Analysis and optimization of green ecological infrastructure based on GIS -- Taking the new town in the north of Jiangjin District of Chongqing as an example

Shan Liu *, Shule Wei
School of Architecture and Art Design, Xi'an Peihua University, Xi'an, China
*Corresponding author e-mail: ls@peihua.edu.cn

Abstract. With the rapid development of urbanization, urban ecosystem is facing an unprecedented threat. At the same time, the concept of green ecological infrastructure has attracted more and more attention. In the practice of engineering design, the priority is given to the corresponding analysis and evaluation of green ecological infrastructure. With the aid of ArcGIS software, the analysis is carried out in the process of natural process, biological process and local cultural landscape. On this basis, the evaluation is carried out according to the detailed data, and the optimization strategy is proposed. In order to provide a scientific basis for the later planning and design. Taking the northern new town of Jiangjin District of Chongqing as an example, this paper verifies the rationality and popularization of the analysis and optimization of green ecological infrastructure, which is of great significance to the realization of sustainable and environment-friendly urban future development path.

Keywords: Green ecological infrastructure; GIS; optimization.

1. Introduction
China is in the rapid stage of urbanization, the urban ecological problems caused by rapid construction are increasingly serious, and the concept of green ecological infrastructure is gradually concerned and studied by Chinese scholars. How to build a perfect evaluation and optimization system of green ecological infrastructure plays an important role in scientific utilization of ecological system, improvement of environmental quality, solution of various urban problems, improvement of human settlements, etc. However, at present, the research on green ecological infrastructure in China is still in the early stage, and the practical application of specific projects aided by ArcGIS software is studied. Therefore, it is urgent to analyze and optimize the green ecological infrastructure based on GIS.

2. Green ecological infrastructure and ecological optimization application
2.1. Green ecological infrastructure
Benedict mark and Edward McMahon of the national conservation foundation proposed the definition in the book "green infrastructure connecting landscape and community" in 2006. They believe that green ecological infrastructure is a network of natural areas and open spaces with internal connectivity, as well
as engineering facilities that may be attached. This network has the function and value of natural ecosystem and provides natural places for human beings and wild animals, such as as as habitat, clean water source, migration channel, etc. their overall composition ensures environmental, social and economic sustainability The ecological framework of development [1].

According to foreign scholars kambates and Owen, 12 ecological and social service functions of green infrastructure are summarized from the aspects of ecology, landscape, leisure, education, etc. and they are drawn into a table [2]. According to the domestic scholars an Chao and Shen Qingji, the functions of green infrastructure can be divided into natural functions and human functions, including ecological functions and environmental functions, and human functions include recreational functions, economic functions and educational functions [3]. Through a large number of literature, this paper will refine the green ecological infrastructure into three aspects, namely, nature, biology and local cultural landscape. The natural aspect mainly includes flood control safety, geological disaster prevention and control, mountain and forest protection, natural non biological safety, etc.; the biological aspect mainly includes habitat suitability analysis and migration process research of regional representative species, so as to establish the biosafety pattern; the local cultural landscape is mainly the representative important landscape area in the region, and through the analysis of the minimum cumulative resistance surface, the local cultural landscape is mainly the representative important landscape area in the region This will establish a safe pattern of local recreation.

2.2. Ecological optimization application of green ecological infrastructure

In recent years, due to the continuous acceleration of the urbanization process, the continuous expansion of the city scale, the rapidly spread of urban lifestyle, the urban environmental problems in the development process are increasingly serious: heat island effect, severe haze, traffic pollution, frequent disasters, etc. Therefore, it is proposed to use ArcGIS to conduct scientific and accurate data analysis, build a complete evaluation and optimization system of green ecological infrastructure, conduct scientific and reasonable data analysis on the current ecological environment, and propose solutions for ecological optimization, so as to provide basic support for the later spatial application and planning and design, optimize the use of urban space, and improve the urban ecological environment of great significance.

3. Analysis and optimization of green ecological infrastructure

3.1. Analysis method of green ecological infrastructure

In the analysis method, we can refer to the identification method of green infrastructure. Benedict mark and Edward McMahon put forward the general steps of green infrastructure identification in the book "green infrastructure - connecting landscape and community". The analysis is to determine the goal and location, collect data to determine the constituent elements, identify the network pattern and evaluate, analyze and optimize [1]. This step is widely recognized by the society. At present, there are four methods widely used in the world: superposition method based on vertical ecological process, spatial analysis method based on horizontal ecological process, graph theory method and morphological spatial pattern analysis method. In this paper, combined with the general method of green infrastructure identification, the analysis method of green ecological infrastructure is proposed, which is mainly carried out in three aspects, namely, the natural aspect, the biological aspect and the local cultural landscape aspect.

3.2. Optimization method of green ecological infrastructure

After the analysis method of green ecological infrastructure is determined, ArcGIS software is used to analyze the data of natural, biological and local cultural landscape. The optimization content is from these three aspects, such as how to build flood control safety pattern, how to prevent geological disasters, how to build biosafety pattern, how to build local recreation safety pattern and so on. In this way,
according to the existing problems of scientific data analysis, the corresponding optimization measures can be targeted to achieve the purpose of scientific and reasonable use of ecological space.

4. Analysis and optimization of green ecological infrastructure in the new northern city of Jiangjin District, Chongqing

4.1. Description of the current situation of the site

4.1.1. Location. The planning area is located in the east of degan area of Jiangjin city, facing the Yangtze River in the south, Jijiang area, the old city of Jiangjin, the foot of Jinyun Mountain in the west, Shuangfu group of Jiangjin district and Tuanjie Lake Park in the north, and Xipeng group of Jiulongpo District, the main city of Chongqing in the East.

4.1.2. Topographic features. The landform in the planning area is mainly "hilly terrain"; the elevation is between 180-470m; the terrain in most areas is gentle, and the elevation of gentle slope land is between 200-300m.

4.2. Analysis and optimization of green ecological infrastructure

4.2.1. Analysis, evaluation and optimization of natural process. Flood control safety pattern: The planning area is adjacent to the Yangtze River in the south, and the flood inundation line of the Yangtze River in this area is between 202.95m (upstream) and 200.55m (downstream). In this paper, GIS computer simulation technology is used to analyze the flood inundation in the planning area, and the low, medium and high security pattern is obtained. Among them, the construction of permanent buildings shall be strictly prohibited within the scope of low safety level (high risk area of flood); the construction shall be avoided within the scope of medium safety level (medium risk area of flood), otherwise relevant flood control standards shall be met; the construction can be properly carried out within the scope of high safety level (low risk area of flood) after taking engineering measures.

Safety pattern of geological disaster prevention and control: The terrain in the planning area is generally high in the west and low in the east, and inclined to the north and south. There are a large number of scarps, which are easy to cause landslides. In this paper, the scarps with a slope of more than 35 degrees and an area of more than 800m2 in the planning area are selected, and the buffer distance is set to prevent potential geological disasters.

| Parameter | Distance from the steep slope area prone to landslide |
|-----------|-----------------------------------------------------|
| 0m        | 10m        | 20m        | 30m        |
| 10         | 6          | 4          | 1          |

Security pattern of mountain and forest protection: Yanziyan low mountain in the planning area divides the land into two parts: East and West, which is a natural isolation zone with good vegetation. At the same time, through analysis, it is found that the land with large slope in the planning area, with an elevation of 350m-450m, is a mountain area. For the purpose of mountain protection, according to the terrain, altitude and vegetation distribution, this paper uses GIS computer simulation technology to determine the safety pattern of mountain and forest protection in the planning area.

Natural abiotic security pattern: The natural abiotic security pattern is obtained by superposing the safety pattern of flood control, geological disaster prevention and control, and mountain forest protection.

4.2.2. Biological process analysis, evaluation and optimization. In this paper, musk deer is selected as the indicator species. Through the study of their habitat suitability and GIS computer simulation, the suitable habitat patches in the planning area are obtained, and the minimum cumulative resistance model is used to simulate the horizontal migration process. In the investigation of the planning area, it is found
that musk deer inhabit in the rocky forest land and are sensitive to human behavior. Based on the relevant research data, the following analysis and evaluation system of musk deer habitat suitability was obtained.

Table 2. Analysis and evaluation system of musk deer habitat adaptability.

| Type | Ecological factors                  | Classification                      | Score | Weight |
|------|-------------------------------------|-------------------------------------|-------|--------|
| 1    | Land cover type                     | woodland                            | 10    |        |
|      |                                     | Grassland                           | 8     |        |
|      |                                     | Garden, farmland                    | 4     |        |
|      |                                     | Country road                        | 2     | 0.6    |
|      |                                     | Rivers, ponds, reservoirs, main     | 0     |        |
|      |                                     | roads, railways                     |       |        |
| 2    | Distance from water body (m)        | 0-100                               | 10    | 0.15   |
|      |                                     | >100                                | 6     |        |
|      |                                     | >200                                | 10    |        |
| 3    | Distance from built-up area (m)     | 0-100                               | 6     | 0.15   |
|      |                                     | >100                                | 10    |        |
|      |                                     | >200                                | 10    |        |
| 4    | Distance from main roads and railways | 30-100                            | 6     | 0.1    |
|      |                                     | 0-30                                | 4     |        |
|      |                                     | 0                                   | 0     |        |

Based on the adaptive habitat analysis, the process of musk deer crossing different land cover types was analyzed by using the minimum cumulative resistance model (MCR), and the resistance trend surface was generated to simulate the horizontal diffusion behavior of musk deer.

Table 3. Table of resistance factor and resistance coefficient of horizontal forest musk deer spatial movement.

| Resistance factor                  | Classification                      | resistance coefficient |
|------------------------------------|-------------------------------------|------------------------|
| Land cover type                    | woodland                            | 0                      |
|                                    | Grassland                           | 10                     |
|                                    | Garden, farmland                    | 20                     |
|                                    | Country road                         | 100                    |
|                                    | Rivers, ponds, reservoirs            | 400                    |
|                                    | Built up area, railway, main road    | 500                    |

Establishment of biosafety pattern: Based on the analysis of habitat suitability and migration process of species represented by musk deer, this paper overlays the research results with potential migration corridors, i.e. current rivers and surface runoff, and establishes the biosafety pattern of the planning area.

4.2.3. Analysis, evaluation and optimization of local cultural landscape process. There are a large number of cultural heritages such as temples and ancestral temples, and natural landscape elements such as ponds and woodlands in the planning area. This paper takes these landscape elements as the source, through the analysis of the minimum accumulated resistance surface, obtains the safety pattern of local recreation in the planning area.
Table 4. Table of resistance factors and coefficients of local recreation.

| Resistance factor | Classification         | Resistance value |
|-------------------|------------------------|------------------|
| Land cover type   | Country road           | 0                |
|                   | Rivers                 | 10               |
|                   | Main road              | 40               |
|                   | farmland               | 60               |
|                   | Garden, grassland      | 100              |
|                   | Pond, built-up area    | 400              |
|                   | Railway, reservoir     | 500              |

4.2.4. Analysis and optimization of green ecological infrastructure. A comprehensive regional ecological landscape security pattern is established by integrating the above natural process, biological process and local cultural landscape process. They together provide guarantee for the health and safety of regional ecological service function. Because the safety patterns of various processes are different due to different safety levels, the overall EI formed after their comprehensive superposition will also have a variety of spatial structures corresponding to different safety standards, which is a group between the highest (when the safety patterns of all processes are the highest safety standards) and the lowest (when the safety patterns of all processes are the lowest safety standards) Solution. According to the actual situation, this paper takes the medium safety level as the recommended scheme for each process. At the same time, the highest and lowest standard ecological infrastructure planning scheme is presented for decision-making reference. (As show in Fig. 1)

Figure 1. Analysis and optimization of green ecological infrastructure
5. Conclusion

Green ecological infrastructure is the basis of our survival, how to build a scientific and digital green ecology infrastructure evaluation and optimization system is one of the important ways to solve the urban ecological problems. Taking the northern new town of Jiangjin District of Chongqing as an example, this paper refines the evaluation and optimization of green ecological infrastructure into three aspects, namely, nature, biology and local cultural landscape. Through ArcGIS, accurate and scientific graphic data are obtained. On this basis, corresponding evaluation and optimization are carried out, providing scientific basis and suggestions for the next step of urban space utilization, and providing green ecological basis for the next step. The accurate research of infrastructure evaluation and optimization provides certain support significance.

References
[1] Li kairan. Green Infrastructure: concept, theory and practice [J]. Chinese garden, 2009 (10): 83-92.
[2] Zhou Yanni, Yin Haiwei. Theory and practice of foreign green infrastructure planning [J]. Urban development research. 2010 (8): 87-93.
[3] An Chao, Shen Qingji. Green infrastructure network construction method based on ecological performance of space utilization [J]. Landscape architecture. 2013 (2): 22-31.