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Correlation between the geometrical characteristics of streets and morphological features of trees for the formation of tree lines in the urban design of the city of Orestiada, Greece

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Abstract This paper classifies the streets of the city of Orestiada, Greece, and examines the correlation between the geometric characteristics of streets and the appropriate height of trees that form the street tree lines so that the microclimate in each street may be improved. The rows of trees improve the aesthetic quality of the urban spaces, and also strengthen the sense of enclosure through tree planting, especially in monotonous urban landscapes. Our main aim is to augment the vegetation in urban areas to achieve the greatest shading of streets in order to contribute to the improvement of the urban environment in terms of bioclimatic conditions. The methodology used in this paper aims to promote the use of trees in urban design, and to evaluate the effects of shading at the city scale with regard to microclimate and energy saving, and to develop tree selection and design guidelines for recommended planting programs. It is expected that the results of the study will be useful to Urban Planners, Urban Arboriculturists, Urban Foresters and Landscape Architects that are engaged in the design and construction of streetscapes in Mediterranean region.

Keywords Street trees · Bioclimatic conditions · Microclimate · Urban design · Street orientation

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Introduction

Urbanization tends to increase urban temperature, energy use, carbon dioxide emissions from fossil fuel power plants, municipal water demand, ozone levels, and human discomfort and disease (Dwyer et al. 1992). These harmful consequences are compounded by global climate change, which may double the rate of urban warming (Akbari et al. 1990). Environmental improvement of urban street trees has the potential to improve existing bioclimatic conditions and create comfortable conditions both inside and outside of buildings (Streiling and Matzarakis 2003; Mayer and Matzarakis 2006; Ali-Toudert and Mayer 2007a; Bourbia and Boucherida 2010; Georgi and Dimitriou 2010; Orlandini et al. 2017).

According to Evangelinos et al. (2005) city surfaces are constructed with artificial, dark coloured, heavy-weight materials, which during the day absorb large sums of solar radiation and radiate heat, significantly raising the mean radiant temperature. All the above drastically reduce the thermal comfort of urban open spaces during hot days; people quickly cross these spaces and search for more shaded and fresh areas to sit and relax (Abreu-Harbich et al. 2014). Moughtin (2003) and Jacobs (1995) agree that a desirable urban condition is for a pedestrian to have a sense of the surroundings as a pleasant and protective space. This feeling can be achieved by the use of trees in city streets (Bourbia and Boucherida 2010; Georgi and Dimitriou 2010; Lowry et al. 2012; Moreno et al. 2015). "In particular, trees are defined as the most effective vegetation element for reducing overheating in urban areas" (Orlandini et al. 2017) while street trees provide valuable environmental, social, and economic benefits (Mullaney et al. 2015). Suggestions that involve planting trees along streets aim to create a landscape that is protected and shaded by the tree foliage. This will also succeed in creating the sense of an enclosed room, according to Moughtin (2003), which will

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