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Ecological Sustainable Landscape Design from Modern and Contemporary Perspectives: Characteristics, Practices, and Future Trends

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Abstract: This article, from a contemporary and modern perspective, discusses the characteristics, practices, and future trends of sustainable ecological landscape design. It reviews the origins of sustainable ecological design, emphasizing it as a product of reflection on environmental protection and the negative impacts of industrialization. The article elaborately discusses the core characteristics of sustainable ecological design, such as respect for local ecology, effective use of resources, and minimization of environmental impact. Subsequently, through specific cases, it demonstrates the application of these concepts in contemporary and modern landscape design, particularly in the use of native plants, water resource management, enhancement of ecosystem services, and community participation. Finally, the article anticipates new challenges and opportunities facing sustainable ecological design and points out that future design will focus more on technological innovation, interdisciplinary cooperation, and public education.

Keywords: Contemporary and Modern; Ecological Sustainable Design; Landscape Design; Ecological Development.

1. The Beginning of Ecological Sustainable Design

The term "ecology" originates from the ancient Greek word "oikos," which originally referred to household management and daily activities [1]. In modern terms, it signifies the various relationships between organisms and their biological and physical environments [2]. The term "ecology" was first coined in the late 19th century by the German biologist Ernst Haeckel in 1866. In his work General Morphology, Haeckel defined "ecology" as the study of the relationships between organisms and their environment. This marked the birth of ecology as an independent scientific discipline.

Haeckel's definition emphasized that organisms interact not only with their physical environment, such as climate and geography, but also with other organisms. This foundational definition laid the groundwork for the subsequent development of ecology, which became a crucial field for studying the interactions between living organisms and their environments.

The modern concept of ecological sustainable design in landscape architecture began in the 1950s and 1960s, a period when environmental awareness started to awaken. With the rapid development of industrialization and urbanization, people began to recognize the environmental impacts of these processes. Although the design field had not yet widely embraced the concept of ecological sustainability, some pioneers began to focus on environmental protection and the rational use of natural resources. Scientists and environmental activists started to explore the effects of human activities on ecosystems.

By the late 1960s and early 1970s, the rise of the environmental movement marked the emergence of ecological design principles. In 1962, Rachel Carson's book Silent Spring sparked widespread public concern about environmental issues, prompting designers and architects to consider the environmental impact of their work. This period saw a questioning of traditional industrial design methods and a push for more natural and ecologically friendly approaches.

As environmental concerns grew, the concepts of ecology and sustainable design gained prominence. In 1972, the United Nations held its first conference on the human environment, marking the first time the international community comprehensively addressed environmental issues. The conference discussed topics related to environmental protection and sustainable development, laying the foundation for future sustainability concepts. In 1987, the Brundtland Commission (World Commission on Environment and Development) released the report Our Common Future, which first explicitly defined "sustainable development" as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [3]. This definition became the basis for subsequent discussions and practices. The 1992 Earth Summit in Rio de Janeiro further advanced the international agenda for sustainable development. The summit adopted the Rio Declaration and Agenda 21, providing more specific guidelines for sustainable development [4].

Entering the 21st century, with the intensification of global climate change and environmental issues, the concept of ecological sustainable design gained broader acceptance and application. Sustainable development has become a guiding principle for global governance, economic development, social progress, and environmental protection. Especially in the face of increasingly severe climate change and global environmental crises, the concept of sustainable development has been widely recognized and practiced.

In summary, the concept of ecological sustainable development gradually took shape in the mid-to-late 20th century. After decades of development and evolution, it has become a core principle guiding global environmental protection and development.

2. Characteristics of Ecological Sustainable Design

Ecological design is an inevitable trend in the current development of society and an indispensable design philosophy. It originated from the reflection on design responsibilities following the Industrial Revolution in the late 18th century and is also a response to the ongoing deterioration of the ecological environment. Ecological design is not only a reflection on the responsibilities of design in the wake of the Industrial Revolution but also an awareness and remedy for the continuous degradation of the ecological environment. In recent years, ecological sustainable design has exhibited several distinct characteristics, which not only reflect a deep understanding of the environment but also demonstrate modern design's responsibility toward ecology and communities. The characteristics of ecological sustainable design can be summarized as follows:

(1) Use of Native Plants and Local Materials

Ecological sustainable design emphasizes the use of native plants and local materials, which enhances the harmony and adaptability of the landscape to the local ecology. This approach not only helps maintain biodiversity but also improves ecological adaptability, thereby reducing time, maintenance costs, and resource consumption. Native plants are better suited to the local climate, requiring less water and fertilizer. They play a crucial role in maintaining and improving ecosystem services, such as air and water purification, soil conservation, and carbon sequestration. Additionally, the use of native plants and materials highlights the natural and cultural characteristics of the region [5].

For example, the Westergasfabriek Park in Amsterdam, Netherlands, is a former industrial site from the 19th century that has been preserved and transformed into a modern park. The park's design incorporates a large number of native plants, providing the city with a sustainable green space and successfully restoring some local wildlife populations.

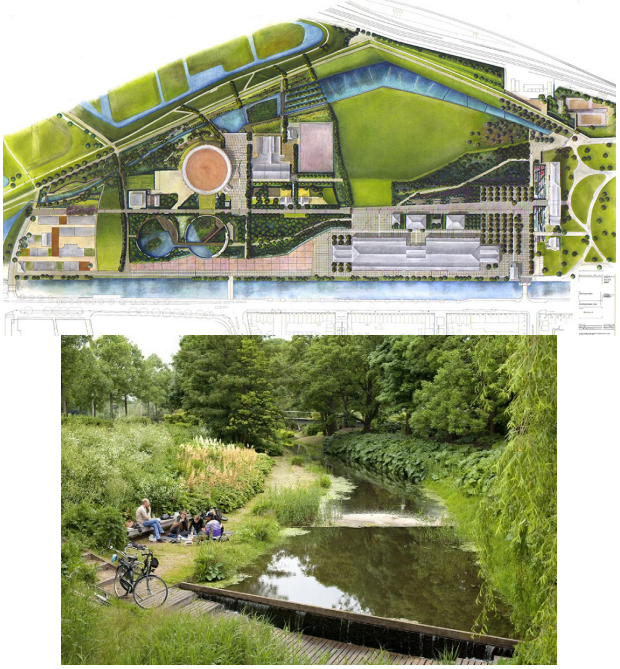

Figure 1. Westergasfabriek Park
Image source: Gustafson Porter + Bowman/ https://landezine.com/ westergasfabriek-park-by-gustafson-porter/

(2) Sustainable Water Resource Management

The decline and depletion of freshwater reserves highlight the importance of changing water resource utilization and management practices. In the face of global water scarcity challenges, ecological sustainable design increasingly focuses on the effective management of water resources. By constructing natural water features such as rain gardens and wetlands, as well as implementing rainwater harvesting and wastewater recycling systems, ecological design not only reduces dependence on groundwater and municipal water supplies but also enhances the ecological functions of the landscape [6].

For instance, the "Green Street Program" in Portland, USA, is a city-wide initiative that integrates urban design, multi-modal transportation systems, watershed health, parks, open spaces, and infrastructure systems through comprehensive planning, design, and budgeting. The program uses stormwater runoff management infrastructure to reduce urban runoff while enhancing the aesthetic appeal and biodiversity of the cityscape.

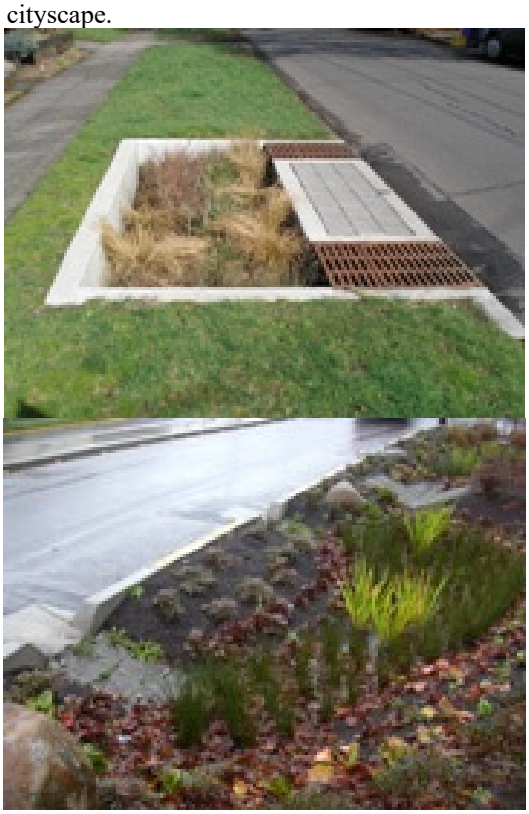

Figure 2. Portland Green Street Program
Source: https://www.portlandoregon.gov/bes/45386

(3) Ecosystem Services and Biodiversity Conservation

Ecological sustainable design places great importance on ecosystem services, such as air purification, climate regulation, hydrological cycles, and the provision of habitats for biodiversity. By creating diverse ecological spaces, protecting and restoring biodiversity, ecological design enriches the ecological structure of cities and enhances their stability and resilience [7].

For example, the Gardens by the Bay in Singapore showcase the best of tropical horticulture and garden art through innovative ecological design. The gardens feature a wide variety of tropical flowers and colorful foliage, creating a multifunctional urban oasis that not only serves as a iconic urban landscape but also enhances the city's biodiversity and ecosystem services.

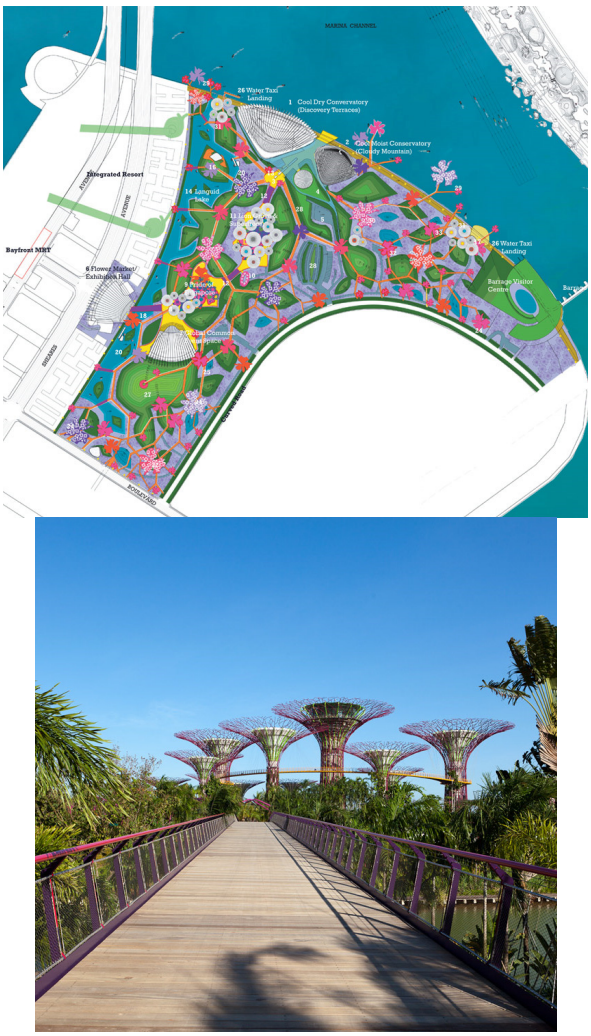

Figure 3. Gardens by the Bay
Image source: Grant Associates/ https://landezine.com/gardens-by-the-bay-by-grant-associates-landscape-architecture/

In summary, these characteristics of ecological sustainable design not only reflect a profound understanding of nature and the environment but also demonstrate the important role of design in improving community quality of life, promoting environmental protection, and advancing sustainable development. Through these innovative design practices, we can see the immense potential of ecological sustainable design for the future development of cities and landscapes.

3. The Embodiment of Ecological Sustainability in Modern and Contemporary Landscape Design

The reflection of ecological sustainability in modern and contemporary landscape design highlights humanity's increasing emphasis on environmental protection and ecological balance. This design philosophy not only focuses on aesthetics and functionality but also prioritizes the protection, restoration, and sustainable use of the ecological environment.

For example, in the history of modern landscape design, the Scandinavian style of the 20th century made significant contributions to ecological design. The Scandinavian style, particularly in countries like Denmark, Sweden, and Norway, emphasized harmony with nature and environmental sustainability. It is characterized by simplicity, functionality, and a deep respect for nature. In landscape design, this style advocates for the use of natural materials such as wood and stone, as well as the integration of native vegetation and natural topography to create spaces that are both aesthetically pleasing and in harmony with the environment. The use of sustainable materials is a key principle in Scandinavian design, reducing the environmental burden. In landscape design, this style focuses on restoring and enhancing ecosystem services, such as improving urban ecological environments by increasing green spaces and water bodies, thereby promoting biodiversity. Representative designers of the Scandinavian style include the renowned Finnish architect and designer Alvar Aalto, who is celebrated for his profound understanding and respect for nature. His design philosophy emphasizes harmony with the natural environment, and many of his works showcase the integration of natural elements with modern design [8]. Another example is the Swedish architect Sigurd Lewerentz, whose designs also reflect a deep concern for nature and ecology. His works emphasize material selection, environmental integration, and the dialogue between architecture and natural landscapes.

A case in point is Haga Park, located in Stockholm, Sweden. This park embodies the core principles of Scandinavian design. It preserves a large amount of natural landscape and native vegetation while incorporating ecological wetlands and natural trails in its design, aiming to enhance biodiversity and ecological education.

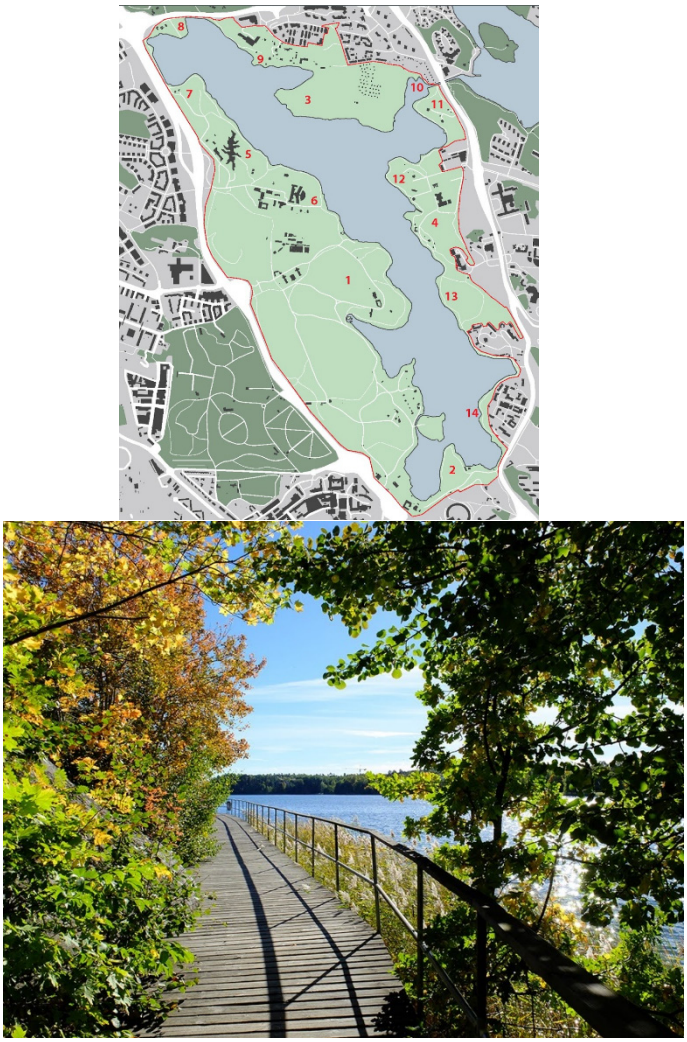

Figure 4. Haga Park
Image source: https://walkingstockholm.blogspot.com/2017/06/haga-park-part-ii.html

Therefore, modernist design styles have played a significant role in the development of ecological sustainability. Modernism emphasizes "form follows function," which, in landscape design, means giving more consideration to the harmonious coexistence of natural environments and human activities. For example, it involves using natural elements such as topography and water bodies to shape spaces, reducing reliance on artificial structures.

Especially in the late 20th century, the rise of postmodernist design styles had a profound impact on ecological sustainability. Postmodernism places greater emphasis on locality and cultural diversity, encouraging designers to use local materials and vegetation, as well as design elements that reflect local environmental characteristics. This approach reduces energy consumption and enhances ecological benefits [9].

Additionally, the influence of New Urbanism on ecological sustainability cannot be overlooked. This concept emphasizes creating compact, walkable communities that reduce dependence on cars and promote efficient land use. In landscape design, this means creating more public spaces and green areas to enhance the city's ecological network.

At the same time, Eco-Art and Landscape Restoration styles have also made significant contributions to ecological sustainability. These design philosophies emphasize the use of artistic and scientific methods to restore damaged ecosystems, advocating for the use of natural processes and ecological principles in design to promote biodiversity and ecological balance.

In summary, modern and contemporary landscape design has made substantial contributions to ecological sustainability. Whether through the use of natural materials, the restoration of ecosystem services, or the emphasis on local culture and natural environments, these efforts have made the concept of sustainable development a global issue in the early 21st century, driving the development of green architecture and landscape design. During this period, designers have placed greater emphasis on using renewable energy, improving energy efficiency, and reducing pollution and waste. In modern history, various design styles and philosophies have made important contributions to the development of ecological sustainability. These styles have not only influenced the practice of landscape design but also reflect society's acceptance and promotion of sustainable development principles.

4. Future Trends

Ecology and sustainability will undoubtedly be the future trends in landscape design, representing a multidimensional, interdisciplinary, and long-term complex issue that encompasses strategies for addressing climate change, the integration of technology and ecological design, the expansion of socio-cultural dimensions, and the integration of sustainable urban planning [10]. The future trends and strategies for ecological and sustainable landscape design can be reflected in the following aspects:

(1) Ecological Design Strategies for Addressing Climate Change:

As global climate change becomes increasingly severe, ecological design is increasingly being used as a tool to mitigate its impacts. In design, this can be achieved by increasing urban greenery, designing efficient rainwater management systems, and creating urban cooling zones to combat the heat island effect. These measures improve the microclimate of cities and enhance their ecological resilience.

(2) Integration of Technology and Ecological Design:

Modern technologies such as the Internet of Things (IoT), big data, and artificial intelligence offer new possibilities for ecological design. The use of smart sensors to monitor environmental conditions allows for more precise regulation of lighting and irrigation in urban green spaces, thereby improving resource efficiency. Additionally, digital simulation and predictive technologies can simulate the ecological impacts of different design solutions during the design phase, helping designers make more sustainable decisions.

(3) Expansion of Socio-Cultural Dimensions:

Ecological and sustainable design is not only an environmental issue but also a socio-cultural one. Design must consider local culture, historical context, and community needs to achieve a harmonious integration of ecological design with socio-cultural elements. In design planning, local art and craftsmanship can be incorporated, along with traditional knowledge and customs, to create public spaces that are both sustainable and culturally distinctive.

(4) Integration of Sustainable Urban Planning:

Sustainable urban planning requires the integration of design principles across multiple levels, including transportation, energy, housing, and green spaces. Urban planning should focus on reducing resource consumption, improving energy efficiency, and enhancing urban ecosystem services.

In conclusion, ecological and sustainable design in landscape architecture is not just a design philosophy but also a responsible attitude and action toward the environment. From its inception, ecological design has reflected a deep concern for the natural environment and a re-evaluation of the negative impacts of industrialization. This design philosophy has gradually evolved into a comprehensive methodology that emphasizes respect for local ecology, efficient use of resources, and the minimization of environmental impacts. In modern and contemporary landscape design, these principles have been widely applied through the use of native plants, water conservation, enhancement of ecosystem services, and community engagement. These practices not only enhance the aesthetic value of landscapes but also play a crucial role in achieving sustainable development and harmonious coexistence with nature. In the future, ecological sustainable design will continue to evolve, addressing global challenges such as climate change and rapid urbanization. Designers will need to combine technological innovation, interdisciplinary collaboration, and public education to drive the continued development of the landscape design field. Overall, ecological sustainable design has become an important direction in landscape architecture, holding immeasurable value for the sustainable development of future cities and natural environments.

5. Conclusion

Ecological sustainable design in landscape architecture is not merely a design philosophy but also a responsible attitude and action toward the environment. From its inception, ecological design has reflected a profound concern for the natural environment and a re-evaluation of the negative impacts of industrialization. Over time, this design philosophy has evolved into a comprehensive methodology that emphasizes respect for local ecology, efficient use of

resources, and the minimization of environmental impacts.

In modern and contemporary landscape design, these principles have been widely applied through practices such as the use of native plants, water conservation, enhancement of ecosystem services, and community engagement. These practices not only enhance the aesthetic value of landscapes but also play a crucial role in achieving sustainable development and harmonious coexistence with nature.

Looking to the future, ecological sustainable design will continue to evolve in response to global challenges such as climate change and rapid urbanization. Designers will need to integrate technological innovation, interdisciplinary collaboration, and public education to drive the ongoing development of the landscape design field.

In summary, ecological sustainable design has become a vital direction in landscape architecture, holding immeasurable value for the sustainable development of future cities and natural environments. It represents a commitment to creating spaces that are not only beautiful and functional but also environmentally responsible and resilient, ensuring a harmonious balance between human activities and the natural world.

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