■ 研究論文

写真投影法と GPS を併用した 利用者が評価する風景の調査手法の構築

Constructing a Survey Method for Landscape Evaluation Using Visitor Employed Photography and GPS

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Abstract : Investigating visitors preferences is important for supporting landscape planning and management of natural parks, we must understand what landscapes visitors prefer and where those landscapes generate. Thus, it is necessary to create evaluation methods, and “Visitor employed photography” has been regarded as one of the useful method. This study conducted two kinds of investigation with a view to create a more effective survey method that utilizes Visitor employed photography. The first investigation aimed at efficiency using a social network service (SNS) and smartphones as survey tools. The second approach aimed to locate the evaluated landscapes through GIS analysis within the site. For this approach, respondents carried Smartphones built in GPS units to get the geospatial information. The overall objective was to verify these procedures and create a method to understand landscapes that visitors prefer. The survey was conducted on Gwanaksan Urban Natural Park, in Seoul, South Korea. Sixty respondents were participated in on-site survey and 921 photos with geospatial information were collected. GIS analysis of these photos clarified five hot spots and its spatial characteristics and landscape that visitors prefer. In this way, this study yielded significant information for creating a method to understand landscapes that visitors prefer.

Keywords : *landscape, Visitor Employed Photography, GPS, GIS, evaluation, Gwanaksan*

キーワード : 風景, 写真投影法, GPS, GIS, 評価, 冠岳山

1. Introduction

(1) Background to the Study

An important role for Natural Park's is providing high-quality experiences of landscapes. In order to play that role, it is important to investigate visitor's evaluations as input for planning and management. A suitable method is needed to investigate visitors preferences effectively.

Visitor employed photography (hereafter VEP) is a method that entails letting survey respondents take photos and then clarifying their landscape preferences through research analysis of the photos. Visitors enjoy a variety of landscapes in natural parks shifting with their eyes. As a result, visitor's evaluations are an accumulation of impressions of serial landscapes, rather than a single impression left by one striking, symbolic location. Hence, we need to understand the linked series of landscapes experiences in the target area. VEP have been regarded as a method to understand this comprehension experience. Cherem et al.,¹⁾ have started to conduct VEP on natural parks visitors. Several studies have also been conducted in Japan and Korea²⁾⁻¹¹⁾. However, researches using VEP have tended to be a lack of spatial analysis for some reasons. For instance, identifying the photo's locations has difficulties for researchers and visitors.¹²⁾ Although, to convert actual park planning, we need particular place information where visitors prefer.

In contrast providing GPS units (hereafter GPS) offers the possibility of thoroughly getting each photo's location. Additionally, by using GIS, it is able to analyze the spatial character and reference data easily, and connect the result directly to park planning.

Moreover, spreading smartphones and SNS (social network

service) helps to conduct VEP with GPS. Recently, most smartphones has digital camera with GPS functions. The use of respondents' smartphones gets rid of supplying participants with cameras or GPS. SNS is possible to communicate with a large number of unspecified people. Consequently, SNS facilitated recruiting respondents, posting survey courses, and exchanging data (e.g., photos and GPS data).

Therefore using smartphones and SNS would solve problems accompanying acquisition of a large number of respondents, equipping them with GPS, and managing implementation of the on-site survey.

(2) Study purpose

This study discusses about constructing a method for getting visitor's landscape preference by inserting a survey method with using smartphones and SNS, and inserting an analysis method using GPS and GIS against prior VEP. Gwanaksan Mountain Urban Natural Park (UNP) in Korea was a case study site.

2. Study Method

Study procedure is described as follows (Figure-1). Recruiting respondents was conducted by using SNS. Afterwards, the respondents were asked to take geotagged photos by using their smartphones, and then fulfill the questionnaire. All this work is done on the web. The final step is extracting spatial character of viewpoints and landscape elements from photos and geospatial information by using GIS analysis.

(1) Survey method

1) Recruiting Respondents and Instructing Them in the Survey

Facebook was used to inform respondents of this survey

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Figure-1 Flow of study

which is combining VEP with GPS in Gwanaksan UNP, which stipulates that 60 respondents with smartphones were required. Following this, the survey course was posted to respondents, and instructions were posted requesting them to take 10 or more photos of favorite landscapes, things and place while walking the course. The instructions also stipulated that respondents were to use their smartphones, tagging each photo with GPS information. The instructions further specified that the survey should be conducted on a clear day between 11:00 a.m. and 4:00 p.m.

2) Post-Survey Directions

Respondents were instructed to send photos via e-mail. Additionally, a Web Questionnaire was administered, with respondents answering the items below.

1. Age 2. Gender 3. Occupation 4. Major
5. Number of visits to Gwanaksan
6. Evaluation of the survey
7. Reason for low evaluation (if necessary)

(2) Analysis Method

1) Spatial Analysis Using GIS

Getis-Ord G_i^* statistic^{14), 15)} was applied to identify the place that were particularly popular area called hot spots. This analysis is superior ability to extract locations with distance damping. It works by looking at each grid within the context of neighboring grid. In this study, target area was covered by a grid of $15m^{13)}$ sections. Afterwards, the number of viewpoints (location where photos were taken) within each square was calculated so as to identify statistically significant hot spots.

The GIS database was constructed for the study site. Information of vegetation, elevation, slope, and ground cover were overlaid and stored on this grid. Data provided by Korea's National Geographic Information Institute were adopted and used for the vegetation, elevation, and slope information. For the ground cover information, the Daum Map (Korean portal site) offers precise aerial photographs. Using TMS for Korea, a QGIS plug-in, images providing an understanding of ground cover can be loaded. Specifically, the images are loaded and then categorized, to mechanically judge whether the ground is covered or not.

Moreover, to visually understand the spatial distribution of the viewpoints, kernel density estimation was used. Kernel density estimation is a method for making estimates about a continuous area that conducts weighting according to the

distance decay effect from geographic points for which the density is calculated. The band range was set to 50 m.

ESRI's ArcGIS10.2 (Spatial Analyst) was used for all processing of geospatial information other than that loaded from the Daum Map.

2) Identifying Landscapes in the Photos

It was necessary to understand what the respondents were attempting to capture in each photo. The following criteria were followed to identify the elements of the preferred landscapes, and thereby categorized and made landscape types. Figure-2 shows an example of the categorization.

Starting with step one, two categories were used for the object of interest photographed: 1) Object (a subject can be clearly discerned in the photo) or 2) Space (the photo shows spatial expanse.)

For step two, the target landscape elements were identified. As shown by the categorization example in Figure-2, 10 labels were used, those are: (1) Trees/Forest, (2) Herbs (3) Rocks, (4) Water, (5) Buildings, (6) Mountains, (7) Townscapes, (8) Signs, (9) Trails, and (10) The Others. Some photos were assigned multiple labels. (Figure-2)

For step three, Higuchi's landscape categories¹⁶⁾ for the distance to landscape elements were referenced. Three labels were used: (1) Near (for landscapes whose trees and leaves can be discerned), (2) Middle (for landscapes whose each trees outline can be discerned), or (3) Far (for landscapes farther away than (2)).

In addition, more labels were used to further differentiate category (1) Trees/Forest. The first comprised two categories: (1) Inside or (2) Outside, with regard to whether the photo was taken among the forest or outside of the forest (with the trail as the center point). The second label also comprised two categories: (1) Green leaves or (2) Colored leaves.

(3) Explanation of the Survey Area and Survey Course

The survey site was Gwanaksan, which is located in the southern part of Seoul, Korea. It is a 632-meter mountain. For feng shui reasons, it has been paid attention and also considered as a natural protective wall for Seoul. Although the mountain's height is not remarkable, there are enjoyable landscape with deep valleys and varied terrain. Moreover, close proximity to Seoul makes it a popular place for a day trip. The park receives approximately 5 million visitors in a year.

Gwanaksan was designated as an "Urban Natural Park" in 1968. Korea's UNP, including private lands, are designated in

Figure-2 Category of landscape elements and example of photo categorization

a zoning system for maintenance to allow visitor use. Many trails have been built in Gwanaksan, and this study's survey set an approximately 5km course focusing on Trail No. 4 (Figure-3), which has the highest traffic.

The course's first 1.5 km is a flat asphalt road (a-b) . After the asphalt, a trail climbs to an altitude of 200 meters amid a deciduous broad-leaved forest. Following this, the trail descends to an intersection of waterways, which passes through a pine forest (b-c). A large open area spreads out near this waterway intersection, after which the trail continues alongside the waterway (c-d). Next, the trail enters a valley flanked by two ridges and runs through alternating deciduous and pine forests. Then, the trail reaches a ridgeline approximately 4 km from the starting point (d-e). A temple called Yeonjuam is located at the next point along the course (e-f), and then the course climbs toward the summit of Gwanaksan where a radio tower and weather observatory are located (f-g).

(3) Survey Contents

Table-1 shows attributes of the respondents. Of the 60 respondents, 37 (61.7%) were male, 23 (38.3%) were female, and the average age was 26.8. Of the respondents, 32 (53.3%) were

Figure-3 Survey area and course

visiting the park for the first time. As for occupations, 20 respondents were university students (33.3%) and 28 (46.7%) were graduate students, which together constitute a large portion. Facebook was used to gather the 60 respondents which meant that they were fairly closely connected to the researcher. The survey was conducted over the 16-day period from October 27 to November 19, 2013 (max : 13 people, min: 1 person in a day).

(4) Data Sampling

The next step involved sampling the photos and GPS data. From the 60 respondents, 1,106 photos were gathered. First, four respondent's photos were eliminated due to lack of GPS data due to erroneous device settings.

Next, photos were eliminated if they were accidentally taken, were duplicates, were taken from the same angle, or if the tagged GPS data was overly inaccurate. The remaining 921 photos were used for the analysis. The average number of photos per respondent was 16.46, with a standard deviation of 9.133; 6 was the lowest number, whereas 47 the highest.

Since the GPS data from respondents depended on their smartphones, there were certain degrees of variation. In response, this study created a polygon file of the walking course, measuring the shortest distance from the course to the location where a photo was taken, then moving the GPS tag to the nearest location along the course. Later, verification of the GPS data is to be conducted.

In this way, the number of photos was greatly different by the individual. There is arguably a high likelihood that respondents who took greater numbers of photos had a higher evaluation of the target area and favored more diverse landscape elements. This indicated differences among individuals in how landscapes are evaluated—a compelling result in itself. So, the value of each photo taken by each individual could have differed. In this study, however, analysis was conducted by placing equal value on each landscape that was evaluated for some reason.

3. Results and Discussion

(1) Spatial Analysis of the Respondents Favored Viewpoints

Getis-Ord Gi* statistics provides a hotspots map. Figure-4 shows statistical significance are in 33 grid sections with $p < .01$ and 41 sections with $p < .05$. Furthermore, these grids are clustered around five zones. These five hotspots are highly favored place.

Zone1 and Zone 2 were intersection of waterway. Zone 3 was nearby a temple called Yeonjuam. Zone4 and Zone 5 were on top of the mountain. In this study, we described Zone1 and Zone5

1) Zone 1 (Fig-5)

Figure-5 shows focusing on zonel combining with GIS database and landscape types.

This area is at an average elevation of 165.7 m and includes an intersection of waterways. It slopes gently compared to

Table-1 Respondents information

	Age		Gender		Occupation				Major						visit count	
	Mean	SD	Men	Women	Under Graduate	Graduate	Employees	the others	LA*	Engineering	IT	Social science	Electronics	Unknown	First time	the others
Count	26.8	3.5	37	23	20	28	9	3	20	22	7	7	3	1	32	28
%			61.7	38.3	33.3	46.7	15.0	5.0	33.3	36.7	11.7	11.7	5.0	1.7	53.3	46.7

n=60

*Landscape Architecture

Figure-4 Statistically significant hotspots

Mesh ID	Count	Elevation	slope	Vegetation	Ground cover	P Value
322	4	163.8	12.8	Oak forest	covered	$p < .01$
329	1	170.2	18.6	Pinus rigida forest	covered	$p < .01$
330	12	165.2	11.2	Oak forest	open	$p < .01$
331	6	164.9	5.8	Oak forest	open	$p < .01$
334	4	166.1	14	Oak forest	open	$p < .01$
335	8	165.0	4.1	Oak forest	open	$p < .01$
339	3	165.0	3.2	Oak forest	open	$p < .01$
345	14	165.0	3.7	Oak forest	open	$p < .01$
346	2	166.4	9.2	Oak forest	open	$p < .01$
Mean	6	165.7	9.2			

object or space	Elements	distance	direction	color	Count	%
objective	Trees/Forest	near		green	2	3.7
	Trees/Forest & Buildings	near		green	2	3.7
	Rocks				3	5.6
	Buildings	near			2	3.7
space	Trees/Forest	near	inside	green	1	1.9
				colored	2	3.7
			outside	green	1	1.9
				colored	6	11.1
	Water	near			31	57.4
	Water & Trees/Forest	middle			2	3.7
	The others	near			1	1.9
					54	100.0

Figure-5 Zone1 description

other areas, with an average slope of 9.2° . Although the area has deciduous broad-leaved forest nearby, it is basically free of ground cover and has a large amount of space with openness.

Many photos from this area captured water landscape, with more than half taken of “Open” and “Near”. Water landscape received the most attention, whereas Trees/Forest was the next most favored subject. In addition to the popular landscape element of water, it appeared that the stimulus for the high number of photos at this spot was that the trail transitioned from the limited sight lines inside the forest to broad, openness areas with no ground cover.¹⁷⁾ Zone 2 have a same tendency.

5) Zone 5 (Fig-6)

This area is around the summit of Gwanaksan, with a maximum elevation of 632 m. Average elevation is 614.7 m, with an average slope angle of 30.6° . Not surprisingly, the view from the summit was among the highest number of photos, with many of these capturing the far-off mountains in Seoul and Anyang city. Besides, this area has a weather observatory as well as a radio tower, and there are impressive rocks and a sign indicating the summit. These were all objects of interest, with their photos taken individually or in combinations. A total of 122 photos were taken at the summit, which appeared to be the most preferred spot along the survey course.

(2) Favored Landscapes and Its Viewpoint Distribution

Next, we attempt to understand the preferred landscapes within the total target area. Table-2 shows the subjects, as understood from the categorization of photos, preferred 1% or more of the time. Seven landscape types were emphasized, with 50 or more relevant photos. Of the landscapes in these, four focused on the hot spots mentioned previously. Meanwhile, the most popular landscape type in the entire target area were “Space”, “Trees/Forest”, “Near”, “Inside”, “Colored” (Fig-7), whereas “Object”, “Trees/Forest,” “Near”, “Colored” was also relatively highly favored. Hence, “Trees/Forest” was highly favored throughout the entire target area.

With this information and to obtain a broader perspective on the favored landscapes, rather than trying to understand more minute landscapes, Table-3 shows the photo numbers by main landscape elements. Figure-9 shows the spatial

Table-2 Favored landscapes type

object or space	Elements	distance	direction	color	Count	%
Object	Trees/Forest	Near		Green	13	1.4
				Colored	51	5.5
	Herbs	Near			12	1.3
	Rocks	Near			66	7.2
		Middle			14	1.5
	Rocks & Buildings	Middle			66	7.2
	Buildings	Near			40	4.3
		Middle			26	2.8
	Mountains	Middle			22	2.4
	Mountains	Far			76	8.3
Space	Townscapes	Far			28	3
	Signs	Near			43	4.7
	Trees/Forest	Near	Inside	Green	58	6.3
			Outside	Colored	129	14
					22	2.4
					29	3.1
	Water	Near			92	10
	Trails	Near			34	3.7
	The others				100	10.9
					921	100.0

Figure-6 Zone5 description

distribution of viewpoints for each landscape elements.

Of the total 322 photos, 35% were of “Trees/Forest,” which constitutes the main preferred landscapes. These popular with landscapes spread throughout the target area, indicating that specific locations were not preferred. In contrast, for some other landscape elements, there was a trend of preferred specific locations.

(3) Reviewing the GPS Accuracy of Smartphones

We conducted to revise GPS data. The average adjustment was 4.63 m, with a standard deviation of 10.72 m; 0 m was the smallest adjustment, whereas 78.923 m was the largest

(Figure-10). This degree of error is acceptable within a natural recreation area. Moreover, 66 photos (6.7%) were eliminated due to GPS problems.

Of these, 42 photos (4.6%) from four respondents were due to erroneous settings. Results showed 24 photos (2.4%) with significant GPS errors, which is, on the whole, not considered problematic for a VEP with smartphones.

(4) Assessment of the Survey

According to the respondents, 42 people, 70% of total respondents, highly assessed the survey method (Table-4). The reason for low assessments, given by 13 respondents, was that the survey course was difficult to find. Moreover, some respondents reported losing the GPS signal during the survey. The presenting way of survey course’s posting also needs improvement, but overall, using SNS and VEP with smartphones were not considered problematic.

(5) Discussion

From spatial analysis of the viewpoints, five popular areas were identified. In these five popular areas, three areas were located near the summit and had highly symbolic characteristics. Preferred landscapes from these locations were the views from the summit, in addition to symbolic subjects such as rock formations, the temple, and the weather observatory. It could be relatively supposed that the respondents prefer on these spots near the end of the trail.

However, these were not the only popular locations—two hot spots were identified along the trail as well. Reasons for their high popularity seemed to be interest in landscape elements, such as waterways and rocks, in addition to being transition points where the relatively confined trail opens out onto broad, openness areas. A series of studies by Zaino et al.¹⁷⁾ into sequence landscape has shown that people’s response to landscape becomes more pronounced when there is a transition from closed to open space. Results from this study infer a similar conclusion.

However, these specific spots were not only analytical focus. An analysis was also conducted from the perspective of what kinds of landscape were preferred throughout the target area. The results showed that forests and deciduous forests with colored leaves were very popular.

These forests were not evaluated from specific viewpoints, but rather tended to be popular throughout the target area. Inside this category, nearby landscapes inside the forest, capturing landscapes of trees with colored leaves was the most preferred. Consequently, although popular specific

Table-3
Favored landscapes elements

Elements	Count	%
Trees/ Forest	322	35.0
Mountains	104	11.3
Water	102	11.1
Rocks	82	8.9
Rocks & Buildings	79	8.6
Buildings	66	7.2
Signs	43	4.7
Trails	36	3.9
Townscapes	28	3
The others	59	6.4
	921	100

Figure-7

“Space”, “Trees/Forest”, “Near”, “Inside”, “Colored”

Figure-8

“Object”, “Trees/Forest,” “Near”, “Colored”

Figure-9 Distribution of viewpoints of landscape elements

Table-4 Movement distance for photo locations

	Assesment of survey		Reason of bad		
	Good	Bad	Route	GPS	The others
count	42	18	13	3	2
%	70.0	30.0	72.2	16.7	11.1

Figure-10 distance correction of GPS

viewpoints were identified, the landscape element of “Forest” was a fundamentally popular subject.

In other words, respondents moved along the trail while positively appraising the trees running along either side, and evaluating specific locations and landscape elements along the way.

4. Conclusion

As described above, we discussed about constructing a method for getting visitors landscapes preference combined new survey method and analysis method.

(1) Survey Method

One of the study aims is constructing an efficient survey method using smartphones and SNS to gather photos taken by respondents and geospatial information for GIS analysis.

For achieving this, the equipment for taking photos and geospatial information is respondents' smartphones. All procedure; recruiting respondents, gathering geotagged photos on-site survey, and obtaining questionnaire is

conducted on SNS and web. In this study, it could achieve to communicate with the respondents. Also, the respondents gave high evaluation toward the research method. However, it found that it is necessary to devise the presenting way when it specifies the research route as site.

As technical issue, it examined the accuracy of GPS. Although it found some errors in data obtained, it is still possible to be recognized in permissible range. In the future, the ability of smartphone and the global navigation satellite system will be improved, thus it considers the accuracy of GPS will not disturb the research.

Though it recruited the respondents this time, it could be considered that it does not task people very much even when it applies the actual visitors because they can use their own smartphone to take photos, geospatial information and questionnaire.

Thus, it is possible to hold down the research cost and to take more respondents for research. Then, it progresses the research efficiency.

(2) Analysis Method

In addition to analyze the photos used by prior VEP, it would be possible to find not only the element of preferable landscape but also the location by taking the geospatial information with GIS as an analyzing object.

In this study, the survey was conducted at Gwanaksan with 60 people as the respondents. From the taken geotagged photos, it revealed the five visitor's preferable place (hot spot) and landscape that show statistically significant.

As the result of case study, it figured out not only the symbolic place like mountaintop but even the place where the turn of the sequence landscape as hot spot. It could be said that this method is useful about extracting the visitor's preferable place and landscape.

However, although Getis-Ord Gi* statistic can show the hot spot, it cannot figure out what does not have specific spatial tendency like the inside forest landscape. Thus, it considers that it is necessary to categorizes and tally each landscape elements, and take Kernel density estimation as a supplement.

By taking this series of operations based on GIS, there are benefits to refer with other data such as protection plan or to accumulate of data easily. It, also can find the specific landscapes and places evaluated by the visitors, so it would be precious information for actual planning of Natural Park.

As a future agenda, it is necessary to analyze not only the viewpoint but also the visual target. The information to be found by geospatial information is only the location of viewpoint. Therefore, it can be considered that it would be useful data by compiling a database including the visual target as the agenda for future research study.

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