Literature Supporting Claims Regarding the Economic Benefits of Plants

Listed in chronological order


High concentrations of people and economic activities in urban areas have strengthened the links between cities, health and the environment. Cities are not only responsible for environmental and health problems but also they hold the key for a greener economy and a sustainable future. Urban built environment is a policy field where appropriate policies and actions could yield significant human and ecological benefits. Among different elements of urban built environment, buildings deserve particular attention due to their large contribution to environmental and health problems. The concept of sustainable (green) building is a recent response to address the problems that stem from the building sector. However, the widespread implementation of the concept is hindered by significant challenges. This paper argues that manifestation of multiple benefits that sustainable buildings deliver could help overcome some of these challenges. The paper presents the extent to which green buildings could generate co-benefits, and underlines the opportunities and barriers to push green building agenda forward.

The results indicate that green and sustainably renovated buildings could yield significant benefits in terms of energy and CO₂ reduction, cost savings, and improved health situation for building users. The case study buildings with the best two performances are found to achieve 33% and 26% reduction in energy use intensity, and 38% and 32% reduction in CO₂ emissions intensity in comparison to benchmark values. Reduction in energy consumption in the top two buildings corresponds to an energy cost saving of $1–1.5 Million per year per building. Furthermore, the top two buildings are found to provide improved healthy environment due to improved indoor and ambient air quality, better thermal comfort and more natural lighting indoors. Making more explicit the multiple benefits of sustainable buildings needs further consideration in this regard. We recommend that the public sector could take key actions to accelerate the number of green buildings including fiscal support, technical assistance and policy reforms.


Objective We investigated whether families with lower individual-level socioeconomic status (SES) reside in less green neighbourhoods in four areas in Germany. Methods Data were collected within two German birth cohorts – GINIplus and LISAplus. Net equivalent household income was categorized into study area-specific tertiles and used as a proxy for individual-level SES. Neighbourhood greenness was calculated in 500-m buffers around home addresses as: 1) the mean normalized difference vegetation index (NDVI); 2) percent tree cover. Associations between income and neighbourhood greenness were assessed per study area using adjusted linear regression models. Results In the Munich and Leipzig areas, families in the low and medium income tertiles resided in neighbourhoods with lower NDVI compared to those in the high income tertile (mean percent change in NDVI: −4.0 (95% confidence interval = −6.7 to −1.3) and −5.5 (−10.9 to −0.2), respectively). In
contrast, in the Wesel area, families in the low income tertile resided in neighbourhoods with higher NDVI (2.9 (0.5–5.3)). Only the association in the Munich area was replicated when using tree cover instead of the NDVI. Conclusions This study provides suggestive evidence that the presence and direction of associations between greenness and SES is region-specific in Germany. The degree of urbanization did not clarify this heterogeneity completely.


In recent years, landscape liveability has become a leading objective in policy and strategic planning. In the anthropocentric view of landscape, ecosystems fulfil important societal needs similarly to urban systems. Urban systems can meet a variety of such needs through Urban Services, which are historically and typically provided within cities. In this view, Ecosystem Services (ES) and Urban Services (US) influence landscape liveability in a comparable manner, so that liveability assessments based on both ES and US can be effective for landscape planning and policy-making purposes. As liveability is strongly dependent not only on objective landscape features, but also on the subjective perception of stakeholders, their involvement becomes essential for a coherent liveability assessment. The present study aims to develop a LIveability Spatial Assessment Model (LISAM) capable of considering both the local accessibility of services and their perceived relevance as expressed by stakeholders. To this end, a conceptual framework to detangle the spatial relationships between service sources, sinks, and delivery points was developed. From this base, consistent and comparable ES and US indices were calculated using GIS spatialisation techniques and then aggregated hierarchically through a Spatial Multicriteria Decision Making Analysis approach. Results include relevant maps showing explicit spatial indices of liveability that integrate, at various hierarchical levels, the local accessibility of ES and US, along with their local perceived relevance. By calculating complex indices able to highlight both the agri-natural and urban system roles on landscape liveability and by taking subjective and objective aspects into account, the model proved to be effective for spatial decision-making. In future applications, indicator and weight uncertainties should be considered and adequately analysed to assess reliability of the final output. The integration of ecosystem and urban disservices would also be relevant for including those landscape factors that reduce the overall level of place liveability.


Green spaces provide various kinds of ecosystem service functions. Though some of them, such as the carbon-sinking and biodiversity preservation functions are of value to everyone, others, especially those related to aesthetic and recreational functions, only benefit people who have direct access to green spaces. In urban settings, where ecosystem services in the second category prevail, this means the spatial dimension of urban green spaces, including their richness, accessibility, shape configuration, and distributional characteristics, may considerably influence the realization of their ecosystem service value, and is therefore subject to scrutiny. In this paper, we study how the spatial pattern of urban green spaces influence the realization of their ecosystem service value by utilizing the Hedonic Price Modeling (HPM) method. Taking Beijing as the case, we use the price and other information in the city's developable land transaction records from 2000 to 2004 to construct the HPM, and use Landscape Ecological Metrics (LEM) as proxies of the spatial characteristics of urban green spaces. Four LEMs are used to measure the above mentioned spatial characteristics of urban green spaces. While subject to
certain shortcomings in data quality and quantitative estimations of the magnitude of the spatial effects cannot be made, results show that most spatial characteristics of urban green spaces do influence their ecosystem service value as embedded in land value, except for the shape configuration characteristic for which the study yields no result. Further, specifically for Beijing, results indicate that in order to effectively realize their ecosystem service value, green spaces should occupy between 2.20% and 13.40% of the total urban area, located within a 50–550 m range from other developments, with green space patches so divided that each patch occupies more than 3.00% but less than 62.50% of the total green space area, and the ecosystem service value will be at the optimal level when each patch occupies 20.00% of the total green space area. Lastly, we stress the practical significance of the findings, urging an integration of the spatial patterns aspect of urban green spaces in urban planning practices.


The use of urban vegetation in cities is a common landscape planning strategy to alleviate the heat island effect as well as to enhance building energy efficiency. The presence of trees in street canyons can effectively reduce environmental temperature via radiative shading. However, resolving shade trees in urban land surface models presents a major challenge in numerical models, especially in predicting the radiative heat exchange in canyons. In this paper, we develop a new numerical framework by incorporating shade trees into an advanced single-layer urban canopy model. This novel numerical framework is applied to Phoenix metropolitan area to investigate the cooling effect of different urban vegetation types and their potentials in saving building energy. It is found that the cooling effect by shading from trees is more significant than that by evapotranspiration from lawns, leading to a considerable saving of cooling load. In addition, analysis of human thermal comfort shows that urban vegetation plays a crucial role in creating a comfortable living environment, especially for cities located in arid or semi-arid region.


The presence of a park in a residential area plays an important role for residents living near the park. The focus of this paper is to examine the significance of a park to the house residents. The methods used in this study include interviews with the developer and a survey administered to the residents living near the park. The main findings gathered from the survey reveal that five most important ‘park-related factors’ to house residents are (i) good park elements, (ii) conceptual or design of the park, (iii) nearness to the park, (iv) existence of a view to the park, and (v) active area of the park facing the house. Other results also indicate that shade trees, lighting and butterflies are elements preferred to be presence in a park. This research provides knowledge on the preferences of house residents and the importance of parks in a neighbourhood. The information from this research is hoped to be useful to policy makers, local authorities, urban planners, developers, corporate bodies, individuals and other related agencies involved in park and residential property development.


Green infrastructure that provides cooling service is regarded as a critical urban planning strategy to mitigate urban heat. This study assesses important greenspace and matrix factors that contribute to greenspace cooling effect beyond greenspaces in Taipei metropolis using Landsat 8 satellite imagery. The results indicated that both greenspace and matrix features have jointly affected greenspace cooling intensity, but their cooling contributions to the mean temperature of greenspace and
that of surrounding built environments were not necessarily identical or explicit. Larger greenspaces with compact/simple shape, containing more water elements and higher greenness tended to be cooler, whereas higher development intensity, lower tree proportion and fewer water elements in the matrix tended to produce warmer built environments. The influence of these features on temperature outside greenspaces varied by distance. With the distance increasing from greenspaces, the effect of greenspace features dropped and that of matrix features rose.


Urban green spaces help to moderate the urban heat island (UHI) effects, and can provide important temperature regulating ecosystem services and opportunities for savings in cooling energy. However, because explicit market values for these benefits are still lacking, they are rarely incorporated into urban planning actions. Green spaces can generate a three-dimensional (3D) cool island that may reduce the cooling energy requirements within and around urban areas, but such 3D cooling effect has not been considered in previous studies quantifying energy savings from green spaces. This study presents a new and simple approach to quantify potential energy savings due to the temperature regulating ecosystem services of small-scale fragmented green spaces using the 3D simulation of the summer-day outdoor thermal environment in Nanjing, China. Field survey data and the microclimate model ENVI-met were applied to examine the outdoor 3D thermal environmental patterns at Gulou Campus of Nanjing University under two different scenarios: “with” and “without” green spaces. Modeling results were applied to quantify potential cooling energy savings based on the effect of green spaces on the outdoor urban environment and to calculate the cumulative temperature reduction due to green spaces using a regression model. The results show that, in the horizontal direction, the simulated distribution of wind speed and mean air temperature at 1.5 m height were closely related to the spatial distribution of the underlying surface types. Removal of green spaces increased mean air temperature by 0.5 °C (33.1 °C vs. 33.6 °C). In the vertical direction, removal of green spaces had little effect on the near-surface wind field; however, above the surface, the turbulence perpendicular to the main wind direction significantly increased. Quantification of the cooling benefits of green spaces in relation to the mean height of buildings on Gulou Campus yielded 5.2 W/m² cooling energy, saving totally 1.3 × 10⁴ kW h during a single daytime hot summer period. This case study corroborates the importance of green space for cooling and informs city planners and decision-makers on how microclimate is impacted by the loss of green spaces. These findings will facilitate preservation, planning, and design of green spaces to increase urban environmental benefits and to improve the microclimate of urban areas at neighborhood, city, and regional scales.


Using the City of Roanoke, Virginia as a study site, this paper quantifies the forest structure, ecosystem services and values of vacant and residential land. Single family residential land had more trees (1,683,000) than vacant land (210,000) due largely to the differences in land area (32.44 km² of vacant land vs. 57.94 km² residential). While the percentage of tree coverage was almost identical across land uses (30.6% in vacant to 32.3% in residential), the number of trees per ha is greater on residential land (290.3) than on vacant land (63.4). The average healthy leaf surface area on individual trees growing on vacant land was greater than that of individual trees on residential land. The fact that trees in vacant land were found to provide more ecosystem services per tree than residential trees was attributed to this leaf area difference. Trees on vacant land are growing in more natural conditions and
there are more large trees per ha. Assessing the forest structure and ecosystem services of Roanoke’s vacant and residential land provides a picture of the current extent and condition of the vacant and residential land. Understanding these characteristics provides the information needed for improved management and utilization of urban vacant land and estimating green infrastructure value.


The production components of an evergreen shrub (Ilex crenata ‘Bennett’s Compacta’) grown in a no.3 container in an east coast U.S. nursery were analyzed for their costs and contributions to carbon footprint, as well as the product impact in the landscape throughout its life cycle. A life cycle inventory was conducted of input materials, equipment use, and all cultural practices and other processes used in a model production system for this evergreen shrub. A life cycle assessment (LCA) of the model numerated the associated greenhouse gas emissions (GHG), carbon footprint, and variable cost of each component. The LCA also included the transportation and transplanting of the final product in the landscape as well as its removal after a 40-year useful life. GHG from input products and processes during the production (cutting-to-gate) of the evergreen shrub were estimated to be 2.918 kg CO2e. When considering carbon sequestration during production weighted over a 100-year assessment period, the carbon footprint for this model system at the nursery gate was 2.144 kg CO2e. Operations, combining the impact of material and equipment use, that contributed most of GHG during production included fertilization (0.707 kg CO2e), the liner and transplanting (0.461 kg CO2e), the container (0.468 kg CO2e), gravel and ground cloth installation (0.222 kg CO2e), substrate materials and preparation (0.227 kg CO2e), and weed control (0.122 kg CO2e). The major contributors to global warming potential (GWP) were also major contributors to the cutting-to-gate variable costs ($3.224) except for processes that required significant labor investments. Transporting the shrub to the landscaper, transporting it to the landscape site, and transplanting it would result in GHG of 0.376, 0.458, and 0 kg CO2e, respectively. Variable costs for postharvest activities were $6.409 and were dominated by labor costs (90%).


The concept of curb appeal and its impact on property values has been largely neglected in the real estate literature. In the context of retail real estate, curb appeal represents the general attractiveness of a store as viewed from the sidewalk or parking lot that is expected to affect consumer patronage decisions and consequently property values. We first develop a measurement instrument for curb appeal and assess its validity using exploratory and confirmatory factor analysis. Our results suggest that curb appeal is multidimensional and consists of an atmospheric, architectural and authenticity dimension. Then, we use survey responses, transaction data and spatial regression to quantify the impact of curb appeal on sales prices. We find that the atmospheric and architectural dimensions have a significantly positive impact on sales prices. We also show that curb appeal dimensions are highly correlated with observable building features traditionally included in hedonic pricing models.


Sustainability trends for buildings require new construction systems to foster energy efficiency and environmentally friendly buildings. Green roofs are interesting construction systems because they
provide both aesthetic and environmental benefits. This paper continues a long-term research in order to evaluate and improve the thermal behaviour and sustainability of extensive green roofs. Simultaneously, this research provides experimental data for specific Mediterranean continental climate conditions. The experiment consists in evaluating the energy consumption and thermal behaviour of three identical house-like cubicles located in Puigverd de Lleida (Spain), where the only difference is the roof construction system. The roof consists of a conventional flat roof with insulation in the reference case, while in the other two cubicles the insulation layer has been replaced by a 9 cm depth extensive green roof (comparing recycled rubber crumbs and pozzolana as drainage layer materials). The electrical energy consumption of a heat pump system was measured for each cubicle during 2012 and part of 2013. Both extensive green roof cubicles show less energy consumption (16.7% and 2.2%, respectively) than the reference one during warm periods, whereas both extensive green roof systems present a higher energy consumption (6.1% and 11.1%, respectively) compared to the reference cubicle during heating periods.


The growing awareness of the contributions of landscaping to real property and the eco-system in general has made real estate industry to integrate landscaping into property decisions. However, little is known about the individual’s willingness to pay for the landscape features as consumers do not really have a clear understanding of the landscape value and its connection to property investment. Thus, this study examined the tenants’ willingness to pay for landscape features, and the factors that determine their willingness to pay. Data was gotten from ninety-three (93) tenants of residential properties within Alagbaka Government Reservation Area (G.R.A) through structured questionnaire. The retrieved data were analyzed using the Frequency Distribution tables to analyze the socio-economic characteristics of the respondents, and Binary Logistic Regression Model based on the Contingent Valuation Method to analyze the tenants’ willingness to pay for the landscape features and the factors responsible for such choices. The study revealed that tenants are willing to pay bid amount of rent for the incorporation of landscape features into housing process. It further revealed that factors such as Length of stay, Fence and retaining walls, Income, Trees and Shrubs significantly influence tenants’ willingness to pay for landscaping. Therefore, the study recommended that landscape be encouraged and properly managed to ensure that it fulfills the full potential of its lifespan and for optimum returns from the properties.


Background: Nearly 40 years of research provides an extensive body of evidence about human health, well-being, and improved function benefits associated with experiences of nearby nature in cities.

Objectives: We demonstrate the numerous opportunities for future research that link metro nature, human health and well-being outcomes, and economic values.

Methods: We reviewed the literature on urban nature-based health and well-being benefits. In this review, we provide a classification schematic and propose potential economic values associated with metro nature services.

Discussion: Economic valuation of benefits derived from urban green systems has largely been undertaken in the fields of environmental and natural resource economics, but studies have not typically addressed health outcomes. Urban trees, parks, gardens, open spaces, and other nearby nature
elements—collectively termed metro nature—generate many positive externalities that have been largely overlooked in urban economics and policy. Here, we present a range of health benefits, including benefit context and beneficiaries. Although the understanding of these benefits is not yet consistently expressed, and although it is likely that attempts to link urban ecosystem services and economic values will not include all expressions of cultural or social value, the development of new interdisciplinary approaches that integrate environmental health and economic disciplines are greatly needed.

Conclusions: Metro nature provides diverse and substantial benefits to human populations in cities. In this review, we begin to address the need for development of valuation methodologies and new approaches to understanding the potential economic outcomes of these benefits.


The presence of metro nature enables daily environmental interactions, and a substantial body of evidence now demonstrates that nature contact generates extensive psychosocial, cognitive, and physical health and well-being benefits. Estimates of the economic values of such benefits have lagged similar valuation efforts for environmental services (such as improved air and water quality). In this article, using a life course approach, we estimate the potential annual value of six metro nature benefits, and cautiously extrapolate to a national scale, based on best available data and research. This is done by applying established economic values associated with epidemiology and public health to metro nature benefits estimates reported in prior peer-reviewed literature. The six situations of benefits valuation potential focused on: birth weight, attention deficit hyperactivity disorder (ADHD), school performance, crime, cardiovascular disease, and Alzheimer's disease. This benefits set demonstrates the importance of nature contact in urban areas over the course of the human lifespan. We estimate that the potential cost savings, avoided costs, and increased income range between $2.7 and $6.8 billion annually (2012 USD). Yet these values represent only a subset of benefits described in the current literature concerning urban nature experiences and health and well-being outcomes, pointing to the need for increased research concerning further valuations. We also point out challenges encountered in developing these estimates and limitations of their use. There is an urgent need to improve, expand, and integrate research methods and valuation strategies that link urban natural resources, public health, and economics. The resulting contributions to policy and programs can greatly improve urban quality of life.


Modern geographic information system (GIS) tools have allowed a more careful examination of how the physical characteristics of a property’s neighborhood and surrounding land uses are capitalized into property values. The ArcGIS Viewshed tool is a case in point: it identifies the cells in an input raster that can be seen from one or more observation points. In this study, we use the tool in a hedonic property value model that estimates a home’s sale price as a function of the percentage of its view that encompasses various “green” land covers—forest, farmland, and grassy recreational lands—as well proximity to such green spaces. We use 25 years of data from St. Louis County, Missouri, along with land cover data from 1992, 2001, and 2006, to estimate a property fixed-effects model. This approach, which minimizes the bias from omission of time-constant unobservable variables, is a methodological advance over some prior studies of the value of a view. We find that forest views negatively affect home prices, whereas farmland and grassy area views have positive effects (though only the farmland results are statistically significant). Proximity to each of these types of lands has value, however: more of each type in a close buffer around the property increases the property’s sale price. We hypothesize that our
results are related to two factors: the topography of the study area and the fact that farmland has been converted to development over time, leading to a relative increase in its value.


Garden centers are facing increasing market pressure from big-box retail stores that offer similar products at more competitive prices but lack a quality produce and exceptional service. In order to differentiate themselves from big-box stores, garden centers must build relationships with their customers which can increase marketing reach. Marketing ability and reach is limiting the expansion of Kansas garden centers which spend the majority of their advertising dollars on traditional media. However, social media can be an effective method for not only understanding consumers but also developing profitable relationships with customers. The purpose of this qualitative study was to explore the perceptions and experiences of stakeholders of metro and non-metro garden centers as they use new media to market their business. Findings indicate garden center stakeholders prefer to use traditional media channels to market to their customers, lack a clear strategy and objectives related to new-media marketing, and are not effectively implementing relationship marketing principles.


Contemporary cities have high stress levels, mental health issues, high crime levels and ill health, while the built environment shows increasing problems with urban heat island effects and air and water pollution. Emerging from these concerns is a new set of design principles and practices where nature needs to play a bigger part called “biophilic architecture”. This design approach asserts that humans have an innate connection with nature that can assist to make buildings and cities more effective human abodes. This paper examines the evidence for this innate human psychological and physiological link to nature and then assesses the emerging research supporting the multiple social, environmental and economic benefits of biophilic architecture.


Cities and towns can be conceptualised as complex social-ecological systems or landscapes that are composed of different spatial elements. Trees in urban landscapes provide a variety of tangible and intangible benefits (ecosystem services) that may be valued differently across diverse households and individuals. Here, we consider how the benefits and values of trees to urban residents vary across public and private spaces in three low income neighbourhoods in two medium-sized towns in northern South Africa. We find that the most asset poor residents in informal settlements derive significant benefits from the provisioning services offered by trees in natural green spaces on the ‘urban periphery’; in particular, they value supplies of wood for energy, whilst also recognising the importance of regulating services such as shade. Trees in such spaces help these immigrants cope with a lack of infrastructure, services and disposable income after their move to the city. In new, low-cost housing neighbourhoods, the importance of trees in providing shade and shelter in gardens is emphasised due to the hot and dusty nature of these settlements, while residents in older township neighbourhoods make more mention of the aesthetic value of trees in private spaces as well as the fruits they provide. In all neighbourhoods, attitudes towards trees in public spaces were mixed because of their perceived association with crime, although low income households did make extensive use of tree products from natural areas. The relevance of the results for urban planning and greening in low income areas is discussed.

Urban water bodies (bluespace) and vegetated open spaces (greenspace) are key sites for building urban sustainability, promoting social, economic, and environmental objectives and influencing human well-being. Building sustainable cities requires an understanding of how urbanities value these amenities, how values vary within cities, and of the factors influencing these values. Hedonic pricing, an economic-valuation technique, is commonly used to estimate values for green and bluespaces based upon home sale prices, but typical applications fail to identify how these values vary within cities, leaving a gap in decision-makers’ knowledge and limiting their ability to plan green and bluespaces that promote urban sustainability. The present study examines this issue by identifying spatial variation in the values of urban green and bluespace across the Twin Cities metropolitan area of Minnesota, USA using both global and local regression techniques. We find that the values of all blue and greenspace amenities examined vary significantly spatially and that values for these amenities can differ greatly from those estimated using global models. Importantly we find that that the influence of tree cover on home sale price is always positive when this relationship is significant and that the landscape context in which an amenity occurs impacts its value with features such as trails, water bodies, and wetlands being more valuable in locations with protected natural areas than elsewhere. We also find evidence that wealth influences access to blue and greenspace, in many, but not all cases, leading to reduced access to these features among poorer groups. These findings suggest that, when used in planning and policy-making, global values may lead to the provision of urban green and bluespaces that fail to meet the needs and desires of local residents. Identifying variation in these values, as in this study, will facilitate more targeted planning of green and bluespace and thus more liveable, sustainable cities.


Can different types of greenery improve the perceived value, safety, prestige, coziness, and aesthetics of multistory residential buildings? To find the answer, two studies were carried out. In Study 1, participants filled in questionnaires designed to measure the perceived value, safety, prestige, coziness, and aesthetics of a building. Every questionnaire was accompanied with one of four images of the same residential building, the only difference between them was the type of greenery present near the building. Participants were asked to evaluate the building in the image by filling in the questionnaire. A convenience sample of 238 university students (mean age 20, SD = 2) participated in the experiment. Study 2 was an internet-based survey in which participants were presented with four images of a residential building and were asked to identify the most cozy, most expensive, most prestigious, most safe, and most aesthetic building. The pictures were the same as in Study 1. A snowball sample of 356 respondents (mean age 30, SD = 11) participated in the survey. The results indicate that buildings with sophisticated greenery and plain grass greenery are perceived most favorably, while unkempt and chaotic greenery were found to be associated with worse overall perceptions and decreased perceived value of residential property. When creating green spaces near residential buildings, we recommend considering plain grass greenery as it is the most cost-effective solution and has a positive effect on the perceptions of residential property and its value.

Green roof offers multiple environmental benefits to urban ecosystems. Some of these benefits can aid cities in addressing global and local climate-change challenges. Many studies have attempted to convert a wide variety of green-roof benefits into economic values but few of them focused on climate-change aspects. This study assessed and valued six climate-related benefits in the compact city of Hong Kong based on localized experimental and modeling studies. The six benefits are thermal insulation, urban heat island (UHI) mitigation, avoided upstream emissions of carbon dioxide (CO2) and air pollutants, CO2 sequestration and air pollutants removal. Two roof greening scenarios, extensive (EGR) and intensive (IGR), were evaluated for their annual benefits and lifecycle cost-effectiveness under district-scale installation. Results suggest that large-scale green-roof installation can substantially reduce energy consumption, upstream emission and atmospheric concentration of CO2. Establishment of EGR in the study district Yau Tim Mong (YTM) has an annual total value of USD 12.98 million with unit value of USD 10.77 m$^{-2}$ of green roof, and IGR, USD 22.02 million with unit value of USD 18.33 m$^{-2}$. EGR is more economically attractive than IGR in terms of benefit–cost ratio (BCR) and payback period. The 40-year lifecycle BCR of EGR is 3.84 with a payback period of 6.8 years, while the equivalent values for IGR are 1.63 and 19.5 years, respectively. The study suggests a better integration of green roof into the current policy schemes in Hong Kong to combat climate change due to the notable benefits and cost-effective characteristics.


Measures to green up cities and built-up areas have begun to spread faster in recent years. For architects, property developers, business property users and local communities, this no longer means reserving a small area of green space in urban and real estate planning, today, greening up means imagining buildings or even entire cities that carry plants and vegetation, with nature taking a dominant place. After years of being considered remote and obscure subjects by urban actors, especially businesses, greening up and biodiversity are now in the front line of debates. As urbanisation gathers pace across the planet and our natural environments become fragmented, devoting attention to these issues is a genuine factor for differentiation and greater appeal, as well as a channel for innovative positioning in sustainable development. But this new paradigm raises two questions concerning the meaning and true functions of greening up, and the technical and economic factors that must be taken into consideration by the real estate sector. This paper sets out to achieve a better grasp of what is at stake in greening up, especially greening up our buildings, and to identify the additional value it provides for businesses in addition to sustainability benefits. Against the dual background of the ‘Grand Paris’ plans for the Greater Paris area and the city council's aim to make Paris one of Europe's green capitals, the case of the Paris region is particularly interesting to explore.


Many cities around the world have undertaken greening programs (e.g., planting urban trees, adding or enhancing parks, providing incentives for green roofs) to benefit from the amenities of urban green spaces. To evaluate the economic benefits of these programs, hedonic pricing is the approach of choice but its application depends on the availability of adequate land cover data. In this context, this paper contrasts results from Cliff–Ord spatial hedonic models applied to single family houses in Los Angeles (California, USA) with land use data at two spatial resolutions: (1) high resolution (0.6 m) but relatively expensive classified land cover (CLC) data; and (2) moderate-resolution (30 m) but low-cost Normalized Difference Vegetation Index (NDVI) data from satellite imagery. Our results show that
elasticities of price with respect to NDVI and with respect to tree canopy cover (TCC) are weakly correlated and often give conflicting signals for prioritizing tree planting efforts. In addition, correlations between NDVI and CLC grass measures are low, which suggest that hedonic models based on NDVI would miss the benefits of grassy areas. Our spatial lag-Tobit models that predict tree canopy cover from NDVI, structural characteristics, neighborhood amenities, and socio-demographic variables highlight the relative importance of the latter in explaining tree canopy cover in the vicinity of single family houses in Los Angeles; these characteristics are much less important to explain parcel TCC. Overall, our results highlight the advantages of using high-resolution CLC data over moderate resolution NDVI data to estimate the economic benefits of urban greening programs.


The facades of these two adjacent buildings in Paris, France, illustrate the direct and indirect application of biophilic design, one through the use of vegetation, while the other through shapes and forms characteristic of the natural environment and the use of natural materials.


The environmental horticulture industry, also known as the “Green Industry”, is comprised of a variety of businesses involved in production, distribution and services associated with ornamental plants, landscape and garden supplies and equipment. Segments of the industry include wholesale nursery, greenhouse and sod growers, landscape architects, contractors and maintenance firms, retail garden centers, home centers and mass merchandisers with lawn and garden departments, and marketing intermediaries such as brokers, horticultural distribution centers, and re-wholesalers. In addition to these commercial sectors, many state and local governments have significant urban forestry operations for management of parks, botanic gardens, and right-of- ways that are an integral segment of community infrastructure. The Green Industry is linked to urban forestry by providing quality plant material and professional personnel with specialized expertise for growing, maintaining, and managing city trees.

Environmental horticulture is one of the fastest growing segments of the nation’s agricultural economy, often experiencing growth and expansion even during recessionary periods. The nursery and greenhouse sector has experienced considerable growth in the last two decades, albeit slowing somewhat in recent years. The landscape design, construction, and maintenance sector has also expanded due to strong economic conditions and robust building activity. Retail sales of horticultural goods have increased for both independent and chain-store type retailers, with considerable consolidation occurring due to the increased presence of home centers and mass merchants in the lawn and garden marketplace. The outlook for the Green Industry is promising, yet there are several challenges that will increase competitive pressures.

In view of its importance, numerous studies have been conducted to document the Green Industry’s economic impacts in individual states or regions, however, the present study represents the first attempt to evaluate it economic impacts for the entire United States, using data from previous studies together with secondary industry statistics. A specific objective of the study was to evaluate the role, value and economic impact of forest tree species (woody ornamental trees) in the urban forestry environment.

Nationwide estimates of the economic impacts of the Green Industry were derived from a variety of information sources, including industry statistics from the U.S. Economic Census and Census of Agriculture (2002), County Business Patterns, and primary surveys by horticulture economics
researchers. Economic impacts for each state were computed using the Implan Pro software to build regional input-output models to derive economic multipliers that estimate the indirect effects of industry purchases and induced effects of employee household spending, and also capture the effects of taxes and transfer payments.

Economic impacts for the U.S. Green Industry in 2002 were estimated at $147.8 billion (Bn) in output, 1,964,339 jobs, $95.1 Bn in value added, $64.3 Bn in labor income, and $6.9 Bn in indirect business taxes, with these values expressed in 2004 dollars (Table ES-1). For the production and manufacturing sectors, including nurseries/greenhouses, lawn and garden equipment manufacturers, and greenhouse manufacturers, total output impacts were $34.6 Bn, employment impacts were 300,677 jobs, and value added impacts were $20.8 Bn. For the horticultural services sectors of landscape services and landscape architects, total output impacts were $57.8 Bn, employment impacts were 753,557 jobs, and value added impacts were $39.0 Bn. For the wholesale/retail trade sectors, total output impacts were $55.5 Bn, employment impacts were 910,104 jobs, and value added impacts were $35.3 Bn. The largest individual sectors in terms of employment and value added impacts were landscaping services (704,875 jobs, $35.6 Bn), lawn and garden stores (347,916 jobs, $14.8 Bn), nursery and greenhouses (261,408 jobs, $18.1 Bn), florists (200,451 jobs, $4.0 Bn), and building material supply stores (123,591 jobs, $6.5 Bn). Other sectors with large value added impacts were general merchandise stores ($4.0 Bn), landscape architects ($3.5 Bn), lawn and garden equipment manufacturers ($2.6 Bn), lawn and garden equipment wholesalers ($2.7 Bn), wholesale flower, nursery stock and florist supplies ($1.9 Bn), and food & beverage stores ($1.4 Bn).

Economic impact results are reported by state and region, as summarized in Table ES-2, Figures ES-1 and ES-2. Total value added impacts were largest in the Midwest region ($19.2 Bn), followed by the Pacific region ($18.4 Bn), Northeast ($17.9 Bn), and Southeast ($13.5 Bn). The largest individual states in terms of value added impacts, all exceeding $3 billion, were California ($13.7 Bn), Florida ($7.1 Bn), Texas ($6.1 Bn), Illinois ($4.3 Bn), Pennsylvania ($3.7 Bn), New York ($3.5 Bn), and Ohio ($3.5 Bn).


Studies have quantified urban forests using well established field sampling methods. Other studies have used hedonic regression with real estate prices and remotely sensed vegetation cover data in valuation models. However, remote sensing introduces unfamiliar perspectives since it changes the scale and resolution perceived by humans. Real estate prices also fluctuate and are not regularly used in urban decision-making processes. This study values an urban forest cultural ecosystem service by integrating an explanatory hedonic regression model with randomly field-measured tree, shrub, and turf data from four cities across Florida, USA, during 2006–2009, and congruent parcel tract-level home attributes and appraised property values from single and multi-family units for 2008–2009. Results, on average, indicate trade-offs in that more trees with greater Leaf Area Indices (LAI) add to property value, while biomass and tree–shrub cover have a neutral effect, and replacing tree with grass cover has lower value. On average, property value increased by $1586 per tree and $9348 per one-unit increase in LAI, while increasing maintained grass from 25% to 75% decreased home value by $271. Our ecological approach is an alternative, applied method that can be used by decision-makers for policy and cost–benefit analyses that calculate the stream of net benefits associated with urban forests.

Greenery on buildings is being consolidated as an interesting way to improve the quality of life in urban environments. Among the benefits that are associated with greenery systems for buildings, such as energy savings, biodiversity support, and storm-water control, there is also noise attenuation. Despite the fact that green walls are one of the most promising building greenery systems, few studies of their sound insulation potential have been conducted. In addition, there are different types of green walls; therefore, available data for this purpose are not only sparse but also scattered. To gather knowledge about the contribution of vertical greenery systems to noise reduction, especially a modular-based green wall, two different standardised laboratory tests were conducted. The main results were a weighted sound reduction index (Rw) of 15 dB and a weighted sound absorption coefficient (α) of 0.40. It could be concluded that green walls have significant potential as a sound insulation tool for buildings but that some design adjustments should be performed, such as improving the efficiency of sealing the joints between the modular pieces.


Ecosystem services (ES) have been broadly adopted as a conceptual framing for addressing human nature interactions and to illustrate the ways in which humans depend on ecosystems for sustained life and well-being. Additionally, ES are being increasingly included in urban planning and management as a way to create multi-functional landscapes able to meet the needs of expanding urban populations. However, while ES are generated and utilized within landscapes we still have limited understanding of the relationship between ES and spatial structure and dynamics. Here, we offer an expanded conceptualization of these relationships through the concept of service providing units (SPUs) as a way to plan and manage the structures and preconditions that are needed for, and in different ways influence, provisioning of ES. The SPU approach has two parts: the first deals with internal dimensions of the SPUs themselves, i.e. spatial and temporal scale and organizational level, and the second outlines how context and presence of external structures (e.g. built infrastructure or larger ecosystems) affect the performance of SPUs. In doing so, SPUs enable a more nuanced and comprehensive approach to managing and designing multi-functional landscapes and achieving multiple ES goals.


Public housing estates (PHEs) in Hong Kong, accommodating 3.3 million of the 7-million population, have generous landscape planting in their grounds. The independent tree management regime generates a tree stock that deviates from the general urban-tree population. This study evaluated species composition, floristic diversity, importance value, and spatial distribution of trees in 102 PHEs (half of the total) occupying 8.31 km² (territory land area of 1104 km²), assessed their contribution to urban biodiversity, and developed a species selection strategy to enrich urban biodiversity. 48,823 trees belonged to 232 species, 151 genera and 59 families. Natives contributed 69 species and 10,837 trees. Species profile was skewed toward exotic species and trees. The species were divided into six frequency groups. The signature group had 45 species each with >200 trees. The dominant, common and occasional groups had 20, 26 and 48 species, respectively. 59 species in the rare group and 34 in the solitary group denoted changing and diverse species selections, respectively. Nonmetric Multidimensional Scaling (NMDS) found that species distribution in PHEs was strongly associated with species diversity, estate area and estate age. However, district and region were not correlated with NMDS. Some 98 species were significantly correlated (Spearman) with one or both NMDS axes. Species groups were analyzed to inform a species selection strategy to improve future planting program
and enrich urban biodiversity. The methods and findings could be applied to south-China and other cities to rationalize urban-forest programs with the help of objective research data.


Urban green spaces have been proven to significantly decrease ambient air temperature and mitigate heat islands created by urbanization. However, the environmental benefits of cooling provided by urban green spaces have rarely been measured. In this paper, we estimated the energy-savings and emission-reduction contribution of urban green spaces in Beijing, applying a empirical model. Our calculations suggest urban green spaces play a major role in reducing energy demand and increasing CO2 sequestration. Urbanized Beijing has 16,577 ha of green space which could absorb $3.33 \times 10^{12}$ kJ of heat via evapotranspiration during the entire summer. The cooling effect reduced the air conditioning demand by $3.09 \times 10^{8}$ kWh which amounts to a 60% reduction in net cooling energy usage in Beijing. The annual reduction in CO2 emissions from power plants associated with electricity saving would reach 243 thousand tons with an average of 61 kg/(ha day). Also, the cooling effect and the environmental benefits of urban green space in Beijing largely depend on the green space's structure and size. Urban managers and landscape planners should take advantage of this research to plan, design and manage green spaces in heat island areas.


It has been proven that proper landscape planning and designs with the sustainability concept and approach help to create a conducive and responsive environment of housing development. This paper presents a brief of conceptual view on the important aspects of landscape design on housing development in urban areas. The review is based on the theoretical framework of the relationship between landscape design in planning and designing the housing development in urban areas as well as how it acts as an added value to the sustainable residential landscape design. A review on previous researches and journals are doing in providing a theory on the importance aspect of landscape design in housing areas. It is hoped that this paper may possibly provide significant information on landscape design towards influencing the prices and values of the house. This paper also can become an indicator towards enhancing the sustainability of living environment.


The temperature of cities continues to increase because of the heat island phenomenon and the undeniable climatic change. The observed high ambient temperatures intensify the energy problem of cities, deteriorates comfort conditions, put in danger the vulnerable population and amplify the pollution problems. To counterbalance the phenomenon, important mitigation technologies have been developed and proposed. Among them, technologies aiming to increase the albedo of cities and the use of vegetative – green roofs appear to be very promising, presenting a relatively high heat island mitigation potential. This paper aims to present the state of the art on both the above technologies, when applied in the city scale. Tenths of published studies have been analysed. Most of the available data are based on simulation studies using mesoscale modeling techniques while important data are available from the existing experimental studies. When a global increase of the city’s albedo is considered, the expected
mean decrease of the average ambient temperature is close to 0.3 K per 0.1 rise of the albedo, while the corresponding average decrease of the peak ambient temperature is close to 0.9 K. When only cool roofs are considered, the analysis of the existing data shows that the expected depression rate of the average urban ambient temperature varies between 0.1 and 0.33 K per 0.1 increase of the roofs albedo with a mean value close to 0.2 K. As it concerns green roofs, existing simulation studies show that when applied on a city scale, they may reduce the average ambient temperature between 0.3 and 3 K. Detailed analysis of many studies reporting a comparison of the mitigation potential of both technologies has permitted the definition of the limits, the boundaries and the conditions under which the considered technologies reach their better performance, in a synthetic way.


This paper carries forth the conceptual framework for biophilic design that was first laid out by Cramer and Browning in Biophilic Design (2008), which established three categories meant to help define biophilic buildings – Nature in the Space, Natural Analogues and Nature of the Space – and a preliminary list of “biophilic conditions”. New research and insights from the neurosciences, endocrinology and other fields have since helped evolve the scientific basis for biophilic design. This paper begins to articulate this growing body of research and emerging design parameters in architectural terms, so that we may draw connections between fields of study, highlight potential avenues for future research, evolve our understanding of biophilic design patterns, and capture the positive psychophysiological and cognitive benefits afforded by biophilia in our design interventions.


This review paper organizes and summarizes the literature on Vertical Greenery Systems (VGS) when used as passive tool for energy savings in buildings. First, with the information obtained in the reviewed literature some key aspects to consider when working with VGS are clarified, such as the classification systems, the climate influence, the plant species used and the different operating mechanisms. Then, the main conclusions of this literature, sorted by construction system (Green Walls or Green Façades) and climatic situation, are summarized. In general, it can be concluded that VGS provide great potential in reducing energy consumption in buildings, especially in the cooling periods. However, a lack of data on operation during the heating period as well as during the whole year has been found. On the other hand, results show that the investigations of VGS are not equally distributed around the world, being basically concentrated in Europe and Asia. Moreover, the review concludes that some aspects must be studied in depth, such as which species are the most suitable for each climate, influence on energy savings of the façade orientation, foliage thickness, presence of air layers, and finally, substrate layer composition and thickness in the case of green walls.


This study uses the hedonic price method to examine if proximity, abundance, and characteristics of green street facilities affect the sale price of single-family residential properties in Portland, Oregon. Different methods for measuring proximity and abundance are explored with distance based on street network, and abundance of green streets at the census tract and census block level, producing statistically significant results. A property's sale price is estimated to increase as distance from the nearest green street facility increases although the magnitude of this effect is small. Facility type does not have a statistically significant effect on a property's sale price, but characteristics such as facility
size, proportion of the facility covered by tree canopy, and design complexity are estimated to influence sale price.


We review the current state of knowledge about urban ecosystem services in New York City (NYC) and how these services are regulated, planned for, and managed. Focusing on ecosystem services that have presented challenges in NYC-including stormwater quality enhancement and flood control, drinking water quality, food provisioning and recreation-we find that mismatches between the scale of production and scale of management occur where service provision is insufficient. Adequate production of locally produced services and services which are more accessible when produced locally is challenging in the context of dense urban development that is characteristic of NYC. Management approaches are needed to address scale mismatches in the production and consumption of ecosystem services. By coordinating along multiple scales of management and promoting best management practices, urban leaders have an opportunity to ensure that nature and ecosystem processes are protected in cities to support the delivery of fundamental urban ecosystem services.


Purpose: The aim of this study is to add to the emerging knowledge base in the UK and be of relevance to land use planners and all stakeholders in property taxation. Urban green open spaces are valuable environmental resources often associated with positive influences for quality of life and property value.

Design/methodology/approach: Using a hedonic pricing specification, this paper measures the proximate effect of public green space on residential property value. It examines the relationship between 3,854 residential sales transactions and public green spaces across the Belfast housing market gathered from Land and Property Services throughout the year 2011 showing the percentage effect on property value with respect to distance to public green spaces.

Findings: The results show that, ceteris paribus, urban green space has a significant positive impact on proximate residential properties sale price for the terrace and apartment sectors and that terrace and apartment property located closer to public green spaces achieved increases in sale price of up to 49 per cent. Adjacency to green open space produced significant property value premiums in only two of the four housing types analysed, with limited statistically significant proximate effects evident for the detached and semi-detached sectors, a finding which has important social and public policy implications.

Originality/value: A number of empirical studies have demonstrated that public green space, such as urban parks, have a positive impact on property values. However, there is a paucity of empirical research on this relationship in the UK. This study serves to address this gap by examining the effect of public green spaces on house price within the medium-sized regional city in the UK.


Focusing on a world class living environment, a good quality residential area can be highlighted as an important issue in creating a sustainable living environment. However, limited green spaces within the proximity of residential properties are not supporting the landscape space and are not conducive to
living space. The aim of the paper is to investigate the impact of landscape design on house prices and values in residential development particularly in urban areas. The paper employed quantitative approaches which include i) a questionnaire survey; and ii) an observation. This empirical study is based on the findings of case studies conducted in several residential areas in Klang Valley. The findings show that the residents have very clear ideas on how much green space is really important in residential areas in order to create a sustainable residential environment. Despite the absence of public actions in terms of providing information, encouraging participations in the survey and promoting awareness of those interviewed have shown considerable interest in promoting landscape design to be applied in residential development. The perceptions of the quality and quantity of landscape designs in residential areas especially in Klang Valley can be further researched for future study.


Although a number of comprehensive reviews have examined global ecosystem services (ES), few have focused on studies that assess urban ecosystem services (UES). Given that more than half of the world’s population lives in cities, understanding the dualism of the provision of and need for UES is of critical importance. Which UES are the focus of research, and what types of urban land use are examined? Are models or decision support systems used to assess the provision of UES? Are trade-offs considered? Do studies of UES engage stakeholders? To address these questions, we analyzed 217 papers derived from an ISI Web of Knowledge search using a set of standardized criteria. The results indicate that most UES studies have been undertaken in Europe, North America, and China, at city scale. Assessment methods involve bio-physical models, Geographical Information Systems, and valuation, but few study findings have been implemented as land use policy.


This paper reports a choice experiment used to estimate the value of street trees in the city center of Lodz, Poland, and the broader context of how valuation results helped to improve governance of urban ecosystem services in this city. Based on a simplified inventory of trees, we prepared a set of hypothetical programs which put varying emphasis on the different ways to increase the numbers of trees, along with different levels of a hypothetical tax that would have to be paid by respondents to implement a given program. Our study indicated that the 351 surveyed Lodz residents were willing to pay the highest price for greening those streets where currently there are few or no trees and confirmed the general importance of planting trees. The results provided an argument in the debate on the new development strategy for the city and helped to promote the concept of ecosystem services.


Using a hedonic property price approach, we estimate the amenity value associated with proximity to habitats, designated areas, domestic gardens and other natural amenities in England. There is a long tradition of studies looking at the effect of environmental amenities and disamenities on property prices. But, to our knowledge, this is the first nationwide study of the value of proximity to a large number of natural amenities in England. We analysed 1 million housing transactions over 1996–2008 and considered a large number of environmental characteristics. Results reveal that the effects of many of these environmental variables are highly statistically significant, and are quite large in economic magnitude. Gardens, green space and areas of water within the census ward all attract a
considerable positive price premium. There is also a strong positive effect from freshwater and flood plain locations, broadleaved woodland, coniferous woodland and enclosed farmland. Increasing distance to natural amenities such as rivers, National Parks and National Trust sites is unambiguously associated with a fall in house prices. Our preferred regression specifications control for unobserved labour market and other geographical factors using Travel to Work Area fixed effects, and the estimates are fairly insensitive to changes in specification and sample. This provides some reassurance that the hedonic price results provide a useful representation of the values attached to proximity to environmental amenities in England. Overall, we conclude that the housing market in England reveals substantial amenity value attached to a number of habitats, designations, private gardens and local environmental amenities.


This study investigates the effect of tree-shading on energy demand in two similar buildings. Outdoor and indoor air temperature was measured simultaneously for a period of 6 months. Five different base temperatures ranging from 20 °C to 25 °C were chosen and used to calculate cooling degree-days. Degree-day and cooling/warming rate methods were used to estimate cooling energy requirements for the two buildings. Indoor and outdoor cooling degree days were observed to be more for the un-shaded buildings compared to the tree-shaded one. Indoor warming and cooling rate show that the un-shaded building warms earlier and faster than the tree-shaded. Results indicate that tree-shading can save up to 34,500 NGN (US$218) on energy costs. The study shows the role of greening in reducing energy demand in buildings.


Value added floriculture is a process of increasing the economic value and consumer appeal of any floricultural commodity. Value addition ensures high premium to the grower, while providing more acceptable quality products for the domestic and export market. The scenario of floriculture products in India is expanding at a rapid rate and holds very good prospects. Considering this, the floriculture is and will continue to be one of the most lucrative and successful components of diversified horticultural industry. To achieve this goal, policy makers, researchers as well as producers are needed.


In this paper we explore whether the enhancement of urban ecosystem services through large-scale, metropolitan tree-planting initiatives is being planned and executed as a component of traditional municipal government or represents new, transdisciplinary strategies in environmental governance. Drawing on qualitative interviews with stakeholders in six major cities (n = 58) we further explore institutionalization of these initiatives and relationships. While much current discourse posits government cannot “go it alone” in providing preventative, “front-end” solutions to complex environmental problems, we found the public sector dominant in the visioning, planning, and management of these green infrastructure initiatives and the role of the private sector to be minimal. We also found that, despite this dominance, the initiatives had limited success in becoming institutionalized. This dichotomy reflects that while discourses labeling the public sector unable to grapple with complex environmental issues and the private sector dominant in environmental governance regimes are premature, institutionalizing the solutions into the machinery of government remains a contested arena.

The home garden has been a staple of American culture dating back to the mid 19th century. As open spaces were converted to homesteads and farmland to suburban developments, Americans turned to seed producers, or seedsmen, and nurserymen to provide plant material that would improve the aesthetics and function of their properties. They wanted colorful flower gardens in spring and bountiful harvests of tomatoes, zucchini and melons in summer. Despite this booming public interest in flowers and vegetables for the home and garden, there was a serious lack of regulation governing the seed industry. How was the homeowner to know if the seed he purchased would do well in his region of the country or which seed catalog offered the highest quality plants? This paper will show how consumer demand led to the rise of the trial garden, which in turn laid the groundwork for creating a non-biased system to rate and compare new varieties of plants to better assist consumers, and eventually industry growers as well. The trial garden would also benefit breeders by giving them credit for their developments and ensure a seal of approval in which their customers could have confidence. Since the inception of this mutually beneficial concept, trial gardens have become the standard of rating new home flower and vegetable varieties not only in the United States, but across the globe.


The potential of green infrastructure (GI) development has been recognised in a number of countries. In the UK, planning policy has identified GI and brought it into the legislative framework. It is assumed that it has a value for landscape enhancement for multifunctional aims: for increasing the adaptive capacity of the environment for climate change and long-term sustainability whilst protecting its ecological and social values. This paper uses an evaluative tool developed from a plan of action proposed in the early stages of GI thinking by applying it to a contemporary case study in England. This assessment reveals a mismatch between policy aims and the potential on the ground for creating GI. The study reveals ‘institutional schizophrenia’, a fragmented approach to the delivery of GI that affects stakeholder collaboration and confidence. The findings suggest a possible decrease in the level of GI creation because of restrictions placed upon local authorities and important repercussions for GI development and potential ecosystem services.


Lifestyle landowners value land for its amenities and ecological characteristics and could play an important role in managing and conserving native vegetation in multifunctional rural landscapes. We quantify values of ecosystem services captured by owners of rural lifestyle properties in Victoria, Australia, using a spatial hedonic property price model. The value of ecosystem services provided by native vegetation is maximized when that vegetation occupies about 40 percent of the area of a lifestyle property. Since the current median proportion of native vegetation is 15 percent, most lifestyle landowners could benefit from increasing the area of native vegetation on their properties.

Vertical greening systems can be used as a mean to improve the environmental conditions of dense urban areas. Several researches have proved the environmental benefits of green envelopes. It is still not clear if vertical greening systems are economically sustainable, differently several Life Cycle Cost Analysis and Cost–Benefit Analysis determined economic costs and benefits of green roofs. This paper presents a Cost–Benefit Analysis of different vertical greening systems – green façades and living wall systems – considering personal and social benefits and costs over their life cycle. Installation, maintenance, and disposal costs of each analysed system are compared with the related private and social benefits (increase of real estate value, savings for heating and air conditioning, cladding longevity, air quality improvement, etc.), determining three indicators: the Net Present Value (NPV), the Internal Rate of Return (IRR) and the Pay Back Period (PBP). The CBA demonstrated that some of the vertical greening systems analysed are economically sustainable. Economic incentives (tax reduction) could reduce personal initial cost allowing a wider diffusion of greening systems to reduce environmental issues in dense urban areas, such as urban heat island phenomenon and air pollution.


In this paper we propose a categorization of green space into eight different types and quantify their impact on housing prices in the city of Aalborg using the hedonic house price method. The categorization was made manually according to an idealized description of the eight types of green space and a rating system in which each green space was rated according to accessibility, maintenance levels and neighboring negative land-use. The hedonic house price schedule for each of the green spaces was estimated using a generalized additive model, which allows for a data driven adjustment of underlying omitted spatial processes. To our knowledge the use of a spatial generalized additive model is novel to the hedonic valuation literature. We find that types of green space, which are rated highly in terms of accessibility and maintenance level, have high implicit prices whereas types with low ratings are not identified or provide ambiguous results. Green space buffering unattractive land-use such as infrastructure and industry is found to provide negative implicit prices despite controlling for the negative neighboring land-use. Our results clearly indicate that green space is not a uniform environmental amenity but rather a set of distinct goods with very different impacts on the housing price.


Trees provide a variety of benefits to urban residents that are implicitly captured in the value of residential properties. We apply a spatial hedonic model to estimate the value of urban trees in 23 suburbs of Perth Metropolitan Area in Western Australia. Results show that a broad-leaved tree on the street verge increases the median property price by about AUS16,889, suggesting a positive neighbourhood externality of broad-leaved trees. However, neither broad-leaved trees on the property or on neighbouring properties nor palm trees irrespective of the locations contributed significantly to sale price. Our result has potential implications on planting and maintaining broad-leaved trees on street verges for neighbourhood development and urban planning to generate public and private benefits of street trees.

Urban populations experience higher temperatures than people in un-developed rural areas due to increased heat production and retention by urban surfaces and structures.

- With a changing climate, urban populations will experience more frequent extreme heat events, which can lead to increased rates of mortality and morbidity.
- Green infrastructure (GI) can help mitigate high urban temperatures.
- The key steps in mitigating urban surface temperatures to minimise high daytime urban temperatures are:
  - Identify priority locations based on assessments of exposure and vulnerability.
  - Maximise the effectiveness of existing GI by integrating water sensitive urban design.
  - Identify priority streets for temperature reduction based on street orientation and height:width ratio, which determine the amount of sun exposure.
  - Select appropriate GI for different environmental conditions.
- A range of options are suggested for policies to leverage GI implementation at local, state and federal levels.


An experimental investigation was carried out to determine the effect of trees on buildings' micro-climate. Parameters of thermal conditions were measured between September 2010 and February 2011 in and around two typical buildings located on a university campus. One of the buildings is shaded on the south eastern side by trees while the other is not. Indoor air temperature, outdoor air temperature and wall temperature were measured, while ancillary wind and solar radiation data were collected from the campus’ meteorological station. Comparisons on air temperature and wall temperature as measured inside and outside the shaded and un-shaded buildings were made. Air temperatures were higher and for longer hours throughout the study period inside the un-shaded building. Indoor–outdoor temperature differences show a peak of 5.4 °C for the un-shaded building while the tree-shaded did not exceed 2.4 °C. The results show that tree-shading constitutes an excellent passive cooling system for buildings, potentially enhances thermal control and conserves energy in buildings.


The attribution of economic value to landscape resources is fraught with technical and methodological difficulties. Little is mandated in UK planning policy explaining how economic value should be established. As a result landscape resources have been undervalued, underfunded and marginalised in favour of larger grey infrastructure development. The UK NEA however outlined for the first time a national scale economic evaluation of environmental resources. The Valuing Attractive Landscapes in the Urban Economy (VALUE) Interreg IVB project examined this issue by establishing a toolkit of economic evaluation methodologies for green investments across North-West Europe. Focussing on the returns that investments in green infrastructure can deliver to cities and city-regions, the VALUE project identified economic values that can be used to influence future policy-making. This paper presents an analysis of VALUE street tree investments in Manchester, UK. Using a contingent valuation survey preference for green investments and associated willingness to pay (WTP) for them were generated. Analysis suggests that willingness to pay is directly related to the size and greenness of the proposed investment and participant perceptions of added value. 75% of respondents were WTP for investments in green infrastructure. Analysis indicates increased WTP and a marked preference for
larger and physically greener investments. Payment values ranged from £1.46 to 2.33, a 59.5% variance, between the preferred investment option and the status quo. The paper concludes that although green investments vary in size and function, respondents consider the specific and wider value of green infrastructure resources when asked how much they willing to pay to fund and maintain such investments.


The proximity principle of urban greenery and its positive effect on the prices of residential buildings is well documented in empirical literature. Application of hedonic price method in many urban and environmental settings has confirmed the proximity principle indicating residents’ positive preferences toward environmental amenities provided by green spaces. As proved in previous applications, the proximity effect lowers with increased distance from the dwelling, and the extent of the citizens’ demand for urban open space also differs with type and size of open space. The empirical evidence is relatively scarce with respect to combining both the distance to and the size of the nearest greenery. The majority of hedonic price studies on green space services have been conducted in the US and Western Europe, but the empirical evidence from the transforming economies of the former communist states of Central Europe is scarce. Similarly to many other European cities, urban sprawl has threatened green areas and agricultural land in Prague since the starting of the transformation process at the beginning of the 1990s. Therefore, our intent is to contribute with two aspects: (i) trace the value of urban greenery amenities on the housing market in the newly transformed economy using a hedonic price model and (ii) capture the distance and size joint effect of green space on the property market by interaction effects. The study confirmed that proximity to greenery and its area are important determinants of housing prices in Prague, and benefits to residents differ with the type of greenery.


Green space is an important part of environment around houses. Generally, most research focused on the economic impacts of green space on urban planning and environmental pollution cost, but ignored the impact on single family home values. Limited research was conducted in this area and few studies of green space and housing prices have incorporated spatial econometric techniques. This technique is necessary since housing value may be influenced by characteristics of nearby properties. This research attempts to quantify the impacts of green space, by using the hedonic price analysis of the relationship between property values and the green space amenities around the selected single family houses in Delaware County, Ohio. Also, by incorporating spatial-lag term, we can compare the results with and without spatial effect. Eventually, after extending the model by quantile regression, the influence of different green space characteristics on housing price may change across the conditional distribution of housing price. Substantial variation was found between the results with and without spatial effects across quantiles, which indicates that luxury house buyers may value green space differently from middle or low level house buyers.

While technological progress has fostered the conception of an urban society that is increasingly decoupled from ecosystems, demands on natural capital and ecosystem services keep increasing steadily in our urbanized planet. Decoupling of cities from ecological systems can only occur locally and partially, thanks to the appropriation of vast areas of ecosystem services provision beyond the city boundaries. Conserving and restoring ecosystem services in urban areas can reduce the ecological footprints and the ecological debts of cities while enhancing resilience, health, and quality of life for their inhabitants. In this paper we synthesize knowledge and methods to classify and value ecosystem services for urban planning. First, we categorize important ecosystem services and disservices in urban areas. Second, we describe valuation languages (economic costs, socio-cultural values, resilience) that capture distinct value dimensions of urban ecosystem services. Third, we identify analytical challenges for valuation to inform urban planning in the face of high heterogeneity and fragmentation characterizing urban ecosystems. The paper discusses various ways through which urban ecosystems services can enhance resilience and quality of life in cities and identifies a range of economic costs and socio-cultural impacts that can derive from their loss. We conclude by identifying knowledge gaps and challenges for the research agenda on ecosystem services provided in urban areas.


A growing body of evidence has reiterated the negative impacts that crime and perceptions of insecurity can have on the health and wellbeing of local residents. Strategies that reduce residents' perceived crime risk may contribute to improved health outcomes; however interventions require a better understanding of the neighbourhood influences on residents perceptions of crime and safety. We examined the impact of changes in the objective built environment following relocation on changes in residents' perceived crime risk for participants in a longitudinal study of people moving to new neighbourhoods in Perth, Western Australia (n = 1159). They completed a questionnaire before moving to their new neighbourhood, and again 36 months after relocation. Individual-level objective environmental measures were generated at both time points using Geographic Information Systems, focussing on the characteristics that comprise a ‘walkable neighbourhood’. Linear regression models examined the influence of objective environmental changes between the two environments on perceived crime risk, with progressive adjustment for other change variables (i.e., perceptions of the physical and social environment, reported crime). We found that increases in the proportion of land allocated to shopping/retail land-uses increased residents' perceived crime risk (β = 11.875, p = 0.001), and this relationship remained constant, despite controlling for other influences on perceived crime risk (β = 9.140, p = 0.004). The findings highlight an important paradox: that the neighbourhood characteristics known to enhance one outcome, such as walking, may negatively impact another. In this instance, the ‘strangers’ that retail destinations attract to a neighbourhood may be interpreted by locals as a threat to safety. Thus, in areas with more retail destinations, it is vital that other environmental strategies be employed to balance any negative effects that retail may have on residents' perceptions of crime risk (e.g., minimising incivilities, improved lighting and aesthetics).


This paper presents life cycle assessment (LCA) as a methodology to evaluate environmental, economic, and social performance of green infrastructure stormwater control measures (SCMs). A case study examining a bio-infiltration rain garden at the Villanova University Campus is offered to demonstrate this methodology. The scope of this analysis is cradle to grave benefits and impacts of
green infrastructure. Metrics used in this case study to evaluate benefits and impacts include carbon footprint (global warming potential), acidification potential, human health cancer impact, human health non-cancer impact, respiratory effects, eutrophication potential, ozone depletion potential, eco-toxicity, smog formation potential, labor impacts, and life cycle economic costs. Results of this bio-infiltration rain garden case study show that the construction phase is the main contributing life cycle phase for all adverse environmental impacts, as well as total life cycle cost and labor impacts. The majority of these construction phase environmental impacts are attributed to the use of silica sand as a soil amendment for the rain garden media and the use of bark mulch to provide ground cover, repress invasive vegetation, and establish target vegetation. The bio-infiltration rain garden operation phase was found to provide significant avoided environmental impacts relative to the construction phase impacts. These avoided impacts are attributed to urban forest benefits from rain garden vegetation, benefits due to stormwater runoff pollutant treatment by the practice, and benefits to combined sewer systems due to reduced stormwater volume through infiltration and evapo-transpiration. Consideration of multiple rain garden decommissioning phase scenarios makes a case to support the onsite reuse on rain garden media at the end of the practice life.

Dilley, J. and K. L. Wolf (2013). "Homeowner interactions with residential trees in urban areas." Urban forests are a critical element in sustainable urban areas because of the many environmental, economic, and social benefits that city trees provide. In order to increase canopy cover in urban areas, residential homeowners, who collectively own the majority of the land in most cities, need to engage in planting and retaining trees on their properties. This collaborative research project surveyed homeowners in Seattle, Washington, U.S., to examine their behaviors and attitudes toward the trees on their property. Attitudes toward trees were mapped to examine geographic distribution, as Seattle has a legacy of neighborhood-based planning. Results show that homeowners planted trees during non-optimal times of the year, preferred trees that are small at maturity over trees that are large at maturity, and showed increased interest in fruit trees. Homeowners intend to plant fewer trees in the future than they have in the past. This research is a model for social science efforts that can be used to develop targeted public outreach programs at the neighborhood scale to increase the planting and retention of trees on residential property.

Colding, J. and S. Barthel (2013). "The potential of ‘Urban Green Commons’ in the resilience building of cities." Ecological Economics 86: 156-166. While cultural diversity is increasing in cities at a global level as a result of urbanization, biodiversity is decreasing with a subsequent loss of ecosystem services. It is clear that diversity plays a pivotal role in the resilience building of ecosystems; however, it is less clear what role cultural diversity plays in the resilience building of urban systems. In this paper we provide innovative insights on how common property systems could contribute to urban resilience building. Through a review of recent findings on urban common property systems and the relevant literature, we deal with urban green commons (UGC)s and discuss their potential to manage cultural and biological diversity in cities. We describe three examples of UGCs, i.e. collectively managed parks, community gardens, and allotment areas, with a focus on their institutional characteristics, their role in promoting diverse learning streams, environmental stewardship, and social–ecological memory. We discuss how UGCs can facilitate cultural integration through civic participation in urban land-management, conditions for the emergence of UGCs, the importance of cognitive resilience building, and what role property-rights diversity plays in urban settings. We conclude by elucidating some key insights on how UGCs can promote urban resilience building.

This issue brief explores how the multitude of green infrastructure practices can help advance the bottom line for the commercial real estate sector. It provides illustrative examples for specific building types, based on published research, as well as a summary of key findings from that research. Commercial properties with well-designed green infrastructure can reap the rewards of higher rents and property values, increased retail sales, energy savings, local financial incentives (such as tax credits, rebates, and stormwater fee credits), reduced life-cycle and maintenance costs, reduced flood damage, reduced water bills, reduced crime, and improved health and job satisfaction for office employees. In fact, green infrastructure and other green building practices are increasingly becoming a quality benchmark for the private sector, because they illustrate a developer’s commitment to healthier, sustainable communities and place-making, while creating measurable value added for property owners and tenants alike.

As illustrated below, the cumulative value of these benefits can total in the millions of dollars over a long-term (40-year) planning horizon—far exceeding the potential stormwater utility fee savings and dramatically accelerating the expected payback of green infrastructure investments on commercial properties.


We analyze 20,660 transactions of single family detached houses sold in 2003 and 2004 in the city of Los Angeles, CA, to estimate the value of urban trees, irrigated grass, and non-irrigated grass areas. To deal with spatial autocorrelation and unobserved neighborhood characteristics, we contrast two models: a geographically weighted regression model, and a Cliff–Ord model with spatial lags in the dependent variable, the exogenous variables, and the disturbances as well as submarket fixed effects and an extensive set of covariates. We find that Angelenos like lawns: over 88% of the properties examined would gain value with additional irrigated grass on their parcel, and even more (89%) in their neighborhood. Although more non-irrigated grass/bare soil on parcels typically hurts property values, it often has the opposite effect at the neighborhood level. Moreover, additional parcel trees would decrease the value of almost 40% of the properties examined and they would have only a small positive impact on most of the others. By contrast, additional neighborhood trees would slightly increase the value of over 97% of the properties analyzed. This suggests that while Los Angeles residents may want additional trees, they are unwilling to pay for them. These results have implications for urban tree planting programs that rely primarily on private property owners.


Urban trees can potentially mitigate environmental degradation accompanying rapid urbanisation via a range of tree benefits and services. But uncertainty exists about the extent of tree benefits and services because urban trees also impose costs (e.g. asthma) and may create hazards (e.g. windthrow). Few researchers have systematically assessed how urban tree benefits and costs vary across different cities, geographic scales and climates. This paper provides a quantitative review of 115 original urban tree studies, examining: (i) research locations, (ii) research methods, and (iii) assessment techniques for tree
services and disservices. Researchers published findings in 33 journals from diverse disciplines including: forestry, land use planning, ecology, and economics. Research has been geographically concentrated (64% of studies were conducted in North America). Nearly all studies (91.3%) used quantitative research, and most studies (60%) employed natural science methods. Demonstrated tree benefits include: economic, social, health, visual and aesthetic benefits; identified ecosystem services include: carbon sequestration, air quality improvement, storm water attenuation, and energy conservation. Disservices include: maintenance costs, light attenuation, infrastructure damage and health problems, among others. Additional research is required to better inform public policy, including comparative assessment of tree services and disservices, and assessment of urban residents and land managers’ understanding of tree benefits and costs.


Biophilia, the innate human attraction to nature, is a concept that has been recognized for several decades by the scientific and design communities, and intuitively for hundreds of years by the population at large. Biophilic design has often been regarded as a luxury for property owners who want the best possible workplace for their employees, or who want to showcase their efforts to be more environmentally responsible. In reality, improving community well-being through biophilia can impact productivity costs and the bottom line. Today productivity costs are 112 times greater than energy costs in the workplace. We believe that incorporating nature into the built environment is not just a luxury, but a sound economic investment in health and productivity, based on well-researched neurological and physiological evidence. In this paper, we will share several examples of small investments involving very low or no up-front cost, such as providing employees access to plants, natural views, daylight, and other biophilic design elements. These measures provide very healthy returns. Integrating quality daylighting schemes into an office space can save over $2,000 per employee per year in office costs, whereas over $93 million could be saved annually in healthcare costs as a result of providing patients with views to nature. These examples, based on scientific research, will serve to demonstrate the financial potential for a large-scale deployment of biophilic design. Whether it is hospitals that allow patients to heal more quickly, offices that boost productivity, schools that improve test scores, or retail outlets with higher sales, this paper makes the business case for incorporating biophilia into the places where we live and work.


Multiple ecosystem services of parks may be capitalized into the property values of nearby houses. A joint hedonic housing price model and recreation demand model evaluates how park services are capitalized into property values for two regional parks in Portland, Oregon. The hedonic model suggests parks are an amenity of bundled positive and negative services. A non-linear variable for the percentage of park land surrounding a home explains how parks affect property values the best. The optimal percentage within a half-mile neighborhood is around 20%. An improvement in the quality of parks for recreation by 30% increases the property value of homes five to ten miles away by 0.04–0.06%. Thus, programs that improve recreation access to parks can increase the property values of a community.

This study uses the hedonic price method to examine if land cover types—trees, shrubs, water and impervious surface areas—affect the sale price of single-family residential properties in Multnomah County, Oregon. We combine detailed structural and location information for 36,753 single-family residential property sales with the percentage of land cover on each property and within three buffers surrounding each property. Trees contribute positively to a property's sale price, but the estimated increase may be less than the costs of planting and caring for trees. Benefits received by nearby property owners may justify actions by government agencies to expand canopy coverage.


The goal of the present study is to characterize water sounds that can be used in urban open spaces to mask road traffic noise. Sounds and visual images of a number of water features located in urban open places were obtained and subsequently analyzed in terms of psychoacoustical metrics and acoustical measures. Laboratory experiments were then conducted to investigate which water sound is appropriate for masking urban noise. The experiments consisted of two sessions: (1) Audio-only condition and (2) combined audio-visual condition. Subjective responses to stimuli were rated through the use of preference scores and 15 adjectives. The results of the experiments revealed that preference scores for the urban soundscape were affected by the acoustical characteristics of water sounds and visual images of water features; Sharpness that was used to explain the spectral envelopes of water sounds was proved to be a dominant factor for urban soundscape perception; and preferences regarding the urban soundscape were significantly related to adjectives describing “freshness” and “calmness.”


The relationship between a property's transaction price and its landscape views has attracted scholarly attention over the years. The Spatial Durbin model, which can provide an unbiased estimate in all types of true spatial data-generation, is introduced in this study to discuss the impact of these landscape view factors on property prices. The emphasis of this paper is on various landscape view influences on different submarkets (i.e. storeys) of high-rise buildings in a compact city such as Hong Kong. The findings indicate that while the availability of garden view is found to be positively correlated with transaction prices of flats in all three submarkets, varying degrees of differences are observed as to the impact of landscape attributes (such as seaview and proximity to avenue/street) and of the spatial lag effect on transaction prices of flats in these submarkets. In particular, contrary to popular beliefs, the availability of seaview is not considered a positive attribute to the transaction prices of high-storey flats. These differences indicate the importance of vertical spatial influence which has not been considered in conventional spatial models, but is useful in studying the situations in other cities which are also compact and consist mainly of high-rise buildings.


Urban green spaces (UGS) form an integral part of any urban area and quantity and quality of UGS is of prime concern for planners and city administrators. Objective measure of greenness using remote sensing images is percentage area of green, i.e., Green Index (GI), which is insensitive to spatial arrangement within the areal units. Measuring UGS at neighborhood level is important as neighborhood is the working level for application of greening strategies. Neighborhood (NH) is synonymous of nearness and can be defined as an area of homogeneous characteristics. The Urban Neighborhood Green
Index (UNGI) aims to assess the greenness and can help in identifying the critical areas, which in turn can be used to identify action areas for improving the quality of green. For the development of UNGI, four parameters, i.e., GI, proximity to green, built up density and height of structures were used and weighted using Saaty's pair wise comparison method. Four different types of NH were compared and it was found that mean GI (0.44) is equal for high-rise low density and low-rise low density NH, i.e., both areas have same quality of urban green based on GI. But mean UNGI is higher for low-rise low-density NH (0.62), as compared to high-rise low-density NH (0.54), hence, area of highrise NH requires more amounts of good quality properly distributed green as compared to low-rise NH. The input for UNGI is easily derivable from RS images, besides the developed method is simple, and easily comprehendible by city administrators and planners.

Dunec, J. L. (2012). Banking on green: A look at how green infrastructure can save municipalities money and provide economic benefits community-wide, JSTOR.

This report focuses on the economic impacts caused by polluted urban runo, also known as “stormwater,” a significantly growing source of water pollution in the United States. It’s not intended to be an academic or technical document, but instead to be an “easy to read” compendium of current experiences, analysis and knowledge. Our goal is to provide something useful for municipal and utility officials, local, state and national elected representatives, and the general public. As stormwater professionals and researchers gather more information about the performance of green infrastructure, and re ne the techniques that fall in this category of stormwater management, it’s important to translate their findings into useful information for policy makers and others.

Information about the economics of green infrastructure and about stormwater more broadly is critical to our ongoing conversations about the shape of our communities and the infrastructure they depend upon. The impacts of stormwater pollution and the need to provide stormwater prevention, management, and treatment all create costs for communities and their residents. These costs can often be set or reduced by making different choices about how we build communities and infrastructure. By incorporating “green infrastructure” practices into our efforts to control stormwater runoff, communities and property developers can reduce energy costs, diminish the impacts of flooding, improve public health, and reduce overall infrastructure costs. In addition, these practices, which rely on natural processes like evaporation, in filtration, and plant transpiration, can effectively and affordably complement traditional “grey” infrastructure, giving stormwater managers the ability to create integrated solutions to better serve their communities. Shifting to this new paradigm also creates more sustainable communities that are better able to meet future challenges, especially in the face of a changing climate.


Urbanisation is increasing and today more than a half of the world’s population lives in urban areas. Cities, especially those where urbanisation is un-planned or poorly planned, are increasingly vulnerable to hydro-meteorological hazards such as heat waves and floods. Urban areas tend to degrade the environment, fragmenting and isolating ecosystems, compromising their capacity to provide services. The regulating role of ecosystems in buffering hydro-meteorological hazards and reducing urban vulnerability has not received adequate policy attention until now. Whereas there is a wide body of studies in the specialised biological and ecological literature about particular urban ecosystem features and the impacts of hazards upon people and infrastructures, there is no policy-driven overview looking holistically at the ways in which ecosystem features can be managed by cities to reduce their vulnerability to hazards. Using heat waves and floods as examples, this review article identifies the
aggravating factors related to urbanisation, the various regulating ecosystem services that buffer cities from hydro-meteorological impacts as well as the impacts of the hazards on the ecosystem. The review also assesses how different cities have attempted to manage related ecosystem services and draws policy-relevant conclusions.


Background: An inequitable distribution of parks and other ‘green spaces’ could exacerbate health inequalities if people on lower incomes, who are already at greater risk of preventable diseases, have poorer access.

Methods: The availability of green space within 1 kilometre of a Statistical Area 1 (SA1) was linked to data from the 2011 Australian census for Sydney (n = 4.6 M residents); Melbourne (n = 4.2 M); Brisbane (n = 2.2 M); Perth (n = 1.8 M); and Adelaide (n = 1.3 M). Socioeconomic circumstances were measured via the percentage population of each SA1 living on < $21,000 per annum. Negative binomial and logit regression models were used to investigate association between the availability of green space in relation to neighbourhood socioeconomic circumstances, adjusting for city and population density.

Results: Green space availability was substantively lower in SA1s with a higher percentage of low income residents (e.g. an incidence rate ratio of 0.82 (95% confidence interval (95% CI) 0.75, 0.89) was observed for SA1s containing ≥20% versus 0-1% low income residents). This association varied between cities (p < 0.001). Adelaide reported the least equitable distribution of green space, with approximately 20% greenery in the most affluent areas versus 12% availability in the least affluent. Although Melbourne had a smaller proportion of SA1s in the top quintile of green space availability (13.8%), the distribution of greenery was the most equitable of all the cities, with only a 0.5% difference in the availability of green space between SA1s containing 0-1% low income households versus those with ≥20%. Inequity of access, however, was reported across all cities when using logit regression to examine the availability of at least 20% (odds ratio 0.74, 95% CI 0.59, 0.93) or 40% (0.45, 0.29, 0.69) green space availability in the more disadvantaged versus affluent neighbourhoods.

Conclusion: Affirmative action on green space planning is required to redress the socioeconomic inequity of access to this important public health resource.


Increasing urbanization has created pressure on land use. Today more and more land in urbanized areas is used for housing, industry, community services or other economic functions. However, green spaces have a proven positive effect on people living in the neighborhood of green spaces, as well as on people working or recreating in the urbanized area. Therefore, green infrastructure investments have been put high on the agenda in many European countries. In order to convince the public and other stakeholders of the usefulness of these kind of green investments, it is necessary to give a correct, understandable and easily repeatable method to value the investment. The current article describes a model that can be used to put the value of green infrastructure investments into economic terms. Evaluating the project at site scale and regional scale will give a complete overview of all direct, indirect and use values of the investment. By using cost–benefit as well as multiplier analyses the monetary values can be estimated. The article shows that using this model helps to justify policy’s support for and investment in green space.

It is well known that urban trees produce various types of benefits and costs. The computer tool i-Tree STRATUM helps quantify tree structure and function, as well as the value of some of these tree services in different municipalities. This study describes one of the first applications of STRATUM outside the U.S. Lisbon's street trees are dominated by Celtis australis L., Tilia spp., and Jacaranda mimosifolia D. Don, which together account for 40% of the 41,247 trees. These trees provide services valued at $8.4 million annually, while $1.9 million is spent in their maintenance. For every $1 invested in tree management, residents receive $4.48 in benefits. The value of energy savings ($6.20/tree), CO2 reduction ($0.33/tree) and air pollutant deposition ($5.40/tree) were comparable to several other U.S. cities. The large values associated with stormwater runoff reduction ($47.80/tree) and increased real estate value ($144.70/tree) were substantially greater than values obtained in U.S. cities. Unique aspects of Lisbon's urban morphology and improvement programs are partially responsible for these differences.


This paper is an analysis of southeastern Michigan, U.S.’s wood residue processing and disposal facilities. The analysis was conducted in order to characterize wood supply patterns, evaluate recovery efficiency, and identify potential alternatives for wood residues. Wood collection and processing facilities were identified and surveyed throughout a 14-county area. This study documented at least 180 wood residue yards operating in the region, which employed an average of six employees per yard (for a total of 1,082 employees in the industry). The total volume of wood entering the yards was quantified at 6,659.6 thousand cubic meters (5.3 million metric tons), mainly from land-clearing and tree removal. The wood residue supply was used to produce a total of 2,035.8 thousand cubic meter (1.6 million tons) tons of new products (e.g., wood chips, mulches, firewood), which were mainly sold locally. The overall conversion rate was estimated at 30% for the entire industry, clearly indicating room for improvement. The industry is estimated to contribute approximately USD $40 million to Michigan’s economy. Improvement of conversion rates and value-added product development would require fundamental changes in equipment, training, and processes used by tree service and land clearing companies.


Treed urban parks provide numerous social, environmental, and economic services of measurable value to a city. To better understand the importance of a forested urban park we employ the Street Tree Resource Assessment Tool for Urban Forest Managers (STRATUM) to investigate the value of services provided by trees in Allan Gardens, a historic public park in downtown Toronto, Canada. A full inventory, conducted in 2008, found 309 trees representing 43 species. Park trees provided 26,326 USD in annual benefits ($16,665 environmental; $9661 aesthetic) during 2008, and delivered a benefit-to-cost ratio of 3.4:1. Tree size and leaf area are larger in Allan Gardens when compared with trees growing in other Toronto parks and across the city as a whole. The flow of benefits from Allan Gardens’ urban forest is heavily dependent upon Norway Maple (Acer platanoides), a finding mirrored across much of Toronto's urban forest. Norway Maple provides the greatest overall annual benefits ($4846 total; $113 per tree) and as a species contributes 17.5% of the environmental and 20% of aesthetic value provided by trees in the park. This work offers a model to urban planners, providing a straightforward methodology for quantifying the value of nature in public city spaces, in the form of treed parks.

Green industry firms have competed for decades on the basis of quality and service. While these competitive dimensions are still important, the industry has continued along its path of maturation and firms must incorporate other factors into their value proposition in order to be successful in this hypercompetitive market. Given the recent economic downturn of 2008–2009, consumers are more value-conscious than ever, but are still willing to consume, and pay premiums for, products and services that enhance their quality of life. This paper summarizes the peer-reviewed research regarding the economic benefits, environmental benefits (eco-systems services), and health/well-being benefits of green industry products and services that serve to enhance the quality of life for consumers.


This article provides an overview of marketing and production practices of the U.S. nursery and greenhouse industry in 2008, based on information collected through the 2009 National Nursery Survey, the fifth such survey since 1988. Lists of nursery firms for each state were assembled from the respective Department of Agriculture (Plant Health Board) offices responsible for licensing nursery producers. The compiled state lists resulted in a combined listing of 38,000 certified nursery operations. A total of 3,044 usable questionnaires were returned from a sample of 17,019 firms for an effective 17.9 \% response rate. The survey was administered through both mail and internet questionnaires, with repeated contacts attempted, and a follow-up telephone survey on non-respondents. Survey respondents reported total annual sales of $4.45 billion in 2008, or an average of $1.73 million per firm, and total employment of 48,833 permanent and temporary jobs. Based on an adjusted population of validated active firms (19,803), total U.S. nursery industry sales were estimated at $27.14 billion, and total employment was estimated at 262,941 jobs. The highest sales and employment were in the Pacific and Southeast regions, led by the states of California and Florida. Overall, 77 percent of sales were made through wholesale outlets including landscape firms, single-location garden centers, and re-wholesalers.


Introduction: Green infrastructure, a network of decentralized stormwater management practices such as green roofs, trees, rain gardens and permeable pavement, captures and infiltrates rain where it falls, reducing stormwater runoff and improving the health of surrounding waterways. These practices provide multiple environmental, economic and social benefits, including, but not limited to:

- Less polluted stormwater runoff
- Improved air quality
- Energy savings
- Increased property values, and
- Reduced greenhouse gas emissions

Green infrastructure's value as a municipal or private investment depends in part on its effects beyond water management and thus upon a community's ability to model and measure these additional values. Although valuation of green infrastructure's monetary benefits has advanced considerably in recent years, it is still a developing field. The 2007 EPA publication Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices documented the comparative
construction costs of green infrastructure practices in residential construction but did not explore performance benefits. While numerous published studies address either the benefits coming from one type of practice, such as energy implications of green roofs, or the collective impacts of a single practice, such as urban forestry’s impact on water, energy, and other elements, such studies do not achieve a cumulative assessment of multiple benefits.

Due to these gaps in information and methodology, the Center for Neighborhood Technology (CNT) and American Rivers joined forces to outline a method for more accurately valuing the benefits of green infrastructure. The resulting guide, “The Value of Green Infrastructure: A Guide to Recognizing Its Economic, Social and Environmental Benefits,” (The Guide) establishes a framework that gives practitioners, planners, builders, and city officials the ability to choose infrastructure investments that are effective, efficient, and long-lived.

The guide distills key considerations involved in assessing the economic merits of green infrastructure practices within an urban context. It examines the steps necessary to calculate a variety of performance benefits gained by implementing green infrastructure strategies and then, where possible, demonstrates simplified illustrative examples that estimate the magnitude and value of these benefits.

In clarifying how to assign value to potential green infrastructure benefits, this guide can assist decision-makers in evaluating options for water management. A more clear view of green infrastructure's values will help communities decide where, when and to what extent green infrastructure practices should become part of future planning, development and redevelopment. The guide aims to:

Inform decision-makers, practitioners and planners about the multiple benefits green infrastructure delivers to communities
Assist communities in valuing the benefits of potential green infrastructure investments

Framework: The research team worked to develop a comprehensive list of potential benefits gained by the use of five specific green infrastructure practices within an urban context, which are the focus of this guide:
Green roofs
Tree planting
Bio-retention and infiltration
Permeable pavement
Water harvesting
An explanation of how particular benefits can be achieved through the practice of specific green infrastructure initiatives is provided within the guide. The following matrix, from the guide, is an illustrative summary of how these practices can produce different combinations of benefits. Please note that these benefits accrue at varying scales according to local factors such as climate and population.


The social and ecological processes impacting on urban forests have been studied at multiple temporal and spatial scales in order to help us quantify, monitor, and value the ecosystem services that benefit people. Few studies have comprehensively analyzed the full suite of ecosystem services, goods (ESG), and ecosystem disservices provided by an urban forest. Indicators, however, are one approach that could be used to better understand the structure of an urban forest, the suite of ESG provided by urban forests, and their influence on human well-being using a simple, innovative and repeatable metric. This study presents a framework for developing indicators using field data, an urban forest functional model, and the literature. Urban tree and soil indicators for groups of ecosystem functions were used to statistically analyze the effects of urban morphology and socioeconomics on urban forest ESG. Findings
show that the most influential ESG indicators were tree cover, soil pH, and soil organic matter. Indicators were significantly influenced by land use and time since urbanization, while analyses of property values and household income did not yield any particularly significant results. The indicators presented in this paper present a first approach to non-monetary valuation of urban forest ESG and can be used to develop urban forest structure management goals and to monitor the effects of urban greening policies on human well-being.


So far, numerous studies have established that view plays a significant role in the market price of a dwelling. The vast majority of those studies have been conducted by means of the hedonic pricing method, which is generally considered to be time-consuming and expensive. In addition, several issues such as model specification and interpretation of results are also argued to be important in the relative literature. This paper presents the results of a study aimed at exploring the effect of pleasant and unpleasant views, e.g. green areas, seashore, cultural monuments, cemeteries, and industrial facilities, on property prices in the broader area of Athens, Greece. The survey was carried out using an alternative approach, which is based on an expert judgment technique, namely the Fuzzy Delphi method. The results indicate that a pleasant view could considerably increase the price of a house, up to about 50%, while an unpleasant view could lead to a decrease in the house price even by about 25%. The implementation of the Fuzzy Delphi method in the field of scenic view valuation seems to be promising, at least from a practical point of view. The method is fast, flexible and inexpensive and could be used as an alternative to hedonic analysis. However, the method faces some shortcomings and further research would be necessary before any firm conclusions could be drawn.


Business today is a key player in addressing social and environmental challenges. Every year companies contribute significant resources—cash, in-kind donations and employee volunteers—to non-profit organizations and community support initiatives. This support is critical for community development. Yet many companies have a limited understanding of the value their initiatives add to the community or to their business. In most cases they measure inputs and outputs but not actual impacts. Measuring and communicating the business value of community-focused programs, however, is critical to maintaining funding for such programs in downturns such as the recession of 2007–2009. This article provides critical analysis of existing efforts to measure the business value of corporate community involvement programs and offers guidance for developing indicators of business impact. Building on lessons learned, it identifies key criteria and makes recommendations for the development of an effective measurement framework and indicators. The article concludes with a discussion on how such a framework can lead to social change.


This report is an update of a previous GLA Economics study- Valuing Greenness: Green spaces, house prices and Londoners’ priorities’- published in 2003. The previous study used a hedonic modelling approach to assess how the amount of green space within wards in London affected house prices, whilst taking into consideration other influential factors such as transportation accessibility and
housing density. The hedonic pricing method is based on the theory that the value of a good is based on the combination of the many attributes the good possesses. In the case of housing this includes domestic facilities, access to services and so on. The value of individual attributes can be inferred from the hedonic model, and thus it is a useful method for estimating the value of attributes that influence house prices, particularly where markets do not exist such as for green spaces. This research builds on the original study with better green space data and a wider range of built environment and locational factors analysed at a more detailed spatial scale.


Trees cast shade on homes and buildings, lowering the inside temperatures and thus reducing demand for power to cool these buildings during hot times of the year. Drawing from a large sample of residences in Auburn, Alabama, we develop a statistical model that produces specific estimates of the electricity savings generated by shade-producing trees in a suburban environment. This empirical model links residential energy consumption during peak summer (winter) months to average energy consumption during non-summer/non-winter months, behaviors of the occupants, and the extent, density, and timing of shade cast on the structures. Our estimates reveal that tree shade generally is associated with reduced (increased) electricity consumption in the summertime (wintertime). In summertime, energy savings are maximized by having dense shade. In wintertime, energy consumption increases as shade percentage in the morning, when outdoor temperatures are at their lowest, increases.


Agricultural land supports not only the production of food and fiber, but a variety of socially valuable non-market goods and services. Examples of those non-market goods and services include aesthetic experiences, wildlife habitat, carbon sequestration, and recreation to name a few. There is a growing awareness of the importance that provision of these non-market services has to the long-run sustainability of agriculture in general, and the sustainability of California agriculture in particular. This awareness has led to an increasing interest in the estimation of the ecosystem functions of non-market goods and services of agriculture. As the ecosystem services are typically not traded in markets and do not carry an explicit market value, they are improperly quantified and often inadequately considered in policy decisions (Costanza et al.’s 1997). Calculating their actual value is a complex undertaking that requires finding an integrative metric that can link these services to human welfare (Pattanyak and Butry, 2005). Value estimates of the ecosystem goods and services can be obtained by relying on two approaches: a) cost-based methods that price these services according to their provision costs, and b) demand-side valuation methods that generate estimates of the willingness to pay or the consumer surplus related to a change in the provision level of these services (Madureira et al, 2007).


Green roof technology is recognized for mitigating stormwater runoff and energy consumption. Methods to overcome the cost gap between green roofs and conventional roofs were recently quantified by incorporating air quality benefits. This study investigates the impact of scaling on these benefits at the city-wide scale using Washington, DC as a test bed because of the proposed targets in the 20–20–20 vision (20 million ft2 by 2020) articulated by Casey Trees, a nonprofit organization. Building-specific stormwater benefits were analyzed assuming two proposed policy scenarios for stormwater fees ranging
from 35 to 50% reduction for green roof implementation. Heat flux calculations were used to estimate building-specific energy savings for commercial buildings. To assess benefits at the city scale, stormwater infrastructure savings were based on operational savings and size reduction due to reduced stormwater volume generation. Scaled energy infrastructure benefits were calculated using two size reductions methods for air conditioners. Avoided carbon dioxide, nitrogen oxide (NOx), and sulfur dioxide emissions were based on reductions in electricity and natural gas consumption. Lastly, experimental and fugacity-based estimates were used to quantify the NOx uptake by green roofs, which was translated to health benefits using U.S. Environmental Protection Agency models. The results of the net present value (NPV) analysis showed that stormwater infrastructure benefits totaled $1.04 million (M), while fee-based stormwater benefits were $0.22−0.32 M/y. Energy savings were $0.87 M/y, while air conditioner resizing benefits were estimated at $0.02 to $0.04 M/y and avoided emissions benefits (based on current emission trading values) were $0.09 M-0.41 M/y. Over the lifetime of the green roof (40 years), the NPV is about 30−40% less than that of conventional roofs (not including green roof maintenance costs). These considerable benefits, in concert with current and emerging policy frameworks, may facilitate future adoption of this technology.


Tourism in protected areas can create considerable income for adjacent communities. Based on face-to-face visitor surveys, the present study measures the structure, size and economic impact of tourist expenditure in the six German national parks Niedersächsisches Wattenmeer, Bayerischer Wald, Eifel, Müritz, Hainich and Kellerwald-Edersee. We find that mean daily expenditure per person of national park visitors is considerably below the national averages for tourists in Germany: day-trippers spend between EUR 7 and 13 per day (national average: EUR 28), whereas overnight visitors spend between EUR 37 and 57 (national average: EUR 120). The proportion of visitors with high national park affinity varies between a maximum of almost 46% in Bayerischer Wald and a minimum of nearly 11% in Niedersächsisches Wattenmeer. Between 49% and 51% of tourist expenditure is captured as direct and indirect income. The total impact of tourism ranges between EUR 525 million in Niedersächsisches Wattenmeer and EUR 1.9 million in Kellerwald-Edersee, reflecting the national parks' distinct trajectories as tourist destinations. In order to increase the economic benefits accruing from national parks regional policy could aim at a qualitative upgrading of tourist services, increased marketing of the unique national park label and the promotion of a diverse regional supply base.


The green industry consists of the floriculture sector (cut flowers, potted foliage plants and bedding/garden plants) and environmental horticulture sector (Johnson, 1997). The environmental horticulture sector includes crops grown outdoors and primarily used for landscaping purposes including golf courses. The industry includes wholesale nursery growers, brokers and distributors, retail garden centers, landscape contractors and maintenance firms, and home centers and mass merchandisers that have specialized lawn and garden departments (S- 1021 Technical Research Committee, 2005). In 2004, the North Carolina green industry recorded wholesale cash receipts of $845 million. This is over $200 million in excess of the receipts from tobacco ($620 million) and turkeys ($449 million). In 2004, North Carolina accounted for 6.2 percent of the national cash receipts from the green industry and ranked fourth nationally, behind Georgia, Texas and Alabama. Potted poinsettia is one of the green industry
products that is growing very rapidly in North Carolina. As with many emerging products, the availability of market information on poinsettia is limited. This study seeks to contribute to the body of information on poinsettias by providing information on the nature of its demand. Such information will help enhance the marketing of poinsettias and strengthen the green industry in North Carolina and the nation by making it more productive, efficient and profitable.

The increasing importance of the green industry in North Carolina is noteworthy for at least three reasons. First, there is a moratorium on large scale hog operations in the state which makes it imperative that additional sources of growth have to be found in the state’s agricultural sector, especially given the importance of the sector in the economy. Second, there is a possibility, though remote, that the broiler industry in the state could be adversely affected by an outbreak of bird flu. The third reason is the demise of the tobacco program. With the elimination of tobacco quotas, tobacco prices, returns and production are expected to decrease thus making tobacco a less profitable and significant portion of North Carolina’s agricultural economy. However, the demise of the tobacco program is accompanied by tobacco buyout payments that started in October 2005 and will run for a period of ten-years. The tobacco buyout payments present both challenges and opportunities for farmers in North Carolina. One of the challenges involves the investment of proceeds from the buyout program. A second challenge is how best to reallocate the land that was previously used to produce tobacco. These challenges offer the opportunity of finding profitable enterprise alternatives. Much effort has gone into finding alternative farm enterprises. Past efforts in this regard include the assessment of the profitability of producing mushrooms, medicinal herbs, vegetables and others. Products that constitute the green industry seem to be viable and profitable alternative enterprises as indicated by their rapid growth in sales in North Carolina, the United States and other countries.

The sustained growth in the green industry implies that the products are one of the few areas in production agriculture that is increasing in value and employing more people. The industry provides an alternative for farmers that have produced traditional crops such as tobacco, corn, cotton and vegetables. This is an especially good opportunity for farmers who may have been displaced as a result of the end of the tobacco program or the structural changes in the farm sector that have forced many small farms out of business. Nursery owners are not the only beneficiaries of the continued expansion of the green industry. The expansion generates rural economic activity, employment and income through the use of dormant resources or the improved allocation of such resources. In addition, society benefits from improved aesthetics and environmental protection. Helping the green industry to thrive will serve the interest of farmers, rural communities and the agricultural sector in North Carolina. In addition to others, such help could be in the form of market analysis for individual green industry products such as poinsettias. This study assesses the demand for poinsettias. Specifically, the study estimates the demand for poinsettias in the U.S. and analyzes the impact of regions on the structure of demand for poinsettias.


Neighborhood satisfaction is an important component of life satisfaction. As a contributor to life satisfaction, neighborhood satisfaction is influenced by individual and household background variables. However, there is limited understanding of how physical environments influence neighbor- hood satisfaction. This paper examines the effect of landscape components (structures, pavement, trees) and land use (residential, commercial, and open space) on neighborhood satisfaction. A survey of 276 respondents in College Station, Texas, was georeferenced and analyzed with landscape components and land-use GIS data. A structural equation model (SEM) examines the relationships among background variables, land use, landscape components, and neighborhood satisfaction simultaneously. Landscape
components and land use were both found to play an important role in neighborhood satisfaction. Trees were found to have a positive effect on neighborhood satisfaction while structures were negative. Pavement, when commercial land use and structures in the SEM model were accounted for, shows a positive relationship with neighborhood satisfaction, suggesting that not all pavement is seen as undesirable. Commercial land use was also found to have a negative effect on neighborhood satisfaction, while background variables have no significant impact. The amount and arrangement of land uses and landscape components in neighborhoods may improve the well-being of residents by increasing their neighborhood satisfaction.


The green industry complex includes input suppliers (manufacturers and distributors); production firms such as nursery, greenhouse, and sod growers; wholesale distribution firms including importers, brokers, re-wholesalers, and transporters; horticultural service firms providing landscape and urban forestry services such as design, installation, and maintenance; and retail operations including independent garden centers, florists, home improvement centers, and lawn/garden departments at home centers, mass merchandisers, or other chain stores. Many current economic trends and driving forces point to the fact that the green industry is in a period of hypercompetitive rivalry due to the maturing consumer demand. A number of firms have already been forced out of the green industry during the 2008-09 recessionary shakeout period and others continue to exit. To address this issue, a workshop was organized by G. Zinati for the 2009 ASHS annual meeting entitled "Managing and Thriving in Tough Times, When Every Dime Counts!", which was sponsored by the Nursery Crops (NUR) and Marketing and Economics (MKEC) Working Groups and the American Nursery and Landscape Association (ANLA). This lead-off workshop presentation: 1) provided an overview of current economic conditions and trends and their influence on the green industry, 2) discussed supply-side methods and technologies for controlling costs during an economic downturn, and 3) addressed proactive demand-side differentiation and pricing strategies that will not only help ensure survival, but will also better position green industry firms for competing profitably in this period of hyper-competition.


This paper presents spatially explicit analyses of the greenspace contribution to residential property values in a hedonic model. The paper utilizes data from the housing market near downtown Los Angeles. We first used a standard hedonic model to estimate greenspace effects. Because the residuals were spatially autocorrelated, we implemented a spatial lag model as indicated by specification tests. Our results show that neighborhood greenspace at the immediate vicinity of houses has a significant impact on house prices even after controlling for spatial autocorrelation. The different estimation results from non-spatial and spatial models provide useful bounds for the greenspace effect. Greening of inner city areas may provide a valuable policy instrument for elevating depressed housing markets in those areas.


‘Urban greening’ has been proposed as one approach to mitigate the human health consequences of increased temperatures resulting from climate change. We used systematic review methodology to evaluate available evidence on whether greening interventions, such as tree planting or the creation of parks or green roofs, affect the air temperature of an urban area. Most studies investigated the air
temperature within parks and beneath trees and are broadly supportive that green sites can be cooler than non-green sites. Meta-analysis was used to synthesize data on the cooling effect of parks and results show that, on average, a park was 0.94 °C cooler in the day. Studies on multiple parks suggest that larger parks and those with trees could be cooler during the day. However, evidence for the cooling effect of green space is mostly based on observational studies of small numbers of green sites. The impact of specific greening interventions on the wider urban area, and whether the effects are due to greening alone, has yet to be demonstrated. The current evidence base does not allow specific recommendations to be made on how best to incorporate greening into an urban area. Further empirical research is necessary in order to efficiently guide the design and planning of urban green space, and specifically to investigate the importance of the abundance, distribution and type of greening. Any urban greening programme implemented would need to be appropriately designed and monitored to continue to evaluate benefit to human health through reducing temperature.


By 2050, 70% of the Earth's human population will live in urban areas. Urbanization can have a devastating impact on local ecosystems, but these impacts vary across time and space. Identifying links between spatiotemporal change in urban ecosystems and neighborhood socio-economics is crucial to management aimed at maintaining flora and fauna in urban areas. Here, we tracked 20 years of socio-economic change and 15 years of vegetation change in 32 residential neighborhoods in south-eastern Australia. Regression models that explicitly accounted for a time lag between neighborhood socio-economic characteristics and vegetation response explained more variation in vegetation cover than models that ignored the effects of time. Also, relationships between vegetation and socio-economic factors were stronger in later years for the same neighborhoods suggesting the influence of socio-economics is more readily identified in established neighborhoods. Socio-economic variables alone, or in combination with biophysical variables, were better predictors of vegetation cover than only biophysical variables. Across space, vegetation cover had a negative quadratic relationship with neighborhood housing density, peaking at mid-density values, and a positive relationship with education level and immigration status (the percentage of residents with a non-Australian background). Over time, housing density had a positive relationship with vegetation cover, reflecting an increase in vegetation as neighborhoods develop. Our results highlight the need to understand temporal context when attempting to explain contemporary patterns in vegetation cover and the increasing importance of socio-economic factors in influencing cover as neighborhoods become established.


While urban disamenities and pollution sources have received considerable attention in environmental justice research, few studies have examined sociospatial inequities associated with the distribution of desirable land uses. In this paper we focus on addressing this limitation by investigating the environmental equity implications of street trees—an important publicly financed amenity that provides several direct and indirect benefits to urban residents. The specific objective was to determine if the spatial distribution of public right-of-way trees is equitable with respect to race and ethnicity, income, and housing tenure in the city of Tampa, Florida, USA. We seek to extend research on equity analysis of urban amenities through several methodological innovations, including: (a) accounting for the heterogeneity of urban land use; (b) utilizing high-resolution remote sensing techniques to quantify parcel-specific tree cover; and (c) using multivariate regression models that control for spatial
dependence within the data. The results support the inequity hypothesis by indicating a significantly lower proportion of tree cover on public right-of-way in neighborhoods containing a higher proportion of African-Americans, low-income residents, and renters. These findings have important implications for local public investment and policy strategies.


Quality of life is fast becoming a standard of measure of long-term care and gerontological service outcomes. Although the issue of quality of life has been of increasing interest in the field of aging, there has been little agreement as to the clarity and definition of the concept and how to measure it, especially as it relates to older adults. Presented here is a comprehensive, integrated model of quality of life that was developed by synthesizing existing constructs within the literature into six major life domains—(1) social well-being, (2) physical well-being, (3) psychological well-being, (4) cognitive well-being, (5) spiritual well-being, and (6) environmental well-being. Consistent with a general systems framework, this holistic model expands the predominant Health-Related Quality of Life constructs to incorporate non-physical aspects of well-being. Each of these domains was broken down into several dimensions in an effort to operationalize the concept of quality of life so that it can have some common standard of useful measurement. These major life domains and indicators are important factors in determining the perceptions of quality of life for older adults. Understanding what constitutes quality of life and how to measure it comprehensively has significant implications for social policy and practice in the field of aging.


We estimated the effect of shade trees on the summertime electricity use of 460 single-family homes in Sacramento, California. Results show that trees on the west and south sides of a house reduce summertime electricity use, whereas trees on the north side of a house increase summertime electricity use. The current level of tree cover on the west and south sides of houses in our sample reduced summertime electricity use by 185 kWh (5.2%), whereas north-side trees increased electricity use by 55 kWh (1.5%). Results also show that a London plane tree, planted on the west side of a house, can reduce carbon emissions from summertime electricity use by an average of 31% over 100 years.


Much effort is expended toward planning for conservation, natural resource management and sustainable land use in agricultural landscapes. Although often not explicitly stated, the aims of these efforts are often to restore natural capital for the provision of ecosystem services and stimulate multifunctionality in landscapes. However, the scarcity of resources for, and the potential economic impact of, ameliorative actions that restore natural capital necessitates the identification of cost-effective geographic priorities, or hotspots, which provide multiple ecosystem goods and services. This requires the integrated spatial modelling of multiple environmental and economic processes accompanied by clear goals and performance indicators. Identification of hotspots provides guidance for highly targeted land use change that cost-effectively adds to the stocks of natural capital in a landscape. Additionally, the multifunctionality of the landscape can be increased through the provision of multiple ecosystem goods and services. This paper begins by examining data requirements for identifying geographic hotspots for land use change. This study integrates traditionally disparate landscape-scale biophysical
and economic data and models. The elements of natural capital considered here are species and ecosystems, soil and water resources, and the atmosphere. It is demonstrated that locating ameliorative actions towards hotspots will be more cost-effective at restoring natural capital and stimulating landscape multifunctionality than a random targeting approach. We calculate these efficiencies using a small set of indicators for assessing aspects of multifunctionality. The focus of this study is the agricultural landscapes of the Lower Murray region of south-eastern Australia.


In May 2009, the Central Park Conservancy released a report on Central Park's impact on the economy of New York City. The report, which was prepared by Appleseed, highlights the multiple ways in which the Park contributes to the City's economic vitality – as a major enterprise in itself; as a magnet for visitors, a location for film and TV production and a venue for major events; as a resource for New York City residents; and through its impact on property values and City tax revenues. Most of the research and analysis presented in the report was completed in 2008, before New York City began to feel the full impact of the current recession. Some of the details of our analysis would of course be different if we had been using 2009 data. Retail and office rents in the area around the Park have declined, for example, and a sharp slowdown in the sale of apartments and commercial properties has meant less revenue from real property transfer taxes. On the other hand, because changes on taxable assessed values always lag behind changes in real market values (both on the way up and on the way down), the real property tax revenues that the City derives from properties near the Park (and in effect, from the Park itself) are actually higher in 2009 than they were in 2007. In other ways as well, Central Park's contribution to the City's economy is probably even more important today than it was at the height of the boom. Spending by Central Park enterprises and visitors to the Park directly and indirectly accounted for $395 million in economic activity in New York City in 2007; and that this economic activity, along with the increase in real property values attributable to proximity to the Park, generated $656 million in tax revenues for the City in 2007.


Strip malls (or mini-malls) are a common land use, historically promoted by U.S. zoning practices that concentrate retail and commercial development in a narrow band along urban arterials and major streets. They are an entry-level retail niche offering opportunity for independent, start-up businesses that serve a limited market. Communities have begun to question land uses that enable efficient ingress and egress of vehicles in retail and commercial districts but give little attention to multimodal motility. Some communities are redeveloping small mall zones on the basis of "complete street" principles, expanding landscape plantings, and redeveloping the character of a business district. This study, assessed public response to one element of small mail (re)development: landscape and vegetation. Prior studies indicated that consumer behavior is positively associated with city trees (urban forest) on multiple cognitive and behavioral dimensions. In mail surveys depicting varied roadside treatments, residents of three major cities in the Pacific Northwest were asked to indicate preferences and perceptions about proposed changes. Survey stimulus materials addressed visual quality, retail perceptions, patronage behavior, wayfinding, and willingness to pay for goods and services. Combined econometrics and psychometrics indicated that respondents prefer landscaped roadsides and report positive retail behavior, such as willingness to pay 8.8% more for goods and services in well-landscaped
malls. Redevelopment and roadside management guidelines are proposed based on the research results, with implications for the economics of local communities.


Soil represents a complex medium, which makes it difficult to evaluate its quality. In the past, soil quality evaluation was biased towards agricultural production rather than for purposes related to the broad range of functions and services that it performs. Soil function and soil quality in the urban environment differ due to the different needs and roles of soil within the diversity of urban land uses. The quality of urban soil should be evaluated to support public services for good environmental quality management. Planners should also adjust their decisions towards more sustainable urban design. Simple and applicable soil quality evaluation methods accompanied by an operations toolkit that could be used by laypeople are needed. This paper discusses soil functions, soil quality indicators, pedotransfer functions, and urban soil quality. It presents an urban soil quality evaluation method for different land uses within one particular evaluation system. The calculation of three one-value measures of soil quality are introduced: index of soil quality (expresses soil quality/suitability for a particular land use), soil environmental quality index (environmental value of soil) in terms of performing the crucial ecological functions of soil, and land use change index (land use planning impact assessment on soil resources). The use of the method is described in two procedures: urban soil quality control and soil evaluation for urban planning.


Understanding the role of diversity in the functioning of ecosystems has important implications for agriculture. Previous agricultural research has shown that crop rotation and the use of cover crops can lead to increases in yield relative to monoculture; however, few studies have been performed within the broader context of diversity-ecosystem function theory and in the absence of chemical inputs. We performed a field experiment in SW Michigan, USA, in which we manipulated the number of crop species grown in rotation and as winter cover crops over a 3-year period to test if varying the number of species in a rotation affected grain yield, a critical metric of ecosystem function in row-crops. The experimental design was unique in that no fertilizer or pesticides were used, and the only management variable manipulated was number of species in the rotation, thus providing a strong comparison to grassland diversity-ecosystem function experiments. Treatments included continuous monocultures of three row-crops, corn Zea mays L., soybean Glycine max (L.) Merr., and winter wheat Triticum aestivum L., and 2- and 3-year annual rotations with and without cover crops (zero, one, or two legume/small grain species), encompassing a range of crop diversity from one to six species. Crop yields and weed biomass were measured annually for 3 years and plant available soil nitrogen was measured over the course of the growing season in the final year of the study. In all 3 years, corn grain yield increased linearly in response to the number of crops in the rotation. Corn yields in the highest diversity treatment (three crops, plus three cover crops) were over 100% higher than in continuous monoculture and were not significantly different from the county average for each of the 3 years despite the absence of chemical inputs. Corn yields in the diversity treatments were strongly correlated with the availability of inorganic soil nitrogen, which was likely influenced by the number of different legume species (crops and cover crops) present in the rotation. In soybean and winter wheat, yield differences among crop diversity treatments were also significant, but of lower magnitude (32 and 53%, respectively), and showed little direct relationship to the number of crop species grown in a rotation. Results demonstrate
that agricultural research motivated by ecological theory can provide important insights into the functioning of agroecosystems and enhance our understanding of the linkages between diversity and ecosystem function. Importantly, these results suggest that reduced chemical inputs do not necessarily result in yield penalties and provide support for incorporation of crop or species diversity when determining how ecosystem services can be included in food, fiber, and biofuel production.


The productive services of nature, such as the ability of fertile soil to grow crops, receive low market prices not because markets fail but because many natural resources, such as good cropland, are abundant relative to effective demand. Even when one pays nothing for a service such as that the wind provides in pollinating crops, this is its 'correct' market price if the supply is adequate and free. The paper argues that ecological services are either too 'lumpy' to price in incremental units (for example, climatic systems), priced competitively, or too cheap to meter. The paper considers counter-examples and objections.


This paper measures the benefits of the urban forest by examining its effect on housing prices. A Geographic Information System is used to develop a measure of the urban forest, the Normalised Difference Vegetation Index, from satellite imagery and to construct other variables from a variety of sources. Spatial hedonic housing price models for the Indianapolis/Marion County area are estimated. The models indicate that greener vegetation around a property has a positive, significant effect on housing price, holding everything else constant. This effect is dominated by measures at the neighborhood level. These findings indicate that property owners value the urban forest, at least in part, by the premium they pay to live in neighborhoods with greener, denser vegetation. These findings also indicate that public action to maintain and enhance the urban forest may be warranted. Planners and urban foresters can use these findings to inform public and policy debates over urban forestry programs and proposals.


Retail sales of container gardens have increased dramatically in recent years, rising 8% from 2004 to 2005, to $1.3 billion. The objective of this study was to determine consumer preferences for three attributes of container gardens; color harmony, price, and amount of care information provided with the purchase. A hierarchical set of levels for each attribute was used in a 3 x 3 x 3 factorial conjoint analysis. A Web-based survey was conducted on 18 Oct. 2006 with 985 respondents. Survey participants were asked to complete a series of questions on a 7-point Likert scale. Survey participants also answered questions about past experiences with and future purchase intentions of container gardens as well as demographics. The three attributes accounted for 99.8% of the variance in container garden preference. Relative importance decreased from price (71%) to amount of care information (23%) to color harmony (6%). Survey participants preferred a container garden with a price point of $24.99, extensive care information, and complementary color harmony. A large portion (76%) of participants in this study indicated that they would be more likely to purchase a container garden if extensive care information was included with the purchase and 85% of participants said they would be willing to visit an Internet Web site that would provide more information on how to care for and maintain a container
garden. Results of this study show that there is a potential to increase the value of a container garden through providing educational material with the purchase.


The purpose of the present study is to conduct product development and market opportunity assessment to assist Michigan entrepreneurs in the identification of product lines, markets and services with high profit potentials. Specific objectives of the study are to (1) explore the structure of the floriculture industry to identify and understand major production and consumption trends, and (2) to examine demand drivers, new product introductions, market channels and other related issues that affect entrepreneurial successes in the floriculture sector of Michigan.

A mix of primary and secondary data has been collected to conduct the study. Available public data have been utilized to assess production and consumption and industry trends. A survey questionnaire was sent to 600 Michigan floriculture growers. Eighty-seven growers responded to the survey and 66 completed surveys were used to analyze demand drivers, product development trends and market opportunities. Views and opinions on industry trends and floriculture supply chains were also collected from key informants including growers and experts that have experience and professional expertise in the industry.

Michigan’s floriculture industry is diverse. State-level statistical data show that bedding plants remain the largest segment in the finished floriculture sector followed by potted flowering plants. Cut flowers and foliage plants have a very small market share. In recent years, sales from foliages, potted flowering plants and bedding plants have experienced growth. The sales trend in cut flowers shows a decline. In terms of production space, production in open ground is also declining. Production in greenhouse covered area has remained unchanged. Survey results show that Michigan’s floriculture industry is characterized by a larger share of older operators who continue to farm even after they reach their retirement age. Most of the growers surveyed (89%) were age 45 and above. Of these, 20 percent were 65 years old and above. Also, 88 percent of the surveyed growers have been operating a floriculture business for more than ten years. Greenhouses were primary production spaces for the growers (84%), and bedding plants were found to be the dominant products produced by the surveyed growers. The majority of the surveyed growers appeared to be small and medium-size operations. In 2007, more than half (55%) of the surveyed growers had annual estimated gross sales of less than $100,000. The remaining 45 percent had sales $100,000 and above. This is in line with the structure of the state’s floriculture sector.

A majority of the growers surveyed have introduced new flowers and plants in the past few years. Product introduction included different kinds of Proven Winner varieties. The list included new varieties in cut flowers, orchids, petunias, marigold, zinnias and others. A majority of the surveyed growers do not have specific plans to introduce new plants in the coming years. The growers mentioned (1) lack of adequate knowledge and information on new plant varieties, (2) policies and regulations that make purchase arrangements difficult, (3) market outlet and logistics related risks and uncertainties, and (4) lack of skilled manpower to maintain and manage the required growing environment for the new plants as key challenges in introducing new flowers and plants.

A combination of factors such as home ownership and improvement, convenience, value, ethnicity, indulgence, wellness and fashion/design influence consumption patterns and demand for floriculture products. The survey results indicate value, convenience and home ownership and improvement as key market drivers that play a very important role in raising sales from floriculture products in Michigan. Michigan growers who can introduce new cultivars and make large-volume sales
through mass merchandise stores and supermarkets can have broad opportunities to raise sales from bedding plants. Growth in new homes and home improvements in Michigan will create and expand markets for annual bedding plants, foliages and potted flowering plants. Convenience will have an important role in raising sales from cut flowers and potted flowering plants. The indulgence and fashion/design market segment appear to play a moderately important role in selling flower and plant products. These market segments could provide broad opportunities for cut flower products that are mainly used as gift items, especially during calendar holidays and for special occasions. Cut flowers and potted flowering plants also fit into the coordinated and seasonal fashion trend and mostly they are a key element in indoor designs and decorations. As foliage plants continue to be widely used for interior decorations, the fashion and design market segment would also play a significant role in selling these plants. Compared to the other market drivers, wellness and ethnicity as market drivers have little or no importance in selling flowers and plants in Michigan.

Market channels and opportunities for Michigan’s floriculture products

Retail operations at greenhouses are the most dominant market channel used by the surveyed growers. Farmers’ markets are also viewed as important retail outlets. Also, garden centers and landscapers were found to be important market outlets for Michigan floriculture products. Garden centers are currently facing fierce competitions from supermarkets, home centers and mass merchandise stores. Some national chains have also started establishing garden center chains. This business model, if expanded, would impact the operations of independent garden centers. Due to the current difficult economic condition in the state and its impacts on new home building and improvements, at least in the short term, landscapers and professional services are not expected to make significant purchases of flowers and plants from Michigan growers.

Most surveyed growers are not selling flowers and plants directly to mass merchandisers, home centers and supermarkets. These growers may not have the required quantity to supply mass merchandisers and home centers. Price could also be another factor that limits sales through these channels. Very few surveyed growers used other market outlets such as the Internet, retail florist shops and sales at trade fairs and special events. Michigan floriculture growers are faced with many challenges when selling products. These include low product prices, competition mainly from other growers and mass merchandisers, and fuel and delivery costs, which affect product transportation and also customer visits to retail stores. Growers who can make efforts to introduce new product innovations that meet the market need will have broad opportunities to increase sales from their products.


Compared with more traditional sectors of U.S. agriculture, little economic information is available on the turfgrass industry, of which golf courses are an integral part. As a result, over the past 30 years individual states have conducted over 60 individual studies that describe in detail the economic importance of their industry. To date, no such information exists at the national level primarily due to the high cost of collecting primary data. To ameliorate this situation, the authors used secondary data from various sources and developed a composite of the turfgrass industry for the entire United States. This report focuses on the golf course industry in particular. Golf represents a very high value amenity use of horticultural products and services, is a major form of development, and uses large amounts of land and water. Results indicate the golf sector is the largest component of the turfgrass industry, accounting for a 44% share. The nearly 16,000 golf courses generated $33.2 billion (B) in (gross) output impacts, contributed $20.6 B in value added or net income, and generated 483,649 jobs nationwide. Economic impacts were also examined for each state, with "top 10" states highlighted. States falling in
the top 10 category varied somewhat depending on the variables being examined. The exception were the top four states-Florida, California, Texas, and Illinois-that remained in the top four irrespective of variable type. In general, the top 10 states accounted for 55% to 60% of economic impacts for the entire United States while the top four alone contributed 40% of the total.


Green (vegetated) roofs have gained global acceptance as a technology that has the potential to help mitigate the multifaceted, complex environmental problems of urban centers. While policies that encourage green roofs exist at the local and regional level, installation costs remain at a premium and deter investment in this technology. The objective of this paper is to quantitatively integrate the range of stormwater, energy, and air pollution benefits of green roofs into an economic model that captures the building-specific scale. Currently, green roofs are primarily valued on increased roof longevity, reduced stormwater runoff, and decreased building energy consumption. Proper valuation of these benefits can reduce the present value of a green roof if investors look beyond the upfront capital costs. Net present value (NPV) analysis comparing a conventional roof system to an extensive green roof system demonstrates that at the end of the green roof lifetime the NPV for the green roof is between 20.3 and 25.2% less than the NPV for the conventional roof over 40 years. The additional upfront investment is recovered at the time when a conventional roof would be replaced. Increasing evidence suggests that green roofs may play a significant role in urban air quality improvement. For example, uptake of NOX is estimated to range from $1683 to $6383 per metric ton of NOX reduction. These benefits were included in this study, and results translate to an annual benefit of $895−3392 for a 2000 square meter vegetated roof. Improved air quality leads to a mean NPV for the green roof that is 24.5–40.2% less than the mean conventional roof NPV. Through innovative policies, the inclusion of air pollution mitigation and the reduction of municipal stormwater infrastructure costs in economic valuation of environmental benefits of green roofs can reduce the cost gap that currently hinders U.S. investment in green roof technology.


The rain garden is an urban storm water best management practice that is used to infiltrate runoff close to its source, thereby disconnecting impervious area while providing an avenue for groundwater recharge. Groundwater recharge may provide additional benefits to aquatic ecosystems via enhancement of stream base flow. Yet, soil conditions can impact on certain aspects of rain garden performance and its provision of ecosystem services. In the context of a watershed-level study to determine the effectiveness of decentralized storm water management, we performed an order 1 soil survey of the Shepherd Creek watershed (Cincinnati, Ohio) to delineate soils and identify and describe representative soil pedons, and then we assessed subsoil saturated hydraulic conductivity (K-sat) in each of the three dominant subsoils with qualitative estimation methods and directly with constant-head permeametry. We next simulated the effect of subsoil hydrology of a hypothetical implementation of a parcel-level rain garden on groundwater recharge in this watershed. Measured subsoil K-sat were overall very low with a mean of 0.01 cm hr (-1) (4 x 10(-3) in hr (-1)) for Eden soil and a mean of 0.2 cm hr (-1) (0.08 in hr (-1)) for both the fine-silty family and Switzerland soils. Compared with the measured values, qualitative measures overestimated K-sat and depth of recharge for Eden and fine-silty, and underestimated the same for Switzerland. Based on median parcel features and 2004 warm-season storm records, rain gardens in the fine-silty family and Switzerland subsoils would be expected to contribute
about 6 cm (2.4 in) of recharge as compared to the 2 cm (0.8 in) expected in Eden soils. Our results also suggest the highest potential for abatement of storm water quantity abatement in Eden soils, with some partitioning of this water to recharge as an added benefit. Our approach and results form the basis for a comprehensive understanding of how storm water management decentralized at the watershed level may positively impact ecosystem services.


The Cincinnati Zoo & Botanical Garden is one of the premier recreational and cultural attractions in the Cincinnati Tri-state region, creating adventure through its exhibits and special events, conveying knowledge through its educational programs, conserving nature through its conservation efforts and serving community through various programs. In addition to its international reputation as an environmental and educational institution, it creates economic benefits for numerous households and businesses in the Greater Cincinnati community through its employment and business activity. This report estimates the economic impact of the Zoo on Greater Cincinnati’s employment, household earnings, and business sales for 2006. The impact of The Cincinnati Zoo on Greater Cincinnati is multifaceted. Through its spending, its contracted services, and spending by visitors from outside the area, it benefits the regional economy. Through its plant and animal exhibits, programs, special events, and continuing development, it has an impact on the surrounding community in many other ways.


Green roofs (roofs with a vegetated surface and substrate) provide ecosystem services in urban areas, including improved storm-water management, better regulation of building temperatures, reduced urban heat-island effects, and increased urban wildlife habitat. This article reviews the evidence for these benefits and examines the biotic and abiotic components that contribute to overall ecosystem services. We emphasize the potential for improving green-roof function by understanding the interactions between its ecosystem elements, especially the relationships among growing media, soil biota, and vegetation, and the interactions between community structure and ecosystem functioning. Further research into green-roof technology should assess the efficacy of green roofs compared to other technologies with similar ends, and ultimately focus on estimates of aggregate benefits at landscape scales and on more holistic cost-benefit analyses.


Benefit-based tree valuation provides alternative estimates of the fair and reasonable value of trees while illustrating the relative contribution of different benefit types. This study compared estimates of tree value obtained using cost- and benefit-based approaches. The cost-based approach used the Council of Landscape and Tree Appraisers trunk formula method, and the benefit-based approach calculated the net present value (NPV, total future benefits minus costs discounted to the present) of future benefits and costs using tree growth data and numerical models. In a hypothetical example, the value of a 40-year-old green ash (Fraxinus pennsylvanica) was $5,807 using the cost-based approach and either $3,102 (for a tree growing in Fort Collins, CO, U.S.) or $5,022 (for a tree growing in Boulder, CO) using the benefit-based approach. This example, however, did not consider planting and management costs. In a multitree example, 15 years after planting five pistach (Pistacia chinensis) street trees in Davis, California, the trunk formula (cost-based) value was $8,756, whereas the benefit-
based value NPV of benefits was negative at discount rates ranging from 0% to 10%. Negative NPVs occurred because future sidewalk repair costs were projected to be in excess of benefits, a relationship not fully captured in the cost-based approach to valuation. Removing and replacing the five pistache street trees was not cost-effective at 7% and 10% discount rates, primarily because high future sidewalk repair costs associated with retaining the trees were heavily discounted. Planting the five pistache trees in their current location was not an economically sound decision, but planting the same trees in a nearby shrub bed would have saved an estimated $1,102 (10%) to $12,460 (0%) over 40 years. These examples illustrate the use of the benefit-based approach as a decision support tool for design and management.


This paper is concerned with the link between urban quality improvements and economic activity. A key question is whether improvements in the urban environment which might be achieved, for instance, through pedestrianisation, will affect business location choices - for example, are office or retail businesses particularly keen to locate in more pleasant urban places? The paper outlines the current state of development of the literature with respect to the influence of urban quality on economic activity, and proposes a framework for forecasting economic impacts based on three communities of reference: customers, employees, and the businesses themselves. The results from original modelling of a case study area in Manchester, England are reported and suggest that the positive uplifts that may be expected from environmental improvement programmes may well be on a scale which is significant. The research is obviously important for the urban regeneration and renaissance agendas which posit attractive and well-designed environments as a way to create the right conditions for promoting economic growth.


Fresh and processed tomato (Lycopersicon esculentum) consumption has increased 40% in the United States over the last two decades. Through better breeding, fresh tomatoes now are marketed in different forms, sizes, colors, and flavors. However, little published information exists concerning consumer demand, preference, and demographic characteristics related to fresh tomato consumption. Taking advantage of a high percentage of Internet use in the U.S., two web-based surveys were released to approximately 6000 e-mail addresses reaching people in every region of the U.S. The surveys contained a total of 61 questions, including 50 digital images of five types of tomatoes (cherry, grape, cluster, plum, and regular slicing) with combinations of three additional factors (price, lycopene content, and production style) and demographic information. Among 389 respondents, 76% preferred and purchased slicing tomatoes in the 4 weeks prior to the survey. These were followed by grape/mini-pear (42%), plum (36%), cluster (27%), cherry (25%), and yellow slicing tomatoes (4.4%). Overall, production method (organic vs. conventional) had low relative importance in comparison to price and tomato type. However, younger participants (<age 38 years) placed more importance on production method. Participants between ages 39 and 57 years were the most price-sensitive, and female were less sensitive than males. Younger participants (<age 38 years) were less price-sensitive and placed more importance on the other attributes (production method, lycopene content, and tomato type).

The amenity value provided by urban green spaces, water bodies and good environmental quality is difficult to assess and incorporate into urban planning and development. Developers and governments in China hitherto have seldom objectively factored these attributes into property pricing and associated decisions. The hedonic pricing method offers an appropriate approach to gauge such external benefits which contribute to real-estate transaction prices. This study explored the impacts of key environmental elements with a bearing on residential housing value in Guangzhou, including window orientation, green-space view, floor height, proximity to wooded areas and water bodies, and exposure to traffic noise. Four large private housing estates composed of multi-storied blocks with similar design and price bracket, catering to the mass property market, were sampled. Transaction price data and structural attributes of 652 dwelling units were acquired directly from developers. Data on environmental attributes, were collected in the field. Two functional hedonic pricing method models, linear and semi-log, were constructed. The semi-log model offered comparatively stronger explanatory power and more reliable estimation. High floor on the multi-story tenement blocks contributed implicitly 9.2% to the selling price. View of green spaces and proximity to water bodies raised housing price, contributing notably at 7.1% and 13.2%, respectively. Windows with a southern orientation with or without complementary eastern or northern views added 1% to the price. Proximity to nearby wooded area without public access was not significant, expressing the pragmatic mindset in the hedonic behavior. Exposure to traffic noise did not influence willingness-to-pay, implying tolerance of the chronic environmental nuisance in the compact city. The study demonstrates that hedonic pricing method could be applied in the Chinese context with an increasingly expanding and privatized property market. It could inform the decisions of policy makers and property developers concerning land selling and buying, land conversion, property development, urban nature conservation, and design of ecological green-space networks.


The United States environmental horticulture industry, also known as the Green Industry, is comprised of wholesale nursery and sod growers; landscape architects, designers/builders, contractors, and maintenance firms; retail garden centers, home centers, and mass merchandisers with lawn and garden departments; and marketing intermediaries such as brokers and horticultural distribution centers (re-wholesalers). Environmental horticulture is one of the fastest growing segments of the nation's agricultural economy. In spite of the magnitude and recent growth in the Green Industry, there is surprisingly little information regarding its economic impact. Thus, the objective of this study was to estimate the economic impacts of the Green Industry at the national level. Economic impacts for the U.S. Green Industry in 2002 were estimated at $147.8 billion in output, 1,964,339 jobs, $95.1 billion in value added, $64.3 billion in labor income, and $6.9 billion in indirect business taxes, with these values expressed in 2004 dollars. In addition, this study evaluated the value and role of urban forest trees (woody ornamental trees); the total output of tree production and care services was valued at $14.55 billion, which translated into $21.02 billion in total output impacts, 259,224 jobs, and $14.12 billion in value added.


This article outlines an approach, based on ecosystem services, for assessing the trade-offs inherent in managing humans embedded in ecological systems. Evaluating these trade-offs requires an understanding of the biophysical magnitudes of the changes in ecosystem services that result from
human actions, and of the impact of these changes on human welfare. We summarize the state of the art of ecosystem services-based management and the information needs for applying it. Three case studies of Long Term Ecological Research (LTER) sites-coastal, urban, and agricultural-illustrate the usefulness, information needs, quantification possibilities, and methods for this approach. One example of the application of this approach, with rigorously established service changes and valuations taken from the literature, is used to illustrate the potential for full economic valuation of several agricultural landscape management options, including managing for water quality biodiversity, and crop productivity.


This study estimates the influence of proximity to water bodies and park amenities on residential housing values in Knox County, Tennessee, using the hedonic price approach. Values for proximity to water bodies and parks are first estimated globally with a standard ordinary least squares (OLS) model. A locally weighted regression model is then employed to investigate spatial nonstationarity and generate local estimates for individual sources of each amenity. The local model reveals some important local differences in the effects of proximity to water bodies and parks on housing price.


Many small cities and towns are located near resource lands, and their central business districts serve both residents and visitors. Such quasi-rural retail centers face competitive challenges from regional shopping malls, online purchasing, and big box discount retailers. District merchants must strategically enhance their market position to prevent outshopping. Streetscape trees are a physical improvement that can be used to attract and welcome consumers. A national survey evaluated public perceptions, patronage behavior intentions, and product willingness-to-pay in relationship to depictions of trees in retail settings. Results suggest that consumer behavior is positively associated with the urban forest on multiple cognitive and behavioral dimensions. Forest amenities of both wildland and built environments can be used to strengthen local economies.


Trees do more than just provide aesthetic benefits, they provide important cooling effects, reduce the urban heat-island effect, reduce incident UV rays and help keep pavement and parked cars cooler. In addition, in properly planted barriers, they can reduce wind and traffic sounds. They can actually reduce air pollution and absorb carbon dioxide (CO2), the predominant greenhouse gas. Given current concerns about global climate change increasing temperatures, anything that helps to ameliorate the urban heat-island effect and reduce atmospheric CO2 levels certainly merits attention and action. However, for the greatest benefits to occur from planting trees, two important details need to be right: species choice and location.


Increasingly, city trees are viewed as a best management practice to control stormwater, an urban-heat-island mitigation measure for cleaner air, a CO2-reduction option to offset emissions, and an
alternative to costly new electric power plants. Measuring benefits that accrue from the community forest is the first step to altering forest structure in ways that will enhance future benefits. This article describes the structure, function, and value of street and park tree populations in Fort Collins, Colorado; Cheyenne, Wyoming; Bismarck, North Dakota; Berkeley, California; and Glendale, Arizona. Although these cities spent $13–65 annually per tree, benefits ranged from $31 to $89 per tree. For every dollar invested in management, benefits returned annually ranged from $1.37 to $3.09. Strategies each city can take to increase net benefits are presented.


Urban areas can contain public parks, protected forests, unprotected (or undeveloped) forest areas, and trees growing around a house or in the neighborhood surrounding the house. Each type of forest cover provides different amenities to the homeowner and to society at large. In particular, while trees on a parcel of land or in a neighborhood may add value for homeowners, the ecological value of these trees as habitat is far less than large, unbroken parcels of forest. We explore different definitions of forest cover and greenness and assess the relative value of these various types of forest cover to homeowners. Using data from the Research Triangle region of North Carolina, we test the hypothesis that trees on a parcel or in the neighborhood around that parcel are substitutes for living near large blocks of forest. The findings have implications for land-use planning efforts and habitat conservation in particular.


Well-designed public open space (POS) that encourages physical activity is a community asset that could potentially contribute to the health of local residents. In 1995–1996, two studies were conducted—an environmental audit of POS over 2 acres (n = 516) within a 408-km2 area of metropolitan Perth, Western Australia; and personal interviews with 1803 adults (aged 18 to 59 years) (52.9% response rate). The association between access to POS and physical activity was examined using three accessibility models that progressively adjusted for distance to POS, and its attractiveness and size. In 2002, an observational study examined the influence of attractiveness on the use of POS by observing users of three pairs of high- and low-quality (based on attractiveness) POS matched for size and location.

Overall, 28.8% of respondents reported using POS for physical activity. The likelihood of using POS increased with increasing levels of access, but the effect was greater in the model that adjusted for distance, attractiveness, and size. After adjustment, those with very good access to large, attractive POS were 50% more likely to achieve high levels of walking (odds ratio, 1.50; 95% confidence level, 1.06–2.13). The observational study showed that after matching POS for size and location, 70% of POS users observed visited attractive POS.

Access to attractive, large POS is associated with higher levels of walking. To increase walking, thoughtful design (and redesign) of POS is required that creates large, attractive POS with facilities that encourage active use by multiple users (e.g., walkers, sports participants, picnickers).


Public parks are often the "engine" that drives tourism in many communities. In a simplified tourism model, visitors use some mode of transportation to leave their homes and travel to attractions, which are supported by various kinds of services, such as hotels/motels, restaurants, and retailing. The
attractions and support services provide information and promote their offerings to target groups they have identified as potential visitors. Attractions activate this tourism system. Rarely do people leave their homes and travel some distance because they want to stay in a particular hotel or dine at a particular restaurant in a different locale. Most of the time, the desire to go to a destination on a pleasure trip is stimulated by its attractions. Many of these attractions are located in parks, while some parks are themselves attractions. This leads to the conclusion that in many communities, parks drive the tourism industry.


Little consumer research is available to help landscape design and installation businesses develop service marketing strategies. We investigated the effect of three components of a landscape design on the perceived value of a home. This information would be useful in marketing lawn and landscape services to prospective clients. Our objective was to provide a consumer perspective on the value of the components in a ‘good’ landscape and determine which attributes of a landscape consumers valued most. Using conjoint design, 1323 volunteer participants in seven states viewed 16 photographs that depicted the front of a landscaped residence. Landscapes were constructed using various levels of three attributes: plant material type, design sophistication, and plant size. Results showed that the relative importance increased from plant material type to plant size to design sophistication. Across all seven markets, study participants perceived that home value increased from 5% to 11% for homes with a good landscape.


As a National Main Street program participant, Athens, Georgia, U.S., has included streetscape tree plantings in economic development efforts. The Main Street program assists downtown merchant groups with physical improvements planning in order to create vital retail environments. If comprehensively managed, the urban forest can be a beneficial long-term improvement. Nonetheless, business people and merchants often have negative perceptions about trees (such as debris and reduced sign visibility) and may influence local policy and budget support for urban forest programs. This study utilized an on-site survey to elicit preference and perceptual response from visitors of the Athens central business district. The presence of a full-canopy forest was found to be associated with higher visual quality ratings of the retail district. District visitors also perceived the streetscape canopy to be an integral amenity of the city’s shopping environment. Quantitative and qualitative research outcomes are reported.


Most research addressing public response to the urban forest has occurred in residential settings; little is known about consumer response to trees in retail places. This study evaluated both potential shoppers’ and business people's preferences and perceptions of trees in inner-city business districts. Trees are highly preferred by both groups, although business people express slightly lower liking for visual categories containing trees. Differences in attitudes regarding tree benefits and annoyances were found, with business people rating tree benefits significantly lower than shoppers. Research outcomes suggest best practices for urban forest planning and stewardship in neighborhood retail environments of large cities.

Communities are often confronted with the difficult decision of land use development. Often the assumption is that developing the land for residential homes offers more revenue to the community than developing parks and open spaces. Several factors show that this assumption is in error. The evidence shows that preserving open space can be a less expensive alternative to development. The evidence clearly indicates that preserving open space can be a less expensive alternative to development. Hence, a number of communities have elected to purchase park and open space land, rather than allow it to be used for residential development, because this reduces the net tax deficit for their residents, which would occur if new homes were built on that land. The conclusion is that a strategy of conserving parks and open space is not contrary to a community’s economic health, but rather it is an integral part of it.


Revitalization programs are under way in many inner-city business districts. An urban forestry program can be an important element in creating an appealing consumer environment, yet it may not be considered a priority given that there are often many physical improvements needs. This research evaluated the role of trees in consumer/environment interactions, focusing on the districtwide public goods provided by the community forest. A national survey evaluated public perceptions, patronage behavior intentions, and product willingness to pay in relationship to varied presence of trees in retail streetscapes. Results suggest that consumer behavior is positively correlated with streetscape greening on all of these cognitive and behavioral dimensions. Research outcomes also establish a basis for partnerships with business communities regarding urban forest planning and management.

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Stochastic budgeting is used to simulate the business and financial risk and the performance over a 6-year planning horizon on a Norwegian dairy farm. A major difficulty with stochastic whole-farm budgeting lies in identifying and measuring dependency relationships between stochastic variables. Some methods to account for these stochastic dependencies are illustrated. The financial feasibility of different investment and management strategies is evaluated. In contrast with earlier studies with stochastic farm budgeting, the option aspect is included in the analysis.


The environmental and economic benefits of trees have been studied relative to a variety of interests including their influence on real estate value. This study investigates the effect of trees and landscaping on office rental rates, based on a comparison of 85 office buildings that comprise 270 individual and unique leases in the Cleveland, Ohio, U.S., metropolitan area. Data that describe the quantity, functionality, and quality of landscaping were gathered from each of the buildings including landscape maturity, the percentage of ground cover (trees, turf, pavement, etc.), and functional attributes (building shade, noise buffer, space definition, recreation, visual screen, and aesthetics). Multiple regression analysis in the form of a hedonic equation was conducted to isolate the economic effects of landscaping. Office attribute data including lease information, physical attributes, and distance variables were used to calibrate the basic model, and landscaping data were added to the hedonic equation to
determine if individual and/or interactive variables had any effect on contracted rental rates. The individual analysis of the variables showed a strong positive effect for those buildings with good landscaping aesthetics and building shade provided by trees. Conversely, landscaping that provides a good visual screen produced significant negative impacts on rental rates.


Parks provide intrinsic environmental, aesthetic, and recreation benefits to our cities. They are also a source of positive economic benefits. They enhance property values, increase municipal revenue, bring in homebuyers and workers, and attract retirees. At the bottom line, parks are a good financial investment for a community. Understanding the economic impacts of parks can help decision makers better evaluate the creation and maintenance of urban parks.


This hedonic study investigates the effect of landscaping on house values, based on a detailed field survey of 760 single-family homes sold between 1993 and 2000 on the territory of the Quebec Urban Community. Environmental information includes thirty-one landscaping attributes of both houses and their immediate environment. By and large, a positive tree cover differential between the property and its immediate neighborhood, provided it is not excessive, translates into a higher house value. Findings also suggest that the positive price impact of a good tree cover in the visible surroundings is all the more enhanced in areas with a high proportion of retired persons. Finally, a high percentage of lawn cover as well as features such as flower arrangements, rock plants, the presence of a hedge, etc. all command a substantial market premium.


This study explored resident involvement in tree planting and maintenance projects on vacant lots in Detroit, Michigan, U.S. Thirty-eight individuals involved in follow-up care of tree planting sites were interviewed and surveyed to understand their motivations for involvement and their perception of these local neighborhood greening projects. "Tending to local residents, as well as the trees, in neighborhoods can have positive impacts on tree survivorship, community development, and improved relationships between foresters and the public. This study explored resident involvement in tree planting and maintenance projects on vacant lots in Detroit, Michigan, U.S. Thirty-eight individuals involved in follow-up care of tree planting sites were interviewed and surveyed to understand their motivations for involvement and their perception of these local neighborhood greening projects. Underlying motivations include an enjoyment from working with nature as well a strong social motivation. Recommendations are offered for forestry professionals seeking improved interactions with local constituents."


Urban development projects may cause loss of amenity values of green areas, which should be taken into consideration in planning. Therefore, quantitative information on residents' valuation concerning urban forests is needed for assessing urban land use. The purpose of this investigation was to study the valuation of urban forests in two different urban environments Joensuu and Sale, Finland. The aims were to study the attitudes towards and benefits related to the use of urban forests and, in particular, to measure the valuations in monetary terms using contingent valuation, i.e. measure the
residents' willingness-to-pay for larger wooded recreation areas and for small forested parks. Urban forests were seen in both towns as clearly producing positive benefits rather than causing negative effects. The negative features of forests were related to the management of the areas rather than their existence. The main values were related to nature and social functions of forests. In contrast, timber production achieved a distinctively low priority in both study towns. The results stress the importance of defining urban forest policies for municipalities in Finland. More than two-thirds of the respondents were willing to pay for the use of recreation areas. Good location and active management raised the average WTP. Moreover, approximately half of the respondents were willing to pay for preventing construction in urban forests. The results also show that the monetary value of amenity benefits in recreation areas is much higher than the present maintenance costs. The examples concerning the advantageousness of construction on green areas suggest that a limit could be found where the infill of housing areas is not worthwhile from the point of view of society, if the losses of green space benefits are taken into account.


Demonstrates how full-scale, standard methods of life-cycle assessment (LCA) methodologies can be integrated with economic analysis methods. Origins of the gap between LCA and life-cycle cost (LCC) analysis; Consequences of the gap between LCA and LCC; How to bridge the gap between LCA and LCC.


Six hundred homeowners, equally divided among rural, suburban, and urban areas in Minnesota responded to a 1999 phone survey on their lawn size, maintenance practices, and the perceived environmental impact of their lawns. The average lawn size was estimated to be 0.62 acres (0.25 ha), with an estimated 872,660 total acres (353,427 ha) in home lawns in Minnesota. Annual spending on lawn care per home was about $200, with an estimated $150 million spent annually in Minnesota. Participants reported low maintenance practices and pesticide use. A majority thought fertilizers and pesticides were harmful to the environment and public health. Respondents felt strongly that the government has a right to regulate fertilizers and pesticides in public park and lawn areas, but were divided with regard to the appropriateness of regulation on private property. Many (78.9%) disagreed or strongly disagreed with the statement that their lawn was harmful to the environment. Most (60%) felt their lawn could have an effect on the environment and 71% felt they personally could make a difference in the environment by how they maintained their lawn.


A survey of 15 Sacramento parking lots and computer modeling were used to evaluate parking capacity and compliance with the 1983 ordinance requiring 50% shade of paved areas (PA) 15 years after development. There were 6% more parking spaces than required by ordinance, and 36% were vacant during peak use periods. Current shade was 14% with 44% of this amount provided by covered parking. Shade was projected to increase to 27% (95% CI 24-37%) when all lots in the sample were 15-year-old. Annual benefits associated with the corresponding level of tree shade were estimated to be US$ 1.8 million (CI US$ 1.5-2.6 million) annually citywide, or US$ 2.2 million less than benefits from 50% shade (CI US$ 1.4-2.5 million). The cost of replacing dying trees and addressing other health issues
was US$ 1.1 million. Planting 116,000 trees needed to achieve 50% shade was estimated to cost approximately US$ 20 million. Strategies for revising parking ordinances to enhance their effectiveness are presented.


There is a simple robust variance estimator for cluster-correlated data. While this estimator is well known, it is poorly documented, and its wide range of applicability is often not understood. The estimator is widely used in sample survey research, but the results in the sample survey literature are not easily applied because of complications due to unequal probability sampling. This brief note presents a general proof that the estimator is unbiased for cluster-correlated data regardless of the setting. The result is not new, but a simple and general reference is not readily available. The use of the method will benefit from a general explanation of its wide applicability.


Quantitative information on residents' valuations attached to urban forests is needed for assessing urban land-use. The aim of this study is to value implicitly non-priced urban forest amenities by comparing dwelling prices and specific amounts of amenities associated with dwelling units. The empirical study is based on data from the sales of terraced houses in the district of Sale in Finland. According to the estimation results a one kilometer increase in the distance to the nearest forested area leads to an average 5.9 percent decrease in the market price of the dwelling. Dwellings with a view onto forests are on average 4.9 percent more expensive than dwellings with otherwise similar characteristics.


An assessment of trees in Brooklyn, New York, reveal that this borough has approximately 610,000 trees with canopies that cover 11.4 percent of the area. The most common trees are estimated to be tree of heaven, white mulberry, black locust, Norway maple and black cherry. These trees currently store approximately 172,000 metric tons of carbon with an estimated value of $3.5 million. In addition, these trees remove about 2,500 tC per year ($51,000/yr) and about 254 metric tons of air pollution per year ($1.3 million/yr). The replacement or compensatory value of Brooklyn’s trees is estimated at $679 million. Potential damage from an Asian longhorn beetle infestation is $390 million (51 percent of the population). Management strategies are suggested for maximizing air quality and carbon benefits from urban trees.


Throughout history, plants have been used to benefit people. In the United States, formal research to document the impacts of plants on people was not published until the 1970s, when papers from social and medical scientists began to appear. In the 1990s, symposiums began to appear that included the first on “The Role of Horticulture in Human Well-being and Social Development,” brought people together from around the world to share and expand their knowledge in this emerging field. Symposium participants have included researchers in the social sciences and plant sciences, practitioners in horticultural therapy, teachers in colleges and public gardens, industry representatives applying the knowledge, and more. This has formed the basis for current activities in research, teaching, and practice throughout the United
States. Examples from research that now documents a variety of beneficial impacts of plants on people are discussed.


This report estimates the potential regional economic impacts associated with construction, operations and tourism in the Heritage Village, Florida Botanical Gardens and Gulf Coast Museum of Art attractions. All three attractions are housed within a 180-acre site of Pinewood Cultural Park in Pinellas County, Florida and serve as research and public education vehicles on issues related to the arts, history and environment. This analysis estimated the total economic impacts associated with the Heritage Village, Florida Botanical Gardens and Florida Gulf Coast Art Museum attractions. Specifically, the total economic impacts of expenditures on or by overnight visitors, annual operations and construction between the years 2000 and 2002 were estimated for each attraction. This analysis was restricted to the 4-county region of Hillsborough, Hernando, Pinellas and Pasco counties and data assumptions employed in this study were based on information provided by the Pinellas County Cooperative Extension Service. Results revealed that the combined cultural attractions will stimulate output by $170.1 million, increase employment by 2,409 jobs, stimulate value-added by $92.1 million and increase labor income by $63.8 million between the years 2000 and 2002. Additionally, the annual economic impacts of 1000-person overnight visitor expenditures were presented given some level of uncertainty surrounding actual overnight visitor attendance in each attraction. Each 1,000 person grouping will stimulate output by $156.6 thousand, increase employment by 3 jobs, stimulate value added by $92.6 thousand and stimulate labor income by $60.4 thousand.


Floriculture and environmental horticulture is the fastest growing segment of agriculture in the U.S., averaging seven percent annual growth since 1992. This industry is an important sector in the economy of Florida and other states. The wholesale nursery sector is closely linked to the horticultural retailer acid landscape services sectors, which provide associated products and services. Florida's subtropical climate and strategic geographic location with respect to Latin America provides a comparative advantage for production of high valued horticultural crops. The state has traditionally been a supplier of plant products to the eastern US, Canada and Europe. Florida dominates the US market for tropical foliage plants with over 90 percent market share. The economic impact of Florida's environmental horticultural industry in 1997 was estimated based on telephone interview surveys with wholesale plant nurseries, horticultural retailers, and landscape service firms. Sales of ornamental plant products by nurseries were estimated at $1.46 billion (B), sales of plants and related horticultural goods by retailers totaled $1.75B, and sales of products and services by landscape service firms were $2.70B. Domestic and international exports of horticultural products and services from Florida amounted to $659 million (M). An input-output model was used to evaluate the multiplier effects of export sales associated with purchased inputs from other industries and personal consumption expenditures by industry employees. The gross economic impacts of the horticulture industry included economic output of $6.36B, total economic value added of $5.42B, and employment of 187,000 persons. These impacts are greater than for any other sector of agriculture and associated manufacturing in Florida, including the large fruit and vegetable industry. Economic impacts for the wholesale nursery sector were also
estimated for seven legions of the state. Reliable information on economic impacts is essential for promotional and development activities by industry associations, and for formulation of sound policies by legislators, regulatory agencies, and local government officials.


Neglected vacant lots in the modern urban setting pose great hazards to community life. These lots, which host criminal behavior, accumulate trash, and create various health risks, epitomize the frustration and despair nearby residents often feel. A recent study reports that more than one-fifth of all land in American cities is classified as vacant.2 Despite the prevalence of vacant land and the reality of urban blight, many communities have been successful in transforming these dangerous urban spaces into thriving community gardens.


Measures of the Quality of Life have always raised questions about what indicators and valuation methods best represent human well-being. This paper argues that the "what" is inseparably linked to "who" is included in the selection and valuation process. It is argued that operative biases undervalue and even neglect the most basic aspects of the quality of life, namely those services provided in households, communities and nature which sustain the social and environmental context of human life.


Accurate leaf-mass determination is a critical factor in estimating the magnitude of biogenic hydrocarbon (BHC) emissions from green plants. In several past studies that developed BHC emissions estimates for urban areas, a volumetric approach was used to estimate leaf masses of urban trees. Crown volumes were modeled by geometric solids and then multiplied by species-specific leaf-mass constants (experimentally determined leaf mass-to-volume ratios) to obtain leaf mass, although associated uncertainties were not well characterized. The purpose of the present study was to examine the precision and accuracy of a volumetric approach using geometric solids to compare estimated leaf masses to measured whole-tree leaf masses, and to compare leaf-mass constants derived from selective sampling within crowns to whole-tree values. Accordingly, total leaf masses obtained through tree harvest and leaf removal of 21 urban trees were compared to leaf masses calculated using geometric solids to model the shapes of tree crowns and leaf-mass constants found in the literature. Leaf masses were also calculated from recently published allometric equations. Using the experimentally measured total leaf mass and dimensions of each tree, whole-tree leaf-mass constants were also calculated. Results from this study suggest that leaf-mass estimates developed for individual trees through a volumetric approach may be within similar to 50% of actual values. For the 21 trees in this study, sums of leaf-mass estimates were within similar to 20% of the sum of the measured leaf masses when the vertical ellipsoid, sphere, or preferred solids were used. Leaf masses per unit area of crown projection for these urban trees were greater than the values of leaf mass per ground surface area reported for eastern deciduous forests.


Ecosystem management's underpinnings have been biological in nature-the concern for ecosystem integrity, health, and resilience. This intent has been translated into a similar societal goal.
However, its philosophy is still evolving biologically and socially. Since the geographic boundaries of an ecosystem may probably cross many different ownership types, this leaves landowners wondering how this new management approach will affect them. We discuss the role of economics within the ecosystem management debate. In addition, we also examine three existing economic analytical techniques that can be used to analyze ecosystem management, discuss the contributions of these techniques and their limitations, and identify three key points that an economic analysis should address. Finally, we survey five examples of ecosystem management in practice on United States Department of Agriculture Forest Service lands.


Green spaces have important amenity values contributing to the quality of urban life. The deconstruction of green spaces cause negative externalities e.g. the loss of non-priced benefits. In land-use planning, therefore, amenity values should be systematically assessed and measured commensurately, i.e. in monetary terms with material values. This paper discusses the suitability of the contingent valuation method in assessing urban forest benefits, and presents the main results of an empirical study conducted in Joensuu, the capital of North Carelia, Finland. The study was designed to measure the use-values of urban wooded recreation areas, and the residents’ willingness to pay for small forest parks contributing to the quality of the housing environment. The results suggest that most visitors were willing to pay for the use of wooded recreation areas. Furthermore, approximately half of the respondents were willing to pay to prevent the conversion of forested parks to another land-use. The results can be used to assess the profitability of the management of urban forests. In addition, the results are useful in assessing the value of green space benefits in different land use options.


Tree shade reduces summer air conditioning demand and increases winter heating load by intercepting solar energy that would otherwise heat the shaded structure. We evaluate the magnitude of these effects here for 254 residential properties participating in a utility sponsored tree planting program in Sacramento, California. Tree and building characteristics and typical weather data are used to model hourly shading and energy used for space conditioning for each building for a period of one year. There were an average of 3.1 program trees per property which reduced annual and peak (8 h average from 1 to 9 p.m. Pacific Daylight Time) cooling energy use 153 kWh (7.1%) and 0.08 kW (2.3%) per tree, respectively. Annual heating load increased 0.85 GJ (0.80 MBtu, 1.9%) per tree. Changes in cooling load were smaller, but percentage changes larger, for newer buildings. Averaged over all homes, annual cooling savings of $15.25 per tree were reduced by a heating penalty of $5.25 per tree, for net savings of $10.00 per tree from shade. We estimate an annual cooling penalty of $2.80 per tree and heating savings of $6.80 per tree from reduced wind speed, for a net savings of $4.00 per tree, and total annual savings of $14.00 per tree ($43.00 per property). Results are found to be consistent with previous simulations and the limited measurements available.


The Sacramento Municipal Utility District's (SMUD) shade tree program will result in the planting of 500,000 trees and has been found to produce net benefits from air conditioning savings. In
this study we assume three scenarios (base, highest, and lowest benefits) based on the SMUD program and apply Best Available Control Technology (BACT) cost analysis to determine if shade trees planted in residential yards can be a cost effective means to improve air quality. Planting and maintenance costs, pollutant deposition, and biogenic hydrocarbon emissions are estimated annually for 30 years with existing deterministic models. For the base case, the average annual dollar benefit of pollutant uptake was $895 and the cost of biogenic hydrocarbon emissions was $512, for a net pollutant uptake benefit of $383 per 100 trees planted. The uniform annual payment necessary to repay planting and maintenance costs with a 10% rate of interest was $749. When high biogenic hydrocarbon emitting tree species were replaced with low-emitters, the base case benefit-cost ratio (BCR) increased from 0.5:1 to 0.9:1. The BCR for the "highest" and "lowest" benefit cases were 2.2:1 and -0.8:1, respectively. Although SMUD plantings produce cost effective energy savings, our application of the BACT analysis does not suggest convincing evidence that there is cost savings when only air quality benefits are considered.


The services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the Earth's life-support system. They contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet. We have estimated the current economic value of 17 ecosystem services for 16 biomes, based on published studies and a few original calculations. For the entire biosphere, the value (most of which is outside the market) is estimated to be in the range of US$16-54 trillion (1012) per year, with an average of US$33 trillion per year. Because of the nature of the uncertainties, this must be considered a minimum estimate. Global gross national product total is around US$18 trillion per year.


The majority of urban forest benefits represent non-consumptive use values, which include benefits derived from pleasant landscape, clean air, peace and quiet and screening, as well as recreational activities. The hedonic pricing method examines external benefits and costs of urban forests associated with housing. This investigation studied whether and how urban forest benefits are capitalized in property prices. It also searches for suitable variables for describing the green space benefits in hedonic pricing studies. Apartment sales data (1006 apartments) were collected in Joensuu, a town of 48000 inhabitants in North Carelia, Finland. Hedonic models were designed to explain purchase prices. Apartment characteristics, location, and environmental quality variables were used as explanatory variables in the models. Environmental and locality data were measured with respect to each specific house. Results indicate that urban forests are an appreciated environmental characteristic and that their benefits are reflected in the property prices. Proximity of watercourses and wooded recreation areas as well as increasing proportion of total forested area in the housing district had a positive influence on apartment price. However, the effect of small forest parks was not clear. The range of the variable values was small, because there were many small wooded green spaces in the study locale. In addition, data concerning the views from the apartment or the composition of the forests was not available.

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Trees New York (TNY) and Trees New Jersey (TNJ) conducted this research to generate quantifiable data and subjective valuation as related to trees and urban forests in commercial areas within the region. It was hypothesized that over the years there had been a steady loss of forest cover in commercially zoned suburban areas, as well as in downtown urban areas. The study examined the trends of forest loss in commercial districts within the region and sought to quantify the public and private benefits of these forests. This was accomplished through the use of Geographic Information Systems (GIS) software, existing scientific modeling techniques and interviews.


Trees absorb gaseous pollutants through leaf stomata and can bind or dissolve water soluble pollutants onto moist leaf surfaces. Tree canopies also intercept particulates and reduce local air temperatures. Urban trees may reduce ambient air ozone concentrations, either by direct absorption of ozone or other pollutants such as NO{sub 2}, or by reducing air temperatures, which reduces hydrocarbon emission and ozone formation rates. On the other hand, biogenic hydrocarbon emissions from trees may play a role in ozone formation. The role of trees in air quality has become coupled with concern over the costs and benefits of large-scale urban free planting programs. Air quality management districts provide pollution abatement credits to businesses and institutions by permitting the use of controls or processes, provided they are technically feasible and cost effective, based upon guidelines in Best Available Control Technology (BACT) manuals. Typically BACT analysis is applied to stationary sources, but the authors apply it here to determine if a large-scale urban tree planting can be a cost effective means to improve air quality.


Surveys taken in 1991 and 1992 in Virginia suggest that the enclave model of employment may be a more successful and long-term method of employing individuals with mental disabilities (IMDs) within Virginia college grounds departments. Individual, competitive placement of IMDs seems to be less successful, resulting in increased level of temporary and short-term employment. Additional research is needed to document the methods and benefits of employment used by other grounds departments, including colleges outside Virginia in the employment of IMDs.

The residential squares of London developed in the seventeenth and eighteenth centuries into a unique urban landscape form that introduced rural landscape values into the urban fabric in ways that continue to shape urban landscape ideals today. This study takes the viewpoint of cultural geography to look at the gardens in the squares as symbolic statements expressing social values in a critical period in the history of European cities, as property and social relations were in transition from late feudal to early capitalist modes. The open spaces of the squares were changed from open plazas in the seventeenth century to enclosed private parks at the end of the eighteenth century, based on the social values of the aristocracy, later adopted by the middle classes. Public rights of access were extinguished and the gardens were planted with trees and shrubs reminiscent of rural landscape parks. The squares and their surrounding residential districts represented some of the first expressions of the desire for class segregation, domestic isolation, and privatized open space that later were to form the basis of suburban living. They also were a major arena for playing out the tension between classes over access to open space and they influenced the development of early public parks. The residential squares and their gardens inspired imitation beyond London, including in the U.S. during the first third of the nineteenth century.


Firms have limited resources that cannot be allocated efficiently to the market as a whole, but can be targeted to selected customer groups. Market segmentation is the process of dividing a market into distinct customer components. Selected products and services that best meet the needs of a selected customer group are targeted to that particular segment in a marketing strategy. Market segmentation and product-targeting concepts help management efficiently allocate scarce resources as part of a comprehensive strategy to expand revenues and profits.


Vegetation can reduce the cooling loads of buildings in hot arid climates by modifying air temperature, solar heat gain, longwave heat gain, and heat loss by convection. However, savings from reduced mechanical cooling may be offset by increased irrigation water costs. In this study, three similar model buildings were constructed and surrounded with different landscapes: turf, rock mulch with a foundation planting of shrubs, and rock mulch with no plants. Irrigation water use and electricity required to power the three room-sized air conditioners and interior lights were measured for two approximately week-long periods. Electrical energy consumed for air-conditioning by the rock model was 20 – 30% more than for the turf and shade models. Factors accounting for these differences in energy performance include dense shade that substantially reduced solar heat gain for the shaded model, a 16% difference in longwave radiation flux between the rock and turf treatments, and a maximum drybulb depression of 4 °C over the turf compared with the rock. Air-conditioning savings exceeded water costs for shade treatments that were simulated to receive moderate and low amounts of irrigation water. These preliminary findings suggest that the localized effects of vegetation on building microclimate may be more significant than boundary layer effects in hot arid regions.

This paper deals with the results of the combination of two deterministic models: a multi-layered canopy leaf energy budget model CANOPY and a complex street canyon energy budget model URBAN 3. Both models were validated previously. In comparing the effect of street parks and roof gardens in contrast to non-vegetated city blocks, four typical urban morphologies were created, ranging from high-rise structures to low buildings and combinations thereof. These building systems were exposed to typical summer and winter scenarios for three latitudes. The simulations indicated a variety of increases in absorbed shortwave radiation and net radiation, and decreases in sensible heat flux and system reradiation compared to non-vegetated environments. It is believed that the discussed features represent generalized limits of the possible effect of adding vegetated surface covers to non-vegetated city blocks.


Investments in urban forests have been increasing in many US cities. Urban forests have been shown to provide countless ecosystem benefits with many addressing climate change issues, such as sequestering carbon, reducing air pollution, and decreasing the heat island effect. Individual groups within the American public may not respond to the issue of climate change in the same way, thus engaging each group in climate change solutions will require different approaches. It is therefore important to understand how the public perceives climate change, their values and preferences, and barriers that might constrain their engagement to policy solutions. A mail survey was implemented, focused on households’ willingness to support and pay for urban forests as a climate change mitigation method. Atlanta, Georgia, USA was selected for this study given its environmental issues such as heat island effect and land cover changes, including conversion of forestland, that come with rapid population growth and urban sprawl. A Tobit model was used to model willingness-to-pay as a function of several variables derived from survey results; and a multivariate weighting strategy was used to address nonresponse issues. The analysis showed that Atlanta households are willing to pay $1.05 million to $1.22 million per year, or $5.24 to $6.11 million over a five-year period. The WTP amount was significantly related with the residents’ income, media source from where they received climate information, and the relative coverage of tree canopy around their residence. Results are relevant to city managers who are interested in understanding the public value of urban greening programs and developing strategies or policies to expand urban forests as part of a climate change strategy.