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A Study of Eco-city Construction and Design in Japan from the Perspective of Urban Ecology

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ABSTRACT

Eco-city is one of the mainstream development directions in response to the global ecological development needs, therefore, we propose a study on the construction and design of Japanese eco-city from the perspective of urban ecology. After analyzing the core and connotation of urban ecology and its new requirements for urban construction, we analyze the construction of Japanese eco-city according to the three dimensions of eco-city construction of circular economy, eco-city construction of science and technology, and eco-city construction of wisdom, and analyze the construction of Japanese eco-city from the perspectives of rational use of energy, adjustment of land-use layout, and complete recycling of residential buildings, combining with specific cases and data, and conduct an in-depth study of Japan's practice in eco-city design. It also analyzes Japan's practice of eco-city design from three perspectives: rational use of energy, adjustment of land use layout, and complete recycling of housing.

Keywords: Urban ecology; Eco-city construction; Eco-city design; Circular economy eco-city; Science and technology eco-city; Smart eco-city; Complete recycling.

INTRODUCTION

From the perspective of urban ecology, in the process of urban construction, it is necessary to take into account a variety of factors to ensure the sustainable development and ecological balance of the city [1-2] . In terms of environmental protection and health, urban construction needs to take into account environmental protection to ensure that the urban environment does not negatively affect the health of residents. This includes the control of air quality, water quality, soil pollution and noise pollution. In terms of resource efficiency, cities should realize the efficient use of resources, including water, energy and land. Resource consumption and waste should be reduced by adopting energy-saving technologies and circular economy models [3-4] . In terms of ecosystem integration, urban construction needs to organically combine various ecosystem elements to form an interconnected ecosystem. This will help maintain urban biodiversity and improve ecological stability. In terms of residents' needs and expectations, urban construction should fully consider residents' expectations and needs for the environment, be people-oriented, and emphasize environmental protection and social benefits [5] . This includes the provision of comfortable living space, convenient transportation facilities and rich cultural and recreational activities. With regard to the balance between economic development and environmental protection, while promoting urban economic development, it is necessary to take into account environmental protection and ensure the scientific and sustainable development of economic growth and environmental protection.

In view of the basic geographic characteristics of Japan, the following factors need to be considered for eco-city design. The first is earthquake and disaster prevention. Japan is located in the Pacific Rim seismic zone and is prone to frequent earthquakes. Therefore, eco-city design needs to take into account earthquake and disaster prevention measures, such as the use of wooden buildings and the upgrading of earthquake-resistant buildings. Secondly, there is a lack of resources and conservation of resources. Japan is relatively resource-poor, so the eco-city design needs to focus on the conservation of resources. This includes the recycling of water resources, the efficient use of energy, and the rational treatment of waste [6-7] . Japan is an island nation, and the marine environment is crucial to its ecosystem. Eco-city design needs to consider marine environmental protection, including the reduction of marine pollution and the preservation of marine biodiversity. Finally, there is climate change adaptation. Japan has a variable climate, so eco-city design needs to consider the impacts of climate change, such as improving the flood resistance of urban drainage systems and optimizing urban green space systems.

In the study on the dynamic evaluation of landscape ecological risk and its driving force based on the optimal spatial scale of island cities [8] , a comprehensive and systematic evaluation of landscape ecological risk of island cities was carried out by determining the optimal spatial scale, which improved the scientificity and accuracy of the evaluation. At the same time, the dynamic change of landscape ecological risk and its driving force were considered, which provided a basis for the formulation of timely and effective ecological protection measures. The results of the study can provide strong support for the ecological protection policy formulation of island cities and promote the sustainable development of cities. In the study on the construction and process of Osaki Modern Industrial City [9] , the lessons learned from the industrialization and urbanization process of Osaki Industrial City are summarized through the construction process of Osaki Industrial City, which provides a good example for other cities. At the same time, the study not only focuses on the economic growth of industrial cities, but also explores various aspects of environmental protection, resource utilization, and urban planning, reflecting the comprehensive and in-depth nature of the study. The results of the study have an important role to play in coordinating the relationship between industrialization, urbanization and agricultural land system, realizing the feedback of industry to agriculture, and allowing farmers to share the fruits of industrialization and urbanization [10-11] .

On the basis of the above, this paper proposes a study of eco-city construction and design in Japan from the perspective of urban ecology.

1 AN ANALYSIS OF THE CORE AND CONNOTATIONS OF URBAN ECOLOGY

A comprehensive analysis of the content of urban ecology includes the four main aspects shown in Table 1.

Table 1 Urban ecology connotations

Connotation	Describe	Notes
Systematic holistic and	The urban ecosystem is a complex system, with interdependent and interdependent components that together form an organic whole.	Urban ecology research emphasizes starting from the whole and exploring the overall nature and changing patterns of the system.
Harmonious coexistence between humans and nature	Urban ecosystems are artificial ecosystems, and humans are the core and determining factor of this system.	Urban ecology research advocates for harmonious coexistence between humans and nature, emphasizing respect for nature and protection of ecology in urban construction[12].
Material cycle and energy flow	The material cycle and energy flow in urban ecosystems are important foundations for maintaining system stability and development.	Urban ecology research focuses on the laws and mechanisms of these processes to improve material conversion and energy utilization efficiency, reduce waste and pollution.
Sustainable development	The ultimate goal of urban ecology is to achieve sustainable	Urban ecology takes into account multiple factors such as environment,

development of cities.economy, and society to ensure the long-term prosperity of cities and the happy lives of residents[13].

Based on the core and content of urban ecology, urban construction and design need to be guided by the following new requirements:

(1)Principle of ecological priority: In urban construction and design, it is necessary to adhere to the principle of ecological priority, respect nature and protect the ecology. This requires full consideration of ecological factors in urban planning, rational arrangement of urban spatial layout and industrial development direction, to avoid damage and pollution of the ecological environment [14-15] .

(2)Efficient utilization of resources: resources in the urban ecosystem are limited, so it is necessary to improve the efficiency of resource utilization and reduce waste. Technical measures such as energy-saving, water-saving and material-saving should be adopted in urban construction, and the circular economy model should be promoted to maximize the use of resources.

(3)Green infrastructure: The proportion of green infrastructure, such as parks, green spaces and wetlands, needs to be increased in urban construction. These green infrastructures can not only beautify the urban environment, but also improve air quality, regulate climate and provide ecological services [16-17].

(4)Comprehensive transportation system: The urban transportation system is an important part of the urban ecosystem. It is necessary to build an integrated transportation system, including public transportation, walking, bicycling and other modes of travel, to reduce vehicle emissions and traffic congestion, and to improve the sustainability and convenience of urban transportation.

(5)Public participation and governance: Urban ecology emphasizes the importance of public participation and governance. In urban construction and design, it is necessary to widely consult the public, respect the public's rights, strengthen the cooperation and communication among the government, enterprises and the public, and jointly promote the sustainable development of cities[18-19] .

Combined with the above analysis of the core and connotation of urban ecology, it will be used as an important theoretical guide and practical requirement for urban construction and design, so as to realize the sustainable development of the city and the harmonious coexistence of human and nature.

2 JAPAN'S ECO-CITY BUILDING PRACTICES

2.1 Circular economy eco-city construction - Kitakyushu City

Kitakyushu City, as one of the four major industrial towns in Japan, has an environmental crisis hidden behind its industrial prosperity. However, since the 1980s, Kitakyushu has undergone profound transformation and was awarded the reputation of "Star City" in 1987, marking a major achievement in environmental governance. In the 1990s, Kitakyushu took a firm step towards ecological transformation and took the lead in launching the Eco-Industrial Park project in 1997. This project was not only the first in Japan, but also set a benchmark in the global circular economy field [20-21] . The details are shown in Figure 1.

Figure 1 Kitakyushu City

The eco-industrial park has planned three core areas: the verification research area, focusing on technological innovation and experimentation; the recycling factory area, dedicated to the efficient conversion of waste and resource regeneration; and the comprehensive environmental protection joint enterprise group area, promoting the industrial chain Close cooperation and resource circulation between upstream and downstream. Kitakyushu makes full use of its profound industrial heritage, technological advantages, talent reserves and multi-party participation network system to explore a unique circular economy path [22] . The core of the Kitakyushu model is to achieve zero emissions of industrial waste and maximize the recycling of resources, advocating the concept of "the waste of one industry is the treasure of another industry". Against this background, environmental protection industries such as home appliance recycling and waste plastic reuse are booming. At the same time, investment in research and development of environmentally friendly technologies is increased, and professionals in related fields are actively cultivated. In addition, Kitakyushu City Government has also carried out extensive ecological education and publicity activities to stimulate citizens' environmental awareness and enthusiasm for participation, and jointly promote the construction of ecological cities. Through the in-depth implementation of the "reduce, reuse, recycle" (3R) principle, Kitakyushu has successfully integrated the two goals of "industrial revitalization" and "ecological protection" and achieved the transformation from a heavy industrial base to an environment-friendly city. Contributed valuable "Kitakyushu experience" [23-24] to the construction of global circular economy cities.

2.2 Science and technology eco-city construction -- Tsukuba Science City

In the 1960s, Japan created the Tsukuba Science City. As a modern science and technology industrial city integrating scientific research, education, and industry, its unique model of science park construction is a model for science cities around the world, and it is known as the "ideal country of science and technology" [25] . The details are shown in Figure 2.

Figure 2 Tsukuba Science City

The layout of Tsukuba Science City can be divided into five functional zones: Biological Research and Experimental Zone, Science and Engineering Research Zone, Literary and

EducationalResearchZone,Civil Engineering and Architecture Research Zone, and Public

Facilities, which are synergized to create a functional and mutually reinforcing research ecosystem. The city is equipped with state-of-the-art research facilities, such as the Cosmic Research Center equipped with a state-of-the-art proton gas pedal, as well as industrial test and research centers and agricultural research centers, providing strong hardware support for research activities. Tsukuba Science City has gradually transformed from a single focus on science and technology research and development to the expansion of diversified urban functions. In the early stages, the strategic positioning of the city as a research and development center has contributed to the advancement of science and technology, but it has also revealed the problems of the city's unitary functions and lack of visibility. Through a series of urban improvement measures, Tsukuba Science City has gradually improved its urban service functions and transformed itself from a scientific and technological satellite city into a regional center. During the period of reinvention and development, Tsukuba accelerated the construction of its transportation network, and the intertwining of railroads and expressways further enhanced the connectivity and convenience of the city. the "New Tsukuba Plan," which was launched in the 1990's, not only deepened the level of development of the Tsukuba Science City, but also adapted the urban management mechanism and system to the city. The New Tsukuba Plan, launched in the 1990s, not only deepened the level of development of Tsukuba Science City, but also adapted the city's management mechanism and system to make it a model of eco-livability and an engine of science and technology innovation. This transformation has not only given Tsukuba Science City new vitality, but has also laid a more solid foundation for its position as a global science and technology city.

2.3 Smart eco-city building a new city in Kashiwa

Kashiwa New Town, a pioneering smart city in Japan, is planned around four core visions: environmental coexistence, transportation system innovation, resident health and well-being, and innovation-driven development. The project's innovative integration of optimized regional energy management, an intelligent transportation system, cutting-edge Internet of Things (IoT) technology, and the advanced concept of a "super smart society" has created a new look for the smart city. Kashiwa New Town is committed to building a green and vibrant city of the future by emphasizing environmental protection, the cultivation of new industries, and the health and longevity of its residents as its three core issues. The details are shown in Figure 3.

Figure 3 Cypress Newtown

In terms of environmental creation, Kashiwa New Town has planned a network of urban green spaces, relying on natural water systems and parks to create an eco-friendly urban space. By strengthening the protection and restoration of the urban ecosystem, Kashiwa New Town not only improves the quality of life of residents, but also lays a solid foundation for sustainable development. In the field of transportation, Kashiwa New Town has constructed a multi-level and sustainable mobility system, covering wide-area, regional and intra-city transportation, and actively introduced new transportation modes, such as car-sharing and customized buses, to realize the "intelligent + diversified" mode of transportation. This innovative initiative not only effectively alleviates traffic congestion, but also promotes the popularization of low-carbon travel concepts. In addition, Kashiwa New Town has established a highly autonomous urban

management system through the tripartite cooperation model of "government-corporate-academic", encouraging all sectors of society to participate in the development of the community and the town. In terms of energy supply, Kashiwa New Town has built a community smart grid with foresight, realizing the intelligent scheduling and efficient use of external power, local solar power generation and regional energy storage systems, setting a model for smart power supply in the city. This series of initiatives not only improves the efficiency of energy utilization, but also further promotes the Park Leaf New City towards a smarter, greener and more livable future.

3 CHARACTERISTICS OF ECO-CITY DESIGN IN JAPAN

3.1 Rational use of energy

In Japan, in terms of the rational use of energy, through technological innovation and policy promotion, the efficient use of energy and low carbon emissions have been realized. Take the Bullitt Center as an example, this green building in Seattle has a variety of built-in sensors that can monitor light intensity, carbon dioxide concentration, indoor and outdoor temperature and weather conditions in real time, so as to intelligently adjust the environmental parameters of the building and reduce energy consumption. The details are shown in Figure 4.

Figure 4 Bullitt Center

According to statistics, compared with traditional buildings, the Bullitt Center's energy efficiency has increased by nearly 40%. In addition, Japan also vigorously develops renewable energy, such as solar and wind energy, and encourages companies and residents to install solar photovoltaic panels and wind turbines through policy subsidies and technical support. According to data from Japan's Ministry of Economy, Trade and Industry, as of the end of 2022, Japan's renewable energy power generation accounted for approximately 24% of total power generation, a significant increase from ten years ago.

3.2 Adjustment of land-use layout

In adjusting the layout of land use, Japan has realized the efficient and intensive use of land through urban planning and policy guidance. In Tokyo, for example, the city has clearly defined the direction and focus of urban development through the formulation of the Tokyo Metropolitan Long-Term Plan, and has effectively alleviated the pressure on land brought about by urban expansion through the construction of urban complexes and the increase of building plot ratios, among other measures. At the same time, Tokyo also pays attention to the construction of public transportation system, through the subway, buses and other public transportation, the city closely connected to each area, reducing the residents' reliance on private cars, reducing transportation energy consumption and carbon emissions. The details are shown in Figure 5.

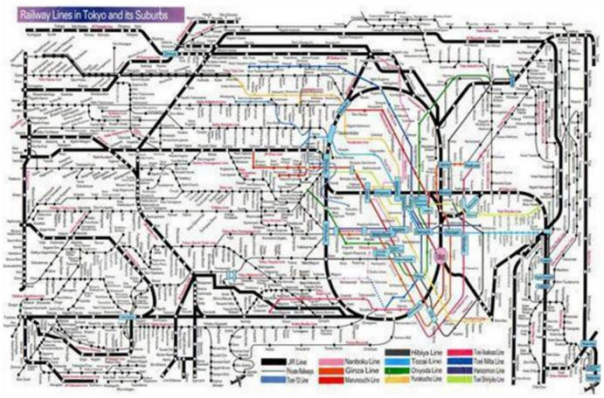

Figure 5 Layout of the public transportation system in Tokyo

In addition, Tokyo is encouraging the cultivation of vegetables and fruits in the city through

the establishment of "urban agricultural zones", which not only beautify the urban environment but also improve the efficiency of integrated land use.

3.3 Fully recycled dwellings

In the area of fully recycled housing, Japan has promoted the recycling and sustainable development of residential buildings through legislation and policy support. The eco-house in Toyooka City, for example, which is one of the 20 eco-house projects of the Ministry of the Environment of Japan, has adopted a variety of environmentally friendly technologies and materials, such as solar water heating systems and rainwater collection and utilization systems, to achieve energy conservation, emission reduction and recycling of residential buildings. At the same time, the project also focuses on the harmonious coexistence with the surrounding environment, through the design of green roofs, vertical gardens, etc., to improve the ecological quality of residential environment. In addition, Japan has enacted strict regulations on the disposal of construction waste, requiring that construction waste must be sorted, recycled and reused in order to reduce the consumption of natural resources and environmental pollution. According to data from the Ministry of the Environment of Japan, the recycling rate of construction waste in Japan has reached a high level in recent years, providing strong support for the construction of eco-cities.

4 CONCLUSION

Urban ecology takes the interrelationship between urban residents and the urban environment as its object of study, emphasizing the wholeness and dynamic balance of the ecosystem. In the construction of eco-cities, the health and stability of urban ecosystems can be promoted by optimizing the urban layout, improving the urban environment and enhancing the efficiency of resource utilization. This will not only help to alleviate the urban heat island effect, improve air quality, enhance water quality and other environmental problems, but also provide a more livable living environment for urban residents. In this paper, we study the construction and design of Japanese eco-cities from the perspective of urban ecology, and comprehensively analyze the development and achievements of Japanese cities in the light of the interactions between urban economy, society and environment. Through this study, we hope to help promote the transformation of cities from the traditional economic growth-centered development mode to the sustainable development mode, and to realize the coordinated development of economy, society and environment.

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REFERENCES

[1] Li W .Analysis of Several Problems in the Construction of Sponge City[J]. WorldArchitecture (Hundred Illustrations), 2022, 6(1):5-9.

[2] Zhe-fu CHEN,Cao-hu MO,Duan-lyu CHEN,et al.Evaluation and zoning of rain-flood adaptability for construction demonstration area in a sponge city of Changde[J].Journal of Natural Resources, 2022, 37(8):2195-2208.

[3] Shi W H W L C .Strategies for Construction of Sustainable Development Experimental Zone in Fumian District,Yulin City[J].Asian Agricultural Research, 2022, 14(2):26-29.

[4] Chen L G S H L .Construction of China Osmanthus City and Intellectual Property Right Protection in Xianning City in the Context of Three New Developments[J].Asian Agricultural Research, 2022, 14(9):1-6.

[5] Tan F , Zhu J , Li X Z Y Y J .Construction logic of ocean city branding: Based on cultural brand and cultural memory[J].Ocean & coastal management, 2023, 244(Oct.):1.1-1.9.

[6] Xie Y , Wang Q , Xie M ,et al.Construction feasibility evaluation for potential ecological corridors under different widths: a case study of Chengdu in China[J].Landscape and Ecological Engineering, 2023, 19(3):381-399.

[7] De Jong W , Urushima A F , Jacquet B ,et al.Cedars of the North Mountains: Historical forest culture and practices in modern day nature policies[J].The International Forestry Review, 2022(3):24.

[8] Ai J , Yu K , Zeng Z ,et al.Assessing the dynamic landscape ecological risk and its driving forces in an island city based on optimal spatial scales: Haitan Island, China[J].Ecological Indicators, 2022, 137:108771.

[9] Demura Y , Kitada H .CONSTRUCTION OF THE MODERN INDUSTRIAL CITY IN

[10] OGAKI AND ITS PROCESS[J].Journal of Japan Society of Civil Engineers, Ser. D2 (Historical Studies in Civil Engineering), 2022, 78(1):115-125.

[11] Wu W , Zhao S , Guo J ,et al.Construction and optimization of ecological security pattern based on the circuit theory: a case study of Hohhot City[J].Environmental Science and Pollution Research, 2023(38):30.

[12] Zhao Z T , Cheng H M , Wang S ,et al.SCC-UEFAS, an urban-ecological-feature based assessment system for sponge city construction[J]. Environmental Science and Ecological Technology, 2022(4):10.

[13] YUHongyang.Discussion on the Role of Ecological Architectural Design in Rural Architectural Design[J]. Foreign Science and Technology Journal Database (Abstract Edition) Engineering Technology, 2022(5):123-126.

[14] Li A , Niu L , Zhou Y .Prediction method of construction land expansion speed of ecological city based on BP neural network[J].International journal of environmental technology and management, 2022(1/2):25.

[15] Bamogo S , Zoma F , Malbila E ,et al.Thermal Characterization of Concrete and Cement Mortar from Construction Sites and Industrial Production Units in the City of Ouagadougou with a View to Standardization in Energy Certification[J]. Engineering (1947-3931), 2023, 15(6):396-415.

[16] Dong J , Lyu Y .Appraisal of urban land ecological security and analysis of influencing factors: a case study of Hefei city, China[J].Environmental science and pollution research international, 2022, 29(60):90803-90819.

[17] Cheng H , Zhou Q , Lou S ,et al.Simulation of the working behavior of Shibahe reservoir rock-filled concrete gravity dam during construction[J].Journal of Tsinghua University (Science and Technology), 2022, 62(9):1408-1416.

[18] Dong F , Li Y , Li K ,et al.Can smart city construction improve urban ecological total factor energy efficiency in China? Fresh evidence from generalized synthetic control method[J].Energy, 2022(Feb.15):241.

[19] Jun F , Yuanpei C , Bei L ,et al.Path Exploration and Practice of Sponge City Construction in the Pearl River Delta:A Case Study of Dalang Town,Dongguan City[J]. Landscape Studies, 2023, 15(1):48-54.

[20] Zhang H , Li J , Tian P ,et al.Construction of ecological security patterns and ecological restoration zones in the city of Ningbo, China[J].Journal of Geographical Sciences, 2022, 32(4):663-681.

[21] Haitao Z , Jialin L I , Peng T ,et al.Construction of ecological security patterns and ecological restoration zones in the city of Ningbo,China[J]. Acta Geographica Sinica, 2022, 32(4):19.

[22] Wenqi Z , Muhammad I .Does healthy city construction facilitate green growth in China? Evidence from 279 cities[J].Environmental Science and Pollution Research, 2023, 30(46):102772-102789.

[23] Shimizu K .Current status and issues of public planting construction in a provincial city[J].Journal of The Japanese Institute of Landscape Architecture, 2022, 85(4):322-323. [23] Masanori T , Yasuo U , Kozo T .Construction of a Small River Flood Prediction System in Maizuru City[J].Project Management Research Report, 2022, 2(1):94-100.

[24] Ni F , Wang Q , Guan S Q .Spatiotemporal characteristics and driving mechanisms of PM_(10) in arid and semi-arid cities of northwest China[J].Journal of cleaner production, 2023, 419(Sep.20):138273.1-138273.13.

[25] Ye Y X, Ma H Y, Li S Y. Research on Energy Consumption Prediction of Public Buildings Based on MLR-GA-WNN [J]. Computer Simulation, 2023, 40(3):514-519.