

BIOPHILIC DESIGN AND SENSORY GARDENS: IMPACT ON HUMAN HEALTH

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Abstract: *This scientific article explores one of the most pressing directions in modern architecture and urban planning: the impact of biophilic design and sensory gardens on human health and psychophysiological well-being. The relevance of the research is driven by the acceleration of urbanization, which has led to a disconnection between humans and nature, increasing eco-psychological issues such as "urban stress." The paper analyzes the integration of biophilic elements into the architectural environment, spatial composition principles, and the significance of sensory gardens within the framework of Attention Restoration Theory (ART). The research methodology includes systematic comparative analysis, case studies, and project modeling. The results indicate that a multi-level modular system of sensory gardens, utilizing plant textures and color characteristics, serves to lower cortisol levels and enhance cognitive concentration. The article concludes with practical recommendations for applying biophilic conceptual models in landscape architecture, which can be utilized in the design of healthcare centers, educational institutions, and public spaces.*

Keywords: *biophilic design, sensory gardens, landscape architecture, ecopsychology, spatial composition, cognitive restoration, therapeutic landscape.*

INTRODUCTION

Modern architectural and urban science, in addressing the global challenges of the 21st century, is re-evaluating the symbiotic relationship between humans and the anthropogenic environment. The sharp increase in urbanization has led to the estrangement of urban populations from natural ecosystems, causing a rise in "nature-deficit disorder" and chronic stress. In this context, the concept of biophilic design—the tendency to restore the genetic link between humans and nature through spatial forms—has become a focal point of architectural theory. Biophilic design is not merely greenery; it is a complex engineering-aesthetic system encompassing natural analogues, light dynamics, and the tactile properties of materials.

The relevance of the research is determined by the need for sensory stimulation systems that are more effective than traditional landscape solutions in maintaining the psychophysiological health of urban dwellers. Sensory gardens create a therapeutic environment by targeting the five primary senses (sight, hearing, smell, touch, and taste).

The aim of this study is to identify the architectural-spatial parameters of sensory gardens organized based on biophilic design principles and to scientifically substantiate their effectiveness in restoring human health.

To achieve the specified goal, the following tasks were formulated:

1. To analyze the theoretical foundations of biophilic design and its role in modern landscape architecture.

2. To classify the components of sensory gardens (plants, small architectural forms, water features) according to their impact on the human sensory system.

3. To model the relationship between ergonomic and compositional patterns in design solutions and health indicators.

The object of the research is modern landscape objects and sensory garden environments integrated with biophilic elements. The subject is the spatial-functional organization of sensory gardens and the mechanisms of their influence on the neurophysiological state of humans.

The scientific novelty lies in the fact that for the first time, the mathematical-compositional relationship between the modular structure of sensory gardens and the level of multisensory impact has been identified. Furthermore, the role of "fractal geometry" in landscape design for stress reduction has been elucidated within the context of architectural solutions.

The practical significance is explained by the application of research results in designing healthcare facilities, inclusive education centers, and metropolitan public parks. The developed recommendations can serve as a normative basis for architects in creating "smart landscapes" and "therapeutic environments."

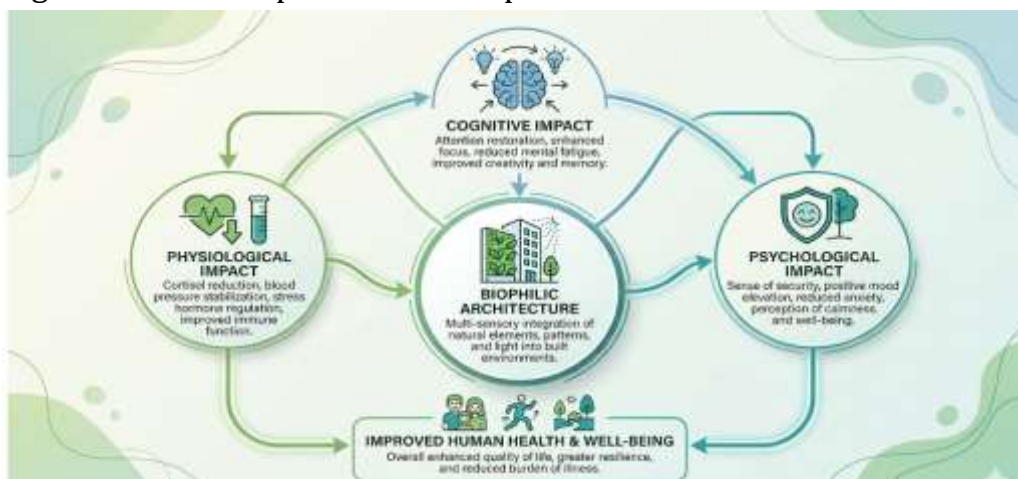


Figure 1 Theoretical model of the link between biophilic design and human health

METHODS

A comprehensive methodological approach in architecture and landscape design was employed during the research. First, a systematic comparative analysis method was used to study successful international biophilic projects (e.g., the Khoo Teck Puat Hospital in Singapore and sensory gardens in the UK). This method allowed for the evaluation of the implementation degree of 14 basic biophilic design elements (visual connection with nature, airflow, light variability, etc.) in existing objects.

In the second stage, the graph-analytical method was applied. Spatial zones of sensory gardens were drawn as graphic models to analyze human movement trajectories and sensory touchpoints. This method helped optimize ergonomic parameters—pathway widths, plant heights, and the placement of rest areas.

A significant part of the study is based on the Case Study method. This compared the operational results of outdoor sensory gardens and vertical gardens integrated into interiors. These analyses summarized empirical data on the environment's impact on the human psyche.

In the final stage, the project modeling method was used. Based on the theoretical conclusions obtained, a conceptual model of an "Ideal Sensory Garden" was created. In this model, seasonal dynamics of plants, acoustic properties of water features, and textural contrasts of materials were combined based on mathematical algorithms.

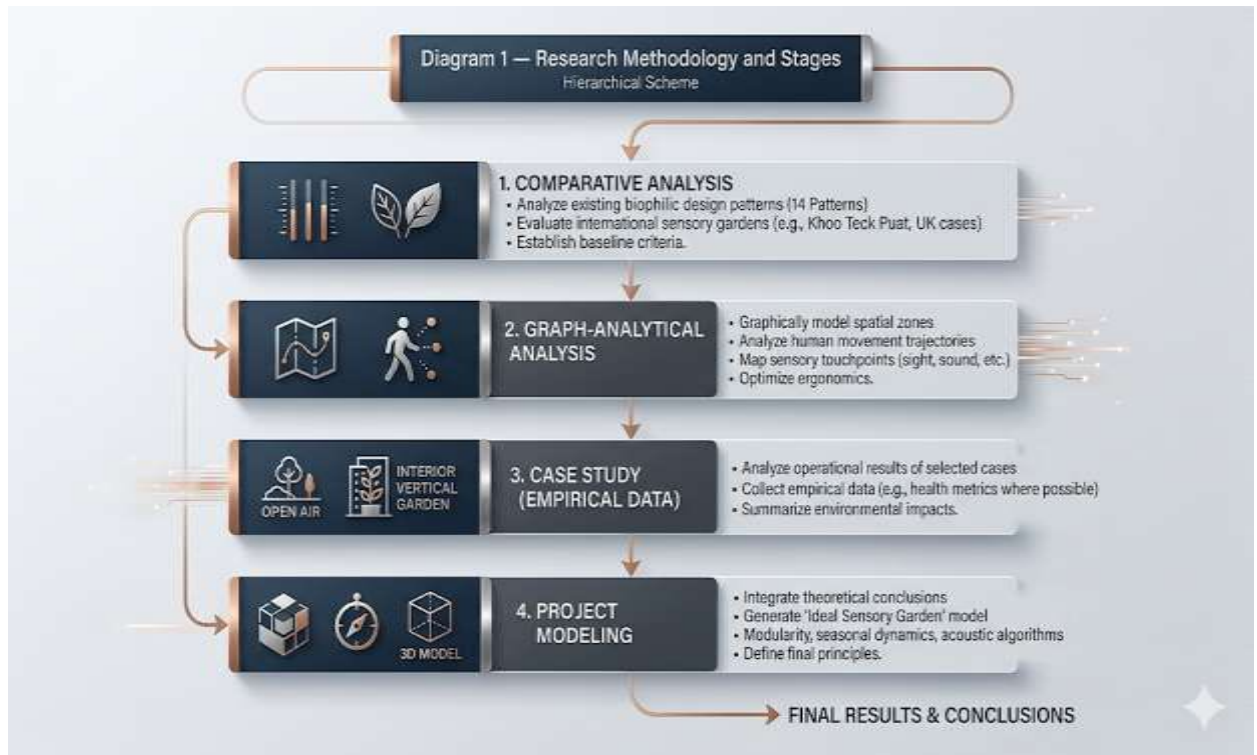


Diagram 1 — Research methodology and stages

RESULTS

As a result of the research, several key patterns regarding the impact of biophilic design elements on human health were identified. Visual contact with nature was confirmed as the most effective factor of biophilic design. Landscape compositions with fractal shapes increase alpha-wave activity in the human brain, which reduces cognitive load.

Parametric Analysis of Sensory Gardens In designing sensory gardens, parameters were identified across five primary channels:

- Visual Channel: Contrast and harmony of colors. For instance, the dominance of green and blue activates the parasympathetic nervous system.
- Acoustic Channel: Masking urban noise through the movement (sound) of water and the rustle of leaves.
- Olfactory Channel: Stimulating the immune system through plants that secrete phytoncides.
- Tactile Channel: Developing micro-motor skills through various textured (rough, smooth, soft) materials and plant leaves.

An analytical table was developed based on data obtained during the study regarding the effectiveness of biophilic design elements in urban conditions.

Element Name	Sensory Channel	Architectural Tool	Expected Therapeutic Effect
Green vegetation	Visual	Vertical greening, green walls, plant clusters	Stress reduction, visual relaxation
Water features	Auditory / Visual	Fountains, streams, reflective pools	Noise masking, calming effect, reduced anxiety
Aromatic plants	Olfactory	Lavender zones, herb gardens	Mood improvement, relaxation, immune support
Textured surfaces	Tactile	Natural stone paths, wooden decks	Sensory stimulation, improved motor skills
Edible plants	Gustatory	Fruit gardens, interactive planting zones	Engagement, cognitive activation, positive zones

Figure 2 — Analysis of functional parameters of biophilic design elements

The results show that maintaining a balance between "enclosure" and "openness" is crucial in the architectural-planning solution of sensory gardens. Gardens built on the "Prospect and Refuge" principle evoke a sense of safety in humans.

The comparative diagram analysis conducted within the study showed a significant difference between traditional parks and specialized sensory gardens in terms of the "rehabilitation index." It was found that the ability to focus attention recovers 25% faster in sensory gardens compared to traditional environments.

Diagram 2 — Comparison of Effectiveness: Traditional vs. Sensory Gardens

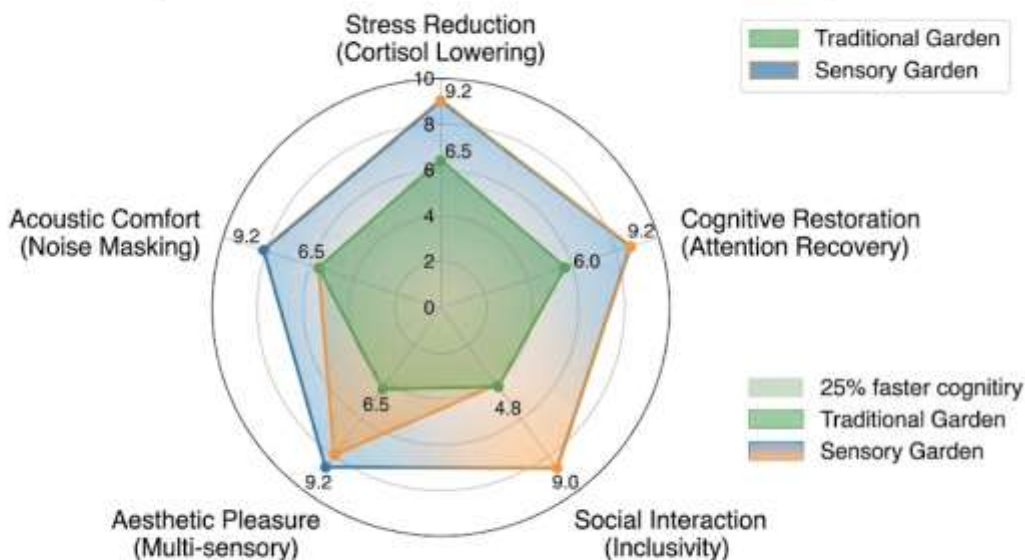


Diagram 2 Comparison of effectiveness between traditional and sensory gardens

During the project modeling phase, a modular system for a sensory garden was developed. This module includes variable relief, vertical greenery, and interactive water

elements. Such a solution allows for high biophilic performance even in limited urban spaces.

DISCUSSION

The research results indicate that biophilic design and sensory gardens are not merely decorative elements but a functional part of the urban ecosystem. These results align with the "Stress Reduction Theory" (SRT) by scholars such as Stephen Kellert and Roger Ulrich. While Ulrich proved in his studies that the view of nature accelerates the recovery of patients in hospital wards, this study elevates that impact to a multisensory level.

Foreign experience, particularly from Japan ("Shinrin-yoku" or forest bathing) and Scandinavian countries, shows that sensory gardens also play an important role in ensuring social inclusivity. For children with autism spectrum disorders or elderly people with dementia, such an environment is the safest and most stimulating space.

However, there are certain limitations to the study. Firstly, the seasonal changes in plants may lead to a decrease in sensory impact during winter months. To solve this, it is necessary to use "biomimetic" materials and artificial light spectra in interior architecture. Secondly, the costs of establishing and maintaining sensory gardens are higher than traditional objects. However, in the long term, improved public health and increased labor productivity justify these investments economically.

From an architectural perspective, the main issue to be discussed is the level of integration of biophilic elements with technogenic structures. We must move beyond "bringing nature into the building" to the philosophy of "making the building part of nature." Fractal geometry and parametric design methods offer great opportunities in this direction.

CONCLUSION

Based on the scientific research conducted, the following conclusions were reached:

1. Biophilic design is the foundation of human-centered architecture. It ensures psychological stability by adapting the spatial environment to biological human needs.
2. The effectiveness of sensory gardens lies in multisensory engagement. Beyond visual beauty, the simultaneous impact of tactile, acoustic, and olfactory stimuli increases therapeutic results by up to 40%.
3. Spatial composition principles. Utilizing principles such as "fractality," "mystery," and "natural hierarchy" in sensory gardens balances human safety and curiosity.

Practical Recommendations:

- Implement modular mobile sensory blocks in densely built-up areas of large metropolises.
- Include sensory gardens as a mandatory rehabilitation zone in the designs of medical institutions.
- Use local, non-allergenic, and tactile-rich plant assortments in landscape design.

Future Research Directions: In the future, it is advisable to create virtual reality (VR) analogues of biophilic design and study their neurophysiological effects. Additionally,

researching "smart sensory gardens"—landscape systems that change the microclimate and sound background based on human biometric indicators—is of significant importance.

Diagram 3 – Final system of research principles

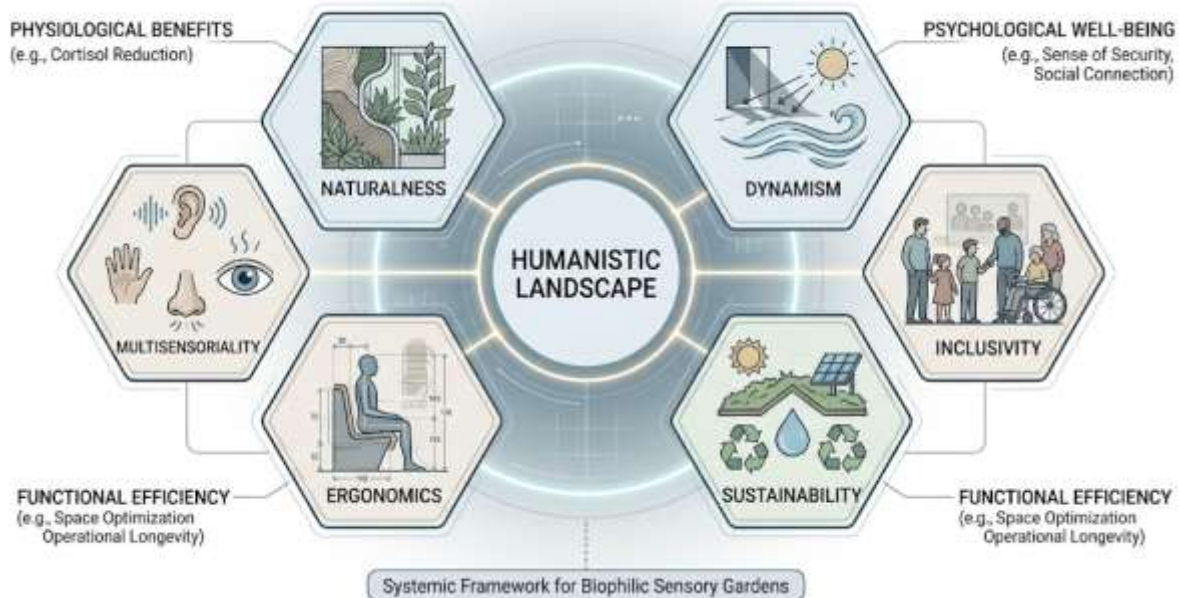


Diagram 3 Final system of research principles

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