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BIOPHILIC DESIGN AS AN APPROACH TO ECOLOGICAL SUSTAINABILITY

Ghaith Aouadi*, Abdulsalam Ibrahim Shema, Hassina Nafa

Design and Fine Arts, Faculty of Architecture, Girne American University, Cyprus, Turkey

Abstract. Most nation's population lives in urban cities in an ever-expanding but linked globe. Life in urban areas is becoming faster, more computerized, and more urbanized than ever before. The urban environment is degrading at an astounding level in conjunction with pressing climate concerns. With the quick rate of urban development, which is frequently unplanned and insufficient, as well as the social, ecological, and cultural issues, the essential link that has been constant between nature and humans is at risk. This result is destroying our pre-existent interactions and connection with nature. An idea of sustainable and green city was frequently imagined while that's not yet to be widely implemented. Being disconnected from nature is one of our cities' main concerns. Isolating humans from nature is causing a wide range of cognitive, social, emotional, psychological and physiological topics. This reality is absolutely essential to consider major sustainable strategies capable of supporting humanity's profound and instinctive connection with nature. Biophilic design is one experimental possibility that believes in the connection between the humans and nature. However, biophilic conceptual design is a novel strategy that focuses on preserving, improving, and restoring great experiences involving nature in built environment. This research explored the experiences and characteristics of biophilic design using the mixed methods between qualitative, quantitative, and comparative method - defined as the systematic comparison of a select variety of examples - with a particular focus on its connection to practical, analytical, and case-study analysis. This study concentrated on biophilic design concept and planning, which could improve residents' environmental attitudes and understanding, and therefore change green life styles among citizens, this is getting us certainly to environmental sustainability and renewing the connection bridge between nature and humans.

Keywords: *Biophilic design, sustainable architecture, ecological sustainability, nature, humans.*

****Corresponding Author:*** *Ghaith Aouadi, Design and Fine Arts, Faculty of Architecture, Girne American University, Cyprus, Turkey, Tel.:0021697684740 / 0033755064919, e-mail: a.ghaith@hotmail.com*

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1. Introduction

The building sector and metropolitan regions have expanded at an astounding level unprecedented in human history. Humans may have been submerged in the tangled complexity of splendid nature for over two eons, where they have both flourished and grown toward the intellectual species that they are nowadays. Our ancestors lived in this large environment throughout evolutionary growth, and it got embedded in their psyche, physical, and cerebral adaption. One was given all of the essentials necessary for growing in this natural environment (Dubos, 1985).

All historic constructors and architects were deeply connected with their culture and the environment, copying natural shapes and producing structures that continue to amaze up to now. However, scientific researches are progressively demonstrating that our

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contemporary industrialized lifestyle, including its technological advances and shifting societies, is harmful to our mental health (Moulthrop, 2009). This disparity is most probable related to the current surge in psychopathologic patients. Consequently, it is risky to believe or suppose that people wits would be clever to swiftly and efficiently adapt to the huge variations occurring around them unless they use the natural world to enlighten and guide their architectural designs. It implies that in order to build sustainable and healthy living environments for humans and protect the earth, one we must be attentive of the natural world and incorporate its principles into architectural designs. By not taking action they may endanger civilisation and the environment.

Sustainability, often known as sustainable architecture, focuses on serving the demands of the moment without jeopardizing future generations' capacity to fulfil their own requirements (Sandberg, 2022). The three sustainability pillars are identified as: economic, ecological, and social factors. Architectural Modernity is the movement that has separated man from nature. People spend most of their time indoors these days, surrounded by wallboard, concrete, wood, and solid steel. As a result, it is critical to convey men closer to splendid nature in order for them to live a healthier existence and live a great experience every time one enters his daily space (Sandberg, 2022). Biophilic concept is an emerging sustainable approach to building that blends natural light, materials, nature vistas, flora, and other natural world experiences into the greater modern made environment. It arose as an effort to create a bridge between both Nature and Human. (Kellert (2018); Kayihan (2018)) Figure1.

Figure 1. Connection Between Nature and Humans. (Source: http1, 2023)

1.1. Methodology

The methodology of this research begins by examining the importance of biophilic design and defining its meaning in relation to nature. Available literatures from sources such as Web of Science, Scopus and Google scholar data base were employed and collected relevant data regarding the approach of biophilia and its conception in relation to build environment and its sustainability and ecological development. The research also attempted to explore the experiences, attributes, characteristics of biophilic design using the mixed methods between qualitative research that relies on narrative as well as written data, while on the other hand, quantitative study using logical or graphical such as pictures and diagrams observations to draw systematic comprehensions and conclusions, and the comparative method - defined as the systematic comparison of a select variety of

examples - with a particular focus on its connection to practical, analytical, and case-study procedures to provide an avenue for exploration of a related case. See Figure 2.

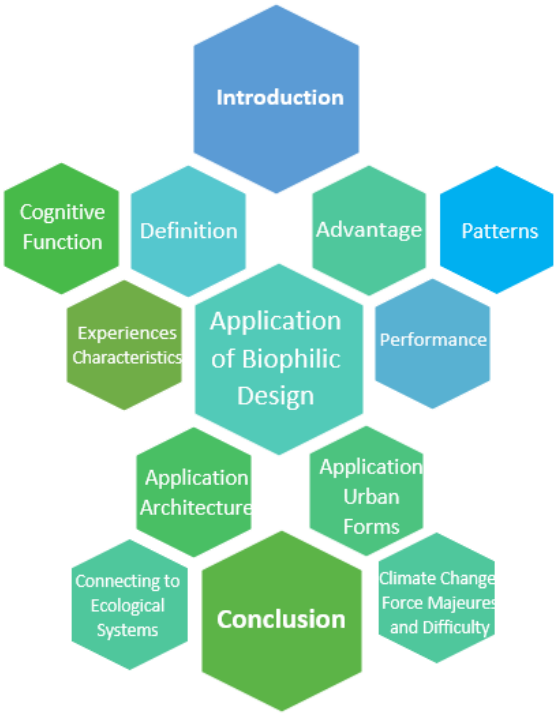


Figure 2. Structure of Research. (Authors, 2023)

1.2. Novelty of the research

One of the key themes in attaining sustainability and general ecosystem protection, particularly in regions with natural features, is biophilic design. The protection of the environment and appropriately investing in its components is a need, not a choice, in connection with climate change as well as an urban intrusion on natural ecosystems. Many academics believe that biophilic design has positive social, economic, and environmental effects, but they neglected to adequately focus on its main concept of reconnecting humans with nature.

2. Literature Review

In urban regions, individuals spend the vast majority of their hours distant from home either in workplaces or in public spaces like train stations, bus stops, malls, etc. Building footprints are getting smaller as cities continue to expand and taller skyscrapers are the result (Ali & Al-Kodmany, 2012). In future, it is expected that working during an entire day in a small space would be the main cause of disease (Kellert, 2008). Stress-related illnesses are caused by such environments. The loss of man's connection to the natural environment as a whole is a drawback of this. Therefore, it is imperative to include "Biophilic Design" in buildings in order to foster a relationship between humans and the environment for the benefit of humankind (Kellert, 2008).

"…Biophilia is not a single instinct but a complex of learning rules that can be teased apart and analysed individually." (Wilson,1993). "Biophilic design is about

creating good habitat for people as a biological organism in the built environment." (Kellert & Calabrese, 2015). Kellert (2008) continues by asserting that "Biophilic design requires repeated and sustained engagement with nature.". Stephen Kellert wrote a book that translated into a language of patterns in the built environment the way Biophilic design could be incorporated into architecture where he identified more than 70 different mechanisms for engendering a biophilic experience, and contributing colleague outlined the different categories of user experience (Kellert *et.al.*, 2008). He also makes the following observation: "Biophilia is the inherent human inclination to affiliate with natural systems and processes, especially life and life-like features of the nonhuman environment." (Kellert *et.al.*, 2008).

2.1. The definition of biophilic design

The sociological psychologist from Germany Erich Fromm is attributed with using the word "Biophilia" which derives from the Greek word for "love of nature" (Wilson, 1984). Edward Wilson, an American biologist, first used it in the 1980s, and as a result, he helped establish a new school of thought that stressed the importance of re-engaging humans with nature (Wilson, 1984). Edward Wilson coined the term "Biophilia" in his book with an equivalent name, published in 1984. The links that people intentionally seek with other aspects of life, according to his definition of the term. The objective of biophilic design is to forge meaningful connections between natural and artificial surroundings, which can improve people's health and welfare (Wilson, 1984). "Biophilic architecture" describes the adaptation or design of a structure to its milieu. An architectural strategy called "biophilic design" aims to develop settings that promote human wellness (Kellert, 2008). Humans may create environments that support both physical and mental wellness by adopting biophilic design concepts. An innovative approach known as "biophilic design" is predicated on the notion that human wellbeing may naturally be enhanced by nature (Kellert, 2008). This is how architects should design natural environments (Kellert, 2008). The fundamental tenet of biophilic concept is that nature ought to be incorporated into architecture progressively. This may be achieved by utilizing organic materials like wood or dirt, as well as by mimicking natural phenomena like waterfalls, sunrises, and fog. In essence, architects employ biophilic design to give people access to natural settings (Kellert, 2008). The researcher of social ecology Stefen Kellert offered a list of requirements for biophilic design and defined six components of biophilic design in his writings, see Figure 3 (Kellert, 2008).

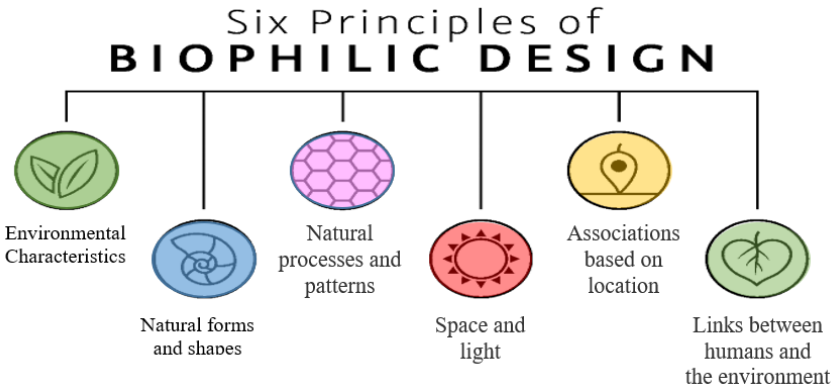


Figure 3. Six Principles of Biophilic Design (Authors, 2023), (Kellert, 2008; http2, 2023)

2.2. The advantages of biophilic design

The advantages of maintaining vegetation around environments could go interminably. The same holds for a plant that is intended to grow on a wall. Having access to the environment is naturally essential, and bringing it inside interior spaces has a profoundly good effect on our human well-being. While technologically evolved urban culture, somehow there is a loss with nature. The following benefits of incorporating biophilia into the architectural design are said to exist (Kellert, 2008): Table 1.

- A lessen tension and anxiety symptoms
- Reduced blood pressure and muscular tension are signs of improved physical health.
- A renewal of mental and emotional strength.
- A feeling of being more socially connected.
- It preserves a clean environment and removes pollutants.
- Positive effects that may be measured on productivity and creativity.
- Even though they are seated inside a structure, they nevertheless sense a connection to nature.
- Reduce energy use and protect natural resources.
- It is among the environmentally friendly methods for green building certification.
- It aids patients' healing and recuperation after sickness and severe surgery.
- Interaction with the natural environment has also been linked to healthy childhood maturation

For the residences, places of employment, educational institutions, and public areas, biophilic design provides considerable economical and health benefits, Figure 4. When Biophilic design concepts are used within homes, one get a wonderful sense of serenity and security, mental healing, and therefore enhanced productivity (Kellert, 2008).

Figure 4. SFER IK in Mexico, an interdisciplinary arts space within the Azulik resort complex near Tulum, designed by the architect and eco-hotelier Eduardo Neira. (Source: http3, 2023)

Table 1. Advantage of Biophilic Design. (Authors, 2023), (Kellert, 2008)

Air Purification	• Finding the opportunity to get fresh air might be challenging when you have a lot on your plate. Bringing wildlife indoors can improve air quality and convert CO2 breathed into oxygen.	 **1**
Engaging with nature repeatedly and continuously is necessary for biophilic design.		
Temperature Regulation	• Your ability to maintain cool in the summertime can be helped by plants' capacity to absorb sunlight. Additionally, they bring humidity to the air in the winter, warming and improving the surroundings.	 **2**
The focus of the biophilic design is on how people have adapted with the beauty of nature.		
Noise Reduction	• A green wall frame made of indoor plants may dampen noise by absorbing it. This is ideal if you require to focus when operating in a crowded place or in your home office. Pretending over your vegetation wall is a great way to unwind and take a little break if you want to clear your mind.	 **3**
Promotes emotional connection to certain locations and surroundings.		
Tranquillity and Peace	• The lovely views of nature that a live plant wall offers have a relaxing influence on the mind as well as the psyche. Humans can feel happy, healthier, more at ease, and more productive when they are close to nature. Think back towards your most recent excursion to a deep forest or a deserted beach. How did it affect how you felt?	 **4**
The biophilic design encourages convergence between humans and the natural environment.		
Shadows of nature	• Nature is awash in colour, and every season has a unique theme. Don't be scared to decorate your home with bold colours. Even painting just one accent wall in a room if you don't feel like decorating the whole thing will have a big positive impact on your attitude. If you prefer something less long-lasting, wallpaper could be a better option.	 **5**
Promotes linked, integrated, and mutually reinforcing architectural solutions.		
A work of art Composition	• Your favourite wildflowers, woodlands, chanting birds, uprising suns, framed green walls, or anything beyond that that brings back particular recollections of time spent in nature can all be included in a wall gallery.	 **6**
Positive effects that may be measured on productivity and creativity.		

1-Stack Effect & Air. **2**-Maggie's Leeds, UK. **3**-Vertical plant walls, Caffe UK. **4**- Biophilic design in practice at Lower 48 in Denver, USA. **5**- King Bill House, Fitzroy, Paris, France. **6**- Université Nanyang, Singapour. (Source: http4, 2023)

2.3. The patterns of biophilic design

As circumstances dictate, Unwin's (2009) linguistic architecture must have its patterns and configurations, uncaring combinations. The Patterns are indeed a collection of resources for understanding design possibilities, same for biophilic design. Christopher Alexander (1977) created a set of patterns that function as linguistic components and build a network to provide solutions to social behaviour, spatial and architectural constraints. He begins at a broad level and then suggests patterns for building. Individual decisions are made by selecting patterns that absorb the necessary traits and may be utilized in conjunction to finalizing the desired answer, while the edifice and aesthetic preference are not considered. Many people identify patterns as valuable tools in the design of architecture. 'Entrance Room' by Unwin (2009) is an example of a pattern. Alexander begins by describing the function: "Arriving in a room or leaving it, you need a room to pass through, both inside the building and outside it. This is the entrance room."; he then offers some solutions. The goal of this research is to project Alexander's pattern language framework into the examination of biophilic design patterns related to architectural solutions (Alexander, 1977).

“The relationship between humankind and nature can be one of respect and love rather than domination.” (Dubos, 1985). Taking it apart even further, may show that there are components to what comprises biophilic design. “The outcome…can be rich, satisfying, and lastingly successful, but only if both partners are modified by their association so as to become better adapted to each other.” (Dubos, 1985). Terrapin Bright Green (2014) defined those qualities using science and psychology in their study, '14 Patterns of Biophilic Design.' Their work teaches how to implement each concept while designing with human needs in mind. “With our knowledge and sense of responsibility… we can create new environments that are ecologically sound, aesthetically satisfying, economically rewarding.” (Dubos, 1985). Although not every place may be constructed to embrace all of the principles, a few contributing biophilic design features can collectively improve a space’s well-being (Dubos, 1985).

The most important collection of research on biophilia has grown considerably (Wilson, 1993). Wilson's ideas include an analysis of biophilic design concepts patterns: “teased apart and analysed individually” (Wilson, 1993) to expose emotional attachments, a in addition to other psychologic and cognition connections to the created environment. The special term 'pattern' is employed to indicate precise elements (Wilson, 1993):

- To offer a consistent and explicit nomenclature for biophilic design.
- To prevent conflicts with many terminologies used to illustrate biophilic design (metric, attribute, condition, feature, typology, etc.).
- By using a familiar language, we may increase accessibility across disciplines.

Biophilic design patterns, while influenced by science, are not formulae; they are intended to inform, advise, and aid in the design phase and should be viewed like another item in the designer's toolbox, See Figure 5. The goal of establishing various patterns is to express linkages between features of the natural and constructed surroundings, as well as how people react to and gain from them. Following the definition of each pattern, it is addressed in regard to the following (Wilson,1993):

- The expertise discusses briefly how the pattern could affect how a location feels.
- Foundations of the Pattern focuses on important scientific data that connects human physiology to ecology and urbanism.

- Collaborating with the Pattern focuses on design qualities, examples, and concerns, while Relationship to Other Patterns highlights prospects for integrated biophilic design techniques.

a b c

Figure 5. a- One Central Park, Broadway, Sydney. b- Jewel Changi Airport, Singapore. c- Amazon Spheres, Seattle, Washington. (Source: http5, 2023)

As Salingaros (2000) emphasizes, new fields such as biophilic design must continually evolve. “Abstract its patterns as they appear… building its own foundation and logical skeleton, upon which future growth can be supported.” (Salingaros, 2000). It is very probable that when more data becomes available, certain patterns may be prioritized above others, and new patterns will arise. however, by creating these 14 fundamental patterns, maybe inspire extensive scientific investigation, cognitive development, and design application of Biophilia (See Figure 6/7).

a **b**

Figure 6: a-Bosco Vertical, Milan, Italy. b- Fallingwater by Frank Lloyd Wright. (Source: http6, 2023)

The 14 patterns are classified into three groups: Nature in Space, Natural Analogues, and Nature of Space Exploring the Table 2 below to learning details about each design and how it might be applied in the architectural design (Terrapin, 2014).

Figure 7. Citibank Wealth Hub, Private Wealth Management Offices, Singapore. (Source: http7, 2023)

The influence of biophilia on health was demonstrated primarily through three psyche categories: psychological, cognitive, and physiological processes; the effect on these logic systems was investigated and studied in a variety of ways to understand how the large environment may impact a user's good health and comfort (Terrapin, 2014). The findings demonstrated how each specific pattern may influence three key categories stress decrease, cognitive function, and emotion, attitude, and preference. All definite patterns used to have an influence on at most one element but majority of them touched more than two and three types.

Biophilic design forms were developed to advise and help in the design progression, with the main goal of explaining the relationship between the features of constructed and natural settings (Terrapin, 2014). Biophilic design patterns are quite adaptable and can be executed in design consuming a variety of forms based on individual necessities; the integration of patterns treats to increase the positive effects on wellbeing, and participating design strategies can result to a modify for users from changed societies and human population statistics (Terrapin, 2014).

2.4. Cognitive aptitude and performance of biophilic design

Research on the positives of nature in the habitation space and workplace may be critically analyzed to inform design improvements by measuring cognitive function and performance. In addition, the study of (Choudhry *et al*., 2015) have found that having access to nature improves work performance, which is frequently assessed by cognitive tests and productivity proxies. There have been a relatively handful of studies conducted in situ for different spaces, and these research efforts are frequently criticized for having correctly modelling the real regularly responsibilities in the different spaces from habitation, administration to hospitalization regarding the research of (Sturgeon, 2017). These researches in the natural sciences indicates the advantages of greater task performance from focus (Choudhry *et al*., 2015; Li *et al*., 2018). The aforementioned warnings should never be utilized in isolation to demonstrate improved performing, but when used in conjunction with other measurements taken at the private and institutional scales, that may offer a good measure of mental capacity and job efficiency. Consequently, biophilic architects may confidently assert that they are close to the natural world could boost people's ability to focus and perform better (Loder, 2020).

Table 2. The 14 patterns of Biophilic Design (Authors, 2023), (Terrapin, 2014). (Source: http8, 2023)

Nature in the Space

A: Peter's house by Studio David

- In a location, direct sensual touch with nature does not only entail closeness to a flower pot or two. Connection with the natural surroundings and biological environment can be felt when there is a fascinating view of nature nearby, or when vegetation, water features, natural air movement or breezes, noises, and fragrances are used. Through diversity, mobility, and multisensory interactions, design utilizing this collection of patterns will generate meaningful, direct relationships with natural.
- **Visual Connection with Nature:** An examination of natural components, life systems, and natural processes.
- **Non-Visual Connection with Nature:** Stimuli are auditory, tactile, olfactory, or gustatory in nature, living systems, or natural processes.
- **Non-Rhythmic Sensory Stimuli:** Probabilistic and transient relationships with nature can be statistically evaluated but not accurately anticipated.
- **Thermal & Airflow Variability:** Precise fluctuations in air temperature, relative humidity, skin airflow, and surface temperatures simulate natural habitats.
- **Presence of Water:** A situation in which seeing, hearing, or feeling water improves one's perception of a location.
- **Dynamic & Diffuse Light:** Using different levels of light and shadow that fluctuate over time to simulate natural situations.
- **Connection with Natural Systems:** Natural processes, particularly seasonal and temporal fluctuations that characterise a healthy ecosystem, must be recognised.

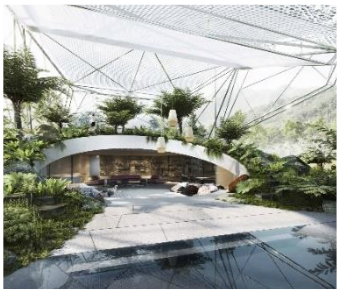
Natural Analogues

B: The "Planetary Park" project in Paris

- We employ components with an indirect relationship to nature in natural analogue patterns to generate a trigger in the brain that ignites the same sensation of well-being associated with the natural environment. You may re-create the biophilic feeling of connectedness, and hence the beneficial reactions, to the vast outdoors by recreating the finer elements of nature with fabrics, artwork, light, forms, or patterns.

- **Biomorphic Forms & Patterns:** Conceptual allusions to curved, patterned, textured, or numerical compositions seen in nature.
- **Material Connection with Nature:** Nature-inspired materials and features that, with little processing, mirror the local environment or geological to create a particular feeling of location.
- **Complexity & Order:** Substantial sensorial information is organized in a large building comparable to that seen in nature.

Nature of the Space



C: Wolfgang Fiel, May 2021

- On a fundamentally human level, the Nature of the area patterns dictates how we react to the structure, apartment, or field in our environment. We have a natural drive to look beyond our surrounding context and are drawn to the slightly scary or unknown. Obscured views, design reveals, installations, and moments of mystery or hazard pique our curiosity and keep our excitement. When these features are combined with combined patterns from the remaining two categories, the impact of biophilic design is maximized.
- **Prospect:** A clear vision over vast distances for observation and planning.
- **Refuge:** A space to retreat from environmental circumstances or the primary flow of activity, where the individual is sheltered from behind and above.
- **Mystery:** The potential of additional information is realized by partially blocked views or other cognitive gadgets that urge the user to explore further into the surroundings.
- **Risk/Peril:** A recognizable threat combined with dependable safety.

3. Biophilic Design Application

The intentions of the biophilic idea are to offer a fresh, more organic dynamic mechanism for the wonderful experience of nature in the building envelope in order to work within the constraints of contemporary creative design and expected environmental standards (Kellert, 2017). In order to create an appropriate habitat for humans in a modern, organic constructed environment that cares for their health, fitness, and welfare, biophilic design is used (Kellert, 2017). Figure 8.

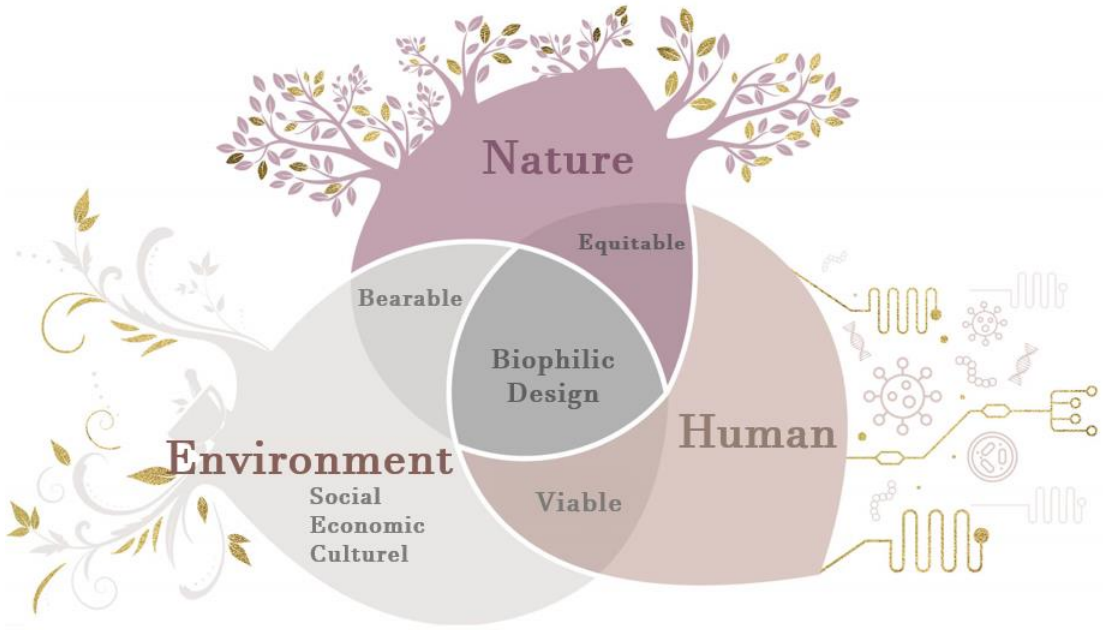


Figure 8. Biophilic Design Diagram Approach (Authors, 2023)

3.1. Experiences and characteristics of biophilic design

With constructed, metropolitan areas dominating the natural landscape, biophilic design is all about bringing the outside inside to enhance one's physical and mental wellbeing. Adding materials from nature to your space may benefit you in a number of ways, including Wilson (1984):

- Enhancing the mood.
- Enhancing the sense of imagination and creativity.
- Increasing the bar for the productivity.
- Regaining the vigor, strength, and mental clarity.

The biophilia theory, first articulated by Wilson (1984), sparked the present biophilic design concept movement. He described biophilia as “the love of life.” … “innately emotional affiliation of human beings to other living organisms. Innate means hereditary and hence part of ultimate human nature.” (Wilson, 1984).

Wilson (1993) asserted the individuals possess an innate need to reconnect with ecosystems and natural events. S.R. Kellert and Wilson subsequently applied this method within the constructed surroundings. The concept went over merely performing duties in an ecological and plant-like environment. Kellert's (2008) recommended traits for

biophilic design were the first to operationalize it, as he presented significant measurements, features, and characteristics associated with biophilic design concept. The author recognized sustainably sourced and place-based/vernacular as two fundamental aspects. Organic dimension is defined as “shapes and forms in the building sector that immediately, indirectly, or symbolically represent the natural human affinity for nature.” (Kellert, 2008). The term 'vernacular dimension' refers to “buildings and landscapes that link to the society and ecology of a locale or geographic area.” (Kellert, 2008).

This last element, as Kellert (2015) reminds out, comprises a sense or spirit of place. The categorization is then broken down into six primary parts, which are further subdivided into biophilic design features. These characteristics include the existence of water, air, sunshine, plants, and animals, as well as more complex ones such as sensory variety, especially in situations, exploration and discovery, and topographical, historical, ecology, and social connection to place. Importantly, biophilic designers must recognize that the environment might take the form of an ambiance, a process, or an experience. Architecture is lifeless unless it is atmospheric and creates a sense of location. Consideration of environments, soundscapes, energy, interactions, and experiences are biophilic design issues that must be addressed if the biophilic design concept should be pleasurable, meaningful as well as enjoyable to live with. (Kellert, 2015). “The ambiance or atmosphere of a room or an urban space is the overall feeling and tuning of the experience. It is a non-material or peripheral experience that tunes our minds in a specific way. We feel atmospheres immediately and without being conscious of the process. The final target of the design is not the physical building but its impact as a lived experience.” (Pallasmaa, 2018).

The core concepts of biophilic design are represented by three different forms of nature experiences (Calabrese, 2017). Figure 9. These include the experiences of space and place, as well as the direct and indirect experiences of nature (Kellert, 2015):

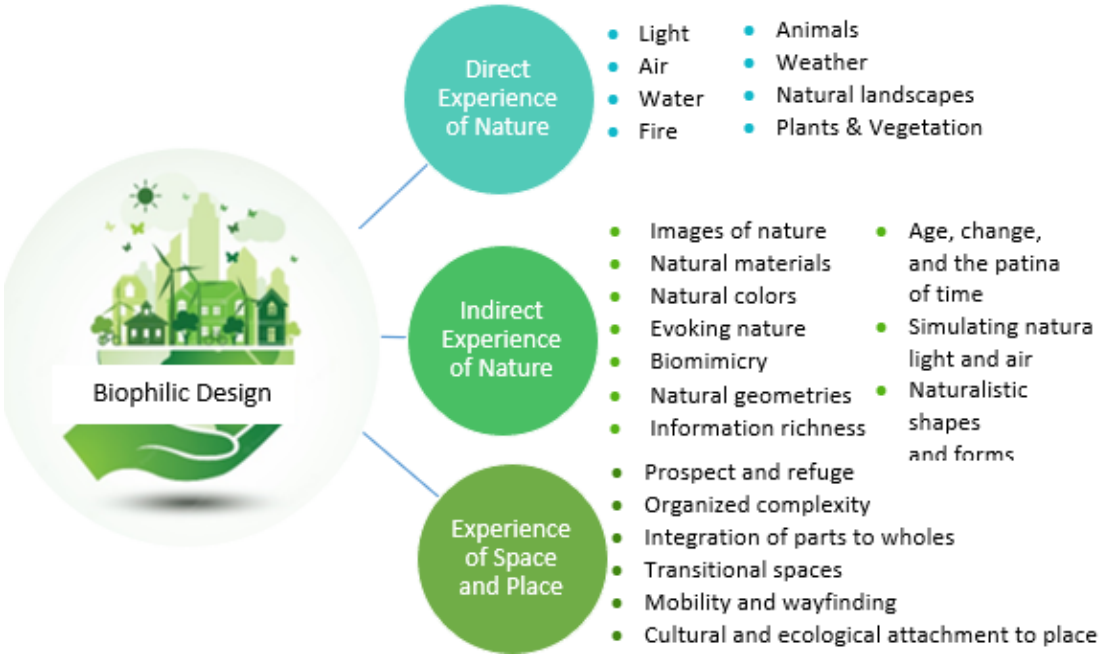
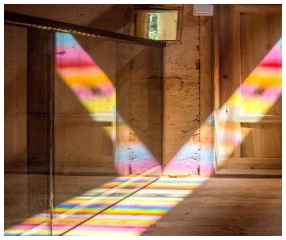
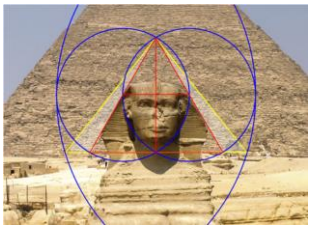
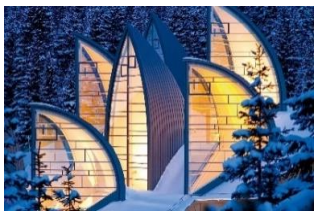


Figure 9. The Three types of experience of nature of Biophilic Design (Authors, 2023), (Kellert, 2015)

3.2. Application of biophilic design approach in architecture

Table 3. Application of Biophilic Design in Architecture (Authors, 2023), (Kellert, 2017).

Attribute of Biophilic Design		Use in Building	Application in design	Problem addressed
Water	1		The urge for a connection to water can be satisfied in several ways, including views of notable, rain gardens, aquaria fountains, fishbowls, water bodies, etc.	A water source within the home controls the temperature.
Light	2		The desired element in developed environments is natural light. Sun daylight is preferable to artificial light because it is more than comfortable, positive healthy, productive, and constructive.	By using large windows and clerestories, reflecting colors and products, and other architectural techniques, natural light may be introduced deeply into interior spaces.
Plants & Vegetations	3		The future architectural conception should have rich, vegetation, and ecologically integrated landscapes that tend to highlight local species.	Vegetations and plants can increase comfort, physical health, performance, and productivity while reducing stress.
Air	4		Air density, humidity, airflow, temperature, and atmospheric pressure fluctuations may all promote natural ventilation in constructed environments.	These trouble factors of air can be met by enhancing the accessibility to the outside using tools like movable windows, static pressure, or more sophisticated technology and engineering methods.
Naturalistic Shapes And Forms	5		Various naturalistic forms may be discovered, such as leaf-like patterns on columns, animal and plant shapes on building facades, and animal impersonations weaved into textiles and coverings.	A static place can acquire the dynamic, active and diffused behavior of a living system when realistic shapes and fantastic forms are present.
Natural Materials	6		Natural materials are used in the creation of vernacular structures. Important natural materials utilized in furniture, textiles, as well as other interior and exterior architecture, comprise stone, wood, sand, wool, leather, and cotton.	The metamorphosis of natural materials typically yields pleasing aesthetic and tactile effects, but also uses less energy during construction, making it sustainable, affordable, and ecologic.

Biomimicry	7		Refers to patterns and processes that occur in nature. Examples include the capacity of some animal hairs to absorb heat or the example of spider net-like danger protection and these bioclimatic regulations of termite mounds.	Shielding from the external environment. thermal coziness.
Natural Geometries	8		Mathematical characteristics that are frequently seen in nature are referred to as natural geometries. These include scales that are arranged, flowing shapes over artificially hard geometries, self-repeating yet different patterns, etc.	It is possible to strike an equilibrium between the quality of the energy created inside an architectural area.
Integration of parts to wholes	9		The progressive and generalized results connection of places, with obvious and definite borders, can frequently lead to the emergent whole.	A primary focus point that happens either functionally or conceptually might improve space integration.
Prospect and Refuge	10		Spectacular views to the beyond, visual, and aesthetic links between internal areas, and the presence of safe and protected environments may all help with it as well.	While refuge offers shelter and security, perspective refers to the combination of environs that enable individuals to view opportunities, risks, and threats.
Cultural and Ecological attachment to place	11		Humans have a congenital, and inherent passion for the outdoors that indicates a territorial nature that may be strengthened by cultural and ecological practices.	Area cultural and biological connections serve as motivation for preserving and sustaining both the built and natural surroundings.
Transitional spaces	12		The spaces that connect the inside and exterior, including corridors, entrance porches, porches, patios, courtyards, big terrasse, colonnades, etc., are considered prominent transitional spaces.	Provides linkages between spaces made possible by distinct and unambiguous transitions.

1- Light in Water, Design Week 2011 de Milan. **2**- Gallery of Shangping Village Regeneration, He Wei Studio. **3**- Green, Vietnam. **4**- Atelier Vens Vanbelle, Belgium. **5**- Bio inspiration, The Gherkin, Londre. **6**- Earthen construction, Fimea, Senegal. **7**- This Pavilion, Stuttgart. **8**- The Pyramid, Egypt. **9**- Milwaukee Art Museum's Quadracci Pavilion, USA. **10**- Mountain house Kamnic Alps, Slovenia. **11**- Spa Tschuggen Berg Oase, Suisse. **12**- B+B House, Brasil – Teresians School, Barcelona. (Source: http9, 2023).

The application of biophilia theory in a constructed setting is known as biophilic architecture. It should satisfy human needs for natural relationships in our current habit-living world. According to the literature, there are several definitions of biophilic architecture. Furthermore, there is no single definition on which all specialists agree. Biophilic architecture, contrasting biophilic design, which is frequently defined by Kellert's (2008) concept in many articles and has a specific definition, lacks any specific definitions. The concept of biophilic architecture was already divided into three elements, the first of which examines the foundation of biophilic architecture, the second of which addresses its goal and aims. Lastly, the third element focuses on the actual application of biophilic design. Refer to Table, the purpose of biophilic architecture has been conceptually examined in the literature, whilst academic works reviewed actual investigations to identify the implicit consequences of biophilic design on humans. Kellert (2008) argued that the second half of said biophilic architecture concept must include the major purposes, goals, or aspirations of biophilic architecture.

3.3. Application of biophilic design approach in urban forms

More than the majority of the world's population now resides in cities. A United Nations (UN) research claims that by 2050, urbanization and general growth might add another 2.5 billion people to the world's metropolitan population. 2014's Nations The quantity of megacities having residents of more than ten million is rising. In the future, India, for instance, will have six megalopolises, making it the nation with the highest concentration of megacities worldwide. Increased urbanization and sprawl have obvious negative effects (Taubenböck, nd). Environmental and socioeconomic issues in many cities have a negative impact on public health and contribute to a variety of urban issues. The installation of urban green places and integrated greenery systems in modern cities is essential for raising the aesthetic and environmental standards of the city's inhabitants. Implementing green the built environment in particular offers ecological services and benefits. (See Figure 10).

The objective of biophilic urban forms is to reverse the current urban separation from nature by incorporating the natural world's experience more fully into daily urban living. Biophilic urbanism is a new method to planning and designing cities that focuses on the physical environment, urban architecture, way of life, as well as approaches and practices (Russo, 2017).

3.4. Biophilic design approach, climate change and force majeures

In determining how to respond to future global catastrophes, our connectivity and interaction with environment, particularly biophilic design concept, could be crucial in fostering sustainable habits as well as our overall well-being. As opposed to relying on theoretical general laws found in nature to encourage sustainable performance, integrating our everyday lives with nature via design concept and regulation at construction, community, and metropolis grows may create connection and make action appear to have greater significance. (Africa *et al*., 2019). Enhancing sustainable habits could possibly then help to address current circumstances and health challenges. The global warming phenomenon is really being dubbed: “the most serious threat to global economic, social and environmental stability in recorded history […] prevalent human diseases linked to climate fluctuations.” (Africa *et al.*, 2019).

Figure 9. Idealistic Biophilic Urban 3D Concepts (Authors, 2023)

For example, although climate change policies have been hampered by inertia and business as usual, a recent outbreak has revealed the link between climate change with severe illness, with people subjected to increased levels of air pollution in the atmosphere (Wu et al., 2020). The function of nature in psychological health and socialization has also been highlighted by disease or epidemic situations.

Consider the influence of adjacent nature on our physical and emotional wellness. The relevance of urban parks and their presence in promoting the emotional and physical well-being of lonely individuals has recently been highlighted in the media (Surico, 2020). Throughout the epidemics that have resulted in lockdowns, federal, provincial, and municipal authorities have acknowledged the importance of space for physical and mental well-being, from rural parks to municipal parks to urban green spaces. Getting out of our buildings and into natural green places, going for a stroll, picnicking, or bathing in the woods has long been seen to be healthful and recommended by doctors. Stress can be relieved simply by seeing the ordered diversity of fractals, which are self-similarity measurements (Wu *et al.*, 2020). The rediscovering of nature's beauty and shelter, particularly regional nature on our own property as well as our landscaping, have resulted in increased interest in the rhythmic details surrounding us as well as a reduction of the rapidity of living in urban areas. That slower pace could be crucial to maximizing nature's healing advantages. Isolation and quarantine have slowed people's lives, allowing them to see nature in real time as changing seasons occur. The impression of the distinction of the environment and the changing seasons is being linked to enhanced focus as well as recovery in employees working in city central business areas. As a result, adding time could be crucial for excellent biophilic design concept, which may stress the changing patterns formed by building's other than humans' components. Mindfulness could be just as important for perseverance in the present volatile environment.

The closer relationship with nature that has emerged from the decrease in speed due to force majeure has also been matched by a heightened awareness of socioeconomic inequalities and persons who lack a connection with area, nature, or security (Loder, 2020). Many cities are beginning to regard greater urban green space as a public benefit,

and uneven opportunity for it has driven current urban landscaping efforts also become a critical component of redesigned resilience plans (Loder, 2020). Combining several of the projects performed by urban areas, as well as research from social and socio-political ecological work, could assist in bridging such conventional blind hole in biophilia concept. For a society to be economically viable, equitable access to the environment, fresh water and air, and natural light in dwelling places is required.

"Biophilic design is justifiably critiqued for its inequity: the health, happiness and productivity of humans is privileged over that of other species, and (de facto) the approach is most accessible among clients of means." (Africa *et al*., 2019). Removing this impediment and visualizing an increased fair biophilic design concept requires being emphasized at all scales, from individual dwellings to communities to an entire globe.

3.5. Difficulty in achieving of biophilic design

Kellert (2008) mentioned for the difficulty in achieving of biophilic design a few of the obstacles that designers have when implementing biophilic design, particularly when converting conceptual and intellectual features hooked on design concept. Biophilic design principles are not continually apparent, and many people seek explicit criteria that they canister employ to design or that may be supplementary to displaying tools. The characteristics and patterns of biophilic design concept have virtually logical in nature, necessitating a comprehensive method and a comprehensive awareness including both nonhuman and human ecological aspects and mechanisms - their resolve and connection in generating the global atmosphere (Kellert, 2008).

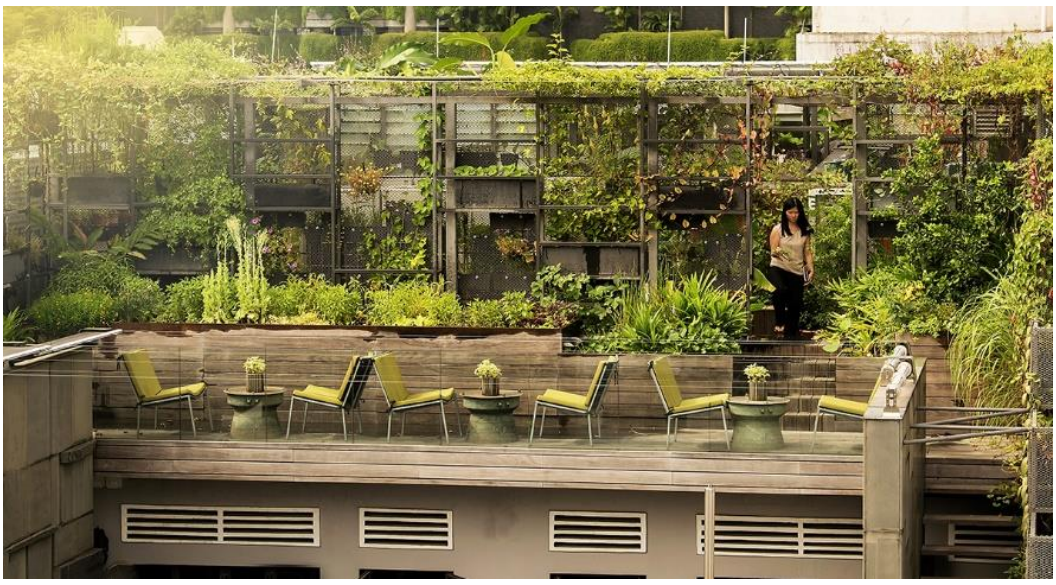


Figure 11. Biophilic design Solutions. (Source: http10, 2023)

Instances comprise their feeling of location, emotion and life experiences, which is architecture's ultimate purpose. Excellent biophilic designers must be very skilled in both logical and irrational space design. architects, artists, and designers must grasp all aspects of area and human practice - intellectual, physical, economic, natural, educational, traditional, cultural and have an intellect of humor. (See Figure 11). This approach to nature's benefits rarely corresponds with existing wellness scientific evidence that uses a

psychological investigation approach, which somewhat can result in a disconnect manifesting as an absence of understanding regarding current health studies or complexity in interpreting biophilic attributes into additional design objectives that may be evaluated and evaluated. (Kellert, 2015).

3.6. Connecting biophilic design to ecological systems

Integrated ecological mixed urban environments may connect established greenery in urban zones allowing greater accessibility and develop pollination paths, that help to sustain life on Earth. Parks and roadside verges, for example, can assist London's National Park Metropolis plan to accomplish its regional objective of greening and rewilding the city for people and the environment. This effort is “an awareness of how inextricably linked and enhanced urban life are by nature.” (Macfarlane, 2020). Comparable forestation and reclaiming paths are currently being expanded throughout the urban built environment's living walls, rooftops, courtyards, and gardens (British Land, 2020). Pollinator trails can now extend certainly up to a biophilic office plant as architecture blur outside or inside envelopes, reassembly of the construction and permitting live biophilia concept.

The concept of biophilia, and specifically the promoter of a more profound relationship to nature, provides the prospective to transform environment design and planning from an environmental nice-to-have to a comprehensive, ecological system strategy and approach, allowing for more deeply beneficial significance and adoption by constructions, towns, and regional. That occurring in certain parts of the design society, where other than humans (nature, location), human (culture), and architectural design situations are being viewed via a distinct biophilic lens. At the project level, practical examples comprise biophilic design seminars which have combined meditation practices and fostered the investigation into one's connection with site. These puts the design concept team in the mindset of asking for permission to develop from the land and seeking reciprocity with minerals, native plants, and diversity (British Land, 2020).

This type of evidence-based biophilic design research and exercise adheres to salute-genic thinking, a health notion (Antonovsky, 1987) that promotes a concentration on elements that increase and promote well-being and instead human health of ones that diminish sickness (Brown, 2016). Since are intimately tied to the condition including well of the planet's ecosystems, combining biophilic and salute-genic design techniques may give a more comprehensive framework for connecting ecological, non-human and human components. Given that investigation at the construction degree has typically concentrated on healthy dangers, a more comprehensive mode to conceptualize and rethinking may be beneficial in developing and fostering wellness-promoting settings (Loder, 2019).

At a wider scale, an important development is bio-Leadership, which is a concept of an ecological system made up of individuals and initiatives that transform management via engagement and collaboration with the splendid nature (Roberts, 2020). The notion shifts from a holistic approach (where the world is considered to work as a mechanism) to a naturally flowing approach in the design and political realm. Currently, this concept has been used to characterize the hoped-for future age of interpersonal interactions. This new method of thinking about nature and human interaction in design and policymaking seeks to foster founder reciprocity (Mang *et al*., 2016) and may hold the prospect of an equitable and regeneration future.

4. Results and Discussion: Connecting the 14 Patterns of biophilic design to ecology

As a result, biophilic design patterns may be thought of as expressions of ecology life. Consequently, using biophilic design patterns may improve the effectiveness of an ecological system in architecture design; the more patterns that are applied, the greater the efficiency. This reunites us to the original research question: May improving the approach to ecological sustainability by including the 14 patterns into the biophilic design? The study intended to introduce an entirely novel ecological sustainable approach by connecting with greater biophilic design patterns, in order to growth the sensitivity of their effectiveness; this strategy was examined in various ways, such as architecture and urban design, in sequence to examine the opportunities and consequences, and to propose a design concept that stimulates the biophilic design performance and acquires pattern interconnection. Overall, biophilic design patterns may be discovered in the landscape aspects of any environment, even if they are not intended or applied on intention. Certain architectural designs might be turned in with a merged sustainable biophilic design idea with few changes, resultant in beneficial benefits on humans and augmented architecture design productivity. Increasing the variety of patterns and their various shapes might readily activate our sense of biophilic design patterns. This would also have an effect on the person's health including well. (See Figure 12).

Figure 12. Biophilic design as ecology approach. The Wardian, London (Source: http11, 2023)

5. Conclusion

Humans disconnect from nature has already harmed their physical and emotional well-being. However, buildings actually are frequently created, maintained, and used independently of nature instead of as a component of it. In addition, biophilic design idea is more about re-establishing our great connection to splendid nature than it is about utilizing a fresh approach to building design. An important transformation in human awareness that results in a novel ethic of accountability and responsibility for protecting the world and our relationship to it will be necessary for it to be accomplished. A biophilic design approach has the potential to provide important advantages. Along with practical and economic benefits for cities as a whole, it offers people a variety of social and psychological gains. To enhance information exchange on research, strategy improvement, biophilic planning rethinking, and smart innovation, cooperation across nations is necessary. Additionally, it creates a novel financial tool to support new technology, smarter urban substructure/ infrastructure, and more sustainable biophilic

urban settings. This encourages cities to become sustainable and climate resilient. Increased investment in environmentally friendly public transit can lower urban air pollution, promote material exercise, lessen traffic jams, and lower the cost into transportation for disadvantaged and susceptible populations. Designing for a sustainable urban environment goes conjointly with creating "Biophilic Cites" in future.

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