

Economical forestry zoning method for forest plantations with based on site conditions

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The majority (58%) of forests are privately owned (national forest 31%, public forest 11%). Most timber production depends on private forest management. In recent years, forestry activity of forest owners is regressing all over the country, and forests tend to be abandoned from timber production because of lack of forest treatments (Sakai, 1999 etc). The increase of non-reforested lands, especially, may cause land erosion with heavy rainfall, if the site condition is poor. On top of that, sustainable forest management and regional economy may be distributed.

During the afforestation boom after World War II, man-made forests were made even on poor site conditions, like steep slopes. However, under the recent marginal severe economic conditions, a form of forest zoning has been required to manage forests on timber and non-timber values in a sustainable way. In this study, the zoning method for economical forestry is presented in terms of sustainable forest management. Two focused features are 1) economical potential of site conditions, and 2) sustainability potential of management affected by forest owners.

Tanaka(2002) studied the zoning methods for forest management planning. They use productivity and accessibility for timber production criteria, but do not consider economical potential feature for timber production affected by site conditions as slope. Noda et al(2006), however, developed a final cutting cost estimation model (FCCEM) with based on site condition, and the model output shows the economical potential degree for timber production of forest plantation. As for sustainability by forest owners, there has been an increase of non-reforested lands after cutting. The issue would cause disturbance of traditional sustainable forest management (Sakai, 1999; Ryuko, 2000 etc). Noda & Hayashi (2004) concluded that non-reforested land occurrence is affected mainly by the owner's absenteeism and the steep slope, and developed the non-reforested land occurrence prediction model (NREFLPM).

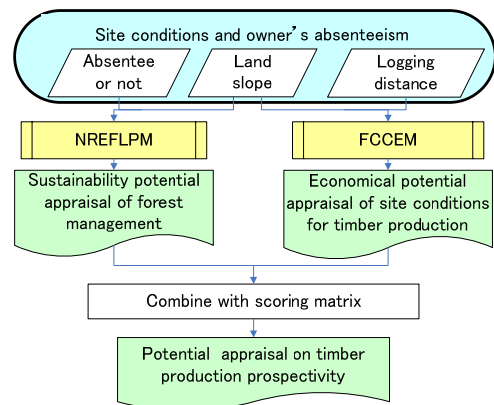


Figure 1. Flowchart of the economical forest zoning for timber production, using the non-reforested land occurrence projection model (NREFLPM) and the final cutting cost estimation model (FCCEM).

MATERIAL AND METHODS

A timber production prospectivity appraisal scoring matrix is implemented to combine the appraisals (Figure 1, Table 1). The appraisals of the focusing features are to be acquired by FCCEM and NREFLPM. The former is for economical potential appraisal, the latter for sustainability of forest management. The sample area is Kamitsue village in Oita prefecture,

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Kyushu, where 95% of the village area, i.e., 8,953ha is occupied by forests. Kyushu district is famous for the most vigorous timber production area in Japan. The increase of non-reforested lands, however, has become the problem of sustainable forest management under severe economic conditions, such as growing labor cost and stumpage price by far below costs.

RESULTS AND DISCUSSION

Economical potential appraisal of site conditions

Noda et al.(2006) developed FCCEM to estimate the economical degree for timber production of forest plantation by sub-compartment through the analysis of actual field data(1998 – 2001) operated by forest owners associations in Oita prefecture, Kyushu, including the logging cost, cutting area and logging machines etc. The input factors for the model are narrowed to the following three site conditions easy to get; site slope, distance from forest road and logging volume.

The estimation error as self-validation of the model was 23.9% (standard error 5.9%). According to the field data, the logging operation systems were classified into four types (cable yarding type/ wheel yarding type, by ordinal forestry machines/ high-performance forestry machines). Three factors were significant among the logging operation types with ANOVA($p < 0.05$). The thresholds of site slope and distance from forest road to distinguish logging operation types from each other, were used for categorizing the factors. The model equations of FCCEM by the logging types were obtained through a categorical multivariate analysis method, Hayashi's Quantification Theory I applied to logging costs and the categorical factors.

Sustainability potential appraisal of management affected by forest owners

Noda & Hayashi(2004) showed that steepness and absenteeism are strongly related to the occurrence of non-reforested after cutting of private plantation, and developed NREFLPM, based on the data taken at Kumamoto Prefecture, next to Oita Prefecture in Kyushu. Nonlinear canonical correlation analysis (Gifi, 1990) was conducted to clarify the factors. The NREFLPM was derived by logistic regression with the two variables, slope and absenteeism. The correct classification ratio as self-validation was 70.7%. The characteristic is to be simple and to include

Table 1. An example of the scoring matrix combining sustainability potential level and economical potential

			Economical potential level		
			L	M	H
			High cost	Medium	Low cost
Sustainability potential level	L	High prob.	1	2	3
	M	Medium prob.	2	4	6
	H	Low prob.	3	6	9

Note) Values indicate the social importance of both potentials and could be manipulated. Probability (prob.) is cost shows the occurrence probability level of non-reforested land, and cost is the estimated final cutting cost level, respectively.

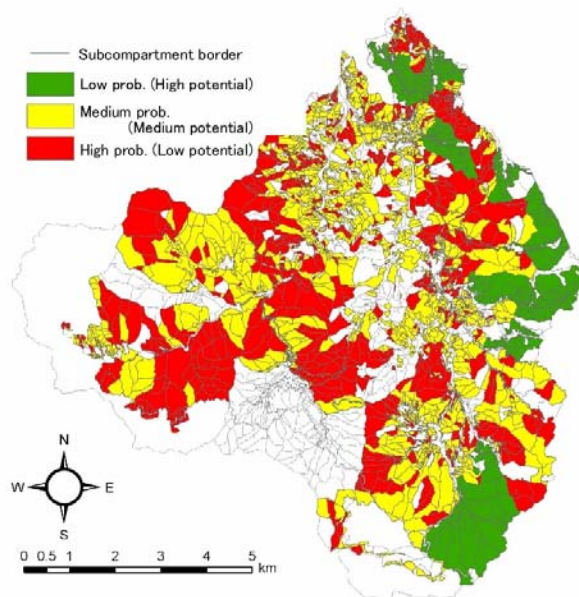


Figure 2. Probability to be non-reforested after cutting in Kamitsue, projected by NREFLPM. Corresponds to sustainability potential appraisal of forest management. Blank polygons show national forests or non-forest areas.

absenteeism factor of forest ownership. The increase of absentee forest owners causes the decrease of seriously managed forests (Ryuko, 2000 etc). Therefore, the model focuses on influences from the owner feature, and appraises forested lands for sustainability potential of timber production under the lack of successors and the economic hardness such as lower stumpage price and higher labor cost (Figure 2).

Economical forest zoning on timber production prospectivity

Both FCCEM and NREFLPM appraise the sustainability potential of forest lands with different features. The FCCEM is focusing mainly on the economic site condition feature, and the NREFLPM is mainly on risk from the owner feature. Each model shows respectively a significant appraisal result. The two features most cover appraisal criteria of forest lands for timber production value. Combining the appraisal of FCCEM with the one of NREFLPM would correspond to making a potential appraisal of forest plantations on timber production prospectivity. The scoring matrix corresponds to regional demands to forestry sector (Figure 2). For example, the weights of FCCEM and NREFLPM are generally equal, but the balance is changeable by tuning under the regional planning demands. As all procedures are practiced on a geographic information system, a zoning map is drawn according to the degree potential, such as high, medium and low on timber production prospectivity (Figure 3). The zones would be available for the criteria of management focuses, such as low /high potential zone is mainly for non-timber/ timber-use.

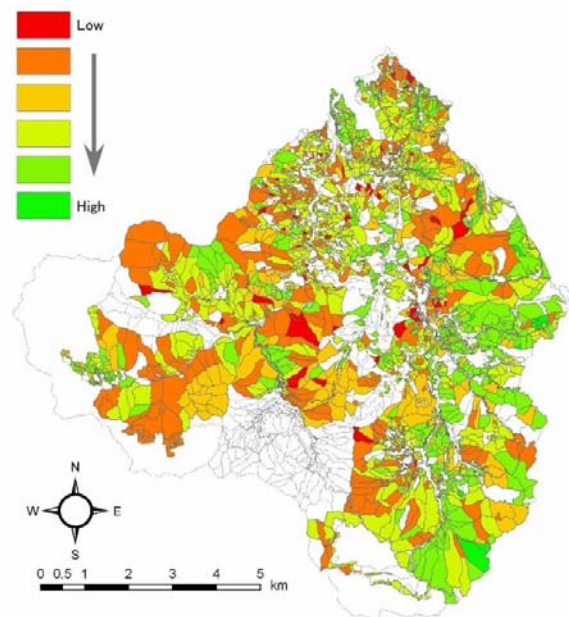


Figure 3. Potential appraisal of forest land on timber production prospectivity with ordinary yarding machine system.

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