Use of the Geographic Information System in relation to Forest Management practices at the Tokyo University Forest in Chiba

Trifkovic Stanko, Yamamoto Hirokazu , Tsurumi Yasuyuki (The University of Tokyo) and Furuya Naoyuki (FFPRI)

I. Introduction

Growing public concern, in an aspiration to manage forest resources in a sustainable manner, gave an additional pressure to forest management practices. It is necessary to have well updated and developed information system.

At the same time, data collection in a conventional Forest Inventory is a time consuming process. In order to estimate the density, Distance-Based methods has demonstrated as a cost-competitive to widely used Fixed-Area methods but it is also demonstrated that they are influenced by a bias and not reliable. Our research goal is to find the way to reduce the cost of Forest Inventory and try to find a way to remove the error in Distance-Based methods.

II. GIS as a Forest Management Information System

The Geographic Information System (GIS) is an information tool which can provide support for all level decision-making and for planning activities in Forest Management. Achieved improvement using GIS lies in the collected data which can be approached easily. Once we collect and input data to the GIS database we will greatly improve the process of the Forest Management and research at the Tokyo University Forest in Chiba. Such data we can divide in to the following groups:

- **Land base Data** (lakes, ponds, rivers, streams, roads, transmission lines, land ownership boundaries, etc.)
- **Forest Data** (tree species, age, height, density, site quality, volume, etc.)
- **Disturbance Data** (harvest, fire, insect damage, wind damage, etc.)
- **Topographic Data** (elevation contours, land features, buildings, etc.)
- **Financial Data** (achieved income and expenses such are harvesting, silviculture activities etc.)

III. Forest Inventory

Regular Forest Inventory at the Tokyo University Forest in Chiba is held every 10 years in a cycle, since its establishment in 1894. Large amount of data is available on the forest plantations which cover approximately 37% of total forest land. For data collection different methods and Forest Inventory systems are used.

This time Forest Inventory information will be obtained by observations and measurements on: **remote sensing sources** (forest classification/stratification, mapping and area determination), **in the field** (applying the Circular Fixed-Area Plot Method, detailed information about forest conditions and timber quantities and qualities will be collected).

i. Fixed-Area Plots

It is planned to use the circular fixed-area plots at the sampling rate of 5% of the measured area; 30m plot network with 4m radius for young plantations / 45m plot network with 6m radius for aged plantations (Fig.1)

ii. Distance-Based Sampling Method

With Distance-Based Sampling Method (n-tree distance sampling) first described by Prodan (Fig. 2), where the number of trees "*n*" per plot is fixed and the distance to the *n*-th nearest tree (*L*) is measured (Fig.3). In a Distance-Based sampling method density is estimated using following basic equation where sample plot area is variable:

$$\frac{\text{Density}}{\text{Area}} = \frac{\text{Number of trees measured per plot}}{\text{Sample plot area}}$$

GIS is used to compare density estimation accuracy of Fixed-Area Plots and Distance-Based Sampling Method at Gobosawa sugi forest stand.

Measured Area = 50336.26ha

Density = 1661 tree (approximately 330 trees/ha)

Table 1. Fixed-Area Plot Sampling Method

Plot radius	Plot mesh	Estimated Density	Relative error
6 m	45 m	1679	1.08%
6 m	30 m	1703	2.53%
4 m	45 m	1866	12.34%
4 m	30 m	1796	8.13%

Table 2. Distance-Based Sampling Method

n-tree	Plot mesh	Estimated Density	Relative error
n = 4	45 m	1539	7.93%
n = 4	30 m	1727	3.97%
n = 5	45 m	1543	7.65%
n = 5	30 m	1624	2.28%
n = 6	45 m	1567	6.00%
n = 6	30 m	1687	1.56%

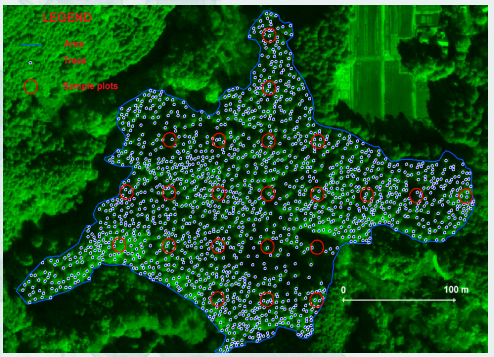

Figure 1. Fixed-area plot method

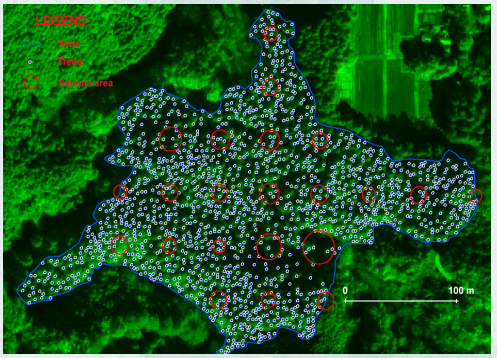

Figure 2. Distance-based sampling method

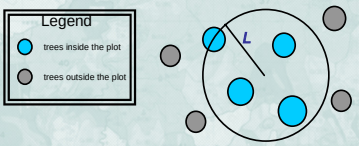

Figure 3. Distance-based sampling method; n = 4

Using GIS we test previously proposed Distance-based sampling methods at Gobosawa sugi forest stand and observed the bias and calculation errors. In order to remove the estimation error, the new formula is developed and density estimation values are shown in the Table 2.

IV. Conclusions and future work

GIS has great potential to store various information on forest resources. We can get accurate and fast measurements for the given area and its use in planning and organizing Forest Inventory can reduce the cost. Very important is to note that the collected data can be presented by friendly user interface.

In order to reduce the cost of Forest Inventory it is necessary, prior to it, to determine sample size and sampling rate. Steep terrain at the Tokyo University Forest in Chiba makes the field data collection even more difficult. If applying distance methods costs can be reduced. Unfortunately these methods appeared as imprecise and unreliable density estimators. Our research goal, at this stage, is to develop a new estimation method which will be more precise and provide reliable results. The new formula is developed and applied to Gobosawa sugi forest stand (Table 2). It can be seen that if we increase the sampling rate more accurate results will be achieved. It is necessary to mention that this research is in an initial stage and there is need to check the developed formula for its reliability when it is applied to different spatial distributions or different forest types. Research on basal area and volume estimation is our next task.