

BIOPHILIC DESIGN IN URBAN ENVIRONMENTS

M. Vijay¹, W. Dixith², M. Shraavan Raj³, Nakka Preetham Goud⁴

¹ UG Student, Department of Civil Engineering, Institute of Aeronautical Engineering

² UG Student, Department of Civil Engineering, Institute of Technology and Management

³ UG Student, Department of Civil Engineering, Sri Indu College Of Engineering & Technology

⁴ UG Students, Department of Civil Engineering, St. Martin's Engineering College, Dhulapally, Kompally

***Corresponding Author E-Mail: npreethamgoud24@gmail.com**

Abstract— Biophilic design in urban environments integrates nature into cities, enhancing well-being, promoting sustainability, and creating healthier spaces. It emphasizes green spaces, water, sunlight, and natural elements in urban planning, reducing stress, boosting creativity, and fostering community connection for harmonious urban living.

Keywords— urban environments, using green spaces, natural elements, and sunlight to promote well-being, sustainability, stress reduction, creativity, and community connection for healthier, harmonious urban living.

I. INTRODUCTION

Biophilic design is an innovative approach that integrates natural elements into urban environments to create healthier, more sustainable, and livable cities. Rooted in the concept of biophilia—humans' innate connection to nature—it addresses urban challenges such as pollution, mental stress, biodiversity loss, and urban heat islands. By incorporating greenery, natural light, water features, and eco-friendly designs, biophilic design fosters well-being, enhances mental and physical health, and promotes environmental resilience. It transforms concrete jungles into vibrant ecosystems, enriching urban life with improved air quality, biodiversity, and aesthetic value while supporting sustainable urban growth and reconnecting people with nature in everyday life.

Urbanization has rapidly transformed cities into dense hubs of concrete, steel, and technology, often alienating people from nature. This disconnection contributes to rising stress levels, mental health challenges, and declining physical well-being. Biophilic design addresses these challenges by seamlessly integrating natural elements into the urban fabric, creating environments that foster a deeper connection with the natural world.

Biophilic design goes beyond aesthetics; it focuses on functional and psychological benefits. By incorporating green spaces, vertical gardens, water features, natural light, and organic forms, urban spaces become more inviting, restorative, and environmentally sustainable. This approach not only improves air quality, reduces urban heat, and

enhances biodiversity but also promotes stress reduction, creativity, and community well-being.

As cities grow larger, the need for sustainable, nature-integrated urban planning becomes critical. Biophilic design bridges the gap between urbanization and ecology, enabling cities to address modern challenges like climate change, resource scarcity, and public health concerns. Ultimately, biophilic design redefines urban living by harmonizing nature and development, creating thriving spaces that benefit both humans and the environment.

II. ORIGINS AND PRINCIPLES OF BIOPHILIC DESIGN

Origins:

1. **Biophilia Hypothesis:** The term "biophilia," introduced by Edward O. Wilson in 1984, suggests that humans have an innate connection to nature, shaped by evolution. Our ancestors' survival depended on living harmoniously with natural environments.
2. **Traditional Designs:** Ancient civilizations intuitively incorporated nature into their urban environments. Examples include Persian gardens, Roman aqueducts, and Japanese Zen gardens, which combined functionality with aesthetics to create harmony with the environment.
3. **Industrial Revolution Shift:** Urbanization led to the loss of nature in cities, causing environmental degradation and disconnection from natural elements. This prompted movements toward sustainable urban planning in the late 20th century.
4. **Modern Influence:** Today, biophilic design integrates scientific insights from environmental psychology, architecture, and urban ecology, aligning human well-being with environmental sustainability.

Principles

1. **Direct Experiences of Nature:**

- Incorporating tangible natural elements like greenery, water bodies, daylight, fresh air, and animals.
- Examples: Rooftop gardens, courtyards, aquariums, and urban forests.
- Benefits: Improves air quality, reduces stress, and boosts mental clarity.
- 2. Indirect Experiences of Nature:
 - Using natural shapes, colours, materials, textures, and patterns inspired by nature.
 - Examples: Biomimicry in design (e.g., leaf-like structures, wood textures).
 - Benefits: Provides comfort and aesthetic harmony, creating calming and immersive environments.
- 3. Spatial Patterns Inspired by Nature:
 - Designing environments with variation, complexity, and intrigue, mimicking natural ecosystems.
 - Examples: Open spaces combined with areas of refuge (like forest clearings), fractal geometry in patterns.
 - Benefits: Encourages exploration, creativity, and feelings of safety.
- 4. Human-Centered Design:
 - Focusing on how people interact with natural spaces and prioritizing well-being.
 - Examples: Restorative spaces for mental relaxation, sensory engagement through sound, touch, and sight.
 - Benefits: Enhances emotional health, productivity, and social interaction.
- 5. Integration with Local Ecology:
 - Urban environments are designed to preserve and enhance local biodiversity.
 - Examples: Restoring native habitats, planting endemic species, and creating wildlife corridors.
 - Benefits: Supports sustainability by reducing environmental impact and improving resilience to climate change.

III. IMPORTANCE

Biophilic design is vital in modern cities as it addresses critical environmental, social, and psychological challenges caused by urbanization. It helps combat urban heat islands by incorporating green spaces, reducing temperatures, and improving air quality. By integrating natural elements like plants, daylight, and water, biophilic design enhances mental well-being, reduces stress, and promotes physical health. It encourages biodiversity, restores ecological balance, and fosters connections between people and nature, enriching city life. Socially, it strengthens communities by creating shared spaces for interaction, recreation, and relaxation. Economically, biophilic design increases

productivity in workplaces, adds property value, and reduces energy costs through natural ventilation and lighting. Overall, it builds sustainable, resilient cities, improving urban liability for future generations. Biophilic design is crucial for creating healthier, sustainable, and liveable cities. It mitigates climate change impacts by reducing carbon footprints, promoting energy efficiency, and enhancing natural cooling. Overall, biophilic design contributes to the well-being of individuals, promotes environmental resilience, and transforms urban spaces into thriving, interconnected ecosystems.

IV. BIOPHILIC URBAN PLANNING

Biophilic urban planning is a holistic approach that integrates natural elements into city development to improve the quality of life for residents, promote environmental sustainability, and address the urban challenges caused by overpopulation, pollution, and rapid industrialization. By creating green, healthy, and resilient urban spaces, this planning method enhances both human well-being and ecological balance. The essence of biophilic urban planning is to design cities that foster a deep connection between humans and nature, making the built environment more sustainable and enriching.

Key Components:

1. Green Infrastructure

- Concept: Green infrastructure refers to a network of natural areas and spaces within urban environments that incorporate plants, trees, and green spaces to enhance ecosystem services.
- Implementation: This can include parks, gardens, green rooftops, vertical gardens, and tree-lined streets, which help cool urban areas, reduce air pollution, and provide habitats for wildlife.

Examples:

- Singapore's "City in a Garden" initiative includes extensive green spaces, vertical gardens, and green roofs.

2. Blue Infrastructure

- Concept: Blue infrastructure focuses on the integration of water bodies, like rivers, lakes, ponds, and water features into urban areas. These water systems help reduce flooding, cool cities, and support biodiversity.
- Implementation: The strategic use of water systems is essential for managing stormwater, reducing heat islands, and providing aesthetic and recreational benefits.

Examples:

The Thames Path in London provides a green corridor along the river that connects communities to water.

3. Mixed-Use Spaces

- Concept: Mixed-use spaces combine residential, commercial, recreational, and green spaces in a single area. This urban design reduces the need for long commutes, fosters a sense of community, and enhances connectivity between people and nature.
- Implementation: By blending parks, walkable streets, and residential areas, biophilic design helps create sustainable neighbourhoods where people live, work, and interact with nature in the same vicinity.
- Examples:
 - The Vauban District in Freiburg, Germany is an example of a mixed-use neighbourhood that integrates green spaces and sustainable living practices, with an emphasis on pedestrian-friendly streets and communal green areas.

4. Sustainable Mobility

- Concept: Promoting walking, cycling, and sustainable public transportation systems reduces reliance on cars, cuts down on emissions, and promotes healthier lifestyles.
- Implementation: Incorporating green spaces along pedestrian paths, cycling lanes, and transport corridors creates a more pleasant and safe environment for commuting.
- Examples:
 - The Copenhagen Green Cycle Route connects neighbourhoods with green corridors, enabling residents to cycle safely through green areas while reducing carbon emissions.

5. Biodiversity Enhancement

- Concept: Urban biodiversity focuses on preserving, enhancing, and increasing local ecosystems and wildlife habitats within cities. This includes introducing native plants, trees, and wildlife corridors, and protecting the natural habitats that urbanization threatens.
- Implementation: Encouraging the planting of native vegetation, restoring ecosystems like wetlands or woodlands, and ensuring green spaces are designed to support wildlife is key to fostering urban biodiversity.

Examples:

- The Atlanta Beltline in Georgia connects 22 miles of historic railway corridors with green spaces and natural habitats for local wildlife.
- The Urban Greening Program in Los Angeles promotes the planting of native trees and the restoration of local ecosystems in urban areas



IV. TYPES AND DESIGN OF BIOPHILIC URBAN PLANNING

1. Green Spaces & Parks

- Design: Includes large public parks, pocket parks, and urban forests.
- Function: Provides relaxation, recreational spaces, and habitat for wildlife.
- Example: Central Park, New York.

2. Green Roofs and Vertical Gardens

- Design: Living roofs with plants and greenery installed on buildings.
- Function: Reduces energy use, filters air, improves biodiversity, and provides aesthetic appeal.
- Example: Bosco Vertical, Milan.

3. Water Features & Blue Infrastructure

- Design: Urban rivers, lakes, ponds, and rain gardens.
- Function: Manages stormwater, cools urban heat islands, and supports aquatic life.
- Example: Cheonggyecheon Stream, Seoul.

4. Urban Agriculture

- Design: Rooftop gardens, urban farms, and community gardens.

- Function: Encourages local food production, improves food security, and connects people to nature.
 - Example: The Farm on the Roof, New York City.
5. Natural Building Materials
- Design: Use of wood, bamboo, stone, and other natural materials in construction.
 - Function: Enhances sustainability, improves thermal comfort, and provides a connection to nature.
 - Example: Earthship homes, sustainable buildings.
6. Wildlife Corridors
- Design: Pathways connecting wildlife habitats through urban areas.
 - Function: Supports biodiversity, allows safe passage for animals, and integrates nature into the urban landscape.
 - Example: Wildlife corridors in Vancouver.
7. Pedestrian-Friendly Streets
- Design: Walkable streets with integrated green spaces, benches, and trees.
 - Function: Encourages walking, reduces traffic, and fosters community interaction.
 - Example: La Rambla, Barcelona.
8. Sustainable Water Management Systems
- Design: Use of permeable pavements, rainwater harvesting systems, and bioswales.
 - Function: Reduces flooding, enhances water conservation, and replenishes groundwater.
 - Example: Melbourne's urban water-sensitive design.

V. BENEFITS OF BIOPHILIC DESIGN

1. Health and Well-Being:

- **Stress Reduction:** Natural elements in design, such as water features, plants, and natural lighting, have been shown to significantly reduce stress. Interaction with nature helps trigger the parasympathetic nervous system (rest and relaxation response), lowering cortisol levels and inducing a feeling of calm.
- **Faster Recovery:** Studies have found that patients recovering from surgery or illness in rooms with natural views or plants heal faster and require fewer pain medications compared to those in more sterile, nature-less environments.

- **Sleep Improvement:** Exposure to natural light and circadian rhythms can improve sleep quality by regulating biological clocks. Spaces designed with natural elements can enhance the connection to natural light, thereby boosting the quality of rest.
- **Physical Activity Encouragement:** Biophilic spaces encourage physical activity by creating walking paths, gardens, or outdoor spaces for recreational use. This helps reduce sedentary behavior and promotes a healthier lifestyle.

2. Environmental Sustainability:

- **Energy Efficiency:** The integration of natural elements like plants, water features, and green roofs can help regulate temperature inside buildings, reducing the reliance on artificial heating or cooling systems. Natural shading and green architecture also improve energy efficiency by lowering cooling costs in the summer and providing insulation in the winter.
- **Water Management:** Biophilic designs often incorporate water management systems that prevent flooding, reduce water runoff, and help to conserve water. Rain gardens, green roofs, and permeable surfaces ensure better water absorption and reduce the risk of urban flooding.
- **Carbon Sequestration:** Plants and trees in urban environments capture carbon from the air, acting as a natural carbon sink. They help to mitigate climate change by reducing the overall carbon footprint of cities and buildings.

3. Economic Advantages:

- **Attracting Talent and Innovation:** Biophilic office spaces have been shown to attract top talent, as employees are increasingly looking for work environments that support their well-being. Creative and innovative ideas are often sparked in environments that nurture creativity, calm, and relaxation, all of which biophilic design fosters.
- **Increased Marketability and Competitive Edge:** Buildings and developments with biophilic design are increasingly in demand among consumers and investors. Whether it's residential spaces with gardens or offices with natural elements, biophilic designs attract both buyers and renters who value green spaces and sustainability.
- **Reduction in Healthcare Costs:** By improving overall health and productivity, biophilic designs can help reduce healthcare costs for organizations and governments. Fewer sick days, a lower incidence of stress-related illnesses, and better

general health result in lower healthcare expenditures over time.

4. Social Cohesion:

- **Increased Social Interaction:** Public parks and gardens serve as shared spaces that encourage people from diverse backgrounds to come together, interact, and build social connections. These spaces act as community hubs, allowing for greater inclusivity and strengthening community ties.
- **Youth and Elderly Engagement:** Biophilic spaces are particularly beneficial for children and the elderly, providing areas for outdoor play, relaxation, and socializing. Youth benefit from exposure to nature, improving cognitive and emotional development, while older adults find nature-based environments to be conducive to mental health and social interaction.
- **Safer Communities:** Green spaces and well-designed natural environments improve neighborhood safety by encouraging outdoor activities and increasing foot traffic. The "eyes on the street" effect, where more people use public spaces, can help reduce crime and foster a sense of community security.

5. Cognitive and Psychological Benefits:

- **Enhanced Creativity and Focus:** The presence of nature or natural elements stimulates the brain, improving creativity and problem-solving abilities. Biophilic design helps with attention restoration, as people can focus better and engage in creative tasks without feeling overwhelmed or mentally fatigued.
- **Mindfulness and Relaxation:** Biophilic spaces often encourage a sense of mindfulness, helping individuals disconnect from the stresses of daily life and engage in activities such as meditation, deep breathing, or simply being present in nature. These practices enhance mental clarity and overall well-being.
- **Connection to Place:** Integrating elements of the local environment and culture into design (e.g., using local materials, native plants, or local art) strengthens the emotional connection between people and their surroundings. This sense of belonging increases community pride and helps with overall happiness.

6. Human-Nature Relationship:

- **Reconnection to Nature:** In urbanized, built environments, people often feel disconnected from the natural world. Biophilic design works to bridge

this gap by bringing elements of nature back into people's lives, offering the opportunity to reconnect with the natural world.

- **Sustainable Habits and Awareness:** By experiencing nature on a daily basis, individuals are more likely to develop eco-conscious habits, such as recycling, conserving water, or engaging in sustainable living practices. Biophilic design fosters a more environmentally aware and responsible populace.

7. Cultural and Aesthetic Value:

- **Aesthetic Appeal:** Biophilic design enhances the aesthetic value of spaces, creating environments that are visually appealing and emotionally uplifting. Natural materials, such as wood, stone, and plants, help foster a sense of beauty and tranquility.
- **Cultural Significance:** In many cultures, nature holds deep symbolic or spiritual significance. Integrating biophilic elements can promote cultural traditions and values, creating spaces that feel meaningful and in tune with local heritage.

8. Long-Term Resilience:

- **Climate Resilience:** As the world faces increasingly extreme weather patterns and natural disasters, biophilic design contributes to climate resilience. Natural elements like trees and green roofs reduce heat island effects, improve air quality, and reduce flood risks, making urban spaces more adaptive and resilient to climate change.
- **Resource Conservation:** By reducing reliance on non-renewable resources (e.g., fossil fuels for heating and cooling) and promoting sustainable urban design, biophilic principles help conserve resources and create more sustainable, future-proof cities.



VII. CHALLENGES AND CONSIDERATIONS

1. Cost and Maintenance

- **Initial Investment:** Green infrastructure, such as vertical gardens, green roofs, and extensive planting, often requires a higher upfront cost compared to conventional construction methods. The need for specialized materials, labour, and technologies to implement these systems can add to the financial burden.
- **Ongoing Maintenance:** Biophilic elements, like plantings, water features, and green roofs, require regular care, including watering, pruning, pest control, and replacement of plantings. This ongoing maintenance must be factored into long-term budgets to ensure the sustainability of these features.
- **Funding Models:** Governments, developers, and private sector stakeholders must collaborate on funding mechanisms, including grants, incentives, and partnerships, to ensure that the long-term upkeep of biophilic designs is feasible and sustainable.
- **Community Involvement:** Encouraging local communities to take part in the maintenance and care of public green spaces can help reduce costs and foster a sense of ownership, ensuring the spaces remain vibrant and accessible.

2. Urban Density

- **Space Constraints in High-Density Cities:** In cities with limited available land, there is often a challenge in finding space for biophilic elements. Developers must get creative in utilizing underused spaces like rooftops, balconies, or vacant lots to integrate greenery without compromising essential infrastructure.

- **Vertical Gardens and Green Roofs:** To overcome space limitations, vertical gardens and green roofs can be implemented in high-density areas. These solutions help incorporate nature into dense environments without taking up valuable ground space, but they require careful design and structural considerations.
- **Design Innovations:** Designers are increasingly turning to multi-functional green spaces (such as urban farms, pocket parks, and green corridors) that serve both ecological and social purposes. These spaces must be well-integrated into the urban fabric to maximize their impact in dense cities.
- **Integration into Existing Infrastructure:** Repurposing existing urban structures, such as converting old industrial buildings into spaces with integrated green elements, can help accommodate nature in already developed areas.

3. Equity and Access

- **Inclusive Green Spaces:** One of the key challenges of biophilic design is ensuring that green spaces are equitably distributed across all urban communities, especially in marginalized or low-income areas. Wealthier neighbourhoods often have easier access to parks, gardens, and nature, while disadvantaged areas may lack such amenities.
- **Community-Driven Design:** To ensure that biophilic benefits reach all residents, cities must prioritize equitable access to green spaces. This could involve engaging local communities in the planning and decision-making processes, ensuring the spaces meet their needs and reflect their cultural values.
- **Policy Solutions:** Governments can implement policies to promote the creation of green spaces in underserved areas, including incentives for developers to incorporate biophilic design in affordable housing projects or urban revitalization efforts.
- **Social Impact:** Access to nature is associated with improved mental and physical health outcomes. Therefore, addressing equity in biophilic design is not just a matter of aesthetic value but also a fundamental public health issue.

4. Climate Adaptation

- **Designing for Extreme Weather Events:** Cities are increasingly experiencing the effects of climate change, including rising temperatures, floods, and extreme weather events. Biophilic designs must be adaptive and resilient to these challenges.
- **Stormwater Management:** Incorporating natural water management systems such as rain gardens, permeable pavements, and wetlands into urban environments can help manage stormwater runoff, reduce flooding, and protect ecosystems. These designs reduce the pressure on traditional

stormwater infrastructure, which may be insufficient in increasingly frequent storms.

- **Urban Heat Island Mitigation:** The proliferation of concrete and asphalt in cities can lead to “urban heat islands” — areas where temperatures are significantly higher than in rural surroundings. Green roofs, tree planting, and green corridors can help cool cities by providing shade and increasing evapotranspiration.
- **Resilient Green Infrastructure:** Biophilic solutions must be incorporated into broader urban climate resilience strategies. For instance, the integration of green spaces in flood-prone areas can serve as flood mitigation, while tree canopies can help protect buildings from heatwaves.

5. Cultural Sensitivity

- **Local Traditions and Values:** For biophilic design to be embraced and successful, it must respect the cultural norms, traditions, and values of the communities where it is implemented. For example, certain plant species or architectural elements may have specific cultural significance in different regions.
- **Contextual Relevance:** The design of public spaces, green infrastructure, and buildings must take into account the local climate, geography, and ecological knowledge. Designs that resonate with the cultural context are more likely to be accepted and used by the community.
- **Community Involvement:** Engaging local communities in the design process ensures that their needs and perspectives are reflected in the final product. This inclusion also builds community ownership and pride in the space, ensuring long-term care and success.
- **Celebrating Local Ecology:** Biophilic design can also promote local biodiversity by using native plants and building materials that are culturally significant, helping create a more authentic and sustainable environment.

VIII. CONCLUSION

Biophilic design represents a transformative approach to urban development, emphasizing the integration of nature into our built environments. As cities continue to grow and face the challenges of rapid urbanization, climate change, and environmental degradation, biophilic design provides a sustainable solution that prioritizes the well-being of both people and the planet. The core idea behind biophilic design is simple: connecting people with nature can improve mental health, reduce stress, and boost overall happiness, while also addressing pressing environmental issues like biodiversity loss, urban heat islands, and pollution. The benefits of biophilic design are multifaceted. For individuals, it leads to improved health outcomes, enhanced cognitive performance, and better emotional well-being. Access to nature within cities promotes physical activity,

reduces anxiety, and fosters social interaction, contributing to stronger and more cohesive communities.

Environmentally, biophilic design supports the restoration and preservation of biodiversity, mitigates the impacts of climate change through natural cooling and flood management systems, and reduces energy consumption by leveraging natural resources. Economically, it adds value to properties, attracts investment and tourism, and has been shown to increase productivity and reduce absenteeism in workplaces.

Despite its many advantages, the widespread implementation of biophilic design faces challenges. High initial costs, ongoing maintenance requirements, and the need for innovative solutions in densely populated urban areas are among the primary barriers. Additionally, ensuring equitable access to green spaces for all residents, particularly those in underserved communities, is a crucial consideration for policymakers. Biophilic design must be integrated into long-term urban planning strategies to create cities that are resilient to climate change, accessible to everyone, and conducive to a high quality of life. Moving forward, it is clear that biophilic design is not just a luxury or a trend but a necessity for sustainable urban development. By prioritizing nature in our cities, we can create environments that support both ecological and human health, address environmental challenges, and foster stronger communities. With the right investments, policies, and collaborative efforts, biophilic design can transform urban landscapes into thriving, resilient spaces that promote well-being, sustainability, and social equity. The future of urban living lies in our ability to reimagine cities as ecosystems where nature and people coexist harmoniously, benefiting both for generations to come.

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