短報（Note）

Characteristic Differences of Non-Reforested Lands Compared with Reforested Lands in Kumamoto, Kyushu

NODA Iwao[1)*] and HAYASHI Masahide[1)]

Abstract

Japanese forests have been maintained by reforestation after harvest. Recently, timberlands without reforestation or with poor maintenance have been increasing, because forest owners are faced with the lack of successors and severe economic conditions such as low timber prices. Such forests should not be disregarded for land conservation and sustainable forestry. It is important to reveal quantitatively the characteristics of non-reforested land to elucidate the variables causing them. We analyzed the differences between non-reforested land and reforested land in five variables: steepness of slope at forest site, altitude of forest site, distance from forest road, categorized site class and the grade of absenteeism, related to timber production in Kumamoto which is facing these issues. As a result, the frequency distribution of non-reforested land differed significantly from that of reforested land. The slope variable affected the occurrence of non-reforested land after harvesting the most, followed by absenteeism. We estimated the prediction model of non-reforested land occurring with these two variables and the ratio of correct classification was 70.7%. The probability of non-reforested land occurring when forest owner lives in a village/town different from his forest is 1.8 times that when he lives in the same village/town as his forest.

Key words : private forest ownership, non-reforestation, absentee forest owner, sustainable forest management, multivariate analysis

INTRODUCTION

Private ownership accounts for 58% of the forest area and 65% of the plantations in Japan. Therefore, the private sector plays an important role of Japanese forestry. As of March 1999, 20% of the harvested sites, 109,000ha, Japan had been left without reforestation more than three years after harvesting (Forestry Agency, 2001). Timberlands without reforestation after harvesting or timberlands without tending operations such as thinning are increasing (Forestry Agency, 2001). The former, especially, may cause land erosion, if the condition of the site is poor. Sustainable forest management and regional economy may also be disturbed. In the Kyushu district, there are many logging contractors who practice harvesting in a large unit size to reduce the cost to compensate for low timber price, often without subsequent reforestation (Yabe, 2002). In Kumamoto Prefecture, Kyushu, a logging contractor needs more than 4 ha to make profit. Therefore the increase of non-reforested land after harvesting is now seriously affecting sustainable forest management (Sakai, 1999). Noda and Hayashi (2003) reported factors concerning forest ownership affected the reforesting besides the cost factor. However, these details in Kumamoto have not been reported.

Aou et al. (2002) showed that the non-reforested land was often closer to a forest road, but there was no significant differences in site conditions: site slope, distance from forest road, site class, between reforested land and non-reforested land in Ume Town and Saiki City, Oita Prefecture, Kyushu, using GIS. Studies in other areas, however, might be necessary to clarify the characteristics.

Here, we investigated the differences between the non-reforested land and reforested land, and analyzed the variables using the data obtained in the Kumagawa river regional forest planning area (forest area 172,000ha), south of Kumamoto with three cities, six towns and nine villages as of 2000.

MATERIALS AND METHODS

We used the forest register, the subsidies data for reforestation activity and the non-reforested land survey reports (Kumamoto Pref., 1999,2001). The forest register is useful for forest resource management and has information concerning ownership, stand age, area size and site variables of each forest subcompartment.

The data on reforested land can be extracted with the subsidies data, because the public government in Japan subsidizes most reforestation activities. Previously, we made a database of non-reforested land (1998-2000) based on the findings of the non-reforested land surveys executed by the prefecture, and database of reforested land (1998-2000) based on the subsidies data. The data set for the following analysis was prepared by building the relational database with two databases and the forest register. The number of

原稿受付：平成 15 年 10 月 1 日　Received Oct. 1, 2003　　原稿受理：平成 15 年 12 月 24 日　Accepted Dec. 24, 2003
＊ Forest Resources Management Group, Kyushu Research Center, Forestry and Forest Products Research Institute (FFPRI), 4-11-16 Kurokami, Kumamoto 860-0862, Japan; e-mail: noda12@ffpri.affrc.go.jp
1) Forest Resources Management Group, Kyushu Research Center, Forestry and Forest Products Research Institute (FFPRI)

subcompartments in the data set was 1492 consisting of 804 non-reforested sites and 688 reforested sites.

For quantitative analysis, we used the following five observed variables: steepness of slope at forest site (SLOPE), altitude of forest site (ALTITUDE), distance from forest road (DFR), categorized site class (SC) and the grade of absenteeism (GA)(Table 1). The SC is shown by classification into seven percentile groups with the same frequency of the site class estimated by the method of Forestry Agency (2002). The state of reforestation (SOR) was expressed as reforested land or non-reforested land.

GA shows whether the forest owner resides near his forest, and is classified into category 1 when the owner and forest are in the same village/town, 2 when they are in the same city/county, 3 when they are in the same prefecture, 4 when they are in different prefectures, and 5 when owner is unknown.

We applied Mann-Whitney test (*U* statistic) to examine differences between the frequency distribution of reforested land and that of non-reforested land. Furthermore, we conducted nonlinear canonical correlation analysis, which is also known by the acronym OVERALS (Gifi, 1990; SPSS, 2001) in order to examine the extent to which the observed variables were related to the occurrence of non-reforested land and the relation of each two or more variables to the occurrence. We applied OVERALS, because the method does not necessarily require a linear relationship between variables, and can treat nominal scale variables beyond numerical or ordinal. Next, we applied a logistic regression model using the influential variables to examine the variable effects as the odds ratio. In this model, the independent variables are the influential variables obtained by the above analysis and the dependent variable is whether the site is non-reforested or not. Statistical analysis was performed with SPSS 11 software package (SPSS Inc.).

RESULTS

Comparison of frequency distributions

Fig. 1 shows the frequency distributions and the ratio in the five variables. The result of Mann-Whitney test showed that the frequency distributions of non-reforested land differed significantly ($p < 0.001$) from those of reforested land in all the variables. The ratio of reforested land designates the frequency balance between reforested land and non-reforested land in the category of each variable. For example, the ratio of reforested land was 84 % of the felling sites where the slope was gentle (< 5 deg.), but only 6 % where the slope was over 15 degrees (Fig.1a). With the categories assumed as ordinal variables, SLOPE, DFR and ALTITUDE showed a significant strong negative correlation ($p < 0.05$) (Fig.1a, c, e) and GA, SC a weak negative correlation (Fig.1b, d). This means that the occurrence ratio of non-reforested land increased as the site condition became steeper/ higher altitude/ further from the road. Also, there was a tendency that non-reforested land occurred more frequently as the GA category or SC category increased.

Factors relating to occurrence of non-reforested land

We conducted OVERALS with two sets of variables. Set 1 consists of the five variables (SLOPE, GA, ALTITUDE, SC, DFR) as impact factors, and set 2 includes only SOR.

The results of OVERALS showed that the solution accounted for 75.6 % of the data, and the component loadings of SLOPE, GA, ALTITUDE, SC, and DFR were -0.830, -.0345, -0.254, -0.245, -0.228, respectively. The component loading corresponds to the importance of variables. Thus, the importance of impact variables for the occurrence of non-reforested land was in the order, SLOPE > GA > ALTITUDE > SC > DFR, and SLOPE and GA were especially important.

Fig. 2 shows the relationships among the categories with the multiple category coordinates according to the results of OVERALS. While the negative coordinate indicates non-reforested land, the positive coordinate indicates reforested land. The extent of coordinate shows the strength of the influence of each category on the SOR. A slope over 10 degrees was closely correlated to the occurrence of non-reforested land, especially a slope over 15 degrees showed a strong positive correlation with the occurrence. On the other hand, a gentler slope less than 5 degrees showed a strong positive correlation with the occurrence of reforested land, followed by a slope ranging from 5 to 10 degrees. GA was correlated with the

Table 1. List of the variables for the analysis and their categories.

x	Variables					
	SLOPE	GA	ALTITUDE	SC	DFR	SOR
1	< 5 deg.	The same village/town	< 200m	≦ 7	< 100m	Reforested land
2	5 - 10	The same city/county	200 - 400	8 - 9	100 - 200	Non-reforested land
3	10 - 15	The same prefecture	400 - 600	10	200 - 400	
4	15 ≦	Outside of the prefecture	600 ≦	11	400 - 600	
5		Unknown owner		12	600 ≦	
6				13		
7				14 ≦		

The *x* means category code. SLOPE: steepness of slope at forest site. GA:grade of absenteeism. ALTITUDE: altitude of forest site. SC: the site class estimated by the method of Forestry Agency(2002). DFR: distance from forest road. SOR: state of reforestation.

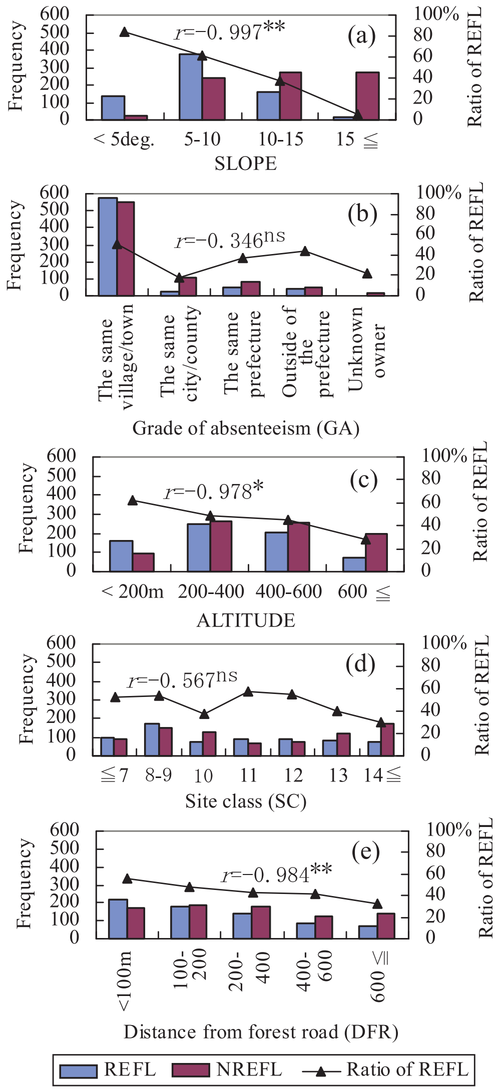

Fig. 1. Frequency distributions of non-reforested land (NREFL) and reforested land (REFL), and the ratio of REFL in five variables. *r* is Pearson's correlation coefficient between the ratio of REFL and ordinal category code. ** Significant at the 1% level; * Significant at the 5% level; ns Non-significant.

occurrence of non-forested land, especially when the owners did not live in the same village/town. A DFR of 400-600m and 600 ≦ and SC14 ≦ were also correlated to the occurrence of non-reforested land (Fig. 2d, e). On the contrary, ALTITUDE of < 200m and DFR of 100-200m and <100m were slightly correlated to reforested land (Fig. 2c).

SLOPE variable showed a significant weak positive correlation with ALTITUDE, DFR, and SC of 0.333, 0.190, 0.206, respectively (Kendall's *tau-b*, $p< 0.01$, n=1492). Thus, ALTITUDE and DFR showed characteristics somewhat similar to the SLOPE for the effects on the occurrence of non-reforested land (Fig.2a, c, e). Also, SC14 ≦ was associated to non-reforested land (Fig.2d). This means that the steeper slope sites were close to be non-reforested land even if they were in a better SC such as SC14 ≦ although the better SC is usually useful for timber producing.

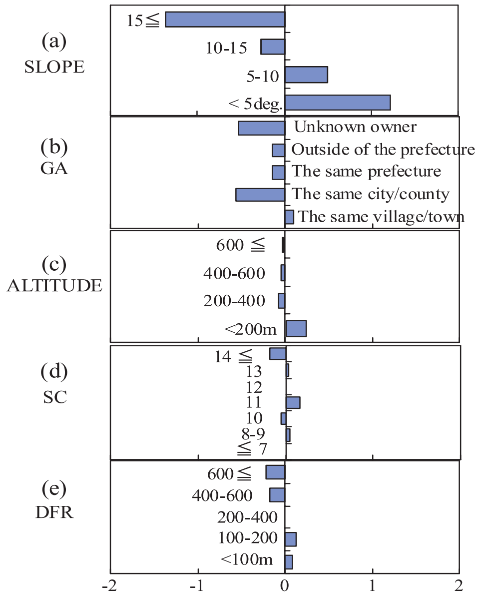

Fig. 2. Relationships among the categories according to the results of OVERALS. Bars show the multiple category coordinates of each category. The multiple category coordinates on OVERALS should be interpreted in the same way as the canonical variables in the standard canonical correlation analysis or the category scores in the quantification method II etc.

The logistic regression to predict the occurrence of non-reforested land was practiced with SLOPE and GA as independent variables. The estimated model (χ^2-test, $p<0.001$) is shown by the following equation:

$$prob = \frac{1}{1+\exp(-1.288SLOPE-0.608BIGA+3.822)} \quad (1)$$

where *prob* is the probability of the occurrence of non-reforested land, SLOPE is the category code value of the variable and BIGA is created by recoding the values of the GA variable as 1 indicating the same village/town or 2 indicating a different village/town. The coefficients of two independent variables and the constant value were significant ($p<0.05$) according to the *Wald* statistics. The odds ratio for SLOPE was 3.624 (Table 2). The odds ratio for BIGA was 1.836. These results mean that the probability of the occurrence of non-reforested land changes approximately 3.6 times when the rank of SLOPE increases by 1. The probability of occurrence of non-reforested land, when the forest owner did not live in the same village/town as his forest was 1.8 times that when he lived in the same village/town. The sites with *prob* of 0.5 or greater are classified as non-reforested land, and the sites with *prob* less than 0.5 are classified as reforested land with the equation. Using this equation, 74.9 % of the non-reforested land sites and 67.2 % of the reforested land sites were correctly predicted. Overall, 70.7 % of the n=1492 sites were correctly predicted.

Table 2. Significance level of logistic regression coefficient of variable and odds ratio derived from the logistic regression.

Variables	*p*-value	Odds ratio	95% confidence interval of odds ratio	
			Lower	Upper
SLOPE	<0.001	3.624	3.108	4.227
BIGA	<0.001	1.836	1.386	2.433

The *p*-value means the significance level of the logistic regression coefficient of variable.

CONCLUSIONS

There were significant differences between the reforested land and non-reforested land in the observed variables SLOPE, ALTITUDE, DFR, and SC and GA in Kumamoto Prefecture. The occurrence ratio of non-reforested land was higher than that of the reforested land when the site was steeper, higher altitude and further from forest road. Also non-reforested land tended to occur more frequently the higher the grade of absenteeism or site class.

The variables showing the closest correlation to the occurrence of non-reforested land was the SLOPE among the five observed variables, followed by GA. The steep slopes of over 10 degrees, and the sites whose owners did not live in the same village/town were closely correlated to the occurrence of non-reforested land. Also s steep slope caused the occurrence of non-reforested land even if SC was higher.

ACKNOWLEDGEMENT

The authors are indebted to the staffs of forestry policy section, forest improvement section and forestry promotion section in Kumamoto Pref. Gov. for their helpful cooperation in collecting data and information.

REFERENCES

Aou Y., Mitsuda Y., Murakami T., Yoshida S., and Imada M. (2002) Analysis of geographic characteristics of non-reforestation area using GIS, Kyushu J. For. Res., **55**, 38-41. (in Japanese)

Forestry Agency (2001) A forestry white paper of FY2000, Forestry Agency. (in Japanese)

Forestry Agency (2002) A service companion for forest planning, Nihonringyochosakai, 242-247. (in Japanese)

Gifi Albert (1990) Nonlinear Multivariate Analysis, John Wiley & Sons, 193-239.

Kumamoto Pref. Gov. (1999) Survey of the present situation of non-reforested lands and the intention of the forest owners, Kumamoto Pref. Gov. (in Japanese)

Kumamoto Pref. Gov. (2001) Survey of promoting intensive forest management forest management, Kumamoto Pref. Gov. (in Japanese)

Noda I. and Hayashi M. (2003) Analysis of variables causing non-reforested lands (I) –A quantitative study on the size of forest ownership classes and the site conditions of non-forested lands, Kyushu J. For. Res., **56**, 36-41. (in Japanese)

Sakai M. (1999) Minds of forest owners for management and forest resources policy: For using and sustaining the resources of artificial forest, J. of Forest Economics, **45** (1), 3-8. (in Japanese)

SPSS (2001) SPSS Categories11.0, SPSS Inc., 330p.

Yabe M. (2002) The basic law on forest and forestry and new development in forest policy, Forest Economy, **641**, 4-10. (in Japanese)

熊本県における再造林地と比較した再造林放棄地の特徴的差異

野田　巌[1)*]・林　雅秀[1)]

要　旨

これまでわが国では主伐後には再造林が行われていた。ところが、後継者不足や木材価格の低迷による経済的条件の悪化によって、主伐後に再造林されない林分やこれまで実施されてきた手入れの停滞といったいわゆる施業放棄林が増加し、国土保全や持続的森林経営という点で必ずしも無視できるものではなくなっている。再造林放棄地の発生要因を解明する上で再造林放棄地と再造林地の特性を計量的に比較することは重要であるが、大分県での限られた研究事例があるにすぎないことから、本研究ではこうした問題を抱えている熊本県のデータを用いて再造林放棄地と再造林地の立地の状態を表す変数と所有者の不在村状態をあわせた計５変数（傾斜、標高、林道からの距離、地位級、不在村状態を示す変数）について再造林放棄地の特徴を比較分析した。その結果、いずれの変数についても再造林放棄地の頻度分布は再造林地との間に有意差が認められた。とりわけ顕著な特徴を示したのは傾斜の程度を示す変数で、それに次いで不在村状態を示す変数であった。２つの変数を用いて再造林放棄地の発生判定を推定するモデル（正分類率 70.7%）を作成した。その結果、不在村状態については森林所有者が不在村である場合、在村である場合に比べ再造林放棄となる確率は 1.8 倍に上がることが認められた。

キーワード：民有林所有、再造林放棄、不在村所有者、持続的森林経営、多変量解析

＊ 森林総合研究所九州支所森林資源管理研究グループ　〒 860-0862　熊本市黒髪 4-11-16　e-mail: noda12@ffpri.affrc.go.jp
1）森林総合研究所九州支所森林資源管理研究グループ