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Native People's Perception of Trees in the Urban Landscape of the Bay of Naples †

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† Presented at the 1st International Electronic Conference on Biological Diversity, Ecology, and Evolution, 15–31 March 2021.

Abstract: In the urban areas, trees play a crucial role as providers of ecosystem services, which enhance human well-being directly and indirectly. Here trees and human works generally depict a complex system of historical, cultural and natural values. However, urban changes can modify historic landscapes by causing the loss of cultural and environmental values. In this study, we assessed native people's perception of trees in the urban landscape of the Bay of Naples (Italy) with the main goals of: i) to highlight the tree species historically characteristic of the urban landscape; ii) to evaluate the quantitative changes and the related causes that have affected trees in the last twenty years. To this aims we conducted a totally anonymous online survey using the Google Forms application. *Pinus pinea* L. (Pinaceae) showed the highest scores as a species historically characterizing the study area, but also in strong reduction, while *Ailanthus altissima* (Mill.) Swingle (Simaroubaceae) showed an increase in the last twenty years. The results of this study will support decision making in the urban landscape planning in the Bay of Naples. Furthermore, the proposed survey method can be tested and applied to other urban areas of the world.

Keywords: tree diversity; urban trees; online surveys; public perceptions; ecosystem services.

Citation: Stinca, A.; Marfella, L.; Esposito, A. Native People's Perception of Trees in the Urban Landscape of the Bay of Naples. **2021**, *68*, x. https://doi.org/10.3390/xxxxx

Published: date

1.Introduction

In the urban areas, trees play a crucial role as providers of ecosystem services, such as mitigation of the urban heat island effect, regulation of microclimate and hydrology, provision of leisure spaces, mitigation of air pollution, sequestration of carbon dioxide, which are likely to become more important with predicted climate change [1–6]. Here trees and human works generally depict a complex system of historical, cultural and natural characters. However, urban changes can modify historic landscapes by causing the loss of cultural and environmental values. In addition to producing an increase in the density of people and related social relationships, urbanization implies many problems related to spatial planning. To support decision making in urban landscape planning, many surveys of the public perception was conducted [7–9]. Indeed, the evaluation of the public opinion allows to make decisions shared by the communities of people looking also at the peculiar ways in which community characteristics contribute to attitudes toward urban trees. However, no studies regarding the perception by citizens of trees in the urban landscapes subject to high urban pressure were conducted. This is particularly relevant and useful in those territories where man has been present since very ancient times, such as the coastal metropolitan areas of the Mediterranean basin.

In this study, we assessed native people's perception of trees in the urban landscape of the Bay of Naples (Italy) using an online survey. Main goals of the research were: i) to

highlight the tree species historically characteristic of the urban landscape; ii) to evaluate the quantitative changes and the related causes affecting trees in the last twenty years.

2. Experiments

2.1. Study Area

Study was carried out in the urban and suburban area of the Bay of Naples, in southern Italy (Figure 1A). It includes 92 municipalities of the entire Metropolitan City of Naples, which cover approximately 1,171 km^2 and host about 3 million inhabitants.

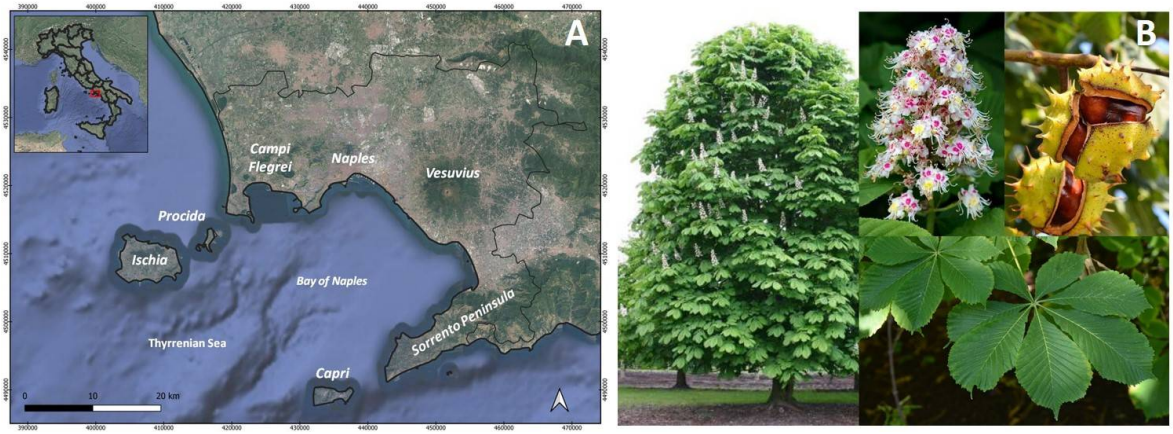

Figure 1. (**A**) Location and an aerial view of the study area. (**B**) Example of panel figures with morphological details of *Aesculus hippocastanum* L.

Within the study area, artificial surfaces cover about 20%, while agricultural areas, shrubs and herbaceous vegetation represents more than 60% of the total surface [10]. The climate is Mediterranean, with a total yearly rainfall of 929 mm and a mean monthly temperature ranging from 11 °C in January to 26.4 °C in August [11].

2.2. Data Collection

Data were collected through a totally anonymous online survey using the Google Forms application (https://www.google.it/intl/it/forms/about/). The questionnaire, which required about 15 minutes to respond, in addition to some socio-demographic data on respondents (e.g. age and level of education), included some questions on tree characteristics.

We have selected 50 native and exotic tree species generally cultivated along the roads and in the green sites of the urban area around the Bay of Naples (A. Stinca, personal observations). To facilitate the identification of species for a wider audience, in addition to the scientific name, we have provided some common names and a photographic report for each tree (Figure 1B). Participants (botanists, agronomists, citizens nonprofessionals, etc.) were asked to state their opinions according to rating scales.

2.3. Data Analysis

One-way analysis of variance (ANOVA) was applied to test the effect of tree origin status (T*os*; i.e. indigenous or exotic in the study area) and tree type with regard the leaves persistence (T*l*; i.e. evergreen or deciduous) on the perception of respondents, i.e. on the average values assigned to the trees to evaluating their historical role in the urban landscape (TP*ul*) and the quantitative changes in the last twenty years (TP*qc*). The significance was assessed at $p < 0.05$ using Tukey HSD test. Furthermore, Pearson's

correlation analysis was employed to identify the relationship between TP*ul* value and TP*qc* ($p < 0.05$).

3. Results

A total of 169 questionnaires were collected. The observations of the respondents were mainly based on the municipalities of Naples, Portici and Sorrento. Most of the respondents was male (62.1%), was over 40 years old (66.2%), and was in possession of a university degree (81.1%).

Pinus pinea L. (Pinaceae) showed the highest average scores (4.77 ± 0.68) as a species historically characterizing the urban area of Bay of Naples, followed by *Quercus ilex* L. subsp. *ilex* (Fagaceae; 4.39 ± 0.98). Regarding the quantitative changes of trees in the study area, the interviewees indicated that *Ailanthus altissima* (Mill.) Swingle (Simaroubaceae) showed an increase (0.64 ± 1.9) in the last twenty years. Instead, a reduction in the abundance of all other trees was perceived, especially the pines (i.e. *Pinus pinea*, -1.48 ± 1.44).

The tree landscape value perceived by respondents (TP*ul*) was significantly affected by the tree origin status (T*os*) (ANOVA, Tukey HSD test $p = 0.001444$) and by the tree type (T*l*) (ANOVA, Tukey HSD test $p = 0.004154$). Likewise, the tree quantitative changes in the last twenty years perceived by respondents was not significantly affected by the tree origin status (ANOVA, Tukey HSD test $p = 0.4545$) and by the leaves type (ANOVA, Tukey HSD test $p = 0.145346$). Pearson's correlation analysis highlighted a weak negative correlation between the TP*ul* and TP*qc* values ($r = -0.4373$, $p = 0.001508$) (Figure 2).

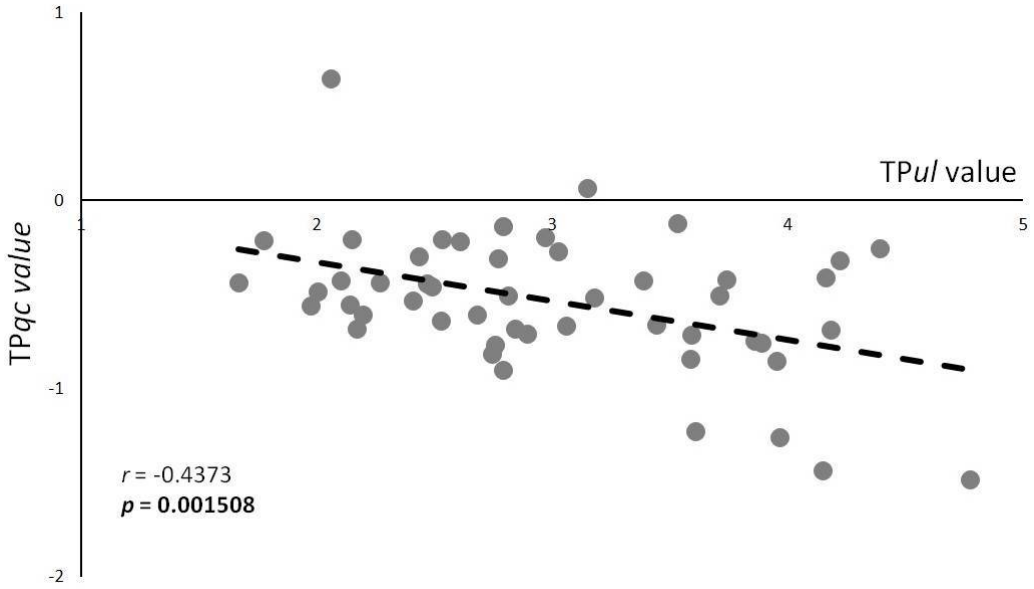

Figure 2. Correlation (Pearson's *r* coefficient and associated *p* value) between tree landscape (TP*ul*) and tree quantitative change (TP*qc*) values perceived by respondents (average values).

The respondents' answers, "inadequate green area planning tools" and "urban transformations and/or land use changes" have been highlighted as the factors that most of all affected the numerical reduction of trees in the study area. On the contrary, an "increased availability of trees on the plant nursery market" produced an increase in the abundance of trees in the last twenty years.

4. Discussion

Most of the native people perceived *Pinus pinea* as typical tree of the urban landscape of the Bay of Naples. Indeed, this species are very widespread along the streets and within public and private parks of the study area. Nowadays *P. pinea* (also known as "stone pine") is widely distributed throughout the Mediterranean basin, where, as a dominant species, it covers more than 700,000 hectares. However, its natural range is difficult to determine, since it has been widely expanded in the last centuries [12]. Due to its ability to grow over dry and sandy soils, stone pine was also introduced in the Bay of Naples both for afforestation and as an ornamental plant. Here it is undoubtedly an alien plant even if it mainly characterizes the lavic slopes of the Vesuvius [13]. Especially in the past, it was highly appreciated for the production of edible seeds named "pine nuts". In addi-tion, *P. pinea*, with its typical umbrella shape, is represented in decorative arts, such as in the famous postcard of Naples, which testifies to the strong symbolism of this plant both for native and visitors of Bay on Naples.

With the exception of *Ailanthus altissima* and *Robinia pseudoacacia*, the reduction in the abundance of all trees perceived by respondents can be generally related to the "inade-quate green area planning tools" and to the "urban transformations and/or land use changes". The first factor also includes the management of adversities affecting trees. In addition to pest and pathogens, trees in urban areas must face multiple anthropogenic stress factors, such as the high pollution levels, the lack of soil for anchoring the root system and incorrect pruning. Also the maintenance of road pavement and underground systems (e.g. water and electrical systems) cause severe stress and physical damage to tree roots. Overall, urban biotic and abiotic stresses limit the tree growth and development, as well as the phytosanitary and static conditions.

As *P. pinea* is perceived by the citizens as an important element of cultural heritage in the Neapolitan area, its death caused a great change in the traditional landscape [14] and a loss of cultural and environmental values.

Changes in the urban landscape of the Bay of Naples were also caused by the quantitative increase in the last twenty years of *Ailanthus altissima* and *Robinia pseudoacacia* (na-tive to South-East Asia and North America, respectively) perceived by the respondents. These are very invasive exotic species in Italy [15] which quickly spreads both by seeds and by suckers [16,17]. Both propagation mechanisms enable the rapid consolidation of these plants in the new areas and can justify the responses of our survey respondents.

5. Conclusions

Management and conservation of trees in urban areas require a holistic approach aim at historical and cultural landscapes conservation. In the present study, it was highlighted that people's perception can support decision making in urban landscape planning in the Bay of Naples, one of the most densely populated and urbanized areas in Europe. Fur-thermore, the proposed survey method can be tested and applied to other urban areas of the world.

Acknowledgments: The authors are very grateful to the survey respondents for providing valuable information.

Author Contributions: A.S. conceived, designed and coordinated the study; A.S. analyzed the data; A.S. writing—original draft preparation; A.S., L.M. and A.E. writing—review and editing. All au-thors read and approved the final version of the manuscript.

Institutional Review Board Statement:

Informed Consent Statement:

Data Availability Statement:

Acknowledgments: The authors are very grateful to the to survey respondents for providing valuable information.

Conflicts of Interest: The authors declare no conflict of interest.

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