indicator to the characteristics of the trees?

2. MATERIALS AND METHODS

The research took place in the region of the Municipality of Thessaloniki, which is located in North Greece. The research included the study of the trees along three central roads of Thessaloniki city, which are a) Nikis Avenue b) Egnatia Street and c) Karamanli Avenue. The three roads were chosen not only for the traffic condition but also for the species, the age and hence the characteristics of the trees that line these roads. These three avenues of trees were chosen in order to study the condition and to evaluate the behavior of the species *Platanus orientalis*, *Celtis australis*, *Albizia julibrissin*, *Liquidambar orientalis*, *Cupressus arizonica* and the clone *Populus X euramericana cv. 'I-45/51'* in correlation to the surface that they occupy in the three representative roads of the city. The first avenue of trees, in Nikis Avenue, was constituted exclusively by the species *Platanus orientalis*, the second one, in Egnatia Street, by the species *Celtis australis* and the third one, in Karamanli Avenue, by the species *Albizia julibrissin*, *Liquidambar orientalis*, *Cupressus arizonica* and the clone *Populus X euramericana cv. 'I-45/51'*.

The total number of trees that was recorded in the three roads was 913 but analytic measurements were taken from 20% of the individuals that is to say; 248 trees (Nikis Avenue 81 trees, Egnatia Street 70 trees and Karamanli Avenue (including the trees in the central division) 97 trees). The trees of our sample were chosen by the method of systematic sampling. Each sample tree was measured for height, height of the start of the crown and crown dimensions. The crown length, the projection of the crown in the ground and the crown volume were calculated. The crown projection was calculated by the type: $G=(G_1+G_2)/2$, where $G_i=\pi/4 \times d_i^2$, $i=1,2$ is the surface of a circle with diameter d_i . The two diameters for each tree were measured along the street and vertical to this. The crown volume was calculated by the type: $V= G \times L/3$, where L is the crown length which results if the height of the start of the crown is subtracted from the total height tree. The product: (crown projection of the average tree) \times (number of trees in each road) was characterized as active surface while the product: (volume of the medium tree) \times (number of trees in each road) was characterized as active volume.

The crown shape of every tree, its general condition and the damages that it presented were recorded. The recording of the damages was done according to a specific damage diagnosis catalogue [16]. Finally, for each road the surface indicator (active surface of the crowns divided by the length of the road) and the volume indicator (active volume of the crowns divided by the length of the road) were calculated. With regard to the relationship between the surface indicator and the tree characteristics, a linear model was estimated using the statistic programme SPSS version 12.0 for Windows.

3. RESULTS AND DISCUSSION

A brief presentation using box and whisker plots of the results of the statistic processing of the tree height values and tree diameter values in the studied roads is given in Figures 1 (1. Nikis Avenue, 2. Egnatia Street, 3. Karamanli Avenue, 4. central division of Karamanli Avenue). In Figures 2 there is a corresponding presentation of the tree height values and tree diameter values of the studied silvicultural species (1. *Platanus orientalis*, 2. *Celtis australis*, 3. *Albizia julibrissin*, 4. *Liquidambar orientalis*, 5. *Cupressus arizonica*, 6. *Populus X euramericana cv. 'I-45/51'*).

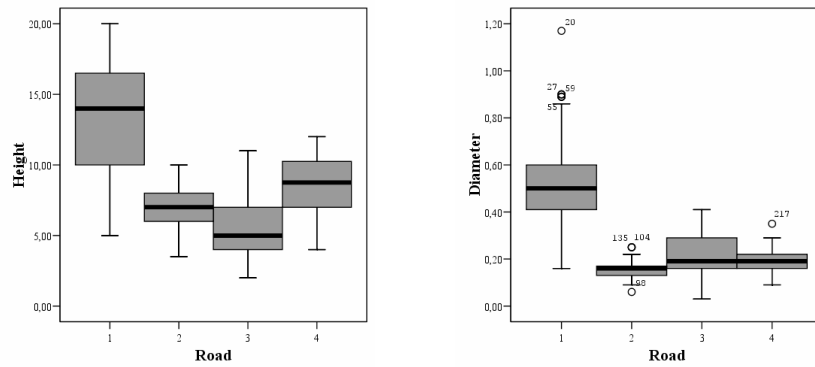


Figure 1. Box-and-whisker plots of height and breast diameter of the three central roads and the central division.

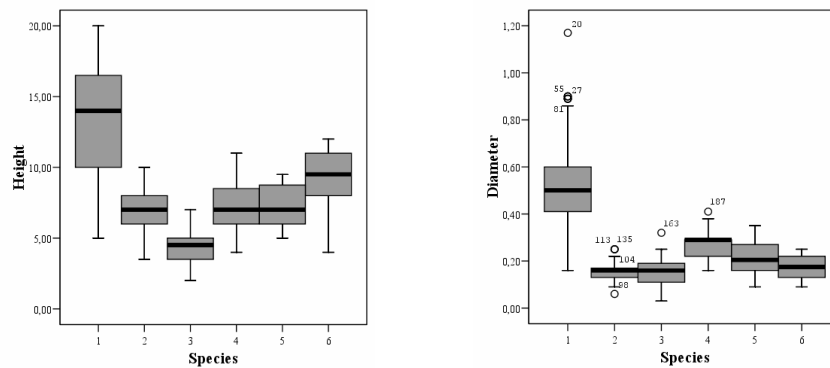


Figure 2. Box-and-whisker plots of height and breast diameter of the six silvicultural species.

According to Figure 1, the distribution of height data is normal in Egnatia Street (road 2) while the corresponding of breast diameter data is normal in Nikis Avenue (road 1) and in the central division of Karamanli Avenue (road 4). According to Figure 2, the distribution of height data is normal in the species *Celtis australis* (species 2) and *Populus X euramericana* cv. 'I-45/51' (species 6) while the corresponding of breast diameter data is normal in the species *Platanus orientalis* (species 1), *Cupressus arizonica* (species 5) and *Populus X euramericana* cv. 'I-45/51' (species 6).

The problems that the trees of each species faced are presented in Figures 3,4,5,6,7,8 (1. drying out of the crown, 2. insect and fungal damage, 3. ivy on trunk, 4. tree too close to road, 5. long crown depth close to asphalt surface, 6. crown width over road, 7. tree too close to buildings, 8. crowns touching each other, 9. crowns touching buildings, 10. damage from construction, 11. trees too close to cables or light source, 12. inadequate root space depth, 13. compaction of soil, 14. soil removal, 15. root damage due to construction work, 16. pavement damage due to roots, 17. root damage, 18. fluid secretion on trunk, 19. bark damage, 20. tree decay, 21. narrow bi-furcation, 22. water retention in bi-furcation, 23. dry and broken branches, 24. spreading branches, 25. branch tufts due to pruning, 26. intensive pruning).

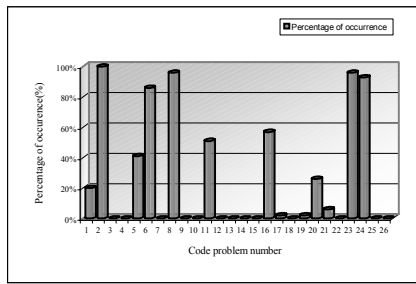


Figure 3. *Platanus orientalis* problems.

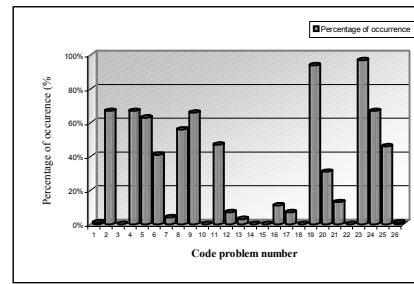


Figure 4. *Celtis australis* problems.

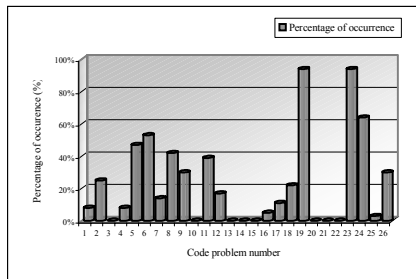


Figure 5. *Albizia julibrissin* problems.

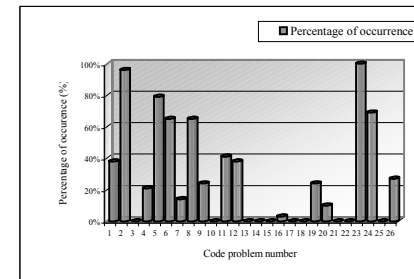


Figure 6. *Populus X euramericana cv. 'I-45/51'* problems.

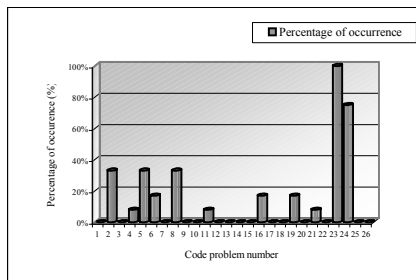


Figure 7. *Liquidambar orientalis* problems.

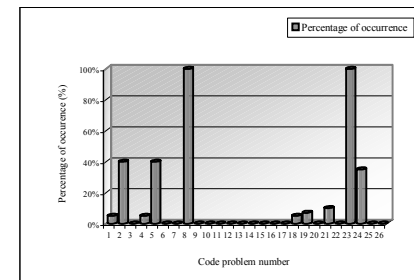


Figure 8. *Cupressus arizonica* problems.

The results of the research showed that the most important problems the trees had in the three roads were the followings:

- Insect and fungal damage (this problem dominates in the trees of the species *Platanus orientalis* and the clone *Populus X euramericana cv. 'I-45/51'*)
- Dry and broken branches of the crown (this problem dominates in the trees of the species *Celtis australis*, *Albizia julibrissin*, *Liquidambar orientalis*, *Cupressus arizonica* and the clone *Populus X euramericana cv. 'I-45/51'*)
- Bark damage (this problem dominates in the trees of the species *Celtis australis* and *Albizia julibrissin*)
- Trees whose crown touches the crown of other trees (this is a big percentage in the species *Cupressus arizonica* and *Platanus orientalis*)

With regard to the crown shape of the trees in the three avenues, it was found that the majority of the trees of *Platanus orientalis* and *Populus X euramericana cv. 'I-45/51'* have an irregular crown while in the trees of the species *Celtis australis* and *Liquidambar orientalis* dominates the spherical shape. Most of the trees of *Albizia julibrissin* have umbrella-shaped crown and those of *Cupressus arizonica* pyramidal one.

The general condition of the trees of the species *Platanus orientalis*, *Celtis australis* and *Cupressus arizonica* was characterized as moderate while the majority of the trees of the species *Albizia julibrissin*, *Liquidambar orientalis* and *Populus X euramericana cv. 'I-45/51'* is in a good condition.

The values of the surface indicator and volume indicator are highest in Nikis Avenue, which is consisted by *Platanus orientalis*. Finally, using the multiple linear regression and considering as independent variables the tree height, the height of the start of the crown and the crown projection, the following volume indicator model was estimated: $Y = -104,048 + 14,64x(\text{height}) - 18,73x(\text{height of the start of the crown}) + 3,48x(\text{crown projection})$. The value of coefficient of determination was $R^2 = 93,5\%$. All model coefficients are significant at the 0.05 level of significance. There is also a good adaptation of the model to our data while the analysis of variance showed a high significance. The estimation of this model may help to the description of our data and its use is indicative.

4. CONCLUSIONS

The analysis of the results led to the following conclusions about the damages that the species presented, the density of ery in the three roads and the volume indicator:

- The attacks on the leaves of *Platanus orientalis* and *Populus X euramericana cv. 'I-45/51'* by fungi and insects are mainly due to the limited available growing space and the insufficient soil and moisture conditions.
- The dry and broken branches that the crown of many species presents are due to the pruning method, which resulted in the development of tufts of branch shoots. These branch shoots had desiccation problems because of the self-thinning, which is a functional reaction of the plant to the excessive increase of branches. This problem is intensified by the insufficient soil and moisture conditions. In the case of *Cupressus arizonica*, the specific problem is due to the premature ageing that this species presents.
- The biggest density of greenery is presented in the Nikis Avenue, which is consisted by *Platanus orientalis*, because the values of the surface indicator and volume indicator are the biggest in this avenue. This conclusion results from the fact that the trees of *Platanus orientalis* have the biggest average values of height, height of the start of the crown, crown projection and breast diameter in relation to the trees of the other roads.
- With regard to the linear model that concerns the volume indicator [$Y = -104,048 + 14,64x(\text{height}) - 18,73x(\text{height of the start of the crown}) + 3,48x(\text{crown projection})$], we must notice that it can be physically explained. The volume indicator increases with the increase of the height and the crown projection and decreases with the increase of the height of the start of the crown because the crown length decreases.

5. PROPOSALS

- The species that line Nikis Avenue is *Platanus orientalis*, which is a very large one. In order to achieve the normal development of the crown and the vertical position of the trunks, a bigger spacing should be applied so the crown can be aired and the interactions between trees to be avoided.

- Egnatia Street has a small surface because of its narrow pavements that prohibit the right growth of the trees. We suggest the filling of the gaps using the same species, *Celtis australis*, and the trees should not be pruned where this is possible.
- Karamanli Avenue has a low surface despite the width of the road and the central division. This avenue should be studied systematically. The poplar and cypress must be removed and substituted with a suitable urban-friendly species. The former, because it is susceptible to branch breakage by windfall and this is dangerous. The latter, because its crown presents thinning in an urban environment.
- With regard to the species *Celtis australis*, *Albizia julibrissin* and *Liquidambar orientalis* it is recommended the avoidance of their pruning or where this is necessary it should be done according to the pruning guidelines.

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