

Importance of Urban Wetland Parks under the Development of Green Healthy Cities: A Case Study of Nanjing City

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Abstract Wetlands are widely distributed all over the world, and have many wildlife resources, which are the main pieces of the puzzle for natural resource conservation and sustainable development on earth and have important irreplaceability. In this paper, through questionnaire survey, field research, literature review, etc., importance weight analysis was conducted by using principal component analysis, and field survey and questionnaire were carried out to collect data on ecological environment function, environmental protection function, landscape beautification function, disaster prevention and mitigation function of urban wetlands. The problems in wetland parks of Nanjing were discussed, such as lack of awareness of landscape planning, deficient late management of wetland parks, weak ability of sustainable development, and unreasonable landscape layout and function. Finally, corresponding solutions were proposed, such as adhering to the planning and design of urban wetland parks with green as the base and health as the basis, persisting in the construction of a wetland system with high biodiversity and near-natural characteristics, adhering to the principle of sustainable development, adopting the construction idea of symbiosis and circulation of urban wetland parks, strengthening education and publicity work, and paying attention to the organic combination of system protection and coordinated construction. The research can build a new development direction for the model of urban wetland parks and green healthy cities, and provide theoretical support for urban sustainable construction.

Keywords Urban wetland parks, Green healthy cities, Importance

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1 Theoretical significance

With the rapid development of national economy, the burden of national environmental conditions is increasingly heavy, and people gradually realize the seriousness of environmental pollution when enjoying a rich and colorful material life. Wetland resources, as a special ecosystem that regulates ecological environment balance and alleviates ecological environmental pollution, have the value of natural sightseeing, tourism, entertainment and valuable education and scientific research. They provide a variety of available resources and are also habitats for wild animals. However, wetlands are also facing serious pollution problems in recent years^[1]. Urban wetland parks are special, and integrate the ecological function and typical characteristics of wetlands. They are incorporated into the planning of urban green space system. The main goals are ecological protection, popular science education, nature exploration and leisure tours. Green healthy cities are a theoretical framework, aiming to realize the ecological sustainable development of cities and the protection of natural resources. For urban wetland parks, green healthy cities can provide the following theoretical improvement or natural resource protection methods: ① in

terms of ecological function enhancement, the theory of green healthy cities emphasizes that natural wetlands should be integrated into urban planning, and urban wetland parks should be as an important part of the ecosystem; ② in respect of social welfare improvement, the theory of green healthy cities emphasizes that ecological services provided by urban wetland parks can increase residents' sense of well-being and quality of life; ③ in terms of water resource management, the theory of green healthy cities encourages the collection, storage and purification of rainwater through reasonable design and planning of urban wetland parks, so as to improve the utilization efficiency of urban water resources; ④ for prevention and control of natural disasters, the theory emphasizes the protection and restoration of urban wetlands to increase a city's natural protection capacity and reduce the risk of natural disasters; ⑤ in respect of air quality improvement, it encourages the construction of urban wetland parks to improve urban air quality and reduce the emission of pollutants. In short, the theoretical framework of green healthy cities provides perfect guidance and methods for urban wetland parks, and can realize the protection of urban natural resources, ecological function enhancement and social

welfare enhancement.

2 Practical significance

The total area of wetlands in Nanjing City accounts for 14.8% of the total area of the city, of which the area of river wetlands, lake wetlands and constructed wetlands accounts for 31.8%, 16.3%, and 51.9%, respectively (Fig.1)^[2]. In Nanjing City, wetland parks are mainly distributed in Jiangning District, Pukou District, Qixia District and other areas (Fig.2), but there are still many problems in the construction and operation of urban wetland parks in Nanjing City. Based on this, the importance of urban wetland parks for urban development, the existing problems of urban wetland parks and their solutions were analyzed to provide reference for the better development of wetland park. The improvement of wetlands has a very important impact on the construction of green healthy cities, which is reflected in the following aspects: ① in respect of ecological protection, the improvement of wetlands can make the urban ecosystem more healthy and rich; ② in term of regulation of water resources, wetlands can regulate water resources, purify water quality, and provide high-quality water sources; ③ in respect of water environment improvement,

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wetland improvement can effectively reduce the discharge of urban sewage and wastewater, improve the quality of urban water environment, reduce water eutrophication and water pollution; ④ in term of climate regulation, wetlands help to regulate urban climate, reduce urban temperature and the heat island effect, and improve urban drought; ⑤ in respect of scientific education and research, wetland improvement can provide an important scientific education and research base for a city to study wetland biodiversity and wetland restoration technology, and promote scientific research and enhancement of environmental protection awareness. Wetland improvement has many impacts on the construction of green healthy cities, including ecological protection, water resource regulation, water environment improvement, air purification, natural landscape enhancement, climate regulation, science education and research. With the acceleration of urbanization and the intensification of population growth, wetlands have been seriously damaged, which poses a great threat to the sustainable development of a city. Wetland improvement can provide clean water resources for cities by restoring wetland ecosystem functions and hydrological cycles, and also help to control flooding disasters. In urban planning, wetlands can be built and protected as a kind of ecological infrastructure, and can not only improve the quality of urban living environment, but also promote the development of urban economy.

3 Related concepts and theoretical analysis

3.1 Significance and function of urban wetland parks

Urban wetland parks have many meanings and functions for urban development (Table 1).

3.2 Influence of green healthy cities on the improvement of urban wetlands

3.2.1 Green healthy cities. A green healthy cities refers to the concept of urban development paying attention to the health of citizens based on green ecology. It aims to create an environmentally friendly, resource-saving and ecologically balanced city and focus on the physical and mental health and well-being of its citizens. The goal of a green healthy city is to promote the healthy development and happiness of citizens by providing clean air, high-quality water, healthy food, good living environment and convenient public services^[3]. With the acceleration of urbanization in China, the ecological environment has been destroyed, and the environment has been polluted. The

climate has been abnormal, and there have been ecological imbalance and other “urban diseases”. In addition, the negative situation such as high pressure of residents and serious

aging is also increasing. In response to this situation, the proposal and practice of the concept of “green healthy cities” has greatly alleviated the negative impact caused by this development.

3.2.2 Influence of urban wetlands under green healthy cities. A green healthy city is an urban mode that conforms to people’s pursuit of better environment. It pays attention to protecting biodiversity and realizing sustainable development of urban environment. The construction of green healthy cities reflects the basic concept of harmonious coexistence between man and nature and recyclable urban green space. Green healthy cities combine aesthetics, social principles and urban landscape greening to create an optimal environment that can fully integrate technology and nature from the perspective of natural ecology and social psychology. It not only protects the natural ecological environment and the social ecological environment, but also guides people’s creative

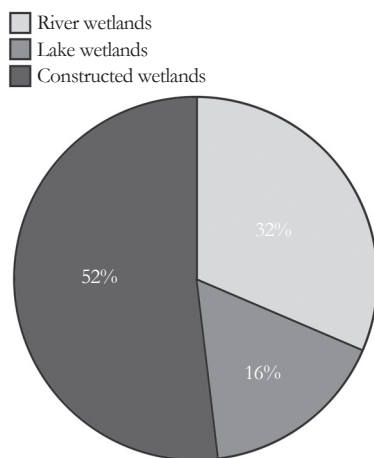


Fig.1 Proportion of various types of wetlands in the total area of wetlands in Nanjing City

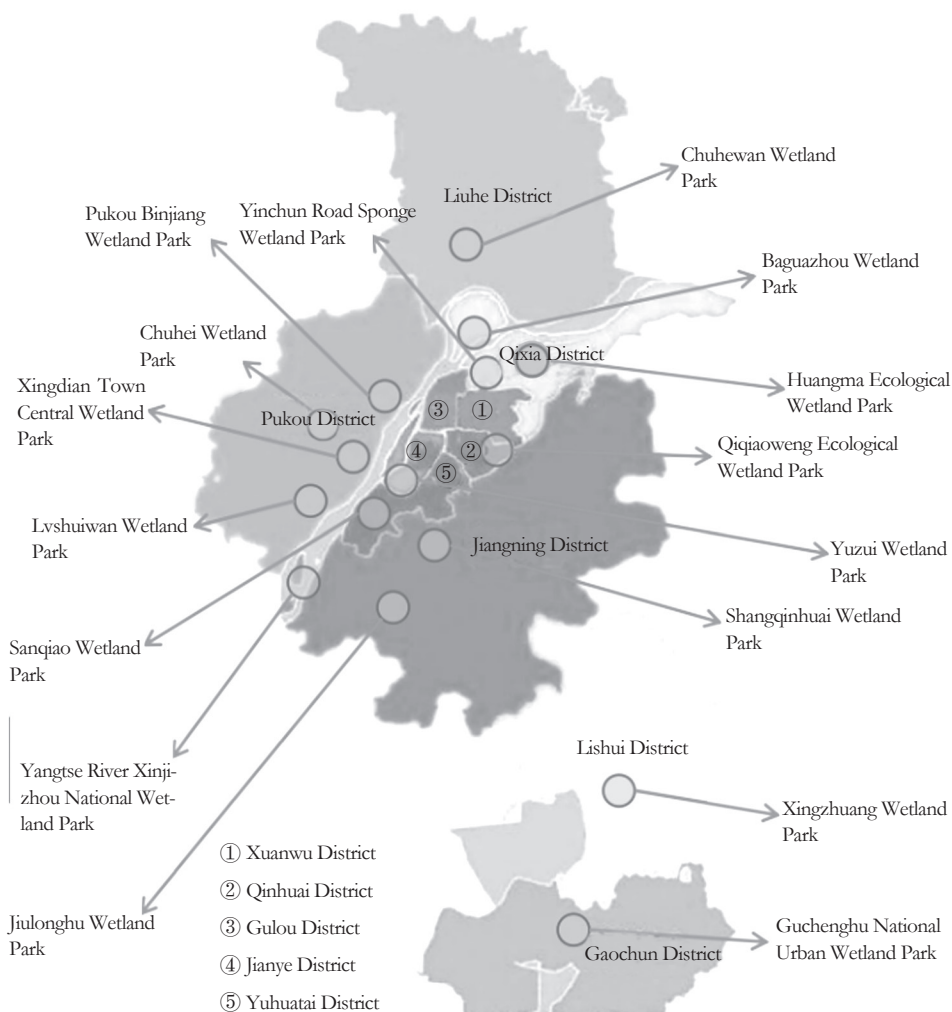


Fig.2 Location distribution of urban wetland parks in Nanjing City

spirit and productivity, providing a higher level of characteristics and cultural life. The specific functions of green healthy cities are shown in Table 2.

3.3 Design principles and content of green healthy cities

3.3.1 Design principles of green healthy cities.

In order to meet the urban environmental requirements of green healthy cities and ensure that green space construction can achieve green ecology and the physical and mental health of citizens, the following design principles need to be adhered to: ① it is needed to adhere to the principle of enriching biodiversity and building a nature-friendly artificial ecosystem, so as to better realize the ecological environment and environmental protection functions of green healthy cities; ② the basic concept of harmonious coexistence between man and nature and recyclable green space construction should be followed, so as to give full play to the landscaping function of green healthy cities at a deeper level; ③ the construction of urban wetlands should strive towards the direction of natural regeneration. In terms of plant selection, local plants should be selected as far as possible, and toxic or susceptible plants and plants that are easy to cause environmental pollution should not be selected^[4]. At the same time, the continuous construction of urban wetlands also provides better disaster prevention and reduction functions for green healthy cities.

3.3.2 Requirements of green healthy cities for urban wetland construction. As a composite of green cities and healthy cities, “green health

cities” should not only protect the sustainable development of urban environment and wetland environment, but also protect residents’ physical and mental health, and improve residents’ happiness during their design and construction^[5]. The requirements for urban wetland construction are as follows.

(1) Protecting original wetland resources: green healthy cities require that existing natural wetland resources should be incorporated into ecological reserves in the planning, and cannot be filled or destroyed at will^[6].

(2) Rebuilding wetland ecosystem: for the damaged wetlands or farmland, green healthy cities require the reconstruction and restoration of wetland ecosystem to increase the ecological public welfare and sustainability of the cities^[7].

(3) Encouraging the construction of new wetlands: the proportion of newly-built wetland in urban planning should be increased to ensure that the area of urban wetlands can meet urban ecological needs, improve urban air quality, and alleviate urban heat island effect^[8].

(4) Strictly controlling wetland development: developers are not encouraged to develop real estate in wetlands to avoid excessive occupation of wetlands and damage to the ecosystem.

(5) Carrying out publicity and education: the publicity and education of urban wetland ecology should be strengthened, so that the public can have a deeper understanding of the ecological value and protection significance of urban wetlands, and more people actively participate in the protection and construction of urban wetlands.

4 Current situation of wetland parks in Nanjing

4.1 Present situation of wetland parks

In Nanjing City, wetland parks are mainly distributed in Jiangning District, Lishui District, Liuhe District, Gaochun District and Yuhuatai District. Nanjing City has a national wetland park—Yangtze River Xinjizhou Wetland Park, and it is located in Jiangning District of Nanjing in the lower reaches of the Yangtze River. The park consists of five islands (Xinjizhou, Xinshengzhou, Zaishengzhou, Zimuzhou and Zihuizhou), as well as the waters of the Yangtze River and the beaches on both sides of the river. In addition, there are three provincial wetland parks in Nanjing City, namely Gaochun Gucheng Lake Urban Wetland Park, Nanjing Lushuiwan Wetland Park and Baguagzhou Wetland Park. Besides, there are 11 municipal wetland parks in Nanjing, mainly including river wetlands and lake wetlands^[9]. Nanjing City protects wetland resources by establishing wetland parks and wetland protection communities, and the protection rate of natural wetlands reaches 68.3%, ranking first in Jiangsu Province^[10].

4.2 Impact on cities

Wetland parks in Nanjing City are not only an important part of structural ecosystem of the city, but also important places for residents to relax. These parks are closely related to the development of cities and the quality of life of residents^[11]. Wetland parks elevate their living standards, and meet the urgent needs of urban residents to live in harmony with nature. Furthermore, the construction of urban wetland parks also plays an important role in promoting urban development^[12].

4.2.1 Promoting the diversification of urban green landscape. In the process of urbanization, in order to promote the improvement and protection of urban environment, a green landscape area should be built in the corresponding urban planning and construction area^[13]. As a part of urban environmental protection, the construction of green landscape areas not only helps to improve the urban environment, but also plays an important role in promoting ecological balance. The construction of wetland parks is the construction of green landscape and enriches the diversity. According to different urban forms, various forms of wetland parks can be built (Fig.3).

4.2.2 Improving the urban ecological environment. Wetlands can purify water and air quality, absorb harmful substances, and provide suitable habitats. The balance of the ecosystem can help maintain the urban ecological environment. Wetlands can absorb water, cope with rainstorms

Table 1 Significance and specific functions of urban wetland parks

Significance	Specific function
Environment	Regulating the climate of urban areas, maintaining air humidity, reducing the temperature of surrounding areas, mitigating heat island effect, absorbing harmful gases and dust, and improving air quality
Ecology	Playing the functions of purifying water quality, flood control and water storage, and protecting biodiversity, improving the stability of urban ecosystem, effectively protecting wild animals and plants in wetland parks of Nanjing, and significantly improving the ecological environment
Society	Playing an important role in the construction and protection of ecological civilization and urban sustainable development of Nanjing City, and also enriching the tourism resources of Nanjing City

Table 2 Specific functions of green healthy cities

Function	Specific function
Ecological environment	Absorbing carbon dioxide, dust and harmful gases, releasing oxygen, improving air humidity, regulating air temperature, conserving water and soil, and improving relative humidity in the air
Environmental protection	Trees can reduce wind speed, reduce large particles of dust; their branches and leaves can absorb a lot of dust; many green plants can secrete strong aromatic volatile fungicides to kill bacteria
Landscaping	Urban wetlands composed of green plants can produce aesthetic feeling. The use of green plants weakens the dull feeling brought by buildings and makes the lines softer. Introducing plants into a city can beautify the living environment and meet people's ornamental needs.
Disaster prevention and mitigation	A large number of urban wetlands can play the role of earthquake refuge. Large wetlands and parks in a city can be used as places to prevent earthquakes and disasters. Urban wetlands are conducive to isolating and blocking the spread of fire. Besides, urban wetlands also have the functions of reducing flood and absorbing radioactive substances

within cities, and reduce the risk and impact of flood disasters^[14] (Fig.4).

4.2.3 Promoting the development of urban tourism and enriching the cultural life of residents. The charming scenery of wetland parks has attracted a large number of tourists, injects vitality into the local tourism industry, and in turn leads to the vigorous development of the city's economy. Wetland parks can not only provide a place for recreation, but also help residents understand the ecological value and significance of wetland parks through cultural, educational and popular science activities^[15].

5 Present problems existing in wetland parks of Nanjing and their solutions

5.1 Analysis of questionnaire survey

Through the analysis of the questionnaire survey of the citizens, in the first question, the satisfied people with Shangqinhuai Wetland Park accounted for 32%, and those of Sanqiao Wetland Park accounted for 20%; the proportion was 30% and 18% for Yuzui Wetland Park and Lushuiwan Wetland Park. Among the the most satisfied reasons for the second question, the proportion of beautiful environment was the largest, up to 40%; reasonable landscape planning accounted for 25%, and convenient transportation accounted for 20%, while complete service facilities accounted for 15%. As for the third question, the problems listed by the citizens can be summarized into four aspects: lack of awareness of landscape planning, lack of late management of wetland parks, weak sustainable development ability, and unreasonable landscape layout and function (Table 3).

5.2 Existing problems

5.2.1 Lack of awareness of landscape planning. Landscape planning of parks is not perfect, and

there is a waste of space and a single function. Urban green space has biodiversity, and a healthy ecosystem is also very important. Therefore, rich biodiversity and artificial ecosystem close to nature are the basis for sustainable development of urban environment. Many landscape designers of wetland parks do not have a comprehensive understanding of it and do not realize that landscape planning should focus on the construction of artificial ecosystem rich in biodiversity and close to nature. The loss of the original wetland environment and value of wetland parks, and lack of targeted planning and design for the culture and climate environment of different regions have led to the low characteristics and value of urban wetland parks, the lack of animal and plant diversity, the lack of local cultural characteristics and the connotation of ecological development.

5.2.2 Deficient late management of wetland parks. Park management is not in place. Com-

mercial development misuses public resources, and tourists can not orderly tour. In addition, there are unreasonable utilization of wetland resources and excessive use of biological resources. It violates the basic idea of urban green space design with symbiosis, circulation and natural regeneration in the development of green healthy cities.

5.2.3 Weak ability of sustainable development. The surrounding environment is dirty and bad, and there are phenomena such as garbage dumping and disorderly construction, which affects the image of the parks and the safety of tourists. At present, China's land use is gradually increasing, and natural wetland culture is more damaged, leading to the formation of disasters. The natural environment is crucial to sustainable development. The landscape design of some wetland parks seriously interferes with the existing hydrological automatic restoration system of wetlands, pollutes and damages the

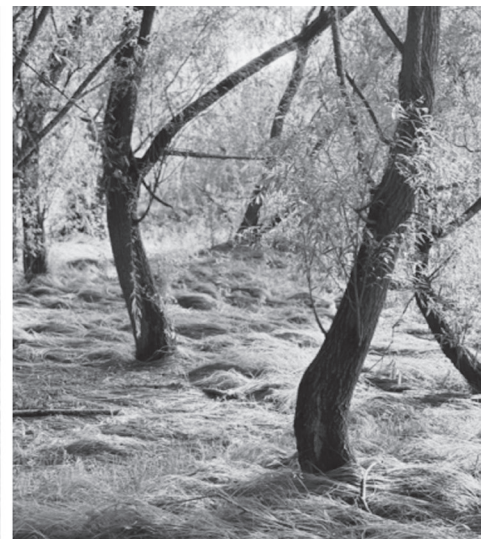


Fig.3 Greening landscape of Nanjing Yuzui Wetland Park



Fig.4 Nanjing Chishanhu National Wetland Park

hydrological system, and causes further changes in the nearby microclimate.

5.2.4 Unreasonable landscape layout and function.

The internal environment and quality of facilities in the parks need to be further improved. For instance, the lack of humane design, inadequate infrastructure and other problems result in poor experience of visitors. The problems of landscape design and functional positioning of wetland parks are mainly manifested in the unreasonable division of park function and landscape structure. Through the investigation of wetland parks, it is found that many scenic spot designs do not carry out reasonable and effective investigation of site space, leading to deviations and errors in the spatial structure design positioning of building areas in scenic spots, or unreasonable positioning of functional areas, functional positioning and design confusion.

5.3 Solutions

5.3.1 Adhering to the planning and design of urban wetland parks with green as the base and health as the basis. It is necessary to improve the planning and design, and set up a variety of functional areas in the parks, such as leisure, sports, entertainment areas, to meet the needs of various tourists. Meanwhile, user-friendly design should be improved to enhance visitors' experience, such as adding infrastructure such as seats, awnings and water fountains, as well as landscape elements such as flower beds and fountains. It is needed to improve the surrounding environment of the parks, increase the investment in the surrounding garbage cleaning and greening construction, and effectively improve the image of the parks and the quality of the surrounding environment. Besides, it is necessary to strengthen the management of parks, as well as the management and

supervision of businesses, and prohibit irregular construction, commercial development and other violations.

5.3.2 Persisting in the construction of a wetland system with high biodiversity and near-natural characteristics. In the construction of urban wetland parks, in order to maintain and increase the biodiversity and naturalness of urban wetland park system, the following measures should be taken: ① native plant species and varieties should be chosen as much as possible, which can not only increases the local characteristics of the plant community, but also makes them better adapted to the local climate and soil conditions, making them easier to grow and survive. ② Artificial plant communities with near-natural characteristics are constructed by simulating natural plant communities. Various plant species and varieties are mixed to simulate the interaction and competition between plants in the natural environment, thus promoting the formation of plant diversity. ③ More complex terrain and habitat is constructed. The topography and environmental factors of urban green space will affect the growth and distribution of plants, so the design of more abundant topography and habitats, such as water, grassland, rocks, etc., can provide more ecological niches and growth conditions, and promote the growth of more different plants. ④ The theory of ecological edge effect is used to increase plant species. The theory suggests that greater concentrations of species occur in transition zones between different environments, known as ecological margins. Therefore, adding ecological fringe areas in urban green space, such as forest edge and lawn edge, can attract more plants and animals to gather here to increase biodiversity.

5.3.3 Adhering to the principle of sustainable

development. At present, the design of wetland parks mostly pursue perfect appearance, and ignores the value and charm of wetland parks. Wetland parks are designed and planned according to the existing wetland hydrology to achieve sustainable development of the natural environment, maintain a good circulation of groundwater, and reduce the occurrence of natural disasters. In the planning and design process, measures to increase air humidity and purify groundwater should be fully considered, and various natural elements of wetland landscape are incorporated into the important elements of the planning.

5.3.4 Adopting the construction idea of symbiosis and circulation of urban wetland parks. Protecting urban wetlands is the first step to achieve a symbiotic cycle. Before the construction of a park, the original wetland needs to be investigated and evaluated to ensure that the construction of the park will not cause damage to the wetland. At the same time, it is also necessary to formulate scientific management measures and implement daily inspection, maintenance and restoration measures of wetlands. In the planning and design of the park, based on ecological prevention and control, landscape diversity and plant diversity should be maintained, and suitable herbs, shrubs and trees should be selected to build habitats and create suitable habitat conditions. In the construction process of the park, renewable and environmentally friendly materials should be used as much as possible, such as recyclable steel and wood. In short, to implement the idea of the construction of urban wetland parks with symbiotic cycle, it is needed to pay attention to the protection of wetlands, ecological design, resource recycling and reuse, and achieve the sustainable development of ecology, economy and society at design, construction and management levels. Meanwhile, all departments should cooperate and actively explore various modes of wetland protection and park construction that meet the local reality.

5.3.5 Strengthening education and publicity work, and paying attention to the organic combination of system protection and coordinated construction. Wetland conservation is a common undertaking that requires broad participation of society, so the first task is to cultivate a new awareness of resources and environment and guide the public to understand the importance of wetland conservation. Besides, it is necessary to strengthen publicity and education, improve residents' understanding of wetland parks, and stimulate the whole society

Table 3 Citizens' evaluation of problems in wetland parks

Target layer	Criteria layer	Factor layer
Citizens' evaluation of urban wetland parks	Planning cognition of parks	Space waste
		Spatial singleness
		Reasonable planning and design
		Lack of designer cognition
	Late management of parks	Improper maintenance and management
		Misuse of public resources by commercial development
		Unreasonable management mechanism
		Improper use of wetlands and biological resources
	Sustainable development of parks	Chaos in the surrounding environment
		Increase in land use rate and destroyed wetlands
		Interference of hydrological automatic restoration system of wetlands by landscape design
		Unsound and unstable ecological development system
	Landscape layout and function	Poor internal environment
		Inadequate infrastructure
		Unreasonable division of park functions and landscape structure

to actively participate in the construction and protection of wetland parks.

6 Conclusions

The above research shows that wetland parks play a very prominent role in promoting urban development, and play a positive and effective role in improving urban ecological environment and living environment and protecting biodiversity. The construction of wetland parks is conducive to making a city become more ecological, livable, green and sustainable. It is also conducive to urban residents to relieve work pressure and relax, meeting the leisure needs of urban residents.

The main research results are shown as follows: ① it is proposed that urban wetland parks play an important role in urban development, and are of great significance for urban sustainable development and ecological balance; ② the relevant concepts and status quo of green healthy cities were analyzed; ③ the current situation of wetland parks in Nanjing was analyzed to lay the foundation for the proposal and solution of the problems; ④ the existing problems of wetland parks in Nanjing were summarized through questionnaire survey, and specific optimization plans were proposed

according to literature, field research and other methods.

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- perspectives of landscape architecture, ecology, and botany, in order to provide reference for promoting sustainable urban ecological development and future construction of wilderness urban parks in the context of the new era.
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