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A Study of Landscape Management Techniques based on Viewing Characteristics of Mountain Landscape
- Focused on the Surrounding Areas of Bukhansan Mountain -

Park, Moon-Ho

Institute of Urban Science, University of Seoul

ABSTRACT

This study is based on the viewing characteristics of mountain landscapes. It investigates whether the current landscape management-related regulations are efficient in terms of the viewing characteristics of the mountain landscape against Bukhansan Mountain in which the conventional landscape management techniques were used. In addition, some viewing characteristics of mountain landscapes, such as distance from the view point to the target mountain, angle of elevation, altitude, gradient, have been analyzed and 3 cases of viewing condition have been simulated.

The following results were obtained:

i) Mountain landscapes can be managed up to 7~8 times of the mountain height with a 5~9° of elevation angle.

ii) In the Natural Landscape District which is situated on the hillside, it is reasonable to include altitude, gradient as criteria for regulation.

iii) According to a simulation of the construction permit height by viewing distance, it was confirmed that buildings can be constructed up to 111.55m when viewing the 20% ridge, 150.75m when viewing the 50% ridge and 189.05m when viewing the 70% ridge.

iv) The construction permit height varies depending on the landscape analysis method that is used and the application conditions. It is therefore unfair to apply height limit regulations to all buildings without considering the geographical features or viewing characteristics.

v) It is unreasonable to apply 2~3 management techniques to the same area for landscape management. Therefore, we recommend the Focused Landscape Management Area based on the landscape master plan as a integrating mountain landscape management techniques.

Key Words: View, Natural Landscape District, Maximum Height Limited District, Focused Landscape Management Area, Construction Permit Height

Ⅰ. Introduction

Since the enactment of the Landscape Act in 2007, local governments have drawn up a landscape master plan which includes matters associated with the preservation of natural landscape such as the mountain landscape or waterscape which are major natural resources which reveal the characteristics of a city. In particular, because many Korean cities aresurrounded by mountains, it is important to preserve the view when planning landscapes. Efficient landscape management techniques have been necessary for proper preservation and management of scenic mountain landscapes.

Under the present law, landscape management techniques for the preservation of mountain landscapes include Land Use Districts (LUD) which are governed by an Act on Planning and Use of National Territory (APUNT) such as the Natural

Corresponding author: Moon-Ho Park, Institute of Urban Science, University of Seoul, Seoul 130-743, Korea, Tel.: +82-2-2210-2201, E-mhp@uos.ac.kr

Landscape Districts (NLD) and the Maximum Height Limited Districts (MHLD), and Focused Landscape Management Areas (FLMA) in accordance with the Landscape Act. The LUD are the strongest means of regulation. They restrict the height and use of buildings and landscape area. In contrast, FLMA are a means of management without strong regulations such as restriction on the height of building. They focus on the balance with surroundings during the development, using a landscape review.

However, with regard to the analysis of landscape structure in 'viewing landscape planning,' it is important to figure out the scope and method of landscape preservation through a selection of view points and view targets. According to this analysis method, the construction permit height increases as the distance from the view point increases, and vice versa. However, when applying landscape management techniques, the construction height rather decreases in mountain areas, and the construction permit height increases in areas close to view points.

This paper identifies efficient mountain landscape management techniques after discovering problems in conventional landscape management techniques. Specific visual factors in mountain landscapes are analyzed with conventional landscape control techniques and appropriate mountain landscape management techniques are developed using a simulation of construction permit height by view points after selecting target areas around Bukhansan Mountain. Conventional mountain landscape management techniques have been used for the mountain with the development of a particular mountain landscape master plan.

II. Literature Reviews

1. Research Trends

The studies on the viewing characteristics of mountain landscape are mostly targeted to investigate the relationship between the target and view points in a visual structure. While Higuchi (1975) proposed visibility/invisibility, distance, angle of incidence, depth of invisibility, angle of depression, angle of elevation and depth as indexes to represent the visual structure of Japanese mountain. Kang (2001) obtained the characteristics of mountain landscape in Seoul as the indexes of altitude, distance, angle and angle of incidence using the said factors. According to a study by Im (2008), the characteristics of landscape around mountain hills was investigated through an analysis on view line, angle of elevation, angle of depression and visibility. According to a study by Yun *et al* (2009), the visual range was set based on point of view and elevation/depression angle in terms of the management of viewing landscape around the Jinjuseong Fortress. The similarities in these studies are that the spatial and visual characteristics of mountain landscape have been obtained. In other words, the visual characteristics such as visibility/invisibility, angle of incidence, angle of elevation, etc. which occur when the geographical features of the mountain are met with vision have been obtained. This paper intends to connect the viewing characteristics with landscape management techniques instead of investigating the fine visual characteristics of mountain landscape. Therefore, major points of view, distance with the view target, angle of elevation and visual skyline have been set as the indexes to examine the viewing characteristics of mountain landscape.

At present, maximum height is set in the districts which have been specially designated for mountain landscape management. The limited height is called, 'landscape altitude.' According to a study by Im (2008), the landscape altitude criteria were set using absolute height, view line, angle of elevation, width of front road and altitude. In the previous studies (Jang, 2009; Yun *et al*. 2009; Keum and Yuh, 2009; Jeong, 2009; Bae *et al*, 2010), which are targeted to estimate landscape altitude, landscape simulation from the view point has been used.

2. Research Hypotheses

Table 1. Natural landscape districts around the Bukhansan Mountain in Seoul

Name of district	Purpose of designation	Date of designation	Area (m^2)
Inwang district	To protect the beautiful viewing landscape of Inwangsan Mountain	Mar. 1941	751,926
Pyeongchang district	To protect the beauty of Bukhansan Mountain	Mar. 1941	2,037,507
Suyu district	To protect mountain hills and the viewing landscape of Bukhansan Mountain	Jan. 1968	1,460,550
Seongbuk district	To protect the natural features and scenic beauty of Bukhansan Mountain	Mar. 1941	1,764,414

In terms of mountain landscape management techniques, there are NLD, MHLD and FLMA. This paper has aimed to investigate the designation of the special districts focusing on the cases of Seoul City, find problems in current techniques through an analysis of previous studies (Seoul Metropolitan, 2004; Jung, 2008; Jeong, 2009; Yeo, 2009; Gyeongnam Development Institute, 2006) and develop a hypothetical alternatives to minimize these problems.

1) Natural Landscape District

The term 'Landscape District' originated from the 'Scenic District' that was designated in 1934 in accordance with the Joseon Downtown Planning Ordinance. It was named in 2000 after the complete revision of the Urban Planning Act in 2000. 'Scenic District' was aimed to preserve scenic natural features, protect the green fields and restore the natural beauty of mountains and skyline. NLD is a district which is targeted to preserve natural landscape such as a mountain hill, and maintain the scenic natural beauty. Under the NLD, the conditions of mountain hill are set. In fact, the City of Seoul designated its major mountain hills of Bukhansan Mountain and Namsan Mountain, etc., as contained in a NLD to preserve and maintain the urban skyline which was developed from 1941 to 1977.

According to 「The Scenic District Management Plan (1997)」, some districts such as Suyu District, Jeongnong District, Hwagok District, Namsan District, were partially deregulated and changed to Type I Residential Area and MHLD. As of 2010, there are a total of 20 NLD in Seoul, 4 around the Bukhansan Mountain, 3 around the urban parks, 3 around the Hangang River, 10 around large facilities such as colleges. The targets for the NLD vary including mountain, park and areas around the Hangang River or large-scale facilities. However, the buildings under the NLD are permitted to be built up to 12m or 16m if reviewed. In fact, there have been a lot of complaints about this strict regulation. Therefore, it needs to be revised or re-designated.

2) Maximum Height Limited District

The Height Limited Districts (HLD) is designated in places in which the height of buildings should be regulated to create refreshing atmosphere and improve the use of height as a criteria. The MHLD is designated in the areas in which the maximum height of buildings need to be set to protect the environment and landscape and prevent over-crowding. The MHLD can also be designated around cultural assets and airports as well as around major mountains. Under this regulation, height is regulated regardless of the characteristics of landscape.

The City of Seoul has introduced the MHLD to preserve landscape around mountains. For example, the maximum height is set across a 7.89km^2 area around the Bukhansan, Namsan, Inwangsan, and the Bukaksan mountains. The

Table 2. Maximum height limited districts with the purpose of protecting mountain landscapes in Seoul

Location	Purpose of destination	Area (m^2)	Height regulations
Bukhansan (Dobong-gu, Gangbuk-gu)	To protect the landscape of Bukhansan Natural Park	3,557,000	Up to 20m (5-story)
Inwangsan Mountain, Bukaksan Mountain, Gyeongbokgung Palace	To protect the landscape of cultural assets and Inwangsan Mountain	1,189,800	Up to 15~20m
Namsan (Jung-gu, Yongsan-gu)	To protect landscape around Namsan Mountain and nearby areas	2,977,169	Street Level −1.5, +4m or below Up to 12m (3-story), 20m (5-story)

Table 3. Comparison of districts in terms of management of mountain landscape

District	Natural landscape district	Maximum height limited district
Purpose and conditions	- Extensive designation conditions such as the protection of good viewing landscape, geographical features and green corridor	- Poor consideration of the characteristics on the subjects of landscape despite the purpose of landscape protection
Regulation method	- Preservation of geographical skyline with the same height regulation	- Poor suggestion of objective grounds for the standardized height regulations
Problems in operation	- Easy operation with the same regulation - De-designation due to a lot of complaints and substitution with the Height Limited District	- Occurrence of complaints due to differentiated regulations by district - Poor reflection of the characteristics by district

height has been set in accordance with the related height limit regulations using the landscape analysis method since 1990 when Bukhansan Mountain and Namsan Mountain were set to the HLD. According to the revision of the height limit regulations, the height limit has changed from a 5-story building or 18m to a 5-story building or 20m, 7-story building up to 28m, if reviewed, in Gangbuk-gu and Dobong-gu around the Bukhansan Mountain, from a 3-story building or 12m to a 5-story building or 20m, 7-story building up to 28m, if reviewed, around Namsan Mountain and from 15m or 20m less from the ground around Inwangsan Mountain and Bukaksan Mountain.

Even though Bukhansan Mountain and Namsan Mountain are different from each other in terms of landscape characteristics or geographical features, an extensive area is regulated under the same regulation in the MHLD. Therefore, a uniformed and monotonous building skyline has been created (Jang, 2008). In addition, even if the purpose and conditions of designation for the special districts which restrict citizens' property rights should be clearly stated, there have been no specific standards. Therefore, there has been confusion in designating a new district. In terms of the management of mountain landscape, in particular, there has been confusion in the NLD and the MHLD due to vague designation criteria. The two districts would even be designated together sometimes. A regulation on construct height has been the most widely used as a means of preserving viewing landscape due to simple designation, clear management criteria, legal support and easy management (Yun *et al*., 2009). However, there has been a doubt on current districts if they are effective as a means of landscape management because they are lack of objective criteria regarding geographical conditions.

3) Focused Landscape Management Area as a Hypothetic Alternative

According to the Landscape Master Plan of Seoul, the areas around the Bukaksan, Inwangsan, and Bukhansan mountains have been set to the Landscape Management Areas. The road and LUD are set to the boundary within approximately 500m from the natural green field boundary. Therefore, the conventional NLD and MHLD are included as they are. In addition, design guidelines on the layout, capacity, height, shape, material, external space, night landscape, color and outdoor advertising materials of buildings, which have an impact on urban landscape and surroundings have been set.

The Landscape Act takes precedence over other laws in terms of the formation, preservation and management of landscape. Under this law, the FLMA have the most dominant position in respect of unique geographical features, protection of good ridge views, management of mountains and establishment of view corridor. Therefore, it has been assumed that the FLMA is an alternative plan to minimize the problems of previous districts.

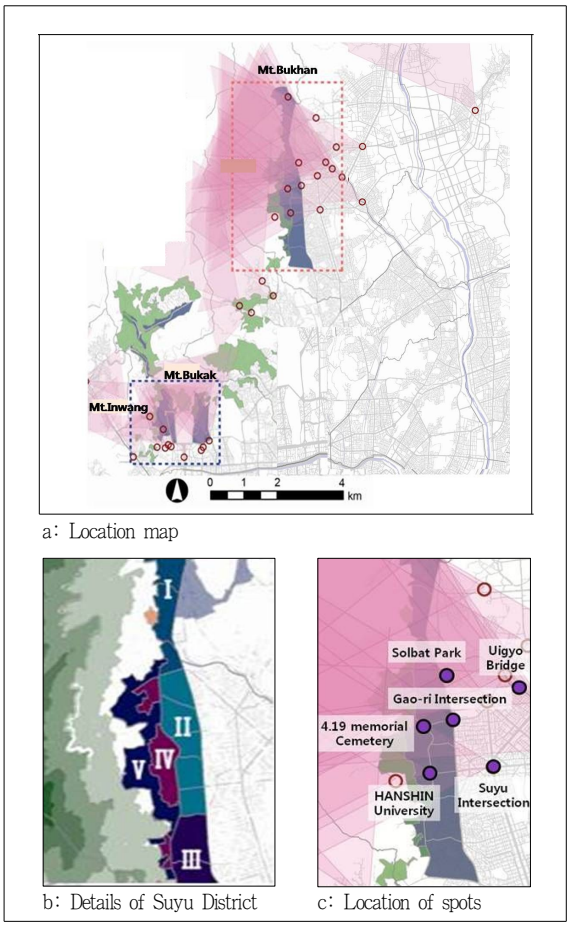
III. Research Methods

1. Selection of Research Sites

The mountains around the downtown in Korea are important landscape factors which form the identity of urban landscape as an urban landmark. According to one landscape plan in the Landscape Master Plan recently drawn by the local government, most mountain landscapes are analyzed as critical land scape resources. The plan includes the preservation and management of the landscape characteristics.

Since the enactment of the Landscape Act, mountain landscape has been analyzed and planned as an important factor to be preserved by local authorities who have set up a landscape plan in accordance with 'Landscape Master Plan Development Guidelines' such as Seoul, Daegu, Gwangju, Gwacheon and Goyang. In particular, Seoul has developed a series of policies to preserve the view of nearby mountains since the 1990s and it has operated related LUD. To save the view of the Namsan mountain, height around the mountain has been controlled. In addition, the following plans were developed to manage the mountain landscape: 「Master Plan of viewing Street」(Seoul Metropolitan, 1998), 「Beautiful Mountain Landscape Preservation Plan in Seoul」(Seoul Metropolitan, 2001), 「Viewing Landscape Preservation Plan around Major Mountains in Seoul」(Seoul Metropolitan, 2002), 「Seoul Metropolitan Landscape Master Plan」(Seoul Metropolitan, 2007) and the 「Seoul Metropolitan River, Mountain and Cultural Asset Landscape Plan」(Seoul Metropolitan, 2009).

As mentioned, the City of Seoul has also designated the FLMA for preserving the view of mountains in addition to the conventional landscape preservation districts. As a result, the appropriateness of diverse mountain landscape management techniques can be compared and reviewed under the same conditions. In consideration of the diverse use of mountain landscape



a: Location map

b: Details of Suyu District c: Location of spots

Figure 1. Location map of target sites and view points

Legend: View point, Range of view
Natural landscape district
Maximum height district

management techniques, the Inwang and Suyu districts of Bukhansan Mountain (Refer to Figure 1), which are included in the FLMA, have been chosen as the research subjects of this paper.

2. Research Methods

1) Analysis of the Visual Landscape Structure of Mountain Landscape

For the objective and quantitative analysis of the visual characteristics of mountain landscape, an image analysis method and a Computer-Aided Design (CAD) method have been used. In an image analysis method which is targeted to find and designate great sites to view mountain landscape, the mountains were filmed in nodal points: intersection of the viewing of major streets and viewing pockets such as cultural asset, public facilities, leisure facilities, open spaces, etc., which were expected to be crowded with many people. As a result, a total of 81 spots were found, in which Bukhansan Mountain can be viewed. In addition, 20 spots with high visibility rates, the ratio of mountain coverage in the photo space, were found.

With respect to research methods, the range of NLD and MHLD have been obtained using the Urban Planning Information System (UPIS, 1:1000) data of Seoul. In addition, the related information such as altitude, distance and angle of elevation has been acquired using the Arc GIS 9.2 (ESRI, 2006).

2) Viewing Mountain Landscape Simulation

This paper has also attempted to obtain landscape altitude which should be controlled when viewing the NLD and MHLD around the Bukhansan Mountain from the key view points using Computer-Aided Simulation. The view plane from which Bukhansan Mountain can be viewed and the boundary between the NLD and MHLD have been drawn. The maximum building height (Refer to Formula 1) in which buildings can be constructed from the closest spot from the view point / the most remote spot to the view plane. Then, the view sides to be controlled have been analyzed under three conditions based on the maximum altitude of the NLD; view of the 20% Ridge, view of the 50% Ridge and view of the 70% Ridge.

Maximum building height = (G. L. of view point − G. L. of spot) + distance to the spot × tanθ(angle of elevation) + eye level (1.6m)

(Formula 1)

Ⅳ. Results and Discussion

1. Visual Characteristics of Viewing Landscape

1) Viewing Distance from Mountain Landscape

In terms of geographical features, mountains are classified into mountain higher than the 70% ridge, 30~70% ridge and lower than 30% ridge. From the target site, the 70% ridge of Bukhansan Mountain and the 90% or higher ridge and peak of Bukaksan Mountain and Inwangsan Mountain were viewed. Which is similar to the 70% ridge of the skyline to protect the mountain landscape according to a study by Seoul Metro-

politan (2002).

Higuchi (1975) suggested distance as an index which is used to investigate changes in the characteristics of Japanese mountain landscape. A short-range view which refers to the area in which the relation between the subject of view and nearby buildings is perceived. A middle-range view is the most important area in which 3D landscape perception is formed. A distant view is the area in which the geographical outline and skyline of mountains become the background of visual subject.

In general, a mountain which is the matrix of the mountain range such as the Mudeungsan and Bukhansan Mountains becomes the background of a town. Therefore, it is usually viewed from the distance instead of a short- or middle-ranged view depending on the shape of the width and the characteristics of geographical features. This kind of ultra-distant view sees mountains as a part of scenery. The openness of a front view which is formed on the viewing line plays an important role in perceiving and preserving skyline. Because the subject of view is too far with no direct perception relationship under the viewing landscape of the ultra-distance view, it is difficult to apply control techniques for landscape management. Even though the area which should be properly controlled to preserve mountain landscapes is just partially viewed in the ridge, it is the areas with short- and mid-ranged views where the public perceives intimacy.

Because the target sites are located at the east bottom of Bukhansan Mountain, citizens can view the ridges instead of the peak in general. In terms of the skyline of Bukhansan Mountain, which can be viewed from 85 view points, 64% ridge of mountain is viewed in average from the 5,905m (D:H=10:1) distance while 69% ridge is viewed in average from the 4,295m (D:H=7.5:1) distance. The Bukaksan Mountain which stretches from the Bukhansan Mountain is viewed in front, the peak is almost viewed at the middle- range view area 2,381m (D:H=7.3:1) to 2,578m (D:H=8:1). In Inwangsan Mountain, 80% ridge is viewed at the middle-range view distance from 1,507m (D:H=5.5:1) to 2,081m (D:H=7.5:1).

As shown above, the distance standards which are targeted to view mountain landscape can vary depending on the characteristics of mountains. In other words, when the landscape of mountain is viewed from the view point in a town, 5~10 times of distance, 7~8 times in average, can be the distant-view areas. Even under the same mountain, the horizontal distance from the view point to the target ridges can differ depending on geographical features. In terms of the distance from six good view points to 20%, 50% and 70% ridges, the distance ratio up to the 20% ridge is 1:0 to 4:4 while the distance ratios up to the 50% and 70% were 2.4~6.5 and 2.9~7.2 respectively. If assumed that the view up to the 50% ridge is managed, the short-range view area would be 1.5km while the middle-range view area and distant-view areas would be 2.0km and 2.5km or above.

2) Viewing Angle

According to a study by Higuchi (1975), a mountain with 5° of angle of elevation has a great skyline but it is shielded by an obstacle in front. A mountain with 9° of angle of elevation, on the contrary, has good visibility in the hillside as well as a great sky line. A mountain with approximately 20° of angle of elevation is mostly available as background. According to a study by Yun (2009), view was analyzed as one method of viewing landscape management around the Jinjuseong Fortress. The angle when viewed, short-range view, from the road around the fortress toward Bukjangdae Peak was 9~12° while the view in which a downtown is viewed from the Jinjuseong Fortress was set to −8 to 10°.

The angle of elevation in the good view points was around 9°, 8.6° for Bukhansan Mountain, 7.23° for Bukaksan Mountain and 9.36° for Inwangsan Mountain. Because a view is

Table 4. Viewing characteristics of mountain landscape

Target	Category	Distance up to ridge (m)	Altitude of skyline (m)	Altitude of view point	Average angle of elevation (°)	No. of view points
Bukhansan Mountain	Good	4,295	573 (69% ridge)	41.1	8.6	20
	Total	5,905	542 (64% ridge)	-	5.96	85
Bukaksan Mountain	Good	2,381	327 (96% ridge)	33.1	7.23	6
	Total	2,578	324 (95% ridge)	-	6.72	14
Inwangsan Mountain	Good	1,507	275 (81% ridge)	38.6	9.36	10
	Total	2,081	278 (82% ridge)	-	7.37	21

Table 5. D:H ratio at good view points (unit: m)

Spot serial No.	20% ridge (114m)		50% ridge (287m)		70% ridge (401m)		Peak (574m)	
	Distance	D:H	Distance	D:H	Distance	D:H	Distance	D:H
Ⅰ	634	1.1	1,403	2.4	2,146	3.7	2,467	4.3
Ⅱ	2,541	4.4	3,747	6.5	4,106	7.2	4,445	7.8
Ⅲ	1,134	2.0	1,799	3.1	2,339	4.1	2,753	4.8
Ⅳ	1,256	2.2	2,017	3.5	2,298	4.1	2,979	5.2
Ⅴ	1,541	2.7	2,354	4.1	2,872	5.0	3,580	6.2
Ⅵ	559	1.0	1,460	2.5	1,692	2.9	2,801	4.9

Table 6. Angle of elevation of good view points

Spot serial No.	Name of view point	Altitude at view point	Angle of elevation (°)		
			20% ridge	50% ridge	70% ridge
Ⅰ	Solbat Park	60	4.9	9.2	9.0
Ⅱ	Uigyo Bridge	30	1.9	3.9	5.2
Ⅲ	Entrance to 4.19 Memorial Cemetery	37	3.9	7.9	8.8
Ⅳ	Gaori Intersection	40	3.4	7.0	8.9
Ⅴ	Suyu Intersection	31	3.1	6.2	7.3
Ⅵ	Hanshin University	49	6.6	9.3	11.8

mostly blocked since many towns start from the hillsides in Seoul, it is hard to secure a view in the view points with 5° or less of an angle of elevation. To have a good view, the angle of elevation from the target mountain should be around 9°.

However, the angle of elevation can differ by the part of viewing ridge even under the same mountain. With regard to the angle of elevation in 6 good view points in Suyu District, for example, the 20% ridge was 1.9~6.6° while the 50% ridge and 70% ridge were 3.9~9.3° and 5.2~11.8° respectively. If it is assumed that a view is properly managed up to the 50% ridge, the angle of elevation is distributed within the range of 5.0~9.0°, which is the desirable range in terms of angle of elevation.

3) Geographical Features

With regard to the civil petition on the MHLD, many have complained about applying regulations without considering geographical features (Jung, 2008). The City of Seoul answered these complaints, stating 'It is a common logic to make the ups and downs of topography exposed when designating the HLD. We regulate heights to make the natural features of mountains such as mountain hills and valley visible in a natural manner,' which means that geographical features such as winding in the hillsides is an important factor in designating the special districts.

In terms of the maximum height of the NLD, Inwang district is as high as 164m, 50% ridge based on the skyline with an excellent view on Bukaksan Mountain, while the Suyu District reaches up to 37% ridge. In terms of the maximum height in the MHLD, on the other hand, Inwang District ranges from 58m to 75m while Suyu District ranges from 60m to 132. Even under the same NLD, the height difference reaches up to over 100m. In the MHLD, however, the height difference is small. The Suyu MHLD 'V' is the area which is designated as both NLD and MHLD, is high in altitude but small in terms of height difference.

In terms of gradient in the Inwang NLD, reaches up to 39.79% with 9.92% in average while Suyu District reaches up to 10.06% with 8.05% in average. In terms of gradient in the MHLD, Inwang District reaches up to 11.48~16.84% with 2.52~3.91 in average while Suyu District reaches up to 7.96~24.39% with 2.73~9.30% on average.

If altitude is considered, the NLD is situated in the relatively high and steep-slope places while the MHLD is located in areas with relatively smooth slopes. If altitude is high, in other words, the NLD is overlapped with the MHLD. Therefore, according to the logic 'to make the ups and downs of geographical features exposed as they are' by the City of Seoul, altitude and gradient are important factors for regulation. In particular, it is critical to maintain high altitude and

Table 7. Altitude and gradient by district

Category		Altitude (m)		Height difference (m)	Average altitude (m)	Mean gradient (%)
		Min.	Max.			
Inwang district	Natural landscape district	50	164	114	80.57	9.92
	Maximum Height Limited District Ⅰ	37	75	38	51.78	3.91
	Maximum Height Limited District Ⅱ	43	58	15	49.04	3.61
	Maximum Height Limited District Ⅲ	41	62	21	46.91	2.52
Suyu district	Natural landscape district	53	204	151	93.90	8.05
	Maximum Height Limited District Ⅰ	48	78	30	178.14	3.99
	Maximum Height Limited District Ⅱ	43	60	17	50.76	2.73
	Maximum Height Limited District Ⅲ	49	111	62	70.95	7.01
	Maximum Height Limited District Ⅳ	61	91	30	75.08	6.09
	Maximum Height Limited District Ⅴ	93	132	39	105.64	9.30

steep slope in the NLD.

2. Simulation of viewing Landscape Overlapped Areas

1) Preconditions of Simulation

As mentioned above, the NLD around the Bukhansan Mountain is targeted to preserve the geographical and ecological mountain landscape. Therefore, it is hard to see it as a viewing landscape management technique. In the MHLD, on the contrary, the visual and viewing characteristics from the downtown are more important than geographical and ecological landscape in designation of district.

According to a study by the Seoul Metropolitan (2004), the MHLD around the Bukhansan Mountain has played a role of 'viewing scenic natural landscape from the downtown and major view points by preserving view corridor around the mountains.' Therefore, the optimum conditions which do not disturb landscape are simulated against the MHLD, the areas which are designated as NLD as well included, which clearly shows the relationship between mountain landscape and landscape management techniques.

Because Inwang District has a multiple purpose for the balance between historical landscape (Gyeongbokgung Palace) and natural landscape, the logic of preservation of historical landscape can be added. Therefore, it has been excluded in a simulation. Suyu District is the area in which the districts under the APUNT and the FLMA under the Landscape Act are designated at the same time. In this district, a variety of mountain landscape management techniques were used.

As shown above, the Suyu District has perfect conditions to compare and manage the weakness and strength of each system. Therefore, each control method and description is compared and reviewed after investigating the viewing characteristics for Bukhansan Mountain and the construction permit height in major view points.

2) Construction Permit Height by View Point

The construction permit height has been estimated after classifying good view points into the short-range view area (spot Ⅰ and Ⅵ in the district), middle-range view area (spot Ⅲ and Ⅳ close to the district) and distant view area (spot Ⅱ and Ⅴ, about 1km away from the district) depending on the

Table 8. Landscape management for protection of Bukhansan Mountain

Means of control	Natural landscape district	Maximum height limited district	Landscape street view district	Focused landscape management area
Purpose of designation	To protect natural landscape	To secure view corridor	To secure view corridor	Preservation of good mountain landscape /viewing landscape
Characteristics	Mandatory	Mandatory	Mandatory/review	Acquisition and review of landscape design guidelines
Restrictions	Up to 12m (3-story)	Up to 20m (5-story)	Up to 6-story (8-story permit at review)	Arrangement, size & height, shape & look, material, external space, night landscape, color and advertising material of buildings

Table 9. Construction permit height within the district (unit: m)

Spot serial No.		Front of the spot			Back of the spot		
		20% ridge	50% ridge	70% ridge	20% ridge	50% ridge	70% ridge
Ⅰ (G.L=−75m)	Max. height	-	-	-	94.0	124.6	123.5
	Permit height	-	-	-	19	49.6	48.5
Ⅱ (G.L=40~53m)	Max. height	83.9	141.8	177.3	92.5	159.7	200.8
	Permit height	43.9	101.8	137.5	39.3	106.7	147.8
Ⅲ (G.L=40~80m)	Max. height	43.5	50.3	51.9	103.3	172.8	189.1
	Permit height	3.5	10.3	11.9	23.3	92.8	109.1
Ⅳ (G.L=40~83m)	Max. height	42.4	45.0	46.5	99.1	163.0	197.8
	Permit height	2.4	5.0	6.5	16.2	80.0	114.8
Ⅴ (G.L=42~122m)	Max. height	59.4	88.3	98.8	117.5	205.7	237.9
	Permit height	17.0	46.3	56.8	-4.5	83.7	115.9
Ⅵ (G.L=−150m)	Max. height	-	-	-	174.1	224.4	272.8
	Permit height	-	-	-	24.1	74.4	122.8

distance from the target. Table 9 is represented the construction permit height, considering the ground level of each spot, that is obtained from maximum building height (Refer to formula 1).

The spot Ⅰ in the short-range view area with the angle of elevation of 4.9~11.8°, is a neighborhood park. If the view is open without any buildings in front, buildings can be constructed up to 19~48.5m, 3 to 12-story building. This spot is the area designated as Type Ⅰ Residential Area and NLD. A sufficient view can be preserved with the designation of LUD only, even though the local maximum height criteria are applied, buildings can be constructed up to 35m in height. It is recommended to control maximum height up to the 20% ridge or lower (Refer to Figure 2). The Spot Ⅵ is a relatively steep area with the angle of elevation of 6.6~11.8°. It is permitted to construct buildings up to 5 stories. Because land is relatively low at the tip of this area, buildings can be constructed up to 112.8m in height. In addition, because altitude is 150m, if buildings are constructed up to the maximum height (70% ridge), the distant view is blocked up to 47% ridge (Refer to Figure 3).

Spots Ⅲ and Ⅳ in the middle-range view area are the places that border the road with similar angle of elevation 3.4~8.9°. The construction permit height is as high as 3.5~11.9m (1 to 3-storied) in front of the Spot Ⅲ and 23~109.1m in the back (Refer to Figure 4). In case of Spot Ⅳ, the construction permit height is as high as 2.4~6.5m in front and 16.2~114.8m in the back (Refer to Figure 5), 83m of altitude, if constructed up to the maximum height, view is blocked up to

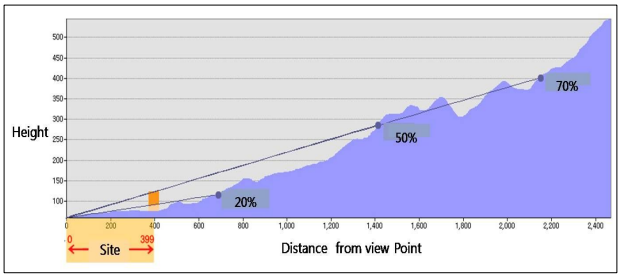


Figure 2. Viewing cross section of short-range view area in spot Ⅰ
Legend: Range of the site Construction permit height

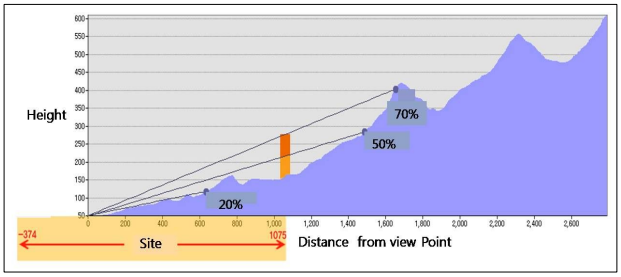


Figure 3. Viewing cross section of short-range view area in spot Ⅵ
Legend: Range of the site Construction permit height

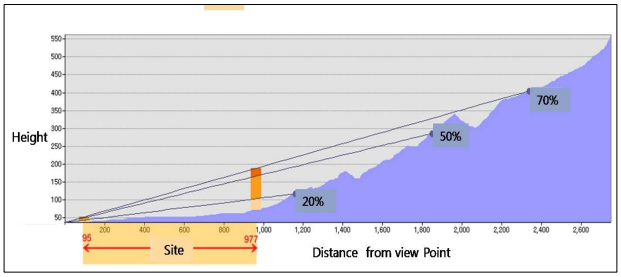


Figure 4. Viewing cross section in the middle-range view area in spot Ⅲ
Legend: Range of the site Construction permit height

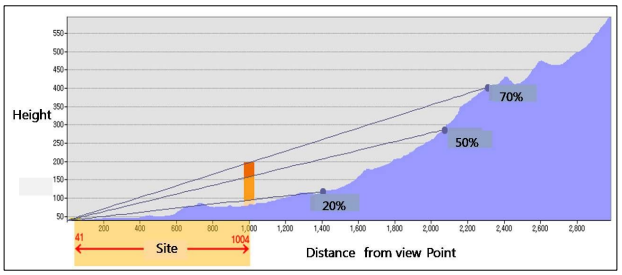


Figure 5. Viewing cross section in the middle-range view area in spot Ⅳ

Legend: Range of the site Construction permit height

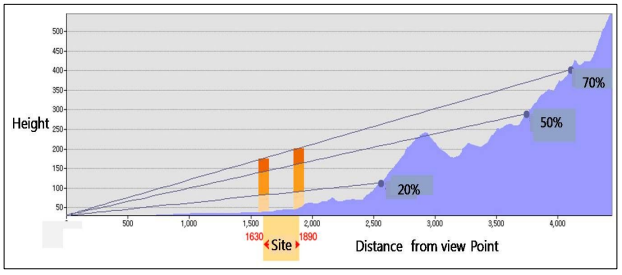


Figure 6. Viewing cross section of distant view area in spot Ⅱ

Legend: Range of the site Construction permit height

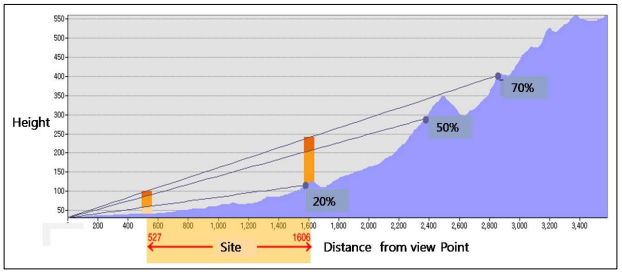


Figure 7. Viewing cross section of distant view area in spot Ⅴ

Legend: Range of the site Construction permit height

the 34% ridge.

A distant-view area is about 0.5~1.5km away from the border of the MHLD. The front area is available as Type Ⅱ Residential Area. Considering the view, however, buildings can be built up to 43.9~137.5m in Spot Ⅱ, 17.0~56.8m in Spot Ⅴ, 39.3~147.8m in Spot Ⅱ. (Refer to Figure 6) and −4.5 to 115.9m in Spot Ⅴ (Refer to Figure 7). Considering the fat that the areas between the view point and the target district is Type Ⅲ Residential Area and commercial area, however, the mountain landscape is already blocked in front. Therefore, control of view corridor is meaningless.

3) Height Regulation Criteria for Preservation of Viewing Landscape

Table 10. Average of maximum construction permit height (unit: m)

Spot serial No.	View of the 20% ridge	View of the 50% ridge	View of the 70% ridge
Ⅰ	77.00	92.30	91.50
Ⅱ	88.20	150.75	189.05
Ⅲ	73.40	111.55	120.50
Ⅳ	70.75	104.00	122.15
Ⅴ	88.45	147.00	168.35
Ⅵ	111.55	136.70	160.90
Mean	84.89	123.72	142.08

To preserve the natural landscape around the Bukhansan Mountain, the height of buildings has been limited to 12m or 3-story in the NLD, 20m or 5-story in the MHLD and 6-story or 8-story at the review of construction on the Samyang-ro and Uidong-gil. According to a study on the landscape height criteria in Suyu District by Jang (2008), differentiated landscape height which does not disturb landscape has been proposed in consideration of the relationship between absolute altitude and nearby buildings. This study intended to partially coordinate the height in the MHLD. Very low absolute altitudes were proposed based on the altitude of the already developed areas, location of little peaks and road altitude. The study targeted regulation of the minimum conditions, view of 20% ridge, with the maximum height. This is considerably different from the height criteria of this paper which has considered the characteristics of viewing landscape.

In this paper, buildings can be constructed up to 174m, if targeted to view the 20% ridge, 224m, about 40% ridge, if targeted to view the 50% ridge or 272m if targeted to view the 70% ridge. If corrected with 1/2 value in consideration of a big difference of construction permit height between the front and the back of the spot, buildings can be constructed up to 111.55m, if targeted to view the 20% ridge, 150.75m, if targeted to view the 50% ridge and 189.05m, if targeted to view the 70% ridge (Refer to Table 10).

3. Landscape Management Techniques based on Viewing Characteristics

There was a big difference in construction permit height depending on the micro landform, location of the view point and the distance from the mountain - even under the same district and a point with the same angle of elevation. As mentioned above, however, because the building height re-

striction is applied to all buildings, it is hard to find the basis for the regulation.

While previous studies have concluded with a goal of maintaining and coordinating the existing districts such as NLD or MHLD, this paper has presented a way to overcome the limitations of the current districts based on the characteristics of mountain landscapes.

1) Landscape Management Techniques in the Hillsides

At present, NLD are basically designated in the 10~20% ridges of mountain. Landscape management is generally a matter of how to manage the hillsides, 30% ridges or below. In the hillsides, the development conditions vary depending on the relationships with nearby towns and mountain height. In general, landscapes are managed up to the 50% ridge for relatively low mountains situated close to towns such as Inwangsan Mountain and up to the 30% ridge for lofty mountains situated in the outskirts such as Bukhansan Mountain.

In the case of hillsides, it is meaningless to regulate height in consideration of the short-range view area, because they are already developed deep into the mountain, refer to the short-range view area cases in the view points Ⅰ and Ⅳ. In these hillsides, therefore, it is more effective to regulate the buildings with the absolute height by maintaining the same altitude and protecting the micro-landform. For example, both the absolute criteria which keeps buildings 1.5m lower than the circular road for protection of the landscape of Namsan Mountain, and height regulation techniques with the same altitude, can be used at the same time.

2) Vewing Landscape Management Techniques in Hillsides Close to Towns

The MHLD belongs to the mountain area. As a gentle-slope and urbanized area, this district is about 1.5~4.0km off from the mountain peak. Therefore, construction is permitted at height ranges from 50 to 110m when the viewing control line is applied to preserve 50% ridge from the major view points around the target areas.

Currently the middle-range view area, in the cases of spot Ⅲ and Ⅳ, is mostly identical with the border of the MHLD. While 5 to 10m-high buildings are only permitted to be built in front, buildings as high as 80~90m can be built in the back. Even in the same district, construction is permitted at heights that vary greatly, depending on the distance with the view point. An imbalance in the height is permitted within the same district. In this case, the view is not interfered with even though buildings are built up to the maximum height. Therefore, it wold be useless to designate the district with a purpose of landscape management.

In the case of the distant-range view areas which are off from the mountain area as well, buildings can be as high as 46.3~101.8m in front and 83.7~106.7m in the back. With the classification of districts, based on the height of construction permitted in relationship to the floor area and building coverage ratios, maximum height can be controlled.

It is difficult, using only the viewing landscape analysis, to determine the optimum maximum height regulation standards that would be applied to all buildings desiring to preserve a mountain view from the town around the mountains. Hence, it is necessary to promote nearby landscape management at the same time.

3) Application of Mountain Landscape Management Techniques

A landscape master plan which is based on the Landscape Act is an essential means to form, preserve and manage urban landscape. It should include a systematic landscape management plan on all areas including the MHLD (Yeo, 2009) and the NLD. In fact, many cities such as Seoul, Daegu and Daejeon have designated the FLMA to preserve good landscape around the mountains. In Gwangju, for example, the MHLD was eliminated after the plan was drawn up.

However, the MHLD is excluded from the subjects which can be operated in accordance with Landscape Act. In addition, it is governed by the regulation on architectural story height in accordance with the APUNT. Therefore, it has been a requirement to apply two laws for preservation of mountain landscape, has proposed changes in the operational direction of local governments towards the landscape district (Gyeongnam Development Institute, 2006). Their proposal includes a practical means of landscape management under the Landscape Act and flexibility in the operation of the landscape district through multiple management instead of a height / use-focused landscape management method.

As described above, a control method which focuses on height only is not enough to preserve mountain landscape. Diverse and flexible landscape management is necessary in terms of geographical features and preserving of a view from

the view points. In the FLMA, the guidelines for preservation and management of landscapes can be included in a comprehensive review on the viewing characteristics, geographical features, view point and relationships with the targets. In addition, the guidelines should address the control of the preservation of mountain landscapes, and the selection of view points that should be preserved to maintain the characteristics of mountain landscape. Specific standards to preserve the landscape structure of mountain landscapes can be investigated.

Based on these characteristics of mountain landscapes, the basic landscape management criteria have been set in the ordinance. The construction and development acts which meet these requirements can be suggested as an alternative to improve the value of architectural landscape. If there is construction within the target area, the appropriate height which does not hinder the view of mountain landscape could be obtained through a review by the landscape/construction integration committee. In other words, the construction acts with the optimal height and shape which do not interrupt landscape through a landscape simulation in the good view points can be encouraged.

V. Conclusions

This analysis addressed the viewing characteristics of mountain landscapes and management techniques for the preservation of scenic mountain landscapes of the NLD and MHLD which are governed by the APUNT. The following results were obtained:

1) When mountain landscape is viewed from a view point in a town, distant-range view area, about 7~8 times of the mountain height, can be the limiting distance for landscape management. The view up to the 50% ridge can be preserved at 1.5km in the short-range view area, 2.0km in the middle-range view area and 2.5km or above in the distant-view area.
2) A desirable angle of elevation at the good view point for Bukhansan Mountain is 5.0~9.0°.
3) In the NLD which is designated in the hillsides, about 20% and 30% ridges, altitude and gradient are important factor for regulation. It is effective for a hillside landscape management technique.
4) If the front of the view point in the short-range view area is open, buildings can be built up to 19~48.5m in height with an angle of elevation or 4.9~9.0°. A sufficient view can be preserved with the conventional districts. If the angle of elevation is high, 6.6~11.8°, buildings can be constructed up to the 122.8m. In this case, ridges are blocked up to 47% so that the view of 50% ridge and 70% ridge will be meaningless.
5) In the middle-range view area, if constructed up to the maximum height, the ridges are blocked up to 30~40%. Therefore, the view with 50% ridge or above becomes meaningless.
6) When viewed from the view point in the distant-view area, buildings can be constructed up to the height of 30% ridge. However, the view is shielded by the buildings in front. Therefore, the control of view corridor becomes meaningless.
7) In terms of the height of construction permitted in consideration of viewing landscape in this paper, buildings can be constructed up to 111.55m, about 20% ridge, when viewing the 20% ridge, 150.75m, about 25% ridge, when viewing the 50% ridge and 189.05m, about 30% ridge, when viewing the 70% ridge. These results differ greatly from the previous studies on the same districts.
8) There is a significant difference in the height of construction permitted for landscape management, depending on the analysis method and application conditions. Therefore, the current landscape management techniques in which the height regulation is applied to all buildings without considering geographical features or viewing characteristics have limitations.
9) It is inappropriate to apply 2~3 management techniques to the same district for landscape preservation. Therefore, an integrated control system which considers the viewing characteristics of mountain landscapes are necessary.
10) The FLMA under the Landscape Act could be an alternative techniques. It would be more reasonable to set the area to be preserved, set the position of the view points, propose the characteristics of a mountain landscape, and identify management procedures and controls after a review by the landscape committee.

However, the subject of this paper is limited to the Bukhansan Mountains in Seoul. In Korea, ingeneral, cities are surrounded by mountains. There have been a lot of studies on

Seoul in terms of preservation of mountain landscapes. Therefore, this paper has also focused on Seoul.

There is a limitation to generalizing the results of this paper because the relationship between the characteristics of mountain landscapes in other cities with a town can differ from that of the Bukhansan Mountain. In addition, there is no capacity for integrated operation as the FLMA. Furthermore, there has been no integrated operation without designating other districts. Therefore, continued study is necessary. It is necessary to study the specific feasibility of scenarios which cover the viewing characteristics and landscape management techniques and perform additional studies to spread the results of this paper and verify their objectivity.

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