



Original Articles

Restorative urban forests: Exploring the relationships between forest stand structure, perceived restorativeness and benefits gained by visitors to coastal *Pinus pinea* forests

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ABSTRACT

Forests are widely recognized as important landscape elements which contribute to human health and well-being. They provide benefits derived from direct and indirect experiences of contact with nature by reducing psychological and physical stress, thus creating positive feelings and facilitating the recovery of psychological resources. In order to establish or manage forests for recreational purposes, it is essential to know which forest stand structure features and indicators are linked to actual or perceived psychological restoration. The aim of this study is to evaluate the association between individual factors, perceived restorativeness, stand structure attributes and self-reported physical-psychological benefits obtained when visiting woodlands in urban or peri-urban areas especially coastal Italian stone pine forests using a quantile regression approach. Perceived restorativeness components such as 'being-away', 'fascination' and 'compatibility' emerged as significant predictors of visitors' perceived psychological benefits, showing a positive and significant association in all of the quantiles under study. Stand density, measured by basal area per hectare of understory trees and shrubs negatively influences the perception of the benefits obtained, holding constant the other covariates.

1. Introduction

Natural environments in and around urban areas have provided people with valuable ecosystem services including the regulation of infiltration and storm water runoff, mitigation of the microclimate, reduction of the heat island effect and air pollution (De Groot et al., 2010; Dobbs et al., 2011; Larondelle and Haase, 2013). Furthermore, urban green infrastructures help to alleviate stress, enhance psychological and physical health and promote well-being in adults and children (Badiu et al., 2016; Hartig et al., 2011; Hauru et al., 2012; Tzoulas et al., 2007). Many authors have reported that a natural environment is "restorative" when it promotes the recovery of psychological and physiological resources required by individuals to carry out daily life tasks, such as directed attention, self-control and other cognitive executive functions (see Hartig (2004) for an overview). These benefits can be obtained by being in contact with nature (e.g. walking or cycling) or by simply viewing natural landscapes, e.g. from a hospital window (Ulrich, 1984).

In recent years, numerous studies have been carried out to

investigate the relationships between overall individual well-being and various environmental dimensions, including climate, air quality, local amenities (Brereton et al., 2008; Ferreira et al., 2013; Rehdanz and Maddison, 2005; Wolch et al., 2014). Much attention has also been paid to comprehending how natural environments (e.g. trees, woodlands, community gardens) are related to the physical, psychological and social benefits obtained (Carrus et al., 2015b, 2017a; O'Brien, 2005; O'Brien and Morris, 2014) and the results showed that natural environments help to restore attention and reduce stress (Berman et al., 2008; Hartig and Kahn, 2016; Tennessen and Cimprich, 1995). Moreover, it has been determined that urban forest elements contribute to enhance human health and well-being better than built-up areas, particularly in densely inhabited areas (e.g., Carrus et al., 2013, 2015b; Van den Berg et al., 2007).

In this context, forests have been widely recognized as important landscape elements which positively affect human health and well-being (Arnberger and Mann, 2008; Hartig et al., 2003; Nordh et al., 2009a,b; Petrokofsky et al., 2010) due to their relaxing qualities (Ottosson and Grahn, 2008). Direct and indirect contact with nature in

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urban forests help to induce positive emotions, reduce psychological stress and facilitate regeneration of cognitive resources (Nordström et al., 2015). This positive effect is even greater if woodlands are located within or adjacent to urban areas (Fuller et al., 2007; Miller, 2006; Peron et al., 2002). In this regard, Italian stone pine (*Pinus pinea* L.) forests located in Mediterranean coastal areas may be regarded as examples of urban and peri-urban forests which contribute to human well-being through a wide range of cultural services (Gasparella et al., 2017). Plantations of these species were originally established along the coasts of Mediterranean countries for mobile dune fixation and to protect crops against sea winds following wetland reclamation. However, due to the intensive urbanization process these forests have become important components of urban and peri-urban landscapes and have assumed different roles. In fact, nowadays most sites are renowned for their social functions such as scenic beauty and recreational use (SoMF, 2013; Gasparella et al., 2017) instead of being important for the production of pine nuts and timber. As a result, pinewoods are currently managed with the silvicultural system based on single-tree selection according to the principles of “urban forestry” (Randrup et al., 2005; Konijnendijk et al., 2006).

Despite the amount of literature on the relationships between landscapes, perceived benefits and stress relief provided by natural environments, further research is still required. Much attention has been paid to evaluating the benefits provided by different green space typologies and changes in individual perceived restorativeness when exposed to different degrees of urbanization (Hauru et al., 2012). However, the effect of stand structure (i.e. the horizontal and vertical distribution of forest stand components including height, diameter, crown layers of trees and shrubs) within the same forest type has not yet been explored. Furthermore, from a policy perspective, it is interesting to examine what occurs throughout the entire distribution of individual beneficial outcomes while visiting woodlands, instead of merely focusing on the conditional mean of distributions. More specifically, the benefits associated with forest trips can be assessed by directly asking visitors “in situ” to estimate the improvement in their subjective well-being and/or the benefits perceived at psychological or physical level during or following their experience. This is generally carried out by administering standardized questionnaires that have been subjected to conventional psychometric validation by previous empirical studies (e.g., Carrus et al., 2015a, 2017b; see also Mercado-Doménech et al., 2017, for a recent account of the basic psychological processes involved in human evaluation of external environmental stimuli and self-awareness of inner mental states). In fact, analyzing the entire empirical distributions could help policy makers and land managers to plan targeted and effective policies and management interventions aimed at enhancing individual benefits and well-being (Scopelliti et al., 2012).

However, in order to establish or manage forests for stress relief, it is essential to determine which elements are required for creating restorative environments. When managing woodlands for recreational purposes it is important to take into account both the vertical (e.g., composition and density of overstorey and understorey) and the horizontal (e.g., spatial distribution of trees and stand density) structure of forests (Nielsen et al., 2012). For instance, tree size is an important variable for recreational value (Edwards et al., 2010) as well as the forest development phase (Edwards et al., 2012). Due to the increasing interest in using urban forests for promoting human health, it is also essential to understand how users perceive them as resources for obtaining benefits and enhancing well-being. Indeed, it is not feasible to propose effective management recommendations for cultural or landscape services without considering the users’ preferences (Nordström et al., 2015).

Bearing these considerations in mind, the aim of this study is to contribute to the literature regarding the cultural services provided by urban forests and how people perceive them. In particular, using Quantile Regression Models (QRMs) our aim is to determine the

relationships between stand structure attributes, individual factors, perceived restorativeness, and the entire distribution of the physical and psychological benefits gained when visiting woodlands in urban or peri-urban areas. Three different examples of urban and peri-urban Italian stone pine forests located in the coastal areas of Latium were considered.

2. Theoretical framework and research hypotheses

People have always regarded contact with nature as an essential human need and green environments as indispensable for their health (Ward Thompson, 2011) and well-being. An important aspect of the psychological benefits and well-being obtained from being in contact with nature is the extent to which people perceive it as being restorative (e.g., Carrus et al., 2017a; Hansmann et al., 2007; Hartig, 2011; Laforteza et al., 2009; Nordh et al., 2009a,b). Even if perceived restorativeness, benefits and subjective well-being are associated, they are different constructs from both theoretical and empirical perspectives. Therefore, it is worth investigating the association between perceived restorativeness, psychological benefits and/or subjective well-being in different forest settings. According to Laforteza et al. (2009), well-being can be defined as the combination of attributes leading to a mentally and physically comfortable psychological state. It is related to specific aspects including life satisfaction, sense of happiness and positive evaluation of one’s life in general, but it can also be influenced by positive experiences such as visiting highly restorative environments that are capable of providing both psychological and physical benefits (e.g., Carrus et al., 2015b; Laforteza et al., 2009).

In this paper, psychological benefits (PSBs) are deemed to be improvements in positive emotions, relaxation and subjective well-being which have a calming effect and reduce mental fatigue. On the other hand, physical benefits (PHBs) are defined as the advantages related to improvement in muscle strength, agility and posture, as well as to a range of mechanisms such as metabolism, respiration and circulation (e.g., Hartig, 2008; Laforteza et al., 2009). Various theories, such as the Attention Restoration Theory (ART) (Kaplan, 1995; Kaplan and Kaplan, 1989) and the Stress Reduction Theory (SRT) by Ulrich et al. (1991), have focused on the possible beneficial effects of being in contact with nature. While the ART mainly refers to the possible psychological benefits, the SRT concerns the possible physical benefits (see also Carrus et al., 2015a).

ART foresees that some environments (and related experiences) may aid the recovery of psychological resources that individuals use to carry out ordinary daily tasks, such as directed or voluntary attention (Kaplan and Kaplan, 1989). Direct attention is the ability to inhibit distractions during ordinary activities, which requires a cognitive capacity that can be depleted if subjected to severe and prolonged requests (Directed Attention Fatigue). Therefore, improved executive functioning may be acquired by being in contact with “restorative” settings, such as natural environments in which individuals can enjoy pleasant experiences without using an excessive amount of voluntary or direct attention (Berman et al., 2008; Hartig, 2004).

According to ART, restorative environments are characterized by four components or properties: (i) *being-away*, (ii) *extent*, (iii) *fascination*, and (iv) *compatibility* (Kaplan, 1995). *Being-away* refers to experiencing an environment physically different from one’s own usual environment in which direct attention is used. The *extent* concept is related to the physical features of an environment. It should be wide enough to capture the attention of people over time, thus promoting exploration without cognitive effort. *Fascination* refers to effortless passive attention. Indeed, environments provide positive aesthetic stimuli thus promoting regenerative experiences. Lastly, *compatibility* is related to the ability of a place to be in line with the user’s expectations and to support his/her engagement in environmental features or processes.

In general, environments with high levels of naturalness or

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