

# CONIFER FOREST BIOMASS ESTIMATION USING MULTI ANGLE SPECTRUM OBSERVATION

Koji KAJIWARA, Yuhsaku ONO, Yoshiaki HONDA

Center for Environmental Remote Sensing (CEReS), Chiba University, y.ono@graduate.chiba-u.jp

## ABSTRACT

This research aimed at developing a technique for estimating the tree height using BRF (Bi-directional Reflectance Factor) through the clarification of the relation between shape of the tree crown and the tree height and the relations between the shape of the tree crown and BRF. This paper, reports the results of analyses of data acquired by field measurements done to clarify relation between crown shape and tree height.

**KEY WORDS:** Biomass, Shape of the Tree Crown, Tree Height, Bi-directional Reflectance Factor

## 1. OUTLINE OF RESEARCH

It is important to estimate the biomass of the vegetation by satellite observations in order to understand the gain and loss of carbon dioxide in the atmosphere. Because only information in the horizontal direction of the vegetation cover ratio is estimated in a general vegetation index such as NDVI (Normalized Difference Vegetation Index), accuracy is insufficient. Therefore, the consideration of the tree height becomes indispensable when the biomass of the trunk of the forest is estimated.

This research aimed at developing a technique for estimating the tree height using BRF (Bi-directional Reflectance Factor) through the clarification of the relation between shape of the tree crown and the tree height [1] and the relations between the shape of the tree crown and BRF. This paper, reports the results of analyses of data acquired by field measurements.

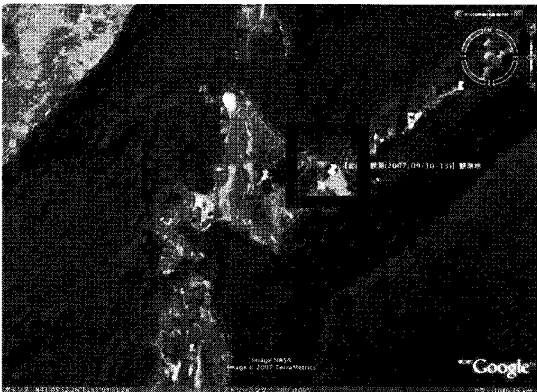


Figure 1. Measurement Area (Nakashibetsu-gun, Hokkaido, Japan).

## 2. OUTLINE OF MEASUREMENT

Two tree-areas having different growth stages were selected in the area of Nakashibetsu-gun, Hokkaido, Japan (Figure 1.) and measurements were conducted on these trees composed of larch species (Figure 2.) closed canopy from September 11 to 13, 2007. The measured features were the radius of the tree crown (north, south,

east, and west directions) and the radius between two adjacent trees crowns, and the height between the ground and the crown base (north, south, east, and west directions), tree height, diameter at breast height (DBH), and tree distance between adjacent trees (Figure 3.).



Figure 2. Larch species.

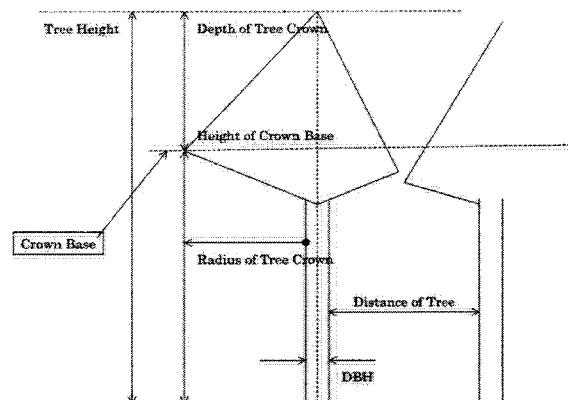


Figure 3. Measured features.

## 3. SHAPE OF LARCH SPECIES

It was assumed during analyses that, the larch species was composed of two parts the tree crown and the stem. Moreover, the shape of the tree crown of larch was

assumed as a cone and, the shape of the stem as a column (Figure 4.).

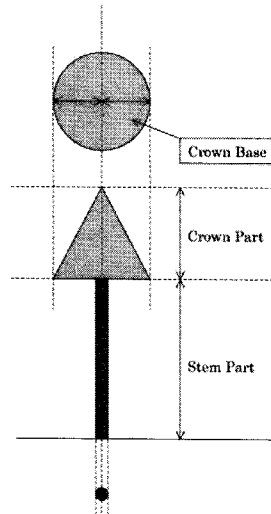


Figure 4. Shape of Larch Species

#### 4. RESULT

##### 4.1 Relation between Tree Distance and Radius of Tree Crown

Figure 5 shows the relation between the radius of a tree crown and the distance separating this crown and that of an adjacent tree along a similar direction. There is a high linear correlation between these two features, as confirmed by the correlation coefficient of 0.838. Therefore, the radius of the tree crown depends on the distance between adjacent trees.

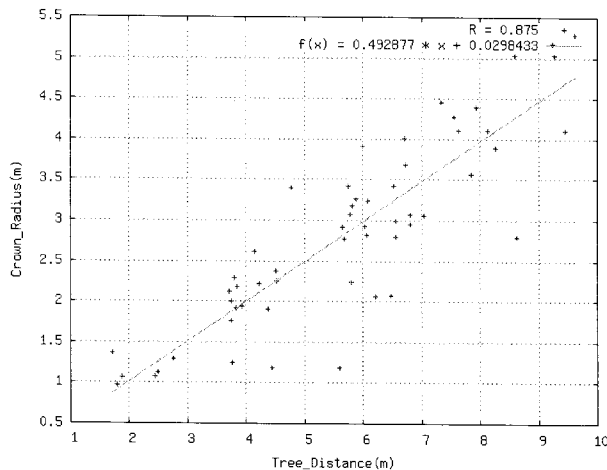


Figure 5. Relation between tree distance and radius of tree crown

##### 4.2 Relation between Tree Height and Radius of Tree Crown

Figure 6 shows the relation between the radius of tree crown (Average of north, south, east, and west directions) and the tree height. There is a low linear correlation between these two features, as confirmed by the

correlation coefficient of 0.452. Therefore, the radius of the tree crown doesn't depend on the tree height.

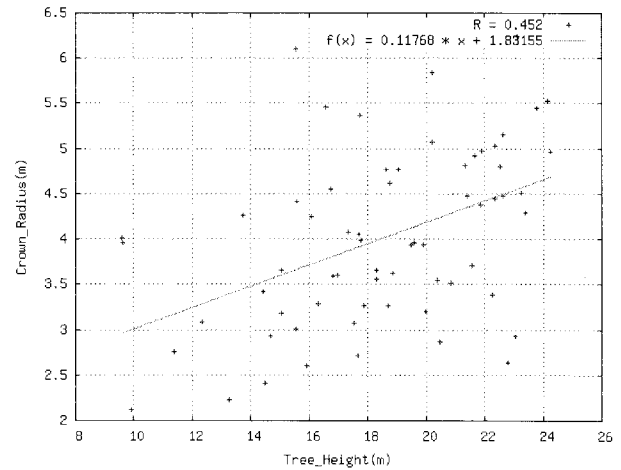


Figure 6. Relation between tree height and radius of tree crown

##### 4.3 Relation between Tree Height and Depth of Tree Crown

Figure 7 shows the relation between the depth of tree crown (Estimate from tree height and height between crown base and ground (Average of north, south, east, and west directions)) and the tree height. There is a high linear correlation between these two features, as confirmed by the correlation coefficient of 0.903. Therefore, the depth of the tree crown depends on the tree height.

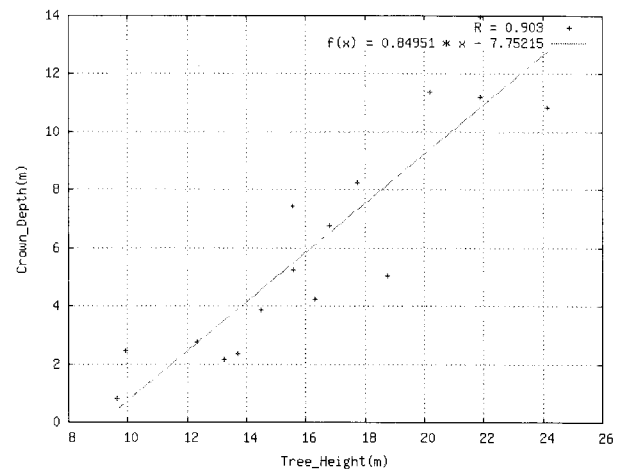


Figure 7. Relation between tree height and depth of tree crown

##### 4.4 Relation between Tree Height and Tree Crown Base Area

Figure 8 shows the relation between the tree crown base area (Estimated from the radius of tree crown) and the tree height. There is a low linear correlation between these two features, as confirmed by the correlation coefficient of 0.431. Therefore, the tree crown base area where the depth of tree crown is considered doesn't depend on the tree height.

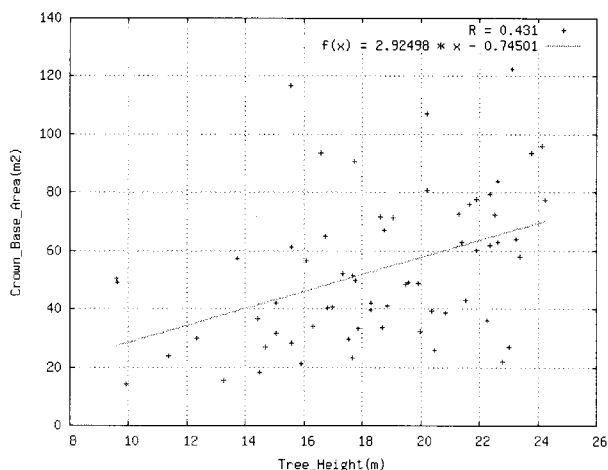


Figure 8. Relation between Tree Height and Tree Crown Base Area

#### 4.5 Relation between Tree Height and Tree Crown Surface Area

Figure 9 shows the relation between the tree height and tree crown surface area (Estimated from the radius and depth of tree crown). There is a high linear correlation between these two features, as confirmed by the correlation coefficient of 0.841. Therefore, the tree crown surface area where the depth of tree crown is considered depends on the tree height.

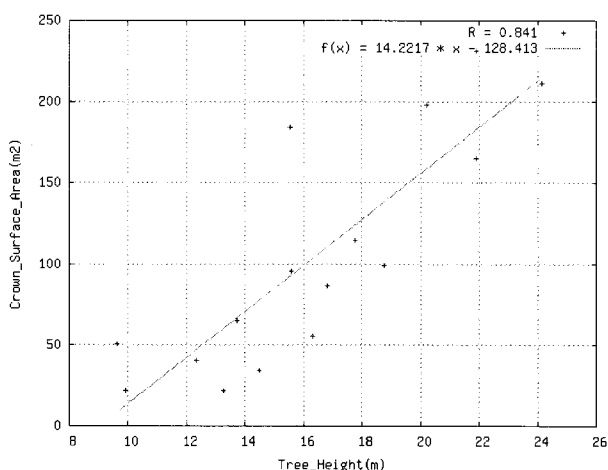


Figure 9. Relation between tree height and tree crown surface area

#### 4.6 Relation between Tree Height and Tree Crown Volume

Figure 10 shows the relation between the tree height and tree crown volume (Estimated from the radius and depth of tree crown). There is a high linear correlation between these two features, as confirmed by the correlation coefficient of 0.832. Therefore, the tree crown volume where the depth of tree crown is considered depends on the tree height.

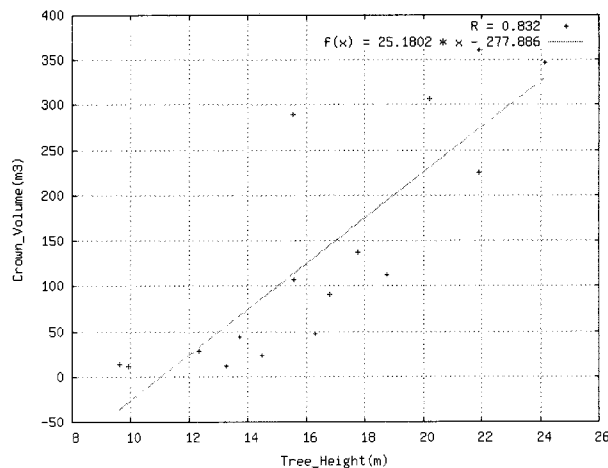


Figure 10. Relation between tree height and tree crown volume

### 5. CONCLUSION

From our results, the following facts were confirmed, in the larch species with closed canopy; (1) The radius of the tree crown depends on the distance between adjacent trees. (2) The radius of the tree crown doesn't depend on the tree height. (3) The crown base area (Estimated from the crown radius) doesn't depend on the tree height. (4) The depth of the tree crown depends on the tree height. (5) The tree crown surface area and volume (Estimated from the depth and radius of tree crown) depends on the tree height.

Therefore, This suggests that when the tree height is estimated from the spectrum data, the consideration of the depth of the tree crown is very important.

### 6. FUTURE PLANS

. The lack of large amount of measurements is a problem for the result obtained though the relation between the tree crown shape (Especially, depth of tree crown) and the tree height of the larch species with closed canopy could be quantified. Measurements of trees where the growth stages are different are scheduled. This, in order to improve the reliability of the result obtained and which will be used to build a growing model of the tree that considers the tree crown shape. This model will be based on the result of the analysis obtained. be based on the result of the analysis obtained. Then BRF will be simulated at multidirectional observations. The relation between BRF and the tree crown shape will be clarified by this way.

#### Acknowledgements

This work has been carried out as a part of the "Global Biomass Estimation Practical Use Project" supported by CREST, Japan Science and Technology Agency.

#### Reference

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