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Estimating the economic value of cultural ecosystem services in an urbanizing area using hedonic pricing

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ABSTRACT

A need exists to increase both knowledge and recognition of the values associated with ecosystem services and amenities. This article explores the use of hedonic pricing as a tool for eliciting these values. We take a case study approach, valuing several services provided by ecosystems, namely aesthetic quality (views), access to outdoor recreation, and the benefits provided by tree cover in Dakota County, Minnesota, USA. Our results indicate that these services are valued by local residents and that hedonic pricing can be used to elicit at least a portion of this value. We find that many aspects of the aesthetic environment significantly impact home sale prices. Total view area as well as the areas of some land-cover types (water and lawn) in views positively influenced home sale prices while views of impervious surfaces generally negatively influenced home sale price. Access to outdoor recreation areas significantly and positively influenced home sale prices as did tree cover in the neighborhood surrounding a home. These results illustrate the ability of hedonic pricing to identify partial values for ecosystem services and amenities in a manner that is highly relevant to local and regional planning. These values could be used to increase policy-maker and public awareness of ecosystem services and could improve their consideration in planning and policy decisions.

1. Introduction

Ecosystem services and amenities are clearly valuable, but, because their economic values are poorly recognized, they are often neglected in planning and policy making in the US. As a result, these services and amenities typically decline as American communities urbanize. Improved monetization of local and regional ecosystem services would serve to increase their consideration in local and regional policy making and planning, making them more difficult to disregard.

A number of methods exist for valuing these services and amenities. These include production function methods in which an ecosystem service or amenity is viewed as an input into the production of a marketed good and its value is estimated based on that good's price (e.g., Barbier, 2007; Barbier and Strand, 1998; Bell, 1997; Klemick, 2011; Richmond et al., 2007; Sathirathai and Barbier, 2001; Simonit and Perrings, 2011), replacement cost analyses that use the price of the least-cost alternative means for providing a service as a proxy for its value (e.g., Allsopp et al., 2011; Ashendorff et al., 1997; Hougner et al., 2006; Kovacs et al., 2011; NRC, 2000), stated preference approaches that use survey results to determine individuals' willingness-to-pay for an increase in a service or willingness-to-accept compensation for a decrease in a service (e.g., Boyle et al., 1994; Campos et al., 2009; Carson et al., 1992; del Saz-Salazar and Rausell-Köster, 2008; Earnhart, 2006; McGonagle and Swallow, 2005; Sayadi et al., 2009), and household production functions that value environmental goods and services based on the sale prices of marketed goods related to them (e.g., Abdalla et al., 1992; Bolitzer and Netusil, 2000; Brasington and Hite, 2003; Cavailhès et al., 2009; Cho et al., 2010, 2011; Conway et al., 2010; Geoghegan, 2002; Hardie et al., 2007; Harrington et al., 1989; Irwin, 2002; Jim and Chen, 2010; Leggett and Bockstael, 2000; Lew and Larson, 2005; Munroe, 2007; Netusil et al., 2010; Phaneuf et al., 1998; Poudyal et al., 2009; Siderelis et al., 1995; Snyder et al., 2008; Tyrväinen and Miettinen, 2000; Wilson and Carpenter, 1999). Each of these methods can estimate a portion of the economic value of an ecosystem service and is thus relevant to different applications for which economic values for services are desirable.

We consider hedonic pricing, a household production function approach, to provide a particularly relevant means for measuring

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the local and regional values of ecosystem services. Using this method, one can elicit the economic values for different levels of service delivery as reflected in the amount individuals pay for their residences or related goods. As such hedonic pricing models can help us understand an important portion of the value of ecosystem services, the portion that contributes directly to tax bases and that is thus particularly pertinent to community land-use policy. Using this method, the values of ecosystem services may be estimated straightforwardly using readily-available data. This method is also transparent such that local and regional planners and policy makers can readily understand how values are calculated and may apply them to decision making.

The present study explores the use of hedonic pricing to elicit the values of several cultural ecosystem services, ecosystem services from which people derive nonmaterial (e.g., recreational, educational, aesthetic, cultural) benefits (Millennium Ecosystem Assessment, 2005) using Dakota County, a rapidly-developing county in the Twin Cities metropolitan area (TCMA) of Minnesota, USA, as our study area. The services examined in this study include local aesthetic quality, access to outdoor recreation areas, and tree cover and associated services. This research makes a number of contributions to the existing literature:

1. Through this research, we identify the economic values residential property owners hold for the target services in this study area thus improving our understanding of the values of these services regionally.
2. This research provides valuable information for the evaluation of land-use policy. Several cities in Dakota County are considering policies aimed at protecting or providing vegetation, particularly trees, and public open space as well as preserving the local aesthetic quality of their environment. The results of this study will inform these policies.
3. This analysis and its results illustrate the utility and relevance of hedonic pricing as a method for estimating the values of ecosystem services and amenities and informing policy in general.
4. This study provides evidence to resolve discrepancies in the values of these ecosystem services as estimated by previous research in this study area as well as to provide a more thorough evaluation of their values through the calculation of a single hedonic model that incorporates these multiple services.

2. Past value estimates for ecosystem services

This study focuses on three ecosystem amenities and services of particular concern in the study area: the provision of areas for outdoor recreation, scenic quality, and tree cover. The first two of these are cultural ecosystem services. The last, tree cover, is not a service *per se*, but, rather provides a series of cultural, supporting, regulating, and provisioning services, among them carbon storage, local and regional climate regulation, enhancement of the aesthetic environment, and air pollution mitigation (Beckett et al., 2000; Brack, 2002; Dwyer et al., 1991, 1992; Ellis et al., 2006; Laverne and Lewis, 1996; Laverne and Winson-Geideman, 2003; McPherson et al., 2005; Nowak and Crane, 2002; Nowak et al., 2006a, 2006b, 2000c; Sailor, 1995; Scott et al., 1998; Simpson, 1998; Simpson and McPherson, 1996). The present study estimates the values of the services provided by tree cover with percent tree canopy cover acting as a proxy for these services. All services and amenities on which this study focuses have received some degree of attention in the economic valuation literature and were in many cases found to be valuable to humans, so it was expected they would be readily valued in our study. However, the values estimated in these studies vary dramatically even within the study area on which this paper focuses. Additionally, no studies have examined all of these services simultaneously. Thus, through this study we hoped to both resolve issues related to service values as well as to combine them in one hedonic model so that we might better elicit their values.

Open space, which provides many services including areas for outdoor recreation and enhanced scenic quality, has previously been found to contribute positively to property values. A literature review of 30 studies on the impact of parks on residential property values found that parks nearly always positively impacted property values (Crompton, 2001). Although these benefits varied considerably with the characteristics of parks, they were generally 10–20 percent of total property values and extended 500–2000-feet (approximately 150–610-m) from parks. More recent studies have supported these conclusions (Asaber and Huffman, 2009; Bolitzer and Netusil, 2000; Cho et al., 2006, 2010; Conway et al., 2010; Earnhart, 2006; Hobden et al., 2004; Jim and Chen, 2010; Lutzenhiser and Netusil, 2001; MacDonald et al., 2010; Poudyal et al., 2009; Waltert and Schläpfer, 2010; Wu et al., 2004). In general, these studies indicate the impact of open space on property values to be greater for natural area parks (Lutzenhiser and Netusil, 2001; Waltert and Schläpfer, 2010), larger parks (Cho et al., 2010; Tajima, 2003), and permanently-protected parks (Earnhart, 2006; Geoghegan, 2002; Irwin, 2002) and that the impact of open space on home sale price may vary with neighborhood context (Cho et al., 2008, 2010; Munroe, 2007). Although many studies have examined the value of open space, these studies are difficult to compare due to differences in their methodologies, study areas, and temporal coverage. However, nearly all studies indicate a positive economic value. As such, loss or creation of open space is likely to impact communities economically.

Scenic quality is commonly assessed by examining the characteristics of views. Previous studies that assessed view quality found that its value was often reflected in property values. A review of the economic values associated with views found that their impact varied, but that many view types had positive impacts on residential home values (Bourassa et al., 2004). Examination of the studies reviewed in this article as well as subsequent studies indicates that views of certain land-use and cover types, notably water (Benson et al., 1998; Bishop et al., 2004; Bourassa et al., 2004; Jim and Chen, 2006, 2009, 2010; Loomis and Feldman, 2003; Luttik, 2000; Sander and Polasky, 2009), forests (Cavailhès et al., 2009; Tyrväinen and Miettinen, 2000), grassy areas (Des Rosiers et al., 2002; Sander and Polasky, 2009), and urban parks (Bishop et al., 2004; Jim and Chen, 2006), positively impact home sale prices as do views with larger areal extents (Sander and Polasky, 2009). Views of built and industrial land-use types may negatively impact property values (Jim and Chen, 2009; Lake et al., 2000a, 2000b), while views of other land-use and cover types may have little or no impact on property values. The arrangement of features in views has also been found to impact home sale prices (Cavailhès et al., 2009; Cho et al., 2008). Thus, as view characteristics impact the values of single-family homes, they are likely to impact local tax bases. Because views are readily and irreversibly impacted by land-use change, they should receive consideration in land-use planning and policy making.

Tree cover in urban areas provides multiple ecosystem services some of which, particularly the provision of local scenic quality and climate regulation, may be capitalized in home sale prices. In general, studies indicate that tree cover enhances home sale prices and that impacts vary with geographic location, tree species, landscape configuration, and tree health (Cho et al., 2009; Dombrow et al., 2000; Holmes et al., 2006; Kovacs et al., 2011; Mansfield et al., 2005; Morales, 1980; Morales et al., 1976; Price