

PAPER • OPEN ACCESS

Preliminary Study on the Landscape Design of Sponge Campus Based on LID Concept——A Case Study of landscape design in Wuhan University of Technology

To cite this article: Junsha Wu 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **621** 012109

View the [article online](#) for updates and enhancements.



ECS The Electrochemical Society
Advancing solid state & electrochemical science & technology

239th ECS Meeting with IMCS18

DIGITAL MEETING • May 30-June 3, 2021

Live events daily • Free to register

Register now!

Preliminary Study on the Landscape Design of Sponge Campus Based on LID Concept——A Case Study of landscape design in Wuhan University of Technology

Junsha Wu

School of Civil Engineering and Architecture, Wuhan University of Technology,
Wuhan, Hubei, 430070, China

274265@whut.edu.cn

Abstract. In recent years, with the rapid development of the research and application of sponge city, colleges have carried out the construction of "sponge campus" with the support of the state. Based on the background of the sustainable development of the campus, this paper takes the concept of LID as the starting point, combs the related concepts and evaluation criteria of the sponge campus, takes the landscape design of the West Campus of Wuhan University of Technology as an example and discusses the key points of landscape design under the campus LID model from the macro and micro perspectives. In addition, it focuses on the discussion of macro-zoning planning, landscape rainwater collection system, plant selection and microclimate, in order to provide references for the sustainable use of campus resources and landscape design.

1. Introduction

With the continuous development of modern society, the construction of a healthy campus environment has increasingly become the focus of social attention. As we all know, campus is an important place for educating people, and the appropriateness of the educational environment is closely related to the healthy development of society. Therefore, as an independent system, the university campus has received the attention of urban construction work, that is, under the guidance of sponge city theory, the construction of sponge campus is advocated. Through the integrated design of "seepage, retention, storage, purification, use, and drainage" and the rationalized application of rainwater resources, the surface runoff and water pollution can be effectively improved, so that the entire campus has the ability to adapt to environmental changes like a sponge.

Low-impact development (LID) is a technology for storm management and non-point source pollution treatment proposed by the United States in the late 1990s. Its purpose is to start from the source and achieve the control of runoff and pollution with decentralized, small-scale technical means, so as to realize the collection and utilization of urban rainwater and a virtuous hydrological cycle.

By constructing a LID rainwater system and taking corresponding source control measures in combination with landscape space design, it can effectively improve campus non-point source pollution, promote the sustainable development of the ecological environment, and provide an effective reference for the development of sponge cities in our country. Therefore, it is an effective practice to apply LID concept in the construction of sponge campus landscape.



2. Existing evaluation standards

2.1. Green Campus Evaluation Standards (GB/T 51356-2019)

Green Campus Evaluation Standards is divided into two sets of evaluation systems for primary and secondary schools and ordinary universities. The evaluation standards for higher education institutions focus on green campus planning and design, water conservation and other energy efficiency management, green campus innovation and green humanities, etc. It specifically includes seven evaluation indicators for land saving, energy saving, water saving, material saving, outdoor environment and pollutant control, operation management, and education promotion.

2.2 Landscape performance evaluation.

Landscape performance evaluation focuses on the efficiency of achieving the established goals of the landscape and the measurement of the sustainability effect. Unlike the *Green Campus Evaluation Standards*, it focuses more on the evaluation of outdoor campus sites, which is an important landscape evaluation method for ecology and sustainable development in the world.

3. Research area overview

3.1 Basic situation of the base

The base is located on the southeast side of the intersection of Building Materials Road and Square West 2nd Road in Wuhan University of Technology, covering an area of about 20,000 square meters. The whole site is approximately square, with rich elevation changes inside. The internal buildings of the base are Teaching Buildings and Experimental Research Centers. The north side is the residential area for teachers and the administrative building on the west side. The traffic is convenient and the flow of people is mixed.



Figure 1. General layout

3.2 Status and problems

Due to the lack of overall landscape planning, the landscape green space in the base is messily distributed and has low ornamental value, which cannot provide a good resting node for surrounding residents and students. What's more, the large height difference of two meters on the south side of the site causes excessive surface runoff in heavy rain weather, which easily causes stagnant water and makes people inconvenient to walk.

4. Low-impact development landscape design measures

4.1 Macro planning and design ideas

4.1.1 Landscape partition.

In order to highlight the design concept of sponge campus and combine it with landscape design, macroscopically, the scattered landscape land in the base is classified and integrated to achieve the goal of water environment optimization such as "seepage, retention, storage, purification, use, and drainage". The landscape in the project can be divided into three categories: Leisure-like planer landscape, semi-private linear landscape and fragmented and scattered landscape. The design strategy is to integrate multiple types of green space and make reasonable plans based on the different needs of water resources in each region to avoid water waste, thereby forming a complete water cycle and purification system in the region.

4.1.2 Design strategy of landscape water system pipeline network

- Fully consider the natural conditions of the site

Wuhan is located in the eastern part of the Jiangnan Plain and the middle reaches of the Yangtze River. It has a humid monsoon climate in the north subtropical zone. It is characterized by abundant rainfall, sufficient sunshine, cold winter and hot summer. The rainfall in Wuhan during the rainy season is concentrated, with an annual rainfall of 1100mm.

The base area is generally characterized by high north and low south, with a large height difference on the south side. Moreover, due to the large concentration of hard paved areas on the campus, the impact of storm runoff is very obvious, and the weak infrastructure construction is prone to cause waterlogging.

Therefore, factors such as topography and climate should be fully considered to form a holistic approach to rainwater management. It is advised to construct a drainage system on the premise of respecting nature, arrange underground pipelines and green rainwater infrastructure according to the topography, and then form a point, line, and plane circulation system.

- Pay attention to the combination of ecological function and landscape benefits

In order to improve the recreational environment of the people around the base, it is wise to coordinate the rainwater ecological treatment methods and landscape design, replace the traditional foundation with green flexible landscape facilities, and increase the interaction and participation of the rainwater landscape on the premise of meeting the functional requirements. Specific applications are listed as follows:

Design vertical landscape. It can not only integrate water resources effectively, but also beautify the roof.

Build rainwater garden landscape. While realizing the benefits of rainwater collection, comprehensively consider landscape roads, sketches and greening design to achieve functional landscape integration.

Activate the campus space environment. Through the water system pipeline network planning idea of "partition first, integration later", specific facilities are arranged according to different spatial requirements, so that functions and landscape are fully integrated, the landscape space environment of the region is activated, and the "negative space" that is difficult to coordinate is eliminated.

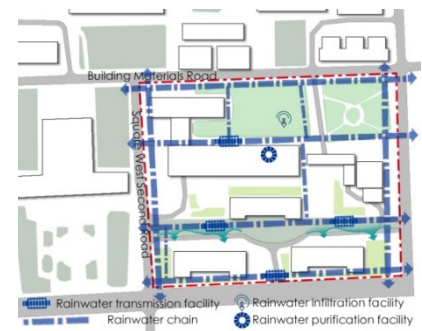
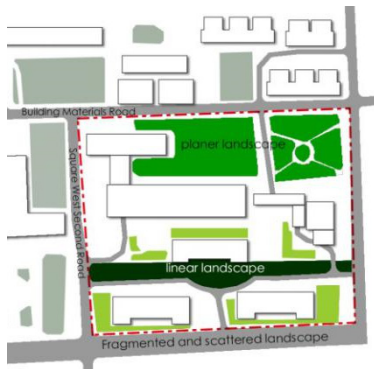


Figure 2. Landscape partition

Figure 3. Site elevation

Figure 4. Rainwater landscape system

4.2 Specific renovation measures for district landscape

4.2.1 Leisure-like planer landscape

- Establish a landscape rainwater collection system

For recreational surface landscape green spaces, it is better to use a natural open drainage system instead of a traditional pipe network drainage system. And combining functional facilities with landscape devices will not only enhance the aesthetics, but also be more economical.

For example, the project planning adopts a landscape rainwater collection and reuse system, that is, the collected rainwater first passes through the abandonment device, and then is piped to the landscape water body for storage. It is also possible to set up overslope green space around the water body to replace the abandonment device for the primary purification of rainwater. The stored rainwater can not only be used to irrigate the surrounding green space and supplement water, but also can be used in combination with a water purification system to keep the water quality up to standard.

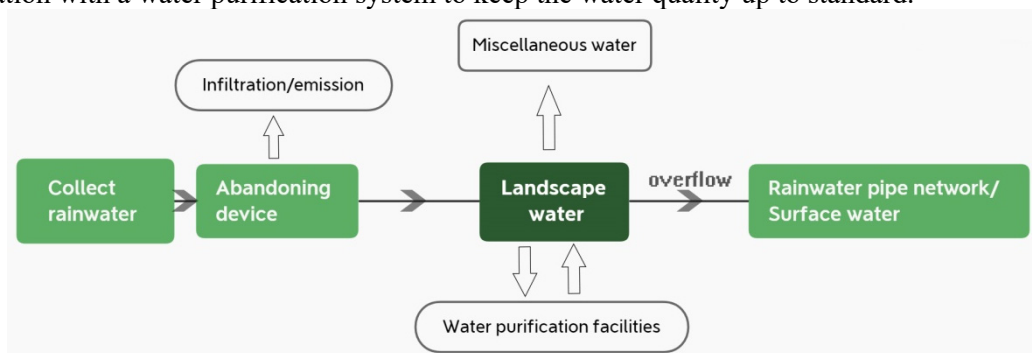
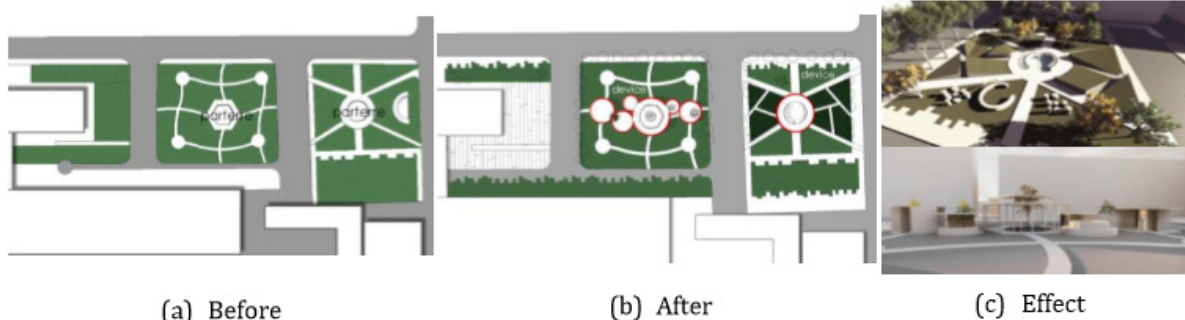


Figure 5. Rainwater collection system flow chart



(a) Before

(b) After

(c) Effect

Figure 6. Landscape water collection device

● Optimize plant landscape configuration

Plant landscape is the most vital element in the construction of LID infrastructure in sponge campus, which is characterized by dynamic changes and diversity changes. As an important part of "rain garden" and "biological retention facilities", plant ecological communities mainly play the functions of rainwater collection and landscape display. The selection of plant landscape configuration should proceed from the three main aspects of ecological function, landscape benefit and economic benefit. Comprehensively consider the internal natural environmental conditions of the base and the surrounding architectural style and color tendency, optimize the selection based on the growth characteristics of the plants themselves.

Taking this project as an example, the analysis of solar radiation on the base shows that the solar radiation on the south side of the site is weak, so shade-tolerant plants should be selected; the solar radiation on the north side is stronger, thus lush trees can be arranged for shading. The overall design adopts the layout principle of "small inside and large outside, dense inside and sparse outside, complicated inside and simple outside", that is, a variety of herbaceous plants are used to create a landscape space, with shrubs and trees surrounding the border to form a background, partially supplemented by colorful shrubs. Taking the humanized design into account, plants with insect repellent effects are arranged around the landscape rest node, so that people can get a good outdoor experience.

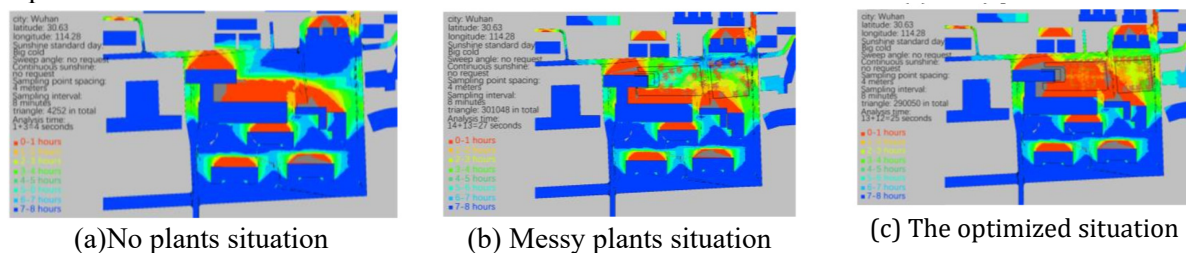


Figure 7. Solar radiation analysis

In addition, through software simulation, it is found that the above-mentioned cluster plant landscape design has also effectively improved the uneven and excessive solar radiation intensity in the site, which is of great significance for regulating the ecological microclimate environment of the region.

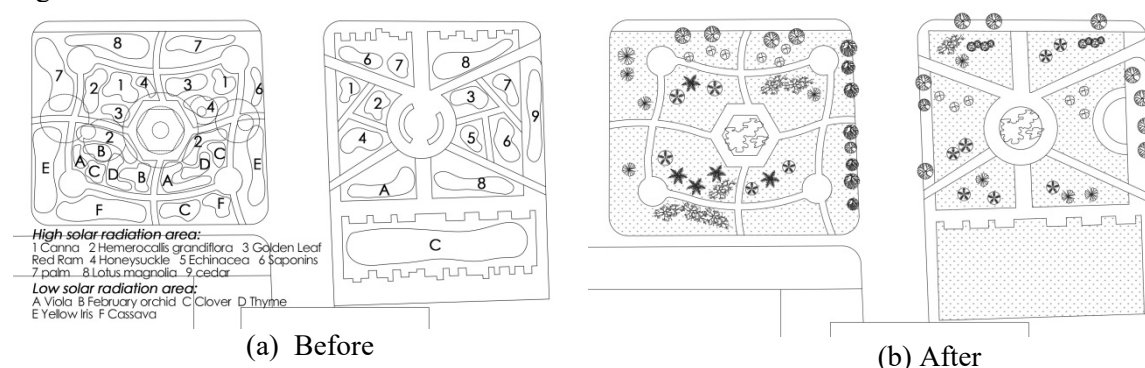


Figure 8. Plant configuration

4.2.2 Semi-private linear landscape

● Road ecological retention pond

The ecological retention pond is one of the efficient measures to reduce rainwater and control pollution from the source based on the LID concept. It is a linear and regular concave landscape form,

which generally suitable for landscape roads with narrow and long green space and high viewing requirements. Its advantage is that it can control rainwater runoff, purify water quality, and enrich the landscape interface in a limited space.

The current condition of the semi-private linear landscape on the south side of the project is poor: the site has a rich variation in elevation, the east-west road and the north side land have a height difference of about 2 meters, and the road as a whole tends to be high in the east and low in the west. The green spaces on the north and south sides of the road are messy, without manual planning, functions and landscapes are to be optimized too. Therefore, a linear ecological retention pond should be set up along the path here, combined with ecological grass ditches and landscape water storage devices, to achieve flexible control of rain and flood in extreme rainstorms.

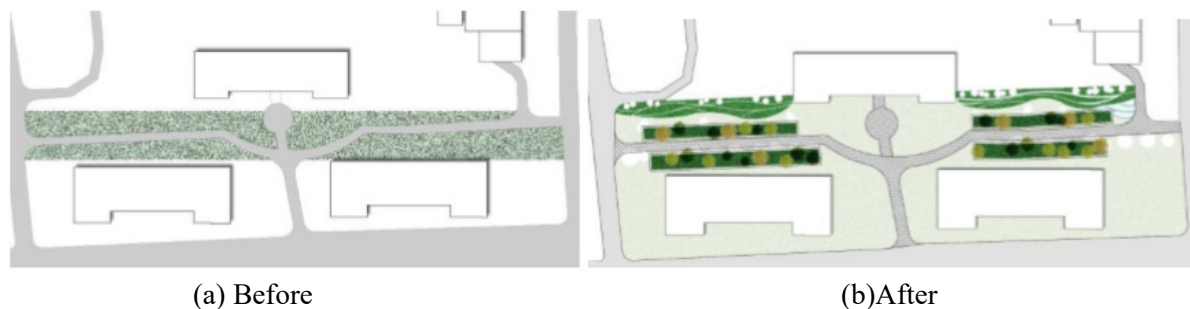


Figure 9. Design of road ecological retention pond

● Pavement material design

In order to meet the requirements of ecologically sustainable construction of the sponge campus, the design of the renovation of the pavement is also particularly important.

For sidewalks, the paving method based on permeable paving can be combined with inverted trapezoidal floor tiles to realize the discharge of excess sewage.

For motor vehicle lanes in colleges, water-permeable bricks should be used for paving, and drainage outlets and seepage ditches should be set up along the roadside stones to achieve the purpose of water purification.

For campus parking lots, grass-planting bricks or permeable bricks can be used to regulate water resources.

4.2.3 Fragmented and scattered landscape.

Fragmented and scattered landscape land is characterized by small area, flexible distribution and mostly without manual planning and management. Therefore, it is advisable to set up point-like LID technical measures for this type of land, such as ecological planting boxes, ecological tree ponds, infiltration ponds, infiltration wells, reservoirs and rain buckets. Through the reasonable arrangement of permeable pipe and canal, it is taken as the node of connecting the linear and planar landscape land, thus forming a complete landscape drainage pipe network system.

5. Conclusion

In summary, the sponge campus landscape design should focus on the application of low-impact development concepts. Firstly, carry out the overall planning from the macro level, and combine the different landscape partitions to form a complete landscape water system pipeline network system. Then focus on the micro-reconstruction design level, and design the green space system, pavement, plant configuration, etc. according to the characteristics of different landscape areas, so as to realize the sustainable development of the ecological environment of the area. Finally, a complete application plan should be formulated and new technologies should be introduced to improve the application quality under the LID concept.

References

- [1] Kong, J.T., Yin, S.Q. (2020) Water System Retrofitting on Campus Based on Sponge-City: On Qian'an College, North China University of Science and Technology. *J. Sci. Commun.*, 48: 139–143.
- [2] Luan, N., Chang, L. (2020) Simulation Study of Flood Control for City Road with Low Impact Development Based on SWMM: Taking Wugong Mountain Avenue in Pingxiang as an Example. *J. Sci. Commun.*, 02: 62–67.
- [3] Ma, J.Y., Wang, J. (2016) Planning and Design for Sponge Campus of Yunnan Industry and Commerce College Based on LID Development Model. *J. Sci. Commun.*, 02: 124–127.
- [4] Wang, M.J., Wu, Z.P. (2019) Research and Practice of "Sponge Campus" Conceptual Planning Based on Low Impact Development. *J. Sci. Commun.*, 02: 124–127.
- [5] Hu, J.Y., Xiao, J.W., Tong, Q.H., Shu, Y. (2019) Application of the Technology in Sponge Campus in China. In: 2019 4th International Conference on Architecture and Urban Planning. Hangzhou. pp. 10-17.
- [6] Bai, Y.P. (2017) The Cultural Expression of Campus Landscape Design in Higher Vocational Colleges under the Background of School-Enterprise Cooperation. In: 2017 International Conference on Social Sciences, Arts and Humanities (SSAH 2017). Harbin. pp. 132-136.