# Biophilic Urbanism: Harnessing natural elements to enhance the performance of constructed assets

Angela Reeve[1], Karlson Hargoves[2], Cheryl Desha[3], Peter Newman[4], Omniya el Baghdadi[5]

## Biophilic Urbanism: Harnessing natural elements to enhance the environmental and social performance of constructed assets

Creating climate resilient, low-carbon urban environments and assets is a policy goal of many governments and city planners today, and an important issue for constructed asset owners. Stakeholders and decision makers in urban environments are also responding to growing evidence that cities need to increase their densities to reduce their footprint in the face of growing urban populations. Meanwhile, research is highlighting the importance of balancing such density with urban nature, to provide a range of health and wellbeing benefits to residents as well as to mitigate the environmental and economic impacts of heavily built up, impervious urban areas. Concurrently achieving this suite of objectives requires the coordination and cooperation of multiple stakeholder groups, with urban development and investment increasingly involving many private and public actors. Strategies are needed that can provide 'win-win' outcomes to benefit these multiple stakeholders, and provide immediate benefits while also addressing the emerging challenges of climate change, resource shortages and urban population growth.

Within this context, 'biophilic urbanism' is emerging as an important design principle for buildings and urban areas. Through the use of a suite of natural design elements, biophilic urbanism has the potential to address multiple pressures related to climate change, increasing urban populations, finite resources and human's inherent need for contact with

[1] PhD Candidate; Science and Engineering Faculty; Queensland University of Technology; George St., Brisbane 4000; angela.reeve@qut.edu.au.

[2] Senior Research Fellow; Curtin University Sustainability Policy Institute; Curtin University; 3 Pakenham St, Fremantle, WA 6160; charlie.hargroves@curtin.edu.au

[3] Senior Lecturer; Science and Engineering Faculty; Queensland University of Technology; George St., Brisbane 4000; Cheryl.desha@qut.edu.au.

[4] Professor; Curtin University Sustainability Policy Institute; Curtin University; 3 Pakenham St, Fremantle, WA 6160; peter.newman@curtin.edu.au

[5] PhD Candidate; Science and Engineering Faculty; Queensland University of Technology; George St., Brisbane 4000; omniya.baghdadi@qut.edu.au

nature. The principle directs the creation of urban environments that are conducive to life, delivering a range of benefits to stakeholders including building owners, occupiers and the surrounding community.

This paper introduces the principle of biophilic urbanism and discusses opportunities for improved building occupant experience and performance of constructed assets, as well as addressing other sustainability objectives including climate change mitigation and adaptation. The paper presents an emerging process for considering biophilic design opportunities at different scales and highlights implications for the built environment industry. This process draws on findings of a study of leading cities internationally and learnings related to economic and policy considerations. This included literature review, two stakeholder workshops, and extensive industry consultation, funded by the Sustainable Built Environment National Research Centre through core project partners Western Australian Department of Finance, Parsons Brinckerhoff, Townsville City Council CitySolar Program, Green Roofs Australasia, and PlantUp.

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## 1. Introduction

Cities around the world are growing rapidly in size and number, as they provide unprecedented economic and social opportunities. The importance of both the scale and density of cities in creating these opportunities is now well understood (Glaeser, 2011; Newman and Kenworthy, 1999). However, in achieving such scale and density, urban areas are becoming increasingly abstracted from nature, and urban residents are more disengaged from the natural world than potentially at any other period in human history. Within this context, the last two decades in particular has seen an emergence of research into how experiences of nature affect human health and wellbeing. A growing body of evidence suggests that humans have a psychological, physiological and emotional need for regular experiences with nature, manifested in a range of neurological and physical responses (Kellert *et al,* 2008). This research is of interest to planners, developers and citizens for the potential to create more liveable, economically viable and functional urban environments (Reeve *et al,* 2011). There is also increasing evidence of a range of direct and indirect benefits from using nature as a design principle, addressing pressures related to climate change, increasing urban populations, and finite resources (SBEnrc, 2012).

Consequently, the principle of ‘biophilic urbanism’ is appearing in the design and retrofit of buildings and cities around the world. The term has been recently defined as an emerging design principle for buildings and urban areas, featuring a suite of natural design elements that address multiple pressures related to climate change, increasing urban populations, finite resources and our inherent need for contact with nature. The principle directs the creation of urban environments that are conducive to life, delivering a range of benefits to stakeholders including building owners, occupiers and the surrounding community (SBEnrc, 2012).

Research undertaken as part of the Sustainable Built Environment National Research Centre's (SBEnrc) 'Greening the Built Environment Research Program' (2011-2012) investigated biophilic urbanism, and how to enable its broader application in Australia. The research was informed by industry and government stakeholders, as well as by leading academics and practitioners in the field. The research specifically sought to identify ways in which nature was being integrated into the built environment around the world, and what benefits this was providing. Key barriers to the use of biophilic urbanism in Australia, as well as strategic opportunities were identified via stakeholder workshops. This formed the basis of an inquiry into city-scale case studies around the world for policies, programs, and initiatives that support the use of biophilic urbanism, and lessons that could be learnt to inform efforts to overcome barriers and enhance opportunities in Australia.

This paper outlines the findings from this research project, including an overview of the literature on the theory of biophilia; evidence of links between human health and wellbeing, and experiences of nature; and how nature is being integrated into urban environments around the world to provide a wide range of benefits. An emerging process for encouraging the application biophilic urbanism is then presented, along with key considerations for policy and decision makers.

## 1.1 The theory of biophilia

'Biophilia' is a concept that has been explored by researchers for several decades, beginning with the German psychoanalyst Eric Fromm in the 1960s, and popularised by Edward O. Wilson in 1984, in his book *Biophilia.* In this, Wilson suggested that humans have 'an urge to affiliate with other forms of life' (Wilson, 1984, p85) that can be explained through evolutionary processes of survival and natural selection. Humans display positive psychological and physiological responses towards certain forms of nature that have historically been vital for human survival (Wilson, 1984; Kellert & Wilson, 1993). Researchers have explored these ideas since. There is general consensus that human's material needs for nature, such as for food, water and shelter, have led to aligned psychological, emotional and spiritual needs (Beatley, 2009; Wilson, 1984; Kellert & Wilson, 1993; Lohr, 2007).

Over the last few centuries, there have been significant shifts in the way humans live. With widespread urbanization, over half the world's population lives in cities. In reaction to industrialism of the 19$^{th}$ century, cities reduced in density throughout the 20$^{th}$ century, often rationalized in terms of seeking to be closer to nature (Mumford, 1961). This 'urban sprawl' has brought a range of issues, including increased dependence on the car and a growing ecological footprint from sprawling cities (Newman and Kenworthy, 1999). However, this pattern appears to be reversing and urban densities are rising again after 100 years of decline (Newman and Kenworthy, 2011). Young people especially are moving back into cities and are choosing not to use cars; the rationale for this is now being led by the health profession who instead of seeing suburbia as natural and healthy, now see it as having bred a generation of obese and unhealthy people who have lost the ability to walk (Newman and Matan, 2012). In parallel to this pro-urban movement there has been a new emphasis on how nature can be more directly and effectively brought back into this dense, urban

environment. This is the driving force for biophilic urbanism as it is most clearly being articulated and demonstrated in dense cities and central areas.

## 1.2 Links between experiences with nature, human health and well-being

Recent research has shown that urban nature (biophilic urbanism) provides multiple benefits, including reduced crime, increased psychological wellbeing, reduced stress, depression and anxiety, enhanced productivity, enhanced healing from illness, increased immunity, increased attention recovery and cognitive abilities, and developmental benefits to children (see Reeve *et al,* 2011). As Timothy Beatley highlights, even small doses of nature, such as a window view of trees and parkland, pot plants in buildings, a short walk in a park, or rooftop gardens can produce benefits (Beatley, 2009). This is an important finding, as injecting nature into an existing built environment will require taking advantage of opportunities to vegetate smaller space, while always seeking ways in which to provide 'more intense and protracted exposure to nature' where possible (Beatley, 2009, p212).

In addition to these health and wellbeing benefits, biophilic urbanism is also being shown to address many significant challenges in urban environments, including climate change, resource shortages, population growth and global financial crises. Biophilic urbanism has been shown to: provide reduce energy demand for heating and cooling; manage stormwater runoff; improve air quality; reduce congestion by encouraging walking and cycling; increase property values and stimulate the economic development and rejuvenation of urban areas; sequester carbon and reduce carbon emissions; enable urban food production and enhance food security; and increase urban biodiversity (Reeve *et al,* 2011).

Ideally, biophilic urbanism can be considered on multiple scales: at the building, neighbourhood and city level, with natural design features, or 'biophilic elements' integrated into the urban environment across all three. Table 1 outlines some of the key biophilic elements commonly used today in cities at various scales, and highlights the principle benefits provided by each. Urban environments and constructed assets at each of these scales are designed, developed and owned by a range of public and private stakeholders, increasingly in partnerships with each other. These stakeholders often have different, if not divergent, motivations and considerations in their investment decisions. As may be evident upon closer inspection, many of the benefits listed in Table 1 may not flow directly to the stakeholder responsible for investment decisions related to introducing a biophilic element into a built environment assets. Further, many of the benefits are accrued over long time periods, or would need widespread application of biophilic urbanism to be realised. These issues highlight some of the complexity involved in the application of biophilic urbanism.

***Table 1: Overview of biophilic elements, across scales of application***

| Element | | Forms | Specific Benefits | Common Benefits |
|---|---|---|---|---|
| **Building** | Indoor Plants | - Pot plants in buildings<br>- Indoor living walls, including pots within a frame (also see Green Walls)<br>- Indoor planted vegetation, such as atriums and large planted installations | - Reduces illness<br>- Increases productivity<br>- Improves air quality | Revitalises urban environments |

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|---|---|---|---|---|
| | Green Roofs | - 'Intensive': Soil deeper than 200mm and vegetation up to the size of trees<br>- 'Extensive': Soil up to 200mm with ground cover vegetation | - Improves building energy efficiency<br>- Water management<br>- Space efficiency<br>- Food production<br>- Sound insulation<br>- Increases roof/wall lifespan<br>- Vertical urban farming | Reduces urban heat island effect<br>Improves air quality<br>Improves microclimate<br>Sequesters carbon/ reduces greenhouse gas emissions<br>Increases biodiversity<br>Improves water cycle management<br>Provides amenity<br>Enhances well-being/ reduces stress<br>Recreation<br>Reconnects with nature<br>Revitalises cities<br>Increases property value<br>Enhances tourism |
| | Green Walls | - Internal and external green walls<br>- Include: vegetation directly attached to infrastructure (such as ivy), panel systems with substrate (such as preplanted panels with soil), and container or trellis systems. | | |
| **Neighbourhood** | Green Verges | - Street trees and canopies<br>- Shade planting for buildings<br>- Green streets and alleys that create cool pervious greenways<br>- Rain gardens and bio-swales integrated into stormwater management plan and consisting of pervious channels<br>- Green permeable sidewalks | - Encourages walking, and cycling<br>- Reduces building cooling/ heating energy use<br>- Water management<br>- Food production | |
| | Green Islands | - Urban parks and gardens placed close to transportation routes<br>- Community farms close to homes<br>- Residential backyards<br>- Lawns and gardens (public and private) | - Encourages walking and cycling<br>- Food production<br>- Increases community cohesion | |
| **City** | Green Corridors | - Green corridors (biodiversity corridors) reaching outside the urban area<br>- Highway crossings and migratory routes<br>- Backyard commons<br>- Vegetated buffer zones along coastal areas | - Links biophilic elements<br>- Encourages walking and cycling | |
| | Urban Farming | - Large scale community gardens and urban farms<br>- Urban and peri-urban agriculture | - Food production<br>- Employment and education | |
| | Waterways, and water sensitive urban design features | - Wetlands (natural and constructed)<br>- Ponds and lakes<br>- Rivers and streams<br>- Vegetated swales, drainage corridors, infiltration basins, etc.<br>- Oceans and associated coastal vegetation | - Water management, treatment and storage<br>- Protects downstream water bodies | |

*(Reeve et al, 2012a)*

## 2. Emerging process for biophilic urbanism

This emerging evidence of the potential of biophilic urbanism to address multiple pressures on urban systems and provide a host of benefits has not yet resulted in its mainstream, intentional use. Its use around the world remains *ad hoc* and largely disconnected. As part of the SBEnrc research project, two stakeholder workshops were held in the early stages of the project to identify current barriers and opportunities for biophilic urbanism in Australia. Key barriers that were found included (Reeve *et al,* 2012a):

- **Limited local research and data** on biophilic elements, preventing decision makers from making informed and justifiable decisions. Biophilic elements are vulnerable to financial pressures if the full economic and social value isn't demonstrable.

- **Benefits and costs of biophilic urbanism are unequally borne** (split incentives) by various government departments and between stakeholders such that the costs may be paid by a department, organisation or individual that doesn't recoup the full benefits.

- A "**silo effect**" restricts holistic governance, and exacerbates split incentives. A **lack of mandatory requirements** makes biophilic urbanism a 'beyond compliance' addition to building and planning. **Existing regulations and planning requirements** generally don't support the inclusion of biophilic urbanism elements.

- **Cultural disconnection from natural environments** causes ignorance of the benefits of experiences of nature and a lack of support for policies to increase urban nature.

- **Traditional economic models** that do not value **externalities** disempower decision makers from including biophilic elements in urban and building design.

Several existing opportunities were also identified, many of which mirrored the barriers:

- **Some supportive and adaptive policies** and **building/design standards** that encourage and enable beyond compliance performance to drive innovation.

- **Leadership in various levels of government** and a willingness to trial and/or introduce supportive policy measures. Creative leadership responsive to community expectations rather than political cycles and traditional economics.

- **Existing social capital**, including community groups, community gardens and community appreciation of and pressure for biophilic urbanism. Community leaders and change agents assisting in educating their community, establishing norms and supporting political processes.

- **The private sector** can provide funding, leadership and 'biophilic entrepreneurship' to develop demonstration sites.

- A growing number of **demonstration sites** showcasing the multiple benefits of biophilic urbanism and driving new norms in urban design.

- Interest in **new valuation techniques and metrics** to value externalities in evaluations of biophilic urbanism, which in turn may enable access to finance.

To enable widespread use of biophilic urbanism in Australia, strategic ways of overcoming these barriers and enhancing the opportunities needed to be found. A method of 'learning by example' was developed in consultation with project stakeholders (see Reeve *et al,* 2012b) involving an investigation of five global cities that are forerunners in this field. This provided

insights into the experiences, processes and outcomes of increasing the application of biophilic urbanism and into addressing the barriers and opportunities identified for Australia. By looking across these five case studies of forerunning cities, an understanding of the important processes and steps leading to the application of biophilic urbanism has been developed. This takes into account the contextual circumstances of each city, and highlights important precedent factors that influence a city's ability to introduce policies and other initiatives to encourage biophilic urbanism.

The findings from this investigation have been distilled into the emerging process shown in ***Figure 1***, with further detail given below. The process is not presented as an endpoint. It is part of an ongoing evolution of understanding and experience of how to encourage and enable biophilic urbanism. As the historical, cultural, political, economic, geographic, demographic (among other) factors differ between each city, no one process or pathway is likely to be appropriate for all cities. This process has been developed with reflection of the barriers and opportunities that were found to exist in Australian cities (however again, these will differ between each individual city in Australia), and the learnings from the case-study cities relevant to these.

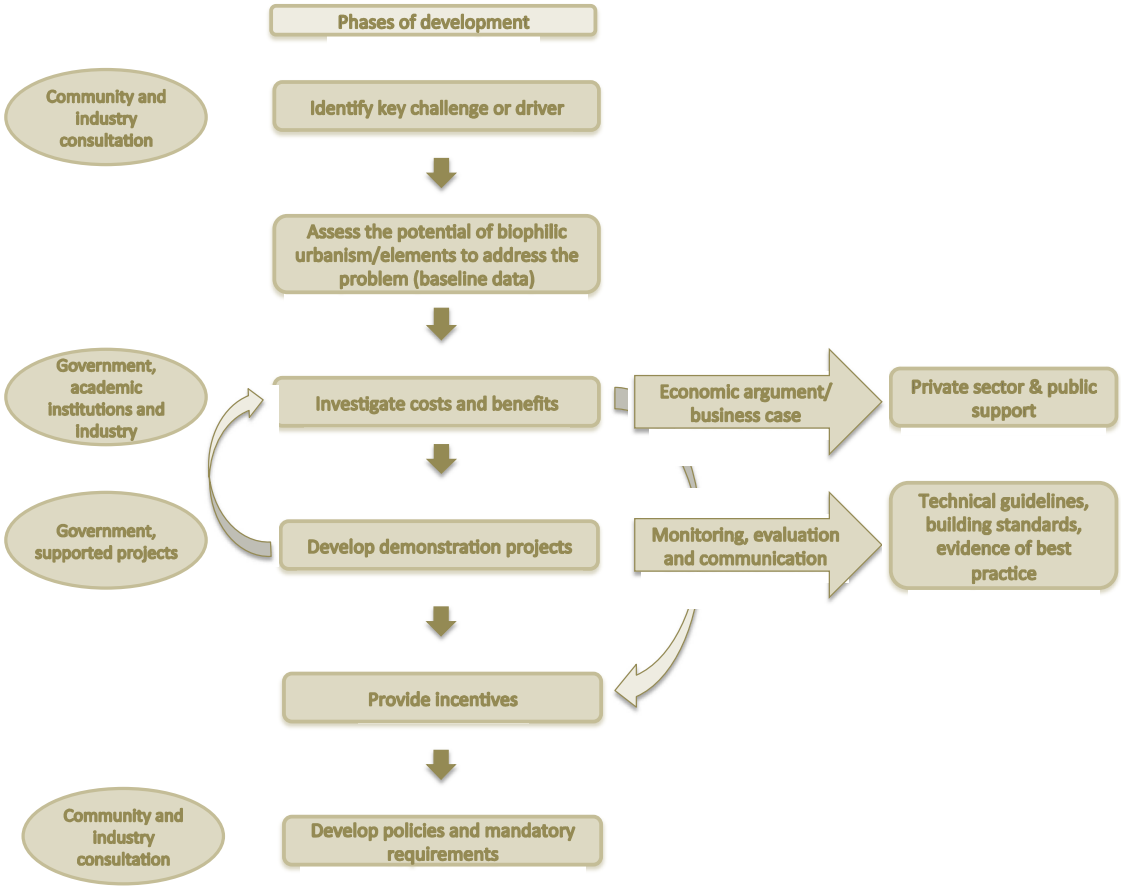


***Figure 1: Emerging process for enabling the application of biophilic urbanism***

1. ***Identify the key challenge(s) and driver(s):*** Identify key challenges faced by the city that can be addressed by biophilic urbanism, especially where there is an existing conversation in government and public domains about the need to address this. There is

a long ‘menu’ of benefits provided by biophilic urbanism, however it can be more effective to focus discussions of biophilic urbanism on areas of existing concern. This ‘piggybacking’ reduces the need to make a case for action, may facilitate cost/benefit analysis and data collection where existing work is being done in this area, and ensures that the way in which the biophilic element is implemented throughout the city optimises the outcomes of particular concern to that city. While taking an issue-specific focus is important, a *whole-system perspective* is also necessary when comparing the costs of biophilic elements to conventional systems.

Common drivers to date have included stormwater management, to increase urban amenity, economic revitalization of derelict urban areas, enhanced international competitiveness, countering the loss of biodiversity and ecosystem services, and to a lesser extent, mitigating the urban heat island effect.

2. ***Develop baseline data:*** Gather initial evidence of existing policies, programs and requirements, as well as environmental conditions. This will help to ensure that any mechanisms developed will be strategic, targeted, transparent and minimize unintended consequences. Data is also needed on the potential application of biophilic elements. For example, an inventory of all available and appropriate roof space for green roofs; a breakdown of land-uses throughout the city, and of government, commercial, residential and other property ownership. This informs the strategy development by identifying the scope for application of any initiatives, and the target audience.

3. ***Assessing the costs and benefits:*** An economic argument is important to gain support from the community and private sector, as well as from decision makers within the government. From a government’s perspective, an economic argument gives some basis for understanding the extent to which biophilic urbanism will reduce their existing financial liabilities (for instance, for stormwater management), and to develop appropriate incentives that reflect this value. From the public, and private sector, perspective, this is a business case to assist in decisions of whether to include biophilic elements in their building developments themselves.

   It may not be possible to develop a full cost-benefit analysis due to the large number of externalities and unquantifiable benefits. Considering the costs and benefits that can be quantified, however, may indicate whether there is sufficient public good to pursue a strategy to encourage biophilic urbanism/elements. Such an investigation provides a starting point for discussions around green roofs by answering high-level questions, such as what are the societal benefits, what are the city-wide benefits, and what are the benefits to individual building owners.

4. ***Demonstration:*** Develop demonstration and pilot initiatives to test, refine and develop local data for biophilic elements. Municipal buildings, and participating commercial buildings, can be used. Monitoring, evaluation and communication of the benefits and performance of elements needs to be an integral part of demonstration project strategies. This should lead to technical guidelines, standards and locally relevant evidence of best practice.

Demonstration of biophilic elements is vital, as many of the benefits are difficult to quantify. It has been found that where citizens have personal experiences with biophilic elements, they inherently understand and value the benefits and are generally supportive of policies and programs to increase their application.

5. ***Provide incentives:*** Financial incentives are generally necessary to encourage private property owners to integrate nature into their property, especially for more costly biophilic elements. Economic modeling done elsewhere suggests that biophilic elements provide an array of public benefits, which can typically justify such incentives. As biophilic urbanism becomes more mainstream, achieving economies of scale, it may be possible to refine eligibility for incentives to promote particular outcomes such as innovation and greater public benefits.

6. ***Policies and programs***: Policies, mandatory requirements and broad programs to require and encourage biophilic urbanism/elements are the final stage of this process. Extensive community and industry consultation has been found to reduce opposition to new policies and programs for biophilic urbanism. It also ensures that these are balanced and meet the needs of the community, and creates a sense of ownership and inclusion that has in some cities underpinned community and volunteer projects that enhances the biophilic benefits and reduces municipal costs for implementation and maintenance of the biophilic elements.

   *Performance based* policies and standards can drive innovation and improve outcomes. These can require more work in ensuring that a biophilic element does indeed meet the performance requirements, however the requirement to do so results in greater transparency, and by measuring and evaluating outcomes, can help communicate the benefits of the biophilic elements and drive continual improvement in these.

   *Integration and consistency* across policies that encourage or require the use of a biophilic element can be achieved through several mechanisms, including: high level policy or vision that provides a process for issue-specific policies, plans and programs; a senior political champion, who sets the agenda and enables inter-departmental cooperation; Multi-departmental advisory boards, or other instituted mechanisms for cross-departmental communication and collaboration; creating a position, such as a sustainability officer, with power to direct other departments on relevant policy and program areas.

### 2.1.1 Additional considerations for policy development and implementation

In addition to the process, there are a number of findings from the case study cities that provide important insight into the process of encouraging and enabling biophilic urbanism. The relative importance of these findings will differ between cities.

**Program and policy development:** There were a number of consistent, important precedent factors common to many of the case study cities that were found to enable biophilic urbanism program and policy development, including:

- *The role of champions and advocates:* To a large degree, the efforts of an individual or group of individuals was of fundamental importance in catalyzing a process of developing demonstration projects to provide evidence and experience with the biophilic element, and enable techniques and technologies to be refined and adapted to the climate and circumstances of the city. In several cities, this included a political champion, who helped overcome the 'catch-22' of cities lacking experience or evidence of the performance of biophilic elements to justify their use, with this in turn preventing them from being able to develop demonstration sites to gain experience and evidence.

- *A visible 'crisis' or challenge:* In most case study cities, a crisis or challenge was the impetus for the city to consider biophilic urbanism as an urban design principle. This includes combined sewer overflows and national pollutant discharge limits in the United States, a need to remain internationally competitive and attractive to investors (Singapore), or to balance increasing urban density and development requirements with public expectation for urban greenspace (Berlin). Such a crisis or challenge typically provides an economic, social, political and/or environmental imperative to move away from the *status quo* of urban design, and helps overcome resistance to such change. Making present and future challenges more visible to politicians, business and the public may assist in enabling biophilic urbanism.

**Policy mechanisms**: In terms of the policy mechanisms implemented in case study cities, some common considerations and findings included:

- *Fee-bate systems:* Feebate systems can put a price on what is otherwise a market externality, such as stormwater runoff, the urban heat island effect, or loss of visual amenity in cities. Several case study cities introduced separate charges for such externalities (in particular for stormwater runoff). This provided encouragement to private property owners to reduce their individual contribution to such costs, and provided the city with dedicated funding to also address the issue.

- *Financial Incentives:* Financial incentives were found to be typically necessary to encourage private property owners to integrate natural design features into buildings and/or to preserve additional greenspace, at least until economies of scale and evidence of the benefits developed. Such incentives were justified on the basis of the public benefit such design features provide. Conditions for receiving such incentives generally ensured good design that enhanced the public benefits.

- *'Biotope Factor'*: Berlin's biotope factor requires any new, or substantial re-development, include a given proportion of green space. Various biophilic elements are given weightings, depending on the degree to which they meet the city's green space objectives, enabling developers to determine the most effective mix of elements for each development. The mechanism has been adopted by cities around the world, as it is found to increase innovation and be effective in its application.

- *Performance based requirements:* Performance based mandatory requirements to include biophilic elements into the built environment tend to result in greater innovation,

provide greater transparency, and ensure that elements are functional rather than 'tick box' inclusions. These can require greater work in evaluating designs and assessing performance.

- *Requirements for new build and significant renovation:* Mandatory requirements have only been introduced for new build and significant renovations in the case-study cities considered. It would appear to be politically too difficult to otherwise require existing buildings to retrofit with biophilic elements.

- *Offset mechanisms*: Offset mechanism can balance development needs with ecological preservation. It is generally considered a last-resort mechanism, to be used if conservation of the original ecosystem is not possible.

**Economic argument**: In terms of developing an economic argument, or cost-benefit assessment to support the use of biophilic elements in cities, the following findings emerged from the case study cities.

- *Externalities in urban environments:* Many costs associated with urban environments are often not fully recognised, such as the urban heat island effect, increased stormwater runoff, a lack of visual amenity and green space, and a loss of biodiversity. The costs related to these urban issues are often aggregated into many different municipal, state and federal budgets. As such, governments and citizens are often unaware of their extent of such costs, nor of the financial benefits thus possible by mitigating these issues.

- *Recognising unquantified benefits:* Many benefits of biophilic urbanism cannot be readily quantified for a range of reasons. This includes many of the social, healthy and well-being, and environmental benefits described in this paper, some of which evidence suggests that these may indeed be economically significant. Hence, most cities justified the use of biophilic urbanism based on a partial cost-benefit analysis with quantifiable benefits, however in comparing the use of biophilic urbanism to conventional urban design and infrastructure approaches, recognised the wide array of additional benefits provided.

## 3. Conclusions and recommendations

Biophilic urbanism has the potential to provide significant benefits in cities, including a wide range of social, psychological and wellbeing benefits to residents, as well as functional and economic benefits to the city as a whole. There is an emerging body of evidence that demonstrates and to an extent quantifies these benefits, and provides insights into the underlying mechanisms that produce them. Despite this, their use in Australia and internationally remains *ad hoc,* constrained by a number of key barriers.

To address some of these barriers, an in-depth investigation of forerunning cities that have to some degree introduced policies, programs and initiatives to encourage the use of biophilic urbanism was undertaken. This provided insights into factors that have led the

development of such policies, programs and initiatives, and what can be learnt from these experiences to help cities elsewhere similarly increase their use of biophilic urbanism. An emerging process is suggested, based on these insights, and within the particular context of the barriers and opportunities to biophilic urbanism in Australian cities, as identified by relevant stakeholders. The emerging process will continue to be developed, informed by growing experience with and understanding of the application of biophilic urbanism in Australia and internationally.

Future work by the research team and others will investigate applications of biophilic urbanism to develop metrics that describe their performance across a range of benefits. This will inform a process for assessing biophilic elements, with a specific focus on building-scale elements. Capacity building training and educational materials will also be developed to enable industry and government to cost- and time-effectively evaluate the value of biophilic elements, and ensure they are well designed to maximise all possible and desirable benefits.

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