Plant planning and urban construction of sponge city based on GIS system

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Abstract
In the process of development in recent years, my country’s urban construction has achieved very good results, but the acceleration of the urbanization process has also brought a lot of pressure and problems to the city itself. In the process of urban construction, the construction of drainage systems in many cities was not perfect, which resulted in the infiltration of surface water in the city. Many places in the city were flooded by rain, which seriously affected people’s daily life. The construction of cities has led to changes in many resources and the environment, and the normal structural network of rivers has also been destroyed. Surface water in cities is more difficult to drain, and urban waterlogging often occurs. To solve the problem of urban waterlogging, it is necessary to use knowledge of multiple disciplines. This article comprehensively considers various factors affecting urban waterlogging, summarizes the advantages and methods of sponge city construction, and introduces the sponge city based on the geographic information system. The construction is simulated and simulated. Through research and analysis, we can know that the use of geographic information system can provide good help for plant planning and architectural planning in the process of sponge city construction. The use of the system can evaluate actual construction work and prevent work mistakes.

Keywords GIS · Sponge city · Plant planning · Urban construction

Introduction
With the development of urbanization in my country, many problems left over from urban construction have begun to affect people’s daily lives. The construction of urban drainage systems cannot meet the actual drainage needs. Urban roads often accumulate a lot of rainwater, which cannot be discharged in time. Walking will cause urban waterlogging, which will seriously affect people’s travel and the orderly development of the city. In the process of urban construction, the construction of the rainwater system is related to the safety of the city. The planning issues of urban construction will also affect people’s daily life and urban development. Therefore, it is necessary to solve the problem of urban waterlogging in time to ensure that the city has a good ecological environment (Egbueri 2018). To solve the related problems of urban waterlogging, it is necessary to apply knowledge of multiple disciplines, including related knowledge of physical geography, application and analysis of remote sensing technology, construction and development of urban water conservancy projects, design and implementation of urban planning projects, landscape architecture domain, and other knowledge (Bob et al. 2016b). Experts and researchers in various fields have conducted specific research and discussion on the problem of urban waterlogging from the perspective of discipline construction. The researchers combined different aspects of knowledge to evaluate the risk of urban waterlogging and the urban rainwater pipe network system. The construction has been monitored; the problems and related policies in the urban planning process have been analyzed; the problems and countermeasures of urbanization have been discussed; the heavy rain disaster data in the city has been collected, and the risk index of the heavy rain disaster has been calculated. In the process of research and analysis, many researchers discovered the new urbanization concept of sponge city and carried out specific analysis of related factors (Georhage 1979). In the process of urban construction, the urban landscape....
layout and vegetation coverage have a certain impact on the urban rainwater network system construction. Looking at the construction of sponge city from the perspective of landscape architecture, researchers have not conducted in-depth discussions on microscopic factors, but only analyzed some macroscopic factors. Landscape construction has not yet played a role in the development of urban water systems (Lloyd and Heathcoat 1985). In most cases, people only effectively discuss a few factors from a microscopic perspective. In the specific practice process, people only pay attention to the transformation of some aging landscape areas in the city, and the scope of operation is relatively small. The significance of urban construction is not obvious. This is because people did not consider the actual problems of sponge city construction and did not link the specific construction process with the design of urban greening projects, resulting in unsatisfactory final construction results.

In the process of urban construction, most of the issues that people are most concerned about are the issues between urban land use and specific development. The construction of sponge cities needs to balance the relationship between the construction of people’s living areas and the construction of other projects. The construction of some projects needs to be considered. The choice of address ensures to reduce the impact of urban land shortage. In addition, the construction of sponge city not only needs to save land but also needs to consider the issue of cost. In order to improve the construction effect, it is necessary to fully consider the construction situation of related projects and strive to create the best effect at the lowest cost. In the construction of the sponge city project, people have skillfully used geographic information technology to build the project construction system. By using this technology, the construction area can be visualized, and people can intuitively understand the various aspects of the sponge city construction process through the computer system. By using this technology, the construction area can be visualized, and people can intuitively understand the various aspects of the sponge city construction process through the computer system, and detect the regional construction situation (Abderrahman and Al-Harazin 2008). Using this technology, people can make effective plans for urban land use and can determine which areas can be used for sponge city projects and which areas can be greened or other projects can be constructed. Through the analysis of a certain area, it can be found that the area that can be used to build sponge city related projects accounts for 19.4% of the total area of the area; the area that can be used for forest and grassland development accounts for 80% of the total area. It shows that the main construction in this area should be mainly woodland and grassland and increase the green area to improve the quality of urban construction. When planning for urban construction, the use of geographic information technology can effectively analyze the value of regional construction and match suitable construction projects for different urban land, which can improve the efficiency of urban land use to a certain extent. The construction of the sponge city needs to choose a suitable address (Hassen et al. 2016). The use of geographic information technology can better analyze the construction of the sponge city project and can visually display the area within the city that can be used for the construction of the sponge city project to facilitate people to carry out actual work.

“Internet +” sponge city-smart sponge city

In the process of exploring the development of beautiful cities, concepts such as garden cities, low-carbon cities, and smart sponge cities have been gradually put forward. Among them, the smart sponge city essentially uses big data, cloud computing, and other emerging technologies as the core to detect and analyze various aspects of the city’s information and use this as a basis to conduct social services and social and economic resources in the city (Lokhande et al. 2008). Comprehensive and effective management and full utilization can greatly improve the efficiency of urban operations, accelerate the development of urbanization in my country, strengthen the comprehensive management of cities, and provide technical support for the rapid development of my country’s social economy.

At present, my country has made considerable progress in the study of sponge cities. The so-called smart sponge cities are simply to incorporate some advanced technological concepts into the construction of traditional sponge cities. With “Internet +” as the main channel of information dissemination, through the Internet of Things, cloud computing and other high-tech technologies, urban water energy, green infrastructure, “gray” (Carlson et al. 2011) infrastructure, and urban construction are organically integrated, so that the original sponge cities have become more intelligent, and management efficiency has also been significantly improved. Vigorously promoting the construction of sponge cities is an important measure to fully implement the national ecological civilization construction strategy. Today, two batches of cities have begun trial construction of sponge cities. It is worth noting that the construction of a sponge city requires more infrastructure, and the cost of managing and maintaining the sponge city is also relatively high, and the demand for manpower is also relatively large, so it cannot be fully promoted and constructed within a certain period of time. Because of this, it is very important to set up pilot projects (Magdy 2015). To make the sponge city more intelligent and open, the staff of the pilot project must work together, actively advise and advise, and at the same time integrate the construction experience of each pilot into a public platform. This can not only improve the utilization rate of construction resources and enable different regions to learn from each other and learn from each other. This is of great practical significance for the construction and development of sponge cities. In today’s society, “Internet +” has
gradually become an important platform for the construction of information networks. In the process of using “Internet +” (Egbueri 2019a) to build a networked platform, project builders can organically combine experimental projects in different regions to achieve the work of each pilot. Personnel can communicate remotely in real time, learn from each other’s effective experience, and summarize the problems that have arisen. This can effectively avoid the recurrence of problems in the construction of the pilot project and greatly enhance the public value of the pilot project. Researchers show that the construction of a smart sponge city requires an Internet platform system as the foundation. This requires pilot project builders to gradually develop multiple interactive remote collaboration applications based on the pilot city’s test area. To a certain extent, the scattered pilot projects are connected together. The networked system of the sponge city platform mainly includes the following modules: control center, real sponge test, virtual sponge test, nationwide connection, remote users, etc.

“Internet +” planning and construction-ArcGis, SWMM, etc.

During the planning of sponge cities, some pilot cities had problems with target planning that did not conform to reality. For example, the total annual runoff control rate was significantly higher than the standard value, and runoff pollution indicators were set too low; there were even some pilot cities that directly apply the construction plans of the developed regions to their own regions, and they do not fully grasp the characteristics of the region and lack the concept of overall resource allocation. If we conduct a careful analysis of the problems found, we will find that when planning the sponge city, the leaders have a one-sided understanding of their own conditions and characteristics, the planning is not reasonable, and the measures are not adapted to local conditions. Today is the era of rapid development of Internet technology, and various new technologies are emerging with each passing day, especially in information monitoring, analysis and simulation, etc., which fully demonstrate the insurmountable advantages of traditional technologies. For this reason, the pilot project builders should use modern and advanced technology to perfectly solve various problems in smart sponge city planning (Al-Badri et al. 2019b). For example, online monitoring systems can be used to monitor water quality in real time, and remote sensing surveying and mapping technology can be used to obtain detailed urban layout information, etc., which can provide data support for overall planning to a large extent; at the same time, builders can also use cloud computing. Builders can also make use of cloud computing methods to process the information data, and use the computer to build a three-dimensional sponge city model, and use this to adjust the combination of LID facilities, optimize the overall layout of the city system; finally, the implementation effect can be visualized through ArcGis, SWMM and other software Compare and analyze to choose the best construction plan. The application of these new technologies makes the construction of sponge cities more efficient.

Modern geography has been organically integrated with spatial information science to produce geographic information systems. At present, geographic information systems are widely used in various fields. GIS is a combination of computer systems, geographic data, and users (Hofmann et al. 2015). Essentially, GIS generates or outputs various geographic information by collecting, storing, retrieving, operating, and analyzing geographic data, thereby providing engineering design. Planning management provides data support.

Materials and methods

Data source and processing

Data source

It can be seen from the above text that the overall situation of the city, the green plant coverage area, and the city’s green development status are all derived from official reports on the Internet by the city’s forestry management bureau (Matsah and Hossain 1993). It is the result of the latest statistics related to the greening of the city in recent years. The relevant development status of the city’s greening project construction is the investigation and research conducted in the city in the recent period. At the same time, the satellite real-life maps of the city all come from the data in the most convincing maps in the world, and these data are also updated in real time.

GIS geographic module elevation analysis method

First check and adjust the relevant image information in detail, load the real-time satellite map of the city and the city boundary planning manuscript into the geographic information system, and use the city boundary planning manuscript of the city to get the location of the main urban area of the city. And export the satellite real-world map of the main urban area of the city and obtain relevant data and image materials (Egbueri 2019b). According to the relevant applications within the geographic information system, the city’s satellite remote sensing is a scenic spot map from different geographic measurement methods such as height, angle, and direction, to analyze and study the city’s satellite remote sensing map and obtain relevant specialized data for the greening construction and design of the city. It provides a theoretical basis and can also be combined with the city’s water resources issues for planning and construction.
Hydrological analysis of GIS geographic module

This research mainly uses geographic information to analyze the city’s water resources, such as the trend of rivers and groundwater. Using water resources related analysis to optimize the city’s satellite remote sensing real-world map, the trend of the city’s rivers and groundwater and the final collected regional information can be seen more accurately. Then, according to the relevant conditions of the city’s water resources, a more reasonable green construction area and design are formulated, and the original plan is adjusted and optimized to provide a more accurate data basis for the ecological sponge construction technology, thereby promoting the rational layout of the ecological sponge construction.

Sample survey

By observing Fig. 1, we can know the specific situation of a certain sponge city construction. In the process of analysis, we mainly conducted specific investigations on the types of plants in the city and conducted specific statistics on the distribution of plant communities. The main content of the figure also includes the construction of the community and the distribution of the plant community during the construction of the sponge city, as well as the statistics of the total rainwater on the roof of the community and the city ground. In order to better analyze the construction effect of the sponge city, the figure also analyzes the city’s drainage system construction and drainage volume and conducts investigations on related facilities. Looking at Fig. 1, we can know that a total of 5 projects in the construction of the sponge city are analyzed in the figure, and 15 biological retention facilities are mainly selected for analysis (Bhakar and Singh 2019). These 15 biological retention facilities are representative of each project. Collect information about related facilities through field surveys, conduct specific evaluations on the collected information, analyze the relationship between the construction of related facilities and the layout of the plant landscape, and use sample plots to analyze the specifics of plants when conducting research. There are a total of 45 sample plots in this study. The sample plots mainly contain the names of plants, types of plants, number of plants, plant coverage, plant growth and growth indicators, and the green area of the city. Save the taken photos in the sample.

When analyzing the situation of plants, it is necessary to analyze the growth indicators of the plants. The growth indicators can mainly be used to describe the weight of the plants. When analyzing the plants in the sample, the weight of the above-ground part of each plant needs to be analyzed. Calculate the weight of the underground part. When
calculating the underground weight, you can use a special root analysis system to analyze the root growth of different plants and use a special system to measure the root length, root diameter, root growth area, and volume of the plant.

In the process of plant growth, the growth form of the plant will change to a certain extent with the changes of the seasons (Nosratii and Van Den 2012). When analyzing the growth of plants, it is necessary to analyze the seasons of plants. In the process of growing many plants, changes in leaf morphology, flower morphology, and fruit morphology will occur. In the process of analysis, the changes in relevant parts of the plant can be divided into seasonal changes and non-seasonal changes, etc. In the situation, according to the diversity of changes, the seasonal changes are scored, 2 min, 4 min, 6 min, 8 min, and 10 min respectively.

In the process of urban construction, landscape design and plant species are inseparable. Researchers need to analyze the vegetation types and the growth of vegetation in the city, analyze the growth habits and growth cycles of plants, and determine some local The growth situation of new plants and exotic plants. Introduce the types of exotic plants that can be cultivated for a long time to the cities (Egbueri 2020). The locality of the plants should be scored. The scoring standard mainly depends on the adaptation degree of the plants and the environment. The scores can mainly include 10 points, 8 points, 6 points, 4 points, and 2 points. In the process of analysis, it is necessary to score the maintenance costs of different plants and the construction costs of landscape projects to actually analyze the impact of plant growth on urban development (Table 1).

Data processing

In the analysis, the specific conditions of plant growth can be analyzed by calculating some specific indexes. The richness index of plants can be used to evaluate the abundance of plant growth and distribution in the biological retention facilities. The main calculation formulas are as follows:

\[ D_{ma} = (S - 1) / \ln N \]  

Simpson index:

\[ D = 1 - \sum_{i=1}^{n} \left( \frac{N_i(N_i - 1) - 1}{N(N - 1)} \right) \]  

Shannon-Weiner Index:

\[ H' = \sum_{i=1}^{n} (P_i \ln P_i) \]  

Pielou Index:

\[ J = \left( - \sum_{i=1}^{n} P_i \ln P_i \right) / \ln S \]  

\[ J_{H} = H' / H_{\text{max}} \]  

Sponge city plant planning

Selection and determination of evaluation indicators

By categorizing the existing plant landscape evaluation indicators into qualitative and quantitative categories, combining these two indicators can make reasonable judgments and comments on the plant landscape design of biological retention facilities, and it is also very convincing and scientific. And in the whole plant landscape evaluation model system, it is divided into criterion layer and target layer (Egbueri and Enyigwe 2020). The criterion layer under this system is subdivided into three categories: ecological benefit, aesthetic quality, and service function. The level of analysis method can be used to better complete the relevant research. Based on this analysis method, the first stage needs to determine the target level of the study, and the plant community landscape of the biological retention facility is selected as the evaluation system of the study; next, the criterion level is determined. It is still divided into three categories: First, the research involves the need to protect the vegetation and the stability of the community in the plant environment and improve the soil quality to enhance its resistance to stress. We can also use the process of plants, the overall coverage, the health and development of plant roots as the criteria to judge the strength of ecological function (Oinam et al. 2012). The reason why the above indicators are used is that relatively accurate data can be obtained through scientific and quantitative methods; second, the landscape presented by a successful plant forest must be pleasing to the eye. Whether the number of communities is reasonable, the four seasons of the plant landscape, and whether the scenery is harmonious are used as the community and landscape aesthetic evaluation indicators; the third is to make the best use of the material, get the material in its place, and maximize the value of plants, from the resources needed to build a plant landscape. We should give full play to the maximum value of plants, and make a comprehensive evaluation from the resources and financial resources required for the construction of plant landscape and the costs required for the subsequent maintenance of plants, which is what people call economic benefits (Yetis et al. 2019). Focusing on the above three types of secondary indicators, professionals selected more than ten tertiary indicators through scientific and reasonable methods, and then questionnaire surveys were issued to people at all levels, and the scores obtained through each indicator were ranked in order and selected. Among them, the ten indicators with the highest support rate are used as the evaluation criteria and combined with the previous evaluation methods. A new plant landscape evaluation
model—the AHP evaluation model—of the plant community of biological retention facilities is created.

Weights of evaluation indicators

The analytic hierarchy process establishes a judgment matrix and its consistency test and determines the index weight according to the eigenvector of the matrix. The judgment matrix of the hierarchical structure model usually uses the 1–9 scale method to compare the indicators of each layer in pairs. This study adopts the method of professional group judgment to overcome the influence of subjective factors, and the judgment matrix of criterion level C3 (see Table 2).

Evaluation index quantification and evaluation classification

The construction of urban greening environment landscape is the main objective of the evaluation. Through comprehensive inspection, statistics, and analysis of the evaluation results of the city’s greening environment landscape, it helps to determine the situation and degree of adaptation of different green plants in the city (Ukah et al. 2020). Draw a comparison of different levels of different green plants, so as to layer different green landscapes. The specific conditions are shown in Table 3.

Table 1 Overview of biological retention facilities of demonstration project in a sponge city pilot area

| Project name | Project type | Project scale | Completion time of biological retention facility | Bioretention facility function | Number of samples | Plant varieties grown in bioretention facilities |
|--------------|--------------|---------------|--------------------------------------------------|-------------------------------|-------------------|------------------------------------------------|
| A Residential area | 116100 m² | June 2019 | Set up an overflow type biological retention pond in the green space in front of the building to collect and store roof rainwater | 9 | Schizophyllum, rims, Lythrum, day lily, Hosta, flower leaf awn, eight treasure sedum, hyssop chrysanthemum, Coreopsis |
| B Residential area | 151288 m² | June 2019 | Two types of biological retention ponds, overflow type and infiltration type, are set up in the courtyard green space of the community to collect and purify rainwater for building roofs and courtyard paving | 9 | Sage, Gaillardia, tall fescue, Hemerocallis, eight treasure sedum, Penstemon, Echinacea, core flower |
| C Public building | 21585 m² | September 2019 | Overflow biological retention ponds are set up in the courtyards between the teaching buildings to collect and store rainwater on roofs and courtyards | 9 | False dragon head flower, Fecai, Hosta, day lily, duck tail, Dutch chrysanthemum, tall fescue, Lythrum |
| D Residential area | 72400 m² | September 2019 | Set up an overflow biological retention pond in the green area of the community to collect rainwater from the roof and roads of the square | 9 | Hosta, reed, Lythrum, iris, sedum, chrysanthemum, daylily, Coreopsis |
| E Residential area | 135800 m² | September 2019 | Set up an overflow type biological retention pond in the green space in front of the building to collect and store roof rainwater | 9 | Sedum, reed, Lythrum, Hosta, eight treasure sedum, rush, Coreopsis, white clover, fresh sorrel |

GIS-based urban construction platform architecture

Based on the multi-level analysis structure system in the geographic information system, using cloud computing

Table 2 Evaluation index weight and consistency test results

| Hierarchical model | Judgment matrix |
|-------------------|-----------------|
| B1-C              | B1C_{ij}        |
| C11               | 1               |
| C12               | 1/2             |
| C13               | 1/3             |
| C14               | 1/4             |
| C21               | 2               |
| C22               | 2               |
| C23               | 2               |
| C31               | 3               |
| C32               | 3               |
| C33               | 3               |
| W_{3j}            | 0.1365          |
| W_{5j}            | 0.1634          |
| W_{7j}            | 0.1873          |
| W_{9j}            | 0.2297          |
| W_{11j}           | 0.2970          |
| W_{13j}           | 0.3539          |
| W_{15j}           | 0.4843          |

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technology, it is divided into many different levels from low to high, such as data analysis layer, service management layer, and information application layer. Of course, different levels of service platforms are also divided into many different service methods (Garrels and Mackenzie 1967). There are five layers in cloud computing, the most basic of which is the physical layer. As the name suggests, the physical layer is a combination of physical hardware, various physical facilities, and various physical machine operation settings and systems, such as computers and the Internet. The virtualization layer is a solid force that supports virtualization technology in cloud computing (Khan et al. 2020). The main components of this layer are virtual machines and virtual machine operating systems. The core technical idea of the virtual layer is to separate the physical storage of data and the electronic data image and present a spliced and simplified virtual view for the system administrator; next is the data layer, which is responsible for the massive data and various kinds of data in cloud computing (Purushothaman et al. 2014). The storage of index information, so as to ensure that various computing applications do not have insufficient data supply, are composed of various software and systems; the service layer is to provide various services for cloud computing users through the cloud platform; the application layer is cloud. The highest level of computing is through the close cooperation and effective operation of the first few layers to combine all the basic forces into a specific application model and extend a series of process-oriented business systems tailored for use.

### Technical requirements for GIS-based urban construction platform

Up to now, there are still many defects in cloud GIS-related systems and technical applications, such as cumbersome and mechanized early deployment work, limited work areas and inability to flexibly relocate work locations, inability to carry out early design work and implementation work at the same time, and data slicing work. The cost is high, but the biggest shortcoming is the solidification of the deployment model, and the delay in innovation and reform. In this case, the newly developed technology can average the characteristics of each node and deployment, so that more than one node can share a data center, so that all data can be grouped together for collective collection and unified externally service (Khan et al. 2017). This method of storing and processing data is very fast and convenient, which is conducive to service transfer and can accurately and quickly grasp the trends and changes of each service node. It can be seen from the above that the adoption of centralized technology ensures the safety and efficiency of the service process and realizes a wide range of large-scale services through multi-node computing. Figure 1 shows the GIS cluster framework structure.

### Results

#### Evaluation of the ecological function of sponge city plants based on GIS system

#### Biodiversity assessment

In the process of this research, we mainly analyzed the types of plants in the biological retention facilities. In order to better highlight the diversity of plants, the article discusses the abundance of plants in the biological retention facilities, the number of plant types, and the distribution of plants (Stoeser and Camp 1985). The degree of uniformity was discussed. By observing Fig. 2, we can know that the plant abundance index of area A selected in this study is at a relatively high level, the plant richness of area B is second only to area A, and the plant richness level of area C is the lowest (Table 4).

#### Evaluation of plant biomass and coverage

Figure 3 shows the growth and distribution of plants in different biological retention facilities.

#### Developed degree of plant root system

The root of a plant is the key part of whether a plant can thrive or not. The growth state of the plant root is closely related to the quality of the soil it is in and the adequacy of environmental nutrition (Sivakumar et al. 2014). In different environments, the effect of soil on plant root growth is different. There is a key indicator in judging the growth of plants—the length of the roots. By comparing the length of the roots of various plant samples, it can reflect the water absorption, nutrient absorption, and soil-fixing ability of the roots to judge the growth of plants. Among them, the root of B is the longest, and the second is the E plant, whose average length is much higher than other plants. In addition, the length of plant roots is

| Plant community landscape evaluation grade | I | II | III | IV |
|-------------------------------------------|--|--|--|--|
| Rating                                    | 100-90| 90-85| 85-80| <80 |
directly proportional to the nutrient content of the soil in the environment. If the nutrient content in the soil is insufficient, the plant roots will extend the length to absorb more nutrients to maintain their growth. Investigations have shown that most plants can store rainwater (Khan et al. 2016b). The higher the plant, the more growth and the greater the amount of retained rainwater. Therefore, the ability of D and E plants to retain rainwater is stronger than that of the same period plants.

**Table 4** Comprehensive evaluation of ecological function index

| Sample | Biodiversity | Plant biomass | Plant coverage | Plant root system development degree | Evaluation score |
|--------|--------------|---------------|----------------|--------------------------------------|------------------|
| A 1    | 0.215        | 0.094         | 0.048          | 0.054                                | 0.411            |
| A 2    | 0.221        | 0.101         | 0.025          | 0.053                                | 0.400            |
| A 3    | 0.185        | 0.121         | 0.035          | 0.050                                | 0.391            |
| B 1    | 0.262        | 0.052         | 0.024          | 0.050                                | 0.388            |
| B 2    | 0.268        | 0.051         | 0.032          | 0.038                                | 0.390            |
| B 3    | 0.283        | 0.051         | 0.055          | 0.059                                | 0.447            |
| C 1    | 0.204        | 0.157         | 0.051          | 0.051                                | 0.463            |
| C 2    | 0.216        | 0.133         | 0.089          | 0.052                                | 0.490            |
| C 3    | 0.213        | 0.101         | 0.037          | 0.050                                | 0.402            |
| D 1    | 0.215        | 0.171         | 0.027          | 0.046                                | 0.459            |
| D 2    | 0.224        | 0.128         | 0.043          | 0.050                                | 0.445            |
| D 3    | 0.240        | 0.071         | 0.038          | 0.050                                | 0.398            |
| E 1    | 0.249        | 0.125         | 0.053          | 0.053                                | 0.479            |
| E 2    | 0.252        | 0.067         | 0.032          | 0.049                                | 0.401            |
| E 3    | 0.274        | 0.085         | 0.037          | 0.052                                | 0.448            |

**Evaluation of sponge city plant landscape benefits and economic benefits based on GIS system**

Through the analysis and calculation of the relevant data and the evaluation results of each level, it can be seen that the relevant scores of different green plants in the construction of the city’s green environment landscape can be seen in the Table 5 for detailed data (Reddy et al. 2018). It can be seen from the table that among the different plots of land, land A...
has the highest score for the different proportions of green plants, but land B has the highest score in the richness and stratification of the green landscape, while land C in both the ratio of green plants and the richness and stratification of green plants has the lowest scores (Fig. 4).

By observing the data in Table 6, we can know the specific situation of the plant landscape configuration in different biological retention facilities. The specific analysis results are shown in Table 6.

**Realization of GIS-based urban construction platform**

The construction of the system mainly relies on the different solutions provided by the cloud environment, which can realize the effective management and control of different resources during the construction process (Jankowski and Acworth 1997). The system can also manage and store the geographic information in the cloud environment and more effectively kind of information for retrieval and use. In this

**Table 5** Plant landscape benefit and economic benefit index score

| Sample | Community configuration | Seasonal landscape | Landscape hierarchy | Construction cost | Vernacular needs | Maintenance needs |
|--------|-------------------------|--------------------|---------------------|------------------|-----------------|------------------|
| A      | 0.53                    | 0.73               | 0.73                | 0.90             | 0.94            | 0.82             |
|        | 0.50                    | 0.64               | 0.68                | 0.90             | 0.87            | 0.80             |
|        | 0.61                    | 0.76               | 0.77                | 0.90             | 0.88            | 0.78             |
| B      | 0.90                    | 0.76               | 0.84                | 0.78             | 0.84            | 0.68             |
|        | 0.95                    | 0.83               | 0.87                | 0.78             | 0.83            | 0.76             |
|        | 0.93                    | 0.85               | 0.90                | 0.78             | 0.87            | 0.70             |
| C      | 0.72                    | 0.87               | 0.92                | 0.73             | 0.77            | 0.55             |
|        | 0.70                    | 0.82               | 0.87                | 0.73             | 0.83            | 0.56             |
|        | 0.77                    | 0.83               | 0.89                | 0.73             | 0.78            | 0.58             |
| D      | 0.54                    | 0.82               | 0.87                | 0.90             | 0.87            | 0.71             |
|        | 0.60                    | 0.89               | 0.93                | 0.90             | 0.90            | 0.67             |
|        | 0.70                    | 0.92               | 0.90                | 0.95             | 0.85            | 0.66             |
| E      | 0.83                    | 0.90               | 0.90                | 0.90             | 0.88            | 0.80             |
|        | 0.81                    | 0.91               | 0.91                | 0.90             | 0.91            | 0.77             |
|        | 0.87                    | 0.95               | 0.95                | 0.90             | 0.95            | 0.75             |
system, relevant users can obtain geographic information for free without paying additional fees, and users can also install the system for free, which expands the scope and efficiency of the system to a certain extent.

Discussion

Sponge city plant configuration strategy

In the process of construction and transformation of existing urban residential areas, the measures of ecological sponge technology for green plants are mainly green roofs, green parking areas, dry and wet separation ponds, and the construction of flower fields in high-altitude places (Rogerson 2001). The construction of a variety of different sponge technologies, the distribution of water resources in the city, rainfall, and other different factors can be divided into aquatic plants, non-aquatic plants, water-loving plants, drought-tolerant plants, etc. from the perspective of whether plants like water (Khan et al. 2016a).

Table 6 Comprehensive evaluation score of plant landscape of biological retention facility

| Sample | Ecological function | Landscape benefits | Economic benefit | Comprehensive evaluation | Evaluation level |
|--------|---------------------|--------------------|------------------|--------------------------|-----------------|
| A      |                     |                    |                  |                          |                 |
| 1      | 0.411               | 0.149              | 0.087            | 0.647                    | 81 III          |
| 2      | 0.400               | 0.137              | 0.085            | 0.622                    | 78 IV           |
| 3      | 0.391               | 0.164              | 0.085            | 0.640                    | 80 III          |
| B      |                     |                    |                  |                          |                 |
| 1      | 0.388               | 0.190              | 0.090            | 0.668                    | 84 III          |
| 2      | 0.390               | 0.186              | 0.091            | 0.668                    | 83 III          |
| 3      | 0.447               | 0.189              | 0.092            | 0.728                    | 91 I            |
| C      |                     |                    |                  |                          |                 |
| 1      | 0.463               | 0.188              | 0.000            | 0.742                    | 93 I            |
| 2      | 0.490               | 0.184              | 0.092            | 0.766                    | 96 I            |
| 3      | 0.402               | 0.191              | 0.091            | 0.684                    | 86 II           |
| D      |                     |                    |                  |                          |                 |
| 1      | 0.459               | 0.162              | 0.083            | 0.704                    | 88 II           |
| 2      | 0.445               | 0.172              | 0.083            | 0.700                    | 88 II           |
| 3      | 0.398               | 0.182              | 0.078            | 0.658                    | 82 III          |
| E      |                     |                    |                  |                          |                 |
| 1      | 0.479               | 0.208              | 0.085            | 0.772                    | 97 I            |
| 2      | 0.401               | 0.214              | 0.085            | 0.701                    | 88 II           |
| 3      | 0.448               | 0.219              | 0.086            | 0.753                    | 94 I            |
Planting roof

In the process of analyzing the problem of urban waterlogging, the distribution of plant roofs in the city was analyzed. The specific conditions of plant roofs should be analyzed, and the green vegetation coverage of urban buildings should be counted. The specific situation is shown in Fig. 5.

By observing the distribution of plant roofs in the figure above, it can be seen that in the process of urban construction, the aquifer and moisture retention layer can retain rainwater to a certain extent, and the rainwater retained through these two levels can be used for plant growth. Provide enough moisture (Sakakibara et al. 2019). In the process of plant growth, the drainage layer can drain excess water in time, prevent the roots of plants from being difficult to breathe due to excess water, and promote the effective growth of plants.

Plant selection During the growth of plants, the substrate layer of the soil can provide the necessary nutrients for the growth of plants, so that the plants can grow healthily. Through specific research, it can be known that the thickness of the substrate layer of the soil is generally about 25 cm. In cities, vegetation planting areas should provide help for urban rainwater regulation, plant more plants that are conducive to air improvement, and minimize urban heat island effects.

Application suggestion In the process of urban construction, the condition of the plant roof determines the planting situation of the vegetation in the city (Italconsult 1979). The environmental characteristics of many areas are helpful to the growth of plants. People can analyze the characteristics of the urban environment and choose different types.

Plant cultivation In the process of landscape construction, a variety of different plants can be planted in the same area, which can increase the species diversity in the area and better promote the construction of urban ecosystems.

High-level flower pond

In the development of the city, the problem of rainwater accumulation has different degrees of impact on the development of the city. In order to reduce the risk of urban waterlogging, high-level flower ponds can be built in the city. The specific construction situation is shown in Fig. 6.

Fig. 5 Planting roof

![Diagram of planting roof](https://example.com/diagram.png)
Fig. 6 High flower pond

Fig. 7 Vegetation shallow trench
Plant selection  The height of the high flower pond is generally no more than 30 cm on the ground, so you can choose dwarf plants for planting, and the types of plants can choose some drought-tolerant plants. In the process of planting, it is necessary to consider the soil condition of the highland flower pond to select the type of vegetation (Bob et al. 2015). The highland flower pond can increase the beauty of the landscape construction and improve the comprehensive effect of the landscape construction. When choosing plant types, you can consider more drought-tolerant and flood-tolerant plants. Sometimes the water in highland flower ponds mainly depends on rain. When rain is insufficient, the vegetation may not have enough water, and the rainy season may cause plants to be covered. Soaked in water for too long and died. Consider all aspects of the situation and choose the appropriate plant type for planting.

Application suggestion  During the construction of high-position flower ponds, people generally have no way to choose better soil. In many cases, they can only fill the flower pond with some bad soil (Singh and Bhakar 2020). When choosing plants, match plants of different heights to improve the landscape.

Vegetation shallow trench

In the process of landscape construction, it is necessary to provide favorable drainage facilities for plants. In the area where plants grow, it is necessary to arrange vegetation shallow trenches. The specific situation is shown in Figs. 7 and 8.

Plant selection  Vegetation shallow ditch is used to disperse the rainwater flow in the area where the plants are located, so the vegetation in the vegetation shallow
ditch area needs to choose a type that can withstand rain erosion (Hydrological Division, Ministry of Water and Electricity 2007). Plant planting should be able to prevent soil erosion in the area where the shallow trench is located and ensure the quality of the land in the area.

Sunken green space

In the process of landscape configuration, it is necessary to set up a certain area of sunken green space. The purpose of this part of landscape construction does not need to consider the functions of water storage and drainage, so it is necessary to choose plant types that are not afraid of waterlogging disasters (Sakizadeh and Ahmadpour 2016). The specific situation is shown in Fig. 9.

Application suggestion

In the construction of urban green planting landscape, water-loving plants or water-resistant plants can be planted. In high latitudes, tall and stout trees can be used as the backbone of the entire urban green planting landscape construction, and small plants can be planted under the trees (Bob et al. 2016a). Shrubs and plants such as flowers, flowers, and grasses can improve the hierarchy and richness of the plant landscape structure, as well as the stability of the vegetation in the entire region, and prevent major impacts caused by natural disasters such as soil erosion.

Plant selection

Choose water-loving and water-resistant green plants to match the green plant landscape construction environment in lower urban areas and adapt and integrate the layering of these green plants with the local environment (Fig. 10).

Operation strategy of urban construction platform based on GIS

In the process of building a sponge city, it is necessary to use the knowledge of geographic information systems to build an intelligent management platform. In order to make it more convenient for people to manage and use specific information, the platform needs to be optimized (Hussain et al. 2010). Through specific practice, five practical modules are reserved for the optimized platform. These five functions mainly include the sponge city project information management module, the module for online monitoring project implementation and use, the risk warning module for project operation, and project assessment and evaluation module, user’s use construction module, etc.

Conclusion

During the construction of sponge cities, the planting of vegetation can provide a solution to the waterlogging problem of sponge cities to a certain extent. In the development of sponge cities, the situation of planting plants is not optimistic. In some residential areas that have been built, the planting space and area of vegetation are restricted. The diversity of plants cannot meet the construction requirements of sponge cities, resulting in sponges. The construction of cities cannot provide effective help for the development of cities. This study analyzed the growth and types of vegetation in some areas. In order to meet the needs of urban construction and development, the planting of plants needs to consider the situation of urban waterlogging and the degree of viewing, etc., and through specific analysis. The vegetation planting in the area is transformed to match the appropriate plant planting plan for the relevant area. In addition, this article also uses the relevant knowledge of geographic information technology to build a more effective sponge city construction management system and provides effective suggestions for building an intelligent sponge city.

Declarations

Conflict of interest

The author declares that they have no competing interests.

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