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Relationship between landscape structure and neighborhood satisfaction in urbanized areas

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Abstract

Humans are an integral part of landscapes in landscape ecology. Theories and models of human–environment relationships suggest that human perception is essential to understand the interlocking relationship between humans and landscapes. This is particularly evident in urbanized areas. In the theories and models in landscape ecology suggesting close relationships between humans and landscapes, human perception of landscape structure hypothetically links ecosystems with many human responses and activities, including land-use decisions, landscape planning, landscape management, and preferences. Here, we attempted to understand the relationship between landscape structure and neighborhood satisfaction, which is a perceptual construct of residents. Neighborhood satisfaction was measured using a mail-out survey to single-family households in the city of College Station, TX, and landscape structures for respondents were also measured at a micro-neighborhood scale with a radius of 750 ft (229 m), an intermediate-neighborhood scale with a radius of 1500 ft (457 m), and a macro-neighborhood scale with a radius of 3000 ft (914 m). To measure the landscape structures around respondents' home, we used IKONOS multispectral images with 4 m resolution and panchromatic images with 1 m resolution. We delineated the landscape structure using the normalized difference vegetation index (NDVI) method. The neighborhood satisfaction of residents was associated with selected landscape structure indices. Specifically, it was more likely to be high when tree patches in neighborhood environments were less fragmented, less isolated, and well connected. Variety in the size and shape of tree patches also showed a positive relationship with neighborhood satisfaction. Interestingly, these relationships became stronger as the neighborhood scale increased. Under a hypothetical framework with theories and models in landscape ecology, landscape preference and neighborhood satisfaction, results of the present study provide insights into planning and management strategies for residential environments enhancing both neighborhood satisfaction of residents and ecological functions.

Keywords: GIS; Holistic approach; Landscape ecology; Landscape metrics; Landscape planning; NDVI; Neighborhood satisfaction; Remote sensing; Tree patch

1. Introduction

Humans are an integral element in holistic landscape ecology. Holistic landscape ecology considers the total human ecosystem, in which human aspects are integrated into landscape ecology (Naveh, 2000). Holistic landscape ecology views humans an integral part of the global ecological hierarchy (Antrop, 2000; de Blois et al., 2001; Naveh, 1995, 2000; Naveh and Liberman, 1994; Tress and Tress, 2001). Understanding the interaction between humans and landscapes, as counterparts of dynamics and complexity of holistic ecosystems, is thus essential to sustainable landscape planning and management in holistic landscape ecology.

Human perception appears to be critical for understanding the interactions between humans and landscapes. Tress and Tress (2001) explained that through their actions, people affect the landscape, and in turn, the landscape affects people by means of its appearance. People perceive landscapes and reflect upon them. Similarly, Antrop (2000) suggested that behavior is conditioned partially by the perceptional evaluation of one's environment. Degraded and derelict land is perceived as being without order, not clean, and not well maintained.

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This condition leads to a human assessment of low value and further attracts spontaneous waste dumping, which reinforces degradation. Grimm et al. (2000) proposed a conceptual model integrating human and ecological systems in land-use decision-making processes. In this model, people perceive landscape structure, and the land-use decision is made through societal processes based on perceived landscape values. In turn, the land-use decision affects ecological structure. Together, the two processes build feedback systems over time.

Numerous studies have dealt with the relationship between landscape elements and human perception. For example, many studies have consistently reported human preference for natural environments over constructed environments from a landscape perceptional perspective (e.g., Herzog et al., 1982; Kaplan, 1987, 2001; Kaplan et al., 1972; Lamb and Purcell, 1990; Purcell and Lamb, 1984; Ulrich, 1977; Zube et al., 1974). A possible explanation why people prefer natural environments over built environments can be found from environments' potentials to restore or improve wellbeing (Appleton, 1975; Ulrich, 1983; Kaplan, 1987; Rohde and Kendle, 1994). Numerous studies also support the natural environments' benefits for urban residents. For instance, Mostyn (1979) indicated that people benefit from natural environments emotionally, intellectually, socially and physically. Similarly, Hayward and Weitzer (1984) found that people were attracted to parks for various reasons including physical activity, enjoyment of nature, social activity, and a sense of relief and escape from an urban setting. Regarding natural environments' possible benefits, attention restoration theory emphasizes cognitive functioning such as restoration from attentional fatigue (Kaplan and Kaplan, 1989; Kaplan, 1995), and the psycho-evolutionary model (Ulrich, 1983; Ulrich et al., 1991) emphasizes affective functioning such as restoration from psychophysiological stress. According to Herzog et al. (2003), there are four properties of restorative settings including being away, extent, fascination and compatibility. Natural environments have been shown to fulfill the requirement of being away from ordinary urban settings (Knopf, 1987), have sufficient content and structure occupying one's mind long enough to allow directed attention to rest, deliver fascination holding one's attention without effort, and provide distinctive settings for the wide range of people's activities (Herzog et al., 2003). Affordance theory (Gibson, 1979) also explains relationships between people and environment through perception. Affordance theory suggests that people perceive in order to operate on the environments and affordance properties of the environment in a direct and immediate way. Fjørtoft and Sageie (2000) reported that structures of landscapes in playground filled the functions for play and children perceived the function of the landscapes (i.e., affordance for play). Motivation may also play important role in relationship between people and environments, particularly in preservation behaviors. Previous studies suggest that adopting conservation practices is associated with extrinsic motivations including economic benefits (Napier et al., 2000; Napier and Forster, 1982), as well as intrinsic motivations, such as personal satisfaction (De Young, 1996; Christensen and Norris, 1983). Recently, Erickson et al. (2002) reported that intrinsic motivations and attachment to land are strong motivations for adopting conservation practices and also good determinants of which farmers may adopt conservation practices while extrinsic motivations are not significant factors in determining the likelihood of adopting particular conservation practices.

Some efforts have been made to investigate a potential relationship between landscape structure and human perception (e.g., Bell, 2001; Brown and Daniel, 1986; Brunson and Shelby, 1992; Buhyoff et al., 1982; Daniel and Boster, 1976; Ribe, 1990; Ruddell et al., 1989; Rudis et al., 1988; Schroeder and Brown, 1983; Schroeder and Daniel, 1980; Shafer et al., 1969). However, according to Purcell and Lamb (1998), only a few studies have considered the relationship between landscape structure and perception on an operational level (e.g., Antrop, 2000; Fry, 2001; Kenner and McCool, 1985; Schroeder, 1986; Schroeder et al., 1986). There are opposing opinions regarding the relationships between landscape structure and human preference. For instance, landscape perception studies have assumed that ecologically sustainable environments tend to be more attractive than degraded environments (e.g., Gobster, 1994, 1999; Nassauer, 1992; Thayer, 1989). However, according to some studies (e.g., Parsons, 1995; Steinitz, 1990), there are conflicts between ecological sustainability and aesthetic preferences.

Neighborhood satisfaction is the complex perceptual construct of a person based on his/her objective and subjective environments and personal characteristics (Amérigo and Aragonés, 1997). Based on systematic theory (Amérigo and Aragonés, 1997), it is believed that as a part of the environment, perceived landscapes within neighborhoods affect neighborhood satisfaction. Indeed, the presence of various forms of landscape elements such as trees within a neighborhood is positively related to higher levels of neighborhood satisfaction (Kaplan, 1983, 2001; Lee, 2002). Theories and models in landscape ecology (Tress and Tress, 2001), urban ecology (Grimm et al., 2000; Tress and Tress, 2001) and neighborhood satisfaction (Amérigo and Aragonés, 1997; Martinez et al., 2002) provide a hypothetical relationship among landscape function, landscape structure, human perception, and neighborhood satisfaction.

In light of these findings, we investigated the relationship between landscape structure and neighborhood satisfaction. We also tested a scale on the relationship between landscape structure and neighborhood satisfaction. In addition, we explored a methodological framework for integrating human aspects into landscape planning and management. The results can provide insight for planning and managing of landscapes that is favorable for both landscape sustainability and the satisfaction of residents. By considering the relationship between landscape structure and neighborhood satisfaction, our results can decrease the gap between ecological findings and related disciplines such as landscape planning, land-use planning, and environmental planning and management. To avoid creating adverse neighborhood environments for both humans and ecosystems, the findings of landscape ecological studies must be shared with planners and managers; this study can be a good way to initiate such integration because both planning activities and landscape ecology are linked through the spatial dimension of landscapes.