Research on Toughness Design Strategy of Wetland Park Based on the "Chain Theory" —— A case study of Wuhan East Lake Falling Wild Goose Scenic Spot

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Abstract. Wetland is the significant territorial resources and natural resources in China, whereas the establishment of wetland park is an effective measure to protect wetland resources. The research, taking the Wuhan East Lake Falling Wild Goose Scenic Spot as the example and pointing out the "chain theory", focuses on the toughness plan and design of wetland park to build "Wetland Pond Chain System" and promote the capacity of nourishing and defending, which can be benefit for the sustainable development of wetland and provide certain references for wetland park plan and design in the future.

1 Background

The wetland, as one of the most biodiversity ecology landscapes in nature and the most momentous survival environments for humans, possesses obvious performances of environment adjustment and ecology improvement[1,2]. With the continuous development of urbanization, the urban wetland parks have been one of the important measures to effectively protect the wetland, which is of great significance for urban ecology base optimization and providing social service function[3]. At present, the establishment of urban wetland park has gained the attention, but it still faces the thereat of over-developing environment resources and human activities. Hence, It is vital to enhance the defence ability of wetland against urban interference and the self-recovering ability after being interfered.

"Toughness", deriving from the concept of ecology, refers to the bearing capacity and self-recovering ability, on the premise of no fundamental changes in sustaining essential life process and structure, when the ecological system gets external interference[4]. According to the status quo of urban wetland, some reasonable plans and designs based on the standard of toughness will be conducted, which could effectively relieve the contradiction between urban wetland and the urban development, as well as ensure the urban ecology safety.

The plan and design of wetland park toughness can enhance its resistance and resilience, and also has a great significance for the sustainable development of wetland park. The research, taking the Wuhan East Lake Falling Wild Goose Scenic Spot as the example, will be based on the theory of toughness design, put forward the "chain theory" of wetland toughness design, build "Wetland Pond Chain System", construct four modularization habitat units and explore the methods of wetland park toughness plan and design.

2 Statues Quo and Problems of Wuhan East Lake Falling Wild Goose Scenic Spot

2.1 Site analysis

East Lake of Wuhan, located the city center in Wuhan, Hubei province, is one of the largest lakes within city in China. Meanwhile,as the important target of urban ecology red line safety[5], it is full of sufficient natural resources and obtains the significant function of protecting and raising ecological system. Its designed position is in Wuhan East Lake Falling Wild Goose Scenic Spot and it covers an area of 50.1 ha, including site subject area of 49.4 ha and two islands area of 0.7 ha.

2.2 Site Surrounding Analysis

The Wuhan Railway Station is located in the north of the site; Tuanhu is adjacent to its west; Yanxihu lies in the east and separated by railways and urban roads; Many built projects situate in the south of East Lake like the Falling Wild Goose Scenic Spot, Moshan Scenic Spot, The Wuhan Botanical Garden and Maanshan Forest Park. The villages and farms are distributed scatteredly around the site and quite a few universities are included in.

2.3 Site Internal Analysis

For the nature condition, there are two larger ponds and several small ponds within the site. The elevation is higher

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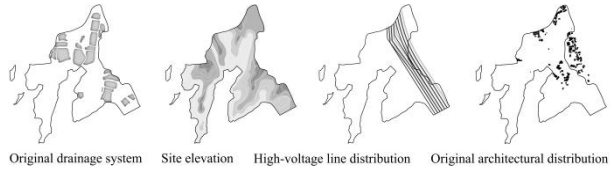
in the east and lower in the west with an elevation difference of about 10M and a gentle slope.

For the humanity and culture condition, there is a group of south-north high-voltage power lines in the eastern site, which limits the building construction and human activity. A adjacent and south-north greenway lying in the west separates the site nature environment strongly. Meanwhile, a few village buildings exist in the internal site, distributing into cluster.(Picture 1:Site Internal Analysis)



Picture 1. Site Internal Analysis.

2.4 Site Problem

2.4.1 wetland habitat destruction

The obvious habitat destruction exists in site status quo, including the four aspects like road fissuration, vegetation recession and water and soil loss, fish and bird resources exhausted,water quality eutrophication. The railway in the east separates the East Lake and Yanxihu, and blocks the ecological corridor, and influences the substance exchange and energy flow; The vegetation along edge of the site recesses hard and the water and soil loss happens in the two islands of eastern site; In recent years, the overfishing results in the species amount decline of fish and birds, which made bad impact on the recovering function of ecological system. The unreasonable emission of nitrogen and phosphorus led to a gradually serious water pollution. Aquatic organisms imbalance weakened the self-refine ability of the water, which accelerates the water eutrophication.

2.4.2 Human Building Occupying the Wetland

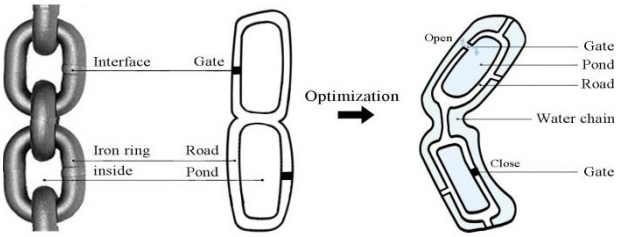
With the development of urbanization, human activity of overconstruction is constantly eroding the natural space. The continuous expansion of surrounding buildings approaches the wetland persistently. With the increasingly dramatic urban industrialization, the emission of sewage and gas causes great damage to the whole East Lake region. The high-voltage power lines in internal site affects the biology survival.The throughout urban greenway is not good for the continuation of the ecological environment.

2.4.3 Lack toughness in ecological system

Due to the location at the city centre, the wetland can be easily affected by the urban development and human activities, thus the ecological system will be destroyed. That is the site lacks the defence capacity on external interference and can hard recover from external interference. The low diversity of species and single ecological environment make the wet land lack the ability of raising lives, and it is difficult to form an entire and strong ecological system.

3 Put forward “chain theory” of wetland toughness design

Through the analysis on the status quo and problem of the site, it is aimed at building a toughness wetland ecology system. It's dominated by “chain theory” to set up a ecological chain of layer-by layer defence for resisting the external thereat, which, simultaneously, can enhance the site self-raising and self-recovering functions and protect the internal ecological safety of East Lake. The chain is a kind of steel rings connected with each other. In the design, each pond unit is regarded as one of the steel rings, the entity of the chain is the road, and the internal space is the pond. Each controllable water-gate of pond units accordingly equals to the open and closed place of the chain steel ring. If there is one of the rings broken, the entire will be influenced. So based the original type of the chain and optimizing the design, a layer of water system is added to its external part to make the dynamic control system be more reasonable, and the Pond - Road - Water Chain modularization distributed mode is formed then.(Picture 2: Chain Mode)



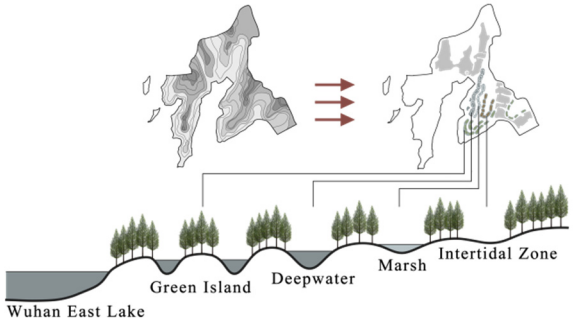
Picture 2. Chain Mode.

3.1 Pond Chain formation of East Lake Falling Wild Goose Scenic Spot

Based on the chain mode and taking full advantage of chain typology characteristics, that is to say each ring is not only the independent one, but also connects with each other, a dynamic modularization pond chain where the chain rings can be both connected with each other and blocked is to be built.

Integration excavation was carried out on the basis of the original ponds to form several single independent small ponds. Excavating the external part of the ponds and putting multiple ponds in a ribbon chain to form four pond chain with different depth by connecting them. There is a water-gate controller set outside the pond, which can make the ponds connect and disconnect mutually. The previous analysis indicates that due to the higher in the east and lower in the west, the underground water level in lower area is higher and the underground water level in the higher area is lower. Thus the four type ponds from east to west is respectively: intertidal zone, marsh, deepwater and green island.(Picture 3: Pond chain sectional drawing). With the depth of pond chain

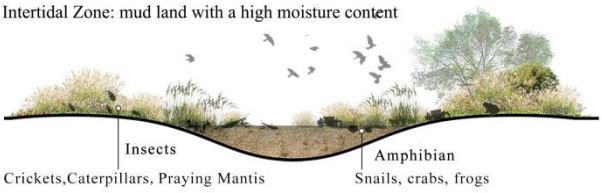
increasing, the diversity of species will be more abundant, more ecological, and the layer-by-layer resistance on urban interference is formed.



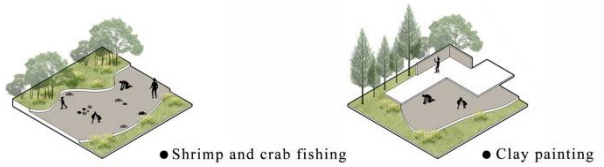
Picture 3. Pond chain sectional drawing.

3.1.1 Intertidal Zone

Tidal flat refers to the newly deposited intertidal flat[6].Intertidal zone is the most external water chain, which situates the highest position in the water chain structure. Therefore, it provides habitats for both insect like crickets,caterpillar and amphibian like crabs and frogs with the high water containing rate of mud(Picture 4:Intertidal Zone habitat).During the post period of construction, many activities like catching crabs and drawing with the mud can be conducted here.(Picture 5:Intertidal zone activity)



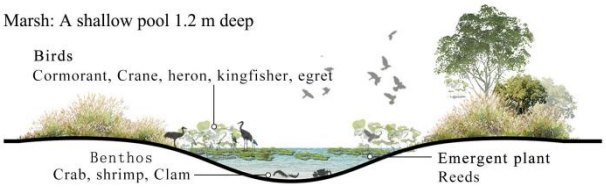
Picture 4. Intertidal Zone habitat.



Picture 5. Intertidal zone activity.

3.1.2 Marsh

Marsh is the middle layer of the water chain. Marsh plants are transitional types of aquatic plants and terrestrial plants[7].The depth of 1.2m shallow pond is created according to terrain relation and water plants are to be planted to provide habitat for the bird like gray cranes, egrets and benthonic animal like shrimps, oysters(Picture 6:Marsh habitat). The activities of picking lotus root and birdwatching can be conducted in such habitat.(Picture 7:Marsh Activity)

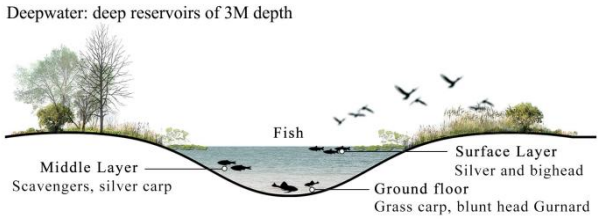


Picture 6. Marsh habitat.

Picture 7. Marsh Activity.

3.1.3 Deepwater

The deepwater is the most internal part of the water chain, which situates the lowest position in the water chain structure. Thus the depth of about 3m ponds are created to make fish species abundant. For example, the chub is suitable to survive on the surface; Scavenger fish and white silver carps is suitable to survive at the middle and the grass carbs is suitable to survive at the bottom(Picture 8:Deepwater habitat). The deepwater is also an appropriate display place of turning on the water-gate to connect the water chains, and can be the display field of water-gate theory and water purification.(Picture 9: Deepwater activity)



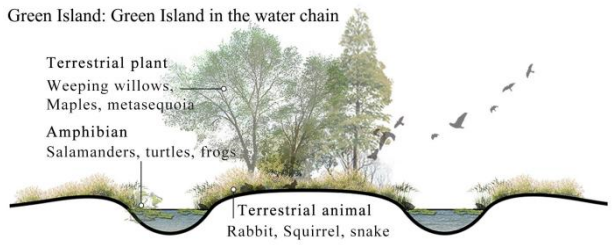
Picture 8. Deepwater habitat.

Picture 9. Deepwater activity.

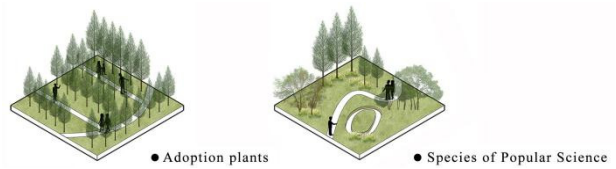
3.1.4 Green Island

The greenway goes through the water chain net, separating the chain into south and north. The south of greenway is the green island water chain whose structure is island-water type. The main plants in island are the terrestrial plant like weeping willow, Chinese ash and metasequoia, which provides the habitat for the terrestrial animal like rabbits and squirrel. The habitat surrounding the greenway water chain is for salamander and tortoise(Picture 10: Green Island habitat). The habitat of green island not only raises these natural lives, but it also

presents the sources for plants acknowledgement and popularization of biology.(Picture 11: Green island activity)



Picture 10. Green Island habitat.

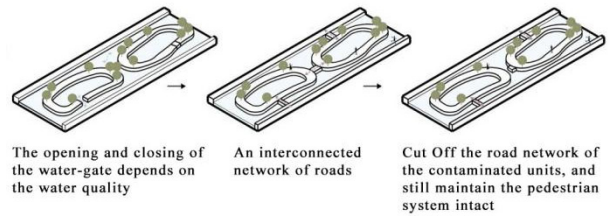


Picture 11. Green island activity.

3.2 Pond Chain System Dynamic Control

The controllable water-gate will be set between ponds and pond chain. When the external interference is small, the pond chain will implement the entirely nourishing. The water-gate of pond units are turned on, each pond builds connection by its own pond chain to raising lives jointly. When one of the pond units is polluted, its water-gate will be turned off, the pond will be separated and conduct self-recover to avoid polluting others, whereas the rest of the pond water-gates are still on, keeping connective and nourishing mutually. When the external interference pollutes the pond chain hard, all the water-gates of pond units should be turned off to separate the ponds from each other and conduct self-recover, as well as the external ponds are comparatively independent.

Due to the entire road net system for individuals traffic between ponds, when some ponds are polluted, the road net can block the pollution dynamically and control the individuals' routes.(Picture 12:Dynamic control)



Picture 12. Dynamic control.

4 Summary and Expectation

From the perspective of toughness of wetland park plan and design, the research put forward the "chain theory", which was put into use of the construction of Wuhan East Lake Falling Wild Goose Scenic Spot. Through the dynamic modularization pond chain that can be connected and disconnected, four kinds of different habitat units are created, which serves as a positive demonstration for the future construction of Wetland Park.

4.1 Ecological Defence

When the water-gates are turned off, the habitat units are separated mutually and conducting the self-recover to prevent the pollution spreading and enhance the defence function of wetland facing the interference.

4.2 Ecologically Nourishing

When the water-gates are turned on, the habitat units connect and nourish mutually, which enhance the self-recovering ability of wetland.

4.3 Realize the Integration of Ecological Defence

Reaching the integration of wetland ecological defence through pond chain and dynamic control, which realizes the toughness design. In this process, the biology resource exchange between East Lake and Site is achieved, which enriches and expands the original ecological resources of East Lake.

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