Biophilic Design :

and its impact on Health and Wellbeing

By Lucy Barrett

Lucy Barrett

Biophilic Design:
and its impact on Health and Wellbeing

Contents

List of Figures

Introduction

The modern world has been disconnecting from nature since the late 18th century, where the growth of modern industry led to a massive urbanisation and the rise of the current great cities. By 2050, 68 percent of the world's population is expected to live in urban areas (UN DESA, 2018). This shift makes it imperative that we design in a way that connects people back to nature. The concept of biophilic design is no longer a luxury, but a necessity for our health and wellbeing. This essay aims to address what biophilic design is, and how a connection with nature can improve overall health and wellbeing. The biology behind this will also be included within this essay, alongside precedent studies which will help the reader to further understand the topic. The implications of the connection between humans and nature being disrupted due to the Covid-19 pandemic, are already being observed. I will highlight the effect of nature deprivation on health and wellbeing and how necessary biophilic design will be, post-covid, to the way humans learn, work, and live their lives.

Chapter One

The human relationship with nature can be best understood through the concept of biophilia and the biophilia hypothesis. Biophilia is a human personality trait first defined by social psychologist Erich Fromm, to describe "the passionate love of life and of all that is alive" (Fromm, 1964). In general, biophilia describes two fundamental characteristics of living organisms: the capacity to sustain life under adverse conditions and the ability to interact positively with other species. The concept of biophilia only became widely recognized 20 years after it was first proposed, due to a series of essays known as The Biophilia Hypothesis. Written by biologist Edward Wilson and Stephen R. Kellert, who defined biophilia as "the innate tendency to focus on life and lifelike processes." (Kellert, S.R. & Wilson, E. O. 1993). The hypothesis asserts the human dependence on nature "that extends far beyond the simple issue of material and physical sustenance to encompass as well as the craving for aesthetic, intellectual, cognitive, and even spiritual meaning and satisfaction" (Kellert, 1993). The hypothesis is compatible with our knowledge of evolutionary biology and psychology; establishing that biophilia is a genetic trait, conserved after the humankind evolved from our apelike ancestors (Wilson, E. O. 1984). Throughout our evolutionary history, nature has shaped our minds, our behavioural patterns, and our physiological functions. Our ancestors' experiences are visible in our attention to the environment, our reactions to it, and how we interpret them. It is evident from the biophilia hypothesis and related research that, as a species, we are still extremely responsive to the forms, patterns, and processes of nature (Kellert, S.R. & Wilson, E. O. 1993). Using the knowledge we have gained as a species over millions of years, we can use our adapted affinity for nature, to create environments which evoke health and wellbeing.

However, we are already experiencing the negative human impact upon the Earth, with the current geological epoch being termed the "Anthropocene"(Crutzen, P. J. 2006), a period of time during which human activities have impacted the environment enough to constitute a distinct geological change. The anthropogenic climate change is not only regarded as "..potentially the biggest global health threat in the twenty-first century" (Costello, A. 2009), but is arguably one of humankinds greatest challenges. As a result of human-caused climate change and environmental degradation, health and well-being can both be directly and indirectly affected. The branch of psychology related to nature connectedness is known as Ecopsychology. It seeks to examine how human wellbeing is related to the wellbeing of the natural environment. This theory is based on the idea that the needs of humans and nature are interdependent, so human health will suffer if nature does as well. It is proven that biophilia has a biological basis, and

that it is fundamental to human health and wellbeing to develop a harmonious relationship with nature. This primal need for humans to connect with the natural world is equally as beneficial to our health and wellbeing as a balanced diet and regular exercise. Fortunately, a connection with nature can be achieved simply through a walk in the park, watching birds through a window or even in the presence of bouquet of flowers in your home.

"Biophilic Design is the deliberate attempt to translate an understanding of the inherent human affinity to affiliate with natural systems and processes – known as biophilia – into the design of the built environment" (Kellert, S.R. (1993). It is thought that as our surroundings come back to life, we ourselves become more alive. When nature and building become harmonious with society, we are proven to feel better, freer and calmer. Rudolf Steiner said, "Man can only experience true harmony of soul where what his soul knows to be its most valuable thoughts, feelings and impulses are mirrored for his senses in the forms, it follows that well-designed buildings can exert a healing and spiritually supportive effect on both individuals and society."

In many cultures, both past and present, nature has a great influence on people's behaviour. You can see this reflected in the way people interact with the natural world. Plants were brought into homes and gardens, as evidenced by tomb paintings from ancient Egypt and remains from Pompeii. (Manaker, G. H. 1996). Likewise, the Hanging Gardens of Babylon and the Alhambra of Granada are arguably the earliest examples of biophilic design. Even before the term biophilia was coined, humans have been designing in accordance with their affinity for nature. The installation of edible gardens in social housing was proposed by Leberecht Migge, for example. It was believed that by creating as many gardens as possible, all social and economic problems would be resolved. Although not built with the idea of biophilia in mind, the concept of creating homes surrounded by nature increased the wellbeing of the occupants, improved productivity and created a generation who were more ecologically aware. Migge described gardens as industrial products that were essentially tools for better living. Furthermore,
Le Corbusier's conceptual project, Immeubles-villas, included apartments with private gardens, and through the use of glass walls and light structural supports, Ludwig Mies van der Rohe's Farnsworth House was able to establish a connection with the external natural environment.

In modern architecture, architects use biophilic design in a wide range of approaches. Fallingwater, one of Frank Lloyd Wright's most famous buildings, exemplifies many biophilic features. Wright believed that a building should emerge naturally out of a site, existing as a natural extension of its surroundings.

Designed with feeling to generate feeling. Wright was strongly influenced by the Japanese philosophy of the existence of harmony between man and nature and that architecture that conforms to nature would conform to what is basic in people. It is through this harmony that a spirit of freedom is created. Wright himself said, "How soon will 'we the people' awake to the fact that the philosophy of natural and intrinsic building we are here calling organic is at one with our freedom" (Wright, F. L. 1957). It was Wright's belief that the closer man was to nature, the greater his physical, spiritual, and even psychological wellbeing. Fallingwater has human-nature connectivity at the forefront of its design, built as an accompaniment to the music of the stream and the sound of the waterfall. Residents can therefore participate in nature instead of simply observing it as they would if the waterfall was downstream. Additionally, the house is built around the existing foliage and integrates the geology of the area by incorporating a large rock in the living room's centre. There are also many glass, exterior walls, allowing the occupants to connect with the surrounding woods. Wright enhanced direct and indirect experiences with nature by building porches and decks, and incorporating organic shapes, colours, and materials into the home. It becomes obvious through the work of Wright and others that "Just being surrounded by bountiful nature, rejuvenates and inspires us." (Wilson, E.O. 1993).

Figure 1: Fallingwater by Frank Lloyd Wright – nature was at the forefront of the design

Chapter Two

Psychologist Oliver Sacks once wrote in his essay, 'Why We Need Gardens': "As a writer, I find gardens essential to the creative process; as a physician, I take my patients to gardens whenever possible. All of us have had the experience of wandering through a lush garden or a timeless desert, walking by a river or an ocean, or climbing a mountain and finding ourselves simultaneously calmed and reinvigorated, engaged in mind, refreshed in body and spirit. The importance of these physiological states on individual and community health is fundamental and wide-ranging. In forty years of medical practice, I have found only two types of non-pharmaceutical "therapy" to be vitally important for patients with chronic neurological diseases: music and gardens."

Among the earliest hospitals recorded in Europe are monastic infirmaries, where gardens played a particularly important role in the treatment of illness (Gerlach-Spriggs, N. 1998). The relationship between nature and medicine has been largely disregarded in the past few decades. This gap is likely due to the advancement of medical science and technology. However, research is being conducted into the effects of nature on human health, with particular focus on how plants can improve conditions in sterile environments. If the research continues to show that access to nature can help aid healing, it may eventually be included in evidence-based medicine. Research has long shown that connections to nature can support the healing process. Roger Ulrich is considered to be the foremost authority on this topic, having shown in his study more than 30 years ago that patients recovering from gallbladder surgery tended to heal faster if they had a direct view of nature.

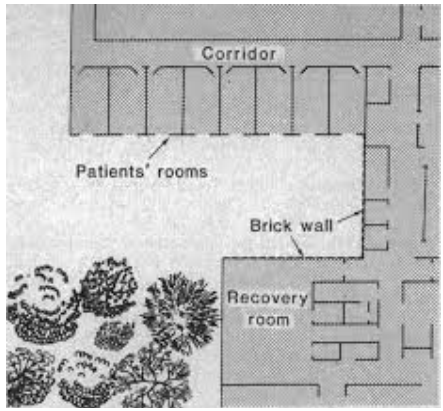

Figure 2: Roger Ulrich - view through a window may influence recovery from surgery

This is based upon the Biophilia Hypothesis, which states that natural environments and features have positive effects on human health and wellbeing. Based upon Ulrich's study, two theories were developed: Attention Restoration Theory (Kaplan, R. & Kaplan, S. 1989) and Stress Recovery Theory (Joye, Y. & van den Berg, A.E. 2012). In summary, both theories suggest that all environments can either be defined as stressful, not at all, or actively able to help people recover from stress and mental fatigue, this is known as a restorative environment.

Environments that draw attention without being stressful or demanding, evoke positive moods and can aid people in recovering more quickly (Gifford, R. & McGunn, L. J. 2012). When compared to urban environments that are often stressful, overstimulating, and boring, natural environments promote renewed attention, fascination, and a sense of comfort. Stress recovery from visual connections with nature have been realised through lowered blood pressure and heart rate (Brown, D. K & Barton, J. L & Gladwell, V. F 2013; van den Berg, A. E. , Hartig, T., & Staats, H. 2007; Tsunetsugu & Miyazaki, 2005); reduced attentional fatigue, sadness, anger, and aggression; improved mental engagement, (Biederman & Vessel, 2006) attitude and overall happiness (Barton & Pretty, 2010). Direct contact (e.g., natural light and vegetation), as well as representational and symbolic depictions of nature (e.g., pictures) have been found to enhance healing and recovery from illness and surgical procedures.

When designing Maggie's Centre Leeds, Heatherwick Studio opted for an overwhelmingly plant-inspired approach, with the aim to create a warm, informal space, as well as an outside landscape that instils positivity in visitors and passers-by. The architecture was conceived as a group of three large-scale planters, with counselling rooms inside their pod like centre. The mushroom shaped volumes set on the sloping site; house rooftop gardens designed by Balston Agius. The buildings frame is made from sustainably sourced spruce wood built from prefabricated parts, with interior glulam fins creating a forest like form. To minimise electricity consumption and give the building a calm, domestic atmosphere, the centre is illuminated with low energy LED lights throughout. Glazed outer walls overlook tree filled gardens, where Maggie's Leeds takes the connection with nature a step further by encouraging visitors to actively particiapte in caring for the on-site plants. Using plants sourced from local Yorkshire woodland and featuring native English species, the structure can stay warm during the winter months, whilst providing an activity which is beneficial to mental and physical health.

Figure 3: Maggie's Centre Leeds by Heatherwick Studios - plants and natural materials are used to create a warm, welcoming environment

Research has demonstrated that horticulture therapy is an effective treatment for mental and behavioural disorders, another well-researched area of nature's benefits to human health and wellbeing. Despite any bodily function or organ being susceptible to illness, the human brain seems to be particularly vulnerable because of its complexity, the fact that it requires substantial maturation after birth, and the fact that it does so in response to environmental stimuli. It may be due to this vulnerability that mental disorders and illness are a major health concern in Western societies (Grinde, B. 2002). Therefore, a closer relationship with nature should improve psychological health given the harm caused by lack of natural exposure.

Known as the 'Garden City' it is no surprise that biophilia can be found in abundance in Singapore. Khoo Teck Puat Hospital, located in north Singapore, opened in 2010 with more than 700 species of native plants on its grounds. Greenery-wrapped outdoor bridges replaced sterile white hallways, machine noises were muted by bird species populating the courtyard, and the distinctive hospital smell was covered up by fragrant plants. Each room includes large windows that let as much natural light into the room as possible, with patients positioned so they can see greenery from their beds, even if it's just a planter on the other side of the window. The hospital is also capable of providing meals made from fruit and vegetables grown on one of the hospitals many rooftop gardens, which is used to promote the widely backed nutritional benefits of a plant-based diet. Moreover, the facility has other roof gardens designed to serve a variety of patient needs, including a dementia garden for its geriatric ward patients to enjoy the green surroundings. The International Living Institute stated that, "Khoo Teck Puat surpasses traditional hospitals and opens the door towards a new kind of building type for the healthcare industry, which considers how the built and natural environment can become part of the healing process.".

Figure 4: Khoo Teck Puat Hospital by CPG Consultants - nature can be used to aid healing

Using organic shapes in construction and furnishing; appropriate airflow and temperature; diverse lighting and water features; and use of natural materials and visual patterns - biophilic design creates numerous opportunities to evoke nature and build a stress-relieving sanctuary. Two new building rating systems which incorporate biophilic design, are being

promoted globally: these are the Living Building Challenge (Scheer, R. & Moss, D. 2019), and the new WELL Building Standard (Delos Living LLC 2014).

Located within the School of Design and Environment of the National University of Singapore, WELL Gold Certified, SDE4 is a living laboratory with the objective to demonstrate and explore human-centred approaches for sustainable development that are integrated into the natural environment. As a result of combining passive and active strategies, optimizing active systems, generating solar energy, and utilizing intelligent building strategies, SDE4 has been able to achieve a zero/positive energy balance. In addition to improving the building's environmental performance, a significant portion of the project was directed toward improving thermal comfort and well-being for its occupants and reducing its carbon footprint. Biophilic design was central to the scheme with, ambiguous boundaries between the indoors and outdoors, allowing for an uninterrupted connection between the occupants and nature. The use of steel, perforated metal, and concrete created a raw and natural material palette, with open platforms, minimal solid walls, and large glazed facades, designed with overhangs, internal blinds and light shelves, creating optimum use of daylight. The large openings and glazed facades allow for cross-breezes and a direct visual connection to the outdoors. Several outdoor spaces have been integrated into the building, which provides a shelter for gardens and mature trees as well as emphasising the close relationship between the building and nature. Psychologists have found that simply adding plants to your work space can increase well-being by 47%, creativity by 45%, and workplace productivity by 38% (Knight, C. 2013).

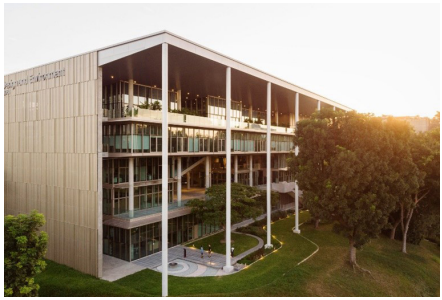

Figure 5: SDE4 by NUS Design and Environment – biophilic design and intelligent building strategies can be used to achieve a zero/positive energy balance

Chapter Three

An increase in urbanization threatens humanity's wellbeing by progressively disconnecting people from nature in a process called 'extinction of experience' (Soga, M. & Gaston, K.J. 2016). Quantifying the effects of extinction of experience is challenging, as the process is slow and gradual, and long-term monitoring of nature interactions is scarce. However, the Covid-19 pandemic provided an opportunity to understand the consequence of nature deprivation on health and wellbeing (Soga, M., et al., 2021). Given that landscapes are biologically heterogenous (Luck, G.W. & Smallbone, L.T 2010), it is inevitable that some people will have greater access to nature than others (Picket, S.T.A., et al. 2001). Socio-economically disadvantaged neighbourhoods have been found to have less overall vegetation cover in many instances (Pham, T.-T.-H., et al 2012), and in some cities advantaged neighbourhoods have more public parkland (Boone, C.G.,
et al 2009) but less private gardens. People who live in the countryside can potentially afford larger properties, therefore having a higher level of vegetation coverage and access to nature (Lowry, J.H., et al 2012). In relation to access to nature and its impact on human health and wellbeing, Covid 19 has varying effects depending on where you live.

As Covid-19 spread, forced isolation was implemented, with individuals only permitted to leave their homes for essential travel, such as food shopping, and daily outdoor exercise. A survey by COVID-19 Public Experiences (COPE) realised that people who lived more than a five-minute walk from a public green space had a lower level of subjective wellbeing, then those less than five minutes away. Furthermore, those with access to private gardens experienced less depression, anxiety, stress and more happiness and life satisfaction. The adoption of remote working policies has also impacted health outcomes, with reductions in stress, burnout and fatigue being experienced, whilst others reported detrimental impacts to general psychological wellbeing and work-life balance (Bosua, R., et al 2013). The reason behind this mixed result is difficult to pinpoint, but a change in routine, less social interaction and ill-designed homes are all likely to have an impact. Environmental Psychologist and Lecturer at University of Surrey, Eleanor Ratcliffe states: "For many of us our home is our favourite place and an important part of our identity. Over recent months our homes have had to become the workplace, school, and gym, and yet still be a place to relax and recover from all the everyday stresses and strains - impacting entire households. The RIBA's research demonstrates that many people realise that their home in its current form does not cater for all these different uses and users. A home design that reflects who you are – your values, needs, and interests – can make people feel good about themselves. A home that meets one's needs because it is appropriately

designed can also make people feel more in control, and that is especially relevant when life feels uncertain."

The result of the Covid 19 pandemic on the development of children is already obvious. As people were unable to meet up with others, children missed out on opportunities to socialise and develop self-regulation. They struggled to adapt to new situations and were unable to fully develop their communication skills. The inability to go outside meant children spent more time in sedentary activities, meaning their physical development including motor skills were negatively affected. Nature Deficit Disorder is the idea that human beings, especially children, are spending less time outdoors than they have in the past, resulting in a wide range of behavioural problems. Cases of ADHD and ADD have increased since the start of the pandemic (Sciberras, E., et al 2022). Even for children not diagnosed with attention deficits, a disconnection from the natural world results in difficulties in concentration, a diminished use of the senses and higher mental illness among children. It is through playing in the natural world where children develop creativity, an attention span, and the desire to explore, but as children increasingly spend more time indoors all of this is being delayed.

Nature became an escape route for relaxing, socialising, and feeling psychologically good during Covid-19, causing people to have the desire to return to natural environments. With nature used as a design tool, biophilic design serves as a guide from which to create environments that are healthy for us and support quality of life. During isolation the movement from urban to rural living began, with the effects of living closer to nature causing permanent shifts in environment. If designed correctly, biophilic architecture can be used to harmoniously integrate nature and the buildings in which we live and work. The design style assumes the role of the natural environment, providing physical comfort to the user, and in extension their health (Almusaed, A. 2011).

The "14 Patterns of Biophilic Design" are the aspects of nature that most impact our satisfaction with the built environment. Created by Terrapin Bright Green, they aim to articulate the relationships between nature, human biology, and the design of the built environment, so that we may experience the benefits of biophilia. The 14 patterns are divided into three sections: 'nature in space', 'natural analogues' and 'nature of the space'. Expert in the field of Biophilic and Sustainable Design, Oliver Health explains the three sections as: "Nature in space is how you improve the direct contact with nature, so it's how you introduce water, trees, plants, and natural light into the space. The real forms of nature. The less well-known one is how we use natural analogues — using elements that mimic aspects

of nature: natural materials, colours, textures, and patterns. And most easily forgotten is how you create spaces that allow people to reconnect with nature."

Context	Patterns
Nature in Space	Visual connection with nature Non-visual connection with nature Non-rhythmic sensory stimuli Thermal & airflow variability Presence of water Dynamic & diffuse light Connection with natural systems
Natural Analogues	Biomorphic forms & patterns Material connection with nature Complexity & order
Nature of the Space	Prospect Refuge Mystery Risk/Peril

Figure 6: 14 Patterns of Biophilic Design by Terrapin Bright Green

Increased natural daylight within a building through the extensive use of glazing for windows and doors, can help to reduce the amount of artificial light required in a site; it also provides a direct view to the outdoors, which in schools, will encourage children to go outside and play. We can greatly reduce our ecological footprint by enhancing the spaces we use for our homes and offices with natural elements, such as vertical living walls.

Not only can they help to purify the surrounding air, but they help to break down the obvious barrier between the inside and outside. However, as this is not always possible, 'natural analogues' makes incorporating biophilic design a lot easier. Earth tones and nature-evoking colours such as greens, blues, and creams, use Ecological Valance Theory, which essentially states that people will enjoy certain colours because they associate them with a positive experience in nature, for example how blue reminds us of clear skies. The use of natural materials also help to improve the wellbeing of occupants, with studies suggesting that exposure to wooden panels significantly decreases blood pressure.

As a result of the Covid-19 pandemic, the way in which people work and live their lives has dramatically changed. If nature deprivation continues, not only will there be a physical and mental health crisis, but there will be a significant delay in childhood development, resulting in a generation who are at a disadvantage to their peers. Biophilic Design will play a vital role in ensuring this does not happen, by improving the health and wellbeing of humans in a post Covid world.

Conclusion

By restoring the interaction between buildings and nature, biophilic design improves the quality of environments and the health of users. There is no difficulty in creating a green oasis within a built environment as long as commitment is present. It is inevitable that environmental needs, public perception, and operational convenience will conflict at times, as biophilic design is not a one size fits all approach. Steve Nygren, founder of the visionary wellness community, Serenbe, argued, "that our world is still sick and depressed because we keep building the same garbage and expecting a healthier outcome. That there is too much focus on the building, but it is still only improving a jail. We must focus on nature, and we will." Suddenly, the locked boxes that we, as a society, have occupied as our homes, workplaces, hospitals, and schools, seem like the enemies. With more and more evidence being collected on the impact of nature deprivation on our health and wellbeing, it would be ignorant to disregard our innate connection to the natural world. Biophilia can no longer be seen as a trend but as the long-term future of architecture and design.

Bibliography

Almusaed, A. (2011). Biophilic and bioclimatic architecture: Analytical therapy for the next generation of passive sustainable architecture. Springer-Verlag.

Barton, J. & Pretty, J. (2010). What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. Environ Sci Technol.

Biederman, I. & Vessel, E. A. (2006). Perceptual Pleasure and the Brain: A novel theory explains why the brain craves information and seeks it through the senses. American Scientist. Available at: http://www.jstor.org/stable/27858773

Boone, C.G., Buckley, G.L., Grove, J.M., Sister, C. (2009). Parks and people: an environmental justice inquiry in Baltimore, Maryland. Annals of the Association of American Geographers.

Bosua, R., Gloet, M., Kurnia, S., Mendoza, A. & Yong J. (2013). Telework productivity and wellbeing: an Australian perspective. Telecom J Aust. Available at: https://doi.org/10.7790/tja.v63i1.390

Brown, D. K., Barton, J. L & Gladwell, V. F (2013) The great outdoors: how a green exercise environment can benefit all. Extreme Physiology & Medicine. Available at: https://doi.org/10.1186/2046-7648-2-3

Crutzen, P. J. (2006). The "Anthropocene". in Ehlers E, Krafft T, Earth System Science in the Anthropocene. Berlin, Heidelberg: Springer.

Costello, A., Abbas, M., Allen, A. et al.. (2009). Managing the health effects of climate change: Lancet and University College London Institute for Global Health Commission.

Delos Living LLC. (2014). The Well Being Standard. International Well Being Institute. Available at: https://standard.wellcertified.com/well

Fromm, E. (1964). The Heart of Man: Its Genius for Good and Evil. New York: Harper and Row.

Gerlach-Spriggs, N., Kaufmann, R.E., Warner, S.B. (1998) Restorative Gardens The Healing Landscape. Yale University Press: New Haven, CT, USA.

Gifford, R. & McGunn, L. J. (2012) Appraisals of built environments and approaches to building design that promote well-being and healthy behaviour. In Environmental Psychology: An Introduction. Hoboken, NJ, USA.

Grinde, B. (2002) Happiness in the perspective of evolutionary psychology. Journal of Happiness Studies. Available at: https://doi.org/10.1023/A:1021894227295

Joye, Y. & van den Berg, A.E. (2012) Restorative environments. In Environmental Psychology: An Introduction. Hoboken, NJ, USA.

Kaplan, R. & Kaplan, S. (1989) The Experience of Nature: A Psychological Perspective. Cambridge University Press: Cambridge, UK.

Kellert, S.R. (1993). 'Introduction' in The Biophilia Hypothesis. Washington: Island Press, 20-27.

Kellert, S.R. & Wilson, E. O. (1993). The Biophilia Hypothesis. Washington: Island Press.

Knight, C. & Identity Realisation research group at the University of Exeter, in association with Indoor

Garden Design (2013). Office plants boost well-being at work. University of Exeter.

Luck, G.W. & Smallbone, L.T (2010). Species diversity and urbanisation: patterns, drivers, and implications. Cambridge University Press.

Lowry, J.H., Baker, M.E. & Ramsey, R.D. (2012). Determinants of urban tree canopy in residential neighbourhoods: household characteristics, urban form, and the geophysical landscape. Urban Ecosystems

Manaker, G. H. (1996) Interior Plantscapes: Installation, Maintenance, and Management. Prentice-Hall: Upper Saddle River, NJ, USA.

Pham, T.-T.-H., Apparicio, P., Seguin, A.-M, Landry, S. & Gagnon, M. (2012). Spatial distribution of vegetation in Montreal: an uneven distribution or environmental inequity? Landscape and Urban Planning

Picket, S.T.A., Cadenasso, M.L., Grove J.M., et al. (2001). Urban ecological systems: linking terrestrial ecological, physical, and socioeconomic components of metropolitan areas. Annual Review of Ecology and Systematics.

Sacks, O. (2019) Why We Need Gardens, an essay taken from, Everything in Its Place: First Loves and Last Tales. Alfred a Knopf Inc

Scheer, R. & Moss, D. (2019). The Living Building Challenge. International Living Future Institute. Available at: https://living-future.org

Sciberras, E., Patel, P., Stokes, M. A., Coghill, D., Middeldorp, C. M., et al (2022). Physical Health, Media Use, and Mental Health in Children and Adolescents with ADHD During the COVID-19 Pandemic in Australia. Journal of Attention Disorders.

Soga, M., Evans, M.J., Cox, D.T.C. & Gaston K.J. (2021). Impacts of the COVID-19 pandemic on human-nature interactions: pathways, evidence, and implications. British Ecological Society - People and Nature. Available at: https://doi.org/10.1002/pan3.10201

Soga, M. & Gaston, K.J. (2016). Extinction of experience: the loss of human–nature interactions. Ecological Society of America.

Thompson, R. (2018). Gardening for health: a regular dose of gardening. Clin Med London.

Tsunetsugu, Y., Miyazaki, Y. & Sato, H. (2007). Physiological effects in humans induced by the visual stimulation of room interiors with different wood quantities. Available at: https://doi.org/10.1007/s10086-006-0812-5

United Nations, Department of Economic and Social Affairs, Population Division, (2018). World Urbanization Prospects: The 2018 Revision, Online Edition. Available at: https://esa.un.org/unpd/wup/.

van den Berg, A. E., Hartig, T., & Staats, H. (2007). Preference for Nature in Urbanized Societies: Stress, Restoration, and the Pursuit of Sustainability. Journal of Social Issues, 63. Available at: https://doi.org/10.1111/j.1540-4560.2007.00497.x

Wilson, E. O. (1984). Biophilia. Cambridge, MA: Harvard University Press.

Wright, F.L. (1957) A Testament. Horizon Press

Biophilia can no longer be seen as a ‘trend’
but as the long-term future of
architecture and design.