The Characteristics of Post-fire Areas by Stand Structure and Topographical Factors

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Abstract

This study was carried out to support the development of forest management systems in post-fire areas because the relationships between stand structure and topographical factors and forest fire causes have been highlighted in South Korea since Kosung forest fire in 1996. With the data obtained from surveyed post-fire areas (5 areas: Gosung-gun, Eastern coastal region, Yesan-gun, Cheongyang-gun, and Yangyang-gun), stand structure and topographical factors were analyzed using 'Quantification theory (I)'. The damages after forest fire in the broad-leaved and mixed (coniferous + deciduous) forests were lower than those *Pinus densiflora* stand and other one which showed high stand density. As a result of this quantification analysis, main factors that would influence on the degree of forest fire damages were high in the order of forest type (*P. densiflora*), slope (30°≤), crown density (low), and so on. In the partial correlation analysis between forest fire damage and topographical factors, high significant differences were shown in the order of stand density, forest floor, slope, whereas aspect was not.

Introduction

Forest fire causing enormous ecological and economic damage is one of the major disturbances in vegetation distribution. In Korea, forest fire is largely determined by climatic conditions; long and dry winter and local wind (Quasis-foehn) especially in east coast region. Consequently, a small flame can potentially lead to severe forest fire with rapid spread. Most of forest vegetations in Korea were classified into pure pine forest and mixed (coniferous + deciduous) forest, therefore it seems to be high in the risk of forest fire occurrence. However, there is still a lack of information about the interaction between post-fire areas and stand structure and topographical factors. The objective of this study was to investigate the relationship between post-fire areas and the stand structure and topographical factors.

Materials and Methods

Five post-fire areas were selected in Gosung-gun, Eastern coastal region, Yesan-gun, Cheongyang-gun, and Yangyang-gun where forest fire was occurred in 1996, 2000, 2002, 2002 and 2005, respectively. To analyse damage intensity after forest fire by stand structure and topographical factors, we investigated site index, tree age, number of trees, height, DBH and volume in selected post-fire areas. After that, the relationship between forest fire damage intensity and stand structure and topographical factors were analyzed with 'Quantification theory (I)' and partial correlation analysis using SAS.

Table 1. Classification of category for stand structure and topographical factors.

Item	Category
Altitude	Topographical map of 10m unit
Aspect	North, South, East, West
Slope(°)	30° < , < 30°
Forest type	Pure pine forest, Mixed conifer and broad-leaved forest Mixed oak forest, Mixed broad-leaved forest
Local topography	Hilltop, Hillside, Foot of hill, Plain
Crown density	Dense, Medium, Sparse
Stand density	0.1 ~ 0.5, 0.6 ~1.0, 1< 3
Degree of damage	No. of dead trees / No. of total trees

Results and Discussion

Most stand structure in post-fire areas consisted of conifer forests and mixed broad-leaved forests. The forest fire damage intensity observed in mixed broad-leaved forests were low compared to *P. densiflora* forests and other stand with high stand density. The reason was that mixed broad-leaved forest was mainly composed of fire resistance species for example of *Quercus variabilis* and *Q. mongolica*. Pure pine forest showed the highest damage intensity by forest fire irrespective of stand structure although the variable of stand structure in pure pine forest was negatively correlated with forest fire occurrence.

Table 2. Score table of stand structure and topographical factors in post-fire areas.

Item	Category	Estimate	Standard error	t-Value	Pr>|t|	Range
Constant	Intercept	86.3	15.7	5.5	<.001	
Forest type (X1)	*Pinus densiflora*	-14.9	12.0	-1.3	0.219	40.96
	Mixed oak forest	-27	17.4	-1.6	0.129	
	Broad-leaved forest	-40.9	15.1	-2.7	0.010	
	Mixed conifer and broad-leaved forest	0				
Altitude(X2)	<100m	2.4	9.2	0.26	0.792	8.29
	<200m	8.3	10.3	0.8	0.427	
	200-400m	4.0	10.2	0.4	0.694	
	400m <	0	0	0	0	
Aspect(X3)	East	-2.8	10.6	-0.3	0.794	4.16
	West	-3.9	8.8	-0.4	0.662	
	South	0.3	8.9	0.03	0.973	
	North	0	0	0	0	
Slope(X4)	30 <	15.3	7.3	2.09	0.043	15.27
	30 >	0	0	0	0	
Local Topography (X5)	Hilltop	5.1	9.2	0.55	0.583	9.77
	Plain	-1.1	11.9	-0.1	0.928	
	Foot of hill	8.7	8.9	0.97	0.336	
	Hillside	0	0	0	0	
Crown density(X6)	Sparse	10.7	9.4	1.13	0.263	10.68
	Medium	7.4	10.1	0.74	0.466	
	Dense	0	0	0	0	
Stand density (X7)	0.1-0.5	-56.2	14.1	-4	3E-04	57.5
	0.6-0.9	1.5	8.1	0.19	0.854	
	1<	0	0	0	0	

The quantification theory was applied to establish the relations between forest fire damage intensity and stand structure and topological factors in post-fire areas, which were divided into 26 sub-categories. These sub-categories were used to establish the category of score and range in statistical analysis. The results suggest that main factors that would influence on forest fire intensity ranging from 57.5 to 4.16 were high in the order of forest type (*P. densiflora*), slope (30°≤), crown density (low), and so on.

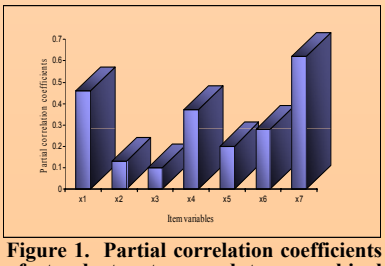

Figure 1. Partial correlation coefficients of stand structure and topographical factors for forest fire damage intensity.

In the partial correlation analysis between forest fire damage and topographical factors, high significant differences were shown in the order of stand density, forest floor, slope, whereas aspect was not.