The Estimation Model of Leaf Biomass in
*Pinus sylvestris* var. *mongolica* Plantations, Northeast China

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1. Study Objectives

The leaves of woody plants play a paramount role in photosynthesis, the process by which practically solar energy enters forest ecosystems. The characteristics of spatial structure of leaves such as the amount, surface area, and arrangement may have direct influence on the light absorption, light intensity, and light spectrum related to leaves, determining the efficiency of harnessing solar energy by trees. This study was carried out to develop estimation model equation for leaf biomass in *Pinus sylvestris* var. *mongolica* (Mongolian pine) plantations of the Maoershan Experimental Forest, Northeast Forestry University, China.

2. Study Methods

Experimental data were collected in the seven permanent research plots of unthinned Mongolian pine plantations, which were varied by age, site condition, and stand density. Employed "equal basal area selective sampling method". The total of 36 sample trees were undamagedly felled to obtain analysis materials. The discs were gathered in the middle of every 1 m of interval node for each felled stem. Each whorled branch from the tree base were assigned with consecutive numbers, tallied 1,576 branches in total. The measurements of every whorled branch were implemented for total depth into crown of each branch (DINC), branch azimuth (ϕ), branch angel (θ), branch diameter (BD), branch length (BL), branch chord (BCL), and bow height (BAH). Fresh weight of stem and disc samples was measured in the field, and branch and leaf samples were weighed by standard branch method (Bai et al., 1987) on the basis of fresh weight. The fresh biomass was separately weighed for the whole leafy branch, leaf-mass only, and branch-mass only. Some portion of disc, branch and leaf samples were sealing tightly transported to the laboratory and dried in ovens at 80°C until fixed weight and then weighed and recorded. In order to develop leaf biomass estimation model for a single tree (WI), the values of correlation coefficient were calculated between total leaf dry mass of the sample tree and attributes of stands and trees on the basis of measure of dispersion and correlation analysis. Among those attributes, having higher values of coefficient than any other attributes, DBH and crown length (CL) were adopted as independent variables to induce leaf biomass model equations for the single Mongolian pine tree. In order to develop leaf biomass estimation model for a single branch (LDM), the values of correlation coefficient were calculated between leaf dry mass of the sample branch and attributes of stands, trees, and branches. Since branch diameter (BD), branch length (BL), and relative height of branch in the crown (BRH) had greater values of coefficient than others, these three attributes were employed as independent variables to induce leaf biomass model equations for the branch of
Mongolian pine. The optimum model equation were selected after examining the fitness by comparison of non-linear and logarithmic prediction models.

3. Results and Discussion

1) Prediction model of leaf biomass for the single tree

Equation (3) with independent variables of DBH and crown length was induced as an optimum prediction model to estimate the leaf biomass in a single Mongolian pine tree.

\[ W_l = a_0 DBH^{a_1} CL^{a_2} \]  

where \( W_l \) is leaf biomass (g), \( DBH \) is the diameter at breast height (cm), \( CL \) is crown length (m), and \( a_0, a_1, a_2 \) are parameter estimates. Parameter estimates and fit statistics of the developed equation were presented in Table 1 and residual diagram of leaf biomass was illustrated in Figure 2, hardly noticing apparent tendency.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard error</th>
<th>( t )-value</th>
<th>( p )-level</th>
<th>( n )</th>
<th>( S_{yx} )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
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<td>( a_0 )</td>
<td>12.40869</td>
<td>9.120749</td>
<td>1.360490</td>
<td>0.184156</td>
<td>32</td>
<td>1491.03</td>
<td>0.8111</td>
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<td>( a_1 )</td>
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<td>0.254523</td>
<td>5.524760</td>
<td>0.000006</td>
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<td>( a_2 )</td>
<td>1.27155</td>
<td>0.345532</td>
<td>3.679978</td>
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<td>32</td>
<td>1491.03</td>
<td>0.8111</td>
</tr>
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</table>

Figure 1. Residual for model of estimating whole leaf biomass of individual tree (Eq. (1))