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Landscape Planning and Design in High-Density Cities of China: Challenges, Strategies, and International Insights

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Abstract

High-density cities, emerging as primary hubs for human activities and products of intensified population-land dynamics, are confronting a series of ecological challenges in China, including land scarcity, urban heat island effects, and fragmented green spaces. These issues exacerbate the vulnerability of urban ecosystems through negative feedback loops. By analyzing Singapore’s transformative experience from a "Garden City" to a "City in Nature", this study systematically summarizes its ecological planning strategies, technological innovation pathways, and social governance models. Integrating China’s practical challenges—such as land constraints, heat island effects, and ecological fragmentation—this research proposes a localized implementation framework of "networked ecological restoration, three-dimensional spatial development, and smart collaborative governance," offering theoretical and practical references for the development of "Park Cities." Local practices in China, exemplified by the Qianhai case in Shenzhen, demonstrate the feasibility of Singapore’s experience through cross-regional ecological corridors, climate-resilient vertical greening, and intelligent management platforms. However, high technical costs, administrative barriers, and the lack of long-term governance mechanisms remain critical challenges. Future efforts should prioritize policy innovation, technology adaptation, and social co-governance to shift high-density cities from "quantitative greening" to "function-first" ecological transformation, fostering synergy between ecological and economic development.

Keywords: high-density cities, urban landscape ecological planning, singapore model, governance transformation, park city

1. Introduction

1.1 Ecological Pressures Faced by High-Density Cities in the Global Urbanization Process

High-density cities are urban areas characterized by a high concentration of population, concentrated buildings, and extremely high land utilization rates. In the global urbanization process, high-density cities have gradually become the main carriers of human activities [1]. According to a statistical report in 2022, there are 21 cities in China with a population density exceeding 1,000 people per square kilometer. Among them, Shenzhen has a population density as high as 7,173 people per square kilometer, while Beijing and Shanghai have population densities of 1,334 and 3,926 people per square kilometer, respectively. However, the intensive development model, while improving economic efficiency, has also triggered multiple ecological pressures, seriously threatening urban sustainable development and residents' quality of life [2,3]. The typical ecological challenges faced by high-density cities can be summarized as land tension, urban heat island effect, and fragmentation of green spaces.

1.1.1 Land Tension: Compression and Imbalance of Natural Space

The scarcity of land resources leads to extremely high intensity of land development and utilization in high-density cities. Natural green spaces, agricultural lands, and ecological protection areas are massively encroached upon, resulting in the loss of biological habitats [4]. For example, the green space coverage rate in the Tokyo metropolitan area decreased from 25% in 1980 to less than 15% in 2020, with urban expansion consuming surrounding forests and farmlands. To alleviate the shortage of land, cities achieve "three-dimensional growth" through high-rise buildings and underground space development. However, this model may disrupt the balance of groundwater levels, cause urban ground subsidence, and exacerbate the area of impermeable surfaces on the ground, affecting the natural hydrological cycle.

1.1.2 Urban Heat Island: The Vicious Cycle of Microclimate

In high-density cities, materials such as concrete and asphalt have strong heat absorption, coupled with insufficient vegetation coverage, leading to significantly higher urban temperatures than the surrounding suburbs [5,6]. For example, the summer temperature in Manhattan, New York, is 5-7°C higher than the suburbs, and the heat island intensity in the central urban area of Beijing can reach 4-6°C. Moreover, the high temperature caused by the heat island effect interacts with air pollutants such as ozone and PM2.5, forming photochemical smog and worsening air quality, as seen in the composite pollution occurring in New Delhi, India, and Mexico City. In addition, the heat island effect increases the risk of heatstroke and cardiovascular diseases among residents and raises air conditioning energy consumption. It is estimated that the increase in air conditioning energy consumption in Shanghai due to the heat island effect accounts for about 15% of the total electricity consumption, further increasing the pressure of carbon emissions.

1.1.3 Fragmentation of Green Spaces: Damage to Ecological Network Structure and Functional Degradation

Urban roads and building clusters cut the originally continuous natural green spaces into isolated "ecological islands," damaging the structure of the ecological network and thereby weakening the functions of ecosystem services, leading to a biodiversity crisis [7]. In most high-density cities around the world (such as Mumbai and São Paulo), the fragmentation of green spaces has led to an increase in the extinction rate of native species by 20%-40%. A study in Berlin showed that more than 60% of birds were unable to complete their migration routes due to the fragmentation of green spaces, resulting in population decline [8]. The carbon sequestration capacity and rainwater detention efficiency of fragmented green spaces are only 30%-50% of those of continuous green spaces. Taking Shenzhen as an example, although the green space rate exceeds 40%, the fragmented green space structure makes its flood regulation capacity less than one-third of that of natural forests [9].

1.1.4 Additional Ecological Pressures in High-Density Cities and Their Interconnections

In addition to the aforementioned challenges, high-density cities also face a multitude of interrelated ecological pressures:

Water Resource Scarcity: The agglomeration of population in high-density cities leads to a sharp decline in per capita water resource availability. For instance, 40% of Mexico City's water supply relies on the overexploitation of groundwater, which has triggered an average annual ground subsidence of 20 centimeters [10]. Waste Disposal Dilemma: High-density cities generate a vast amount of waste, posing a significant challenge to waste management. For example, Tokyo produces 12,000 tons of garbage daily. The saturation of landfills has forced the city to adopt incineration methods, but the emission of dioxins threatens the health of surrounding residents [11]. Energy Dependence and Carbon Emissions: Buildings in high-density cities consume a large amount of energy. For example, building energy consumption accounts for 60% of the total energy consumption in Hong Kong. The extensive use of glass curtain walls not only exacerbates light pollution but also leads to significant energy waste [12].

These issues are not isolated; instead, they reinforce each other through a negative cycle of "land tension - heat island effect - green space degradation." For example, the scarcity of land resources exacerbates the encroachment on natural spaces. The reduction of green spaces intensifies the heat island effect, and the resulting high temperatures necessitate increased energy input for cooling, further raising carbon emissions. Moreover, fragmented green spaces weaken ecological resilience, making cities more vulnerable to extreme climate impacts, such as flash floods caused by heavy rainfall. This systemic imbalance calls for a shift in urban planning from a single-engineering mindset to an ecosystem governance model that couples nature and society.

2. Focusing on Indigenous Planning Challenges: A Case Study of Shenzhen, Shanghai, and Beijing

2.1 Common Issues

The landscape planning of high-density cities in China faces both common ecological dilemmas, as mentioned above, and differentiated characteristics unique to specific locations. In terms of common issues:

Land tension and spatial overload: High-density cities in China generally face land tension and spatial overload. Land tension is characterized by land development intensity approaching its limits. For example, the developed area in Shenzhen accounts for nearly 50% of the city's total area, and the development intensity within the Fifth Ring Road in Beijing is 80%, far exceeding the international livable city standard of 30%-40%. Spatial overload is manifested in the ecological cost of vertical expansion. The dense high-rise building cluster in Shanghai's

Lujiazui has led to a 40% decrease in local wind speed, intensified heat island effect, and a 25% increase in summer air conditioning energy consumption.

"Heat Dome" phenomenon and health risks and economic losses caused by deteriorating microclimate: The "heat dome" phenomenon in cities and the health risks and economic losses caused by deteriorating microclimate are significant. For instance, the peak ground temperature in Shanghai's Xujiahui commercial area can reach above 50℃, and Shenzhen's medical expenditure increases by about 1.2 billion yuan each year due to high temperatures. The heat island effect increases urban energy consumption by 15%-20%.

Island-like distribution of green spaces and decline in biodiversity: The island-like distribution of green spaces and the resulting decline in biodiversity are also serious issues. In Beijing, 60% of the park areas within the Fifth Ring Road are less than 5 hectares. The green space connectivity in Shenzhen's Futian District is only 0.35 (the ideal value is greater than 0.6). The number of native bird species in Shanghai has decreased by 30% compared to the 20th century, and nearly half of the butterfly populations have disappeared due to habitat fragmentation.

Overloaded infrastructure: Water resource shortage is particularly prominent among the overloaded infrastructure. The per capita water resource volume in Beijing is less than 300 cubic meters [13], and the overexploitation of groundwater has caused a 3-centimeter ground subsidence each year.

2.2 Regional Characteristics

In China, typical high-density cities have different underlying environments, development orientations, and localized planning strategies due to their regional characteristics, resulting in differentiated challenges. Taking Shenzhen, Shanghai, and Beijing as examples:

Shenzhen: Shenzhen faces ecological imbalance during rapid expansion. Firstly, the hidden contradiction of the "City of Thousand Parks" project is that although it has brought 1,206 built parks to Shenzhen, community parks account for more than 80% of them, with insufficient large ecological patches and broken biological migration corridors. Secondly, the ecological cost of land reclamation. The land reclamation in Qianhai New Area has led to a 40% reduction in mangrove areas in the Pearl River Estuary and a decline in the ecological service functions of coastal wetlands.

Shanghai: Shanghai faces the dilemma of updating historical urban areas. For example, the conflict between Shikumen (traditional Shanghai lane houses) and Ferris wheels: The floor area ratio (FAR) limit in the Bund historical district (≤2.5) and the Lujiazui Financial District (FAR ≥8) create a spatial value gap, and the cost of updating is extremely high.

Beijing: As the political center of China, the capital function has, to some extent, restricted the implementation of ecological protection strategies in Beijing. On the one hand, although it has improved in recent years, the Beijing-Tianjin-Hebei region still has high PM2.5 concentration air quality issues and urgently needs to increase the dust retention efficiency of green spaces. On the other hand, in order to shape the characteristic style of the ancient capital, some districts along the streets strictly implement height restrictions, limiting the potential for three-dimensional greening. At the same time, in the traditional Siheyuan (courtyard) protection areas, the role of modern ecological technology is relatively limited.

The evidence presented above clearly indicates that landscape planning in China's high-density cities currently faces practical issues such as land tension, heat island effect, and ecological fragmentation. To address these issues, landscape planning in China's high-density cities needs to achieve a systemic transformation of "engineering-society-ecology." In this study, we analyzed Singapore's transformation from a "Garden City" to a "City in Nature" and summarized the implications for landscape planning in China's high-density cities.

3. A Paradigm of Ecological Governance through Systematic Planning, Technological Innovation, and Public Participation: Lessons from Singapore’s Transformation from a “Garden City” to a “City in Nature”

Located at the southern tip of the Malay Peninsula and the entrance to the Strait of Malacca, Singapore is a world - important transit port and an aviation hub connecting Asia, Europe, Africa, and Oceania. It comprises Singapore Island and 63 nearby smaller islands. In 2020, Singapore’s population density reached 8,357.6 people per square kilometer, exceeding that of Shenzhen as recorded in the seventh national population census. As a global model for ecological governance in high - density cities, Singapore’s journey from a “Garden City” to a “City in Nature” exemplifies the deep integration of systematic planning, technological innovation, and social collaboration. This transformation is not only about ecological restoration in physical spaces but also a civilizational practice that reshapes the relationship between cities and nature. Through five decades of continuous iteration, Singapore has established a trinity based urban development paradigm of “ecological network - three dimensional space - smart governance,” providing valuable references for high-density cities worldwide.

3.1 Transformation Background: From Beautification to Ecological Resilience

In the early years after its independence in 1965, Singapore faced multiple pressures, including resource scarcity, environmental degradation, and a housing shortage. Then - Prime Minister Lee Kuan Yew proposed the “Garden City” vision, aiming to rapidly green the city to improve its image and attract foreign investment. By the end of the 20th century, Singapore’s green coverage rate had increased from 36% to 47%, with an average of 7.8 square meters of park green space per person, earning it global recognition as a “Garden City”. However, the singular pursuit of green space ratios led to fragmented ecological functions: isolated parks failed to form biological migration networks, artificial landscapes became disconnected from natural systems, and the number of native species decreased by 40%. Meanwhile, the threat of climate change intensified — with the sea level rising by an average of 3 millimeters per year and the frequency of extreme rainfall events increasing by 30% — forcing Singapore to shift towards a more resilient “City in Nature” model. The release of the “City in Nature” Development Blueprint in 2015 marked Singapore’s formal incorporation of biodiversity protection, carbon sequestration enhancement, and public health into its national strategy.

3.2 Core Strategies: Systematic Ecological Restoration and Spatial Revolution

Singapore has restructured its ecological network across the entire territory through a “three - tier green space system”:

Tier 1: Core Conservation Areas: It demarcated four nature reserves (5% of the country’s land), including the Central Catchment Area and Sungei Buloh Wetland, prohibiting development and restoring original habitats. Mangrove areas were restored to 200 hectares, and the fiddler crab population increased by 120%.

Tier 2: Ecological Corridors Linking Core Areas: It constructed a 300 km Park Connector Network (PCN) and 150 km “Nature Ways,” connecting 94% of ecological patches with green belts 5-15 meters wide [16].

Tier 3: Blue-Green Infrastructure: Under the “Active, Beautiful, Clean Waters” (ABC Waters) program, Singapore transformed 17 reservoirs and over 100 rivers into multifunctional corridors. After the Kallang River was restored from a concrete drainage channel to a natural meandering stream, the number of fish species increased from 4 to 12, and its flood storage capacity tripled [17].

Faced with land scarcity, Singapore has unleashed ecological potential through the vertical dimension [18]:

It requires new buildings to compensate for 110% of the lost green space area. This has given rise to the “Supertrees” in Gardens by the Bay (18 vertical gardens 25-50 meters tall, with an annual carbon sequestration of 200 tons) and the Parkroyal on Pickering hotel (the exterior walls of the 15 - storey building are covered with 210,000 tropical plants, reducing building energy consumption by 40%). By 2022, the area of rooftop and vertical greening had reached 200 hectares, with a 40% increase in carbon sequestration capacity compared to 2010 [19].

The ecologicalization of underground spaces is also a highlight. The ION Orchard shopping complex on Orchard Road designed its four underground levels as an “ecological breathing system,” introducing natural ventilation through sunken plazas and regulating the microclimate with shade - tolerant plant walls, reducing air-conditioning energy consumption by 30%. The underground reservoir in Marina Bay collects 9 million cubic meters of rainwater annually, meeting 15% of the city’s water demand.

Singapore has incorporated species protection into the urban gene pool through the Biodiversity Masterplan:

Conservation of Native Species: It launched the “National Biodiversity Strategy and Action Plan” (NBSAP) [20], restoring 12 key habitats such as coral reefs and mangroves. The number of bird species recorded in Sungei Buloh Wetland increased from 185 in 2010 to 260 in 2022, including the endangered black-faced spoonbill.

Heritage Tree Protection System: For trees with a trunk diameter exceeding 50 centimeters, GPS - based positioning and health monitoring are implemented. A compensation fee of up to 500,000 Singapore dollars is required for felling. A 200 - year - old rain tree (Samanea saman) in the Botanic Gardens had its lifespan extended by 30 years through root - system reinforcement and minimally invasive treatment.

Management of Human-Wildlife Conflict: The “Otter Working Group” was established. In Bishan Park, underwater culverts were designed to guide otters to safely cross water areas, increasing the population from 50 in 2015 to 170 in 2022.

3.3 Smart Governance and Public-Participation Mechanism

The smart governance and public-participation mechanism in Singapore’s transformation comprises three aspects: rule-of-law based rigid constraints, digital precision control, and community empowerment and public participation.

Singapore safeguards ecological bottom - lines through stringent regulations. The Parks and Trees Act stipulates that unauthorized tree-felling can lead to a fine of up to 50,000 Singapore dollars (about 250,000 yuan) and six months' imprisonment. Developers are required to pay a "development charge," compensating for ecological losses with 70% of the value added part of the floor area ratio. In 2021, a project was ordered to plant 300 trees of the same species and fined 220,000 Singapore dollars for illegally removing three heritage trees.

In terms of digital precision control, the "Virtual Singapore" digital twin platform integrates real - time data of 200,000 trees [21]. Through AI algorithms, it predicts heat island changes and tourist distribution, dynamically adjusting the park irrigation system. In 2020, the system helped the Botanic Gardens reduce water usage by 30% during the dry season while maintaining a 98% plant survival rate.

Regarding community participation, Singapore has implemented the "Friends of Community Gardens" program and established a nature-education network. Citizens can apply for municipal land to build community farms, with the government providing free seeds and training [22]. The rooftop farm in Pearl's Hill Community produces 8 tons of vegetables annually, benefiting 2,000 households. Primary and secondary school curricula include "ecological - practice credits," with students participating in projects such as coral planting and mangrove restoration. In 2022, 87% of teenagers indicated a willingness to pursue environmentally - related careers, a 40% increase from 2010.

3.4 Transformation Outcomes and Global Implications

After systematic reforms, Singapore's ecological resilience has significantly improved: the urban heat island intensity has decreased by 1.5°C, the annual average concentration of PM2.5 in the core area has dropped to 12μg/m³ (better than New York and Tokyo), the Biodiversity Index (BSI) has risen from 0.62 to 0.78, and the carbon sequestration capacity has increased by 25%. Its experience reveals that ecological restoration in high-density cities needs to break through the "man-made greening" mindset and achieve a leap from physical space beautification to life system reconstruction through "nature based approaches, technology empowered solutions, and social co-governance." For Chinese cities, Singapore's "City in Nature" practice not only provides a toolbox of technological solutions but also points to a new paradigm of urban civilization where humans and nature coexist.

4. Localization Path of Singapore's Experience: Collaborative Innovation in Planning, Technology, and Governance

The transformation of Singapore from a "Garden City" to a "City in Nature" provides a comprehensive paradigm for ecological governance in high - density cities worldwide. However, Chinese cities need to confront their unique characteristics when drawing lessons from Singapore — a larger population size, more complex historical - legacy issues, and more pronounced climate differences between the north and south. Against this backdrop, this chapter proposes a localization framework of "networked planning - technology adaptation - collaborative governance," transforming Singapore's experience into a practice path suitable for the Chinese context.

4.1 Planning Level: Building a Territorial Ecological Network to Solve Spatial Fragmentation

Singapore's "three - tier green space system" and "park connector network" have achieved territorial connectivity of the ecosystem. In contrast, the ecological space in high - density cities in China is often fragmented due to administrative - boundary division and complex land - ownership rights. In response, the following dimensions of localization transformation need to be advanced:

Cross administrative district ecological corridor construction:

In the Pearl River Delta urban agglomeration, drawing on Singapore's "Nature Corridor Plan," a cross- border ecological corridor is being built at the junction of Shenzhen, Dongguan, and Huizhou to restore the wildlife migration path from Dapeng Peninsula to Baiyun Mountain. Through the "ecological - compensation - fund" mechanism, the three cities are coordinated to share the construction cost. Before 2025, 100 kilometers of cross - city greenways will be completed, with the expected survival rate of animals crossing the city increasing by 50%.

In the Yangtze River Delta, the Blue-Green Integration Pilot Project: The transformation of Shanghai's Suzhou River, benchmarking Singapore's ABC Waters program, has removed 6 kilometers of concrete revetments and restored the natural river bank curve. Meanwhile, rain gardens and wetland pods have been incorporated. The flood storage capacity of the pilot section has been upgraded from a once in 20 years event to a once in 50 years event, and the number of fish species has increased from 8 to 23, making it a key node in the Huangpu River ecological network.

Ecological - oriented renewal of existing spaces:

In Beijing, the micro renewal of hutongs: Under the constraint of restricted demolition and reconstruction in historical - protection zones, drawing on Singapore's "pocket gardening" strategy, abandoned coal sheds have been converted into "Siheyuan kitchen gardens" (each with an area of 10 - 30 square meters), planted with shade tolerant vegetables and medicinal plants.

In Shenzhen, the regeneration of elevated bridges: The grey space under the bridges has been utilized to create "linear park belts." Following the experience of Singapore's Bishan Park elevated - bridge greening, climbing plant walls (with a coverage rate of ≥80%) and solar - powered lighting systems have been installed on the Futian Overpass, with an annual carbon sequestration of 15 tons and a 30% reduction in bridge body heat radiation.

4.2 Technological Level: Innovating Three Dimensional Ecological Technologies to Adapt to Regional Climate Characteristics

Singapore's vertical greening and underground space development technologies need to be adaptively improved in combination with the climate differences and building codes between northern and southern China:

Localization of vertical greening technology: R & D of stress resistant plants and optimization of structural safety: For the severe cold climate in the north, low temperature resistant vertical greening modules have been developed for application on building exteriors. These modules are equipped with drip irrigation and underfloor heating systems to reduce winter energy consumption. Shanghai has revised the "Technical Code for Three Dimensional Greening of Buildings" to ensure the wind resistance of plant walls during the typhoon season.

Ecological development of underground spaces: Operating a "sponge - business - transportation" integrated model to create underground habitats: Shenzhen's Qianhai underground city has been designed with a three - level three - dimensional structure. Compared with traditional development models, the utilization rate of underground space has been increased, and heat emission has been reduced.

Smart Ecological Management System: Carbon Sequestration Monitoring Platform and AI - Based Microclimate Regulation. Hangzhou's Xixi Wetland has introduced Singapore's Virtual Park system, deploying IoT sensors to track in real - time the carbon sequestration of vegetation, soil moisture, and animal movement trajectories. The data is fed into the "City Brain" to dynamically regulate tourist flow and improve the wetland's carbon sequestration efficiency. The "cool alley algorithm" has been applied. Through machine learning, it optimizes building layouts to form natural ventilation corridors.

4.3 Governance Level: Improving Collaborative Mechanisms and Activating the Potential of Social Co - governance

Singapore's rule-of-law based and community participation models need to be transformed into operable governance tools under the Chinese institutional framework:

Upgrading the legal protection system:

Referring to Singapore's Parks and Trees Act, China could revise the "Regulations on Greening," raising the maximum fine for unauthorized tree felling to 500,000 yuan and adding compensation of 10,000 yuan per centimeter of trunk diameter.

A Transferable Development Rights (TDR) system pilot could be launched, allowing developers to offset floor - area - ratio restrictions by purchasing "ecological credits," with the proceeds used for mangrove restoration.

Innovating public participation mechanisms: a "Park City Citizen Code" could be introduced, allowing residents to accumulate points by participating in tree planting and waste sorting activities, which can be exchanged for benefits such as public transportation card recharges and scenic spot tickets. An enterprise carbon account system could be established, incorporating the area of rooftop greening into carbon quota trading.

Empowering professional forces through collaboration: a university - community pairing plan could be implemented, with idle corner spaces transformed into "edible landscapes," maintained by residents. A "Green Chain Alliance" could be formed, with environmental NGOs providing low cost greening solutions for urban villages. Modular vertical farms could be adopted to increase the greening rate of building facades and reduce indoor temperatures in summer.

4.4 Challenges and Adaptive Adjustments in the Localization of Singapore's Experience

The Dilemma between Conservation and Development: In Beijing's Siheyuan (courtyard) conservation areas, the floor area ratio (FAR) limit of ≤0.8 conflicts with the high cost of ecological - technology integration. This issue can be addressed through the "Historic District Conservation Fund" to subsidize technological upgrades. Technological Divide between the North and South: In the north, the cost of developing frost resistant vertical greening substrates is higher than the standard modules in the south. Special fiscal subsidies are needed to promote their application. Conflict between Short-term Performance and Long-term Benefits: Under the local - government tenure system, ecological projects have a long payback period (e.g., mangrove restoration requires 10-15 years). It is necessary to establish an "ecological performance" assessment system.

The essence of Singapore's experience lies in "systematic restoration" and "public participation construction." High-density cities in China need to abandon the "indicator based greening" mindset and regard ecological networks as vital infrastructure. Through planning integration, technology adaptation, and governance innovation, these cities can achieve a paradigm shift from "parks as embellishments" to "symbiosis with nature." Only in this way can they blaze a trail for ecological urban development that is both distinctively Chinese and up to international standards, under the constraint of land overload.

5. Shenzhen Qianhai: From Land Reclamation to Ecological Engine

Shenzhen Qianhai, a core economic engine of the Guangdong - Hong Kong - Macau Greater Bay Area, bears the dual mission of economic innovation and ecological demonstration. When its development began in 2010, most of Qianhai's land was formed by land reclamation, with a fragile ecological base, the near disappearance of native mangroves, and an extremely high rate of surface hardening. Faced with this challenge, Qianhai took Singapore's "City in Nature" as a blueprint and proposed the planning goals of "connecting mountains and sea, three dimensional permeation, and intelligent symbiosis," establishing a framework for implementing a three - tier ecological network.

5.1 Integration through the three - tier ecological network:

Restoring mountain - sea corridors: By removing hard revetments and restoring intertidal zones, Qianhai has rebuilt the mangrove corridor from Dachan Bay to Xiaochan Island and Muzhou Island, adding 42 hectares of wetland area and restoring the fiddler crab population from zero to 15 species.

Penetrating urban green cores: It has planned a "one bay, two rivers, four corridors" green space system, linking seven large ecological patches such as Guiwan Park and Qianhai Stone Park through greenways to enhance green space connectivity.

Building community micro green networks: In 80% of residential plots, "10 meter setback green belts" have been implemented, combined with rooftop farms and vertical gardens, achieving a community green space rate of 35%.

5.2 Implementation outcomes: Symbiotic win - win for ecology and economy

After nearly a decade of practice, Qianhai's "Natural City" experiment has achieved remarkable results (Table 1):

Table 1.

Indicators	2015	2023	Changing rates
Green Space Ratio	12%	38%	216%
Carbon Sequestration Capacity (tons of CO_2 per year)	1.2*10^4	4.5*10^4	+275%
Surface Temperature (summer peak)	42℃	38.5℃	-8.3%
Number of Native Bird Species	23	67	+191%
Public Ecological Satisfaction	58%	89%	+53%

Through the construction of ecological networks, technology adaptation, and governance innovation, Qianhai has not only recreated the essence of Singapore's "City in Nature" but also explored a Chinese style "mountain - sea integrated city" model. This case provides an ecologically transformative approach with reference value for the construction of new cities such as Beijing's Xiong'an New Area and Shanghai's Lingang.

6. Conclusion

The transformation of Singapore from a "Garden City" to a "City in Nature" provides a set of reference models for ecological governance in high-density cities worldwide. The core of this transformation lies in the reconstruction of the symbiotic relationship between cities and nature through systematic planning, technological innovation, and social collaboration. For high-density cities in China, learning from Singapore's experience is not only about technological transplantation but also a revolutionary shift in planning thinking from “indicator oriented” to “function first.”

Firstly, Singapore’s practice has revealed the systematic logic of ecological restoration in high - density cities. Through the “three - tier green space system” and “park connector network,” Singapore has achieved the networked connection of ecological spaces, solving the problem of green space fragmentation. By implementing vertical greening and underground space development, it has unleashed the ecological potential of the three dimensional dimension. Through rule-of-law constraints and public participation mechanisms, it has established a governance model of public co-construction. These experiences provide a full process reference for Chinese cities, from planning to implementation.

Secondly, the indigenous practices in Chinese cities have begun to show results. The “Natural City” experiment in Shenzhen’s Qianhai demonstrates that by constructing ecological networks in high-density cities, it is possible to achieve synergistic growth of ecology and economy amidst high-intensity development. Cases such as the Shanghai Suzhou River transformation and the micro renewal of Beijing’s hutongs further verify the adaptability and flexibility of Singapore’s experience in the Chinese context. However, the localization process still faces multiple challenges: high technological costs limit the participation of small and medium sized cities, administrative barriers hinder cross regional ecological cooperation, and the contradiction between short-term political achievements and the long-term nature of ecological projects is prominent. In the future, a combination of strategies such as “carbon finance tool innovation, ecological compensation legislation, and community self governance funds” needs to be adopted to promote the transformation of governance models from government dominated to multi-stakeholder co-governance.

In the future, the ecological transformation of high-density cities in China needs to continue exploring in the following directions:

Policy innovation: Establish an “ecological performance” assessment system, incorporating indicators such as carbon sequestration capacity and biodiversity into the promotion criteria for officials to encourage long-term ecological investment.

Technological breakthroughs: Develop low-cost, highly adaptable indigenous ecological technologies (such as frost resistant vertical greening modules and AI driven microclimate regulation algorithms) to lower the threshold for promotion.

Social collaboration: Strengthen community empowerment and stimulate the initiative of the market and the public in ecological construction through mechanisms such as citizen points and enterprise carbon accounts.

Singapore’s practice has shown that high-density cities can fully rebuild nature in the course of development. Chinese cities need to abandon the singular thinking that “greening equals beautification” and regard ecological networks as the core infrastructure of the urban ecosystem. By achieving a paradigm shift from “City of Thousand Parks” to “City in Nature” through planning integration, technology adaptation, and governance innovation, they can blaze a trail of sustainable development that is both distinctively Chinese and up to international standards, under the rigid constraint of land overload.

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