Research on Urban Water Environment Design Based on the Concept of Ecological Restoration

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Abstract. Natural disasters and extreme abnormal weather caused by global climate change challenge the sustainability and stability of urban system. Urban river and lake system is an important ecological background of urban environment. Improving the ecological resilience of urban water system plays an important role in consolidating the stability of urban system. In view of the above problems, using the methods of literature research, case analysis and comprehensive analysis, this paper summarizes the theoretical research and practical experience of coping with global climate change and improving urban water system at home and abroad, and analyzes the challenges faced by China's urban water environment under climate change. From the perspective of ecological restoration, this paper attempts to build the evaluation index system of water ecological restoration and the urban design technology system guided by water environment, and puts forward urban design strategies from three urban design dimensions: macro (urban agglomeration or region and its basin), meso (city and its basin) and micro (block and its basin), and explores the implementation of urban water system planning and design based on the concept of ecological restoration This is the way.

1. Introduction
Urban design refers to the comprehensive three-dimensional and control guidance based on the overall and macro background analysis, including regional, urban, block and other aspects. However, nowadays, urban design scholars at home and abroad pay more attention to the in-depth study of urban areas or blocks. The concept of urban design is also divided into three-dimensional space, as an art treatment, for the public domain, emphasis on functional organization, attention to the interaction between behavior and environment, emphasis on the process and generalized comprehensive urban design. Global climate change has become a global concern. Climate change means that cities need to have the ability to cope with future disasters. Eco city design, as a research hotspot to cope with global climate change, highlights its importance[1]. Among them, effective protection of water resources and water cycle is one of the important links to mitigate climate change. As a country in the period of development and transformation, urban development leads to further increase of ecological environment pressure. Urban river and lake system is an important ecological background of urban environment. With the continuous development of region and city, water quality is also affected by urban development. As urban agglomeration enters a new development peak, the growth of city and economy highlights a series of contradictions, among which water ecological environment is one of
the main contradictions. Different levels of urban planning strategies have different guiding functions for different regions, cities and block water system planning. Based on reducing the impact of the development of urban agglomerations on the fragile water ecological environment, this paper studies the evaluation system of water ecological restoration, constructs the urban design technology system guided by water environment, puts forward urban design strategies, and explores the realization of urban water system planning from the perspective of ecological restoration[2].

2. Research experience of water ecosystem management at home and abroad

Different regions and countries have different urban forms, hydrological conditions, climatic conditions and economic levels. Different regions and countries have theoretical research on water ecosystem management according to local conditions. At present, the world's more advanced water ecosystem management theory is introduced as follows. Low impact development (LID) was originally adopted in Maryland, the United States. The purpose of lid is to alleviate the impact of increasing impervious surface. The application of lid can reduce the pressure of rainwater infrastructure and enhance the resilience to climate change. Compared with the traditional urban stormwater management mode, lid promotes the water cycle back to the state before development. Sustainable urban drainage system (SUDs) is a new method for sustainable urban development in the UK. It introduces the concept and measures of sustainable development, considers the water quality, environmental comfort and biodiversity as a whole, and forms a "sustainable urban drainage system" to solve the surface water drainage problem. The full English name of water sensitive urban design (WSUD) is water sensitive urban design (Figure 1). The term WSUD first appeared in academic research and then in the 1994 Western Australian government report[3]. In general, WSUD is a comprehensive scheme of non-point source control and prevention combined with land use, rainwater and flood collection source control, and runoff control, while giving play to landscape aesthetics, water ecosystem, leisure and entertainment and other comprehensive values. ABC waters is an active beautiful clean waters. It is a tropical water ecosystem management project proposed by the Singapore Public Utilities Bureau in 2006 based on the integrated rainwater management experience of Australian water sensitive urban design. Many researchers have studied Singapore's water resource management from the perspectives of water supply, water quality management, urban design and infrastructure. Unlike lid, suds and WSUD, the most obvious innovation of ABC waters is to enhance the cooperation among citizens, government departments and companies; encourage citizens to participate in the supervision of ABC waters project; establish a good training system and professional technology certification system. The development of a city can not be separated from the support of water ecosystem. As early as ancient China, the harmonious relationship between the city and water has been emphasized. In 1990, Mr. Qian Xuesen proposed the landscape city, which continued the traditional Chinese view of landscape nature and the philosophy of the unity of man and nature, and then developed the urban design under the concept of landscape environment and the urban design based on the water environment protection. Sponge city is the most commonly used concept of urban stormwater management in the current urban development in China. In many studies, many lid measures are used for planning and design of sponge City, and the simulation shows a good effect of sponge city construction[4]. The research and practice of international existing water ecosystem management are summarized. The research of lid, suds, WSUD and sponge city mostly focuses on rainwater and flood management and pollution control. The empirical research is relatively micro, lacking consideration of water ecosystem vulnerability from the macro level of urban agglomerations and the meso level of cities.
3. Urban design technology system based on the concept of ecological restoration

Since Clements introduced the concept of "ecological transition zone" into ecological research in 1905, the research of ecological restoration has attracted the attention of global scientific research institutions and scholars. For example, the International Biological Program (IBP) in the 1960s, the man and biosphere program (mAb) in the 1970s, and the geosphere and biosphere program (IGBP) in the 1980s all took ecological restoration as an important research field. In 2001, the third assessment report of the Intergovernmental Panel on climate change (IPCC) defined ecological vulnerability as the degree to which the system is vulnerable or unable to cope with climate change, including the adverse effects of climate events with extreme climate variability. The assessment of ecological restoration starts from the study of natural disasters, and is the core content of the study of watershed ecological restoration[5]. Although some scholars have studied the evaluation of regional and urban ecological restoration, there are few researches focusing on the evaluation of water ecological restoration related to urban design and urban spatial form. PSR model is widely used in the field of ecosystem assessment because of its logic. Therefore, from the perspective of ecological restoration, this paper combs the vulnerability assessment factors related to urban design and urban spatial form, and constructs the vulnerability assessment system of water ecosystem based on the "pressure state response" model. In this paper, P represents the direct pressure that leads to the change of water ecosystem structure and function, such as the change of rainfall, the change of original water ecosystem caused by the construction of shoreline project, the change of total water consumption and total pollutant discharge caused by urban expansion and population growth, etc. This paper summarizes the relationship between the pressure of water ecosystem and urban design. The pressure mainly includes the pressure of natural environment, space environment and social environment. S represents the change of water ecosystem caused by pressure P, such as the decrease of water area, the deterioration of surface water quality, the decrease of groundwater level throughout the year, the rise

![Figure 1. Design process of WSUD](image)
of groundwater level in coastal areas throughout the year, the increase of pollutant content, the
decrease of flow, the loss of land, the loss of biological community, the destruction of living environment,
the increase of flood inundation range, and the aggravation of urban heat island effect. S can be divided into water ecosystem and gas There are two aspects of climate change. R represents the response of system construction, economic structure adjustment, technology improvement and other measures to the change of water ecosystem[6]. Combined with the vulnerability assessment system of water ecosystem, a water environment oriented urban design technology system is proposed from three scales of urban design (Figure 2).

![Figure 2. Water environment oriented urban design technology system](image)

4. Water environment oriented urban design strategies of different scales
In this paper, from the perspective of ecological restoration, the vulnerability evaluation system of water ecosystem is constructed. Combined with the vulnerability evaluation system of water ecosystem, the urban design technology system for the three urban design scales of region city block is proposed. In order to reduce the vulnerability of water ecosystem and improve the quality of urban design, the water environment oriented urban design strategy is proposed from three urban design dimensions[7].

4.1. Urban design strategy of urban agglomerations or regions and their watersheds
The regional river basin is the main water ecosystem background of urban agglomerations, and the main supply of water resources for the development of urban agglomerations. The regional river basin water ecosystem is more or less affected by the development of urban agglomerations, such as the Haihe River Basin is an important water resource in Beijing Tianjin Hebei region, and the Haihe River Basin is the most polluted one among the seven major river basins in China. The main causes of water pollution in the Haihe River Basin are the attributes of public resources, the high proportion of high pollution industries, the separation of management power and regional economic development imbalance. In the process of urban agglomeration development, the destruction of ecological environment, such as the destruction of vegetation, leads to soil erosion; the destruction of upstream water ecosystem leads to the pressure of downstream water ecosystem; the discharge of upstream industrial and agricultural production and domestic sewage pollutes the downstream urban watershed; the high-density population of the city leads to excessive pressure of water resources; the North China Plain has become the world's largest area due to the overexploitation of groundwater for many years The biggest "funnel area" and other problems[8]. To sum up, the urban design strategy of water
environment orientation for urban agglomerations or regions and their watersheds includes the following contents.

4.1.1. The spatial layout of urban agglomerations in combination with water system. Control the concentrated and continuous development of urban agglomerations, especially in areas with fragile water ecosystems. The spatial layout of urban agglomerations can be based on the analysis of current water systems and catchment areas to understand the basic water ecological conditions; the use of 3S technology to analyze flood areas to guide the development of urban agglomerations land layout; the use of 3S technology to analyze water ecological zoning to obtain the water ecological sensitivity analysis conclusions; the establishment of water and soil conservation forests between the built-up areas and rivers and lakes (if the conditions are appropriate, the national forest companies of sufficient scale can be defined Park and other protected areas) to achieve the effect of water conservation and filtration. Combined with the results of quantitative analysis, a dynamic and balanced spatial structure of urban agglomerations is formed by using the natural, organic and ecological multiple combination mode[9].

4.1.2. Focus on protecting the core areas of the river basin. Important Lakes (reservoirs) are the main components of water ecosystem, and in some aspects, the quality of important Lakes (reservoirs) determines the overall water ecosystem quality of the basin. For example, Baiyangdian is the kidney of North China, its ecological environment will affect the balance of water ecosystem in the whole Haihe River Basin. It is particularly important to protect the core area of the river basin. The national water source protection area can be divided into core area, buffer area and experimental area.

4.1.3. Control the development scale of urban agglomerations. In order to protect the water ecosystem in the development of urban agglomerations, we have to be constrained by the ecological carrying capacity, which refers to the maximum sustainable ecological service capacity that the ecosystem can provide for human activities and biological survival under certain conditions, especially the maximum capacity of resources and environment[10]. In the development process of urban agglomerations, it is necessary to control the scale of urban construction area, establish a reasonable proportion relationship between the urban built-up area and the natural, ecological and agricultural hinterland around the city, and ensure the ecological carrying capacity, climate adaptability and disaster resilience of the whole city under the principle of ensuring the self maintenance and self-regulation ability of water ecosystem.

4.2. Urban design strategy of city and its basin
The city is the main gathering place of human life. China's rapid urbanization has posed a great threat to the water ecosystem, and the increase of impervious surface has resulted in the unsmooth water cycle. The production activities of agriculture, animal husbandry and fishery around the city have resulted in a large number of synthetic chemicals such as pesticides, pesticides and antibiotics entering the city's water body, water ecosystem and food chain, resulting in secondary production Pollution; the discharge of urban sewage and waste water causes water pollution; heavy rainfall in rainy season causes urban waterlogging; global climate change causes the aggravation of urban heat island effect; the layout of urban internal space hinders the circulation of wind environment and causes the poor comfort of urban internal wet environment. Based on these problems that hinder the construction of human settlements, this paper puts forward the urban design strategies of cities and their watersheds, mainly including the following contents[11].

4.2.1 Integration of green infrastructure and grey infrastructure. The construction of green infrastructure is in full bloom all over the world, but only relying on the construction of green infrastructure can not fully meet the major needs and goals of urban rainwater and flood management, gray infrastructure is also essential in the city. Therefore, we should not separate "green" and "gray" in the construction of stormwater management infrastructure in the city, but should integrate these two
methods into the same sustainable stormwater management system in combination with the local situation and the practical situation. In the case of existing gray infrastructure, green infrastructure should be integrated to reduce the load pressure of gray infrastructure. For example, green infrastructure should be integrated into the construction of city square, solve the problem of land use shortage, play the rain and flood function of green infrastructure, improve the landscape effect of city square at the same time, and increase the hydrophilicity of citizens[12]. The reasonable utilization and control of urban rainwater and flood resources shall be implemented. In different river basins, the period, scale and scope of urban disaster shall be analyzed reasonably, and the buffer zone of rainwater and flood disaster shall be constructed. For cities with intermittent climate of drought and flood, it is necessary to make rational use of the leached water, and effectively delay, dredge, store and utilize it.

4.2.2 Water environment protection in the upper, middle and lower reaches of the river basin. Taking Beijing Tianjin Hebei Urban Agglomeration as an example, it is necessary to plan and design the water environment protection of Beijing Tianjin Hebei from the national strategic height. We should build a cooperative platform, break the thinking mode and management mode of the administrative area, avoid pollution in the upstream area and non close cooperation after the request of the downstream area, and establish a water environment ecological compensation mechanism. For example, Hebei province undertakes the main function of providing water resources to Beijing and Tianjin. Beijing and Tianjin should provide sufficient ecological compensation to Hebei Province, improve the enthusiasm of Hebei Province to actively participate in water environment protection, at the same time, improve the level of economic development of Hebei Province, and reduce the imbalance of regional economic development. Adjust the industrial structure of Haihe River Basin, reduce the proportion of high pollution industries, and increase the proportion of new technology industries, low pollution and low energy consumption industries in the basin economy. Reduce the scale and proportion of artificial breeding and animal husbandry in the core area and water source area of the basin, and limit the utilization rate of pesticide, fertilizer and antibiotic products.

4.2.3 Water safety prevention and control. There are many practices in the city to cut the bend and straighten the river. Although the river changes from curved channel to straight channel, the flood discharge is smoother in flood season, and the impact of flood on the city is reduced, but the river with too fast flow velocity is not conducive to the formation of wetland, reducing the ecological purification capacity of the river, and reducing the biodiversity on both sides of the river. In the planning of urban internal water system, it is necessary to reserve a straight channel at the bottom of the river to ensure sufficient flood discharge capacity while maintaining the natural curve of the river as much as possible. The rainwater shall be collected from the rainwater collection source by using the rainwater management technology such as lid, and the regulation and storage pool shall be planned. Collecting rainwater in the peak flow period of rainwater runoff can not only avoid the peak of rainwater, improve the utilization rate of rainwater, but also control the pollution of rainwater to the receiving water body, and reduce the pressure on the urban drainage system. In order to achieve the goal of adapting to environmental changes and improve the ability of resisting natural disasters brought by floods.

4.3. Urban design strategy of block and its basin

Block is an important ecological unit in the city, which provides a space carrier for the realization of urban rainwater and flood management technology. From the block level, there are mainly problems such as the unscientific layout of block space, the poor comfort of water climate environment and physical environment, the low utilization rate of rainwater resources, the destruction of waterfront landscape ecosystem caused by the development of waterfront areas, and the high energy consumption of buildings. Based on these problems, the urban design strategy of block and its basin is proposed, which mainly includes the following contents[13].
4.3.1 Water cycle and intensive utilization. Water cycle and intensive utilization are important parts of water ecosystem protection, and also important contents of micro urban design. The common lid, suds and WSUD in the world can be said to be based on the concept of natural water ecology, adopting decentralized and small-scale pollution source control mechanism and design technology to achieve rainwater control and utilization. At the block level, these theoretical methods are easier to implement. According to the natural water system and rainwater collection area inside the block, combined with the water storage units set up in green parks at all levels of the block, the water volume can be effectively controlled, and sufficient landscape water can be provided for the green park. At the same time, the hydrological conditions of the block itself can be improved, the ecological conservation capacity of the water body can be maintained, the water quality can be improved and the water ecological balance can be maintained.

4.3.2 Waterfront landscape system shaping. The construction of waterfront landscape should focus on the harmony between water ecosystem and landscape, take strict protection measures for waterfront areas with dense natural vegetation and rich species, reduce the adverse impact of artificial construction on water ecosystem, and take ecological restoration and ecological compensation measures for waterfront areas with lack of natural vegetation and single species. According to the functional requirements of the city, leisure facilities such as squares and hydrophilic platforms should be built appropriately. For the systematic water network design, it is necessary to rely on the existing water body for ecological transformation as much as possible, such as taking the existing rivers, lakes and ponds as the natural sponge catchment area; for the newly planned water body, the ecological impact on the original water body system should be considered, which should not be too large in scale, scale and shape design.

4.3.3 Green building design. Encourage large-scale construction of green buildings, promote urban vertical greening technology, and reduce the proportion of light and hard roofs. Comprehensively promote the construction community block integrated sponge city technology. Relying on blocks and communities, a wide range of green climate adaptation space units are constructed. We will encourage the construction and development of community farms built by citizens in high-density communities, and strengthen the climate resilience at the community level. Green roof and building vertical greening can not only collect rainwater, improve the efficiency and quality of rainwater use, but also reduce the cost of roof maintenance, reduce the carbon dioxide content, provide wildlife habitat, increase the planting space of agricultural products, increase the green space for public activities, and beautify the urban environment. When setting green roof and vertical greening, the maintenance and management of green vegetation under different climatic conditions should be considered. In hot and humid areas, the climate changes little in four seasons, the temperature and humidity are suitable for plant growth and survival, and the three-dimensional strategy of green space is easy to implement. The climate conditions of the four seasons in the cold area are distinct, and the growth conditions of green plants are extremely harsh, so it is necessary to select cold resistant, drought resistant and pollution resistant plants according to the local climate characteristics.

5. Conclusions
Under the background of global climate change, as the ecological background of regional and urban development, the protection of water ecosystem is particularly important for the sustainable development of regional and urban. The construction of water ecosystem restoration evaluation system, water environment oriented urban design system and different scale urban design strategies for water ecosystem are conducive to the construction of urban human settlements in three scales of region city block. In the process of new urbanization in the future, the construction of eco city will be the focus of development, and the research on water ecosystem in urban design will be more in-depth.
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