



Biophilic Design as a Tool for Livable Cities

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ABSTRACT

One of the essential planning concepts developed for a healthy continuation of the dynamic relationship between the city and its user is "livability". While livability consists of a combination of physical, social and economic components, sustainability is ensured by long-term livability and quality of life as a holistic output that emerges from the interaction of all these factors. Socio-economic threats to the city and physical changes have triggered research into improving an individual's quality of life and urban space quality. Some scientific studies consider livability within the residential environment, the urban area, or by using different indicators. However, there are not many studies associated with biophilic design. As a method, biophilic design offers the opportunity to develop an inclusive design for individuals to interact with nature. The infrastructure of the approach is based on an architectural solution with nature, the sensitive use of nature and the maintenance of natural systems.

Purpose: In this context, this study aims to associate livable city indicators with biophilic design criteria and to produce suggestions for more livable urban areas from the perspective of biophilic design.

Approach: As a method to develop proposals on livability and biophilic design, specific criteria – the areas determined to impact livability – and the use of biophilic design patterns developed by Terrapin Design LLC are discussed as catalysts in associating the aspects of livability with biophilic design.

Findings: As a result of that discussion, it is seen that biophilic design patterns can support livable environments at the residential, neighborhood, regional and urban scales.

Originality: From livability perspective it is discussed that the biophilic approach has the potential to deliver an architectural form that combines the natural and built environment to cities with aspects such as increasing the green infrastructure and surfaces, improving aesthetics in the city, maintaining biological diversity and using genuine natural systems to organize space. In addition to supporting individual multisensory experiences, biophilic design supports well-being, and healthy and safe living spaces with a sense of belonging that can increase social sharing and social interaction. Biophilic design allows the integration of the built environment and natural systems at different scales and offers the capacity to use nature as the dominant aspect for human beings, to make urban health and cities livable, sustainable and resilient.

Keywords: Livability, Livable City, Biophilic Design, Biophilic Architecture, Quality of Life

1. INTRODUCTION

Cities are important in terms of being the location and geography where individuals establish a relationship with the environment and where a multidimensional organism is associated with space. In addition to its physical importance, the city is also a symbol of the collective unity between different user groups (Mumford, 2000). All people who live in the town, or who are merely passing through, are at the center of spaces and processes at the national and global level, because they create the city. Therefore, cities have been one area that has been thought about, discussed and changed since ancient times. Planning strategies have been developed because they meet the multifaceted needs of individuals and communities living in the city that use and provide different opportunities. One of the most important planning concepts developed for maintaining the dynamic relationship between the city and its users is "livability". The concept of



livability, with aspects such as population, environmental and noise pollution, and inequality in the provision of services, has triggered research on improving an individual's quality of life and urban space (İnceoğlu and Aytuğ, 2009). The addition of intensive migration from different countries to the rapid migration to large cities has made the issue of livability an issue that needs to be evaluated from the perspective of other social groups.

As physical spaces, cities are exposed to multifaceted social and economic interventions. Also, the COVID-19 pandemic has been a dynamic that required a rethinking of spatial use and urban resilience. The concept of livability and its sustainability, the city's ability to adapt to different situations, and the possibility of meeting the need for socialization in urban areas have become issues that need to be solved in cities subject to other interventions. The efficiency and quality of urban open spaces have the potential to generate solutions and develop alternatives. The need for outdoor socialization, increasing awareness of opportunities for physical activity, improving the quality of life, and the presence, quantity and quality of green spaces have become very important in supporting mental health, especially with a change in understanding after the pandemic. As stated by Ahmadpoor and Shahab (2021), the importance of green spaces and their accessibility in terms of transportation, quantity and facilities has not diminished after the pandemic. The fact that nature has become an escape route in terms of relaxation, breathing, socializing and psychological well-being has brought urbanites living in big cities back to nature and reminded them of the vital place of the natural environment in human life. Also, the pandemic has shown that urbanites face different risks and that cities must maintain their resilience under all conditions. At this point, biophilic design, which uses nature as a design element and a tool, is a guide that can be used to make cities that are constantly changing under internal and external factors, more livable.

As discussed in the next section, scientific studies have addressed livability within the housing environment, within the urban area, or through different indicators. However, the studies in which it is associated with biophilic design criteria are limited. In this context, the present study aimed to associate livable city indicators with biophilic design criteria and to produce a series of recommendations from the perspective of biophilic design for more livable urban areas. Accordingly, livability criteria and the principles guiding biophilic design are presented using different classifications in light of published literature. Then a conceptual model was developed from the perspective of biophilic design to support livability criteria. Based on this conceptual expression, the discussion section addresses the prospects for biophilic design to support livability, highlights successful examples that can be adapted to different regions and urban areas, and develops recommendations for livable, resilient, and therefore, sustainable urban spaces. Biophilic design can solve persistent threats to urban dwellers and potentially deliver more livable cities that offer a better quality of life for social groups that share cities, such as migrants and minorities.

2. APPROACHES AND INDICATORS FOR A LIVABLE ENVIRONMENT/CITY

Livability is not only a quality of the environment but also a concept that reflects the current state of the physical space and its relationship with its users. Pacione (1990) defined livability as a human behavior-based quality arising from the interaction of environmental and personal characteristics, while Newman (1999) similarly associated the concept with the individual and defined it as a quality related to human needs, such as health, well-being and social activity encompassing individual and social well-being. Veenhoven (2000) associated livability with Amartya Sen's capability approach theory and defined it as the degree to which a region's conditions suit an individual's needs and capacities. From a well-being perspective – a concept related to well-being – livability refers to the spatial, social, and environmental characteristics and qualities that contribute to individual and collective well-being and the individual's sense of satisfaction from being a settled resident. In this context, livability is more concerned with the current timeframe than sustainability, which deals with the long-term timeframe.

It is seen that the qualities of the physical environmental necessary for livable environments and quality of life have been examined in depth in published literature (Ülengin et al., 2001; Marans, 2003, Van Kamp et al., 2003). Good quality of life and livability researchers evaluate the sustainability and the physical and social environment with a holistic approach in terms of both conceptual policies and methodology. Linking environmental, social and economic dimensions of sustainability with quality of life, Shafer et al. developed a model that expressed the dynamic relationship between livability, equity and environmental sustainability. Within that context, livability is a combination of physical and social components, equity is a combination of social and economic components, sustainability is a combination of environmental and economic components, and quality of life is a holistic output emerging from the interaction of all these factors. In the model (Figure 1), the physical environment creating a “livable place” represents the ideal state. In this ideal state, it is important that members of society can meet their basic needs and have equal economic opportunities in a fair and honest environment. The study emphasizes the necessity of a holistic approach to policies for a healthy, productive and “beautiful” life, and of the importance of ensuring a good balance between livability, quality of life and sustainability (Shafer et al., 2000). Under this framework, policies for livable cities and a high quality “good” can be transformed into decisions that turn into real advances in urban environments.

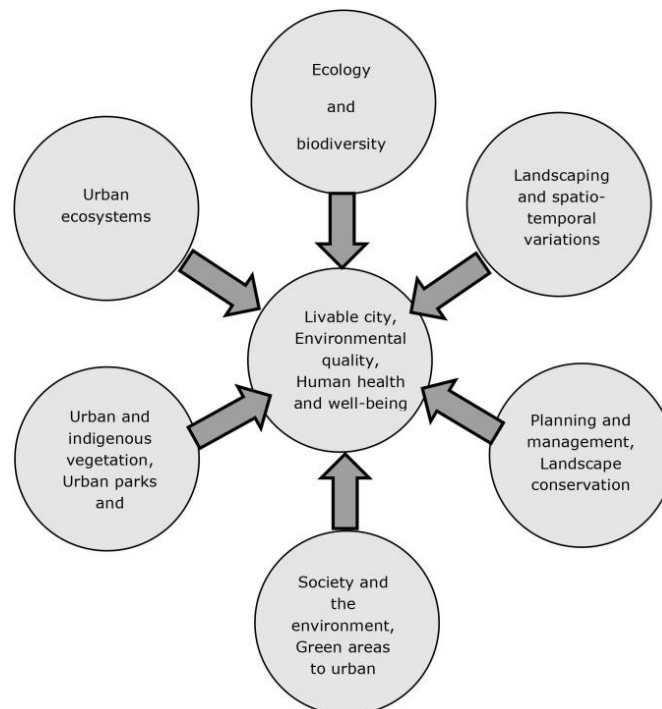


Figure 1. Quality of life, livability and sustainability from a human ecology perspective (adapted from Shafer et al., 2000).

As a result of globalization, quality of life is one of the essential elements to be examined in changing urban environments under the influence of economic and social evolution processes both countrywide and worldwide. It should be evaluated holistically with livability and sustainability. Van Kamp et al. (2003) underlined that there is no consensus on livability, environmental quality, quality of life and sustainability. It supports their transactional relationship theory (Van Kamp et al., 2003). In a similar vein, Shafer et al. (2000), linked environmental, social and economic dimensions of sustainability with quality of life and developed a model that expressed the dynamic relationship between livability, equity and environmental sustainability. In this context, livability is a combination of physical and social components, equity is a combination of social and economic components, sustainability is a combination of environmental and economic components, and a quality of life results from the interaction of all these elements. In the

model (Figure 1), the physical environment constituting a livable place defines an ideal environment. Community members must meet their basic needs and have equal economic opportunities in a fair and just environment. To support sustainable societies, it is stated that policies should be considered by a holistic approach, not just the economic, social or environmental elements and that individuals can lead a healthy, productive, and “beautiful life” by ensuring a balance between them (Shafer et al., 2000). Duque and Panagopoulos et al. (2016) investigated livable cities and environmental quality by focusing on ecology, natural resources, urban planning and ecosystems. In their model developed to emphasize the importance of meeting social, economic and environmental requirements for a livable city (Figure 2), it is seen that it is possible to plan “comfortable” cities with a high level of welfare and environmental quality through ecology, landscaping and urban development. Critical elements linked to environmental quality for livability in this framework comprises the following:

- Protection of the ecosystem and biodiversity,
- Planning urban ecosystem components in a balanced manner, producing strategies and urban textures for the protection of the ecosystem in projected land use during the planning of urban environments,
- The implementation of urban vegetation, urban parks and wooded areas in relation to residential areas in a way that will enable the socialization of individuals, and support the aesthetic aspect and competitiveness of urban areas,
- Designing temporal–spatial diversity that can offer rich experiences over different periods (different hours of the day, different days of the week and different seasons) in land arrangements and landscape design,
- Using the supportive power of nature and environmental design in terms of individual needs and social interaction by producing green spaces for society, the environment and urban users.

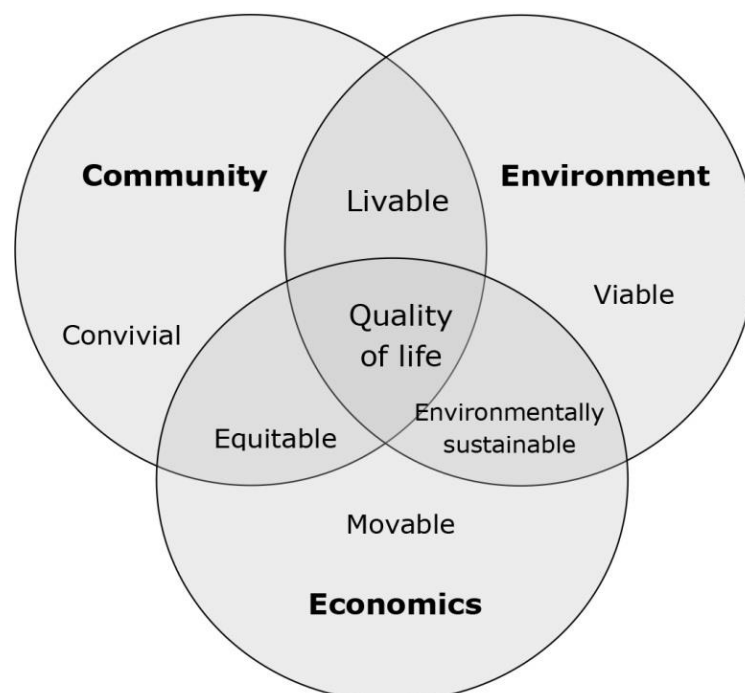


Figure 2. Environmental quality, health and well-being for a livable city (adapted from Panagopoulos et al., 2016).

The concept of livability has been formulated using specific criteria by various institutions conducting research across the world’s cities, and indices have been created in these processes to measure livability. Examining the elements proposed by these studies to define livability, it is seen that main topics like quality, quality of public services such as education and health, and accessibility are commonly used. Environmental health, quality



of life, urban life, and livability and sustainability feed and complement each other. Livability and quality of life reveal the current situation, while sustainability aims to maintain this state in the future. The National Environmental Health Association (NEHA), which advocates the importance of specialization in this field to provide a healthy environment for everyone, has identified different elements of environmental health (www.neha.org). Here, the areas that need to be managed and improved in considering the human factor can be summarized as controlling issues that threaten health, developing and implementing guideline policies, providing health communication and educational materials, developing recommendations for construction and land use, and conducting research on the relationship between health and the environment.

Examining institutional indicators in the measurement of livability, the internationally recognized "Global Livability Index", developed by The Economist Intelligence Unit (The EIU), emphasizes the importance of differences between individuals. The scale's initial point is based on evaluating the elements of the lifestyle of individuals in different locations, measuring problems and comparing different locations. In the scale determined by the organization, livability is addressed through 30 indicators under five main groups: stability, health services, culture and environment, education and infrastructure. With the COVID-19 pandemic, the scope of these indicators has been expanded to include vaccines, health services and country scores (EIU, 2022). The AARP Foundation (<https://www.aarp.org/>), which has been making comparisons between different cities, provinces and states in the United States for more than 60 years and focuses on increasing the opportunities of more disadvantaged groups such as low-income groups and the elderly, has developed a livability index consisting of seven main categories. This organization aims to improve the quality of life for people of different ages and social groups, and it measures livability using the following categories: housing, neighborhood, transportation, environment, health, social integration-participation and amenities. In this context, livability is a human behavior-based quality resulting from the interaction of environmental and personal characteristics (Pacione, 1990). In the definition given by Keleş (2010), livability is a multidimensional qualitative and quality indicator. This definition defines livability as a concept that refers to spatial, social and environmental characteristics and the quality that will contribute to individual and collective welfare and to the individual's sense of satisfaction from being a resident of a settlement. As seen in published literature, important indicators for livability focus on environmental qualities, including the following:

- Housing and the neighborhood in which it is located,
- Transportation and infrastructure,
- Health,
- Environmental opportunities,
- Social integration and participation.

Consequently, those environments ensure:

- The balanced design of urban ecosystem components,
- The support of social life and the aesthetic aspect of cities by linking urban green areas with residential areas,
- The time-spatial diversity in this process,
- The enrichment of both individual and community experiences,
- Livability, which is essential where individuals are happy with the socio-physical environment in which they live.

The following sections of the text discuss the biophilic design approach as an approach that improves human health in relation to the socio-physical environment, residential environment and urban environment scales, and it evaluates the positive effects of the approach on livability.



3. BIOPHILIC DESIGN APPROACH

For urban populations, connecting with nature is crucial for maintaining well-being. Human interaction with nature positively affects physical and mental health (Andreucci et al., 2019). The positive effects of green spaces on physical health, such as increasing physical activity, reducing obesity, and discouraging smoking and alcohol use, diversely affect mental health in terms of reducing cognitive decline and dementia. The mental health of people who engage in physical activity in a natural environment at least once a week is half as good again as those who do not. It has also been found that the risk of mental disorders decreases as the frequency of outdoor use increases in a week (Mitchell, 2013). Even visiting natural environments once a week is a component of life that makes people happy and increases well-being in other areas of life (White et al., 2017). Designing green spaces of different scales and uses in urban areas positively supports the health of urban dwellers.

As a result, a biophilic design approach is a design approach that brings positive experiences in terms of human performance, and physical and mental health. The infrastructure of biophilic design is the coexistence of the architectural solution with nature rather than against it, the sensitive use of nature and the maintenance of natural systems. Biophilic architecture has a wide scope, ranging from green roof-scale spaces to the interaction of urban space with large green areas. Through biophilic design, the negative effects of climate change, which are unavoidable today, can be reduced, and natural resources can be managed effectively to adapt to these conditions. Through biophilic architecture, nature and physical environments can be harmoniously integrated. Biophilic architecture is different because the design process is interpreted together with nature. For example, in the traditional architectural process, while dressing the building with plants makes it a green building, biophilic design is more advanced in terms of interpreting and designing with different subjective and objective situations in mind. As a result, a biophilic design supports the physical comfort and health of the user (Almusaed, 2011).

As a method, a biophilic design offers the opportunity to develop an inclusive design for individuals to interact with nature. Biophilia, defined as "humanity's innate biological connection with nature", is the origin of biophilic design (Browning et al. 2014; Ryan et al. 2014). Biophilic design is a conscious attempt to design a human relationship with natural systems and processes in the built environment (Kellert et al., 2008). Biophilic design, as a method that reduces stress and increases perceptual functions and the creativity of individuals, is supportive in terms of performance enhancement, patient recovery, community integrity, health and general well-being (Browning et al., 2014). In modern cities with a socially, economically and physically chaotic atmosphere, the natural environment is necessary rather than a luxury for people's well-being (Kellert et al., 2008). Biophilic design is based on the design interaction between nature and health that examines what is appropriate and sensitive for the individual in the context of health and well-being indicators.

Considering the interaction of natural and physical environments through biophilic architecture, the possibilities defined by Almusaed (2011) for space design can be raised. These are considered to be possibilities that establish the relationship between habitat and the natural environment. The spatial possibilities that can be established with natural environmental data such as water, daylight and airflow are defined by the author as spatial pressure, end-to-end contact, face-to-face contact and interconnecting surfaces, and also the possibilities that can be developed to establish the relationship of habitats with green space are variously defined as pointed, linear, radial, clustered, grid and comprehensive forms (Almusaed, 2011). These different alternatives for integrating green spaces and habitat support the development of creative solutions while combining the needs and desires of the space used with the qualities of the natural environment. In biophilic architecture, in addition to the interaction with outdoor nature, another alternative is the effect of indoor plants on improving air quality for human use



(Heerwagen, 2000). Biophilic architecture is a sustainable understanding that respects people and the environment while meeting the demands and obligations of nature, life and architectural potential. From this point of view, biophilic design is a natural and creative architectural solution from the perspective of developing a livable environment (Almusaed, 2011).

The biophilic design framework defined by Terrapin Bright Green LLC provides a comprehensive roadmap for biophilic design to improve the experiences of individuals and the quality of life of people and communities from the perspective of nature, the individual and health. The framework operates through two main areas in biophilic design, namely the nature–health relationship and the nature–design relationship in the built environment, and it offers a multidimensional opening in the context of three relationships. The nature–health relationship deals with individuals’ cognitive, physical and psychological interactions with their environment and concerns how, and how much, the environment affects people. Hypotheses explain the nature–design relationship development based on “the theory that contemporary landscape design is the result of human evolution” (Ryan et al., 2014). The framework within the patterns and groups defined in the approach, which categorizes the nature–design relationship as a) nature in the space, b) natural analogy and c) the nature of the space, shown in the following sections.

a) Nature in the space: In addition to visible physical entities such as plant life, water and animals, it also includes wind, sound, odor and other natural elements that can be perceived through feeling or hearing. Designs for the strongest experience of nature in the space support multidirectional sensory interaction through these natural elements. Biophilic design elements within the scope of the natural pattern in the space can be briefly defined by:

- A Visual Connection with Nature: Monitoring nature, natural elements and natural processes,
- A Non-Visual Connection with Nature: A perceptual process via auditory, tactile and olfactory senses,
- A Non-Rhythmic Sensory Stimuli: Variable, short-term, random interactions with nature,
- Thermal and Airflow Variability: Weather-related perceived temperature, humidity level and airflow,
- The Presence of Water: Visual, auditory and tactile interaction provided by water element that affects the experience,
- Dynamic and Diffuse Light: Variable light conditions, intensity and shadows,
- A Connection with Natural Systems: Awareness of natural processes that vary at different times of the day or seasons, as characteristics of a healthy ecosystem.

b) Natural Analogues: The natural analogy approach, which deals with animate, inanimate or indirect associations with nature, can exist in the built environment in the form of artwork, ornaments, furniture or textile surfaces in relation to objects, materials, colors and forms. Strong natural analog experiences can be designed by interpreting some organic textures in nature in the space. In this context, biophilic design can be briefly defined as follows:

- Biomorphic Forms and Patterns: Designing symbolic references to some elements in nature in terms of texture, form, number sequence, etc.,
- Material Connection with Nature: Using materials and elements from nature in their natural state to reflect the local ecology and geology while at the same time creating a distinct sense of place,
- Complexity and Order: Constructing a sensory richness related to the spatial hierarchy that exists in nature.

c) Nature of the Space: In interpreting spatial patterns in nature, it can be described as designing safe, surprising and interesting spatial constructions by adding the psychological effect of people’s attraction to the unknown and the



hidden. Four design elements that relate to the nature of space can be defined as follows:

- Prospect: Designing certain distances with barrier-free perspectives in terms of observation and planning,
- Refuge: Creating a refuge area that protects the individual from environmental conditions or areas of intense activity,
- Mystery: Designing spaces that arouse curiosity while giving an idea about the experience through partial perspectives, and the different sensory ways that trigger the circulation of individuals in the environment.
- Risk/Peril: A number of threats in a secure area.

These items related to biophilic design can shape the design by multidimensionally reflecting different aspects of an individual's interactions with nature. The framework that Terrapin Bright Green LLC developed for the relationship between nature and health encompasses three basic mental and physical systems: cognitive, psychological and physical. From a cognitive perspective, it is stated that strong connections with nature support mental development and that the relationship with nature makes it more efficient and productive in terms of thinking, learning and generating ideas. The psychological state, which has an effect on an individual's emotions, mood, concentration, adaptability, etc., is positively affected by interaction with nature, as people can relate to their experiences. Nature improves people's psychological health regarding emotional renewal, feeling better and coping with stress. Regarding physiological health, nature and green spaces positively affect an individual's musculoskeletal, respiratory, circadian, blood pressure and heart health systems (Browning et al., 2014). In relation to these factors, the impact of nature on an individual's well-being can contribute to a livable environment.

Biophilic design focuses on supporting psychological health through the form, material, spatial design and qualitative use of daylight to associate the user with nature. Accordingly, it is important to incorporate the biophilic approach into the design at the preliminary stages of the design process (Kellert et al., 2008). Biophilic design elements and the qualities that stand out in this context are grouped as environmental characteristics, natural forms, natural patterns and processes, light and space, place-based relationships, and evolving human-nature relationships, as seen in Table I. The environmental characteristics under these headings overlap with the biophilic patterns identified by Terrapin Design LLC. Natural analogies overlap with Kellert's natural forms, patterns and processes. They are related to a number of visual, auditory and thermal interactions, light-space and environmental factors in the space. To further customize and strengthen the design, components within the context of place-dependent and evolving human-nature relationships can be included in the nature in space framework defined by Terrapin Bright LLC. While the approach that associates biophilic design with 14 items summarizes the biophilic system from its perspective, the framework produced by Kellert et al. (2008) provides an even more detailed design guide. A different perspective that develops these approaches is "conscious silence", which focuses on the positive effects of nature through silence. This approach deals with the healing effects of nature on individuals, and research has shown that children's attention capacity increases (Berto and Barbiero, 2015).



Table I. Biophilic Design Elements and their Corresponding Attributes (Kellert et al., 2008)

Biophilic Design Elements and their Corresponding Attributes		
Environmental features	Natural shapes and forms	Natural patterns and processes
Color Water Air Sunlight Plants Animals Natural materials Views and vistas Façade greening Geology and landscape Habitats and ecosystems	Botanical motifs Tree and columnar supports Animal (mainly vertebrate) motifs Shells and spirals Egg, oval, and tubular forms Arches, vaults, domes Shapes resisting straight lines and right angles Simulation of natural features Biography Geomorphology Biomimicry	Sensory variability Information richness Age, change, and the patina of time Growth and efflorescence Central focal point Patterned wholes Bounded spaces Transitional spaces Linked series and chains Integration of parts to the wholes Complementary contrasts Dynamic balance and tension Fractals Hierarchically organized ratios and scales
Light and space	Place-based relationships	Evolved human–nature relationships
Natural light Filtered and diffused light Light and shadow Reflected light Light pools Warm light Light as shape and form Spaciousness Spatial variability Space as shape and form Spatial harmony Inside–outside spaces	Geographic connection to place Historical connection to the place Ecological connection to place Cultural connection to place Indigenous materials Landscape orientation Landscape features that define building form Landscape ecology Integration of culture and ecology Spirit of place Avoiding placelessness	Prospect and refuge Order and complexity Curiosity and enticement Change and metamorphosis Security and protection Mastery and control Affection and attachment Attraction and beauty Exploration and discovery Information and cognition Fear and awe Reverence and spirituality

On the architectural and urban level, the scales that can guide biophilic design in the housing and residential environment where daily life occurs can be classified as building, site, street, neighborhood and region. Examples of these different design scales are as follows: at the building scale, elements related to space design, such as green roofs and green walls, come to the fore; at the site scale, residential spaces, such as those around green areas and green roads; at the street scale, planted narrow streets and edible landscaping; at the neighborhood scale, community gardens, parks and urban streams, and within the scope of the region, elements such as community forests, green corridors and tree canopies constitute the components of biophilic cities (Beatley and Newman, 2013). It should be emphasized that biophilic cities are not just “green cities” but also involve the direct participation of citizens in the creation of the process. For those living in biophilic cities, learning about and caring for the nature around them is a responsibility. They are individuals who have essential emotional ties with nature and enjoy it. As a result, the characteristics that the lifestyles of the people living in biophilic cities should have, and the items related to the management system in these cities, should support the resilience of cities (Beatley and Newman, 2013). However, due to limited land and high-rise buildings in urban environments, it is not a realistic to create the characteristics of a rural setting. Design strategies should be developed in the context of climate, geography, terrain and ownership.

In the planning phase of biophilic design, which has a flexible and iterative character, it is important to determine the degree of intervention in the space and the value of the element in the design. Biophilia is an integral part of environmental quality as a more wide-ranging component than parameters related to environmental quality, such as air quality, thermal comfort and daylight. Biophilia impacts peoples’ health and well-being and, in this context, can support the integration between human needs and the built environment. The richness of content, user accessibility and diversity of strategies are



key factors in a suitable intervention. Since biophilic design patterns can be at the scale of a micro-area, a room, a building, a neighborhood, or even an entire region or city, these different scales present different design challenges depending on programming, user types and dynamics, climate, culture, various physical parameters of the infrastructure needed. Design models should be scaled according to the user density envisioned for the environment and the site. Frequency of use, the usage pattern, participation rate, and purpose of visit vary greatly across ages, gender and cultures. In this manner, research results show that relationships with nature and physical activities in nature vary according to age and gender regarding the immune system or well-being (Li et al., 2010; Barton and Pretty, 2010). The positive effects of nature on peoples' health and well-being – in other words, quality of life – concerning biophilic design are discussed in the following paragraphs.

4. THE POSITIVE EFFECTS OF INTERACTION WITH NATURE AND GREEN SPACES ON HEALTH AND WELL-BEING

The positive effects of green spaces on individuals' well-being and physical and psychological health have been proven through research on different variables, as we have personally experienced. In addition to demographic factors, many factors such as the distance to green spaces, the quantity of green spaces, the opportunities to use these spaces, the reasons for their use, an individual's motivation and ease of use, the mode of transportation, the physical capacity to use them, the different usage patterns, the characteristics of the environment, the weather conditions and the local traffic can all change the relationship between green space access and physical and psychological health status. The size of green spaces and their attractiveness to different individuals, safety and aesthetic qualities all change the effects of green spaces on health in the context of green space qualities (Giles-Corti and Donovan, 2002). Studies conducted in different types and locations show that the way green spaces are used in different situations and cultures varies (Lachowycz and Jones, 2013). In a study conducted in urban areas in England, the quality and proximity of green spaces in the neighborhood, the frequency of visits by individuals, and their impact on well-being were examined. The results obtained showed that people who visited more frequently were happier. The results also suggested that there was no need to go to remote, rural areas to establish a relationship with nature (White et al., 2017). In another study by the same authors, it was observed that approximately 70% of people frequently preferred urban parks in the vicinity of their residences (White et al., 2013). Visiting natural environments – even once a week – is a part of life that makes people happy and increases well-being in relation to other areas of life. Interaction with nature is extremely important for urban populations in maintaining their well-being (White et al., 2017).

The positive effects of human interaction with nature on psychological and physical health have been proven (Andreucci et al., 2019). The positive effects of green spaces on physical health, such as increasing physical activity, reducing obesity and discouraging smoking and alcohol use, are also seen to improve mental health by reducing cognitive decline and dementia. It is possible to design green spaces on different scales and uses in urban areas that positively support mental health. The mental health of people who engage in physical activity in nature at least once a week is half as good again as those who do not. Also, it has been found that the risk of mental disorders decreases as the frequency of outdoor use pursuits increases in a week (Mitchell, 2013).

Urban green spaces have multifaceted health benefits: physical, psychological, social and even nutritional. For example, community gardens are landscapes that contribute positively to health in terms of physical activity, access to organic vegetables and fruits, as well as establishing and supporting social networks, providing a sense of belonging to the local community, and a sense of purpose and achievement (Sanchez and Liamputtong, 2017). The positive effects on the mental health of visiting green spaces around the residence, or even having a view of green spaces from the window, can be seen in a study conducted in Tokyo. In that study, it was observed that visiting green



spaces around the residence and having a view of green spaces had an impact on self-esteem, life satisfaction and subjective happiness, and that people who visited these areas at certain intervals and saw green spaces from their homes experienced fewer problems of loneliness, anxiety and depression.

The fact that cities have an approach to planning and design that includes green spaces and mixed-use is a highly supportive factor for resilient cities (Ugolini et al., 2020). Since the sense of psychological well-being tends to decrease in modern living environments, integrating nature or natural forms into the built environment and architectural design positively affects users (Berto et al., 2014). Most users value urban parks as spaces that allow for experiences ranging from concrete needs to abstract connections and different interactions with nature. Urbanites, especially more highly educated individuals, find it necessary for local actors to increase the scope and accessibility of green spaces (Ugolini et al., 2020). In the aftermath of the pandemic, producing green spaces that respond to different needs, interactions and behaviors have become even more critical in urban policy and planning (Honey-Roses et al., 2020). The inclusion of existing green areas of varying scales in urban design, including different types of landscaping arrangements, streets supported by well-maintained trees, pocket parks, gardens, walking and bicycle paths, and green corridors on important axes, can be considered as some suggestions that will positively affect the planning of cities.

In the planning of cities, studies proving the positive impact of green spaces on well-being show the importance of green spaces that individuals can easily access and visit frequently. Human beings need to be in contact with nature for a healthy, happy and productive life. Nature is an essential component of a high quality of life (Beatley, 2016). Green spaces interact with individuals' health and well-being in terms of their proximity to living spaces, their quality and their quantity. Results in published literature show the positive effects of green spaces on peoples' physical and mental health. The presence of green space increases physical activity and has a positive impact on health, psychology and well-being (Barton and Rogerson, 2017). Consequently, ensuring integration with green space at different spatial and environmental scales is indispensable for a high quality of life and for quality space. Incorporating green streets or sidewalks with small gardens that can be planted and cultivated into local design strategies in neighborhoods that are more deprived of green space, providing those green spaces that allow for a variety of bicycle and pedestrian activities, and designing areas for bicycle parking, can create green spaces integrated within built environments that appeal to all users, and are long-term recommendations for healthy individuals, and healthy and livable cities.

5. DISCUSSIONS ON THE BIOPHILIC DESIGN APPROACH TO SUPPORT LIVABILITY

In most of today's cities, buildings dominate the built environment, and urban areas are dense settlements. The fact that there are far more roadways than pedestrian pathways in urban areas makes it difficult for urban environments to integrate with nature. Most residential neighborhoods lack green spaces with a variety of plants and trees to allow users to interact with nature. However, in addition to their environmental benefits, green spaces improve physical and mental health, and support fair and healthy living. Integrating biophilic design into green space planning for healthy living has the potential to be a tool for making a cost-effective contribution to public health (Barton and Rogerson, 2017). Biophilic design is a catalyst for improving quality of life by positively affecting user behavior, perception, built environment planning, and physical and psychological health in the living space.

This present study defines livability criteria and impact areas as a method for developing recommendations on livability and biophilic design. Biophilic design patterns developed by Terrapin Design LLC are used as a tool and catalyst for associating these dimensions with biophilic design. In this context, as seen in Figure 3, and in light of published literature, livability criteria comprise:

- Balanced planning of urban ecosystem components,
- Implementation of urban green areas, urban parks and wooded areas in relation to residential areas in a way that will enable the socialization of individuals, support the aesthetic aspect and competitiveness of urban areas,
- Designing temporal-spatial diversity that can offer rich experiences over different periods (different hours of the day, different days of the week, and different seasons) in land arrangements and landscape design,
- The enrichment of both individual and community experiences through the production of green spaces for the community, the environment and the urban user is determined by whether the individual is happy with the socio-physical climate in which they live.

The main livability parameters directly affected by these criteria are grouped under the main headings of housing and neighborhood, transportation and infrastructure, health, environmental opportunities, social integration, and participation. Under this framework, biophilic model relationships were established with the criteria and impact areas determined in the transformation of the space, nature in the space, and natural analog patterns of biophilic design into recommendations by associating them with livability and discussing livability (Figure 3).

The potential of “nature in space” can be considered one of the main suggestions for integrating biophilic design into the urban fabric (Figure 3). The physical and mental health benefits of access to nature are detailed in the previous sections. The users’ preference for green areas and urban parks around the housing areas show the necessity of design proposals such as landscape areas and green-supported roads in residential areas. These environmental qualities enable the user to communicate with nature through visual and other sensory means. In the context of biophilic design parameters, these areas will also support the interaction with nature at different times of the day and at different times of the year along with the experience of daylight and weather. Through biophilic design patterns, it is possible to strengthen visual and non-visual relationships with nature, to establish a relationship with the natural ecosystem, to engage different senses such as daylight, thermal effects, and odor. In other words, it increases interaction with nature via a multisensory approach. Residential environments with plenty of trees will support people’s access to nature within walking distance.

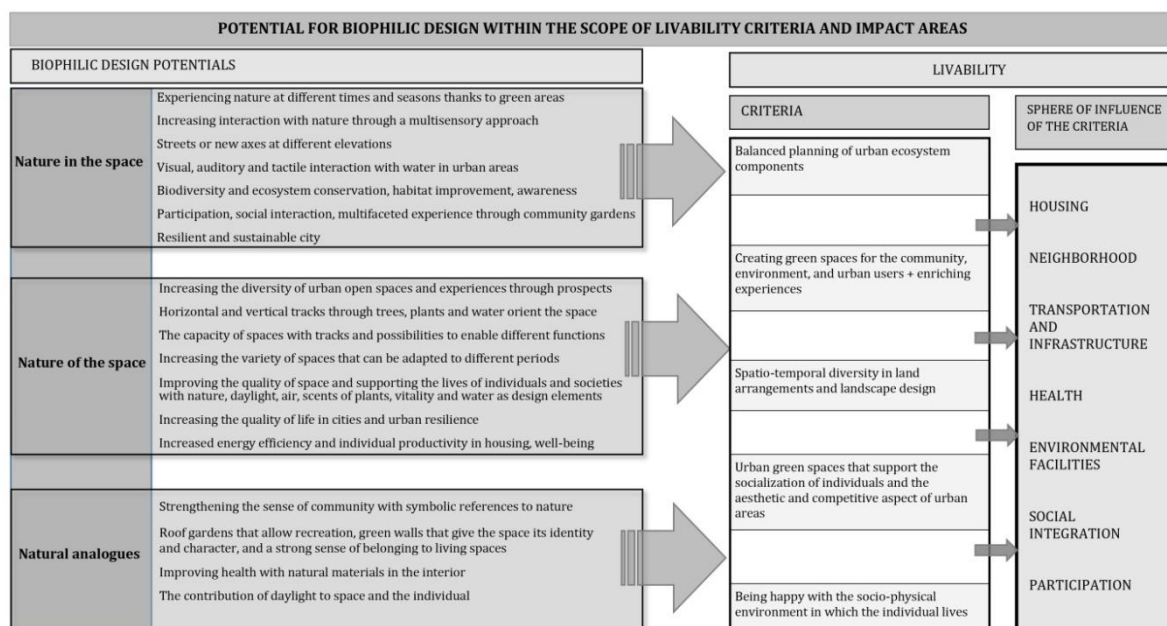


Figure 3. A conceptual model for the potential of biophilic design to support livability criteria



In areas that support livability, these experiences at the scale of the immediate surroundings of the housing and the neighborhood can be provided through streets supported by landscape designs in accordance with the character of the city or by new axes and usage surfaces that can be built with landscaped areas provided at different levels. In this situation, it is important that green spaces can be integrated with the streets and traffic, and articulated into the space.

As a design element that increases quality, using a water element, which evokes distinct spatial and psychological effects in biophilic design, is a factor that will support peoples' experience with nature in both urban areas and urban parks, and strengthen ecology and biodiversity. Interaction with water will contribute to the design defining and orientating space, as well as creating diversity in urban parks for people who want to spend time outdoors with their children. Where appropriate, visual, auditory and tactile interaction with natural or artificial water trails/zones at different elevations can be designed into the urban areas. Including some aquatic creatures in the design will strengthen the protection of biodiversity and ecosystems, and raise awareness of this issue.

Supporting the natural habitat in urban parks should be included in the design as a quality that differentiates these areas from the streets around the housing. According to the patterns of biophilic design, supporting biodiversity as an extension of a healthy ecosystem should be ensured through natural habitats designed in urban parks. Community gardens, as another proposal that can be designed in urban or rural areas, are a type of green landscape that can contribute to cities with versatile and enjoyable experiences in terms of supporting participation and social interaction while keeping the cultivation experience alive. These qualities have the capacity to make cities more resilient and sustainable in terms of climatic crises.

In the context of another pattern, the nature of the space, biophilic design has a diversity that can extend from the urban scale to the spatial scale. While urban parks meet concrete needs in terms of physical activity and sheltered time for families with children, they can also turn into a personal sanctuary and intangible experiences through different interactions with nature on an individual scale (Ugolini et al., 2020). Given this context, the possibilities of biophilic design to define different perspectives and approaches to a sheltered space that creates an escape for individuals include the capacity to increase the dynamism, diversity, experience and use of urban open spaces. In biophilic design, different types of trees, plants and water features can be used to create tracks both horizontally and vertically to orient and define the space. These tracks and spaces possibilities have the capacity to enable activities such as open-air concerts, shows and celebrations, as well as daily activities in open and public spaces. This can be considered a supportive factor in terms of enriching spatial diversity that can be adapted to different time periods. To improve the quality of spaces and support the lives of individuals and communities, it is necessary to use the potential of biophilic design to use nature, daylight, air, the scent of plants, vitality and water as design elements. This is an aspect that will increase the quality of life and, therefore resilience in cities.

As mentioned in Figure 3, successful urban examples of incorporating biophilic design into livable urban and residential spaces are inspiring, and the parameters that guide these designs can be adapted to the dynamics of different countries. Portland, Oregon, is one of the successful biophilic cities where green fabric is integrated into the city (<https://www.biophiliccities.org/portland-oregon>). With more than 200 green streets, 4000 hectares of urban parks and large natural areas such as the Forest Park and Oaks Bottom Wildlife Refuge, the region is one of the greenest cities in the world. A Biophilic Cities Member since 2013, Portland has one of the highest per capita land areas of parks in the country (Figure 4).

San Francisco is also a good example of integrating biophilic design into the urban environment in different ways. Through the Street Parks program, median strips and



other areas along the road have been transformed into small community parks and gathering spaces, incorporating parks into city life (Figure 5). In this participatory approach, residents are responsible for the planning and maintenance of the parks (<https://www.biophiliccities.org/street-parks>).

Spain went through a different process in the 1980s when, faced with overpopulation and urban sprawl, the mayor at that time established the Center for Environmental Studies. At this stage, it was realized that one region of the country had one of the highest biodiversity indices, and nature conservation became important. Since then, Vitoria-Gasteiz, with a population of around 242,000, has become one of the few European cities with a compact urban approach, with one of the highest per capita green space ratios of around 25 square meters in 2012. In 2012, the city was chosen as the "Green Capital" of Europe (<http://www.bcnecologia.net/en>).

As seen in these different examples, what is important is to transform biophilic patterns into unique design decisions in spatially appropriate areas in line with the climatic, environmental and social dynamics of the city and social structure. On an urban scale, the community gardens established in Edmonton, Canada, the tree planting and maintenance activity implemented in Austin, the restoration of local habitats, and the slow street practices called "Healthy Streets" that facilitate outdoor exercise and active transportation on neighborhood streets, are positive initiatives to build biophilic design into the city (<https://www.biophiliccities.org/covid19-research>).



Figure 4. Green fabric integrated into the city of Portland (<https://www.themanual.com/travel/portland-or-travel-guide/>)



Figure 5. Parks integrated into urban life in San Francisco (<https://sanfranciscoparksalliance.org/lombard-street/>)



Other design decisions that will support experiences in the context of both nature in the space and nature of the space from biophilic design patterns include diverse options like roof gardens, vertical green walls, natural or artificial landscape elements that can be provided at different elevations in residential environments and landscape details that can be included in the interior space. In fact, nature implicitly exists in the city in the form of biodiversity in the soil, micro-organic life and the water ecosystem. From an architectural aspect, this can be adapted to the built environment with design tools such as ecological roofs, facades designed with a vertical green garden approach, and eco-bridges. Design decisions such as green interior walls, natural ventilation and daylight have the capacity to bring nature indoors (Beatley, 2016).

People who can or have to work from a home office – a common occurrence today – replicate an office life in a residential environment, and long hours spent in front of a computer create symptoms such as psychological negativity and physical pain in terms of health. Terraces and balconies where natural landscapes can be integrated into workspaces in residential areas will increase the concentration of both adults and individuals and support their well-being (Browning et al., 2014, Kellert et al., 2008). Taking the elevation where the space is located into account, its relationship with other housing units, the urban context in which it is located, and the existing spatial size, landscape elements to be preferred on the ground and/or vertically in accordance with the climate suitable for the user's life will support the well-being and productivity of individuals in working and living environments and improve space satisfaction.

In this manner, the natural analogs approach, which is one of the biophilic design patterns, can be included in the interpretation of the space. Symbolic references to nature that can be constructed at the scale of the interior or at larger scales, such as urban parks, can function to strengthen the sense of community among users in urban parks. At the spatial scale, elements such as roof gardens and green walls as spaces that the user can re-create over and over again have the potential to become living spaces that give the space its identity and character, and which create a strong sense of belonging in the user. The natural analogy approach of biophilic design will positively affect the health of individuals through the use of natural materials in the interior. The effect of daylight in space is similarly a biophilic design parameter that positively affects the quality of space, well-being, and human experience. Including individuals interacting with nature at different scales by providing multisensory experiences through biophilic design will support livability criteria and quality of life in terms of both space and human health.

As far as integration of biophilic patterns in housing, Agar Grove and Living Grid Houses can be mentioned as positive examples at different scales related to housing and the residential environment. A successful example at the housing estate scale is Agar Grove, a high-quality yet affordable housing development in London. Agar Grove in London, with its landscape designs that encourage biodiversity and that are suitable for different times of the year, and with habitat types in the roof gardens, is a sustainable and multifaceted residential area that supports quality of life at different scales and elevations with biophilic design in unique forms. Using these different aspects has won multiple awards (<https://grant-associates.uk.com/projects/agar-grove>). Thanks to its original design approach, the Living Grid House in Singapore combines housing and nature together in a grid that integrates daylight, privacy and nature (Figure 6). This system, which is a functional grid, provides irrigation for the plants, creating a quality and functional design example (<https://www.dwell.com/article/biophilic-home-design-f58257d5>). These examples show that human needs, which diversify over time, can be met with nature even in dense urban areas.



Figure 6. Living Grid House, Singapore (<https://www.dwell.com/article/biophilic-home-design-f58257d5>)

6. CONCLUSIONS

Biophilic design has positive effects on people's physical and mental health in terms of green areas with different dimensions at city, neighborhood and housing scales, and the interaction between nature and the individual. It is a strong design policy to support a livable environment, quality of life, and urban competitiveness and resilience. Transferring what nature and natural systems offer for humans to living spaces makes biophilic design a guideline in this context. Biophilic design has the capacity to direct the design by affecting the interaction of individuals with nature in different dimensions in different design patterns, such as plants, water, daylight, air and temperature. The present study discussed biophilic design from the perspective of the framework defined by Terrapin Bright Green LLC in terms of the contribution of the possibilities offered by "nature in the space", "nature of the space" and the "natural analogs" approaches to livable environments and their potential was investigated. Biophilic design is a design method that:

- Increases the interaction with nature through a multisensory approach, enabling the perception and comprehension of space with nature at different times and seasons,
- Facilitates the feeling of climatic and meteorological changes, sun, rain or cold and breathing quality air,
- Supports the inputs used in the design, such as water, vegetative landscape, visual perception and the individual's satisfaction with the well-being of environmental spaces,
- Recognizes the importance of natural lighting, ventilation and shading in design,
- Considers the characteristics of the ecosystem in terms of where the design is located, at different times of the day/year, together with its changing natural processes in the spatial design,
- Protects biodiversity and ecosystems and raises awareness of this issue,
- Facilitates an increase in the diversity of urban open spaces, user experiences and potential use,
- Supports the potential to promote participation, social interaction, symbolic references and a sense of community,
- Increases the variety of spaces that can be adapted to different time periods of the livable environment,
- Overlaps with the characteristics that livable environments should have with their multidimensional benefits, such as supporting human and building health, energy efficiency and individual productivity, well-being and user satisfaction.

The fact that social life along with economic and social imbalances can reduce urban resilience requires an interaction with the environment to be built from more sensitive design perspectives. Humankind's experience of nature and their perception of space in



nature in their abstract and individual world make it necessary and powerful to design spaces that support discovery and enjoyment in their life with nature. A design approach in which threats are eliminated in spatial constructions will support well-being and healthy and safe living spaces where there is a sense of belonging while simultaneously nurturing the livability, sustainability and resilience of cities.

The biophilic approach will bring an architectural form that combines the natural and built environment to cities with aspects such as the inclusion of green areas in all parts of the design, increasing air quality as well as visual quality in the city, maintaining biodiversity, increasing green infrastructure and surfaces, and incorporating unique natural systems in indoor and outdoor situations. Although the way of life changes, the human need for nature by nature's dominant party will not change, and the use of nature as a design element provides opportunities that can increase social sharing and social interaction as well as individual experiences. In these aspects, biophilic design for livable environmental scales and cities is a tool that allows users to participate in life at different spatial scales and has the capacity to enrich multisensory and multifaceted experiences both individually and socially.

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