

Ecological Evaluation, Management and Threats from Biotic and Abiotic Factors in the Vegetation of an Urban Park

A.A. Papadopoulos^{1,2*}, G.S. Efthimou¹ and E.B. Andrianopoulou¹

¹Agricultural University of Athens, General Dept.,

Iera Odos 75, 118 55, Athens, Greece,

athanaspapado@aua.gr, efthimiou@aua.gr

²Municipality of Katerini, Environmental Office,

Plateia Dimarchiou 1, 60100, Katerini, Greece, athanaspapado@yahoo.gr

*Corresponding author: Email: athanaspapado@aua.gr

ABSTRACT

Main purpose of the present study is to evaluate the ecological value of the tree species of an urban park in the Railway Municipal Park in the city of Kalamata, a comprehensive ground measurement to record qualitative and quantitative variables has been implemented. For each tree species, the following variables have been recorded: its type, diameter at breast height (DBH), height (H), slenderness (H/D ratio), crop start height (Hk), crop length (Lk), diameter crown (Dk), crown class, vitality class, evolutionary trend, trunk position, age, crown shape, root problems, crown pruning, insect infestations and fungi. From the statistical analysis and processing of all the above variables, an assessment of ecological state of health and stability was made. Also, the threats and risks from biotic and abiotic factors were studied in order to take the necessary tree management measures. So, the main problems presented by the forest species mainly concerned the unsuitable and dense planting connections, the sloping, crooked and serpentine trunks, the space of the roots, asymmetrical crown shape, inappropriate pruning, wounds and infestations by insects and fungi. The results of the present study recorded for the trees of the park, problems in the trunk (86.25%), crown (96.25%), pruning (96.25%), but very seriously, problems are also the infestations by insects (80.75%) and fungi (59%). Necrosis from insect infestations and fungi reach 9.30% of the park trees. The management measures proposed below are necessary for the protection of trees and their continued safe growth and survival.

Keywords: Urban Green Inventory and Management, Urban Forestry, Forest Protection, Tree Register, Dendrometric Parameters

I. INTRODUCTION

In Europe, since the 15th century Renaissance era, parks had begun to grow, growing in the 17th century in other countries, such as France and England [1]. In the late 18th century, parks were created in Britain as privately owned blocks giving London the image of a green city [2, 3]. Urban ecosystem management was started by the University of Toronto in 1965 [4] and developed into a separate branch of forestry science entitled, Urban Forestry.

While in the 19th century parks were only picnic areas for workers, they now serve multiple uses and functions [1, 5, 6, 7], which make them (the parks) necessary for landscaping cities and improving living conditions within them [8,9]. A park may be part of the urban fabric or tangent to it, they may have a long history or be recently created [10, 11, 12, 13]. Riparian ecosystems are among the most biologically diverse ecosystems on Earth [14, 15].

The purpose of the present study: record and evaluate (with qualitative and quantitative variables) the vegetation of the Railway Park, in the city of Kalamata, Greece. For the first time it is attempting the creation of a register of riparian vegetation. Also the recording of the problems of the trees by biotic and abiotic factors of the park, and the formulation of proposals for its management and quality upgrade, with special reference to the stability of trees, their state of health and protection from human interventions and diseases (insects and fungi).

II. MATERIALS AND METHODS

A. Study Area

The survey was carried out in the context of the registration of all trees of the existing greenery in the Municipal Railway Park, in the city of Kalamata, with a total area of 54000 sq.m during the summer of 2020. This park was inaugurated in 1986 as a recreational

and cultural activity park dedicated to the history of Greek railways with an outdoor train exhibition.

The registration concerned the type and number of trees per species. In the park a total of 564 living trees were recorded out of a total of 622. Recorded in the study area in the study area were various species such as *Ligustrum Japonicum*, *Morus alba*, *Laura nobilis*, *Eriobotrya japonica*, *Ceratonia silliquastum*, *Pinus spp.*, *Olea europaea*, *Citrum ayranium*, *Cupresus spp.*, *Cercis Siliquastrum*, *Phoenix sp.* Also had riparian tree species like *PopulusXeuramericana*, *Eucalyptus rostrata* and *Platanus acerifolia*.



Photo 1. View of the park



Photo 2. View of the park

In the study park there is a small artificial lake and small water channels. The aquatic element in combination with riparian forest species such as *Platanus*, *Populus*, *Eucalyptus*, *Nerium oleander*, enhance its aesthetic and ecological value. They increase the biodiversity of species and habitats, and are a reference point for all cities in the world [16].

For this reason, this research work has been extensively involved in the ground measurement and inventory of all qualitative and quantitative variables of the total vegetation, for the first time, with the purpose of compiling a tree register and highlighting its problems in relation to the rest of urban areas environment, climatic conditions and human activities.

B. Research Methods

The total number of trees recorded in the Railway Park is 564 trees. The most accurate way to describe and evaluate the urban ecosystem is the overall ground measurement and inventory of each information for each tree separately, especially in cases where the assessment of the condition of the urban green is done for the first time [13, 17, 18, 19, 20, 21] in this park.

All trees of each species were counted and measured for each tree by Haga altitude, tree height (H), crown initiation height (Hk), and with specific tape measure the diameter of breast high (DBH). From the difference between the height and the height of the starting crown, the crown length ($Lk = H - Hk$) was calculated. Evaluation of problems from root, trunk, pruning, insect, fungal, fluid outflow assessment was performed in two categories (YES/NO), and trunk position in three (Yes Vertical Position, Slightly Inclined Position trunk and non-vertical trunk position), as well as health and stability status (Good, Poor, and Moderate). Crown and vitality classes and evolutionary tendency were calculated according to the (IUFRO) ranking system.

From the values of height (H) and diameter (D) we calculated the compressible factor (H/D), which deducing the smaller the tree, the stabler the tree can be. Statistical analysis was done with the package S.P.S.S. 16.0. Variable data is presented in Microsoft office Excel spreadsheets.

III. RESULTS

From the detailed recording and study of the 564 trees of the Municipal Railway Park, it turns out that its composition consists of 15 different species, of which 485 (85.99%) are broadleaves and the 79 (14.1%) conifers.

The first three species are *Ligustrum Japonicum* with 247 trees and a percentage of 43.79%, *Robina pseudacacia* with 67 trees and a percentage of 11.88% and *Morus alba* with 35 trees and a percentage of 6.21%, while *Cercis siliquastrum* with 1 tree (0.18%), *Olea europaea* and *Citrus aurantium* with 2 trees and percentages of 0.35% (Figure 1).

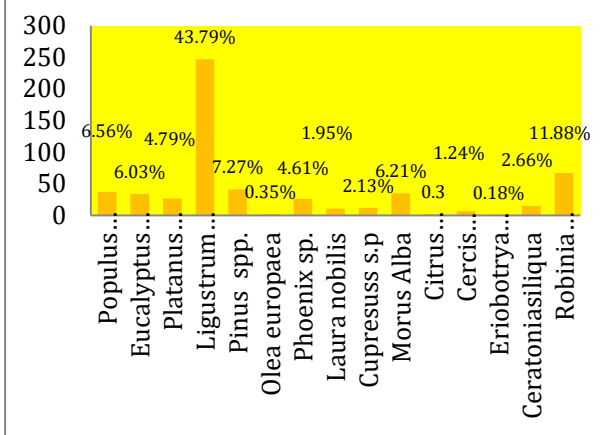


Fig. 1. Percentage (%) of species

A. Overall evaluation of the riparian forest vegetation of the park

In 14 species the whole population was recorded and studied, while in terms of trees of the species *Ligustrum japonicum*, due to the large number, we took representative Sampling Areas of 83 trees. So, a total of 400 trees were studied.

The total population of the trees studied is dominated by the long crown with a percentage 74.93%, followed by the short-crown with 16.45% and finally the middle-crown with 8.6%. The majority of trees 85.82% are normally growing, while 9.11% poorly growing. Regarding the trend of evolution, 71% of the trees are classified as remaining, while 29% belong to the rest. The absolute majority of trees 87% developed an asymmetric crown and only 13% symmetrical. Deviation from vertical position presents the 35.60% of trees with no deviation 38.99% and slightly inclined 25.32%.

Problems in the trunk (86.25%), crown (96.25%) (Figure 4) and pruning (96.25%) are dominant in all types of vegetation (Figure 2), while insect (96.25%), (Figure 3) fungal (59%) problems are significant. In addition to evaluating all the qualitative variables related to infestations and problems, as previously analyzed, in conjunction with the macroscopic image of each tree, the health status of the three categories, good, moderate and poor, was assessed.

The vast majority of the total tree population, 178 trees (44.50%), are in poor health (Figure 5), 157 trees (39.25%) of the total population are in good health while 65 trees (16.25%) are poor. Of the 400 trees, 179 (44.75%) had good stability, 156 (39.00%) had poor stability, and the remaining 156 (39.00%) were moderate (Figure 6). The majority of the samples we studied have root problems with 247 trees (61.75%) but also a portion of the trees show outflow liquids with 139 (34.75%).

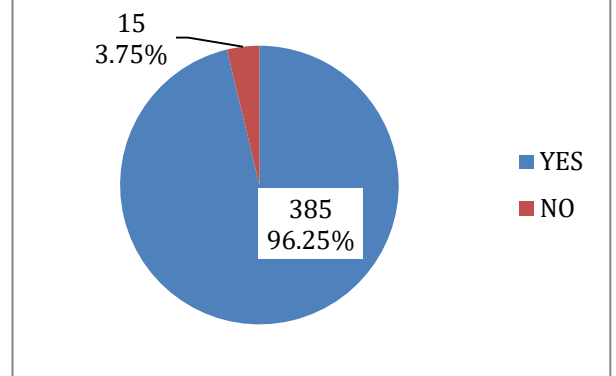


Fig.2. Frequencies and percentages (%) of Problems from pruning of the trees species of the Vegetation of a Railway Municipal Park in the City of Kalamata.

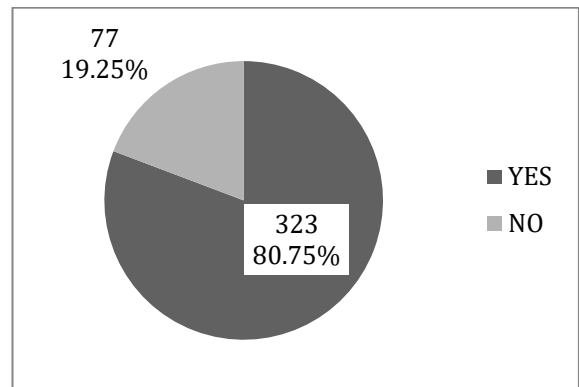


Fig.3. Frequencies and percentages (%) of Insect Infections of the Vegetation of a Railway Municipal Park.

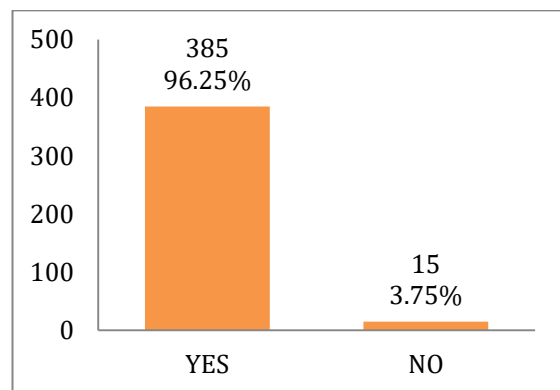


Fig.4. Frequencies and Percentages (%) of Problems of the crown of the Vegetation of a Railway Municipal Park.

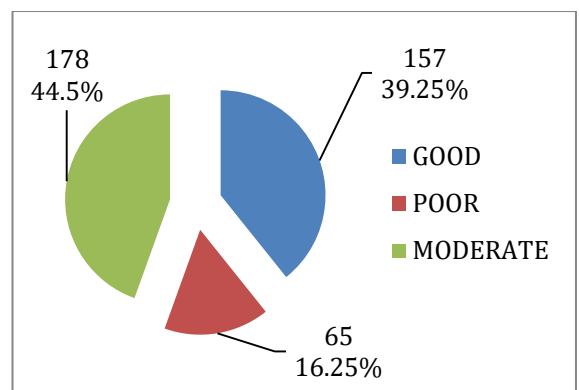


Fig. 5. Frequency and percentage (%) of health classes of the trees of the Vegetation of a Railway Municipal Park.

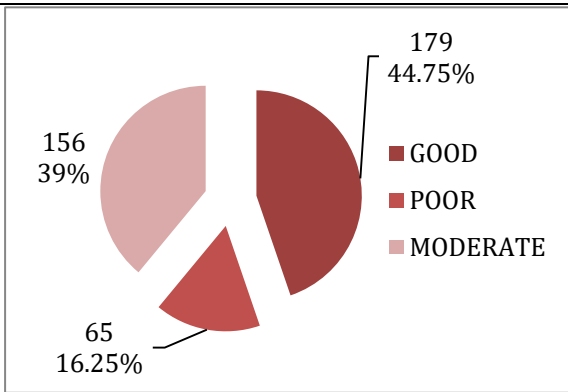


Fig. 6. Frequency and percentage (%) of stability classes of the trees of the Vegetation of a Railway Municipal Park.

B. Problems - Infections of park trees

Below in more detail are the problems and infestations by insects and fungi that were identified and recorded by the research in the Railway Park of Kalamata :

- Wrong choice of tree species during the initial design of the park and the use of many foreign species has resulted in the dominance of such species as the species *Ligustrum Japonicum* at a rate of 43.79% of the total population of trees in the Parks well as a large number of broad leaves with 485 individuals (86%) compared to conifers with 79 trees (14%) in the Total Population of the mixed cluster of the Municipal Park Kalamata.

- Due to the initial planting of large coniferous trees as scouts-photophilous species, among themselves and in relation to other broadleaves, such as *Populus*, *Platanus*, *Eucalyptus* etc. in dense and unsuitable planting link with concentrated harvest, created due to the phenomenon of photomodulation and its natural branching (Dafis 1986) twisted, serpentine and sloping trunks with deviation from the vertical position, with dead branches and asymmetrical growth of the crown.

- Improper and violent pruning resulting in a substantial reduction in stability of trees and create a multitude of poorly made open cuttings branches and broken branches. In particular, the removal of the lower part of the crown affects the center of gravity of the tree, creating negative conditions in terms of its stability.

- Wounds of trees in the bark from ice and violent man-made activities such as tying wires, nailing signs, engraving on the bark etc. With resulting in secondary infestation of trees by bark-eating and wood-eating insects and fungal growth.

- Trapping of the root node area by concrete walls and covering of roots from concrete walkways and paving resulting in its compression soil and the creation of unsuitable conditions for soil aeration, its filtration rain water and root respiration, suffocation of the root system and the breaking of the cement by increasing the diameter of the trunk at the root node

and from the roots to species with a superficial root system.

- The open wounds and incisions in the trees throughout the years result secondly to have the creation of "carcinomas", deformities and sepsis in the central trunk and branches. In addition, insect infestations were observed fungi particularly important for the sustainable presence of trees as well as outflow liquids such as resin in pines and even necrosis in other species [24].

- Existence of fork and fork at a certain height from the ground to the central trunk, creates an increased risk of branch breaks and infestations.

- Of the 622 trees originally recorded in the park, the living today trees reach 564, which means that the deaths from fungal infestations and insects make up 9.3% (58 trees) of the park trees.

IV. DISCUSSION - CONCLUSION

In the Railway Park, under the trees, there is dense shrubby vegetation mainly from *Nerium oleander*, a riparian species, which is particularly important in terms of the protection and safety of park users especially the elderly and young families who use the site as it is not visually accessible from everywhere [25].

It is known from the literature that mixed clusters with a complex and layered structure contribute to the search for ecosystem biodiversity, their resilience attacks by biological and abiotic agents and their aesthetic upgrade [21, 26, 27, 28, 29, 30]. It is deemed necessary and the gradual balanced restoration is proposed about the same number of trees between Broadleaf and Conifers from the current composition which are 86% broadleaf and 14% coniferous.

Active and incorrect pruning in recent years has increased the vulnerability of plants to fungal and insect infestations as well as outflow of fluids also caused its deterioration phenotypic condition of trees (cachectic growing trees with asymmetric crown) and biodiversity loss of urban vegetation and fauna [1, 24, 31].

The riparian forest trees planted in the Railway Park are not species of native riparian vegetation. These are hybrids of *Populus*, a foreign species of *Platanus* and *Eucalyptus* found in the riparian ecosystems of Australia.

V. PROPOSED MANAGEMENT MEASURES FOR PARK'S CORRECTION AND PROTECTION FROM LIVING BIOTIC AND ABIOTIC DANGERS

The park can be upgraded qualitatively and ecologically refurbished with appropriate management measures, such as:

1) It is necessary to gradually restore a more balanced situation in composition of the number of trees between Broadleaf 86% and Conifers 14%.

2) Enrichment of riparian vegetation with native riparian species in order to increase biodiversity and ecological stability in the park [16, 32, 36].

3) Gradual removal and replacement of the foreign species of the park .

4) Pruning on park trees should only be done when citizens' safety, tree health and poor aesthetic problems arise and with strict scientific criteria [13, 31], in order to improve the ecological tree growth conditions with moderate to poor stability and to avoid falling, especially in extreme weather conditions [1].

5) Removal of infected trees from insects and fungi found in advanced stage of degradation .

6) Dangerous trees with poor stability must be removed after the relevant logging licenses have been issued and after all possible conservation measures have been exhausted.

7) Healing of cortical wounds and open incisions from old pruning.

8) Biological or mechanical control of insects by placing ecological paper tapes/glues at a suitable height of the trunk depending on the case.

9) Maintaining the tree registry contributes effectively to the preparation of management plans, the presentation of appropriate forestry interventions as well as maintenance measures for emergence, enhancement and improvement for this specific ecosystem [10, 21, 33, 34].

10) The technical works (water channels) of the park should be remodeled in accordance with modern scientific trends that highlight the naturalness of streams in urban tissue.

The results of the research show that the targeted implementation of the proposed measures means from the sustainable management of the park in the following years, with simultaneous replacement of species, will significantly improve ecological growth conditions and forest protection, will restore and improve the phytosanitary situation, the stability [30] and their viability [35, 36].

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