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The Aesthetic Evaluation of Coastal Landscape

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Abstract

The evaluation of coastal landscape is absolutely necessary when coastal zone is managed or coastal space is newly created. However, research on coastal landscape is rare and no guidelines exist for coastal landscape planning and management. This paper therefore aims to present techniques for evaluating coastal landscape from the visual perception opinions of respondents through questionnaire survey and multivariate analysis. The questionnaire is evaluated by the 5-point scale of Semantic Differential (SD) method. With Principal Component Analysis (PCA), the following four principal components are extracted and named as principal component loadings: harmony, safety, rurality, and spatiality. All beaches are classified into the 4 groups by cluster analysis. By plotting scores of their principal components in a 2-dimensional semantic space, the aesthetic characteristics of coastal landscape are clarified for every beach. To clarify the interaction between the principal component scores and the SD scores of preference items, multiple regression analysis is performed. Therefore, the relationship between principal components and the preference trends of coastal landscape will be ascertained. If citizen's universal perceptions about favorite coastal landscape are understood and their needs are considered in the design and building up of coastal structure or space, more visitors will experience enjoyment, comfort and convenience.

Keywords: *aesthetic evaluation of coastal landscape, questionnaire survey, S.D. method, PCA (Principal Component Analysis), cluster analysis, multiple regression analysis, preference*

1. Introduction

1.1 Background and Purpose

The coastal zone is an area of a special spatial unit where the environment of the sea and land exists in harmony and that has offered assistance to humans throughout their evolution. Therefore, this area includes the range of coastal environment that resulted from the land and is directly or indirectly influenced by each other. Especially, the coastline of the coastal zone is very important in regard to land use, scenery or environmental preservation as a buffer zone which joins the ocean and inland.

Unlike general urban landscape, coastal areas have both landscape and seascape with views from land to sea, from sea to land, and along the coastline. The landscape and seascape are dynamic and have been shaped over time by the combination of natural forces and human action. As Korea has a very wide closed sea as compared with its limited land space, a great deal of development in coastal zones is expected from now on.

The landscape and seascape will continue to evolve in the future as new demands are placed upon them. Therefore, these demands must be managed so that coastal landscape retains its value and distinctiveness even after development. To achieve this purpose, the intrinsic characteristics of coastal landscape must first be understood. However, very little research has been conducted in this area, and no techniques or guidelines have been established for quantitatively evaluating such a coastal landscape.

Following the establishment of the landscape law in Korea on November 18th, 2007, the evaluation of landscape before and after development has become important. In this law, "Landscape" includes the local environmental characteristics consisting of nature and the artificial elements and living style of resident. Thus, the Korean government and local governments are eager to encourage local residents to participate autonomously in making their regional space or community development. However, their participation is based on community spirit, where subjective matters such as a sense of value, regional image, or needs of residents are very intricate.

Before long, landscape law and the active participation of local residents will affect even civic design and the design of various public facilities. Civil infrastructures are supported by the national tax and also constructed on a large scale. The public facilities or structures which make a favorable impression on visitors and which are equipped with universal design or function will be popular among the more public and catch their attention. Furthermore, in the future such places may become tourist attractions and sites of social heritage for both Korea and

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the world.

According to social and economic progress, the welfare of the people has consistently prompted, and the tastes and demands of individuals have diversely increased over time as the levels of desire qualitative satisfaction increase.

In recent years, human-centered product or interior design has become an important matter for manufacturing. As individual needs changes over time, the new term, "amenity", defined as 'the right thing in the right place', has become a hot issue in urban planning and landscape field. This issue involves the people's feelings of convenience, enjoyment, and comfort provided from some space or facilities.

From now, civic design must consider user's feelings, preferences and needs. To include their emotion or perception in design planning, statistical data that interprets the universal demands and desires of people must be obtained. The collected data have to be analyzed statistically before the affective results of investigation can be verified objectively.

As a measurement technique to assess affective meaning, the Semantic Differential (SD) method, developed by Osgood *et al.* (1957), has been proposed (Nagamachi, 2005). Although more than forty years have passed since its proposal, SD remains the most powerful quantitative method to analyze affective meanings in many different fields. The SD method has been adopted as a representative technique for measuring impressions received not only from images of various objects but also from images of architectural space or landscape.

The approach in this paper is based on concepts of aesthetic engineering as exemplified in the study of Nagase *et al.* (1998), Kumagai and Matsubara (2001), Matsubara (2003), and Matsubara *et al.* (2005). These studies purport to show a new approach to the evaluation of coastal landscape using the SD method, and reveal common demands and emotions covered among the study respondents by statistically analyzing the visual perception of local residents. Similar research in Korea has included Lee and Lee (1999), Kim and Koh (2001), Lee and Jung (2006), and Kim and Kang (2007).

The main purpose of the present study is to introduce a technique of landscape evaluation using the SD method, to apply it to a sandy beach in Jeju island, and to evaluate the results. A second objective is to determine the structure of semantic space regarding coastal landscape and to clarify the factors related to the preference of coastal landscape.

1.2 Research Procedure

This research process can be summarized as follows:

(1) Selection of objects
(2) Field investigation and photography
(3) Collection and selection of adjective words
(4) Preparation of image slides and questionnaire
(5) Gathering respondents for evaluation experiment
(6) Conducting the practical questionnaire survey
(7) Recollecting the questionnaire and coding the data
(8) Understanding semantic space of coastal landscape and classifying all beaches by multivariate analysis
(9) Determining principal component which has an effect on preference by using multiple regression analysis

2. Outline of the Questionnaire Survey

An overview of this evaluation experiment is shown in Table 1.

Table 1. Overview of the Evaluation Experiment

Period	October 23rd -25th, 2007
Object	17 sandy beaches in Jeju island
Valid respondents	18/21 persons
Return rate	85.7%
Image offered	Slide image(3 shots/ each beach)
Evaluation item	28 adjective pairs +2 items on preference

2.1 Evaluation Objects

The following presents the distribution of 17 sandy beaches, which are the survey stations of this research as shown in Fig. 1.

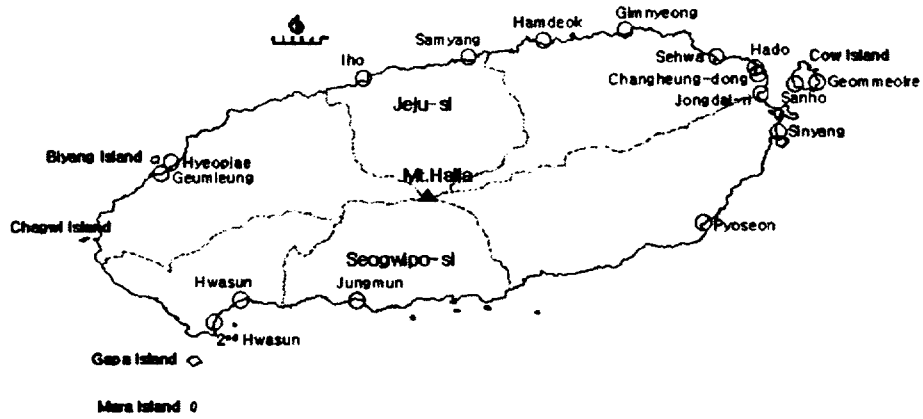


Fig. 1. Location of the Survey Stations

(1) In Jeju city: Geumleung, Hyeobjae, Iho, Samyang, Hamdeok, Gimnyeong, Sehwa, Hado, Changheung-dong, Jongdadl, Geommeolre, and Sanho (12 stations)
(2) In Seogwipo city: Sinyang, Pyoseon, Jungmun, Hwasun, and 2nd Hwasun (5 stations)

2.2 Slide Images for Evaluation

To ensure photographic consistency among variables such as temperature, sunshine amount and tide level, all photography of the beach samples is conducted by one of authors whenever it is comparatively sunny in spring or autumn several times. Besides, the evaluation by slides has been proven to produce the similar results for evaluation performed with the actual objects (Nakada, 1997). It is therefore assumed that any variation in marine and meteorological conditions have nearly effected on the evaluation by slide.

In order to model the actual beaches as closely as possible, by physically comparing the slides to the actual beaches, the slides that most exactly matched the color and appearance of beach are selected. One sheet of a slide per beach is offered as an evaluation sample and consists of 3 pictures showing three views of many directions in each beach (Figs. 2 and 3).

After gathering in the same room, in accordance with the investigator's direction, each subject fills in the form of a self-administered questionnaire. The respondents continue sitting and watching a slide of sandy beaches projected on a white screen by beam projector until the evaluation experiment regarding every beach is finished.

2.3 Evaluation Adjectives and Scale

A provisional list of about 100 adjective words that are appropriate for expressing coastal landscape are selected from magazines and books regarding landscape, aesthetic engineering, and ergonomics. Finally 28 descriptive adjectives for evaluating coastal landscape are selected by deleting indistinct or duplicated adjective words after a preliminary experiment is conducted more than twice.

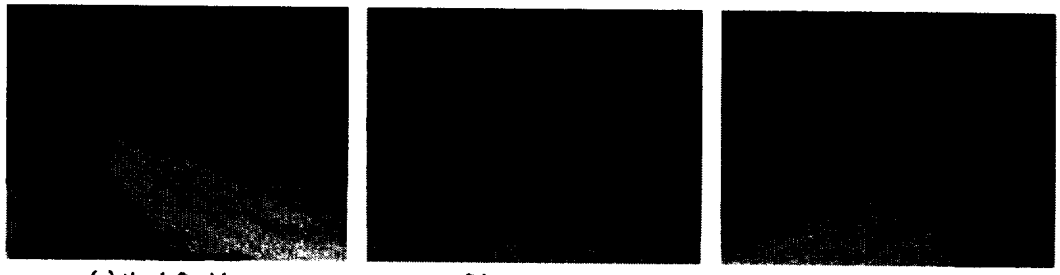
As indicated in Table 2, the questionnaires are printed lists of 28 terms on visual perception and 2 terms regarding preference. Also included are 3 questions on the attributes of the respondent in the top of the questionnaire and a question on the visit experience.

Collected evaluation terms are paired in a "good-bad" fashion on the SD by the 5-point scale. The subjects are asked to give their impression of each object using the SD method in which the evaluation adjectives are scored according to a 5-point scale, with their negative counterparts serving as antonyms. To help the subjects' judgments, numerical values of scale intensity from 5 to 1 in turn, making '3' the midpoint, are assigned to each evaluation adjective corresponding to "very positive", "somewhat positive", "in-between", "somewhat negative", and "very negative".

The subjects are requested to avoid, when rating, being inclined to only a polarity or neutrality as much as possible. Hence, the quantitative figures of estimate terms evaluated across subjects can provide a stable estimate of the concepts.

2.4 Subject Characteristics

On the basis of research results showing no significant



(a) the left side (b) a front view (c) the right side

Fig. 2. Representative Pictures of Geumleung Beach

(a) a side view (b) the whole view (c) circumference

Fig. 3. Representative Pictures of Jungmun Beach

Table 2. List of Practical Evaluation Adjectives

No.	Negative Boundary (1 point)	-	Positive Boundary (5 point)
1	Dirty	-	Clean
2	Usual	-	Individual
3	Disharmonious	-	Harmonious
4	Dark	-	Bright
5	Narrow	-	Wide
6	Cool	-	Warm
7	Unbeautiful	-	Beautiful
8	Rustic	-	Chic
9	Noisy	-	Quiet
10	Complicated	-	Simple
11	Curved	-	Linear
12	Disagreeable	-	Cheerful
13	Hard	-	Soft
14	Artificial	-	Natural
15	Rural	-	Urbane
16	Crowded	-	Uncrowded
17	Unpleasant	-	Pleasant
18	Bad view	-	Good view
19	Dangerous	-	Safe
20	Closed	-	Opened
21	Dynamic	-	Static
22	Unfamiliar	-	Familiar
23	Old	-	Young
24	Masculine	-	Feminine
25	Heavy	-	Light
26	Short	-	Long
27	Separated	-	Integrated
28	Boring	-	Exciting
29	Dislike	-	Like
30	Do not want to visit	-	Want to visit

difference between expert and amateur or between male and female in many landscape evaluations, twenty-one subjects participated in this subject evaluation (Yun, 2005). These participants are all men in their mid-20s and in the 4th grade of the dept. of civil and environmental engineering in Cheju National University. They are students taking a lecture of coastal and harbor engineering, coastal protection against disasters, and marine recreation. All the respondents have lived for at least 5 years in Jeju and are familiar with the sandy beach in Jeju island.

Judged from their characteristics, it is possible for them to answer more aggressively in this evaluation experiment. Because all the participants are set a goal of 100% rating of the 17 sandy beaches, a reply of eighteen persons became effective. Their characteristics are shown in Table 3.

Table 3. Respondent Characteristics

Variable	Category	Frequency	Ratio (%)
Gender	Male	18	100
Marriage	Single	18	100
Age	20s	18	100
Habitation	Jeju city	16	88.9
	Seogwipo city	2	11.1
Major	Dept. of Civil and Environmental Eng. (4th grade)	18	100
Total		18	100

3. Evaluation of Coastal Landscape

3.1 Analysis of SD Profile

The mean score and variance of the 28 descriptive adjectives are calculated in all beaches. However, as only the mean score and variance according to each beach are collected from the evaluation data table, it is not possible to obtain a broad outline of their landscape feature. Therefore, for a better comparison between each beach, the SD profile chart can be expressed as a weighted P value, which is calculated in the following equation:

$$P = 0.25 \times (4N_5 + 3N_4 + 2N_3 + 1N_2 + 0) / \sum_{i=1}^{5} N_i \quad (1)$$

where, N_i is the sum of respondents who evaluated as i-point of the 5-point scale.

When all the subjects marked a full mark of 5-points for a certain evaluation adjective, P became 1.0, and if they answered the lowest point concerning that adjective, the value of P became zero, indicating a more negative impression.

The SD profile comparison by all sandy beaches is illustrated in Fig. 4. As the presentation of all twenty-eight evaluation items and curved lines for every beach would be overly complicate the chart, only the marks of twelve adjective pairs for every beach are illustrated.

The chart analysis which is illustrated the P values of typical target measured by SD scale is called the SD profile analysis. This profile chart represents the collective impression of respondents, and which, therefore, can be used to evaluate their special or total characteristic about a certain target from them.

For instance, the adjective pairs of "Rural-Urbane" are easily distinguished as being divided into three groups among every beach. The first group is Samyang, Iho, Jungmun, and Hamdeok beaches from the right hand, with a P value greater than 0.5. The second group is Geumleung, Hyeobjae, Pyoseon beaches from the right side, with a P value less than 0.5, but greater than 0.25. The others belonged to the last group with a P value approaching to 0.25.

The first group gives the impression of urbanity to respondents, due to its location in the center of Jeju city or Seogwipo

city, and being enclosed by such artificial structures as residence region and tourism or industrial complex. The second group is not so close to city center, but the number of visitors to its places is increasing these days. So it gives the intermediate impression between urbanity and rurality to respondents. The third group gives a rural impression to respondents, due to its distance from the city center, or being a small and less developed region. Because there are few convenient facilities, and these beaches are not well known to tourists, it is possible for visitor to enjoy the clear, soothing water and clean surroundings there. Figs. 5(a), 5(b), and 5(c) display representative pictures of the three groups, respectively.

In addition, it is possible to easily see distinguished characteristics as follows in Fig. 4: Geommeolre is shown as the most unique, but the narrowest and shortest beach.

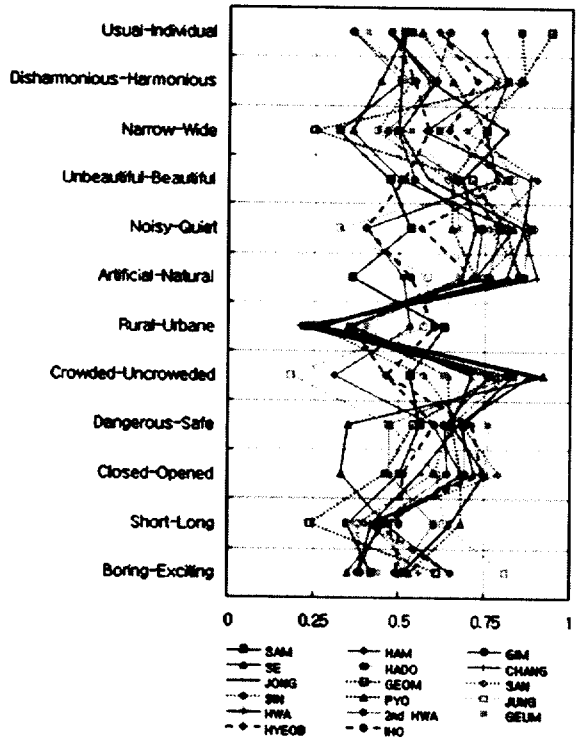


Fig. 4. SD Profile Curve

Sanho gives the impression of being the most harmonious, beautiful and opened beach. Hwasun is seen as the widest beach, whereas Pyoseon is seen as the longest beach. Sinyang is presented as the quietest beach. Sehwa is presented as the most uncrowded beach. Whereas Jungmun is shown as the noisiest, crowded, and exciting beach. Geumleung gives the impression of being the safest beach.

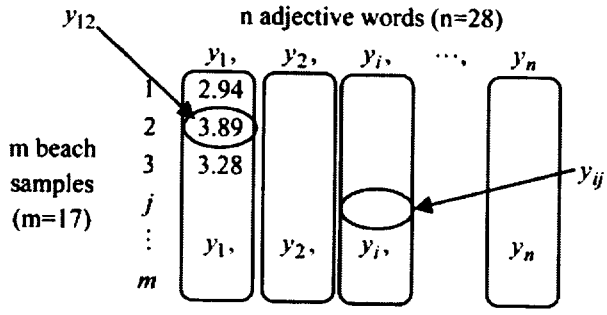


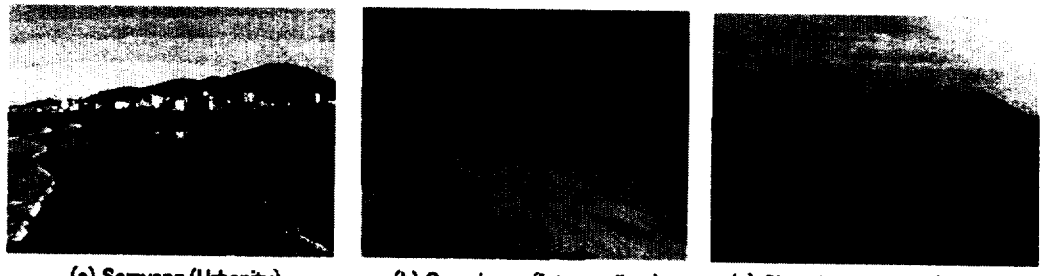
Fig. 6. Input Data Table to Conduct PCA

3.2 Extractions of Principal Components

The principal components extracted through principal component analysis (PCA) are the psychological factors which decide the structure of semantic space regarding coastal landscape. A data table is prepared in matrix form to perform PCA (Fig. 6). Here, y means the average score of all subjects in every beach.

Originally, four principal components are extracted up to a cumulative contribution rate of 90.150% based on the performance of PCA with mean scores assigned to the initial twenty-eight adjective pairs. However, similar evaluation adjectives exist in these abstracted principal components. A great similarity with each other is assumed if the correlation coefficient of both adjectives is greater than 0.9. This allowed one of both with a correlation coefficient greater than 0.9 to be properly deleted. Moreover, except for 「familiar-unfamiliar」 which has factor loadings of less than 0.6, twelve adjective pairs are finally left for PCA after the removal of adjective pairs which have eigen vectors of less than 0.3.

The performance of PCA with mean scores assigned to the twelve adjective pairs produce four principal components with



(a) Samyang (Urbanity) (b) Geumleung (Intermediate) (c) Changheung-dong (Rurality)

Fig. 5. Representative Pictures

eigen values greater than 1. These four principal components are capable of describing the characteristics of costal landscape up to a cumulative contribution rate of 96.464% (Table 4). This statistic value indicates that the proper selection of the adjectives with great similarity can increase the contribution rate for describing coastal landscape with only the principal components of a number.

Each of the extracted components is named according to the principal component loadings: 「atmosphere, rurality, safety, and spatiality」 The first principal component pertains to the degree of 「atmosphere」, and can be represented by such adjectives as "individual", "harmonious", "beautiful" and "exciting". The second principal component signifies the visual impression of 「rurality」, and is expressed by such adjectives as "un-urbane", "natural", "uncrowded" and "quiet". The third factor means the feeling of 「safety」, as typified by such adjectives as "safe" and "opend". The fourth factor can be interpreted as the sensation of 「spatiality」, which is conveyed by the appearance of each beach, as expressed by such adjectives as "long" or "wide".

3.3 Classification of Sandy Beaches

Hierarchical clustering is used to determine the optimal number of clusters. The scores of the four principal components and seventeen sandy beaches are used as variables and cases, respectively. The transform values are selected by none. Ward's linkage is selected as a cluster method of calculating the distance between two clusters, while squared Euclidean distance is used as the formula for calculating distance. In the proximity matrix, the distance is closest between Gimnyeong and Sinyang and farthest between Jungmun and Geumleung. From the agglomeration schedule which is a numerical summary of the cluster solution, the optimal number of cluster is considered using a 4-cluster solution.

Table 5 presents a cluster membership from 3- to 7-cluster and a dendrogram plot of showing optimal 4-cluster solution confirmed by cutting line. As indicated in Fig. 7, every beach can be represented with four symbols on the map.

The mean value of the principal component score of the beaches belonging to the same group is shown in Fig. 8. The first cluster appears to be pretty negatively rural, and the second cluster makes a negative impression on subjects about only atmosphere. The third cluster shows the characteristics of greatly negative in safety. The fourth cluster presents pretty positive values except spatiality.

Fig. 9 shows mean SD scores of the four principal components, preference and visit experience (As stated in the second paragraph of the section 2.3) using a vertical bar chart. Here, visit experience means a question which asks them how often the respondents have ever visited every beach in their experience: 1: 'never', 2: 'hardly ever', 3: 'sometimes', 4: 'often' or 5: 'very often'. Secondly, like is an item on preference asking how much you like. Lastly, revisit intention means whether respondents will visit again next time or not. As shown in Fig. 8, the score pattern of revisit intention is similar to the pattern of like. Samyang and Iho show negative values in all principal components, while only rurality is negatively exhibited in Hamdeok, Jungmun, and Iho

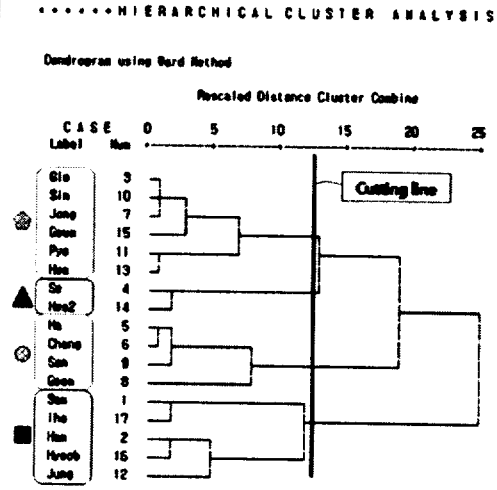
Table 4. Rotated Component Matrix[a]

Adjective pairs	PC (Principal component)				Naming of PC
	1st	2nd	3rd	4th	
Disharmonious-Harmonious	**0.950**	0.062	0.207	0.007	Atmosphere
Usual-Individual	**0.940**	-0.065	-0.237	-0.103	
Boring-Exciting	**0.907**	-0.311	0.138	0.205	
Un beautiful -Beautiful	**0.837**	0.186	0.430	0.159	
Rural-Urbane	-0.084	**-0.979**	-0.068	0.041	Rurality
Noisy-Quiet	-0.204	**0.945**	0.009	-0.179	
Artificial-Natural	0.292	**0.921**	0.159	0.006	
Croweded-Uncroweded	-0.399	**0.879**	-0.143	-0.151	
Dangerous-Safe	-0.011	0.102	**0.968**	-0.121	Safety
Closed-Opened	0.221	0.005	**0.926**	0.250	
Short-Long	-0.033	-0.102	-0.055	**0.982**	Spatiality
Narrow-Wide	0.287	-0.226	0.538	**0.735**	
Total	3.736	3.683	2.442	1.715	
% of variance	31.132	30.695	20.346	14.291	
Cumulative %	31.132	61.827	82.173	**96.464**	

"Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization."
a. Rotation converged in 5 iterations.

Table 5. Cluster Membership and Dendrogram Plot

Case	7 Cl.	6 Cl.	5 Cl.	4 Cl.	3 Cl.	Dendrogram
1:Sam	1	1	1	1	1	
2:Ham	2	2	2	1	1	
3:Gim	3	3	3	2	2	
4:Se	4	4	4	3	2	
5:Ha	5	5	5	4	3	
6:Chang	5	5	5	4	3	
7:Jong	3	3	3	2	2	
8:Geom	6	6	5	4	3	
9:San	5	5	5	4	3	
10:Sin	3	3	3	2	2	
11:Pyo	7	3	3	2	2	
12:Jung	2	2	2	1	1	
13:Hwa	7	3	3	2	2	
14:Hwa2	4	4	4	3	2	
15:Geum	3	3	3	2	2	
16:Hyeob	2	2	2	1	1	
17:Iho	1	1	1	1	1	



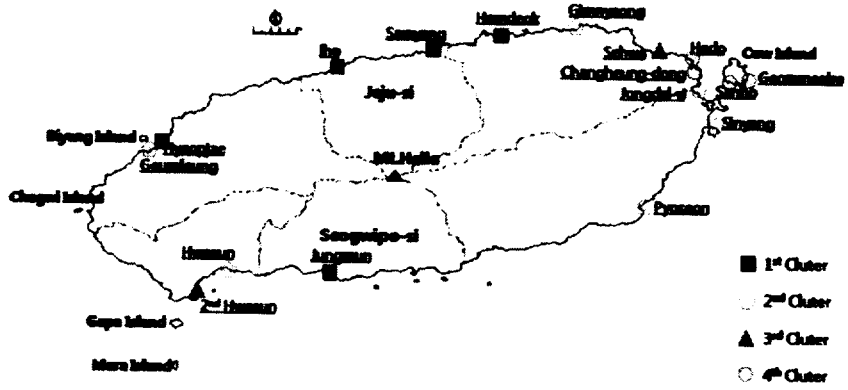


Fig. 7. Distribution Chart of Cluster Membership

beaches. Sehwa and 2nd Hwasun are evaluated lowly in terms of safety, while Geommeolre is evaluated most lowly in spatiality. Atmosphere is highest in Jungmun, Geommeolre, and Sanho.

Iho, Hamdeok, Hyoebjae, and Jungmun gain a high score in visit experience due to their easy access or being a favorite with families and couples. Geumleung and Samyang gain an average score. All other beaches present low scores. However, Iho beach had a slightly low preference for its high visit experience, whereas four Beaches belonging to 4th cluster had a slightly high preference for low visit experience. For the revisit intention, the beach displaying the lowest value is Sehwa. The mean scores of preference of Hamdeok, Hyeobjae and Hado are high, but that of revisit intention is low.

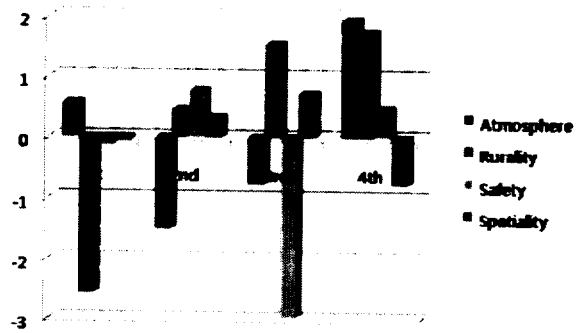


Fig. 8. Mean PC Score of Each Cluster

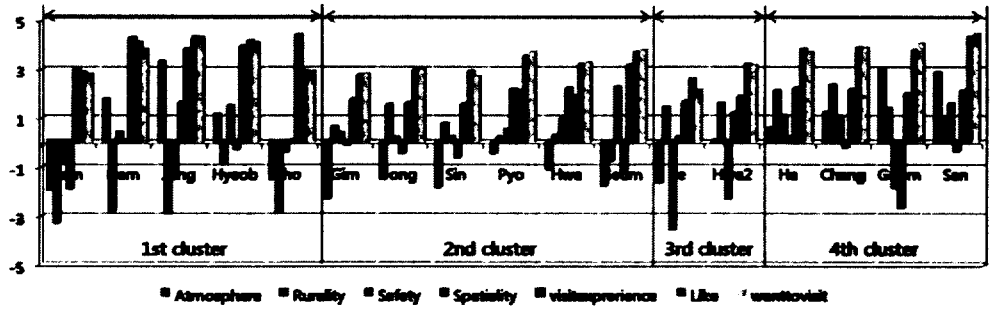


Fig. 9. Mean SD Score Comparison of Each Sandy Beach

3.4 Semantic Space of Coastal Landscape

All beaches are plotted in a semantic space that is explained in the axis of four principal components. Each point illustrated in the scatter plot graphically represents the affective influence on coastal landscape.

By interpreting the aesthetic and semantic space of all the sandy beaches plotted on the scatter plot, the characteristics of each beach or cluster can be elucidated. With abstracted four principal components, a total of six sheets of scatter plot can be drawn. To take an instance, only a sheet of the scatter plot with axes of atmosphere and rurality is shown in Fig. 10. The atmosphere in Jungmun beach appears the most distinguished, while Sinyang exhibits the beach of the worst atmosphere. Unlike Iho is presented as the most urban beach, Changheung-dong is shown as the best rural beach.

To compare the assessment results concerning the sandy beach landscape, every principal component is marked on an absolute

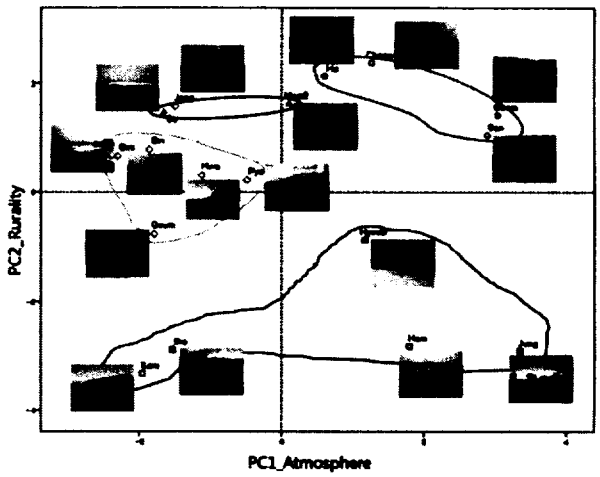


Fig. 10. Scatter Plot

Table 6. Final Landscape Evaluation

Cluster	Case	Atmosphere	Rurality	Safety	Spatiality	Total evaluation		
						Sums	Grade	Rank
1	Jung	5	1	2	2	10	C	6
	Ham	4	2	3	3	12	B	4
	Hyeob	4	2	5	5	16	A	2
	Iho	2	1	2	2	7	C	8
	Sam	1	1	2	2	6	C	9
[redacted]	Pyo	3	2	3	3	11	B	5
	Hwa	3	3	4	4	14	B	3
	Jong	2	4	2	2	10	C	6
	Geum	2	2	5	5	14	B	3
	Sin	1	3	3	3	10	C	6
	Gim	1	3	3	3	10	C	6
3	Hwa2	3	5	1	1	10	C	6
	Se	2	4	1	1	8	C	7
[redacted]	Geom	5	4	4	1	14	B	3
	San	5	3	5	5	18	A	1
	Chang	4	5	5	4	18	A	1
	Ha	3	5	4	4	16	A	2

5-point scale: 5: 'less than the top twenty percent', 4: 'greater than the top twenty percent to less than the top forty percent', 3: 'greater than the top forty percent to less than the top sixty percent', 2: 'greater than the top sixty percent to less than the top eighty percent' or 1: 'greater than the top eighty percent'.

As indicated in Table 6, when the total of their evaluation scores is less than 10 points, from greater than 10 points to less than 15 points, and more than 15 points, their evaluation grade became C, B and A, respectively. There are three A grades and no C grade in the 4th cluster of the whole beach, unlike 2nd Hwasun and Sehwa beaches belonging to 3rd cluster are rated as only C grades.

4. Interactions between Preference and PCS

4.1 Interactions between 'Like' and PCS

Multiple regression analysis is selected as the forecasting tool to determine the variable able to explain the reason of preference as to the coastal landscape. The regression model of the PC score X_i and SD mean score on the 「Like」 Y_1 is therefore expressed in Eq. (2):

$$Y_1 = 3.490 + 0.258X_1 + 0.158X_2 \quad (2)$$

where: Y_1 = like; X_1 = atmosphere; X_2 = safety.

Here, the multiple correlation coefficients R is 0.965, and the standard error of the estimate is 0.163.

As shown in Table 7(a), this model summary table reports the strength of the relationship between the model and the dependent variable. The significance values from the first to the second models are less than 0.05, indicating that the estimated predictors all had a significant meaning statistically as each independent value. The other PCs, rurality and spatiality cannot clearly say how much have an effect on 「Like」 because their significance values are 0.134 and 0.486, respectively.

The stepwise algorithm chose atmosphere and safety as predictors (in terms of preference regarding coastal landscape). 「Like」 of preference is positively affected by atmosphere (PC1) and safety (PC3). The type of beach looks better atmosphere and the safer makes a favorable impression on the respondents of this questionnaire survey.

4.2 Interactions between 'Revisit Intention' and PCS

The regression model of the PC score X_i and SD mean score on the 「revisit intention」 Y_2 is therefore expressed in Eq. (3):

$$Y_2 = 3.461 + 0.282X_1 + 0.191X_2 \quad (3)$$

where: Y_2 = revisit intention; X_1 = atmosphere; X_2 = safety.

Here, the multiple correlation coefficients R is 0.961, and the standard error of the estimate is 0.190 as also shown second model in Table 8(a).

Atmosphere and safety as predictors (in terms of preference regarding coastal landscape) are also chosen by the stepwise algorithm. Above all the PC, from first model, atmosphere is committed and explains 84.3% of 「Revisit intention」. Safety is secondly committed as the next best thing to account for this dependent variable, and then the ability of explanation became increased up to 130.6%. But real increment of the explaining power by safety is 46.3%. It is possible to say that 「revisit intention」 is positively affected by atmosphere (PC1) and safety (PC3). In other words, the beach with some views of better atmosphere (PC1) and improved safety (PC3) can also make respondents in this study feel like revisiting that place.

Table 7. Interactions between 'Like' and PCS

(a) Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.865[a]	0.748	0.731	0.299
2	0.965[b]	0.930	0.921	0.163

a. Predictors: (Constant), PC1_Atmosphere
b. Predictors: (Constant), PC1_Atmosphere, PC3_Safe

(b) Coefficients[a]

Model		Un-standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.490	0.072		48.158	0.000
	Atmosphere	0.258	0.039	0.841	6.676	0.000
2	(Constant)	3.490	0.039		88.532	0.000
	Atmosphere	0.258	0.021	0.865	12.273	0.000
	Safety	0.158	0.026	0.427	6.057	0.000

a. Dependent variable: 「Dislike-Like」

Table 8. Interactions between Revisit Intention and PCS

(a) Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.843[a]	0.710	0.691	0.359
2	0.961[b]	0.924	0.913	0.190

a. Predictors: (Constant), PC1_Atmosphere
b. Predictors: (Constant), PC1_Atmosphere, PC3_Safe

(b) Coefficients[a]

Model		Un-standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std Error	Beta		
1	(Constant)	3.461	0.087		39.706	0.000
	Atmosphere	0.282	0.046	0.843	6.058	0.000
2	(Constant)	3.461	0.046		75.007	0.000
	Atmosphere	0.282	0.025	0.843	11.444	0.000
	Safety	0.191	0.030	0.463	6.287	0.000

a. Dependent variable: 「Do not want to visit-Want to visit」

5. Conclusions

This study has conducted an aesthetic evaluation of coastal landscape at 17 sandy beaches in Jeju island. Subjective evaluations are conducted by questionnaire survey using the SD method. These results are analyzed through multivariate analysis such as PCA, cluster analysis, and multiple regression analysis.

The major conclusions can be summarized as follows:

1. The following four principal components are extracted by PCA: 「atmosphere」, 「safety」, 「rurality」, 「spatiality」.
2. The SD profile analysis results indicate that visual impressions or sensations of coastal landscape can be roughly inferred from the subjective evaluation performed by the respondents.
3. All beaches are classified into 4 clusters based on the results of performing cluster analysis with 4 principal component scores of each beach as the variable. Only three beaches which belong to the 4th cluster are evaluated most highly, whereas both Samyang beach and Iho beach are evaluated most lowly. These results are also confirmed that the particularly excellent sandy beaches are located at the east of Jeju city.
4. Multiple regression models indicate that the respondents like beaches with better atmosphere, improved safety.
5. The major limitation and remarks for future study can be summarized as follows:
   Firstly, It is worth to be performed this evaluation experiment again by showing a slide consist of the picture or CG image for each beach regarding every four season and orientation to a respondent. The results of this work which conducted over more spacious area or composed more various respondents in questionnaire survey may be brought more accuracy or refinement beauty results than one of this study.
   Secondly, because the ratio of the PC abstracted by PCA is not same, the study compared to the difference which has an effect on the degree of preference when having come out by the same percentage, will be with an interesting thing.
   Thirdly, it would be also interesting to examine how much the PC scores and the degree of preference regarding coastal landscape are related to what kind of landscape element.
6. It is indicated that evaluation technique of coastal landscape by using SD method of aesthetic engineering can be a support system useful to a design of shorescape protection facilities and coastal villages that agreed with the sense of aesthetics of the residents. It can be utilized as an effective tool in reaching consensus on their vision among local residents which will be perfomed at the business plan stage from now on.
7. If citizen's universal perceptions about favorite coastal landscape are understood and their needs are considered in the design and building up of coastal structure or space, more visitors would be experienced better enjoyment, comfort and convenience.

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