Considering the Economic Value of Natural Design Elements at City Scale

Omniya el-Baghdadi, Faculty of Engineering and Science, QUT, Brisbane, Australia
Dr Cheryl Desha, Faculty of Engineering and Science, QUT, Brisbane, Australia
Karlson 'Charlie' Hargroves, Curtin University Sustainable Policy Institute (CUSP), Perth, Australia

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Abstract

With increasing signs of climate change and the influence of national and international carbon-related laws and agreements, governments all over the world are grappling with how to rapidly transition to low-carbon living. This includes adapting to the impacts of climate change that are very likely to be experienced due to current emission levels (including extreme weather and sea level changes), and mitigating against further growth in greenhouse gas emissions that are likely to result in further impacts. Internationally, the concept of 'Biophilic Urbanism', a term coined by Professors Tim Beatley and Peter Newman to refer to the use of natural elements as design features in urban landscapes, is emerging as a key component in addressing such climate change challenges in rapidly growing urban contexts. However, the economics of incorporating such options is not well understood and requires further attention to underpin a mainstreaming of biophilic urbanism. Indeed, there appears to be an *ad hoc*, reactionary approach to creating economic arguments for or against the design, installation or maintenance of natural elements such as green walls, green roofs, streetscapes, and parklands. With this issue in mind, this paper will overview research as part of an industry collaborative research project that considers the potential for using a number of environmental economic valuation techniques that have evolved over the last several decades in agricultural and resource economics, to systematically value the economic value of biophilic elements in the urban context. Considering existing literature on environmental economic valuation techniques, the paper highlights opportunities for creating a standardised language for valuing biophilic elements. The conclusions have implications for expanding the field of environmental economic value to support the economic evaluations and planning of the greater use of natural elements in cities. Insights are also noted for the more mature fields of agricultural and resource economics.

Keywords:

Climate change, biophilic urbanism, economic value

Introduction

In Australia, Preston and Jones note that average air temperatures have increased by 0.7^{o}C, which has also been coupled with declines in regional rainfall.[i] They also predict that this increase in temperature is expected to trigger more tropical cyclones, extreme precipitation, and heat waves; all of which will have negative implications on Australian cities' infrastructure and public health. This is expected to be further exacerbated with the increasing population. The Australian Bureau of Statistics estimated that in 2009, 64 per cent of the Australian population lived in a capital city.[ii] This has caused Australia to be amongst the ten countries with the largest ecological footprints, ranking fifth globally.[iii]

In their recent publication '*Cents and Sustainability*', Smith, Hargroves and Desha [iv] developed the theory of 'decoupling' environmental pressures from economic growth. Case studies and evidence for how five key areas (decoupling, biomimicry, whole system design, sustainable practice, and resource productivity) can maintain economic growth without damaging the environment were presented and explored. These case studies address the fundamental issue of sustainable development as defined in the Brundtland report,[v] which emerged in response to a growing realisation to balance economic growth with environmental concern. The underlying philosophy of sustainable development is improving the quality of life of people should not degrade the environment and resources such that future generations are at a disadvantage. Sustainable development comprises of numerous benefits, which the United Nations categorizes into three subgroups - social, environmental, and economic.[vi] While these subgroups may be distinguished independently, Hargroves and Smith highlight their interconnectedness in 'The Natural Advantage of Nations'.[vii] They discuss how looking at sustainable development from a whole-of-system economic perspective can actually incorporate social and environmental considerations. Indeed, establishing a rigorous, whole-of-system business case for sustainable development is critical to ensuring that the solution can be implemented and maintained in a way that does not diminish future prosperity.

Appreciating these consequences, this paper begins by discussing the concept of biophilic urbanism, including its current and emerging application in the urban environment. Subsequently, 'economic valuation techniques' and the 'economics of biophilic urbanism' are introduced, then discussed with regard to the current the level of understanding about these two fields of enquiry and the extent to which they converse.

Methods

The research method employed for this paper is a contextual review of the literature, which provided background context of the available information in the field of biophilic urbanism (*what is so?*); this then shed light on what the missing gaps in the literature is (*what is missing?*). Once the existing literature and gaps have been identified using qualitative techniques, an integrative literature review followed, which involved drawing on the existing context to distil insights and overall findings to provide the literature review with an added depth of analysis. This framed research question that guided this paper to highlight the gaps in knowledge (*what is the key question?*). The research design and methodology employed is the qualitative method, which included distilling the key information and synthesising this data to present a literature review that is relevant and informative. The sources referenced include journal articles, industry and government reports, online pages and case studies.

Literature review

<u>*Biophilic urbanism as a design response:*</u> Stemming from the theory of sustainable development, biophilic urbanism has been gaining momentum in the world of urban planning as it poses to be a win-win solution to deal with the challenges of climate change and economic development. Biophilic urbanism originates from E. O. Wilson's concept of 'biophilia', which advocates that there is an innate bond between living systems and humans[viii] and it is now considered a new urban design principle.[ix] In their book 'Resilient Cities', Newman, Beatley, and Boyer discuss its global recognition, where it has begun to be implemented in urban areas within Europe and North America in particular.[x] This method of planning is capable of providing local, state, and national governments with options to mitigate climate change, reduce energy consumption, enhance urban biodiversity, improve worker productivity, and respond to densification pressures of cities. Thus it allows economic growth to prosper while simultaneously fostering a more sustainable, resilient urban environment.

Studies have shown that replacing the natural vegetation with buildings and roads causes urban areas to have higher air temperatures than their rural surroundings as a result of these gradual surface modifications; this is also known as 'Urban Heat Island' effect.[xi] This has caused several countries, particularly in Europe and North America, to investigate the potential benefits of incorporating nature in urban settings and the possible mitigation of the UHI effect. This is supported by other work internationally. For instance, the UNEP confers that the presence of green space within cities aids in regulating natural processes such as mitigating local temperature extremes.[xii] One study further explains that a 10 per cent increase in tree canopy reduces cooling and heating energy use by 5 to 10 per cent.[xiii] Thus, new design techniques fostering the use of green roofs and facades on buildings have emerged in cities.[xiv] In addition, vegetation and green spaces can also help cities manage the consequences of heavy rainfall and also serve in helping flood mitigation in coastal cities.

<u>*Emergent elements of biophilic urbanism*</u>: Integrating biophilic urbanism into urban environments is facilitated through the use of 'biophilic elements'; i.e. natural design features. According to SBEnrc[xv] these elements can occur at three geographic scales, from as extensive as urban parks and green streets at the city and neighbourhood levels to as concentrated as green walls and pot plants at the level of buildings. Table 1 demonstrates that each scale comes with a number of design elements, which are further broken down to various forms of incorporation. Each of the biophilic elements has a few specific benefits while a few other benefits are shared by all, as outlined in the last column. Although it is acknowledged that benefits can be incurred from the application of a single element, a full suite of benefits can most likely be enjoyed by adopting a holistic application of these elements from all three scales.

Table 1: Overview of the elements of Biophilic Urbanism

Element		Forms	Specific Benefits	Common Benefits
Building	**Indoor Plants**	- Pot plants, on desks, around office, or in banks of pots - Indoor living walls, including pots within a mess frame (also see Green Walls) - Indoor planted vegetation, such as atriums and large planted installations	- Reduced illness - Increased productivity - Improved air quality	- Response to growing needs for densification of cities
	Green Roofs	- '*Intensive*': Soil deeper than 200mm and vegetation up to the size of trees - '*Extensive*': Soil up to 200mm with ground cover vegetation	- Improved building energy efficiency - Water management - Space efficiency	- Revitalise urban environments

	Green Walls	- *Panel System: Pre-planted structural panels* that are secured to wall, and have an in-built watering system - *Felt System:* Pre-fabricated structural panel with *felt planting pockets* that is planted onsite and kept moist - *Container/Trellis System:* Pre-fabricated structural panel with *planting pots*, with drip irrigation system for pots	- Food production - Sound insulation - Increase roof/wall lifespan - Vertical urban farming	- Alleviate urban heat island effect - Improved air quality
Neighbourhood	**Green Verges**	- *Street trees and canopies are chosen depending on physical properties.* - Shade planting for buildings are placed to remove heat load - Green streets and alleys create cool pervious greenways - Rain gardens and bio-swales integrate into stormwater management plan and consist of pervious channels - Green permeable sidewalks	- Reduce traffic / encourage walking and cycling - Reduce building cooling/ heating energy use - Windbreak - Water management - Food production	- Improved microclimate - Sequester carbon/ reduce greenhouse gas emissions
	Green Islands	- Urban parks and gardens placed close to transportation routes - Community farms close to homes - Residential backyards provide space for food production - Lawns and gardens reduce UHI effects - Rehabilitating and uncovering waterways and streams	- Reduce traffic / encourage walking and cycling - Food production - Reduce reflection - Community sense - Education	- Increase biodiversity - Improve water cycle management
City	**Green Corridors**	Green corridors (Biodiversity corridors) reaching outside the urban area, - Highway crossings and migratory routes. - Backyard commons can be part of the green corridor - Buffer Protection from storms surges along coastal areas.	- Linking of biophilic elements - Reduce traffic / encourage walking and cycling - Connectivity - Increased tourism - Cognitive way finding	- Provide amenity
	Urban Farming	- Community gardens - City farms - Urban and peri-urban agriculture	- Food production - Create employment - Education	- Enhance wellbeing/ reduce stress

	Water Ways	- Wetlands - Constructed wetlands - Ponds and lakes - Day-lighted streams - Vegetated swales & drainage corridors - Infiltration basins - Mangroves	- Water management - Water treatment - Water storage - Filtration / enhance water quality - Protect downstream water bodies	- Recreation - Reconnection with nature - Revitalise cities - Increase property value - Enhance tourism

Source: (SBEnrc, 2012)

The SBEnrc research findings suggest that integration of these elements will create a natural environment that is well connected, enhancing the benefits to both biodiversity and the local community. Singapore serves as great example of a city that has retrofitted a number of these biophilic elements and currently enjoys most of the common benefits listed in Table 1. Former Prime minister, Lee Kuan Yew, introduced the concept of a 'Garden City' in the 1960s with the main intention of making Singapore a developed country with high standards of living to enhance liveability and attract investors.[xvi] Five decades later, Singapore has achieved its 'Garden City' goal and is now entering a new era of sustainability, 'City in a Garden'. This new vision dictates a more holistic application of biophilic elements by adding vegetative elements to the building and neighbourhood level to connect with the already existing city scale elements (urban parks and forests). Studies conducted in Singapore have demonstrated that a whole suite of benefits from the aforementioned three scales (building, neighbourhood and city) are evident, some of these benefits include reduction in ambient temperatures by as much as 4°C due to green roofs, increased property values due to greener neighbourhoods, and increased local biodiversity due to enhanced connected corridors throughout the city.[xvii,xviii]

<u>*Economic valuation and biophilic urbanism:*</u> With the literature on biophilic urbanism and research conducted by SBEnrc highlighting the emerging stages of the field, the need to enquire into the economic valuation of benefits is apparent. Over the years, the field of economics has experienced a range of changes prompting a relatively mature valuation method of goods and services. This has been important in incorporating environmental assets in decision-making processes, as their value is better understood. These valuation techniques are without shortcomings, inhibiting the direct translation into biophilic urbanism. The following sections will explore what has been used to explore environmental economics and biophilic urbanism.

<u>*Environmental Economics:*</u> Contrary to neo-classical economics, environmental economics argues that economic efficiency of a monetary activity occurs at the point where net *social* benefits are higher than net *social* costs or when the marginal benefits are equivalent to the marginal costs.[xix] Building on from conventional 'cost-benefit analysis' (CBA), environmental CBA is an analytical tool that follows the theories of environmental economics by

aggregating the total costs and benefits of a project or policy and portrays welfare improvement only if net social benefits are larger than net social costs.[xx] Environmental CBA, though, is difficult to conduct since many social costs and benefits are non-quantifiable or are still externalities. Externalities are the external costs to society that are neglected in decision-making processes.[xxi]

Total Economic Value (TEV): The notion of 'total economic value' (TEV) emerged in the mid-1980s and is now recognised as an important concept that helps capture the true market and non-market value by identifying the quantifiable and also some non-quantifiable benefits of a good or service.[xxii] The valuation of these non-market costs and benefits (i.e. market externalities) sheds light on the high and wide-ranging economic costs associated with environmental degradation, which extend far beyond the loss of the resource's quantifiable benefit.[xxiii]

TEV identifies two categories of benefits derived from using an environmental good, use and non-use values. This breakdown of potential benefits ensures that almost all benefits of a good or service are recognised. 'Use values' refer to the values that individuals derive from directly using the environmental good; while non-use values refer to the value individuals get from the environmental good even if they are not necessarily using it.[xxiv] Use values can be further categorised into direct use values, indirect use values and option values. Direct use values come from the direct consumptive use of the environmental good. Indirect use values refer to the secondary benefits of an environmental resource elsewhere, such as a tree's ability to mitigate stormwater flow. Finally, option value refers to individuals who do not necessarily use a resource in the present time, but still value the option of using it in the future.

Non-use values are the values that individuals may derive from an environmental good without necessarily using it or intending to ever use it. These can be further classified into existence value, bequest value and altruistic value. Existence value is defined as the value a person may place upon the conservation of an environmental good, which will actually never be directly used by them or by future generations. Bequest value refers to the idea that future generations will have the chance to enjoy an environmental resource. Similar to bequest value, altruistic value refers to the selfless thought of preserving an environmental good for future generations even if they do not intend on ever using it.[xxv]

Economic Valuation Techniques: Methods for valuing environmental resources were, in fact, developed as far back as the 1970s, however they only gained considerable recognition in the late 1980s.[xxvi] Appreciating the maturity of the literature on valuation techniques, there is a plethora of articles in this field.[xxvii] [xxviii] These valuation techniques were developed to evaluate the worth of land and resources in order to adequately allocate funds, lands, natural products, and other resources.[xxix] Although valuation techniques are quite useful tools, they still do encounter several significant challenges. One challenge is that valuation is usually incomplete. Some environmental benefits, such as non-use values, may never be quantifiable and some are not even recognised.[xxx] Economic valuation is also partial because it is only one of many sources of information for environmental planning and decision-making and will not necessarily ensure protection. One study contends that economic valuation is not even considered in an environmental manager's day-to-day decisions.[xxxi] Another challenge relates to their practicality. Most valuation techniques require large amounts of data and human resource capacities, which require time and funds.[xxxii] Also, results can often contain omissions and inaccuracies. Economic valuation is normally based on a specific person's or group's thoughts or ideas of what an environmental good or service is worth at a particular point in time. This data may not be universally valid nor be able to be extrapolated to different groups, areas, or species. Studies indicate that aspects such as culture, variations in property rights[xxxiii], poverty, and inequality[xxxiv] are the main reasons to these inaccuracies. Valuation methods also hold the risk of being bias, often overestimating the benefits to serve a particular agenda.[xxxv] Finally, these valuing techniques could at times have a negative effect on environmental issues such as biodiversity protection. This is because incomplete or incorrect valuation could depict biodiversity conservation as less favourable, thus granting developers or decision makers the legal credibility to confidently pursue a project.

Results - *Economics of biophilic urbanism*

The literature discussing the cognitive benefits of biophilia have been studied quite extensively by the scientific community, dating as far back as the 1980s. Studies on the economic benefits of biophilic design, however, are still an understudied area. This means that conceptual understanding of the physiological and psychological effects of exposure to nature is widely recognised and understood, but has not yet been systematically translated to monetary terms due to the difficulty in quantifying benefits attributed to biophilia. Although, some benefits such as stormwater management and UHI effect have been evaluated, indicating that economic valuation methods are effective in assessing the monetary benefits in some regards, but not others.

Identifying this gap, the report by Terrapin Bright Green[xxxvi] attempted to investigate the economics of biophilic urbanism. This report has not provided a methodical quantification method *per se*, but being the first of its kind, it has started to lay the foundation by identifying seven indicators that value certain benefits on five sectors of the economy. By assigning value to these seven indicators, the research team at Terrapin Bright Green argue that the business case for biophilia is strengthened, as the extent of its potential is better understood.

An example of this, is distinguishing where a company's funding is most utilised. This report explains that, on average, a staggering 112 times the cost of energy in the workplace is actually spent on employees. According to the BOMA[xxxvii] and US Department of Labor[xxxviii], 90.3 per cent of costs per square foot are directed towards wages, while only 8.9 per cent is funnelled towards rent and mortgage, and the remaining 0.8% is paid towards energy costs. Such statistics demonstrate that the largest asset to companies is their employees. Hence, creating a work environment that enhances productivity and reduces absenteeism could have significant affects on profitability, rather than the preconceived notion of reducing energy costs. Such examples demonstrate the need to explore this area of study, since this is precisely where the business case for biophilic design begins to pique the interest of decision-makers. Branching out to other case studies, some have attempted to quantify the economic returns on biophilic elements but appear to be quite *ad hoc*,[xxxix] with limited conversation across studies. Most of these studies have also acknowledged the gaps in their investigation as certain social benefits, such as aesthetic benefits, were difficult to quantify.

Discussion

Exploring the existing literature on economic valuation and economics of biophilic urbanism has demonstrated that there is limited conversation between these two fields of enquiry and potential to further the current level of understanding. Furthermore, within the field of environmental economics there is uncertainty on how to appropriately capture economic benefits of environmental goods and services.

Many researchers recognise significant shortfalls in environmental valuation techniques and a lack of comprehension regarding all the potential benefits that are analysed as part of an environmental CBA. This limitation, coupled with limited economic considerations regarding biophilic urbanism and economic performance, has permitted externalities as well as market failures to continue to exist. In addition, the research conducted by Terrapin Bright Green has indicated a number of potential biophilic urbanism related revenue streams that businesses are missing out on.

Within this context, it is clear that there is opportunity to contribute to the field of biophilic urbanism by identifying the full suite of benefits from biophilic elements and a method of quantifying them. Creating a conversation between environmental CBA, economic valuation techniques and the economics of biophilic urbanism would be of significant use to determine the business case and to allow biophilic urbanism to be mainstreamed in cities worldwide.

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