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Forest Vegetation Units and Landscape Structures of Mt. Inwang in Seoul, Korea[1]

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仁王山의 山林植生單位와 景觀構造[1]

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ABSTRACT

The forest vegetation developing on Mt. Inwang, an isolated forestland in Seoul, Korea was analyzed phytosociologically and its spatial distribution mapped out. Using the vegetation map, The characteristics of landscape structures in terms of the number and size of patches are discussed. Forest vegetation of the study area was classified into ten communities, ten groups, and eighty subgroups. Landscape element types were classified into secondary forests, relict communities, introduced plantations, and other elements including urbanized area. *Pinus densiflora* community, natural forest and *Robinia pseudo-acacia* community, plantation, formed matrix and some secondary forest elements, relict communities and the other plantations of small size tended to distribute as small patches in such matrix. The number of patches per unit area in secondary forest elements was more than that in plantation elements. The result in patch size was vice versa. The vascular plant species richness of the landscape element types in Mt. Inwang was found to be positively related to their size. As the results of landscape ecological analyses, it was estimated that differentiation of patches recognized in community level would be related to human interference and those in subordinate levels to natural process such as progression of succession.

Key words : Forest vegetation, isolated forestland, spatial distribution, landscape structures, patches, landscape element types, matrix.

要　約

도시화에 의해 고립된 임지인 인왕산에 발달하고 있는 산림식생이 식물사회학적 방법으로 해석되고 그것의 공간적 분포가 정밀하게 지도화되었다. 정밀식생도상의 patch의 수와 크기를 이용하여 인왕산의 경관구조 특성이 검토되었다. 인왕산지역의 산림식생단위는 10개 군락, 10개군 그리고 8개소군으로 구분되었으며, 경관요소유형은 이차림요소, 유적군락요소, 인공림요소 그리고 도시화지역을 비롯한 기타요소로 구분되었다. 소나무군락과 아까시나무군락이 각각 기질(matrix)을 형성하고 있었으며, 그와같은 기질내에서 소면적의 일부 이차림, 유적군락 그리고 기타 인공림들이 소규모 patch로 분포하고 있었다. 단위면적당 patch의 수는 이차림요소가 인공림요소보다 많았으며, patch의 크기는 그 반대의 경향이었다. 경관요소유형별 유관속식물의 종풍부성은 patch의 크기와 양의 관련이 있는 것으로 판단되었다. 경관생태학적 검토결과, patch의 분화는 군락수준에서는 인위적 간섭이, 군이나 소군 등 하위군락수준에서는 자연적인 천이과정이 주로 관계하고 있는 것으로 생각되었다.

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INTRODUCTION

Forest vegetation and its landscape structures of urban area are established and changed under the influence of artificial interference and human activities(Kamada et al., 1991). Actual vegetation reflects not only characteristics of natural environment but also the past and present land-use patterns in a given area(Kamada and Nakagoshi, 1996). Results of land-use are shown in distinct types, such as residential area, plantation, agricultural field, the area used for facilities, etc. and also in secondary effects induced from those uses as well(Lee et al., 1998a). That is, vegetation structure formed by characteristics of natural effects of human, and such changes are remarkable in urban area(Taoda, 1979 ; Lee et al., 1998a).

Classification and mapping of the forest vegetation are indispensable subjects in clarifying the land-use pattern of the past and in preparing the plan to maintain vegetation as an ecologically, healthy state in a given area. Landscape pattern can influence a variety of ecological phenomena, like population or community structure(Danielson, 1991 ; Pulliam et al., 1992). Landscape structure is maintained or changed under a balance of the effectiveness between natural and anthropogenic disturbances. The dynamics of structural change as the relative importance of these disturbances change under different human-land relationships. In a human dominated region, anthropogenic factors are a more prominent force altering landscape structure than natural disturbances(Kamada et al., 1991 ; Bastian and Bernhardt, 1993). The landscape structures, for example the number and size of patches, are changed as a resultant with a social change.

Generally, forest ecosystem of the urban area become simpler in function and composition and fragmented in size as one approach the urban core where human influences increase. Isolated fragments in an urban environment often are too small to sustain populations of species for very long. Forest vegetation develops in harsh environments and human interferences. A delicate balance between social and natural environments maintains the urban forest and it often contained a characteristic flora and fauna. Forest communities form in a slow process of succession and are very sensitive to environmental conditions. For these reasons and others, urban forests have much scientific value, both in forestry and in landscape ecology.

International attention to forest and forestry has recently focused on degradation and protection of the urban forest. From this point of view, urban forest are as noteworthy ecosystems as coral reefs, mire vegetation and tropical rain forests. Therefore, to document and understand vegetation units and landscape structures of urban forest are very important. The area of the urban forest in Korea is relatively small compared with that of mountain forest. The forest in the urban core is usually isolated and has a low biodiversity in comparing with that of suburban area or mountain area. There are several studies concerning the urban forest vegetation in Korea(Lee et al., 1995 ; Cho, 1997).

However, there are few reports quantifying and mapping in detail of urban forests in Korea. In particular, there are no works on these topics in the view of landscape ecology. For these reasons, this study was designed to examine recent conditions in the isolated forestland of the urban area.

The forests in an urban area offer many opportunities to maintain and enhance local and regional biological diversity(Anderson, 1993). The forestland of an urban area exist as part of an ecosystem and need to be managed as an ecosystem, and it is certainly complex and dynamic systems of many natural resources more than a collection of trees. And thus, it is necessary to assess and categorize forest vegetation, the representative components of the forestland for restoration and maximization of the ecological function in the forestland of an urban area with minimizing costs in the view of landscape ecology. The spatial distribution map separated by the vegetation units in detail also needs(Burgess and Sharpe, 1981 ; Kursten, 1993 ; Cho et al., 1995). A detailed vegetation mapping provide the information for a tool and methods available to look at, study and map the forest resources in cities(Kuchler, 1967 ; Hampe, 1982 ; Toyohara, 1984).

The objectives of this study were to classify vegetation units and to prepare a detailed mapping of forest vegetation units of Mt. Inwang, a isolated forestland, located in the core of Seoul city, Korea, as a sample site in the view of landscape ecology. Reported here are descriptions of vegetation units classified and a detail mapping for the spatial distribution of vegetation landscape and the landscape structures in terms of the kind, number and size of patches.

STUDY AREA AND METHODS

The study area chose is a forest islands in the center of Seoul, the capital city of Korea. It lies at longitude 126° 59′ east and latitude 37° 34′ north. And attains a height of 338.2m at elevation(Fig. 1). Its forest area is about 210ha. Its climate is intermediate between the continental and oceanic climates, making the weather very warm and rainy in the summer and cold and dry in the winter, with an average annual temperature of 11.8℃. Average annual rainfall is 1,370㎜ and is slightly higher than 1,274㎜, the average of the country(KMA, 1997).

Most of the forests are secondary forests and artificial plantations, which have been strongly influenced by human activities. Natural forests have mostly been destroyed and replaced by substitution communities such as secondary forests, artificial plantations and others. *Pinus densiflora* forest and *Robinia pseudo-acacia* plantation occupy most of the forests, and they are estimated to cover as wide as 84.8% of the forest area in Mt. Inwang. *Stephanandra incisa*, *Spodiopogon sibiricus*, *Zanthoxylum schinifolium*, *Rhododendron* spp., and *Lespedeza* spp. is a representative of understory vegetation.

A phytosociological survey of vegetation(Braun-Blanquet, 1964) was conducted in 1998. Plots were selected only at the most typical segment of the homogeneous community. All vascular plants in the plot were recorded and assessed for dominance in six degree(+ to 5) and sociability

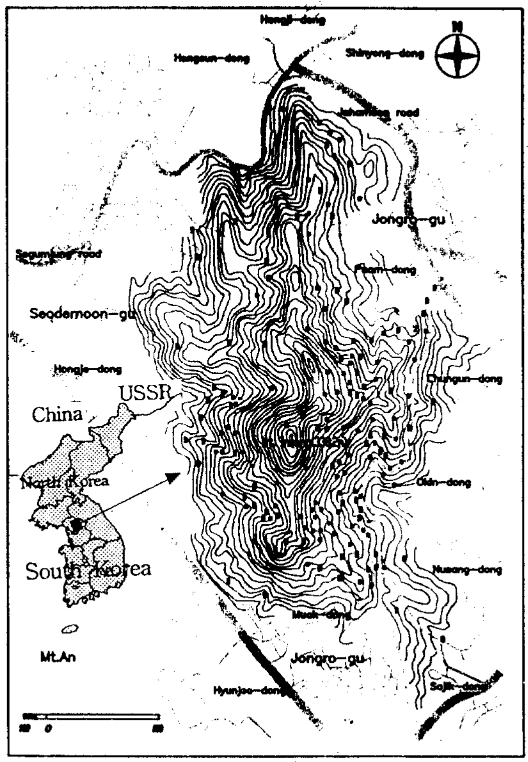

Fig. 1. Map showing the study area. Black marks indicate the sampled plots.

in five degrees(1 to 5). The taxonomic nomenclature of species followed Lee(1985). The classification of forest vegetation units is based on floristic-structural releves, which were established using the floristic-physiognomic approach introduced by Braun-Blanquet(Braun-Blanquet, 1964 ; Muller-Dombois & Ellenberg, 1974). Vegetation units graded community in higher unit, group in middle unit, and subgroup in lower unit. The higher units based on physiognomy and rarity of forest plant communities. The middle and lower units based on species composition and structure. A detailed vegetation map including land-use pattern was made by 1998 aerial photographs and field survey referring to the phytosociological method(Braun-Blanquet, 1964), which mainly based on the spatial distribution of vegetation landscape, so called vegetation units. In addition, using the vegetation map, all forest patches were classified and the number and size of patched landscape elements measured.

RESULTS AND DISCUSSION

1. Classification of the forest vegetation units in the study area

The study area is mostly covered with secondary forests and plantations. The vegetation units of the forests studied in the study area can be divided into ten communities with correspond to the association or relict community, and they are further subdivided into ten groups which correspond to the subassociation, and eight subgroups which correspond to the variants. A description of the vegetation units and their subordinate units is made as follows(Table 1, Fig. 2).

Secondary forests : four communities, eight groups, and four subgroups

These forests are widely distributed above the middle part of slope, and mostly developed on relatively dry sites such as the most steep and rocky sites. *Pinus densiflora* community is the widest patch community in size, and developed on the most steep and rocky sites all over the slope. This once was the most broadly distributed throughout the study area. In the present time, however, it has mostly been destroyed and replaced by substitution communities such as *Robinia pseudoacacia* plantation, *Quercus acutissima* community, and others due to human interferences, fire, and cutting. The tree layer is only dominated by *Pinus densiflora*. The floristic composition of the understory showed very poor. *Pinus densiflora* community established on the outcrop of the ridge part is recognized as an edaphic climax(Lee, 1995a, b).

Quercus acutissima community is developed on the moderate sites with relatively deep soil, and Miyawaki et al.(1978) identified *Quercetum acutisimo-serrate* association in Japan. *Prunus levellina* community is mostly developed on the moderate dry to mesic sites at lower elevation (<150m), but can be ascend to higher elevations along valley slopes. *Sorbus alnifolia* community is mostly developed on the steep slopes, moderate dry to xeric sites.

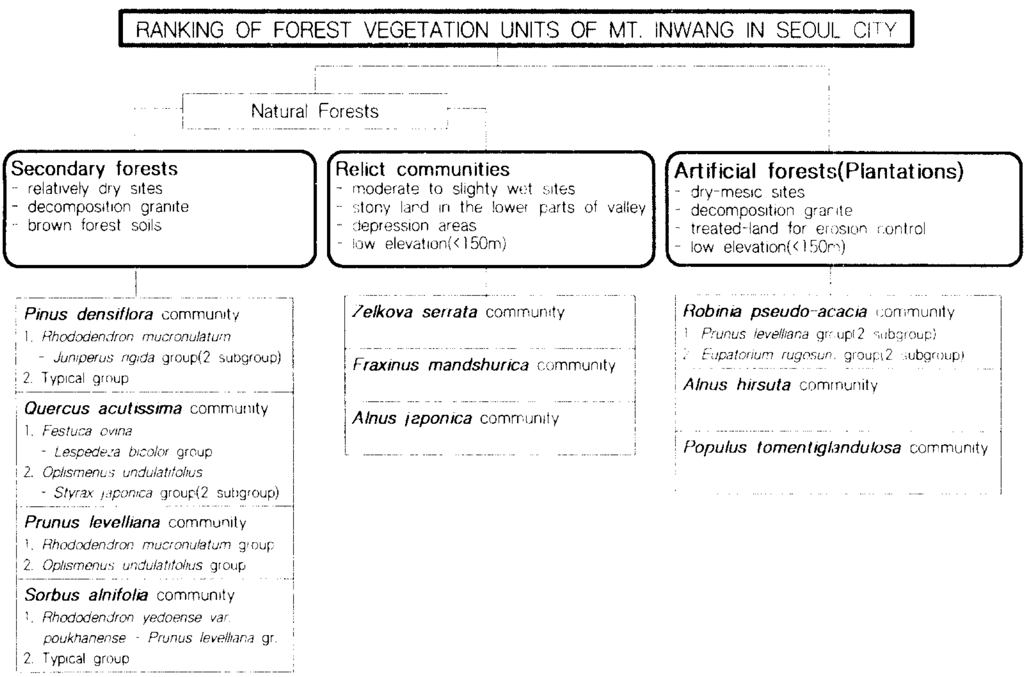

Fig. 2. Forest vegetation units of Mt. Inwang in Seoul and their hierarchy in classification(refer to Table 1).

Table 1. Flioristic composition table of forest vegetation in Mt. Inwang.

Ⅰ. *Pinus densiflora* **community**
Ⅰ-A. *Rhododendron mucronulatum-Juniperus rigida* group
Ⅰ-A-1. *Rhododendron yedoense* var. *poukhanense-Quercus mongolica* subgroup
Ⅰ-A-2. Typical subgroup
Ⅰ-B. Typical group

Ⅱ. *Quercus acutissima* **comm.**
Ⅱ-A. *Festuca ovina-Lespedeza bicolor* group
Ⅱ-B. *Oplismenus undulatifolius-Styrax japonica* group
Ⅱ-B-1. *Parthenocissus tricuspidata* subgroup
Ⅱ-B-2. Typical subgroup

Ⅲ. *Prunus levelliana* **comm.**
Ⅲ-A. *Rhododendron mucronulatum* group
Ⅲ-B. *Oplismenus undulatifolius* group

Ⅳ. *Sorbus alnifolia* **comm.**
Ⅳ-A. *R. yedoense* var. *poukhanense-Prunus levelliana* group
Ⅳ-B. Typical group

Ⅴ. *Zelkova serrata* **comm.**

Ⅵ. *Fraxinus mandshurica* **comm.**

Ⅶ. *Alnus japonica* **comm.**

Ⅷ. *Robinia pseudo-acacia* **comm.**
Ⅷ-A. *P. levelliana* group
Ⅷ-A-1. *Celastrus orbiculatus* subgroup
Ⅷ-A-2. Typical subgroup
Ⅷ-B. *Eupatorium rugosum* group
Ⅷ-B-1. *Rosa multiflora* subgroup
Ⅷ-B-2. *Ailanthus altissima* subgroup

Ⅸ. *Alnus hirsuta* **comm.**

Ⅹ. *Populus tomentiglandulosa* **comm.**

	Natural vegetation																		Artificial vegetation					
	Secondary forests															Relict communities			Plantations					
	Ⅰ				Ⅱ				Ⅲ			Ⅳ				Ⅴ	Ⅵ	Ⅶ	Ⅷ				Ⅸ	Ⅹ
Vegetation units	A			B	A		B		A		B	A			B				A		B			
	1		2		1	2	1	2											1	2	1	2		
Species richness	63	65	34	17	40	49	17	20	25	38	54	28	32	24	24	13	14	10	71	46	55	44	34	17
Introduced plants	1	1			1		1				3				1				1	3	5	4	1	
Naturalized plants	7	5	3	1	5	3	1	2	1	4	5	1	3	2	3	1	1	1	7	9	5	6	6	2
1 *Pinus densiflora*	V15	V14	V34	12	31	V+1			1+	V1	III+1	3+1	1+	21	+1				IV+2	III+1	I1	II1	III1	
2 *Rhododendron mucronulatum*	IV13	V+3	III13		11	III+2		1+	21	V+2		2+2	12	11	++				I2	III+1			III+1	
Juniperus rigida	II+2	III+2	III+2			III+				II+1				1+		1+			I+	I+1		II+		
Cymbopogon tortilis var. *goeringii*	I12	I+	III+												1+									
3 *Rhododendron yedoense* var. *poukhanense*	III+2	IV+2			2+1	III+2		1+	3+3	II+		2+1	31	213		1+			II+2					
Quercus mongolica	III+1	IV+2			..	III+3			2+1	I1		1+	11	21						I+	+		I+	
Rhus chinensis	III+	II+1			3+2	IV+				+				1+	2+				I+	I+	II+1			
4 *Quercus acutissima*	IV+1		V+3		34	V35	234	34	2+1	II+2	II+		21	2+2			+	1	IV+2	I1	II+1			
5 *Lespedeza bicolor*	V+4	V+3	V13	11	3+2	V+3			2+2	IV+2	II1	3+1	2+2	2+2	3+				V+2	II+2	II+	II+	II+2	
Festuca ovina	IV+2	I+1			312	II2						1+			2+				III+2	I+	+	II+		
6 *Styrax japonica*	I12	I+1	II13			1+	234	323	3+3	I+	V+4		2+1	12		223	+		I+	II+1	II3			
Oplismenus undulatifolius							213	2+			V+2						1		I1	I+1	II+1			
7 *Parthenocissus tricuspidata*	II+1	II+2	II+1		1+	IV+	213		11	III+1	V+2	2+	3+2				2		II+3	III+3	I+	III+1	III1	
Persicaria blumei							2+1				II+								I+	II+	II+3			
8 *Prunus levelliana*	V+2	III+3	V+2		21	III2	11	313	334	V35	V14	312	212	12		21	1	1	IV+2	III12	I+		III1	
Symplocos chinensis var. *pilosa*	I+	II+				I+		2+	2+2	III+1	II+	1+	11						I+					
Smilax sieboldii	I+	I+			1+	II+		1+	3+1	III+1	III+1		2+	1+	1+	1+			I+	I1		IV+	II+1	
Callicarpa japonica	I+	II+	I+		1+	II+			2+	II+	III+2	2+	21	1+			+		I+	II+1	II+	III+	II+	
9 *Sorbus alnifolia*	III+2	III+3	V+4		12	V+2	11	323	324	III1	IV+1	334	44	24	445	212	+	2	I+2	III+3	II+1		II+	
10 *Zelkova serrata*								11								25			I+					
11 *Fraxinus mandshurica*											I1						5							
12 *Alnus japonica*							12											5			I+			
13 *Robinia pseudo-acacia*	IV+3	I+3	IV+1	1+	11	V12		213	2+	II+2	II1		21	2+1	21	2+1	1	1	V35	V+5	V45	V15	V1	
14 *Celastrus orbiculatus*	I+2	II+	I1	1+	1+	II1				II+	I+	2+							IV+2		II+1	V+1	II+2	
Melica onoei	I+	I+			2+1	II+		1+		II+	III+	1+	2+	1+			+		IV+2		II+	IV+	I+	
15 *Eupatorium rugosum*		I+					1+				II+1									II+2	V14	V14	II+	+
Ambrosia artemisiifolia var. *elatior*	I+1	I+			11										1+					II+	V12	IV+		
Chenopodium ficifolium											I+									II+2	V+2	IV+		
16 *Ailanthus altissima*	I+	I1	I+				1+				I+								I+	I+1	I+	IV+2	I+	+
17 *Alnus hirsuta*	III+3	I1	II+			II+		2+		III12	II12		11	11	21				II+4	III14		II4	V4	
18 *Populus tomentiglandulosa*																				I2		II+		3
19 *Stephanandra incisa*	II+2	IV+4	II+5		11	III13	213	334	223	V24	V14	2+	413	11	2+1	223	3	1	II13	V+5	II+1	IV35	V35	1
Spodiopogon sibiricus	IV+2	IV+2	III+2	12	21	V+1		3+1	3+2	V+1	II+1	3+	3+2	21	4+1	11			IV+3	IV+2	IV+1	IV+	IV+1	1
Zanthoxylum schinifolium	V+2	V+2	II+	1+	1+	V+1	1+	2+	3+	V+3	III+1	2+	3+1		3+1	1+			III+3	III+1	IV+	III+	IV+1	+
Arundinella hirta	V+2	IV+2	V+2	1+	2+1	II+			11	III+		1+	3+1	2+	2+				III+2	II+	I+	III+	III+2	
Cocculus trilobus	IV+2	IV+3	II+1	1+	21	V+2			2+1	III+2	II+1			11	2+				IV+3	III+3	II+	III+	V+3	
Commelina communis	III+1	I+1		11	3+1	II2	11			I+	III+1	2+			2+		1		IV+3	III+2	V+2	V+3	II1	+
Rubus crataegifolius	III+2	II+	III+			IV+	1+	1+		II+1		2+	1+			1+			III+2	II+	III+1	IV+1	II+1	
Carex lanceolata	III+1	I+		1+	11	IV+		2+1	11		II+	1+		2+1	2+		+		II+1	I+	II+1			
Lespedeza cyrtobotrya	III+2	II+2	III+1	11	11	III+2			11	III12	II+1	1+	1+2	2+1	2+	1+			II+1	II+1	I+	I+	I+	
Clerodendron trichotomum	II+1	I+			1+	II+		I+	2+	III+2		1+		11					III+1	I+				
Rhus trichocarpa	I+	II+1	I1			II+				II1	III1	2+	11				1		I+	I12	I+		I1	
Weigela florida	IV+1	III+1	II+		2+	II+				III+	II1	1+	3+1						II+2	I+			I+	
Quercus serrata	II+	I+	II+1			III+1			1+	I1					1+				I+	I+	I+		I+	
Artemisia keiskeana	I+1	I+	I1			III+				I+		2+	1+		1+				II+3					
Lindera obtusiloba		I+1	II+						2+	II+	Ir		2+1	1+					I+	I+				
Artemisia princeps var. *orientalis*		I+			1+	II+	1+					1+							I+1	I+	II+1	V+	I+	
Smilax china	I+	I+			1+	I+		.2		I1	I+								I+		I+			
Athyrium yokoscense		I+				II+				III+	III+2		2+2				+		I+	II+				
Amorpha fruticosa	III+1				13					I1		1+						+	III+2		III+2		I2	
Quercus aliena	II+1	I+		13						II+1										I+	I1	III1	I+	+

note : 123 species omitted

Relict communities : three communities and no subordinate units

These communities are relicted to the lower parts of the valley of the area, and mostly developed on the moderate to slightly wet sites, stony land. *Zelkova serrata* community is a topographic or edaphic climax in the area, and one of relict community representing the forest vegetation of the valley parts. This was orginally described *Q. aliena-Zelkova serrata* community(Choi and Park, 1985), *Celtis sinensis-Zelkova serrata* community(Choi and Park, 1985), *Zelkova serrata-Prunus padus* community(Kim and Kim, 1986), *and Acero-Zelkovetum serrate* assoc. nov.(Kim and Yim, 1988). *Fraxinus mandshurica* community is mostly developed on the site conditions smiliar to *Zelkova serrata* and *Prunus padus* community. *Alnus japonica* community is mostly developed on the lower parts of the slope and mesic stony sites at lower elevation.

Plantations ; three communities, two groups, and four subgroups

Robinia pseudo-acacia plantation is widely distributed throughout the area, and mostly planted on the lower or middle parts of slope at lower elevation(<150m) for erosion control. Many species of the naturalized plants such as *Phytolacca americana* and *Ambrosia artemisiaefolia*, are often found and ecologically distributed by human interferences. This seems to be changed into *Q. serrata* forest due to the development of the young trees of *Q. serrata*. *Poplus tomentiglandu-*

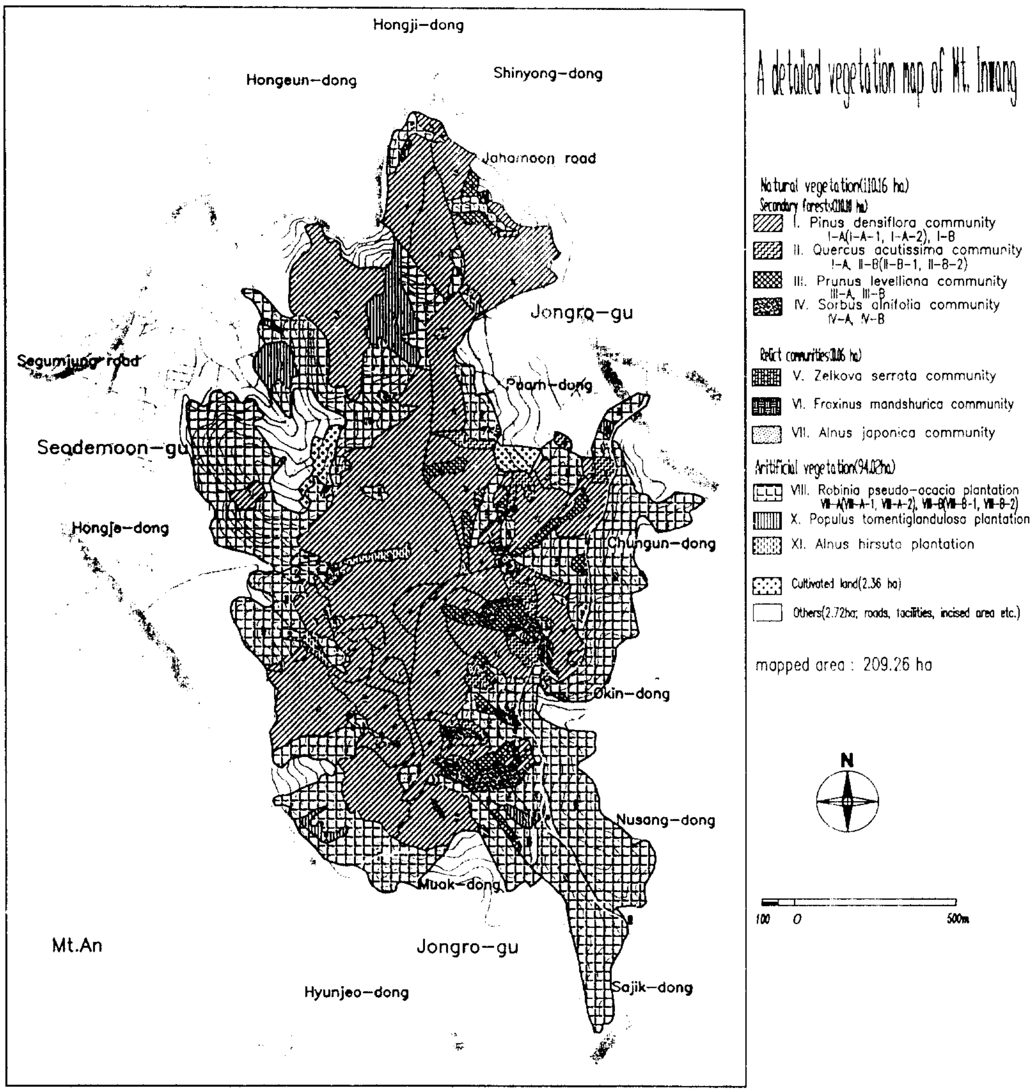

Fig. 3. A detailed vegetation map of Mt. Inwang in Seoul, Korea.

losa plantation is mostly planted on the lower parts of slope or near valley, and inclined to fall down of itself due to its ecological age. This plantation seems to be changed into *Q. serrata* forest. *Alnus hirsuta* plantation is locally distributed on the belt type of small patch in the area, and mostly developed on the moderate dry to mesic sites at lower elevation(<150m). This seems shortly to be declined due to its ecological age in the sites and disease and insects. This seems to be changed into *Q. serrata* forest according to site conditions.

2. A detailed vegetation mapping and its landscape ecological review

As a sample of the basic map for the ecological conservation and management of vegetation landscape of isolated forests, A detailed vegetation map at a scale of 1 : 5,000 was made in the study area, based on floristic composition and structure of the vegetation units, by the phytosociological methods. In drawing units, community level(landscape element type) showed by the borderline and color, the group level by the patterns, and the subgroup level, which are the lowest units, by serial numbers.

Total area for detailed mapping was 209.27ha, of which *P. densiflora* community accounted for 91.12ha, the largest portion, *R. pseudo-acacia* plantation for 86.39ha, and non-forested area including barren, facilities, roads, and others for 2.72ha. The survey area consisted of natural vegetation(secondary forests 110.10ha, relict communities 0.06ha) and artificial vegetation(94.02ha), and the ratio of natural forest element showed 55%.

The other secondary forests and plantations tend to distribute as small patches in matrix of *P. densiflora* community and *R. pseudo-acacia* plantation. A number of native species consisting potential natural vegetation is established in substratum of plantations existing as huge matrix.

From this result, I could predict change of landscape with the progression of succession(lee et al., 1998). *Zelkova serrata* community, *Fraxinus mandshurica* community, and *Alnus japonica* community, relict community elements, exists as a remnant patch in the valley around INWANGSAN ROAD, being protected as a military affairs. Patches of them reducing landscape element suggest reduction of their dimension (Forman and Gordon, 1986).

The landscape element types(LES) identified from the vegetation map is summarized in Table 2. LES of Mt. Inwang were identified as secondary forest occurred from natural succession, relict communities, introduced plantation element for erosion control, and other elements including residential area, road, facilities of diverse types, and so on. Secondary forest element was composed of *P. densiflora* community, *Q. acutissima* community, *Prunus levelliana* community, and *Sorbus alnifolia* community. Dominant landscape element type among them was *P. densiflora* community. Relict community element was composed of *Z. serrata* community, *F. mandshurica* community, and *A. japonica* community. Introduced plantation element was composed of *R. pseudo-acacia* plantation, *Alnus hirsuta* plantation, and *Populus tomentiglandulosa* plantation, dominant element of which was *R. pseudo-acacia* plantation. *R. pseudoacacia* is a representative plant species introduced for erosion control of devastated forest in Korea. *Q. acutissima* established naturally or artificially after fire, which developed on the lower parts of slope. Other elements including residential area, military facilities, road, graveyard, incised land, etc. are distributed throughout the study area but are concentrated on the lower parts of slope or valley and roadside. On the other hand, urbanized area centered on residential area is mostly restricted on the lower parts of the mountainous area.

3. The number and size of patches

The landscape element types identified from the detailed vegetation map(Cho et al., 1998) are summarized in Table 2. The number and size of patches reflect the intensity of disturbances caused by both nature and man in the human-influenced landscape, and hence they become indices reflecting the intensity of disturbance(Turner, 1989 ; Forman and Gordon, 1986 ; Hong *et al.*, 1995 ; Raedeke and Raedeke, 1995). The vascular plant

Table 2. The configuration of landscape elements identified from the detailed vegetation map of Mt. Inwang

Landscape element types	Total area (ha)	Number of patches	Mean size of patches(ha)	Species richness
Natural vegetation				
Landscape element types of secondary forest				
Pinus densiflora community	91.12(43.54)	7	13.02	97
Quercus acutissima community	9.92(4.74)	16	0.62	81
Prunus levellina community	5.70(2.72)	18	0.32	81
Sorbus alnifolia community	3.36(1.61)	10	0.34	55
Subtotal	110.10(52.62)	51	2.16	(139)
Landscape element types of relict community				
Zelkova serrata forest	0.03(0.01)	1	0.03	13
Fraxinus mandshurica forest	0.02(0.01)	1	0.02	14
Alnus japonica forest	0.01(0.00)	1	0.01	10
Subtotal	0.06(0.03)	3	0.02	(29)
Artificial vegetation				
Landscape element types originated in forestry				
Robinia pseudo-acacia plantation	86.39(41.28)	23	3.76	132
Populus tomentiglanadulosa plantation	6.26(2.99)	9	0.69	34
Alnus hirsuta plantation	1.37(0.65)	6	0.23	17
Subtotal	94.02(44.93)	38	2.47	(132)
Landscape element types originated in agriculture				
Cultivated land	2.36(1.13)	3	0.79	
Others(road, facilities)	2.72(1.30)	2	1.36	-
Total	209.26(100)	97	2.16	175

species richness of the landscape element types in Mt. Inwang was found to be positively related to their size.

Percentage occupied by the naturally developed patches among the total number of patches (52.65%) was a little more than that of the introduced elements(44.93%). The number of *R. pseudo-acacia*, *Prunus levelliana*, and *Q. acutissima* patches was particularly numerous and occupied 23.47%, 18.37%, and 16.33% of total number of patches, respectively.

Causal factors of patch differentiation, viz. landscape fragmentation can be recognized by comparing the number of patches per unit area of each landscape element(Lee *et al.*, 1998a). When the number of patches per unit area between natural forest elements and introduced ones is compared, mean number of patches of the former was lower as 7.25 than that of the latter of 12.67. Natural vegetation patches are emerged patches or remnant patches with the progression of succession and military affairs in this study area(Forman and Gordon, 1986). From those results, we could know that causal factor of landscape fragmentation would be related to the development of succession process and remnant patches. Such result showed similar one to that obtained from the other areas of Seoul, in which excessive artificial interference were causal factors of landscape fragmentation(Lee *et al.*, 1998a).

On the other hand, the mean size of patches per landscape element type was similar between secondary forests(2.12ha) and plantations(2.47ha). The mean size of patches of Relict communities was 0.02ha. Especially, *P. densiflora* community protected by the military affairs and topographic characteristics, which showed the greatest size among all of the landscape element types.

That is, the size of patches in the lower part of mountainous area near the urbanized area was showed the lager one than those in the mid-slope and the upper parts. From this result we could know that differentiation of patches in community level in isolated areas like the present study area was dependent on artificial interference.

But the results compared on the basis of the number of patches identified in the level of lower communities, group or subgroup showed some different ones from those in community level. That is, the number of patches decreased as approaching to the urbanized area. Such results would be related to the causal factors of differentiation of patches in sub-communities levels. Most patches in sub-communities(groups) levels seems to be originated from the natural process like progression of succession considering that vegetation of this study area, especially artificially planted ones under mild artificial interference were succeeding to natural vegetation(Cho and Lee, 1998). In fact, that the number of patches in group levels in distant sites from the urban area, in which artificial interference was mild, was more than that in near sites from that area under severe artificial interference prove such estimation.

From those results, we could judge that patches in community level recognized as homogeneous pattern by aerial photograph were mainly introduced elements and those in sub-community levels were mainly regenerated ones originated from natural process of succession. In fact, the human have been continuously utilized forest around their living environment by traditional living methods and regulations since their birth on earth(Holzner *et al.*, 1983). Therefore, even though a forest was recognized as homogenous pattern by aerial photograph, its internal structure is changed to heterogeneous one by artificial interference or natural recovery after disturbances of diverse types(Kuchler and Zonneveld, 1988 ; Nakagoshi and Rim, 1988 ; Nakagoshi *et al.*, 1992 ; Forman, 1995 ; Zonneveld, 1995).

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