GIS-BASED VISUAL PERCEPTION ASSESSMENT OF MOUNTAIN SKYLINE:

A Case Study of Jinzishan Hill and the Building Layout of an Adjacent Site Planning Project

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Abstract. In this paper, we present a GIS based approach to evaluate the visual perception quality of mountain skyline. Through computer generated analytical maps and perspectives, this tool can assist planners to define the visual reservation scopes for mountain skyline within urban area. It also offers concrete data supporting for appropriate strategy in building layout or site planning to preserve valuable natural skyline scenery.

1. Introduction

In the Chinese Culture Circle, natural mountain skyline plays a significant role in landscape aesthetics (Higuchi, 1983). In urban area, mountain skyline also dominates the visual landscape in which artificial and natural elements mingled. This kind of visual landscape character is one of the most important heritages of China urban planning and is sustaining most Chinese cities’ genius loci through out the history (Sun, 1994). But due to modern urban development, natural mountain skylines are always destroyed by improper planning and construction, especially in recent two decades in China. Although most of these damages are the obstruction of visual scenery instead of physically, but unfortunately, because there are few available tools to evaluate the inherent visual structure of urban natural landscape or predict the effect of a developing project precisely in Chinese professional field, planners and managers are feeble in preventing these errors effectively. In this paper, through a case study, we present our approach for overcoming these limitations in planning and management.
The proposed GIS tool is a part of analytic technology of a prototype system which we developed to studying the Visual Sustainability of urban natural landscape. This system offers scientific and reliable references for planning consulting, as well as introduces simple analysis procedures for the urban planning practical application. In its technical support, the potential of the use of GIS is demonstrated in the conjunction of system functions of viewshed calculation, overlay operation for visual sensibility assessment and 3D simulation (He and Tsou, 2001). This system can also serve as a substitute of preliminary assessment of site perceiving or planning prediction. It is especially valuable for China urban planning since many detriments in large-scale landscapes are in the sequence of lacking proper prediction (He, 2001).

2. Research Methodology

The GIS based solution in this paper is focused on the visibility of mountain skyline study, and integrate these visibility results with further visual quality description parameters. Furthermore, visual distance, vertical and horizontal visual angels of the mountain skyline are also introduced.

2.1 VIEWSHED ANALYSIS OF MOUNTAIN SKYLINE

Using an ArcView GIS program, we firstly calculate the viewshed of each typical point of the mountain skyline. Then we overlay the visible maps to find the ratio and distribution of the superposition of these visible scopes. Those data demonstrate the continuity of the characteristic points, the integrity of the whole skyline, and the identifiability of typical skyline formation.

2.2 SPATIAL LIMITATION OF SKYLINE VISUAL PERCEPTION

To define the visual perception quality into more reality to match the human vision, we consult human visual ergonomics and psychology of visual landscape perception to establish the limits of visual distance and view angles. The high quality visions are located in the potential development districts for further site planning consideration in either planning rules formulation or project building layout.

3. Case Study

The case study, the Jinzishan hill region in Zhongshan city, Guangdong Province of China, which is the site picked by collaborating discussion of
research team and local government, locates on the edge of urban built-up area. The hill is the prominent landscape element of the surrounding environment. The most distinguishable character of the massif is there are two peaks alongside to each other that build a gentle and diverse outline. Therefore, the physical part of two peaks with the saddle between them is considered as the most significant feature of the mountain skyline.

3.1 SKYLINE VISUAL PERCEPTION QUALITY

In this research, we choose two formations of Jinzishan massif skyline to evaluate the sceneries of different directions. On these two skylines, every thirty to forty meters along the chine a point is picked as the characteristic point in viewshed calculating. Additionally, some significant points that mark out the alternation of the terrain feature are also collected. These points are categorized into different visual significance. Visible areas of the points in same importance are overlaid according to the visual sensibility strategy (Figure 1).

![Figure 1. Visible areas of categorized skyline characteristic points: scopes can see both peaks (left); scopes can see the center of the saddle (right).](image)

Besides visibility of the mountain skyline, we also introduce other ergonomics data or spatial scale characters which limit the visual perception quality into this analysis. These information include: visual cone parameters in horizontal visual angels in 60° (upper limit of good vision range), 70° (upper limit of good vision with oculomotor) and 30° (the most comfortable visual perception angle) (Tilley, 1983); critical value of psychology reflection to natural hill vertical view angle in 5° (critical angle to enjoy skyline scenery); 9° (suitable for both skyline and hillside details views) and 20° (cannot observe the skyline directly) (Higuchi, 1983).

These parameters are translated into spatial data and overlaid with the visibility maps. This procedure engenders the internal divisions in variant
visual qualities to the mountain skyline. Accurate computer generated spatial coordinates of these divisions can be employed as site planning reference (Figure 2).

![Figure 2. Visual quality mapping of skylines by overlaying viewshed analysis and human visual ergonomics and psychology parameters analysis](image)

3.2 BUILDING LAYOUT ANALYSIS OF ZHONGSHAN CCP SCHOOL CAMPUS

The authors were also invited to evaluate the first stage designing projects of the new campus of Zhongshan Chinese Communist Party School which is positioned in a sensitive landscape place north to the Jinzishan hill. Part of the high visual quality zone to the most important section of the massif skyline situates in the site. And the building height may affect the skyline visual perception along an adjacent urban arterial road northward. There were four design projects represent different building layout models in site planning (Figure 3).
The research team reviewed the viewshed situations of different building layout in these four projects (Figure 4) and compared the building positions with the former proposed visual reservation zones (also see Figure 3). We concluded that all of those designs couldn’t meet the requirement of regional visual landscape protection mentioned in the bidding document. To create a guidance for further design, based on the general Jinzishan skyline visual perception study, the research team use the above-mentioned GIS tools to create 2D visibility maps as well as 3D site perspectives for multi-possibility site planning evaluation (Figure 5, Figure 6). Finally, a visual
Figure 5. 3D human visual perspective simulation on comparative study of building height and receding line analysis.

Figure 6. Comparative study of visual corridors. From above to bottom: viewshed maps; view from Baishichong Bridge; view from south sidewalk; view from north sidewalk (with building height comparison). From left to right: the max visual corridor scope plus; the medium visual corridor scope plus; the minimum visual corridor scope.
corridor system is decided to be reserved in the site (Figure 6), and its accurate coordinates are marked (Figure 7). These advices have been adopted as basic regulations to stipulate this development and legalized in the official verdict of instructing further site planning (Zhongshan CCP School New Campus Designing Judging Panel: 2001).

4. Conclusion

This tool introduced in the case study firstly offers scientific and reliable references for the planning support. Such kind of planning and visual analysis used to be based on manual operation or even surmise in China. The GIS technology promises the accuracy, validity and reliability of this tool. Secondly, this tool has a large potential in professional application. For example, comparing with similar researches, such as the view corridor study of Zacharias (1999), in which use color pencil decorated computer graphics to assess the public preference of urban natural skyline, this tool focuses on the spatial distribution and spatial impact of visual quality. Therefore its analysis results can be more accessible in urban planning and management process. Such functional advantage is also highly recommended by the participating experts and academicians in the judging panel meeting of the case.

There are still some further topics to be discussed. For instance, after calculated the visibility, landscape aesthetics becomes the basic criteria of visual perception quality (Higuchi, 1983; Litton, 1982). An operable
methodology of quantifying the mountain skyline visual formation into aesthetical characters is still in vain. Other problems also occurs in data version and data overlay in system architecture (He, 2001). This tool is still in progress to its ultimate solution in natural skyline assessment.

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References


