B-15.4 Development of Forest Resources Alteration Model (FRAM) for Asia-Pacific

Contact Person Haruo Sawada
Chief,
Remote Sensing Laboratory,
Forestry and Forest Products Research Institute,
Ministry of Agriculture, Forestry and Fisheries
1 Matsunosato, Kukizaki-machi, Inashiki-gun, Ibaraki, 305 Japan
Phone +81-298-73-3211 (Ext. 636), Fax +81-298-74-8507
E-mail: sawady@ffpri.affrc.go.jp

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Abstract:
The deforestation mechanisms in Soutn-East Asia was analysed to make clear the causal relationship among changing situations surrounding forest area from socioeconomic point of view. Many study reports were collected and reviewed which relate to deforestation model in tropical region to develop the Forest Resources Alteration Model (FRAM). A computer software in FORTRAN was also collected and modified to deal with the model. Various kinds of information related to the study region were also collected on a geographic information system GRASS. Although forest fire has the key role in that area and is treated as one of the important factors in the model, the actual information on forest fire are not well obtained in publications. Then satellite observation is necessary to evaluate the model in the actual world. The simulation shows us very severe conditions in the next century.

Key Words deforestation, model, tropical forest, fire

1. Introduction

Tropical forests in the world are under various kinds of pressure caused by population increase and their life style changes. The FAO Forest Resources Assessment Project of 1990 revealed that more than 15.4 million hectors of tropical forest were disappearing in each year between 1980 and 1990*(1)*. In consequence, that situation brings not only diminishing of species, increase of erosions, threat to native people in a local scale but also environmental problems in a global scale.

The deforestation ratio in Asia is about 1.2 % per year and is much higher than that of south-central America, 0.8%, and of Africa, 0.7%. Even though one executes selective cuttings, sometimes natural regeneration does not progress well and/or forest fire happens so often. These situations make low-graded condition in secondary forest. After selective cuttings are performed, many areas are transformed to agricultural land or pasture. This degrades the soil and makes it difficult to come up forest trees. Then farmers need much more land for agriculture because of the degraded soil and ask new forest land for cultivation. As a result, there remains broad degraded land and small forest patches where it is difficult to access and cultivate for agriculture.

On the other hand, forests are considered one of the most important vegetation types for protecting global warming because of the biggest biomass to reserve carbon *(2)*. But, as mentioned above, it is necessary to take into account the relations between forest conditions

and human activities. For analyzing these problems, forest information is needed to be collected from the socio-economic point of view and from natural scientific point of view using satellite images. That will make it possible to develop a practicable resources alteration model of forest area in Asia-Pacific region.

2. Study Objectives

The main study objective is to develop a model to analyze the mechanisms of deforestation caused by pressures to forest land according to the population increase, GNP rise, etc.. The other object is to develop methodologies to obtain global forest information using remote sensing data. The information is necessary for applying the developed model to real forest conditions in the Asia -Pacific region where reliable forest information lacks. This study aims to make it possible not only to simulate forest changes in numerical forest resources alteration model but also to check and see forest condition on images and/or maps.

3. Research Method

The first approach is to analyze the deforestation mechanisms that make clear the relations among situation surrounding forest area from socioeconomic point of view. Many study reports were collected and reviewed which relate to deforestation model in tropical region.

The next step is to collect and develop a computer software that deals with the model. The FORTRAN language was used to develop the software and IBM personal computer with graphic plane is selected as the main computer for the modeling and coding.

At the same time, various kinds of information related to the study region were collected on a geographic information system. These data cover the whole Asian countries and were put in a data base on the GRASS.

Remote sensing data were also collected and analyzed on the geographic information system to obtain the actual information about forest area.

4. Result

4.1 Forest change model (numerical model)

A.Grainer (Sulford Univ.) and M. Palo (Finnish Forest Research Inst.) are well known for their deforestation models *(3)*. FAO estimates forest area in 2000 based on the population increase. However, no clear relations were evident between changes of population density and that of forest area. It means that the deforestation does not directly link to agricultural activities that supply food for people and support population increase of the specific region. As a result, it shows that the deforestation model that is based on only the population increase is not affective in the real world.

Within previous deforestation models, land use changes were assumed to be caused by the wood production and development of agricultural land and/or pasture. It is clear, however, that it does not show the real world, as explained above. Forest fire is found very important in deforestation and degradation of forest land. Very little forest area affected by forest fire are used for agriculture or shifting cultivation. It was found that the effect of forest fire should be included in a deforestation model. The information on forest fire are very rare in

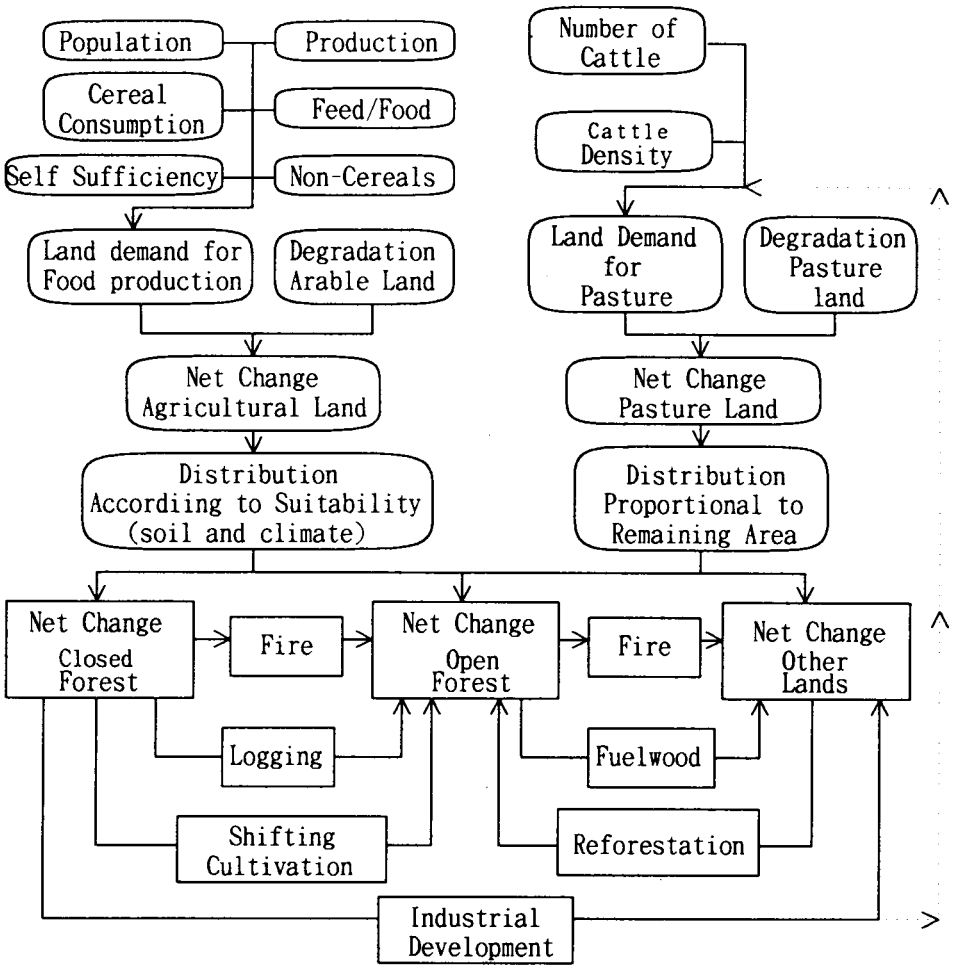

Figure 1. Structure of the FRAM (Forest Resources Alteration Model

developing countries and it is necessary to collect the information using satellite remote sensing by ourselves.

4.2 Development of computer software

The software 'IMAGE (An Integrated Model to Assess the Greenhouse Effect)' were offered by the author, Dr.J.Rotmans *(4)*. The deforestation model in the software was used and arranged to this study. This software is written in FORTRAN and runs on the IBM micro-computer with VGA graphic board for showing simulation graphs. The original deforestation module does not consider forest fire. So, we arranged the module to make it possible to take into account the forest fire in the model. In this model, four types of vegetation are considered, that is ,tropical forest, grass land, agricultural land and semi-desert area. The tropical forest is devised into two forest types, closed forest and open forest. Secondary forest is considered to be involved in the open forest. Forest land is changed to reforested area, agricultural land, grass land or eroded land. That means that the main reasons that cause deforestation are various demands to forest land arisen from population increase and socio-economic growth and forest fire.

The model uses simple flow as shown in Figure 1. For example---, although it is assumed that the fuel wood are collected only in open forest, closed forests are considered that there are enough net growth production which deals with the fuel wood supply and are not affected by the fuel wood production. The reforestation is assumed to be executed on bare land. Forest cutting is assumed to be done in closed forest and the closed forest becomes open forest.

The model is developed to be applied to analyze long term forest changes under various kinds of development and activities on forest land. Four scenarios were considered for evaluating steps for controlling global warming, A) set no restriction, B) set moderate restriction, C) set restriction to the tendency and D) set severe restrictions. In the Scenario A, environmental problems make no limitation to forest development. People want to develop forest land quickly to get wood like mining resources. That increases the amount of wood supply to increase industrial activities. No step for controlling global warming is considered in this scenario. The effectiveness of political programs for over coming the global warming should be evaluated and compared, at least, with this level.

Some limitations to deforestation are considered from the economical point of view in the scenario B and C, like that of ITTA and of Forest Action Plan of FAO, respectively. In Scenario D, forest is considered to be reserved from the ecological point of view. This scenario does not consider the socioeconomic aspects in the region.

The population increase is assumed the same in all scenario.

From this model, the deforestation in Asia could be simulated. By the scenario A, almost all closed forests disappear before middle of the next century.

4.3 Development of data base

For analyzing the deforestation mechanisms, various kinds of forest information on Asian countries were collected and put into a data base system. At first, parameters about forest area, population and other socioeconomic information were obtained from the world data base. Although it supports numerical data for each country, the forest area data were found not reliable.

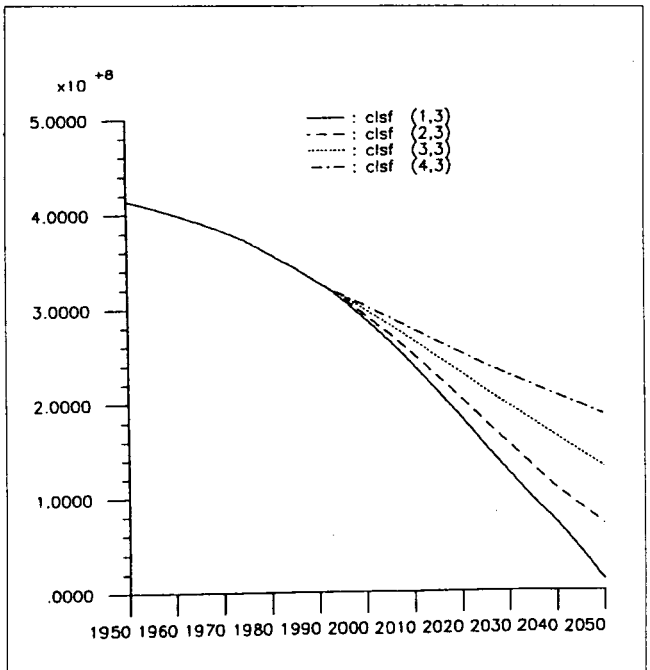

Figure 2. Simurated area of closed forests

4.4 Forest information observation using remote sensing data

Computer algorithms to classify forest types using NOAA GVI data were developed . It was found that global phenological information could be obtained from the 10 important aspects derived from the data, 1) the week with the biggest value, 2) maximum value, 3) the week with the smallest value, 4) minimum value, 5) start of growing season, 6) length of growing

season, 7) number of growing time (seasons), 8) average GVI, 9) average GVI of growing season and 10) accumulation of GVI in growing season.

Seasonal changes and annual changes of vegetation condition in each country were analyzed using NOAA GVI data. Forest lands were assumed to have higher GVI values than grass land and agricultural land. A threshold value was set to estimate forest area of each country from sequential GVI values. The pixels that are bigger than 0.4 of DN are counted each month and these numbers are plotted time sequentially. From this time series plotting, seasonal characteristics was analyzed. Then the locally weighted regression was applied to the plotting for estimating forest area. This method was found effective in tropical seasonal forest area.

5. Discussion

The Forest Resources Alteration Model (FRAM) was developed for Asia-Pacific region. Although forest fire has the key role in that area and is treated as one of the important factors in the model, the actual information on forest fire are not well obtained in publications. Then satellite observation is necessary to evaluate the model in the actual world.

The FRAM model and developed methodology for estimating real forest conditions using remote sensing data make it possible to simulate the remaining forest area in future. The simulation shows us very severe conditions in next century.

References

1) FAO, 1993, Tropical Forest Resource Assessment
2) Myers, N. and T.J. Goreau, 1991, Tropical forests and the greenhouse effect: A management response, climatic Change, 19, 215-225
3) Palo, M., 1992, Terms of transition from deforestation into sustainable forestry in Latin America, IUFRO Centennial Meeting
4) Rotman, J., 1990, IMAGE An Integrated Model to assess the Greenhouse Effect

Figure 3. An example of collected global data for this study (deforestation ratio of study countries)

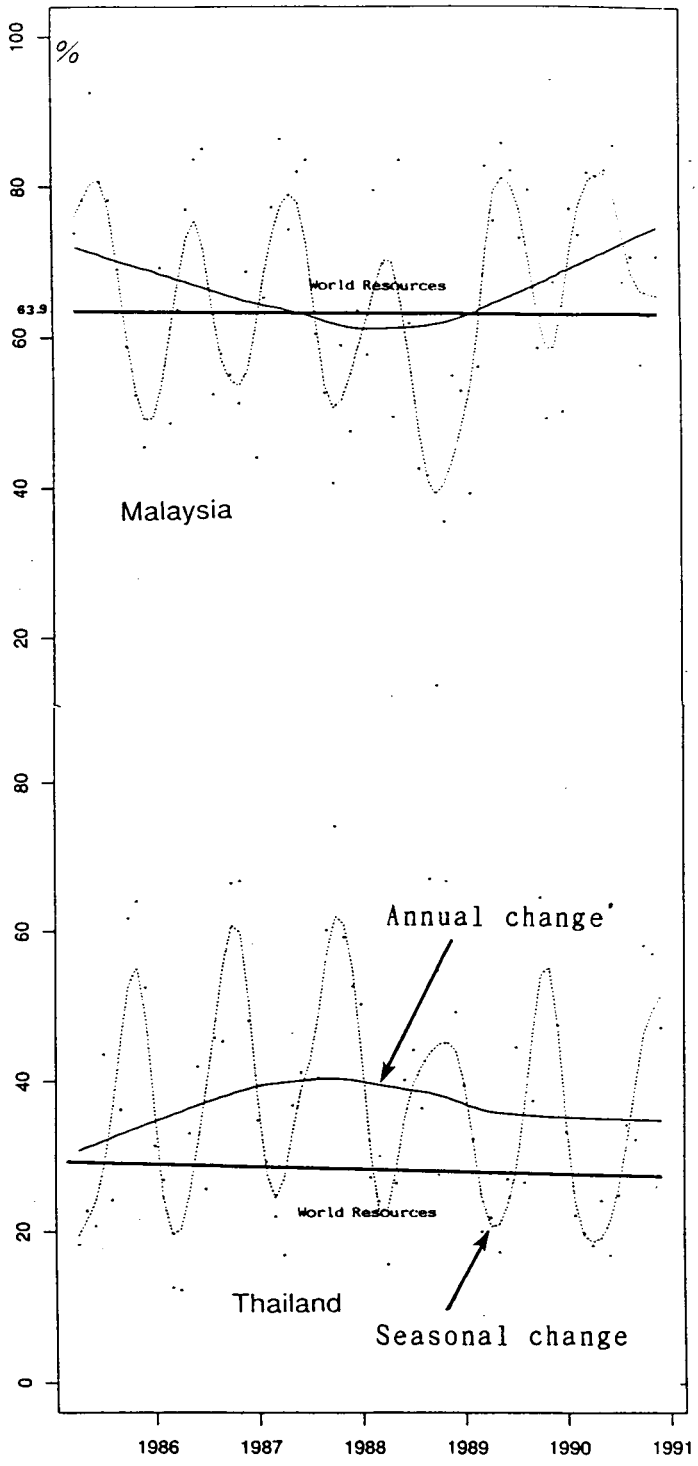

Figure 4. Estimation of forest area of each country using NOAA GVI data (1985.4 - 1990.12)