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Research on the Design of Urban Wetland Parks from the Perspective of Flood Resilience—Taking Yuweizhou Park in Nanchang City as an Example

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Abstract: *With the intensification of global climate change and rapid urbanization, urban waterlogging and flood disasters have become severe challenges faced by many cities. Urban wetlands, as an important component of natural ecosystems, play an irreplaceable role in regulating floods, purifying water quality, and providing habitats for living organisms. The main content of this article is to explore the application of the concept of flood resilience in urban wetland parks, based on the interpretation of this concept. Taking Yuweizhou Park in Nanchang City as an example, this article explores the concept and practice of landscape design in urban wetland parks from the perspective of flood resilience, aiming to provide reference value for the protection and construction of similar urban wetlands.*

Keywords: *Flood Resilience; Urban Wetland Park; Ecological Restoration*

1. Introduction

In today's society, natural ecology has unfortunately become a sacrifice for rapid economic development. The extensive natural ecological foundation has been replaced by hardened road surfaces, which makes it difficult for cities to withstand the challenges brought by extreme weather. At the same time, wetland resources in cities that are essential for effectively regulating climate and maintaining ecological balance are also facing increasing depletion. As a key cornerstone of urban ecosystem resilience, wetlands help restore and strengthen the ecological service functions of cities. This level of research is crucial for enhancing the adaptability and resilience of cities in the face of unforeseeable challenges such as natural disasters and environmental changes. Therefore, it is particularly urgent and of profound significance to combine the protection and construction of urban wetland parks with the concept of flood resilience.

2. The Concept of Flood Resilience

The concept of resilience to floods, also known as flood resilience, is a specific application of resilience in the field of flood control and disaster reduction. The concept of resilience has received increasing attention and application in the field of disaster management. This concept originated in the field of engineering materials science and is used to represent the ability of physical systems to maintain stability under disturbance and stress.

With the progress of the times and the deepening of interdisciplinary studies, the concept of resilience has gradually crossed the boundaries between natural sciences and humanities and social sciences, and has been widely applied in multiple fields such as ecology, sociology, and economics. Especially in the context of rapid social transformation, increasingly complex environmental changes, and frequent extreme weather events, the concept of resilience has become an important theoretical tool for evaluating system adaptability, enhancing disaster resilience, and promoting sustainable development.

The concept of resilience to floods emphasises the defensive capacity to carry floodwaters and resist external disturbances in the face of a rain or flood disaster, as well as the capacity to recover quickly from a rain or flood disaster and avoid catastrophic consequences, and the adaptive capacity to adjust and change in response to subsequent rain or flood disasters in different scenarios.[1]This not only requires the construction of robust flood control infrastructure, but also involves improving the response efficiency of social organizations, optimizing resource allocation, enhancing public disaster prevention awareness and self rescue capabilities, and other aspects, in order to form a more resilient and sustainable flood control and disaster reduction system.

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3. The Role of Urban Wetlands in Rainwater and Flood Control

3.1 Urban wetlands can regulate rainfall and runoff

Urban wetlands, as regulators of nature, have demonstrated outstanding abilities in rainwater and flood control. During the rainstorm and river water level rise, it can effectively intercept and store the surplus rainwater, thus greatly reducing the urban waterlogging, and also effectively reducing the water level height and flood volume of the downstream river peak. Taking the Yangtze River Basin as an example, Dongting Lake and Poyang Lake, as important wetlands in China's Yangtze River Basin, play an important role in flood control. Dongting Lake has always been the largest throughput lake in the Yangtze River, with dual functions of reducing flood peaks and regulating floods. According to statistical data, Dongting Lake can reduce the peak flood of Jingjiang River by an average of 34.4% over the years, playing a decisive role in flood control of Jingjiang River. Although the area of Poyang Lake has decreased in the past 60 years, it still plays an important role in regulating and storing floods, accounting for 82.6% of the total regulated flood volume. These lakes and wetlands can absorb and store a large amount of floodwater during floods, effectively reducing the peak water level of downstream rivers and minimizing the potential damage that floods may cause to downstream areas.

3.2 Urban wetlands can store rainwater and maintain regional water balance

Wetland soil, with its unique hydrological and physical properties, exhibits excellent water storage capacity and is therefore known as a "natural reservoir" or "biological reservoir".[2]In urban environments, wetlands have become important places for collecting and storing rainwater and runoff. These rainwaters are cleverly accumulated in different layers of the wetland, including the wetland surface, lush plant bodies, nutrient rich peat layers, and dense grassroots layers.

3.3 Urban wetlands can purify rainwater and floods

With the rapid advancement of urbanization, the problems of air pollution and ground pollution have become increasingly severe, which directly leads to the aggravation of rainwater runoff pollution. In this context, wetlands, with their excellent ability to purify rainwater and floodwaters, have become the key to solving this problem. Wetlands form an efficient natural purification system through the intricate synergy between soil, microorganisms, artificial media, and plant roots. During this process, wetlands can not only effectively retain sediment carried by rainwater runoff, but also absorb harmful pollutants such as heavy metals, as well as excess nutrients such as ammonia and phosphorus.

4. The Significance of Applying the Concept of Flood Resilience to the Construction of Urban Wetland Parks

4.1 Replace traditional flood control projects

Although traditional flood control projects such as embankments and reservoirs can withstand floods to a certain extent, they often have problems such as high costs and impact on the ecological environment. The concept of flood resilience advocates the comprehensive use of engineering and non-engineering measures (such as flood warning systems, flood insurance, flood management, etc.) to replace or supplement traditional flood control projects and enhance the overall resilience of cities or regions.

4.2 Enhance flood adaptability

The concept of flood resilience also emphasizes enhancing resilience by improving the flood adaptability of cities or regions, means that it has some adaptive capacity for stormwater and has some spatial or functional connection to urban precipitation.[3]This includes restoring and protecting natural ecosystems, such as wetlands and rivers, enhancing their natural ability to absorb and regulate floods. Additionally, flood resilience involves strengthening the construction and management of urban drainage systems to improve drainage capacity and efficiency. Finally, it includes enhancing public education and outreach to improve residents' awareness and response capabilities in the face of flood disasters. Through the natural regulation and storage of wetland systems, parks can quickly collect, transfer, and infiltrate floodwaters during floods, reducing the pressure on urban drainage systems and optimizing flood

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management.

4.3 Promote ecological protection and restoration

The construction of wetland parks guided by the concept of flood resilience focuses on the restoration and protection of wetland ecosystems, providing a good living environment for animals and plants through measures such as planting wetland plants and restoring water bodies. The construction of wetland parks provides habitats for birds, fish and other organisms, which helps to enhance biodiversity and maintain ecological balance.

4.4 Achieve sustainable development

The concept of flood resilience encourages the circular utilization of resources in wetland park construction, such as using rainwater for irrigation and wetland plants for water purification, to reduce resource waste. The construction of wetland parks can drive the development of green economy in surrounding areas, such as ecotourism, ecological agriculture, etc., achieving a win-win situation between economic and ecological benefits.

5. Design Principles of Urban Wetland Parks under the Concept of Flood Resilience

5.1 Ecological priority principle

The design of urban wetland parks should prioritize the protection and restoration of wetland ecological environment, and ensure the coexistence and prosperity of wetlands and surrounding environment through comprehensive protection, system design and other measures. The ecological priority principle pays attention to the protection of ecosystems, makes reasonable use of local plants, soil, and other natural resources, and aims to design with minimal environmental damage and impact whenever possible.

5.2 Redundancy principle

This principle emphasises that the redundancy of the system should be taken into account in the design and planning of wetland parks, and that the overlapping stacking of different patch functions is effective in reducing system collapse that occurs when thresholds are breached in a short period of time.[4]By strengthening the resilience structure, sufficient buffer space is provided for the ecosystem to cope with external disturbances, thereby enhancing its overall resilience. In the design and planning of urban wetland parks, by cleverly overlapping and integrating the functions of different sections, the risk of system collapse caused by reaching the threshold in a short period of time can be significantly reduced. Specifically manifested in rainwater management facilities, habitat gardens, and flood control embankments. These designs not only provide leisure and entertainment venues for tourists, but also play an important role in temporary accommodation during rainy and flood periods, effectively alleviating the pressure on the urban drainage system, thereby achieving the integration of various functions and improving system resilience.

5.3 Adaptability principle

In the context of building resilient cities, the design of urban wetland parks needs to closely revolve around the principle of adaptability. This principle emphasizes that wetland parks should have a high degree of self-regulation and adaptability in the face of natural disasters such as floods, in order to ensure the sustainable functioning of their ecological functions and the stability of their ecosystems. When designing wetland parks, it is necessary to fully consider the impact of extreme weather conditions such as floods, and improve the park's flood tolerance and resilience through reasonable terrain shaping, vegetation configuration, and hydrological management.

5.4 Principle of moderate manual intervention

Since ancient times, humans have pursued a state of "harmony between man and nature". In contemporary urban wetland park design practice, this vision is reflected in the pursuit of harmonious integration with the natural environment. In the urban wetland ecosystem, we prudently implement a

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certain degree of artificial intervention within the framework of scientific planning to ensure that it does not cause damage to the ecosystem. In this process, we integrate ecological elements to create an artificial environment that meets both natural laws and human needs, aiming to achieve a dynamic balance between ecology and human society.

5.5 Principles of sustainable development

The ultimate goal pursued by the concept of resilient cities is to achieve sustainable development. Guided by the concept of flood resilience, the design of urban wetland parks must strictly adhere to the principles of sustainable development, the core of this is to take into full consideration the limiting conditions of the carrying capacity of the environment as well as the supply capacity of resources, so as to truly and effectively combine the interests of current use with those of long-term development.[5]This means that in the design process, the ecological, economic, and social sustainability of the park should be fully considered to ensure that the wetland park can maintain its ecological functions, economic benefits, and social value in the long term.

6. Application of Flood Resilience Carrying Concept in Nanchang Yuweizhou Wetland Park

6.1 Project overview

Yuweizhou Park is located on Aixi Lake North Road in Qingshan Lake District, Nanchang City. This project aims to transform a heavily polluted 51-hectare aquaculture pond into a resilient, urban natural shelter through design, providing a variety of ecosystem services for urban wetland parks, including urban flood regulation, water filtration and purification, bird and other wildlife habitats, as well as high-quality public spaces for leisure activities for citizens. The project reconstruction has attempted to endow the city with greater resilience and promote harmonious coexistence between humans and nature.

6.2 Issues and challenges

In recent years, due to climate change and rapid urban development, regional floods and urban waterlogging during the rainy season have been challenges faced by Nanchang city. (see Figure 1)The site was originally a fish farm developed from natural wetlands, with over 30% of the land being a fly ash landfill, causing serious pollution to urban runoff and surface water. At the same time, the site is low-lying and easily submerged; Water system barriers, disrupted transportation networks, and large areas of barren land do not meet the needs of migratory birds for foraging and habitation. Therefore, the issue that the site needs to address is how to restore wetland ecosystem services, including urban flood regulation, water filtration and purification, bird and other wildlife habitats, as well as high-quality recreational spaces for citizens.

Figure 1: Plan before site renovation (source: network)

6.3 Application of Flood Resilience Carrying Concept in Fishtail State Park

At the beginning of its design, the Yuweizhou Park aimed to build a resilient ecosystem. As an important ecological node in Nanchang City, the park not only has basic leisure and entertainment functions, but more importantly, as a "sponge park", it can play an important role in regulating and purifying during rainy and flood periods, effectively alleviating urban waterlogging problems, improving the overall ecological environment quality of the city, and promoting urban development. This design

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concept embodies the core idea of flood resilience, that is, in the face of natural disasters, the system can maintain and restore its functions while reducing negative impacts on the surrounding environment.

6.3.1 Water system layout and regulation function - Restoring the resilience of natural ecology

(See Figure 2)By recycling fly ash from the site and mixing it with the soil of the fish pond foundation, Yuweizhou Park improves soil permeability, constructs floating islands, and shapes a flood storage lake. During rainy and flood periods, the park can adjust its water storage capacity to 882000 cubic meters, and during flood periods, it can also adjust its water storage capacity to 623000 cubic meters, effectively alleviating the pressure on the municipal pipeline network and reducing the risk of urban waterlogging. The park has also implemented a top-down overflow well water diversion project that crosses the north road of Aixi Lake, achieving connectivity with the water of Aixi Lake and further enhancing its regulation and storage capacity, becoming a "natural rainwater regulation and storage pool" within the high-tech zone.

Figure 2: Post renovation plan (source: network)

6.3.2 Ecological restoration and water quality purification - Creating rain and flood adaptive landscapes

According to the differences in water level and aquatic plants, green spaces and wetlands are divided into four areas: sedimentation area, plant purification area, deep and shallow purification pond area, and stable area. Design terraced artificial wetlands, construct rainwater purification systems, filter and purify urban surface runoff.

Affected by the local monsoon climate of Poyang Lake (as shown in Figure 3), the wetland park has planted tree species that can survive in water level fluctuations, including Chinese fir, pond fir, and water fir. Due to the fluctuating water levels often exposing barren and muddy shorelines, perennial and annual wetland plants have been planted along the shorelines and island edges, and a large number of lake surfaces have been covered with plants such as lotus and lotus to form wetland aquatic habitats. The rich wetland plants, including trees, shrubs, emergent plants, and floating plants, constitute the wetland plant community belt, forming "aquatic forests" and "underwater forests", significantly improving the self-purification capacity and environmental capacity of water bodies.

Figure 3: The combination of aquatic plants and trees (Source: Network)

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6.3.3 Terrain design and flood control and drainage - Creating ecological retention areas

The park has fully considered the needs of flood control and drainage in its terrain design. By constructing ecological embankments and setting up flood retention areas, the flood flow rate has been slowed down, the peak flow has been dispersed, and the surrounding areas have been protected from flood invasion. At the same time, facilities such as permeable paving and green infiltration ditches in the park also promote the natural infiltration of rainwater and the replenishment of groundwater, reducing surface runoff and peak rainwater runoff.

7. Conclusion

The deep integration of the concept of flood resilience with urban wetland parks is not only an innovative measure to address the current complex and changing urban environmental challenges, but also an important way to promote urban sustainable development and build an ecological security pattern. This concept emphasizes the integration of resilience thinking into the design and management of wetland parks, that is, the system's ability to absorb, adapt, restore, and continuously provide critical ecological services in the face of natural disasters (such as floods), human interference, and long-term environmental changes, thereby promoting a more harmonious and balanced relationship between the city and the natural environment.

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