Estimation of leaf quantity using spectrum data

Yoshito NISHIHARA, Koji KAJIWARA, Yoshiaki HONDA
Center for Environmental Remote Sensing of Chiba University
1-33 Yayoi-cho, Inage-ku, Chiba, 263-8522, JAPAN
Tel: (81)-43-290-3875,
Fax: (81)-43-290-3857
E-mail: yoshito@cr.chiba-u.ac.jp, kaji@cr.chiba-u.ac.jp, yhonda@cr.chiba-u.ac.jp

ABSTRACT : How many leafs the forest has can be very important information to understand the forest is healthy or not, or it is growing or declining. However until now, very much labor and long time is needed to measure it. The purpose of this study is to develop the method that estimate how many leafs there are at the forest.

KEY WORDS: Leaf Quantity, Spectrum data, NDVI, LAI

1. Introduction

Leaf quantity is very important element to understand a condition of forest. In this paper, I use leaf quantity to mean quantity of leafs that the forest has at per unit area. It is thought that how much leafs at the forest has shows condition of it. Until now, human had gone to the observation site regularly and gleaned leafs that were fell on the ground. This method needs much labor and a year to show leaf quantity. Accordingly, the method of estimation using spectrum data has been studied. If such method is developed, leaf quantity can be estimated in little labor and real-time. As the result, it was developed the method that can estimate it by a few times observation in a year.

2. The Study Object and Area

The study object is larch forest. Larch is proper object for this study because it is a conifer deciduous tree. A larch's leafs fall in winter, therefore leaf quantity change greatly. It makes us see a change of leaf quantity easily.

The study area is Yatsugatake in Japan. There is a larch forest (*Figure 1*). This forest has various instruments for observing the forest. There is a tower (*Figure 2*) for observing, and it has five floors. The height of it is 25m. On the other hand, since the trees of there are about 20m, this top of forest can be observed form the top floor of the tower. A spectrum mater is equipped at the top flower of the tower. It has measured spectrum data at head of the forest from 9.A.M. to 6.P.M. in everyday for 5 years. And, it was used NDVI that was calculated from the spectrum data to estimate.

Besides it, LAI (Leaf Area Index) is measured by LAI-2000 (*Figure 3*). LAI is the index that show the gross area of leafs at per area and LAI-2000 is the machine for measuring LAI. This machine measures it by measuring transmission light and incidence light.
LAI-2000 can measure LAI very easily.

On the ground, leaf quantity is measured using the instrument that called “litter trap” (*Figure 4*), that is equipped on the ground at the observation site. Leafs fell from trees into the litter trap, and that leafs were gathered. Then, that leafs were weighed after dried.

These three, NDVI and LAI and leaf quantity, are used in this study.

Figure.1 Larch forest

Figure.3 Litter trap

Figure .2 The observation tower within the limited term.

3. Analysis Measurement Data

Table 1 shows relationship between leaf quantity and LAI that were measured in 2002. We can see from this graph that there is high correlation between them. This case shows that leaf quantity can be estimated form LAI by the relationship of them.

Then, Table 2 shows NDVI and Table 3 shows LAI in 2002. It is found that NDVI has a different characteristic in comparison with LAI. The characteristic is NDVI was not changing around summer, in spite of LAI is moving in same term. The reason for this is that NDVI is saturated around 0.7. It follows from this that NDVI dose not have information of leaf quantity during saturated. Since NDVI is saturated, it is found that to estimate annual LAI from NDVI is difficult. Table 4 shows relationship of them. There is coloration between LAI and NDVI in some measure. However, points on the graph are varied around 0.7. Table 5 shows the relationship of them within the limited term when NDVI is increasing and decreasing. This graph tells us that within the limited term there is a high correlation between them. These results show that leaf quantity can be estimated from NDVI

4. Estimating Method And Estimating Result

So far, we have seen that leaf quantity can be estimated from NDVI within the limited term. However, There is a question how to estimate leaf quantity when NDVI is saturated. As I shown earlier, saturated NDVI dose not have information of leaf quantity's change. Thereupon, in this paper, leaf quantity was estimated by the method that use measured LAI by LAI-2000. Detail of the method is next.

--When NDVI is not saturated, LAI is estimated from NDVI using correlation ratio of them, and next, leaf quantity is estimated from estimated LAI using correlation ratio of them.

--When NDVI is saturated, it is needs that several measuring LAI by LAI-2000 to estimate leaf quantity. Secondly, a quadratic curve is drawn as curve's peak becomes a biggest point of measured LAI

points. Then, leaf quantity is estimated from the LAI using correlation ratio. This is the method to estimate annual leaf quantity.

Table 6 shows the LAI that was estimated in this method, and measured in 2002. RMS error between them was 0.083. This value is good result. Then, leaf quantity that was estimated by this method and measured by litter trap appears in Table 7. RMS error between estimation result in this method and measured leaf quantity is 6.12g. In the observation site, leaf quantity becomes over 350g. Therefore, it is said that this estimation method has sufficient accuracy at the site that was observed in this study.

5. Conclusion

The method of estimating leaf quantity that was developed in this study needs only several times observation by understanding the relationship between LAI and NDVI, LAI and leaf quantity, on the assumption that NDVI is acquired by artificial satellite. Therefore, It is said that this method is effective for long-term observation. However, this method is not perfect because this method needs observation at the site.

A further direction of this study will be to develop the method that dose not need measuring LAI.

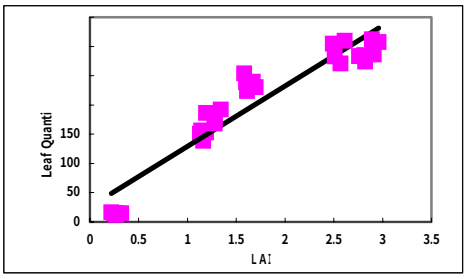

Table.1 The relation between leaf quantity and LAI

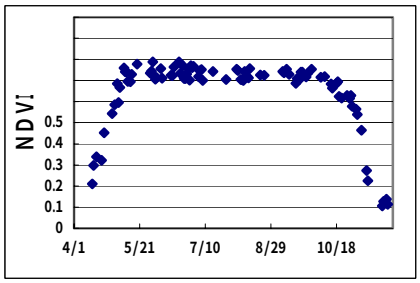

Table.2 NDVI measured in 2002

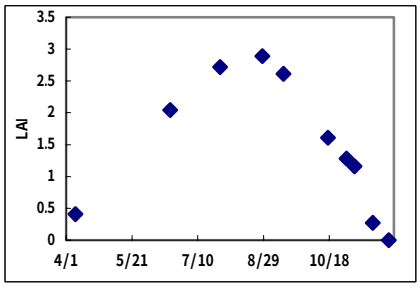

Table.3 LAI measured in 2002

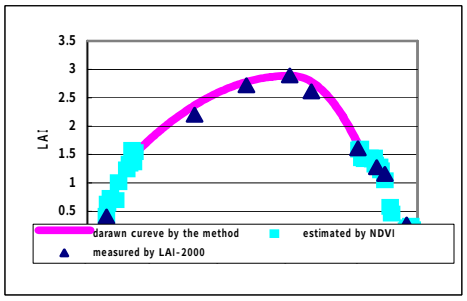

Table 4. The relation between NDVI and LAI measured in 2002

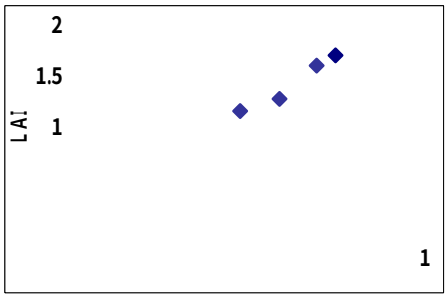

Table 5. The relation between NDVI and LAI during NDVI is not saturated

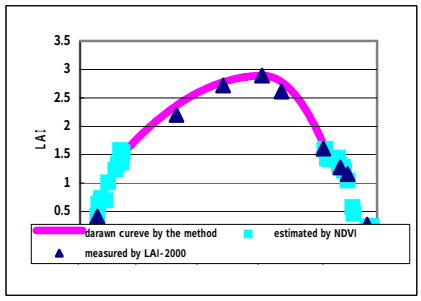

Table 6. Mesured LAI and estimated LAI

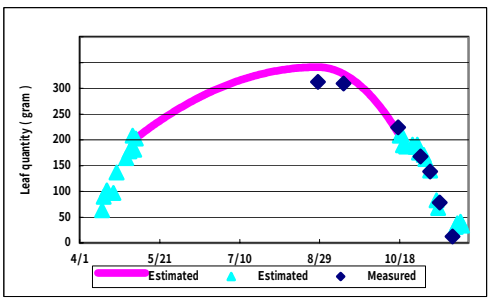

Table .7 Estimated leaf quantity by the method And Measured leaf quantity by litter trap