Research on Sponge City Planning Based on Resilient City Concept

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Abstract: In recent years, China has made great efforts to promote the planning and construction of sponge cities. The State Council also pointed out that the low-impact development mode should be actively carried out to promote the construction of sponge cities in the approval of the overall planning of the pilot cities of sponge city construction. With the intensification of climate and environmental problems such as global warming, sponge city is gradually adopted for urban planning and construction in the development of modern cities, so as to improve the utilization rate of urban water resources. But still exist in the process of urban planning integration, the problem of the relative lack of systematic and consistent, so we need resilience thinking, introduced on the basis of the sponge city, in the city the top-level design from multidimensional perspectives of using toughness thinking mode for planning and construction, to further improve city heat island effect, and the ability of severe weather. Based on the current advanced concept of resilient city, this paper puts forward the conception of sponge city planning in view of the problems in the planning and construction of sponge cities in China, in order to provide a reference model for the pilot city construction.

1. Introduction

Since the "technical guide for the construction of sponge city" was published in November 2014, in 2015 and 2016, the state published two central financial strategies to support the construction of sponge city pilot projects, a total of 30 pilot projects, to vigorously carry out the construction of sponge city. However, according to incomplete statistics, 19 out of the 30 cities that had been included in the pilot had waterlogging problems, accounting for 63% of the total, indicating that the domestic sponge cities still face many problems in planning, construction and academic research. The goal of sponge city construction refers to the city's ability to resist and recover when facing various urban water problems, which is consistent with the goal of resilient city rising in the field of urban planning in recent years.[1] It can be said that the construction of sponge city is regarded as an important part of the construction of resilient city. Therefore, it is a more comprehensive concept to take the resilient city as the research scope.[2] When there are problems in the construction of sponge city, it can provide new ideas and planning perspectives for the research of sponge city. In this paper, by carrying
out a large number of theories and practices of sponge city sorting, taking the theory of resilience as the guide and the pilot city as the research object, the concept of sponge city planning is put forward.

2. Theoretical basis

2.1 Resilient theory
The etymology of "Resilience" is "Resilio", which originated from the Latin word "bounce" and means to return to its original position. Resilience is widely used in many disciplines, including mechanics, psychology, sociology and ecology. [3]Different disciplines have different understandings of its connotation and different emphases. However, the consensus reached is the ability of a system to cope with and recover from external changes, interference and self-changes. Countries all over the world are committed to the planning and construction of resilient cities, but most of them are developed countries, and they show strong local characteristics, such as "a stronger and more resilient New York" in New York, the United States, "managing risks and enhancing resilience" in London, the United Kingdom, "strengthening resilient territory plan" in Japan, etc. "A stronger and more resilient New York" in New York, starts with the analysis of the overall climate change, carries out a series of analysis of the impact of natural disasters, including the analysis of the safe sea-level rise, hurricane and flood in New York, and lists the urban infrastructure and human resources, including coastline protection, construction, economic recovery, community disaster prevention and early warning, environmental restoration and other urban infrastructure and living environment construction detailed action plan, and provides financial support. "Managing risks and enhancing resilience" in London, the United Kingdom requires that the construction of a resilient city should meet the following aspects: ① identifying potential disasters; ② setting resilient targets; ③ implementing projects; ④ regularly evaluating and updating projects and targets.[4] London clearly put forward the concept of resilient London, the core of which is to carry out the assessment of the response capacity and measures for the risk of major disasters and accidents that may occur in London, to ensure that when major accidents occur, the city can adapt, bear, make decisions and respond quickly, to minimize the loss. Japan divides the concept of "strengthening resilient territory plan" into four basic objectives: ① try the best to protect people's lives; ② protect the important functions of the state and society from fatal damage; ③ ensure the minimization of national property and public facilities; ④ the ability of rapid recovery.

2.2 Sponge city theory
Michael Rubiner first proposed the idea of a "sponge city" in 1995. T·Budge(2006) and Neilargent (2008) and other Australian scholars used the concept of "sponge city" to metaphor the adsorption effect of cities on surrounding rural population. Ignacio F·Bunster-Ossa(2013) used the term "sponge city" to describe the resilient ability of cities to deal with natural events of rainwater like a sponge. However, there are not many overseas scholars who directly study sponge city. The representative works include Sponge City edited by Sophie Balbo from France. Wolfgang F. Geiger, Germany, paper "Sponge City and Low-Impact Development Technologies: Vision and Tradition", etc. Foreign studies on sponge city construction are mainly focused on the utilization of urban rainwater resources and the management of urban rainwater resources. The urban stormwater resource management technology system mainly includes optimal stormwater management measures, sustainable drainage system, water sensitive urban design, flood risk control decision support system and low impact development, etc.

The connotation of sponge city can be summarized as "sponge body" through protecting rivers, lakes, wetlands, etc., to repair the damaged urban water ecosystem, through the rainfall methods to adopt "slow release" and "source dispersion", so as to carry out technological innovation, improve the level of ecological environment governance, ensure urban water safety, solve a series of problems of water pollution and ecological degradation. [5] The essence of sponge city is to solve the problem of coordination between urbanization and resources and environment, realize the construction of sustainable and healthy water circulation system, and finally make the city have the ability of
"resilience" to adapt to environmental changes. As some experts have said: the essence of a large number of water problems is caused by the overall dysfunction of the water ecosystem. From the perspective of ecosystem services, the core of the construction of "sponge city" is to carry out the construction of water ecological infrastructure across scales and combine various specific technologies to build water ecological infrastructure. [6] Therefore, from the connotation of sponge city and the core theme of construction, we can find that the characteristics of sponge city project are different from general projects. These characteristics show that compared with the promotion of ordinary projects, the promotion of sponge city construction projects is facing more complex and hidden problems.

Through the analysis, we know that the core concept of sponge city construction is very similar to the concept of urban resilience. Therefore, adding resilient thinking in the process of sponge city construction can help us to re-examine various problems existing in the construction of sponge city from a new research perspective, so as to break the current difficulties faced by the construction of sponge city.

3. Sponge city construction under the guidance of resilient thinking

3.1 Analysis on the main purpose of introducing resilient thinking into sponge city planning

The concept of sponge city is put forward in the development of modern city, which aims to make the urban water system have the same function as sponge. When the precipitation is relatively large, it can absorb and store too much rainwater for the city to use during the period of water shortage, so as to enhance the city's ability to cope with heavy rain, typhoon and urban heat island effect. Resilient thinking and this development concept maintain a high degree of similarity. The so-called resilient thinking mainly emphasizes the ability of the system to recover and maintain the stability of the state under pressure. Due to the excessive dependence on various infrastructure construction and the lack of research on the effectiveness of facilities in the current sponge city planning in China, the introduction of resilient thinking will be an effective supplement to this situation. The introduction of resilient thinking in sponge city planning can not only improve the ability to identify the multi-level vulnerability of urban water system, but also carry out in-depth analysis of potential risk factors existing in the construction of urban water system, so as to realize the pertinence, scientificity and rationality of the planning scheme, so that the water system of sponge city can obtain stronger self-recovery ability to cope with various environmental problems such as rainstorm, typhoon and urban heat island effect, and effectively maintain the stability and balance of the urban water system.

3.2 Analysis of the main function of introducing resilient thinking into sponge city planning

Introducing the concept of resilient thinking into the planning of sponge city can not only provide a new solution to various practical problems encountered in the development process of sponge city at the present stage, but also broaden the scale of research, so that the sponge city has a systematic and macro planning pattern. At the same time, it can also enhance the ability of sponge city to cope with rainstorm, typhoon and urban heat island effect in the planning and construction of the overall framework system, and further consider the construction of urban flood control facilities, including natural storage water, large-scale storage facilities and drainage channels, so as to enhance the integrity and coordination of urban water system and related subsystems planning, for example, in the planning of flood control facilities, we should focus on the coordination of flood control mode of regulating and storing water body and gate pump combined discharge, so as to give full play to the due functions of sponge city.

4. The research direction

The research object is the system architecture and implementation path of sponge city construction from the perspective of resilient city. The system architecture of sponge city construction from the perspective of resilient city is studied, and the basic path of collaborative innovation to promote the construction of sponge city is discussed.
Firstly, theoretical basis: the theoretical basis of sponge city construction from the perspective of resilient city. The scientific connotation of the concept of "resilience" is defined, and several theoretical bases of sponge city construction are explained, including "resilience" city thought, urban development law, water philosophy, etc., emphasizing "Chinese wisdom". This paper discusses the theoretical basis, historical basis and practical basis of sponge city construction from the perspective of resilient city. Analyze the necessity of sponge city construction. New-type urbanization and urban development need to be endowed with the connotation and characteristics of "innovation-driven" and "green development", and explore the construction path of sponge cities.

Secondly, value positioning: the strategic significance of sponge city construction from the perspective of resilient cities. What are resilient cities and sponge cities? This paper discusses its scientific connotation, main characteristics and main body selection, and then clarifies the strategic significance of sponge city construction. Emphasize the value orientation of "people-oriented", from the reality of economic and social development, explore solutions and extract experience.

Thirdly, empirical research: the status quo and problems of sponge city construction from the perspective of resilient cities. According to the identification of key elements from the perspectives of economy, technology, government, society, resources and environment, empirical research is conducted on the pilot cities of sponge city construction through the tools of investigation, interview and data statistics, and the status quo, main problems and deep-level reasons of sponge city construction are analyzed.

5. The practical application of sponge city construction under the guidance of resilient thinking

5.1 Improve the ecological resilience of sponge city planning
In terms of sponge city planning, based on the macro perspective, we should carry out the research on the basin and regional characteristics of the city, reasonably carry out the planning construction of urban water system and green space, accurately identify the potential vulnerability risks in the local ecological environment of urban water system, including matrix, patch and corridor, and systematically carry out the ecological environment planning of urban water system, to ensure the safety of water system, and through the optimization of green space system and ecological pattern of sponge city, to reshape the ecological resilience of sponge city.

5.2 Improve the engineering resilience of sponge city planning
In terms of sponge city planning, we should not only reduce the impact of engineering construction on the environment, but also improve the engineering resilience of the city from multiple dimensions, so as to make the gray facilities with stronger carrying capacity of the city. In terms of planning and construction, we should constantly strive to improve the urban drainage and flood control system, strengthen the gray green combination of municipal facilities construction and sponge city construction through the mutual coordination and cooperation of natural storage water body and sluice pump drainage flood control mode, so as to enhance the city's ability to cope with extreme weather such as heavy rain or typhoon, and reduce the city's heat island effect. In addition, in order to enhance the unity of sponge city planning, we should carry out the detailed decomposition of construction indicators, promote and implement the planning scheme of sponge city according to the state and nature of land use, and provide necessary management and guidance for the construction of related projects.

5.3 Improve the economic resilience of sponge city planning
Due to the planning of sponge city needs a lot of capital support, it is necessary to complete the formulation of more attractive industrial development planning on the basis of the existing PPP mode and fully combined with the actual characteristics of the city, so as to widely attract investment from various sources of funds, and ensure that the development of sponge city can obtain sufficient construction funds.
5.4 Improve the social resilience of sponge city planning

The key to improve the social resilience of the sponge city planning is to improve the management and control mechanism. For the planning and construction of sponge city, we should make clear the main body of management and control, establish a perfect management and control system, provide sufficient technical support, and strengthen the cooperation of relevant departments, so as to make the city's management system have the ability to respond to emergencies in a timely manner and make effective emergency treatment, to comprehensively enhance the social resilience of the sponge city. Therefore, in terms of the planning of sponge city, we should adopt technical control means to complete the construction of information platform, realize the implementation of planning results in urban management, and carry out real-time monitoring, evaluation and decision-making management of the situation.

6. Conclusion

In general, although foreign research perspectives on resilient cities are still comprehensive, supported by theories and corresponding practical applications, on the one hand, the development of theories is not mature enough, and there are still big controversies in many aspects. On the other hand, the introduction and application of the concept of resilience, especially the domestic research is still in the initial stage of urban planning and architecture, while the introduction and promotion of sponge city construction has not attracted much attention.

Combined with China's reality, we should introduce more urban governance and practice and explore from several perspectives based on the resilient city framework.

1. We need to be aware that the development of resilient cities is a long process. This is mainly because the development of resilient cities is affected by many aspects and has many uncertain factors.

2. Due to the different environmental conditions and backgrounds faced by different regions, it is not meaningful to compare the toughness between cities. It is advisable to study the toughness changes of a region or city along the longitudinal axis of time.

3. The construction of resilient cities requires cooperation from multiple parties. Various stakeholders are involved in the construction of resilient cities, such as government, builders, residents, etc.

4. The perspective of sponge city construction should be changed from single rainwater management to resilient city construction. It is far from enough to find out the flood risk and assess the vulnerability of the city. Under the background of the constantly changing external environment, sponge city construction needs to deal with the risk with a positive and proactive concept.

At present, the construction of sponge city in China is still in its infancy, and it still needs to carry out further exploration in many aspects, such as planning methods, construction approaches and management guarantee measures. This paper attempts to introduce the concept of resilience into the planning and construction of sponge city, and conceive the planning framework of pilot cities of sponge city construction, hoping to enhance the resilience of cities in dealing with water environment and water disasters. The construction of sponge city will become the trend of sustainable development in the future. How to carry out the planning, construction, operation and management of sponge city according to local conditions will be worth our further thinking and exploration.

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