A Comparison of Choice-based Landscape Preference Models between British and Korean Visitors to National Parks

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Abstract: This study aims to formulate landscape preference models using a conditional logit model, and compares them between visitors to the Cairngorms National Park in Scotland and those to the Jirisan National Park in Korea. The visual elements of each landscape photograph were segmented using digital image processing, before reduced to orthogonal principal factors. The formulated models suggest that the effect of the Cairngorms landscape (exp(coef.=22.678)) was of more importance than that of the Jirisan landscape (exp(coef.=7.701) in determining landscape preferences of Cairngorms visitors, while the effect of the Jirisan landscape (exp(coef.=29.061)) was of more importance than that of the Cairngorms landscape (exp(coef.=18.131)) in determining landscape preferences of Jirisan visitors. This implies that, in determining landscape preference, the landscape effect of the National Park that is typical to respondents is larger than that of the different National Park, although visual elements play a considerable role.

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1. Introduction

Visual elements are the most important factors contributing to landscape preferences. The term landscape commonly refers to the appearance of the land, including its shape, texture, and colour (Institute of Environmental Assessment and the Landscape Institute, 1995). Bell (1993) suggested four basic visual elements important in landscape design: form, colour, line and texture. To evaluate the visual quality of landscape using these visual elements, landscape has been assumed to have an intrinsic beauty(Lothian, 1999). Landscape preferences are seen as a function of visual stimulation arising from the elements of landscape from a psychophysical viewpoint. Psychophysical assessments are useful due to their quantitative precision, objectivity, and basis in public perception and judgement. Based on such a psychophysical approach, Shafer *et al.* (1969) proposed a predictive model of landscape preferences. They presented landscape preferences as a function of landscape elements in photographs such as land zone variables, dimension variables, and tonal variables. Daniel and Schroeder (1979) also developed the Scenic Beauty Estimation method for assessing the scenic beauty of forest landscapes. In their research, landscape variables were defined in terms of manageable features, such as trees per acre, pounds per acre of grass, and cubic feet of shrubs.

The psychophysical approach usually depends on an averaged judgement from a group of the public, so group measures are appropriate. The respondents state their preferences among a set of combinations of attributes that define visual landscapes. To evaluate landscape preference, individual perception is methodologically expressed in several ways such as ranking them in order of importance (Arriaza *et al.*, 2004; Tips and Savasdisara, 1986) or rating them on a scale indicating strength of preference (Hammitt *et al.*, 1994; Kent, 1993; Sayadi *et al.*, 2005). The latter has been mainly used for landscape preference modelling.

However, a choice-based method for landscape preference which allows respondents to choose one of the answers based on the nominal scale has many advantages over the rating-based method (Lee, 2006b). It is more efficient in the number of judgments that respondents are required to make and more realistic in that it asks target respondents to make actual preference decisions rather than indications of preference. The choice-based method also allows respondents to choose 'none of these'. It makes sense in many situations to use a constant option such as 'no-choice' (or, status quo) which adds realism and value to the choice model (Louviere *et al.,* 2000). This study formulated landscape preference models for visitors to the Cairngorms National Park in Scotland (CNP) and to the Jirisan National Park in Korea (JNP). A conditional logit model (CLM) was used to involve a selective situation with alternatives in a choice-based method. To determine any implications across cultures, the formulated models were compared between the two visitor groups.

Preference judgement is conceptualised through a model of choice (Einhorn and Hogarth, 1988; Hogarth, 1980). A common type of statistical model for the discrete choice situation is the logit model. Whereas explanatory variables are the characteristics of individual observations in a multinomial logit model (MNLM), the characteristics of the dependent variable itself are used as an explanatory variable in a conditional logit model (CLM; Long, 1997; Wrigley, 1985). In terms of the response probabilities, the standard MNLM is expressed as follows.

$$Pi = \frac{\exp(Vi)}{\sum_j \exp(V_j)}$$

where, V is the linear combination expressed as

$$Vi = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta i Xi = Xi^T \beta i$$

The CLM is more general than the MNLM. The predicted probability of observing outcome *m* given x_i is expressed as follows (Long, 1997):

$$P(y_i = m \mid x_i) = \frac{\exp(x_{im}\beta)}{\sum_{j=1}^{J} \exp(x_{ij}\beta)}$$

where
i : observation number
m : m^{th} choices
J : number of parameters
x: attributes of the choice alternatives

The CLM expression is extended to include the characteristics of the individual along with choice characteristics through incorporating individual covariates called alternative specific constants (ASCs). The ASCs are the location parameters of the random utility component and are not associated with any one attribute, so that they capture the effect of omitted variables (Louviere *et al.,* 2000). In the case of choosing one of three categories, the combined form of the two linear logit models that use the 3^{rd} category as a baseline is specifically represented as follows:

$$\log\left[\frac{P(y_i = m \mid x_i)}{P(y_i = 3 \mid x_i)}\right] = \beta_{0m} + \sum_{j=1}^{J} \beta_j (x_{mij} - x_{3ij})$$

A goodness-of-fit using McFadden's pseudo r-square (ρ^2) is used for fitting the overall model. McFadden suggested ρ^2 values of between 0.2 and 0.4 should be taken to represent a very good fit of the model (Louviere *et al.,* 2000).

$$\rho^2 = \frac{\log L_0 - \log L_c}{\log L_0}$$

where
log L_0: log-likelihood estimated from null model
log L_c: log-likelihood estimated from current model

In addition, the logit probability has a property called independence from irrelevant alternative (IIA). This property implies that the ratio of probability for any two alternatives should not be affected by any of the other possible alternatives that are available to a decision maker. The ratio of the probabilities of choosing one alternative over another is unaffected by the presence or absence of any additional alternatives in the choice set. The model with the IIA violation has a weakness because the observed and unobserved attributes of utility are not independent of one another, and because there is correlation among the unobserved components of utility among alternatives (Powers and Xie, 2000). A simple approach to test the IIA assumption would be to exclude one choice, estimate the reduced model, and compare the estimate from the restricted and unrestricted models to see whether the interpretation of the results differs between the models (Powers and Xie, 2000).

Based on the examination of the IIA property and on the estimated McFadden's pseudo r-square (ρ^2), conclusions were drawn as to which was more appropriate, and subsequently a better-fitted model was suggested and compared.

- Models CNP1 and JNP1 excluded the ASC, which suggested an effect of the variables only related to visual characteristics on landscape choice.
- Models CNP2 and JNP2 included the ASC, which suggested an effect of landscape itself with the variables related to visual characteristics on landscape choice.

2. Material and Methods

The CNP has a landscape typical of the Central Highlands of Scotland. The Cairngorms have been categorised as a National Scenic Area (Andrews, 1989; Murray, 1962). The ideal of the Cairngorms has been pictured through artistic works and tourist leaflets (Gold and Gold, 1995). The CNP, located in the central Highlands of Scotland (latitude 57^o N. and longitude 3^{o}40' W. approximately) and extending up to 1,309m above sea level, is the second National Park in Scotland and the largest in the British Isles, with an area of about 3,800 km^2. The most impressive topography of the Cairngorms is characterised by the extensive summit plateau at about 1,000m, with accompanying rock-cliffs and ex-glacial features of lochs (lakes) and glens (valleys). Ben Macdui, the highest peak in the Cairngorms, reaches 1,309m and is the second highest peak in the British Isles.

The Cairngorm plateau is divided by glens and glacial troughs, with two glens penetrating into the massif, Glen Derry and Glen Dee, and leading to two passes, the Lairig an Laoigh (48km) and the Lairig Ghru (43km), respectively. The Lairig Ghru is a famous footpath passing through the heart of the

Cairngorms, which shows the heart of pine woods and wide open hillscapes. The Lochnagar massif with a maximum altitude of 1,150m is relatively small and is located to the southeast of the main Cairngorm massif. The most distinctive and ecologically important component of vegetation in the Cairngorms is the tundra-like plant communities such as mountainous heath (e.g., *Calluna vulgaris*), and extensive grassland on rock debris. At low altitudes there is an extensive area of native pinewood (e.g., *Pinus sylvestris*).

Jirisan is one of the mountains representing Korean natural landscape. Geological and geographical characteristics make Jirisan a representative mountain of Korea (Jang *et al.*, 2003). It is also famous for its idealised history with a regional community (Lee, 2006a). The JNP, located in the southern central part of Korea (latitude 35^{o} N. and longitude 127^{o}34' E.), was established as the first National Park in Korea in 1967. With an area of approximately 470km^2 and a perimeter of 320km, the JNP is the largest among the mountainous National Parks of Korea. Jirisan has a relatively high mountain range and deep and long valleys. The physical features of the area are distinctive with a rolling plain, hills and mountains culminating in the highest peak of Cheonwangbong (1,915m) in the eastern part of the mountain. The main ridgeline from Cheonwangbong to Nogodan is 25.5km long and is renowned as an excellent footpath through Jirisan. Jirisan is well endowed with natural resources, providing a dense forest ecosystem. Nearly the whole region of Jirisan is covered by temperate trees and shrubs (e.g., *Pinus densiflora, Abies koreana, Camellia japonica*).

A self-administered photo-questionnaire was applied as the principal survey instrument to obtain responses from the participants. Several researchers have shown high positive correlations between the ratings based on photographs of natural landscapes and those made by direct experience of the actual sites (e.g., Brown *et al.*, 1988; Hull and Stewart, 1992; Shuttleworth, 1980). Digital photographs were taken to represent the natural landscape of each National Park. To present the CNP landscapes, 105 pictures were mainly taken through the Lairig Ghru, as well as Glenmore Forest Park, Ben Macdui, Loch Avon, Mar Lodge, Derry Lodge, and Lochnagar in the summer of 2002. Seventy JNP landscape photographs were mainly taken at the viewpoints along the main footpath from Cheonwangbong to Nogodan, as well as Banyabong, Saeseok, and Baemsagol in the summer of 2003.

The digital photographs were printed on A4 photo-quality paper in order to produce a photographic book. In order to select photographs showing the typical CNP landscape, 26 visitors to the Lochnagar visitor centre in the CNP participated in the questionnaire survey. Randomly selected visitors who were very familiar with their landscape graded the degree of typicality of the photographs of the National Park. Landscape photographs were aligned and selected by the highest number of its degree of typicality. The most typical CNP landscape scored 4.6, whereas the least typical landscape scored 2.9 (Figure 1). Similarly, typical JNP landscape photographs were selected by 30 visitors to the Nogodan visitor centre in the JNP. The most typical JNP landscape scored 4.7, and the least typical 2.1 (Figure 2).

Score: 4.6 Score: 2.9

Figure 1. Typical Landscapes of the CNP

Score: 4.7 Score: 2.1

Figure 2. Typical Landscapes of the JNP

Eighteen photographs obtaining a score of above 4, as suggested by Ross (1974), were randomly matched into nine Cairngorms-Jirisan pairs for use in the discrete choice method to formulate the landscape preference model. The final questionnaire included the option of 'not choosing', as well as each pair of photographs (Figure 3). Participants were expected to select one of the photographs that they preferred, and then to mark it on the separate answer sheet. The answer sheet was distributed to the respondents with a photographic book composed of the nine-paired photographs. The socio-demographic section in the answer sheet requested each respondent to provide information on their personal background (e.g., age, gender, and occupation). The answer sheet also included a brief introduction to the survey outlining the purpose, importance and identity of the researcher involved in the study. Respondents were assured that all responses would remain confidential.

Landscape A Landscape B

Q. Which natural landscape do you prefer?
Landscape A ( )
Landscape B ( )
Neither ( )

Figure 3. Illustration of Questionnaire

The survey design of this study was comparative with two cross-sectional data, so surveys of visitors to the CNP and the JNP were executed respectively. A non-probability sampling method was used when visitors were available at the time of survey. Non-probability techniques are appropriate when the population is so widely dispersed that the sample could not be representative. Rather, the interest lies in an examination of the exploratory data to reveal patterns. This weakness of the external validity of landscape preference research is more pervasive, especially in cross-cultural situations, because the population is so widely dispersed.

According to the National Parks Authority of Korea (2001), the highest number of visitors arrived during the peak period in August (Figure 4). The arrival of visitors during this month was approximately 20% of the total visitors in a year. To maximize the number of respondents, and thereby increase the sample representativeness, in the minimum survey time, both surveys were conducted on weekends in summer, which is the peak time for visitors to the National Parks.

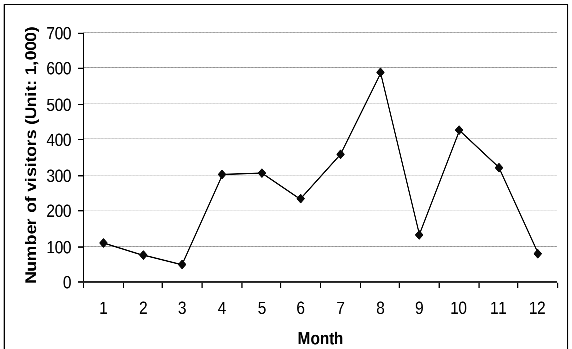

Figure 4. Visitors to the Jirisan NP by Month, 1991 to 2000

A general rule for sample size could be considered, which was that any sub-group should contain at least 50 members in order to compare with other sub-groups (Scottish Natural Heritage, 1995). The planned sample size was therefore set at approximately 100 subjects for both samples due to the limitation of the researcher's resources in terms of costs and survey time. Both the CNP and the JNP were visited to distribute the questionnaire. The survey involved person-to-person contact with the respondents to show them the book of photographs for the questionnaire. In the JNP, the survey at the Nogodan visitor centre was conducted on two consecutive weekends on the 17th, 23rd, and 24th of August 2003. The survey of visitors to the Lochnagar visitor centre in the CNP was undertaken on two consecutive weekends on the 21st, 27th, and 28th of September 2003.

In order to generate variables of visual landscape elements to determine landscape preference, digital image processing was used with photographs of each National Park. The first step was segmentation of the photographs to define the landscape elements. Each segment was measured by quantifying the visual characteristics including area, perimeter, and RGB colour. The segmentation of a photograph by landscape elements largely followed the suggestion by Shafer *et al.* (1969), as the fundamental purpose of this study was not to find the general measures of landscape preferences, but to compare preferences based on the same criterion.

Each landscape photograph was divided into different segments in which landscape features were represented by different textures, e.g. vegetation, water, and sky. The vegetation parts were divided by distance within the photographs, as this was an important factor affecting the texture, i.e., 'Near distance', 'Middle distance', and 'Far distance'. With respect to the vegetation parts by distance characteristic, each segment was defined and classified according to its degree of being an open or closed landscape. Each area was then quantitatively evaluated by both scalar measurement (i.e., area and perimeter) and RGB colour. Numeric data for landscape image segmentations were produced using ERDAS 8.3 IMAGINE software for image processing and geographic information system.

The data produced were subsequently reduced to orthogonal principal components. The calculated factor scores were used as explanatory variables in formulating the logit model, whose response variable was a choice of preferred landscape between alternatives. The data for the logit model were analysed using R version 2.01 integrated computer software for data manipulation, calculation, and statistics. This is widely used for statistical analysis with an ease of mathematical procedure (Venables and Ripley, 1999; Venables and Smith, 2004).

3. Results

Table 1. Rotated Factor Loading Matrix

PV	Factor (loadings)				
	F1	F2	F3	F4	F5
FOA	.107	-.007	.100	.828	.064
FOP	.269	.104	.091	.912	.068
FOR	.373	.317	.040	.818	.116
FOG	.382	.334	.044	.800	.114
FOB	.396	.339	.053	.792	.106
FCA	-.145	-.196	.520	-.529	.023
FCP	-.150	-.293	.592	-.644	.051
FCR	-.239	-.318	.586	-.635	.113
FCG	-.216	-.320	.584	-.644	.105
FCB	-.208	-.322	.581	-.647	.101
MOA	.285	.847	-.018	.082	.214
MOP	.308	.871	-.020	.169	.194
MOR	.313	.882	-.016	.167	.195
MOG	.312	.883	-.011	.171	.196
MOB	.310	.882	-.002	.171	.191
MCA	.009	-.718	.221	-.251	.318
MCP	-.013	-.836	.335	-.122	.263
MCR	-.082	-.787	.366	-.212	.311
MCG	-.078	-.793	.360	-.194	.312
MCB	-.064	-.775	.380	-.202	.292
NOA	.882	.214	.086	.142	.014
NOP	.911	.214	-.002	.193	.085
NOR	.922	.214	.073	.162	.053
NOG	.928	.227	.060	.159	.066
NOB	.933	.220	.064	.168	.062
NCA	-.873	-.052	-.125	-.214	-.243
NCP	-.908	-.081	-.072	-.214	-.191
NCR	-.896	-.156	-.231	-.223	-.069
NCG	-.875	-.145	-.306	-.210	-.100
NCB	-.882	-.136	-.290	-.218	-.129
WA	-.360	.059	-.831	-.046	-.301
WP	-.167	.145	-.885	.011	-.009
WR	-.178	.057	-.929	.003	-.187
WG	-.150	.123	-.927	.012	-.179
WB	-.131	.176	-.921	.006	-.147
SA	.291	-.120	.683	.044	.132
SP	.359	-.057	.712	.061	.424
SR	.172	-.025	.275	.079	.909
SG	.210	.003	.288	.081	.900
SB	.227	.003	.282	.067	.898
E.V.	15.78	11.56	3.44	2.72	1.99
% Var.	39.44	28.94	8.59	6.80	4.99
% Tot.	39.44	68.38	76.97	83.76	88.75

Principal component analysis was undertaken to select a subset of variables which represented the underlying patterns of relationship between visual landscape elements and hence the important characteristic of the landscape. To decide how many factors were needed to represent the landscape data, both eigenvalues and scree plot were used. Five common factors explained 88.75% of the total visual elements of landscapes and sufficiently represented the characteristics of the photographs that composed the visual landscape elements. To enhance the interpretability of the visual landscape element, the varimax rotation method was used (Table 1). The first factor (F1) was summarised as the near-distance-related landscape component, the second (F2) as middle-distance-related, the third (F3) as water-related, the fourth (F4) as far-distance-related, and the fifth (F5) as sky-colour-related. Using these five factors, factor scores were calculated for each of the landscape photographs. The factor scores of the visual landscape elements were subsequently used as the independent variables in the logit analysis of landscape preference.

The landscape preference survey respondents comprised 88 visitors to the Lochnagar visitor centre in the CNP and 134 to the Nogodan visitor centre in the JNP. The socio-demographic characteristics of the respondents are summarised in Table 2. The average age of the respondents in the CNP was older than that in the JNP. The genders were equally distributed in the CNP, but slightly more men were present in the JNP (60% vs. 40%). Many students were present in both samples: 20% in the CNP and 25% in the JNP.

Table 2. Socio-Demographic Characteristics

	Category	CNP	JNP
Age	< 19 yr	4 (4.7%)	13 (10.4%)
	20 – 29yr	16 (18.8%)	44 (35.2%)
	30 – 39 yr	10 (11.8%)	44 (35.2%)
	40 – 49 yr	27 (31.8%)	20 (16.0%)
	> 50 yr	28 (32.9%)	4 (3.2%)
	Total	85 (100.0%)	125(100.0%)
Sex	Male	44 (51.2%)	77 (61.6%)
	Female	42 (48.8%)	48 (38.4%)
	Total	86 (100.0%)	125(100.0%)
Job	Student	16 (18.6%)	32 (27.6%)
	Housewife	4 (4.7%)	6 (5.2%)
	Civil serv.	6 (7.0%)	23 (19.8%)
	Others	45 (52.3%)	55 (47.4%)
	Retired	15 (17.4%)	0 (0.0%)
	Total	86 (100.0%)	116 (100.0%)

Two landscape preference models of visitors to the CNP were formulated using a CLM for the choice of landscape alternatives. Model CNP1 was the CLM with three choices excluding the ASC

(Table 3). Only photo-characteristic variables (PVs) were assumed to be a predictor for landscape choice. The far-distance-related variable (F4) was a non-significant predictor of landscape choice on photographs, as evidenced by p-values < 0.05. To test the IIA assumption, the restricted model of CNP1 was estimated as follows:

$$\log\left(\frac{P_{CNP}}{P_{JNP}}\right) = -0.355(F1)^{(**)} + 0.250(F2)^{(**)} - 0.258(F3)^{(**)} - 0.188(F4)^{(**)} - 0.092(F5)^{(**)}$$

The restricted model suggested that the IIA property might be violated, because the sign of F4 in the restricted model was opposite to that in the unrestricted model of CNP1. In addition, the overall fit of the model measured by McFadden's pseudo r-square (ρ^2) was 0.19, which was below the range of good fit suggested by Louviere *et al.* (2000). Tests of the choice data indicated that the CLM without the ASC (i.e., Model CNP1) did not show a good fit. Under these conditions, the parameter estimates of model CNP1 were therefore likely to be biased.

Table 3. Conditional Logit Model – Cairngorms Visitors (Model CNP1)

Type	Name	Model CNP1		
		coef.	exp.coef	S.E.
ASC	Cairn.	n/a	n/a	n/a
	Jirisan	n/a	n/a	n/a
PV	F1	**-0.302	0.739	0.058
	F2	**0.384	1.467	0.053
	F3	**-0.756	0.469	0.059
	F4	0.043	1.044	0.077
	F5	**-0.186	0.831	0.039
N		2376		
DF		5		
LR		514		
Wald		451		
R^2		0.194		

**Significant at 0.05

Model CNP2 was the CLM with three choices including the ASC (Table 4). The ASC suggested an effect due to the omitted PVs (Ed- this acronym has already been defined above). The results from the logit analysis are shown in Table 4. The restricted model of CNP2 was revealed as follows. The model suggested that the IIA property was not considerably problematic for the unrestricted model. The overall fit of the model as measured by McFadden's pseudo r-square (ρ^2) was 0.30, representing a very good fit:

$$\log\left(\frac{P_{CNP}}{P_{JNP}}\right) = -1.079^{(**)} - 0.680(F1)^{(**)} + 0.045(F2) - 0.096(F3) - 0.683(F4)^{(**)} - 0.149(F5)^{(**)}$$

The better fit of the ASC modeling suggested that the landscape preference model should incorporate an effect of landscape itself due to the omitted PVs on the landscape choice. Landscape preferences of CNP visitors were determined by the latent effect of the landscape itself. For Cairngorms visitors, the effect of the Cairngorms landscape (ASC = 3.12) was larger than that of the Jirisan landscape (ASC = 2.04).

Table 4. Conditional Logit Model – Cairngorms Visitors (Model CNP2)

Type	Name	Model CNP2		
		coef.	exp.coef	S.E.
ASC	Cairn.	**3.121	22.678	0.223
	Jirisan	**2.041	7.701	0.206
PV	F1	**-0.678	0.508	0.076
	F2	0.043	1.044	0.060
	F3	-0.118	0.888	0.067
	F4	**-0.665	0.514	0.108
	F5	**-0.155	0.856	0.043
N		2376		
DF		7		
LR		848		
Wald		491		
R^2		0.300		

**Significant at 0.05

Two landscape preference models of visitors to the JNP were formulated using a CLM, the same as for the CNP. Model JNP1 was the CLM with three choices excluding the ASC, which shows that all attributes are significant predictors (Table 5).

Table 5. Conditional Logit Model – Jirisan Visitors(Model JNP1)

Type	Name	Model JNP1		
		coef.	exp.coef	S.E.
ASC	Cairn.	n/a	n/a	n/a
	Jirisan	n/a	n/a	n/a
PV	F1	**-0.116	0.890	0.046
	F2	**0.132	1.141	0.054
	F3	**-0.493	0.611	0.050
	F4	**-0.157	0.854	0.044
	F5	**-0.125	0.882	0.034
N		3561		
DF		5		
LR		212		
Wald		206		
R^2		0.058		

** Significant at 0.05

The restricted model of JNP1 was estimated as follows. The model suggested that the IIA property might be violated, because the sign of a water-related variable(F3) in the restricted model was opposite to that in the unrestricted model.

McFadden's pseudo r-square (ρ^2) with 0.06 also suggested a poor fit.

$$\log\left(\frac{P_{CNP}}{P_{JNP}}\right) = -0.480(F1)^{(**)} + 0.135(F2) + 0.368(F3)^{(**)} - 0.267(F4)^{(**)} - 0.094(F5)^{(**)}$$

Model JNP2 was the CLM with three choices including the ASC (Table 6). The results from a logit analysis are shown in Table 5. The restricted model of JNP2 was revealed as follows, which suggested that the IIA property was not problematic for the unrestricted model. In addition, the overall fit of the model JNP2 was good when estimated by McFadden's pseudo r-square (ρ^2) with 0.25.

$$\log\left(\frac{P_{CNP}}{P_{JNP}}\right) = -0.401^{(**)} - 0.354(F1)^{(**)} + 0.209(F2)^{(**)} + 0.330(F3)^{(**)} - 0.096(F4) - 0.013(F5)$$

Table 6. Conditional Logit Model – Jirisan Visitors(Model JNP2)

Type	Name	Model JNP2		
		coef.	exp.coef	S.E.
ASC	Cairn.	**2.898	18.131	0.193
	Jirisan	**3.369	29.061	0.181
PV	F1	**-0.288	0.749	0.074
	F2	**0.220	1.246	0.075
	F3	**0.253	1.288	0.084
	F4	-0.055	0.946	0.068
	F5	0.001	1.001	0.047
N		3561		
DF		7		
LR		1014		
Wald		451		
R^2		0.248		

** Significant at 0.05

Model JNP1 was not as good as model JNP2, as was the case with the CNP. The ASC modeling was more appropriate for Jirisan visitors, which revealed that the effect of the Jirisan landscape (ASC = 3.37) was larger than that of the Cairngorms landscape (ASC = 2.90).

4. Discussions

Choice-based landscape preference models based on the psychophysical approach were formulated for visitors to both the CNP and the JNP. Two CLMs, with and without the ASCs, were devised for visitors to each National Park. Based on the examination of the IIA property and on the estimated McFadden's pseudo r-square (ρ^2), the CLM with the ASCs was more appropriate for simulating landscape preference than those without ASCs that excludes the effect of landscape itself. The landscape preference model including the effect of landscape itself satisfied the IIA assumption and showed high goodness of fit. Subsequently, only the CLM with ASCs of each visitor group was compared.

Visitors to the CNP tended to choose landscapes involving less near-distance-related landscape component, less far-distance-related, and less colour factor of sky. On the other hand, visitors to the JNP tended to select landscapes revealing less near-distance-related landscape component, more middle-distance-related, and more water-related factor. The most significant variable in selecting the landscape was the near-distance-related landscape component for visitors to the CNP (exp(coef.)=0.508), and the water-related landscape component for visitors to the JNP (exp(coef.)=1.288). It implies, from a perspective of visual landscape component, that CNP visitors tended to prefer a landscape rarely coverd by short distance view that was thought of as a typical landscape of Cairngorms, whereas JNP visitors preferred the landscape involving more water regions.

The formulated models also suggest that the effect of the Cairngorms landscape (exp(coef.=22.678)) was of more importance than that of the Jirisan landscape (exp(coef.=7.701) in determining landscape preferences of Cairngorms visitors, while the effect of the Jirisan landscape (exp(coef.=29.061)) was of more importance than that of the Cairngorms landscape (exp(coef.=18.131)) in determining landscape preferences of Jirisan visitors. This implies that, in determining landscape preference, the landscape effect of the National Park that is typical to respondents is larger than that of the different National Park, although visual elements play a considerable role. It cannot be simply concluded that the Jirisan landscape is more preferred by both cultural groups, due to more trees in the landscape. Together with these extrinsic reasons, intrinsic reasons related to attitude of both Cairngorms visitors and Jirisan visitors have to be considered. The formulated CLMs precisely reveal these intrinsic reasons. If visual landscape components(e.g., near distance, middle distance, far distance, water, and sky factor) are assumed to be the same between the two landscapes of the National Parks, both visitors to the Park tend to choose their own landscape instead. This might imply that people like their own landscape from the "heart", and that there is no universally preferred landscape between different ethnic groups, for intrinsic human-related reasons.

One of the strong points of this research is the use of a CLM to incorporate the psychophysical method in landscape preference modelling. Previous studies have mainly focused on measuring the value of scenic preferences based on the ranking or rating method. The CLM, which is useful when choices are made between alternatives, has not been greatly used for landscape preference modelling. The question of preference fundamentally embraces the problem of selection because choosing a certain landscape means more preferences than other landscapes. In this respect, the CLM for choice situation of the respondents is potentially useful for landscape preference modelling. Another advantage of our research comes from using digital photographs to measure visual landscape elements. This enhances the measuring technique by obtaining numeric data from digital photographs using computerised digital image processing, and further enhances the grid-overlay method by Shafer *et al.* (1969) that identified the variables such as the land zone and its dimensions and tonal variables. The grid-overlay method has also been applied in a series of studies conducted by Buhyoff and associates (Buhyoff and Wellman, 1980; Buhyoff *et al.*, 1982).

The landscape preference model based on a psychophysical approach has a limitation in that the preference may be revealed in different ways according to the socio-economic factors and psychological status of the respondents. However, the basic assumption of the approach lies in a deterministic preference based on the extrinsic visual component of physical landscape. The aesthetic value of a landscape comes from the landscape design factor such as the proportion and balance on a philosophical basis. To increase the validity of this research, a comparative study with a wider sample of National Parks should be conducted. In this case, the same methodology can be applied on both national and international scales to explain people's perceptions and preferences for landscape photographs of the natural environment. In addition, the change of constituents in a society might affect the landscape preference as a whole, and the degree of individual landscape preferences may change over time. Therefore, a dynamic approach is needed to elucidate the latent features of landscape preference so that longitudinal analysis over time will be a valuable exercise.

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