Balancing Visual and Ecological Resource Reservation in Large-scale Recreation Area Planning Support on a GIS Platform

A case study of the Wenzhou Ecological Park

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This paper proposes an experimental approach in visual landscape analysis on a GIS platform, which has the potential of integrating with ecological aspects and consequently making scientific decision making supports for urban and landscape planning practices. The research team scrutinizes the potential of the GIS platform in balancing multi-aspect planning strategies. The methodology of GIS-based visual landscape protection for recreation purpose is demonstrated through the case of the Wenzhou Ecological Park. The same platform can also be introduced the landscape ecology capacity analysis. This methodology can improve the comprehensiveness of the landscape resource management system, and enhance its validity and reliability in its application in the landscape ecologically considerable projects.

Keywords: *GIS; urban planning; visual landscape; landscape ecology; resource management decision making support*

Background

The natural resource reservation has become critical in urban development, especially for Chinese cities, in which the rapidity on economical progress largely remodels the urbanscape. Urban ecology is the central consideration on the natural resource management in recent years. Meanwhile, the aesthetical performance of natural resource is another important characteristic of urban resource management and planning. Although the resource management from ecology aspect has become prominence in landscape planning in China, but the visual resource management consideration is still feeble in planning and management process.

This paper proposes an experimental approach to implement the visual landscape analysis through a GIS platform, on which the visual and ecological aspects can be integrated into landscape ecology conservation criteria. Consequently scientific decision making supports can be made for urban and landscape planning practices through this platform. The case of the Wenzhou Ecological Park is introduced to demonstrate the processes. Composed by the Sanyang Wetland (11.4km^2) and the Daluoshan Mountain area (114 km^2) (Figure 1), the Wenzhou Ecological Park locates to the adjacent suburban of the downtown of Wenzhou, Zhejiang Province. The further development of the entire urban structure is to enclose this mountain and wetland scope. The park will become the ecological nucleus of the future Wenzhou city. Since this area is also proposed to recreation functions, the visual resource value becomes another important consideration besides its ecological value. The balance between ecology protection, visual aesthetics, tourism and urban development is the central problem in this park planning project.

Research Methodology

This research is supported by the methodology of „visual sustainability“ developed by the research team (He & Tsou, 2003; He et al, 2002). In this project, the GIS-based analyses are divided into two parts. The first phase is the visual perception assessment. This quality is classified by different variables based on visibility assessment, such as visual sensitivity or visual openness for certain landscape resources. The second stage is introducing parameters of ecological concerns in topography, planting coverage, and so on, and then mapping through the GIS platform. Overlaying the two kinds of map can clarify the site for both visual and ecological significance, and balance the weight of consideration if any location appears to be extremely crucial for one aspect (Steinitz, 1990).

The technical supporting is based on GIS calculation on 3D digital elevation model (DEM) and 2D geographical/spatial analysis. The analytical data is illustrated through spatial distribution mapping. The visual or ecological analytical results are rated and classified into scores to distinguish the significance or priority of context respect in each theme. As mentioned above, GIS is employed as an analytical and technical platform in this project.

Analytical methodologies of the case study

In the park planning project, our research team is invited to offer scientific consultancy for the conceptual planning procedure for overall land-use decision making. In this stage, the research mostly emphasizes on the inventory of the visual and ecological performance of the mountain scope, and classification and mapping on the capacities for development impacts.

On the other hand, according to the requirement of visual landscape protection and development, the Daluoshan Mountain Scenic Area is the main parts of the Wenzhou Ecological Park. Firstly, there are rich visual landscape resources within the Daluoshan Mountain scope. The landscape value as well as its sensibility and capacity, will seriously affect the tourism development and landscape protection of the scenic area. Moreover, main visual

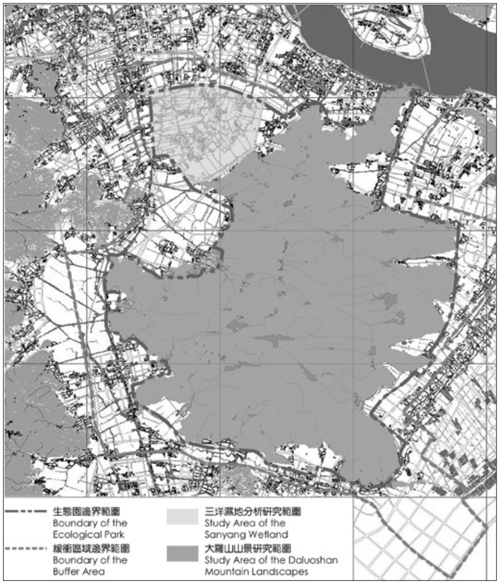


Figure 1
Map of the study areas in this project

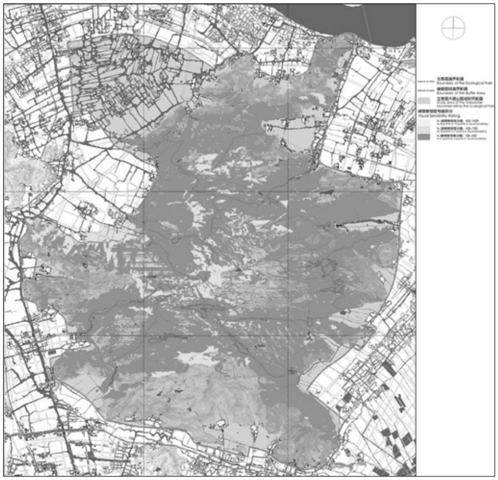


Figure 2
Mapping of visual sensibility ratings of the Daluoshan-Mountain Area (V_1-V_3)

resources perceived during the tourism within the Daluoshan Mountain scenic area are the mountain landscapes themselves. So also due to the research concentration and limit of paper length, only the analysis of the Daluoshan Mountain area is introduced in this paper.

The consideration on the impact of tourism development is the main concern in the analysis of the Daluoshan Mountain area. Based on the based on the viewpoints along the inherited tourism trails, which will be respected in the new planning., the visible scopes, frequency of visual perception, attenuation in visual quality along visual distance, and the mountain topography effects are calculated. Classification and numerical ratings are give to the appearances in visual sensibility (V), visual distance (D) and mountain topographical effect which mainly in gradient of slopes (S). Finally, these ratings are summed up to a combined score for each cell, and consequently translated into the priorities of protection/management consideration for resource management purpose (USDA, SCS, 1978; Yu, 1991).

The ecological aspects are represented through the inventories on topography and land-use or landcover/vegetations (Brown et al, 1986). These characteristics are rated through GIS calculation and then the indices are integrated through a matrix model. The combination values are classified into four categories of resource reservation in which landscape protection has to be considered in different significance. According to these reservation classes, planners and resource managers can define different development and landscape impact control strategies which educed from the reliable scientific supporting data.

Case Study

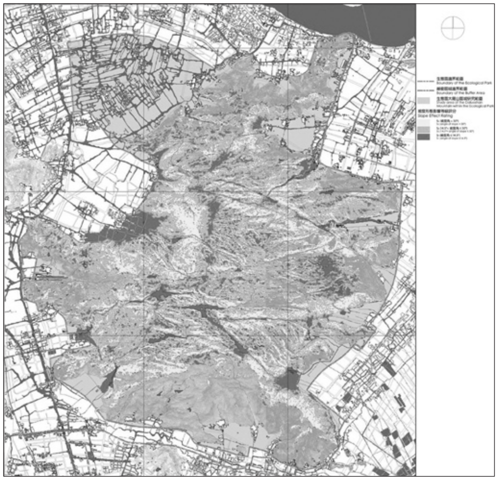
Visual sensibility analysis

The visible scopes of every segment of the tourism trails are overlapped to compute the visual sensibility through cell statistics. The numerical value of the visual sensibility of a cell describes the amount of tourism trails which can see this cell. The blank scopes of the mountain area are invisible from every main tourism trails. And the other visible cells, each of which can be seen from any single trail, or becomes the common visible objects for two to ten trails. Larger number of points in one location reflects more sensible in visual perception, and more potential visual impact when any landscape alteration happens in further development. The visual sensibility values are classified into three categories and rated from V_1 to V_3 in sensibility from low to high (Figure 2).

Visual distance and slop effect analysis

The visible scopes from the study trails are classified into categories in short-distance (0-360m), mid-distance (360-3300m), and long-distance (more than 3300m) (Higuchi, 1983). These categories are rated into D_1 (long-distance view), D_2 (mid-distance view), and D_3 (short-distance view) to quantify the visual quality of the landscape resources in visual distance effect.

The slope effects are translated into S_1, S_2 and S_3 to depict the different ranges in gradients as well as the relevant landscape sensitivity impact parameters



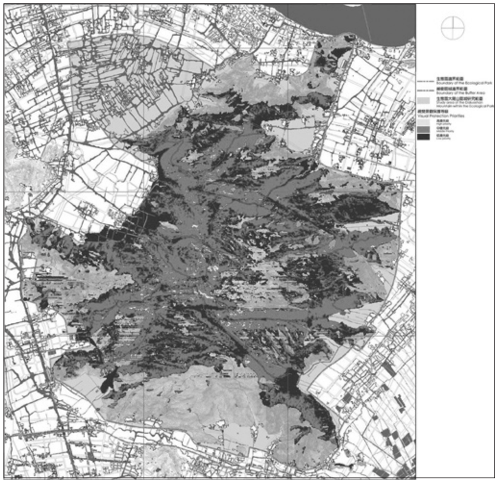


Figure 3
Mapping of the slope effect ratings of the DaluoshanMountain Area (S_1-S_3)

Figure 4
Mapping of the visual resource protection/management priorities of the Daluoshan Mountain region

(Figure 3). Steeper slopes, which is in larger number on gradient, are easier to be visualized. In addition, it is more sensitive in development impact.

Analysis on visual resource protection/ management classification

The numeric value of visual resource sensibility of each cell is calculated by combining ratings in visual sensibility, visual distance and slope effect through cell statistics (table 1). The values are varied from 3 to 8 points. Higher point means higher landscape sensitivity to development impact. Invisible areas from the study trails are determine as zero point in visual resource sensibility. These places are flexible to further development without affecting the important mountain landscape.

Table 1 is a matrix illustrating all possible combinations of the ratings in V, D and S. The combination values are classified into three categories in which visual protection and resource management has to be considered in different levels (He et al, 2002). These categories are High Priority (8), Middle Priority (6-7), and Low Priority (3-5) to represent the importance of visual protection. This protection/management level system offers scientific support to planners and managers. And different development and landscape impact control strategies should be established according to the above-mentioned visual protection and visual resource management priorities (Figure 4).

Ecological parameters and integration with visual resource concern

The slope gradient, the vegetation coverage, and the slope orientation which affect the plant growing are introduced as ecological indices. According to Yu (1997), these parameters are integrated and translated into the landscape threshold of land-

		V_3			V_2			V_1	
D_3	H_9	H_8	M_7	H_8	M_7	M_6	M_7	M_6	L_5
D_2	H_8	M_7	M_6	M_7	M_6	L_5	M_6	L_5	L_4
D_1	M_7	M_6	L_5	M_6	L_5	L_4	L_5	L_4	L_3
	S_3	S_2	S_1	S_3	S_2	S_1	S_3	S_2	S_1

Table 1
Combination value on the visual resource sensibility and the classification of resource protection/management priorities

scape ecology. Ratings of these thresholds are classified into T_1 to T_4, which reflect the highest to lowest endurance of the development impact. These thresholds are inventoried and mapped in the whole mountain area through GIS.

As mentioned before, location with higher visual resource sensitivity has more potential of being seen by the tourists, and more sensitive for impacts to the visual perception quality. Therefore it requires more protection in the future development. On the other hand, larger number in the threshold means less capability for ecological disturbance and higher priority of resource protection. The reservation categories 1 to 4 are designated to both of the visual resource sensitivity and ecological landscape threshold (Table 2). Overlaying maps of these two themes, an integrated resource reservation map can be conducted. The integrated reservation classification (Table 3) is calculated through the following equation:

$$P = \min (P_V , P_E) \qquad (1)$$

Where

P : the integrated resource reservation classification

P_V : the reservation category draw from the visual resource protection/management priority (the visual resource sensitivity)

P_E : the reservation category draw from the ecological threshold

The integrated reservation classification is calculated in each cell within the study mountain area and mapped through the GIS platform. The mountain landscape resource is rated from class I to IV which reflect the highest to lowest reservation priority.

Conclusion

The result of this research project is validated through field surveying. The land-use strategy generated through this platform can also have satisfied coherence with most of decision making by experienced planner in traditional work module (He et al, 2002). Collaborators in planning and management have consensus that this platform can offers more reliable decision making support efficiently. This research proposes an innovative planning process in urban landscape resource protection and management. The methodology integrates the ecological criteria into the system which the research team established for visual resource management. This integration can improve the comprehensiveness of the landscape resource management system, and enhance its validity and reliability in its application in the ecologically considerable projects.

The research team also reviewed the system implementation on the GIS platform for further revision. There are still potential ameliorations in the further study in the following two aspects. The first one is there is still shortcomings in the quality of some data input, such as the validity of several kinds of

Table 2
Conversion of reservation categories

Reservation categories	1	2	3	4
Visual resource protection/management priorities	H	M	L	nil
Ecologocal threshold	T_4	T_3	T_2	T_1

Table 3
Matrix of integrated landscape resource reservation classification

Pv / Pe	1	2	3	4
1	I	I	I	I
2	I	II	II	II
3	I	II	III	III
4	I	II	III	IV

visual or ecological characteristic translation into numeric attributes of spatial cells. More reliable data processing methodologies will be reviewed through other references. In addition, the dimension of the raster cell applied in this analysis is still too large. It limits the application of those results in a more detailed scale planning. The effective analytical model available in hierarchical scales for diverse planning assignments is the next research objective.

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