

Comparative Study on the Development of Sponge Cities in China in Recent Ten Years

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ABSTRACT

The development of society has caused serious damage to the natural environment, which made the frequency of extreme weather events have greatly increased. Sponge city has the ability to store water, trap water and recycle water, which gives it huge advantages compared with traditional cities. By analyzing the development of Chinese sponge city and compared with other countries' similar treatment, this paper has concluded that Chinese sponge cities have developed rapidly, but still exist many problems that need to be solved. This paper aims to make a summary on the development of sponge cities in China, and provide some possible solutions for the exposed problems.

Keywords: *Sponge City, Project Construction, Sponge City Design, Green Building*

1. INTRODUCTION

As early as the pre-Qin period, terraced fields were created to reuse water resources. The design of Chinese classical gardens retains the water culture with traditional characteristics. Mature schemes and ideas on the use of water. It also reflects the unique view of ancient China on the use of water [1]. China has long had the vision of building sponge cities, but due to the immaturity of time and conditions, the project has been shelved until 2015, when the State Council officially issued the pilot city of sponge city construction in China, kicked off the curtain of sponge city construction in China. The advantages and disadvantages of sponge city development in China can be clearly understood by comparing with foreign countries that started sponge city construction earlier. At present, the United States, the United Kingdom, Australia and other countries have introduced their water treatment plans, but they are all implemented by local enterprises, and only after reaching a certain scale can the central government lead the full implementation. China's overall urban construction and other countries the same sponge, basic it is aimed to a reasonable allocation of water resources utilization in order to achieve environmental protection, reduce the occurrence of natural disasters, such as urban waterlogging, but China's urban construction compared with foreign sponge the difference is that it is an urban planning project, led by the central government, has the obvious advantages of concentrate resources to accomplish large undertakings. The speed of development is much higher than that of

western developed countries. However, it should be noted that there are a series of major problems in China's urban construction, such as old equipment, backward concepts, relatively fixed urban construction mode, incomplete relevant regulations and a late start, so there is a certain gap between China and the sponge city constructions in developed countries. We should solve the above problems and give full play to the obvious advantages of the central government to develop and perfect Sponge cities in China. Sponge city construction is mainly reflected in unique architectural facilities, such as permeable pavements, constructed wetlands, rain gardens and so on. These facilities can intercept and store rainwater to a certain extent, delay their entry into the pipe network, and reduce the drainage pressure of the pipe network. It is worth explaining that the construction of sponge city can only reduce the impact of flood disaster on the city, but cannot completely eradicate the impact of flood disaster [2]. This paper summarizes the development process of sponge cities in China and compares them with similar governance schemes in other developed countries.

This paper points out the current problems of sponge city in China and puts forward some solutions, aiming to summarize the development of sponge city in China, in order to give reference and help to the construction personnel of sponge city.

2. OVERVIEW OF VARIOUS “SPONGE CITY” PROJECTS AROUND THE WORLD

2.1. Some developed countries’ similar governance schemes to sponge city

Rational utilization of water resources and reduction of urban waterlogging and other disasters are common challenges faced by most countries. Because the United States, the United Kingdom and other developed countries started earlier in this respect, summed up rich experience, established a relatively perfect water treatment system. Here are some similar governance schemes for sponge cities in developed countries.

Table 1. Similar governance schemes among developed countries [3]

Country	Treatment
America	best management practice (BMP)
	low impact development (LID)
	green infrastructure (GI)
England	sustainable urban drainage systems (SUDS)
Australia	water sensitive urban design (WSUD)
Japan	rain water inflection program

Sponge cities have something in common with many of these projects. For example, low-impact development in the United States is a storm management and non-point source pollution treatment technology developed in the late 1990s. It aims to control runoff and pollution generated by storm through decentralized, small-scale source control, so that the development area is as close to the natural hydrological cycle as possible. Through the construction of rainwater gardens, green roofs and other buildings to achieve the purpose of in-situ collection, natural purification, nearby use or reclamation of groundwater. This is the same as the concept of sponge city construction. For example, in Japan's rainwater infiltration plan, such as laying permeable pavement or gravel pavement in parking lots and squares, and constructing seepage wells; the regulation of building bypass channel in the narrow part of urban river also has something in common with the concept of water utilization in sponge city [4].

3. SPONGE CITY CONSTRUCTION IN CHINA

3.1. The plan of sponge city construction in China

Under the guidance of the six-character policy of "infiltration, stagnation, storage, clean, use and discharge", the construction of sponge cities in China is required by the six-character policy of "infiltration,

stagnation, storage, clean, use and discharge". The construction technology of sponge city has formed the technology or technology combination represented by permeable pavement, permeable concrete asphalt, sunken green space, biological retention pond, seepage pond, seepage well, rainwater garden, rainwater recycling and utilization, initial rainwater discarding and so on.

Sponge city -- "infiltration": with the advancement of urbanization construction, the hardening area of urban road surface increases sharply, which changes the original natural ecological background and hydrological characteristics. The way of natural precipitation replenishment of groundwater is blocked, making the groundwater level decrease year by year, causing great danger to the conservation and protection of groundwater. The means of "infiltration" mainly rely on pervious paving materials to change the characteristics of hardening, so that rain water "infiltration" down.

Sponge city -- "stagnation": understood as "stagnation". Rainwater delays rainwater runoff by means of microtopography, which can be manifested by sunken green space, rainwater garden, ecological retention pond, infiltration pond, constructed wetland and so on.

Sponge city - "storage": the main performance is to use the sponge city measures to store rainwater, to regulate storage and peak shifting purposes. The common measures are plastic module water storage, underground reservoir, water body with storage volume, etc.

Sponge city -- "clean": through soil infiltration, through vegetation, green space system, water, etc., can produce purification effect on water quality, such as soil leachate purification, constructed wetland purification, biological treatment.

Sponge city -- "use": in the "storage" stage, rainwater is recycled for green land sprinkling, water replenishing, etc., to realize rainwater reuse.

Sponge city - "drainage": the use of vertical urban and engineering facilities combined, the excess rainwater discharged into the river, municipal drainage pipe network, to prevent the formation of new waterlogging disaster [5].

Under the guidance of the six-character policy, the construction of sponge cities in China has been carried out.

3.2. The process of sponge city construction in China

In April 2012, the concept of "sponge city" was first proposed in the "2012 Low Carbon City and Regional Development Technology Forum". On December 12, 2013, General Secretary Xi Jinping emphasized in his speech at the "Central Conference on Urbanization" that "when improving the urban drainage system, priority

should be given to reserving the limited rain water, making more use of natural forces for drainage, and building sponge cities with natural storage, natural infiltration and natural purification". In 2015, the State Council issued the "Sponge City Construction Roadmap", pointing out that through sponge city construction, the impact of urban development and construction on the ecological environment will be minimized, and 70% of the rainfall will be absorbed and utilized locally. It

proposes that by 2020, more than 20% of urban built-up area should meet the target; by 2030, more than 80% of urban built-up areas will meet the target. The control rate of annual runoff is taken as the rigid control index of urban planning. The reward areas are built into sponge cities. 30 sponge cities are selected as pilot cities. These pilot sponge cities are distinguished from the city scale, climate zones and other aspects to strive for diversity and richness of sponge city construction data.

Table 2. Distribution of Pilot projects in 30 sponge cities across the country [6]

Classification	Level	Number of pilot city
Climate partition	rainy	2
	wet	16
	sub-humid	12
City size(population)	megacity	3
	huge city	4
	big city	7
	medium city	9
	small city	7
City level	municipalities directly under the central government	4
	deputy provincial city	6
	prefecture level	16
	state-level new district	2
	county-level city	2

3.3. The conclusion of sponge city construction in China

Since 2015 and 2016, the list of 30 pilot sponge cities has been gradually announced. More than 400 cities have actively responded to the call and carried out sponge city construction projects. Most cities have reached the target of "by 2020, more than 20% of the urban built-up area will reach the target". For example, as the second batch of pilot cities for sponge city construction, Shenzhen has completed 226.00km² of sponge city construction by the end of 2019, accounting for 23% of the urban built-up area. Achieve the national sponge city construction target one year ahead of schedule [7].

But sponge cities are not a permanent solution. Zhengzhou is a sponge city pilot city, which has spent more than 50 billion yuan in three years to build sponge city. However, in 2021, the city was affected by the extreme weather of extremely heavy rain, which caused severe flooding and nearly paralyzed the city. Sponge city can only cope with small and medium rainfall and have little effect on large rainfall [8].

4. FUTURE DEVELOPMENT OF SPONGE CITY IN CHINA

4.1. Problems encountered in sponge city development in China

The development of Sponge city in China is not smooth sailing, it also faces many obstacles and difficulties. (1) Imperfect laws and regulations. The construction of sponge city is a huge and complex project, which needs to be guided by perfect and detailed laws and regulations. China's vast territory, geographical location and natural conditions are different, which brings great difficulties to the construction of sponge cities. (2) Technological innovation is lagging behind. Technological innovation ability determines the construction quality of sponge city. In the construction of sponge cities, technical problems such as rain gardens and green roofs are often encountered. The development of sponge city in China starts relatively late, and the accumulation of science and technology is relatively backward. (3) Backward construction concept. In the construction of sponge cities in China, there are a few people who unilaterally pursue the construction speed

and the overall construction concept is relatively backward. In the process of urban construction, due to the one-sided pursuit of construction speed, the overall planning of urban construction is not strong, and the construction concept is backward [9].

4.2. Possible solutions to China's sponge city construction problems

(1) Improve relevant laws and regulations. The construction of sponge cities in China is a major national project, with many departments involved in the construction and extremely difficult coordination and management among departments. Therefore, it is quite important to improve relevant laws and regulations. (2) Improve the technical level of sponge city. Rainwater gardens, green roofs and other buildings in sponge city construction require high technical level, so it should be improved as soon as possible. Foreign related construction started earlier, rich experience, can be used for reference; secondly, to improve their own research ability. It can promote the combination of production, education and research, strengthen the cooperation between enterprises and universities, and attract excellent talents to conduct relevant research by launching special projects [10].

5. CONCLUSION

By comparing the construction of sponge cities in China and abroad, the construction of sponge cities in China has been on track. Over the past decade, guided by the six-character policy of "infiltration, stagnation, storage, clean, use and discharge" and supported by relevant policies, China has made sponge city develop rapidly, completed the sponge construction of more than 400 cities in China, and solved the problems of urban waterlogging to a great extent. However, we still have to admit that there are series of problems in the development of sponge city in China, such as the backward ability of scientific and technological innovation. In order to better build sponge City, we need some solutions, such as try to improve the relevant technical level of sponge city. This paper has summarized the development process of sponge city in China in recent ten years, and pointed out some problems and superficial solutions about them in the construction of sponge City, in order to provide reference and help for the builders of sponge city.

AUTHORS' CONTRIBUTIONS

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