

Design and Application of Ecological Water Landscape Based on the Concept of Sponge City

Honghong Dong

Art Department, Tianjin University of Technology and Education, Tianjin, China

Abstract: With the significant acceleration of urbanization and industrialization, urban construction faces severe water shortage problems. Such problem greatly affects the development of cities and disrupt the natural way of people's lives. In order to solve the problem of urban water circulation, the Sponges city concept is proposed. The concept is to re-use and recycle the urban water and rainwater. Moreover, it intends to make the urban water cycle more flexible, achieves the combination of urban development and water recycling, reshapes the ecological environment and urban natural hydrology, and rationally controls and manages urban rainwater problems.

Keywords: Sponge city, ecological water landscape, water cycle.

1. THE BACKGROUND OF DOMESTIC URBAN LANDSCAPE CONSTRUCTION FROM THE ECOLOGICAL URBAN WATER LANDSCAPE POINT OF VIEW

Along with the rise of the 21st century modernization waves and the continuous advancement of social development, science has brought about the advancement of knowledge and technology. Most households are now being built on high-rise buildings, and their design is driven with development of science and technology. This had led people to realize their wildest fantasies. Most designs nowadays have shown to involve and decorate nature through pursuing natural beauty, natural vegetation and animal pattern-less prints. However, nature has also been suffering from industrial pollution. One of these significant distractions is groundwater quality pollution which tends to bring about many diseases. Sound water landscape design focuses on urban planning paying much attention to local plant landscape. It can show the unique cultural and historical context of the region enhancing people's quality of life, and integrate with the green landscape. Responding to the major strategic deployment, the 18th National Congress of the Communist Party of China has dedicated t promoting the construction of ecological civilization and follow the green design of harmonious development between man and nature. In the general strategy of socialism with Chinese characteristics, the 18th National Congress of the Communist Party of China proposed the integration of ecological civilization construction with politics, economy, culture and society, and building a socialist road with Chinese characteristics. How to achieve the coexistence and harmonious coexistence between man and nature and how to build an eco-city waterscape under the new road are two problems which

must be solved. In recent years, domestic water resources problems have continued to occur, and numerous cases of water pollution have already occurred frequently. In different media news reports, we have seen many problems in the use of human water resources in major cities. For example, it is often reported that cities have difficulty in discharging rainwater, many urban roads have been covered water of meters in depth, and many residents' in urban areas were trapped by water. Furthermore, many rivers are polluted and the water quality is very poor. This problem has also led to shrinking wetlands and their function gradually declines. Various investigations have found that the city's water pollution is shocking. Water is the most precious resource for mankind, and the pollution of water quality has caused tremendous obstacles to the development of China and people's lives.

Most of the intensification of water resources problems are caused by human beings' endless demand from nature. This kind of problem has become a chain reaction, which not only affects people's normal life order, but also causes serious losses to our economy, material and cultural living standards. The water consumption is increasing rapidly, however, more and more fresh water resources are being polluted in large quantities. The large discharge of industrial sewage and domestic sewage has exerted tremendous pressure on the development of cities.

In their natural state, different species have their internal living organization and structure. Yet they will exhibit different ecological and organizational structures in different environments. The ecological type maintains the structure of natural production in accordance with the development of nature, and maintains its stability in any environment. In the natural existence, the growth of all things can only exist in harmony with nature, otherwise it will cause the imbalance between all things and nature. The question of interest is what the water landscape in the ecological organization and structure is. The water landscape is a landscape composed of water in the natural environment. The water landscape provides the leisure and entertainment functions for people's lives. In view of the current domestic water pollution problems, we could find out the reasons from the water landscape.

The water landscape design is not only useful to create beautiful landscape for people and provide leisure, but also contain fingerprints of natural, historical and cultural records, and reflect its ecological grade. The industrial society is developing rapidly, and many urban parks are being built at this stage. At the expense of the environment, we continue to pursue the form for appearance. Under the concept of sustainable ecology of the Chinese Party, when designing the water landscape, its should start from the concept of ecological development so that people can enhance self-sustainability of ecology. This can be achieved through the planning and environmental design of these parks thus being close to the natural scene. At the same time, the problem should be solved from the root cause by building a water scene with a certain cultural and educational value, and actively promote the planning of a multi-functional landscape.

2. ANALYSIS OF DOMESTIC WATER SHORTAGES BASED ON THE CONCEPT OF SPONGE CITY

2.1 Sponge city theory research and analysis

Sponge City is a new type of artificial ecological environment designed to solve the problems of rain and flood in an environment. It is the city plan that solves its environmental problems by primarily integrating nature into artificial world. It has a sponge-like water-absorbing and water-discharging function for solving natural disasters. Also known as the “Waterborne Automated Retractable City”, it is a major rainwater drainage system and is making a significant contribution. This ecological world has a system regulating function of water absorption, water storage, water seepage, water purification and drainage formed from natural regulators.

As the name indicates, the sponge concept will store water when there is excess which can be ‘squeezed out’ to be re-used. The concept of the sponge city has a great impact on people's thinking, wondering if the city really achieves the practical application of its name. The urban pavement breaks the initial dirt road for the flatness of the road surface. The pavements of city roads are mostly cemented and leveled, which nowadays have become slogans of clean and tidy city. However, these are the major causes of problems of urban water pollution and rainwater flooding. Now that most of these roads are already covered with such impermeable layer, the problem of urban rainwater causing water accumulation and flooding can only be solved by adjusting underground pipelines. Thus, large number of rainwater discharge problems are solved only by thickening pipelines, which consumes huge financial and human resources. During the rainy season, since roads are expected to flood, city management is called to clear and open the road to public again. As long as rain exists, cities will constantly face this problem unless the pavements are changed. In the face of serious urban rainwater problems, many cities do not achieve internal self-regulation. The flooding of water in the rainy season forces many districts of each city to expend a large amount of human and financial resources. However, this problem will also cause many districts serious deficiency in water and in need to be supplied by external forces from other regions since ground water cannot be recharged. This shows that urban water resources and water quality problems need to be adjusted using design ideas. Such design should tackle this problem to advantage, and transform the rainwater flooding into a problem that is conducive to urban development and create values for the entire city. According to the development concept of sponge city, urban construction will emphasize the priority of nature-based and green-orientation. The main forms of this design include grass ditches, rain garden, roof garden, sunken green space, water absorbing pavement and other green measures. Cities need to use sponge concept to give control over main planning and design concepts.

2.1.1 Roof garden

As the name suggests, the roof garden is an idea of filling the roof of a building with green plants. It not only improves the self-sustainment of the environment, but also insulate, add aesthetic value, purify the air, improve leisure and the greening area of the building, and further

increase the surface area of the building for specific purposes. Urban green coverage may seem insignificant measure considering the entire ecological environment. These small thoughts and actions however can bring about the balance and development of the entire ecosystem. Moreover, based on the fact that people are now interested more and more in time spent enjoying their surrounding aside work n stress, such designs will make more sense.

The nature and essence of ecotype is actually the cover of green rate. There is a saying that the ecological knowledge of the moment is well described as "Trees need to grow in clumps", "Green should be planted in patches", which is the best feedback to the city. Therefore, the ecological thought of roof garden has made a great contribution to the ecological construction of China.

In modern home design, the major design requirements of the house are based on a warm and comfortable design concept. Therefore, the design will pursue healthy and environmentally friendly green decorations. Some designs even use a more direct approach to cover the entire interior with green plants as a decoration. Space. In conclusion, the roof garden generally not only meet the needs of customers, but also greatly help the adjustment of the entire ecosystem.



Figure 1. Roof garden

2.1.2 Permeable pavement

Generally, the roads and pavements people walk on are made of different materials. The large-scale asphalt pavement on the road has no water absorption performance. It is more for the convenience of vehicles and meeting the looks of urban life. However, as proposed by the Sponge city concept, when designing the landscape one should use permeable paving (as shown below). More rainwater in the rainy season will penetrate into the ground and replenish groundwater. This is a natural ecological structure, and a green ecofriendly water circulation method. The water will be in the rainy season is infiltrated into the soil and stored. This process will increase urban freshwater resources, and helps to compensate for urban water shortages. In addition, it will also have the function of flood control.



Figure 2. Pervious floor filled with permeable bricks and green plants



Figure 3. Permeable pavement of park trails

2.2 Reasons for water shortages

The shortage of water resources is mainly due to the intensification of urban industrialization and the discharge of a large amount of sewage. Generally, China's population is not not evenly distributed over its vast land. In addition, the population of China continues to grow, which implies increase in water consumption. Yet the urban residents use excessive water and water saving is very weak. The irrational use of water and resources has led to the deterioration of the ecological environment and the aggravation of drought. The self-regulation system of nature is destroyed by human beings, which further aggravates the problem of urban water shortage.

2.3 Current status of urban resource utilization in China

2.3.1 Implementation status of domestic sponge cities

In response to domestic water resources utilization and ecological environment issues, many famous designers in China have planned ecological water landscape design. The famous landscape design master Yu Kongjian has solved the problem of ecological environment and water resources in many areas, and has transformed the design of many domestic decoration products. He has for instance designed different parks all over the country such as the design of Tianjin Bridge Park, the red ribbon of Qinhuangdao in Hebei, Zhongshan Park, the rice field campus of Shenyang Jianzhu University, and so on.

China's urban landscape is mainly reflected in the design and application of urban public space including parks, urban roads, streets, waterfront parks and other ecological rainwater constructions. Urban residential places, residential high-rise buildings, small indoor spaces use planting ditch, seepage paving, roof garden, green plant decoration, cultivation of wall plants, etc. On the other hand, outdoor plantings such as, flowers and trees, use a green ecological form to increase the green-ness of the environment. In the public roads, parks, play grounds, parking lots, tourist attractions and other public areas, permeable pavement are also used. Another useful design is grass-growing ditches used on both sides of the road, which makes up for the impermeable surface of road by seeping sewage and surface water flow into the grass ditch. It filters it through to recharge groundwater.

For the collection and discharge of water resources, green vegetation that readily absorbs water resources is grown counteracting to the rainfall season especially in the North part of China where it's mostly dry. There are also different plantings of precipitation appropriate to the local shrubs and trees. Therefore, green vegetation that store water are planted more. During the rainy season, the rainwater remaining after reaching used by sufficient vegetation is absorbed and stored by the plants. In the dry season, the plants can automatically replenish water. This can reduce the amount of artificial irrigation, and enhance the concept of sustainable development. In addition, more natural water-absorbing materials, including sand, asphalt, stone particles and so on can be used.

In the engineering construction sites for instance, wastes should be disposed of in a clean way before polluting and damaging the surrounding environment. The discharge from factories however, is directed into water bodies before being filtered. Therefore, these water bodies surrounding factories carry a large amount of chemical substances. Therefore, permeable devices should be used in the factory area to control the spread of sewage. These are the implementation status and practical cases of some water pollution and water shortage in China.

3. FROM ECOLOGICAL WATER LANDSCAPE PLANNING TO THE DEVELOPMENT OF URBAN SPONGE CITY

3.1 Landscape planning based on natural ecological water cycle research

The water cycle is the moisture content of different time and place in the entire planet. The sun radiates heat turning the liquid water into vapor. From figure 1.4 below, it can be seen that the water from the local pools and the ocean evaporates into water vapor. Thus, the three states of water; solid, liquid and gaseous, are continuously being converted into one another. The water is distributed as it precipitates on different areas, such as ground surface, rivers, lakes and oceans.

Adhere to the concept of eco-city construction, follow the laws of nature, maintain the self-regulation ability of natural ecosystems, and regulate the environmental problems of ecosystems through water systems such as constructed wetlands, and plant a large number of green vegetation land.

Landscape planning is most usually based on the local climate and attributes. It is carried out in a specific areas and regions. In the process of landscape layout, the natural water circulation system is maximized without changing its own characteristics and nature. For example, the design of Binjiang Park, shown below in figure 1.5, uses waterscapes and embankments to plant aquatic plants suitable for local growth environment for landscaping. This is the water circulation system created by the garden landscape in line with the natural ecological laws combined with the landscape techniques. The artificial landscaping method and the cultivation of aquatic plants belong to the symbiotic relationship. In addition, the landscaping environment system and structure are closely related to the development of the city and the living standards of people. The construction of water features has a great relationship with the local geographical environment, climate and hydrological factors. These factors play an important role in the artificial landscape. For the foundation of the entire ecological planning system, these must be connected according to local conditions. Factors from the concept of sustainable ecology to build a water cycle system should combine natural environment alongside with the human made measures.



Figure 4.



Figure 5.

3.2 Water resources recycling and recycling in sponge city

The water resource cycle of the sponge city is an ecological planning system that is based to tackle problems such as waterlogging disasters, unreasonable distribution of water resources, and the shortage of water resources. According to the rainy season climate, urban water accumulation is difficult to discharge during this season, and pipeline drainage is largely at risk. The sponge city concept has created a system for regulating urban water system problems. Discharged water can be used to recharge rivers, lakes and groundwater through special structures and frameworks.

The core of the sponge city design concept is to create a water circulation system that conforms to the natural environment. The whole ecosystem is planned using new technologies, mainly using the six-character technology of seepage, stagnation, storage, infiltration, reuse and drainage management system. In the engineering facilities, it mainly presents grass-growing ditch, sunken green space, roof garden, rainwater gardens, constructed wetlands, and permeable pavements to reduce surface runoff. This also allows a large amount of underwater seepage and promotes natural water circulation and recycling.

4. ANALYSIS OF URBAN CONSTRUCTION MATERIALS BASED ON THE CONCEPT OF SPONGE CITY

The most important concept in the construction of sponge city is the “green construction”. Therefore, the concept of green vegetation’s design is used as much as possible in urban architectural planning and interior decoration. In the process of planning any space, a large area of green land should replace other urban construction materials. That can happen to some extent, and it not only enhances the air quality, but also conveys the concept of green ecological education for pedestrians and passers-by, as well as it reduces the tremendous pressure on urban development.

Facing the difficulty in discharging rainwater in urban space, the largest sponge is the display of water leak’s usage. The use of permeable pavement on the road has become the foothold and foundation point for solving urban rainstorm disasters. The traditional platoon-based approach can no longer help the problem of urban drainage difficulties. The permeable material is a special “pipeline” for urban drainage. It has an important role and significance for the drainage of surface runoff and has great practical value for urban construction. The accumulation of rainwater will cause blockages in urban roads, increase the pressure on urban residents, and use the self-collecting system to permeable the sponges. In that way the rainwater will be completely replenished to the underground and the city will be better developed. Also people continuously extract the groundwater and both of these actions cause the ground to sink, so the rainwater harvesting system not only relieves the pressure on the city, but also recycles the rainwater to achieve a balanced discharge system. In recent years, the city has been flooded by rain, causing a lot of loss of human and financial resources. For example, according to news reports, on July 21, 2012, most of the country was hit by heavy rain, and neighboring cities such as Beijing suffered the strongest floods for many years. A large number of people died

and many houses collapsed, causing huge human and financial damage. In the recent years, from June 15 to 19, three small counties in Xianyang, Shaanxi Province, were hit by hail and heavy rain, causing a large loss of crops which as well affected the population. The area touched by the disaster is huge. Based on the various cases reported by the news in recent years, China's problem of urban water accumulation is facing severe challenges. Therefore, urban construction needs to emphasize the use of urban construction materials. Reduce the contaminants attached to the surface and spread the rainwater everywhere. The use of permeable pavement and the coverage of green vegetation will absorb, filter and recharge the groundwater level. Aspects such as environmental compensation capabilities are far greater than the ability to handle environmental problems.

5. MAINTAINING THE ECOLOGICAL FUNCTIONS OF NATURAL ECOLOGY AND WATER CYCLE, OPTIMIZING THE PLANNING AND DEVELOPMENT OF SPONGE CITIES

5.1 Increase water resources recycling

As the problem of urban shackles continues to intensify, the rain has caused great damage to human and financial resources. The country has paid more and more attention to the problem of rain and flood, and has taken a lot of measures, including the application of the sponge city concept in the whole landscape planning. The development of the sponge city concept has solved a large number of domestic rainwater problems from the source and controlled the spread and loss of surface rainwater runoff. However, this low-impact development does not cover the entire corner of the city. Many domestic cities still need to use the dredging of the pipeline network to deal with the flooding problem. Any shape and organizational structure is not unique or fixed. The Sponge City concept solves the problem of 70% of the water in the country, but it also requires the combination of pipeline transportation to make the development of green cities sustainable. So the problem is how to make the construction of sponge city more optimized and it is one that needs to solve now. Systems that prevent internal flooding should consider the balance and the cooperation between different systems in urban planning.

The optimization and utilization of the sponge city promotes urban planning and development, follows the natural characteristics of the water cycle, and builds a natural-oriented, people-oriented environmental ecosystem and water landscape. To achieve a harmonious urban water circulation state, the water cycle filters harmful substances in water through a seepage, stagnation, storage, usage, net and discharge, providing nutrients for water and improving water quality. The concept of the sponge city is effective in controlling urban land and laying a solid foundation for the development of the city, such as maintaining global water balance, keeping fresh water resources updated, regulating global heat balance and shaping the surface of Earth.

5.2 Improving urban water network damage

The urban residents' water use situation, the use of urban construction materials, and the design and construction of urban water landscapes have great significance and value for urban water network management.

Urban water network management, urban security and residents' safety issues are the key factors for urban development. Only by establishing an ecologically harmonious water network relationship can urban water quality management and urban water resources be used effectively. This can further push to improve water quality. The largest construction of the pipe network is the ecological chain of centralized sewage treatment, which is effective for the treatment of engineering sewage. Planning should be promoted to build a structured, orderly drainage system.

5.3 Remodeling construction and research of sponge city

The construction of the sponge city is essentially the coordinated development and harmonious unity between green land, water resources, urban construction and residents' lives. Sponge city is not only the existence form of “sponge body”, but also needs to combine the local water network management problem, climate environment factor, human factor and geographical factor to create the optimal sponge system. Only the sponge city design combined with various factors can achieve the best coordination state. Moreover, it can contribute to a coordinated development, increase management, and design a landscape-based water network based on nature. Further research and shaping are needed for the development system and application of the sponge city.

6. SUMMARY

The development of water landscape has created a green ecosystem. It has created a natural water resource system, which is conducive to the development of the city and the continuous improvement of people's living standards. When planning the water landscape, sustainable ecology is its primary consideration. However, the design must also follow the natural and ecological concept. The landscape of the park must maintain its ecological nature. This is the development trend of landscape vegetation, and it is also the need of water resources transformation and harmonious development of the society. The design of the water landscape not only meets people's desire, but also realizes its own maximum benefits and values for the environment. The development of the sponge city has solved lots of domestic water resources and environmental problems. The ecological concept of ‘infiltration, stagnation, storage, use and drainage’ creates the greatest water cycle in terms of ecological value. Building a sponge city starts from the household level with reasoning every water use.

This paper mainly combines the development concept of Sponge City with the urban management drainage system to solve the serious problems in China. In addition, the construction of this design is not only the proposal and application of the sponge city concept, but can also reflected in the reshaping of the sponge economy system and the sponge value system.

REFERENCES

- [1] Yu Kongjian. Design Ecology [M]. Beijing: China Building Industry Press, 2013.2.
- [2] Mc Hag. Design combined with nature [M]. Tianjin. Tianjin University Press, 2006.3.
- [3] Yu Kongjian. The beauty of the foot and the beauty of the weeds [M]. Beijing: China Building Industry Press, 2003.3.
- [4] Gao Jun. Planning and design of recreation and sports [M]. Chongqing: Chongqing University Press, 2011.