GIS-Based Touring Route Planning for Forest Parks - Baiwangshan Forest Park as an Example

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Abstract. With the popularization of low-carbon concept, residents pay more and more attention to the demand of urban forest parks. In this essay, the GIS software based on remote sensing technology is used to analyze the elevation, slope and slope direction of Baiwangshan Forest Park and carry out superimposed data processing, followed by distance analysis of park nodes, and finally obtain different types of tour organization routes such as cultural experience, ecological civilization, sports and fitness, to realize the efficiency and rationality of forest park tour route design, improve the utilization rate of forest resources, and provide reference for future tour route planning of the same type of The tour route design of forest park is efficient and reasonable, and the utilization rate of forest resources is improved.

1. Foreword
With China's strong support for the implementation of the national ecological civilization, people's awareness of ecological protection has gradually increased, and forest park recreation activities rich in natural wilderness have gradually become a good place for residents to relax and recreation, which is also closely related to the quality of life of urban residents.

Using GIS algorithm research to consider park attractions as well as changes in slope direction, seek the best tour route from the superposition of multiple elements, grasp the points of different scales in different spatial levels, and control the focus of different compositions [1], take Baiwangshan Forest Park as an example to empirically analyze the method and design the best tour route that traverses all attractions.

2. Basic overview and data processing
2.1 Overview of the study area
Beijing Baiwang Mountain area is located in the northwest end of Beijing, belongs to the southern branch of the Xishan Mountain Range, geographical coordinates 116°21'43"~116°28'12"E, 39°57'52"N "~ 40°02'11", with a total area of 126 km², of which the mountainous area accounts for about 35.57% and the plain area accounts for 64.43% [2], with a warm temperate continental monsoon climate, the soil is mostly brown soil or brown loam, and the general topography is high in the west and low in the east.

Baiwangshan Forest Park is surrounded by water from the Beijing-Milian Diversion Canal, with trees and shrubs interspersed, making the air exceptionally fresh. Baiwangshan is densely forested, with a vegetation coverage of over 95%, and is known as the oxygen source of Beijing city. The park is close to the North Fifth Ring Road, with The Summer Palace and Old Summer Palace to the east and the Beijing Botanical Garden to the west.
2.2 Data processing

2.2.1 Functional zoning of the park. The plot is divided into four areas according to the information, which are humanistic landscape tour area, forest landscape tour area, ecological culture experience area and ecological conservation area. The functions of the four divisions are not the same, and the largest area to the smallest is arranged as ecological conservation area, ecological culture experience area, forest landscape tour area, and the smallest area is humanistic landscape tour area as shown in Figure 1.

2.2.2 Internal road analysis. There are main and secondary access roads and fire escapes in the park. The main road is a common road for people and vehicles, with a wooden landscape path, and the road surface is in good condition to meet the needs of visitors. The secondary roads are paved with stone, concrete and wood, and are in good condition. The branch roads connect the attractions with the nearest main and secondary roads, which are convenient for visitors to reach various locations in the park. The location of the current roads in the park is shown in Figure 2.

2.2.3 Park control points. Park attractions are set to focus on recreation and cultural values, mainly natural scenery and humanistic landscape, and it is also essential to configure infrastructure when setting up attractions, of which the infrastructure planning in the park is shown in Table 1, and the distribution of attractions is shown in Table 2.

| Serial number | Types                              | Quantities |
|---------------|------------------------------------|------------|
| 1             | Level I Visitor Centre             | 2          |
| 2             | Level II Visitor Centre            | 3          |
| 3             | parking                            | 2          |
| 4             | Park entrance                      | 2          |
| 5             | public toilet                      | 2          |
| 6             | Emergency traffic evacuation points| 2          |

Table 2. Distribution of attractions

| Main Attractions                                                                 |
|---------------------------------------------------------------------------------|
| Wang'er Terrace, Art Wall, Taijun Temple, Baiwang Cao Tang, Ginkgo Garden,       |
| Qinglong Lake, Heavenly Nightmare Arch, Ancient Tree Platform, Parent-Child      |
| Paradise, French Church, etc.                                                   |

| Secondary Attractions                                                                |
|--------------------------------------------------------------------------------------|
| Maple Forest Monument Forest, Monument Forest of Calligraphers of All Ages,        |
| Monument Pavilion, Maple ting, Wangly ting, Wangjing Building, Friendship ting,     |
| Wangxiang ting, Range ting, etc.                                                   |

Point elements are established on the map, i.e., points of interest. The points of interest are found on Google Maps and referred to the guide map of the points of interest as well as combined with the current research situation, and the elevation slope slope direction is extracted from the points of interest by using the extraction analysis tool in spatial analysis, as shown in Figure 3.
2.2.4 Park Elevation Model. Baiwangshan Forest Park is a mountain park, so the topography is particularly prominent. The topography directly affects the planning layout, touring line organization and landscape construction of the park, etc. With the help of GIS tools, not only can we intuitively understand the topography and geomorphology, but also can objectively conduct single-factor analysis.

The geographic DEM data downloaded from China Geospatial Data Cloud was imported into ArcGIS10.7 to form a spatial database, as Google Maps has road information and is also a vector map with digital elevation information. The boundaries of the scenic area were determined in the software, and the elevation model of the scenic area was obtained, as shown in Figure 4.

2.2.5 Park slope orientation model. Convert the elevation map into a raster map using the TIN tool, and after getting the raster map, find the slope direction in the system toolbox and use the raster map corresponding to the elevation to generate the slope direction model, and set the data in the map in the symbol system, as shown in Figure 5.

2.2.6 Park slope model. The slope model is based on the output process of the slope model in the system toolbox to find the slope to use the tool to output, the slope is an important indicator of line selection, the slope will affect the thickness of the soil layer and thus affect the ability of plant growth, the slope model is shown in Figure 6.

The analysis found that the lowest elevation of the planning area is about 56 M and the highest is 210 M, with an elevation difference of 154 M. The whole area has a large difference in elevation, with steeper sections at the higher hills, and the ridge of the mountain range line is clearly visible from the city direction. The main slope in the park is 9°-22°. The slope has certain influence on the construction
of buildings and roads as well as the growth and development of plants. The slope of buildings should be controlled below 8°, the longitudinal slope of main roads in the park should be less than 8°, the longitudinal slope of common park roads should be less than 12°, and the longitudinal slope of branch roads and paths should be less than 18°.

Slope orientation has a greater role in mountain ecology, and the orientation of the mountain affects the intensity of solar radiation, while the duration of insolation also varies depending on the orientation of the mountain \[4\]. The most sunlight radiation is directed to the south slope, followed by the southeast and southwest slopes, then the west and east slopes and the northeast and northwest slopes, and least to the north slope. Due to the combination of factors such as light, rainfall, wind speed, and soil texture, slope orientation can have an effect on plant growth and thus cause changes in the ecological relationship between plants and the environment.

3. Trail route optimization
In order to let tourists in the limited tour time, to understand more tour information to choose a suitable route can be pleasant to spend the tour time and leave a good impression of the scenic spot \[5\].

3.1 Tour line planning principles

3.1.1 Rationalization of routes and no backtracking. During the tour, if the phenomenon of backtracking occurs, it is both a waste of energy and time for tourists. Therefore, the attractions in the scenic area can be strung into a circular tour route, not only to avoid the phenomenon of backtracking, to meet the tourists wish to enjoy the landscape more psychological, but also save travel time.

3.1.2 Rationalize the pace of the tour. In the tour route design, must fully consider the psychological condition and physical condition of tourists, combined with the type of landscape sorting, etc., in the tour process to achieve a combination of work and rest, with tension and relaxation; put the high-quality attractions in the back, mobilize the excitement of tourists, when tourists arrive at the core attractions, the excitement of tourists also reached the peak.

3.1.3 Adaptation to local conditions. The tour route is organized in various ways, and different thematic attractions have different tour routes, and the terrain will also affect the succession of tour sites. In the path design of the forest park, the tour route is organized according to the four functional divisions of the site in accordance with the mountain. The main road links each landscape control group and follows the contour development, while other roads enrich the visitors' touring experience under the premise of satisfying the park planning, which is not only adapted to the local conditions, highlighting the scenic features, but also people-oriented to meet different needs.

3.1.4 Protection of the natural environment. In forest parks, the natural environment is the place where plants and animals survive and reproduce, maintaining the dynamic balance of the biological world. In forest parks, limited natural resources are used under the premise of rational development to prevent pollution and damage to the environment, so that nature and humanity can develop together in a balanced and sustainable manner and ensure the stable development of the ecosystem. Therefore, the organization of the tour route in the forest park needs to take the protection of the natural environment as the premise.

3.2 Analysis of the results of excursion route organization
According to the existing routes in the forest park combined with the landscape nodes, as shown in Figure 7, four experience routes are set up, which are cultural experience tour line, ecological civilization tour line, forest experience tour line, and sports and fitness tour line, and these four routes connect the attractions with different functions in series, as shown in Figure 8.
The cultural experience tour route is mainly visual experience, featuring appreciation of nature and ascent to the heights, with attractions such as Baiwang Cao Tang, Youyi pting and Wanglv ting. Ecological civilization is an experience route featuring leisure and sightseeing, with attractions such as Wangxiang ting, the French Church, and the Cultural Wall. Sports and fitness tour line is an induced experience featuring forest hiking and exercise and fitness, with attractions such as Huaisu ting and Ancient Tree Platform. The forest experience tour line is based on olfactory experience, featuring health and wellness, relaxation and stress reduction, with attractions such as Lanfeng ting, Wangjing Building, etc.

4. Concluding remarks
This paper takes Beijing Baiwangshan Forest Park as the research object, based on GIS software to analyze the cooperation between various elements of the park, and summarize the relationship between the park's tour line and landscape nodes as well as the mountain topography. The park is divided into functional partitions, limited roads, and landscape control points, and the elevation, slope, and slope direction are analyzed based on DEM, and the factors are superimposed.

The unique geographical characteristics of mountainous areas determine the layout of forest park tour routes, and its limitations make it present a natural layout. In the selection of attractions and roads to create space using the height difference, make full use of the terrain to highlight the mountain features more attempts to combine the GIS analysis function with the forest park tour route planning, with the powerful data storage and processing capabilities of GIS, play its maximum use in the forest park, more scientific for the planning and service.

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