Study on Strategy Planning of Sponge City Construction in Guizhou Province from the View of Resilient City

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Abstract. In recent years, extreme weather is constantly emerging on a global scale. Excessive development and construction of cities has changed the original water systems of cities, and lead to urban water hazards and water environment deterioration. Since 2014, after China has been vigorously promoting the plan of sponge city and relative construction, the problems of urban water systems gradually get relieved. By introducing the concept of resilience in this study into the development of sponge city planning strategies, a comprehensive and systematic top-level design of sponge city planning and construction is made from the four dimensions of ecological resilience, engineering resilience, economic resilience and social resilience. At the same time, combining with the issues in existing pilot sponge urban planning and construction process such as the lack of systematicness, integrality, fragmentation etc., based on the study case of pilot sponge city - Guiyang city in Guizhou province, with the resilience concept as the guidance, it is presented in this study the planning strategies of sponge city ecological pattern developing, systematic planning and construction guidance, and explored the extended industrial development of sponge city and the construction control mechanism, trying to provides a new way of thinking and a new approach of sponge city planning and construction related research.

1. Introduction
The theory of resilient city is derived from the concept of resilience in physics, which is introduced by the ecologist Holling and has been adopted beyond ecosystem research, and has become a topic of research in different disciplines, including natural disasters and risk management, climate change adaptation, engineering and planning. In the face of environmental and socio-economic uncertainties and risks, “resilience” has also become the core goal of urban construction planning and development. For the concept of resilience, different scholars have different way of perception. From the initial ecological restoration, to the engineering resilience combined with urban hardware construction, and till economic and social resilience, the perception of resilience that integrates economic and social impact is the mainstream of current academia. A “resilient city” in this vision refers to a city that is able to take flexible response measures, preserves itself, maintains the vitality of development, attracts resource collection, avoid potential losses and cope with challenges and changes through self-organized learning of social system. Five points are summarized as the characteristics of a resilient city: (1) multi-functionality, emphasizing the mixing and overlying of urban functions; (2) redundancy and modularization, emphasizing the dispersion of risks in time and space; (3) ecological...
and social diversity; (0) multiscale network connection; (5) planning and design with adaptability. Generally speaking, the basic meaning of resilience is to be able to effectively mitigate the impact of external shocks, maintain the operation of its main functions, and quickly recover from the crisis.

In China, the theory of resilient city has also begun to attract the attention of scholars in the industry. In 2012, the annual forum of the school of architecture and landscape design of Peking University has set resilient city as its subject, which was the first focused exchange on resilient city in China. In the same year, Qiu Baosheng pointed out at the Chinese Urban Development and Planning Conference that urban diversity is beneficial to the realization of urban “resilience”. The theme of the 7th annual conference of the IACP - International Association for China Planning in 2013 was “Building resilient cities in China: planning and scientific”. In the same year, in his capacity as Secretary General of Environmental Initiative Council, Zimmerman also pointed out the need for China to build resilient or dynamic cities at the fourth China International Eco-city Forum. In addition, academic circles also began to publish papers to discuss the development status and prospect of urban agriculture and bicycle transportation system in resilient cities. In a word, although the research on resilient city in China has started late, it has received more and more attention and extensive thinking.

2. Application value of the research
Guided by the theory of resilient city, the resilient thinking is carried out in this study, to respect the law of urban development, adheres to the principle of people-oriented, and faces the problems of “rain equals to flood” and “submersion” as the “urban disease”; when it is dry, the drought is on the way, and intensification of “heat island effect”, etc., to discuss the system framework and implementation path of sponge city construction in Guizhou Province from the perspective of resilient thinking, so as to fundamentally identify the vulnerability of all levels of the city, analyze the potential risks of the city, so as to make the construction plans more reasonable, scientific and targeted, so that the city can have the ability to restore the balance and stability of the urban water system in the face of water environment, water resources, water ecology and other related issues. To put forward constructive suggestions to housing, urban and rural construction and other relevant departments of Guiyang as the pilot city will help promote the intensive, environment friendly, low emission and smart development of Guizhou Province, improve the capacity of urban ecological governance, and promote the establishment of the environment friendly development concept and policy selection and institutional arrangement.

3. Problems in the planning and construction of sponge city in Guizhou Province

3.1. Poor systematicness of planning and construction
Projects contained in sponge city construction are highly complex, involving a wide range of specialties including: urban planning, landscape design, municipal engineering, water conservancy engineering technology, construction engineering technology and so on, which require cooperation of professionals from different fields to make the sponge city system more systematic and holistic as a whole [1]. While in the current sponge city construction projects, due to the restriction factors of construction time, development area and so on, the construction system of sponge city in some parts of the city has not formed an organic whole, with a lack of top-level design and unified planning, the connection between the construction projects of sponge city is weak, and have not become a complete system to work together to solve the problems existing in the urban water systems.

3.2. The research scale is too limited
In 2014, “Sponge City Construction Guide” (hereinafter referred to as the “guideline”) issued by the Ministry of Housing and Urban-Rural Development of the People’s Republic of China ( MOHURD ) points out that in the construction of sponge city, it is necessary to protect the original ecosystem of the development area to the maximum extent, for the damaged ecological environment, ecological restoration is essential, which suggests that the sponge construction of a city should not be limited to
small scale study such as streets, community and so on, but should be covered from the multiple scales of city, region or watershed. At present, the construction of sponge cities mainly focuses on the small-scales, such as the reconstruction of residential areas, streets, parks and small leisure areas towards the direction of a sponge city, and the construction of local sponge infrastructures. These micro-scale measures cannot satisfy the need to protect and repair the whole city’s ecosystem.

3.3. Over-reliance on infrastructure construction
The guideline states that in the construction of sponge cities, the overall planning of low impact development rainwater systems, municipal drainage systems and excessive stormwater runoff discharge systems should be take into account. At present, the focus of sponge city construction is mostly focused on the construction of low-impact development infrastructures, such as the construction of concave green space, permeable paving and green roof. Low-impact development infrastructure construction of sponge cities can solve the problems of waterlogging, surface pollution of a city to a certain extent; however, low-impact development infrastructures cannot solve all urban water problems, the invariable pursuit of low-impact development infrastructures in size and quantity, ignoring the overall role of other related urban systems, will result in a significant reduction in the efficiency of sponge city construction and construction efficiency.

3.4. Construction projects are fragmented
The problem of fragmentation of sponge city construction projects is the consequence that sponge city construction is eager to advance the project construction pace, but with the insufficiency of overall planning. During construction, the existing problems in the city or watershed are not analyzed and coordinated as a whole, while the construction of low impact development infrastructures is regarded as a unitary way to promote the construction of a sponge city, which is only addressed by focused at a certain point or a certain area where problems occur. This way of promoting sponge city construction in fragmentation is easy to cause problems such as repeated construction, difficult operation and maintenance in the follow-up constructions, which have greatly affected the construction and implementation effect of sponge cities.

3.5. There are fewer sources of economic support
In 2015, the Ministry of finance of the people’s Republic of China proposed to provide a three-year financial support for the pilot construction of sponge cities. The annual financial subsidies for municipalities directly under the central government, provincial capitals and other cities were 600 million, 500 million and 400 million respectively. The State Council proposed that local governments at all levels should increase their investment in the construction projects of sponge city, and encourage banks and other financial institutions to increase their credit support for the construction projects of sponge city. In “The Guidance on Promoting the Construction of Sponge Cities” issued by the State Council, it is proposed that by 2020, more than 20% of the built-up areas in all provinces and cities need to meet the requirements for the construction of sponge cities. While according to the statistics of the Ministry of Housing and Urban-Rural Development of the People's Republic of China, the construction cost of sponge cities is huge, that the capital required per square kilometer is about 100 million to 150 million yuan. [2] Although the investment from the central finance and local governments at all levels can support the construction of some pilot areas, there is still a huge funding gap to achieve the construction goal of 2020.

3.6. The management mechanism is not yet wholesome
Sponge city construction needs to go through planning and design to construction, operation and maintenance and a series of processes, which involve the functional departments of housing and urban-rural development, Development and Reform Commission, Water Resources, Finance, Land and Resources and so on, and also involves the cooperation of planning, gardening and other professionals. The departments and the professionals act as different roles respectively in the sponge
city construction, Therefore, the construction of a sponge city needs each department and each specialty to perform each of their duties with high degree of cooperation [3]. However, the sponge city construction nowadays has not yet established a sound management mechanism to clarify the problem of “which department to control what content in a specific stage”; therefore, the management mechanism needs to be further improved.

4. Application of resilience thinking in the planning and construction of sponge city in Guizhou province

4.1. Building a sponge city with ecological resilience

Guiyang, as the capital of Guizhou province, has entered the stage of rapid development in recent years. The rapid development of the city not only changed the urban water system, but also has destroyed the overall ecological resilience of the city, making it difficult for the city to maintain the stability of the urban ecosystem when disturbed by extreme weather. For example, on July 16, 2014, a heavy rainfall occurred in the central urban area of Guiyang city and the districts (cities and counties) under its jurisdiction. The rainfall in the central urban area reached 201.7 mm, which is the maximum since meteorological records began. More than 198,000 people in the city have been suffered from the torrential rain, 8,905 hectares of crops were damaged, and 359 houses collapsed or ruined. To conduct sponge city construction from the perspective of reshaping urban ecological resilience, it is able to stand from a macro scale to take city, region or watershed as the research objects, to strengthen the restoring force of urban green space system, water system and other subsystems in the face environmental interference, and to conduct planning for its water ecology, water environment and water safety in a systematic manner, so as to identify the potential risk and vulnerability of its ecological background such as patch, substrate, corridor and so on, while to build the sponge city ecological landscape, and optimize the green space system.

4.2. Building a sponge city with engineering resilience

The improvement of the urban water system from the sponge city system not only depends on the construction of low-impact development infrastructures. The sponge city construction projects of Guiyang City are mainly concentrated in Gui’an New District. Compared with the central urban area, the area is low in density, with larger development space. Thus, it is able to strengthen the resilience of regional engineering from many aspects, so as to enhance the loading capacity of regional gray infrastructures, improve the regional flood control and drainage systems, improve the reproduction period of municipal storm drainage system, and strengthen the integration of gray infrastructure and green pipe network between sponge city construction and municipal system, and make low-impact development infrastructures and municipal pipe network systems work together to ensure the stability of urban functions in response to extreme rainy weather[4]. At the same time, in order to avoid the fragmentation of construction projects, the construction indicators of sponge cities in the region need to be re-decomposed, to design the index scheme of the sponge city which can be generalized and reproduced according to the hydrological properties and land use status of the development area, so as to guide and manage the construction projects of the sponge city[5].

4.3. To develop a sponge city with economic resilience

The investment in sponge city construction is extremely high, and the central financial distribution and local government financial subsidies can’t fill the huge fund gap of sponge city construction. In the notice issued by the Ministry of Finance, if PPP mode used for pilot construction of sponge city has reach a certain proportion, 10% of the special subsidy from the central government will be awarded. This incentive system can promote the adoption of PPP mode for the construction of sponge cities as a means of raising funds for the construction of sponge cities. However, the current scale of cooperation and capital investment still cannot meet the capital demand of the construction goal in 2020. If we want to attract more social capital to participate in the construction of the sponge city, Gui’an New
District of Guiyang city needs to introduce a series of preferential measures to ensure that investors can obtain stable returns, to improve the economic resilience of sponge city construction, make it not only rely on the government to purchase services to earn profit, but also make plans for relevant industries of sponge city according to local conditions, to attract more social capital investment, so as to provide a more stable source of investment funds for sponge city project construction.

4.4. Building a sponge city with social resilience
The aspect of improving social resilience of sponge city is reflected in the improvement of the management and control mechanism. By defining the three aspects of control subject, technical control and management implementation in different stages, the process of building sponge city system is ensured with clear department of responsibility, perfect technical guarantee and sound system control, to ensure the joint operation of every functional department and the rapid response to sudden situations, so as to enhance the social resilience of sponge city construction. The establishment of a wholesome sponge city planning control system is an important guarantee for the smooth progress of sponge city construction. In the planning stage, technical control should be focused on to transfer the planning and design results into urban management language. While in the operation stage, the management and control should be strengthened, to establish the information management and control platform of the sponge city, to realize the whole-process control of monitoring, evaluation, simulation and decision-making.

5. Conclusion
At present, the country is paying high attention to sponge cities, which has brought great changes and development opportunities for urban and rural planning, municipal engineering and other related professions. The theory of sponge city has also provided a guarantee for the rapid and sustainable development of the city’s future. The research on planning strategies of sponge city construction in Guizhou Province under the resilient city view point is a positive exploration of the planning and construction of sponge cities in Guizhou Province. It is hoped to improve the stability and resilience of the city to deal with water system problems. Nonetheless, the study of sponge city from the perspective of resilient city is a relatively blank field, and the research on the system structure and implementation approach of sponge city construction under the resilience thinking view is still in its initial stage, and there is still a long way to go to create a sponge city theory, norm and standard with Chinese discourse.

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