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Invest From the Ground Up!
The Benefits and Economics of City Trees and Greening

Abstract

Research in many nations demonstrates that city trees provide important environmental benefits (such as improved air or water quality). Yet some stakeholders or audiences may not find this information compelling. For instance, a series of studies has explored both merchants' attitudes about trees and shoppers' responses to the urban forest canopy. The research results support business investment in trees for urban sustainability and, more salient to retail interests, shows how trees enhance the appeal and success of business centres. This is but one example of the economic contributions of urban greening and city trees to local communities. This paper presents findings that pertain to the retail settings that are found in many cities, as well as other recent economic valuation findings. First, background concepts about urban resource valuation are provided. Then, a series of valuation findings are presented, starting with hedonic valuations of residential properties, then contingent valuations and retail consumer responses, and ending with the economic potential of urban greening for improving public health. The paper ends with suggestions for future research concerning city tree benefits and the economic implications for communities.

Introduction

City leaders and citizens have long recognised that nature in cities and towns provides beauty and respite. Tree planting has historically been an important element of beautification programmes in cities throughout the world. Aesthetics may still be the most commonly described benefit of city trees, parks and gardens. Local government leaders must balance ever-greater community needs against static or even declining public budgets. Many decision-makers weigh scientific evidence and economic valuations as the basis for public policy decisions. Even though they may privately acknowledge the positive experiential aspects of human encounters with nature, they must justify their public actions using empirical sources.

Recent research indicates that urban forestry and greening provide many environmental, social and environmental benefits. Much of the evidence about urban forest, parks and open space benefits has economic implications. Environmental benefits, such as stormwater management, better air quality and energy conservation, have been translated into economic terms. i-Tree (a set of software-based analysis tools made available by the USDA Forest Service) was initially orientated to urban situations in the United States; its monetisation calculations are now applied to cities in other nations.

In addition to the environmental services analysis provided by i-Tree and similar tools, extensive evidence about social services and human wellness provides additional opportunities for economic valuation. Claims of the profound benefits associated with the human experience of nature in cities now have significant scientific support (Kuo, 2010; Marcus and Sachs, 2013).

The economic aspects of human dimensions and nature-based social benefits are the focus of this chapter. Research evidence supports this value perspective.

Keywords:

behavioural economics,
consumer behaviour,
hedonic value,
property value,
public health,
valuation

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Three general domains of monetisation – confirmed and potential – associated with urban forestry and urban greening are described: residential property values, retail responses and behaviour, and human health and wellness. The results illustrate the fundamental importance of city trees, parks, gardens and greenspaces for the quality of life and economic vitality in any community – important concerns for many local leaders.

Economic Valuation Methods

City trees and nearby nature provide a wide variety of public goods and services. Tangible goods, such as timber products or food, are limited. While not impossible, the economic valuation of 'intangibles' is less straightforward than supply and demand pricing. Benefits research continues to expand our understanding of the environmental and social public goods provided by urban forests (Wolf, 2008).

The public goods provided by city trees and greening differ from market goods in several ways, raising important questions about who will pay for the costs of urban forest management, and who will benefit. Generally, the consumption of benefits by one person or entity does not reduce the amount available for another (Samuelson, 1954). Second, such consumption is non-excludable. That is, it is nearly impossible to exclude non-paying individuals from consuming a public good. For example, any number of people who walk under a street tree will enjoy its shade and beauty irrespective of who pays for the planting and maintenance of the tree. This contrasts with trees grown for timber harvest, as owners of such a forest can legally exclude others from using it, and once consumed (i.e., harvested) the forest will not be used again for many years.

Market-based pricing is infeasible for many of the public goods provided by city trees, so quantifying their economic value is performed through analysis of observed or hypothetical behaviour. Hedonic pricing uses the sales prices of buildings or properties to isolate the effect of environmental attributes on property values. The Travel Cost Method (TCM) uses the cost of travel incurred by visitors to a specific site or event to estimate the willingness to pay (WTP) to visit the site. The contingent valuation method (CVM) asks survey respondents to identify WTP for improvements, or the willingness to accept (WTA) payment for damages to a resource. Similarly, discrete choice experiments also elicit WTP and WTA, but can include multiple levels of attributes at different cost levels. The results can be used to create a ranking of preferences for alternative conditions or scenarios.

Other approaches are possible, yet have been rarely applied to the social benefits of urban forest and urban greening. These include factor income, avoided cost, replacement cost and opportunity cost. For more in-depth explanations of environmental economic methods, see Champ *et al*. (2003) or Tietenberg and Lewis (2011).

Decision-making in the public realm typically makes use of more than one estimation method to capture all benefits and costs. Benefit-cost analysis (BCA) calculates the total expected benefits and costs of a project or conditions over time and discounts them to a net present value. The overall goal is to identify the option(s) that will provide the greatest net benefit. Cost-effectiveness analysis (CEA) compares the relative benefits and costs of multiple means of reaching the same goal by identifying the cost differentials associated with the different approaches. The option that meets the objective for the least cost is selected. In both instances, an adequate representation of city tree and greening is needed for thorough analysis by local governments.

Residential Property Values

The hedonic price method is perhaps the most commonly used city tree valuation approach, as it estimates the effects of environmental amenities on house prices. Observed market prices for a market good with multiple attributes can be statistically pulled apart to uncover the value of a particular trait for which there may not be an overt indicator of value. Real estate sales data typically include parcel, structural and neighbourhood traits. Employing GIS locational data about environmental conditions and quality allows estimates of the relationship between the variability of one characteristic (such as the number of trees in a yard or building floor space) and property value by holding the other variables constant. One drawback of the method is that it only measures the perceived value of nearby property owners, but not of people who are some distance away and may benefit (such as residents adjacent to a greenbelt versus those who visit to use a trail).

Studies using hedonic methods concerning the effects of trees fall into two main categories: those that estimate the value of proximity to wooded areas, such as parks and open space, and those that estimate the value of individual trees. While there is variability as to the degree of the price effect, there is a general trend in the literature of increased value associated with the presence of trees. The following review is adapted from Donovan and Butry (2010).

Wooded Areas

An evaluation of the effect of adjacency to Forest Commission land in the United Kingdom found that the presence of broadleaf trees within a square kilometre of a house increased the sale price, whereas Sitka spruce decreased the sales price (Garrod and Willis, 1992). A study in Finland found significant positive effects on apartment sales prices based on proximity to watercourses and wooded recreation areas (Tyrväinen, 1997). Another study in the same country (Tyrväinen and Miettinen, 2000) estimated the effect of proximity to a forested area on house prices, and concluded that a 1 km increase in distance from a forested area reduced the sales price by 5.9%, and that a forest view increased the sales price by 4.9%. Considering the impact of different types of forest cover on the value of land parcels, Mansfield *et al*. (2005) found that adjacency to private forests added value to houses, but adjacency to institutional forests did not. An interesting multivariate approach was used to evaluate the combined effects of tree cover and proximity to chemical facilities in a Texas (USA) community. Tree cover positively influenced house prices and proximity to a chemical facility decreased house prices, although tree cover partially mitigated the negative effect (Lee *et al*., 2008). Finally, considering the urban forest canopy, Vesely (2007) used CVM and surveyed residents of 15 New Zealand cities; respondents were willing to pay $184 NZD annually to avoid a 20% reduction in tree cover.

Individual Trees and Parcel Tree Cover

When examining the effect of trees and other landscaping on the sales price of houses in Quebec Urban Community (Canada), Des Rosiers *et al*. (2002) found that an increase in the proportion of tree cover on a lot relative to the surrounding area increased the sales price. However, if the tree cover increased too much, there was a negative effect on the sales price. Finally, trees had a bigger impact on the sales price in areas with a higher proportion of retired people. Morales (1980) examined tree cover and house sales in Connecticut (USA), and concluded that good tree cover added 6% to the sales price of a house. Anderson and Cordell (1988) studied the effect of front-yard trees on houses sales in Georgia (USA), and found that intermediate to large sized trees were associated with up to a 4.5% increase in the sales price, indicating that trees can increase property tax revenue. Culp (2008) looked at more detailed tree attributes and outcomes in considering market outcomes for homes (in Pennsylvania, USA), and found that trees overhanging one side of a house reduced the sales price, while mature trees on the property increased the sales price. Time on the market (TOM) was also analysed. Trees on three sides of a house's lot reduced the TOM by over half, while large trees at the rear of a house also reduced TOM, but showed a smaller effect.

Donovan and colleagues conducted a series of studies in Portland (Oregon, USA), finding that, on average, street trees added $8,870 USD to house sales prices and reduced TOM by 1.7 days (Donovan and Butry, 2010). The price effects were found to 'spill over' to the price of houses within 30 m, adding value to adjacent homes. Another study focusing on the rental prices of single-family homes found that an additional tree on a house's lot increased the monthly rent by $5.62 USD, and a tree in the public right of way increased the rent by $21.00 USD (Donovan and Butry, 2011). Extrapolating from the Portland data on home sales, local property tax rates and parcel-assessed values, Donovan and Butry (2010) estimated that street trees increase property tax revenues across the city by an annual value of $15.3 million USD. The maintenance costs to sustain quality street trees are substantially less, yielding a benefit-cost ratio of nearly 12 to 1.

Retail Environments

Central business districts are the retail and civic centres of many urban neighbourhoods and smaller cities. As business associations implement district improvements and strategies to attract and retain shoppers, some retailers may overlook the effects of a quality streetscape on a visitor's experience.

The direct costs of an urban forest improvement programme can be readily tallied; assessing the consumer response benefits is more difficult.

The basis of consumer behaviour has changed in recent decades (Joye *et al*., 2010). Traditional economists once maintained that shopping was a highly rational process of goal setting and achievement. While the retailer-consumer relationship still involves rational transactions, it also includes a variety of non-economic factors. Shopping has become much more than an activity of necessity, and now has leisure and entertainment components. Despite extensive retail research, the aspects of the retail environment that attract customers and encourage them to purchase are not completely understood. The concepts of behavioural economics and neuromarketing have been applied to marketing in recent years to pursue a better understanding of economic and retail behaviour.

Value Approaches

In the absence of observable behaviour (such as travel or a house prices), stated preference methods can yield monetary valuations for urban greening amenities. Typically, the contingent valuation method approach poses hypothetical scenarios that have descriptions of alternatives. Respondents express their willingness-to-pay for a proposed nature improvement (such as a new park or restoration of an existing park), or willingness-to-accept payment for the loss or decline of a natural element (such as the loss of a scenic view). The survey or interview responses then produce an estimate of the economic value for a selected population of people of an environmental amenity.

A series of studies explored the psychosocial response of shoppers to outdoor consumer environments (Wolf, 2004; Wolf, 2005). Surveys were used to evaluate how business district visitors respond to the presence of a quality urban forest canopy. These research questions focused on the relationship between variations in urban forest canopy presence, and guided the presentation of place scenarios:

- visual quality, or the degree to which people judge a setting as pleasing and desirable
- place perceptions, meaning the mental representations or assumptions that one infers from an outdoor setting
- patronage behaviour, including the stated frequency and duration of shopping actions, such as length of visit
- price perceptions, represented by consumers' willingness to pay for products and services.

Additional questions explored attitudes about benefits and annoyances that consumers may associate with trees, and how business people may differ from consumers in their preferences and attitudes towards trees.

Each study involved two sampling approaches. Across the research studies, the sampling of retail environments included the 'main street' business districts of large, mid-size and small cities of the United States. Districts were selected based on architectural characteristics, the status of revitalisation programmes and the socio-economic status of neighbouring residential areas. Respondent sampling across the studies typically included randomly selected nearby visitors from within a buffer distance of the targeted business districts. Replicate studies also evaluated commercial areas adjacent to freeway roadsides and small malls.

mean 4.00, sd 0.60 | mean 3.17, sd 1.04 | mean 1.95, sd 0.61

Figure 1: Respondent ratings for 'how much do you like this image?' summarised as visual preference mean scores using a scale of 1-5.

Research Results

An overview of the studies and results can be found in Wolf (2014). Not surprisingly, respondents judged places with larger trees to be places with better visual quality (Figure 1). Across business district settings, shoppers claimed a WTP from 9 to 12% more for products in downtown business districts with trees versus comparable places without trees. Respondents also claimed a willingness to travel greater distances and for longer periods to reach a canopied district, thereby expanding the consumer catchment area. While the monetisation was an important result, additional significant results indicated that customer service, merchant helpfulness and product quality were all judged to be better in places with trees (Wolf, 2005). Drivers viewing commercial settings (such as auto sales and motels) from a high-speed highway expressed more positive impressions of a community with a roadside landscape that included trees, claiming a WTP from 7 to 20% more for goods and services there (Wolf, 2006).

A four-concept framework guided the trees and retail research programme: visual quality, place perceptions, patronage behaviour and price perceptions. While focused on retail environments, the results suggest that there are mediating psychological perceptions and inferences about the character of a place, the people within and the role of trees as a signal of potential positive experiences. The full cohort of measures yields insights as to why shoppers may be willing to pay more for products in central business districts that have a quality urban forest. It is important to note that each of the studies asked respondents to indicate their responses to entire districts, each with a unified character throughout, and not to individual merchants or shops that may or may not have had fronting trees. Investing in district-wide urban forestry improvements provides perceptual richness and a sense of place for visitors, with potential revenue implications.

Public Health and Wellness Opportunities

Studies about the psychosocial benefits of the human experience of urban nature provide a substantially broader basis for economic valuation. Emanating from public health, environmental psychology, sociology, urban planning, urban forestry, geography and other disciplines, a diverse assemblage of studies display a consistent pattern of positive outcomes associated with nature contact. To date, efforts to derive monetary expressions of the benefits have been limited.

Nearby Nature for Human Health and Wellness

Until recently, analysts regarded the reported benefits of urban greening for human health, happiness, functioning and spirit as important, but not quantifiable. In recent decades, researchers have employed high-quality science methods, providing two outcomes. First, the observed benefits of restorative experiences and social renewal due to time spent in gardens and parks that have been intuitively noted for centuries are now confirmed. Second, and more important, the systematic, critical approaches of science have revealed greater texture and dimension in the human relationship with nature. We are now able to describe benefits in terms of psychology, physiology and sociology, and to recognise variability across place, time and human groups. This critical mass of knowledge provides urban greening advocates with substantial evidence about the importance of having trees, parks, gardens and green spaces in cities.

A content analysis and review of publications about the relationship between urban greening and human health and well-being has revealed more than a dozen themes of services and benefits, supported by more than 3,000 scholarly publications (GCGH, 2014). This evidence base spans nearly 40 years (Wolf, 2012). Many human services are provided by small-scale nature elements that are in close proximity to the everyday places of neighbourhoods and communities. The expanded understanding of benefits through the application of empirical methods in the social sciences, applied disciplines (such as urban planning and landscape architecture), epidemiology and public health has emerged in just the past several decades, perhaps corresponding to the accelerated urbanisation of the planet in recent times. Nonetheless, assessments of the potential economic values provided by such services have been limited (Bratman *et al.*, 2012).

My colleagues and I propose a thematic framework (Figure 2) to summarise the broad array of services and benefits provided by metro nature and urban greening, as generated by both constructed and

ecological landscapes. The economic implications of city trees and nearby nature will be proposed below while the key elements of the framework are introduced.

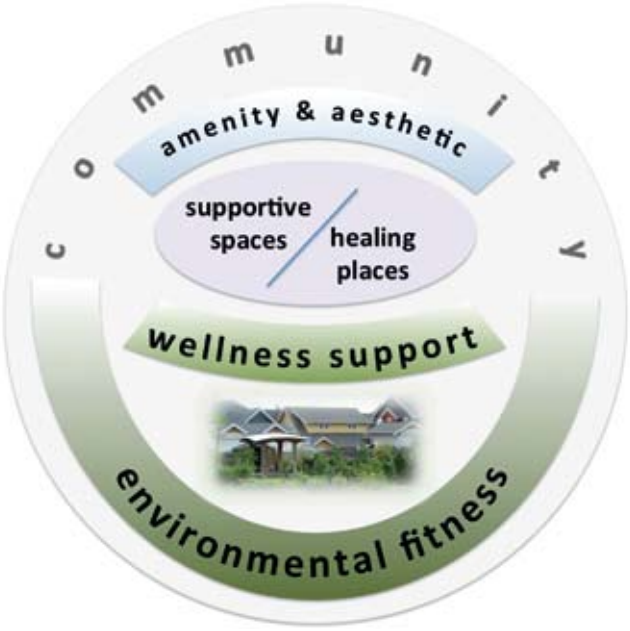

Figure 2: Thematic framework for metro nature health and wellness benefits

Environmental Fitness

The best practices and systems of a sanitary city provide the most basic conditions necessary for the good health of all city residents, such as clean air and water, and the absence of toxins (Pincetl, 2010). Thus *environmental fitness* is the baseline condition of environmental support for human health. Environmental protection agencies attempt to monitor and regulate the potential harmful impacts of pollutant emissions, materials dumping and industrial and agricultural by-products. Urban forests and green infrastructure are increasingly utilised as a prevention or mitigation strategy in both regulatory and voluntary efforts to sustain healthful environments within cities.

Wellness Support

General *wellness support* describes the ubiquitous conditions that enable baseline human health conditions. Industrialised cities have grey infrastructure systems that support hygiene and basic human welfare (such as potable water and sewage treatment systems). In addition, research in recent decades indicates that having equitably distributed green systems such as parks, community gardens, trees and greenspaces provides supplemental benefits. Having nearby greenspace within one's neighbourhood is associated with positive effects across the human life course, from infant birth weight (Donovan *et al.*, 2011) to elder mortality (Takano *et al.*, 2002). Loss of city trees and nature is associated with increased cardiovascular and respiratory illness (Donovan *et al.*, 2013). Convenient and pervasive access to nearby nature includes passive views from home and during travel, greenspaces within walkable distances and active encounters with nature (such as gardening and tree planting), all of which are nature experiences that support positive physiological, cognitive and emotional outcomes.

Supportive Spaces and Healing Places

Certain landscapes, often fairly small in size but containing more detailed design treatment, may heighten human performance and function. Within cities are facilities and institutions where one conducts routine activities (such as school or work) or accesses intermittent healing services or assistance (such as medical care or therapy). Studies have found that nature is supportive in human performance situations, such as reduced workplace absenteeism (Kaplan, 1993) and high school success (Matsuoka, 2010). A more extensive literature indicates that both passive experiences of nature and the directed activity of horticulture therapy can aid people in both physical and emotional healing. *Healing places* are dedicated, constructed spaces and may include specific design elements that engage people to achieve specified experiences or outcomes. Such places include healing gardens within hospitals, horticulture therapy gardens and sacred spaces (such as memorials). In contrast, *supportive spaces* are the expressions of nature that are adjacent to and augment the places where people work, learn or study; they provide benefits but not necessarily with the direct intention of healing spaces.

Amenity and Aesthetics

Aesthetic enhancement is perhaps the most commonly perceived benefit of trees, parks and greening. While urban greening initiatives are ever more frequently premised on environmental benefits,

the term 'beautification' is commonly used in public appeals for greening support. Green industry firms often rely on appeals to their clients' sense of emotion and beauty (such as LoveYourLandscape.com). The City of Seattle (USA) conducted marketing research to develop residential outreach programmes for homeowner tree planting to boost canopy cover; citizen responses about the beauty, wonder and spiritual connection to trees were more common than responses about trees' environmental services (Seattle ReLeaf, 2013). Urbanites' stated appreciation of urban nature may focus on aesthetics, yet research indicates significant psychological and physiological responses following even brief exposure times, and a person may not be conscious of such outcomes.

Community

Due to local government commitments to sustainability and participatory urban planning, citizens are becoming ever more involved in urban greening planning, implementation and management. In resurgent cities, programmes to clean up vacant lots, restore parks and create community gardens are often markers of community recovery (Harnik, 2010). These acts of civic ecology can lead to social engagement and cohesion, perhaps improving local social resilience (Krasny and Tidball, 2012). Studies that address neighbourhoods or general human populations suggest that nature-based activity develops the social foundations that can support disaster recovery (Tidball, 2012; Tidball and Krasny, 2014). Having adequate and well-managed landscapes and natural capital are associated with greater neighbourhood satisfaction and social cohesion and reduced incivility and crime.

Health Valuation Methods

As described earlier, there are a number of applied methods that can be used to estimate the economic or monetary value of environmental attributes. The health economics field is similarly well defined. Some approaches are used across both fields, including avoided or replacement cost, as well as decision-analysis frameworks such as benefit-cost analysis, cost-effectiveness and cost-utility. Stated preference methods were developed in environmental economics, but are becoming more widely used in the medical economics literature. For further details of health economics approaches, see Culyer and Newhouse (2000) or Drummond *et al*. (2005).

Health economics methods largely centre on the cost of illness and treatment. Many of the methods described earlier can be applied to disease prevention and therapies. In addition, evaluations are performed using decision-making frameworks. The Value of Statistical Life (VSL) represents the aggregation of individuals' willingness to pay to reduce the incidence of preventable death across a population. Burden of Illness methods estimate the economic burden of diseases and the potential savings associated with the eradication of a disease. Quality-Adjusted Life-Year (QALY) provides a measure of the number of life years and quality of life for those years added by medical treatments and disease prevention.

Based on the literature on urban greening and human health and wellness, it seems that avoided cost valuations show much promise. Nature-based benefits may provide cost-saving mitigations, as well as reduced levels of treatment or therapies. Such savings accrue as a result of actions that reduce expenses for materials, medication, human resources or professional services. Avoided costs may accrue to individuals, households, institutions or across communities. For instance, improved mental health due to experiences of nature may reduce treatment and medications costs to individuals, as well as the level of services required of public agencies.

Valuation Opportunities

The nature-based services described above are potentially available to all urbanites, and are generated by city trees and other urban greening elements. Community investment in urban green systems is necessary to achieve optimal levels of such services. The research literature describing associations between the experiences of nature in cities and improved human wellness and function has rarely expressed its findings in economic terms. Highlighting the full complement of benefits and their associated economic values can provide decision makers and urban planners with important information when making decisions about trade-offs of public investment in these public goods.

Multiple economic situations are imbedded in the everyday lives and activities of people of all ages.

Analogous to the relationship of the sales price margin for a parcel and property tax revenue across an entire city, the per-person increment in value may be modest, yet the cumulative effects across an entire city or region can be substantial. For instance, studies reporting improved school performance and workplace outcomes (such as reduced absenteeism and better task attention) may be fairly low-cost interventions that can boost human performance. The more complete body of literature about the prescribed use of nature in healing or therapy suggests substantial deferred costs sums. The experience of nature is unlikely to be a full substitution for medication and treatment services, but even a modest reduction in individuals' use of expensive medical procedures can quickly accrue major cost savings for medical facilities, insurers and public health systems.

One of the most promising valuation opportunities may be the relationship between outdoor space and active living, given the high costs of treating the chronic diseases associated with obesity (such as diabetes, heart disease and stroke). Preliminary research suggests that quality parks, open space and streetscapes contribute to activity behaviour. The potential economic consequences of routine, mild physical activity are enormous when aggregated across regions, entire cities or a nation. Deferred costs are possible, as medical expenses are lower for people who do routine physical activities and exercise. For instance, a US Center for Disease Control study estimated that obesity-associated annual hospital costs for youths aged 6 to 17 were about $35 million USD between 1979 and 1981, and nearly tripled to $127 million USD during 1997-1999 (Wang and Dietz, 2002). Weight-related medical expenses for adults are equally alarming, as trends of increased weight gain and associated chronic disease impact the business sector; costs estimates for workers include direct and indirect medical care, workers' compensation and lost productivity.

Summary and Future Research

This article is a succinct overview of economic valuations associated with human experiences of city trees and urban greening. Some valuations are associated with specific land uses or zoning types, and others, particularly the emergent evidence on urban greening and public health, may be applicable across almost all land within a city. A brief overview was presented about positive parcel sales prices correlated with the presence of trees, landscape quality and proximity to forested lands. This was followed by evidence of positive interactions between *biophilia* and retail, a field of study that is limited but important to local community economics. Finally, the potential monetisation of urban trees and greening and relationships to improved human health, wellness and function was considered.

Economics in Local Policy

Proposals that incur public costs or affect private development are often supported by advocates with evidence on how much financial value will be gained or lost should the proposal go forward. Meanwhile, those who favour conserving or creating non-commodity nature can be at a disadvantage in political debates if they cannot speak in economic terms. The lack of a monetary representation of value for city trees and greening suggests that the public costs of urban greening are not offset by any economic gains (Boyer and Polasky, 2004).

Yet government authorities invest in public resources that members of society intuitively accept as providing value, some examples being education, emergency response systems and transportation. Public officials may be more willing to invest in nature-based public goods if presented with estimates of benefits and services that can be considered against economic returns from development or foregone payments for other municipal infrastructure. A fair comparison of policy alternatives requires that all the consequences of a proposal be weighed, not just aspects that are readily measured using market-based monetary terms. Non-market valuation approaches for natural resources have more frequently been applied to rural land or forests; here I have shown how such methods are applied in urban situations, with examples of actual and potential valuations.

Trade-offs

Scientific understanding about how city trees and greening benefit people has expanded substantially in recent decades. Nonetheless, there is a lag in policy response, as municipal leaders may still regard

urban nature as a beautification strategy, or the 'parsley around the pig'. Some people are critical of the construction of non-market valuations of nature services, as the process is fraught with uncertainty and assumptions. It is important to recognise that the point of valuation analysis is to frame public choices and make clear the trade-offs between alternative investments and outcomes (Boyer and Polasky, 2004). How do the costs and benefits of investments in natural capital compare to investments in other urban services such as law enforcement or education? Is the trade-off worthwhile? These are the types of questions for which even preliminary valuations can provide useful information.

Monetisation Cautions

Trees and forests provide diverse environmental services such as air and water quality improvements, flood control and wildlife habitats. Recent research points to additional human health and wellness benefits. Both sets of benefits extend beyond the boundaries of a single parcel or place, but may be invisible to property owners and users. Urban forest analysis tools (such as i-Tree of the USDA Forest Service) address the economics of distributed services, attempting to capture the value of human well-being using hedonic analysis.

The techniques of non-market valuation are still formative and not widely applied in urban settings. Local decision makers may not understand the nuances of resource economics, and may assume that a preliminary, single-method assessment represents the sole economic contribution of trees. As suggested here, the true and full value of city trees and urban greening is probably greater than the value estimated by any single valuation method.

There is a broader philosophical issue (Wolf, 2007). If local communications about trees focus exclusively on costs and economic value, there is the risk of reducing the meaning of trees to a single indicator. Economic calculations may be an awkward and incomplete way to describe the range of values that quality trees, parks and gardens contribute to quality of life in communities. For some people, there are deeply held meanings and principles that extend beyond economic calculations of nature. Keen observers of nature have noted the beauty and restorative qualities of trees for centuries. Recent research confirms those intuitions, and adds greater breadth and depth of understanding. Public dialogue about trees in terms of the estimation of their value can bring urban forest concerns into budget and policy deliberations, but may also narrow the scope of public debate about the importance of trees in communities.

Future Research

There is increasing public recognition of the contributions of city trees and urban greening to green infrastructure functions, urban sustainability and quality of life. Economic valuation is an analytic approach that can be used to concisely represent the importance of integrating nature elements with other urban systems (such as housing, transportation and health services). Recognising the limitations of economic valuation, what are the additional research and analytic needs?

The hedonic valuation of parcels is perhaps the most consistently and rigorously applied method for estimating the value of human responses to trees and nature. Whilst this approach provides information about the marginal values associated with trees and landscape character, there is little theory or indication concerning why people may be willing to spend more. Meanwhile, the research on consumer responses to the urban forest in business districts includes pricing statements and perceptual variables. Inferences about merchants, product quality and positive experiences are associated with the presence of a quality urban forest canopy. Thus, positive cognition and emotions appear to influence price responses, findings that are consistent with the premises of behavioural economics. Finally, the evidence on the role of urban nature in wellness, healing, therapy and improved human function indicates the deeper connections between *biophilia* and economics.

There are several sets of questions that are important for future research:

What are the underlying reasons for higher property values as detected by hedonic valuation? At this point in time residential hedonics may be a proxy for multiple important human responses, and a better understanding of the contributing dynamics may help to build a stronger case for community investment in city trees and landscapes.

Hedonic valuation is often used to represent the full range of human responses to city trees. The substitutability of hedonics as a representation of more specific responses and values may be adequate for some benefits, but not for others. For instance, referencing the benefits framework described earlier, the hedonic valuation of residential parcels may indicate value for general wellness. But as people engage in work or school, or have need for medical or therapy services, the support provided by nature in settings away from home is not now well represented in such valuations.

The evidence on human responses to nature is complete enough to suggest that people respond differently at various stages within the human life course. Consideration of the unique responses of children, as compared to adults and the elderly, suggests that more detailed valuation approaches are needed to provide a comprehensive understanding of economic functions. At different ages and stages in life the provision of urban nature has varied cost and income implications.

Finally, this treatment of human response economics is similar to efforts to monetise other ecosystem services. While many ES valuation studies focus on a particular ecosystem and a single service (such as a forest preserve and potable water supply), there is growing interest in the concepts of service bundling and co-benefits (Raudsepp-Hearne *et al*., 2010). Considering the restrictions on parcel availability and plantable spaces in cities, a multi-tasking approach to the planning and design of nature installations and management is essential. Looking forward, it would be important to include economic valuation as a tool to determine the optimal cohort of services to be provided by a nature element. For instance, green infrastructure could be planned to manage stormwater and co-designed to provide a healing garden within a large hospital complex, with the monitoring of both functions to include benefit-cost analysis.

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