

Estimation on Aesthetic Value of Tourist Landscapes in a Natural Heritage Site: Kanas National Nature Reserve, Xinjiang, China

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Abstract: Most world natural heritage sites are designated partly by reason of their prominent aesthetic values in accordance with Article VII of World Natural Heritage Convention. In this paper, the aesthetic values of Kanas National Nature Reserve, which has potential for such designation, was analyzed quantitatively using scenic beauty estimation (SBE). The landscapes of 19 representative scenic spots in the Kanas National Nature Reserve in summer and autumn were selected as the objects of evaluation. The contributions of different landscape factors to the aesthetic value of the Kanas National Nature Reserve were revealed using a multivariate quantitative model. The main factors affecting the aesthetic value were waterscapes, vegetation, mountains, folk culture and the tourist environment. The *t*-test and *F*-test results are extremely significant. According to the results, some suggestions were given for conserving the landscapes in the Kanas National Nature Reserve.

Keywords: Kanas National Nature Reserve; aesthetic value; scenic beauty estimation; World Natural Heritage; Xinjiang

1 Introduction

Aesthetic value is one of the important criteria in the evaluation of application for natural areas to be designated by the UNESCO as World Natural Heritage. It was pointed out in the *Convention Concerning the Protection of the World Cultural and Natural Heritage* (World Natural Heritage Convention for short) of the UNESCO that world natural heritages are "natural features consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view", or be "natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty" (UNESCO World Heritage Centre, 2008). Up to December 2008, 174 world natural heritage sites had been designated, of which 105 met the criteria in Article VII of the World Natural Heritage Convention, meaning that they "contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance" (UNESCO World Heritage Centre, 2008). This reveals

that aesthetic value has been an important criterion for designation as a World Natural Heritage site.

The quantitative evaluation of aesthetic value is a difficult task and an important topic in researching and establishing world heritage (Xie *et al.*, 2001; Lu *et al.*, 2006). Aesthetic evaluation is a value judgment involving the comprehensive reflection of observers to aesthetic objects at different spatial and temporal scales, and according to Daniel (2001), it is amenable to quantitative analysis. The evaluation methods can be divided into four main schools of thought, i.e. the expert school, psychophysical school, cognitive school and experiential school (Wang *et al.*, 2006). Relatively stable evaluation modes can be established under the guidance of different theories associated with the different schools of thought. The first is called the detailed description method, emphasizing the study of the physical characteristics of aesthetic objects. It involves two components: the modal aesthetic mode and ecological mode (Chen, 2005). The second is called the public predilection method, addressing the subjective assessments of observers. It includes three modes: psychological, cognitive

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and experiential modes (Chen, 2005). The third approach is called the integrated method or the psychophysical method, paying equal attention to the observers and the aesthetic objects, and explaining the affiliations among them. The scenic beauty estimation (SBE) in the psychophysical method based on public judgment is dominant (Ouyang *et al.*, 2007; Song *et al.*, 2006).

SBE was put forward by American environmental psychologists Daniel and Boster (1976). In this method, the relation between landscapes and observers is regarded as a stimulus-response relationship and the aesthetic tastes of groups of observers are the criteria for scaling landscape quality (Elena *et al.*, 2009). SBE includes three parts: 1) public aesthetic evaluations are based on photographs to attain SBE values; 2) landscape assessments are made to get scores for various stimulus factors; and 3) a model is developed to establish the relationships between the SBE values and the stimulus factors (Wang and Chen, 1999). The method has been used to carry out aesthetic evaluations of forest parks (Deng *et al.*, 1996), lacustrine landscapes (Yu, 1998), road scenery (Akbar *et al.*, 2003), forest vegetation (Chen and Jia, 2003), and residential areas (Zhou *et al.*, 2006). However, there have been few such studies on SBE values of the landscapes in the world heritage areas.

The Kanas was approved as a national nature reserve in 1986, nominated China National Natural Heritage Convention Tentative List in 2006, and its application for the World Natural Heritage was started from 2009. It has very important value for environmental conservation, scientific research and tourism development because of

its rich natural landscapes that accord with the criteria in Articles VII, VIII and IX of World Natural Heritage Convention. Thus, there is potential for the application for World Natural Heritage designation (Liu *et al.*, 2009; Liu *et al.*, 2007; Di and Yang, 2009). Based on the election criteria in Article VII, this paper provides a quantitative analysis of the aesthetic values of the tourist landscapes in the Kanas National Nature Reserve using SBE. Also, suggestions are given for guiding the conservation and exploitation of the landscape resources and for applying for World Natural Heritage designation.

2 Study Area and Methods

2.1 Study area

The Kanas National Nature Reserve (48°35'–49°11'N, 86°54'–87°54'E) is located in Burqin County of Altay Prefecture, Xinjiang, China, and it borders on Kazakhstan and Russia in its north and abuts on Mongolia in its east. The nature reserve is 74 km long from east to west and 66 km wide from south to north, and its area is 2 200 km². The Siberian flora and fauna as well as the natural landscapes are mainly conserved in the Kanas National Nature Reserve (Du and Zhang, 2006). The nature reserve is divided into three functional zones: the core zone, buffer zone and experimental zone (Fig. 1). Tourist activities are allowed mainly in the Kanas Lake area on the southern margin of the experimental zone. The peak tourist season in the Kanas National Nature Reserve is from July to September.

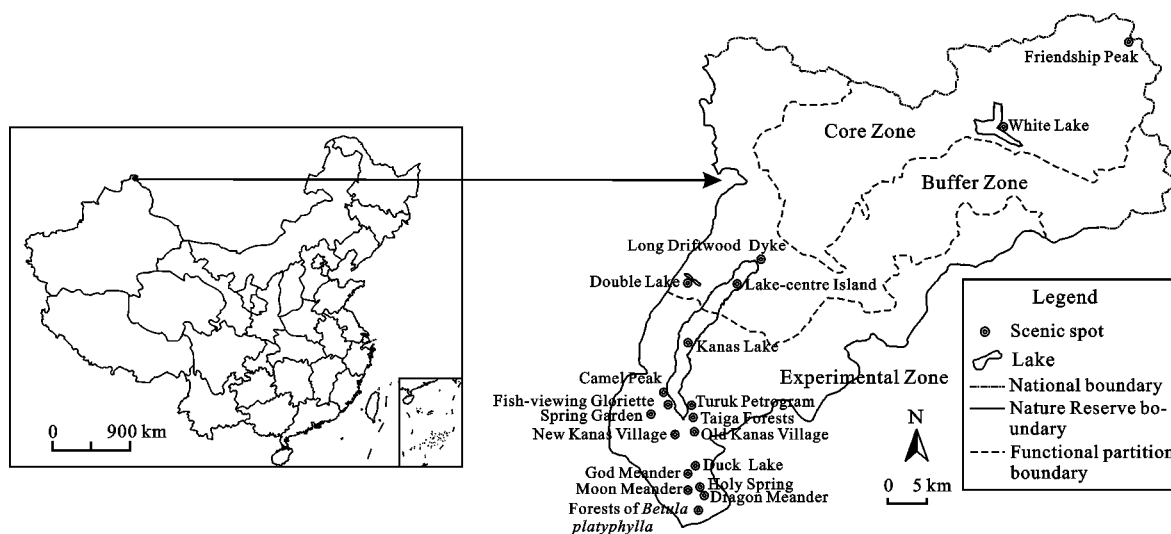


Fig. 1 Location and distribution of scenic spots in Kanas National Nature Reserve

2.2 Methods

The evaluation of the landscapes in the study area was undertaken through the evaluation of photographs by judges. In this study, some close-shot landscape photographs in 19 key scenic spots in summer and autumn were selected for evaluation based on the typicality, aboriginality and accessibility of tourist landscapes in the Kanas National Nature Reserve (Fig. 1). The photographs used here were shot at distances shorter than 500 m away from scenes so that the observers can readily see the appearances, colors, patterns, textures, *etc.* of these landscapes.

2.2.1 Landscape evaluation

(1) Judgment medium. Many researchers have shown that no significant difference is found in evaluating the aesthetic value of landscapes between the way of using photos to stimulate responses and that of carrying out field evaluation (Daniel and Michael, 2001; Yu, 1998). Furthermore, the former is a much more convenient, less expensive and less time-consuming procedure. Therefore, in this study, each scenic spot is represented by one photo and the aesthetic values of landscapes are judged using lantern slides.

(2) Judges. The judgments of different representations of aesthetic subjects are highly similar (Daniel and Michael, 2001; Yu, 1998). About 50 persons who had previously visited the Kanas National Nature Reserve were invited to be the judges. They included: 1) experts who had visited some world natural heritages and were engaged in or studied such subjects as tourism geography, landscape design, physical geography, phytoecology, *etc.*; 2) doctoral and master students who had understood the world natural heritages in China; and 3) staffs of the Management Committee of Kanas National Nature Reserve.

(3) Judgment scale. A scale from 0 to 9 was used to judge the slides, and the higher the value, the more beautiful the scenery and the higher the quality of landscape.

In order to compare the judged results with the world natural heritages, some lantern slides met the criteria in Article VII of the World Natural Heritage Convention and taken from the world natural heritages in the similar latitudes as the Kanas National Nature Reserve were shown before carrying out the aesthetic estimation of the Kanas National Nature Reserve. A photo similar to the typical tourist landscape in the Kanas National Nature

Reserve was selected as the base photo evaluated as 0, based on which all the scenic spots in the Kanas National Nature Reserve were judged.

2.2.2 Calculation of SBE values

Based on the values assigned by all of the judges for each slide, the SBE value of each scenic spot was calculated. The frequencies (f) of all levels from 0 to 9 were counted up, then the cumulative frequency (cf) was calculated. The cumulative frequency is divided by the judge number (50 judges in this study) to attain the cumulative probability (cp). The one-side fractile of normal distribution (Z) was looked up based on the cumulative probability, the average value of Z (\bar{Z}) was calculated, and then the SBE value of scenic spot i was calculated as follows:

$$SBE_i = (\bar{Z}_i - \bar{Z}_{bp}) \times 100 \quad (1)$$

where SBE_i is the SBE value of scenic spot i , \bar{Z}_i the average Z value of scenic spot i , and \bar{Z}_{bp} the average Z value of the base photo.

2.2.3 Analysis of landscape factors

In order to further analyze the effects of landscape factors on SBE values, seven landscape factors (mountain massif, water body, vegetation, animal, atmospheric phenomenon, folk culture and tourist environment) were selected to evaluate the landscapes of the study area. Each factor was divided into three landscape divisions based on their features (Table 1). The landscape values $\delta_i(j, k)$ reflecting all of the evaluating factors of each scenic spot were attained using following equation:

$$\delta_i(j, k) = \begin{cases} 1, & \text{when the content of evaluating factor } j \\ & \text{in scenic spot } i \text{ is in division } k \\ 0, & \text{otherwise} \end{cases} \quad (2)$$

2.2.4 Establishment of evaluation model

The SBE values of the various landscapes were regarded as dependent variables, the values of the judges were regarded as independent variables, and the model of relation between the landscape factors and the SBE landscape values was established using the quantitative model:

$$y_i = b_0 + \sum_{j=1}^m \sum_{k=1}^{r_j} \delta_i(j, k) b_{jk} \quad (3)$$

where y_i is the SBE value of the scenic spot i ; b_0 is the constant term; m is the number of evaluating factors ($m=7$ in this study); $\delta_i(j, k)$ is the value of evaluating

Table 1 Analysis of close-shot landscape factors

Serial No.	Evaluating factor	Division		
		1	2	3
1	Mountain massif	Non-mountainous landscapes or familiar mountains with gentle slope and general shape	Beautiful mountains with steep slopes and handsome shapes	Peculiar mountains with distinctive shapes, cliffs, deep valleys and cloud-kissing peaks
2	Water body	No water bodies or the familiar water bodies	Relatively beautiful waterscapes with attractive banks and clear water without pollution	Beautiful and elegant waterscapes in splendid environments
3	Vegetation	Ordinary structure of plant communities, simple appearance of forests with coverage lower than 70%, and no old and famous trees	Complex structure of plant communities, obvious appearance of forests with coverage of 70%–80%	Complex structure of plant communities, significant appearance of forests with some rare and national-level protected species and coverage higher than 90%
4	Animal	Some familiar animals or no animals	Many animal species	Many animal species and some national-level protected species
5	Atmospheric phenomena	Some general atmospheric phenomenon	Some beautiful atmospheric phenomenon worthy viewing	Some famous atmospheric phenomenon
6	Folk culture	No folk culture or only some familiar buildings and legends	Some folk culture of scientific and artistic values and local color recognized locally	Some folk culture with typical local color, and high scientific and famous artistic values at home and abroad
7	Tourist environment	Destroyed and polluted environment, and low tourist comfort level	Slightly destroyed and polluted environment, with landscape authenticity and integration	Undestroyed or unpolluted, authentic tourist environment

factor j in scenic spot i in division k ; r_j is the number of divisions of evaluating factor j ($r_j=3$ in this study); b_{jk} is the score of each division.

3 Results and Analyses

3.1 SBE values

The calculated SBE values of the close-shot landscapes in 19 tourist spots in the Kanas National Nature Reserve are shown in Table 2. The average SBE value of the 19 scenic spots is 27.9.

3.1.1 Analysis of extremes

According to the results in Table 2, the SBE value of the Dragon Meander is the highest (88.5) because of its unique landform and changeable water color. The Dragon Meander is Ω -shaped due to the long-term lateral erosion along the right bank, and an alluvial deposit with flourishing vegetation has formed as the river channel is widened, the stream flows slowly, and silt accumulation occurs. Forests grow luxuriantly along both banks of the meanders, and reflections occur with seasonal changes in the vegetation and weather. The diversity and dynamic features of the landscape attract tourists from all over the world. Therefore, the tourist aesthetic value of the Dragon Meander is very high.

Table 2 SBE values of close-shot landscapes

Zone	No.	Main scenic spot	SBE	Grade
	1	Base photo	0	
Core zone	2	Friendship Peak	48.8	A
	3	White Lake	35.4	B
Buffer zone	4	Double Lake	35.7	B
	5	Long Driftwood Dyke	-24.8	C
	6	Lake-centre Island	19.0	B
Experimental zone	7	Kanas Lake	57.6	A
	8	Dragon Meander	88.5	A
	9	Moon Meander	81.1	A
	10	God Meander	72.7	A
	11	Duck Lake	71.6	A
	12	Holy Spring	-24.2	C
	13	Spring Garden	32.5	B
	14	Taiga Forests	62.8	A
	15	Fish-viewing Gloriette	-31.9	C
	16	Camel Peak	-54.9	C
	17	Old Kanas Village	14.1	B
	18	New Kanas Village	12.6	B
	19	Turuk Petrogram	22.7	B
20	Forests of <i>Betula platyphylla</i>	10.9	B	

The SBE value of Camel Peak is the lowest (-54.9 only) of the 19 scenic spots because the mountain slope

is gentle and the bedrock along some sections of the hilly road is bare without any vegetation.

3.1.2 Grading of scenic spots

A cluster analysis on the SBE values was carried out, and the SBE values were classified into three groups, A, B and C with scores higher than 42.25, from -6.95 to 42.25 and lower than -6.95. Correspondingly there were seven, eight and four landscapes in the three groups respectively (Table 2).

3.2 Evaluation of SBE values

3.2.1 Establishment of evaluation model

In modeling, the factors with low partial correlation coefficients and insignificant *t*-test results, such as the animal and atmospheric phenomena, were eliminated, and the evaluation model of close-shot landscapes in the Kanas National Nature Reserve was established after screening out the 5 most important evaluation factors, i.e. mountain massif, water body, vegetation, folk culture and tourist environment (Table 3).

$$y = 2.9 + 38.8x_{12} + 91.65x_{13} - 73.6x_{21} - 41.95x_{22} + 7.7x_{32} + 69.9x_{33} + 15.85x_{42} + 62.8x_{43} + 0.55x_{52} + 31.6x_{53}$$

In the model, the partial correlation coefficients of the five variables are all higher than 0.54, and the multiple correlation coefficient (*R*) is 0.97. These reveal that the correlation of the model is very high. The determination coefficient (*R*²) is 0.94, which indicates that 94% of the variability in the induced variables can be explained using the five selected variables.

In the model, the degree of freedom (*Df*) is 13 (*Df*=*n*-*a*-1, *n*=19, where *n* is the number of samples, and *a* is the variable, *a*=5). In the model test, *t*-test is used for testing the partial correlation coefficients, and the results show that *x*₁, *x*₂, *x*₃ and *x*₄ are extremely significant (*t*>*t*_{0.01}(13)), and *x*₅ is significant at confidence level of *p*=0.05 (*t*_{0.05}(13)<*t*<*t*_{0.01}(13)). *F*-test is used for testing the multiple correlation coefficient, and the result is extremely significant (*F*=45.14>*F*_{0.01}(5, 13)). The test results show that there are the extremely significant correlations be-

Table 3 Results of evaluation model

Evaluation factor	Factor code	Division	Score	Score difference	Partial correlation coefficient	<i>t</i> -test
Water body	<i>x</i> ₁	1	0	91.65	0.8694	6.3433**
		2	38.80			
		3	91.65			
Vegetation	<i>x</i> ₂	1	-73.60	73.60	0.8738	6.4779**
		2	-41.95			
		3	0			
Mountain massif	<i>x</i> ₃	1	0	69.90	0.7733	4.3978**
		2	7.70			
		3	69.90			
Folk culture	<i>x</i> ₄	1	0	62.80	0.7554	4.1567**
		2	15.85			
		3	62.80			
Tourist environment	<i>x</i> ₅	1	0	31.60	0.5406	2.3172*
		2	0.55			
		3	31.60			
<i>b</i> ₀ (constant term)				2.9		

Notes: **p*<0.05, ***p*<0.01, *t*_{0.05}(13)=2.16, *t*_{0.01}(13)=3.01, *R*=0.97, *R*²=0.94, *F*_{0.01}(5,13)=4.86, *F*=45.14** (very significant)

tween the five evaluating factors and the SBE values.

3.2.2 Influence of evaluation factors on SBE values

(1) Influence of water body on the SBE value. The contribution of water bodies to the SBE value is the highest, and their correlation is the second, which reveals that the water bodies are the core factor affecting landscape aesthetics in the Kanas National Nature Reserve (Table 3). The scores of the water bodies in the study area are all

positive and their coefficient in Division 3 is the highest, revealing that waterscapes are advantageous for increasing SBE values. The shapes of the water bodies in the Kanas National Nature Reserve are peculiar and rare, and some beautiful scenic spots include waterscapes, such as the Kanas Lake and White Lake dammed by terminal moraines, Duck Lake, Dragon Meander, Moon Meander and God Meander formed under fluvial erosion. Water

color in Kanas National Nature Reserve changes with the seasons, weather change and the changing mineral components of the stream water.

(2) Influence of vegetation on the SBE values. The contribution of vegetation to SBE values is second only to that of water bodies. There are six vertical vegetation zones and seven vegetation types in the Kanas National Nature Reserve, the community structure is complex, and the appearance of forests is changeable. The vegetation coverage is higher than 70% in the most scenic spots in the Kanas National Nature Reserve, and the high vegetation coverage increases the aesthetic value. Moreover, seasonal variations and the changing beauty of the vegetation also increase the aesthetic value. *Trollius altaicus* and *Paeonia anomala* are in full bloom in spring, the Taiga forests are luxuriantly green in summer, the beautiful golden and yellow forests of *Betula platyphylla* and *Populus davidiana* intermix in the green coniferous forests in autumn, and all the forests are snowy white in winter. Such landscapes attract tourists all the year round.

(3) Influence of mountain massifs on the SBE values. The contribution of mountain massifs to the SBE value is relatively high, and their correlation is also high because the mountain massifs are the basic framework integrating the landscapes features. The geologic structures of the mountains in the Kanas National Nature Reserve were the Fuyun anticline of Altay geosyncline foldbelt, and the high peaks around the Friendship Peak (4 374 m a. s. l.) were formed under the combined effects of Paleozoic folds and fractures. The mountain shape is irregular with hummocks, mountain chains and inselbergs. The mountain massifs are the main landscapes in the Kanas National Nature Reserve, and they significantly influence the SBE values.

(4) Influence of folk culture on the SBE value. The natural landscapes are conserved in the Kanas National Nature Reserve. However, folk culture is also regarded as a factor affecting the SBE value in this study. According to Table 3, the score of Division 3 is the highest, which indicates that the aesthetic value of the Kanas National Nature Reserve is mainly reflected by the human-nature harmonious beauty. The study area is the only region where the Tuvas people of Inner Mongolia live in compact communities, and their traditional lifestyles still exist in the nature reserve. The local distinctive culture attracts both the domestic and foreign tourists. Moreover, some features of grassland cultural heri-

tage, such as the petrograms from the Warring States (475–221 B.C.) to the Yuan Dynasty (1271–1368 A.D.), have been found. The aesthetic value of the scenic spots is promoted by these mysterious artifacts.

(5) Influence of tourist environment on the SBE value. According to Table 3, the contribution of the tourist environment to the SBE value is less than that of other factors because the environment in the study area is basically in its original state (Liu *et al.*, 2009). Negative impacts to environment come mainly from road construction and the point-source pollution in the tourist centre. Therefore, the management is required in the scenic spots that have been destroyed and the conservation of tourist environment should be enhanced, which will improve the effect of the tourist environment on the SBE values.

4 Conclusions and Suggestions

In this paper, the scenic beauty estimation of the tourist landscapes in the Kanas National Nature Reserve was carried out by taking the tourist landscapes similar to the criteria of World Natural Heritage as the judging standards. The average SBE value of the 19 scenic spots in the nature reserve is 27.9, higher than 0, revealing that the Kanas National Nature Reserve has a potential for the nominated properties of World Natural Heritage.

The SBE values of 19 scenic spots in the Kanas National Nature Reserve have been calculated. The SBE value of the Dragon Meander is the highest (88.5). In the tourism development, it is suggested to open some new tourist routes to increase the capacity of the environment for tourism, and the beauty of the Dragon Meander can be enjoyed from new angles. The SBE value of Camel Peak is the lowest (−54.9), therefore, the regeneration and conservation of the environment are required.

The cluster analysis reveals that there are seven, eight and four scenic spots at grades A, B and C respectively in the nature reserve. The A-grade scenic spots in the Division experimental zone should be mainly conserved, tourists are forbidden to enter the core and the buffer zones, and only scientific research is allowed. There are six A-grade scenic spots in the experimental zone and they occupy 85.7% of the number of A-grade scenic spots in the Kanas National Nature Reserve. This indicates that the aesthetic value is high in the experimental zone. The standards of "authenticity and integrality" of World Natural Heritage should be strictly followed in tourism

development and construction, and the conservation of the A-grade scenic spots should be enhanced. For example, roads should not pass through the A-grade scenic spots, and the unharmonious tourist buildings and service facilities should not be constructed; some capacity-increasing and tourist-repositioning measures should be undertaken so as to avoid overloading environmental capacity; livestock movements should not pass through the scenic spots, and number of livestock in the peripheral areas of A-grade scenic spots should be reduced so as to avoid environmental degradation.

The analysis reveals that the evaluation model is highly reliable. From the model it can be concluded that the contribution of water body to the tourist aesthetic value of the Kanas National Nature Reserve is the highest, and then those of vegetation, mountain massif and folk culture, and that of the tourist environment follow. The different landscape factors can be separately conserved so as to conserve the integrated aesthetic value of tourist landscapes as much as possible.

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