The Korean Journal of Quaternary Research
Vol. 17, No. 2, pp. 149~152 (2003)

Biomass Estimation of Common Tree Species of Mongolia

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Introduction

Mongolia's nature and environment are its biggest assets, of global importance - an ecologically unique area where the Siberian taiga forest, the central Asian steppe, the Altai mountains, and the Gobi desert converge.

The continental climate is harsh-much harsher than in other countries of the same latitudes - and characterized by extremes in both temperature and its fluctuations. For six months of the year, mean temperatures fall below freezing. A remarkable feature is the number of clear, sunny days, some 220-260 per year. The frost-free growing season averages 115-120 days.

The area classified as forest land (including certain non-forest areas) is estimated at 17.8 million ha, i.e. 11.4 percent of the land area. Closed forest covers 12.8 million ha(8.2 percent), open forest 3.6 million ha, and non-forest 1.4 million ha. The area of potentially exploitable forests is estimated to lie between 5 and 6 million ha. In large parts of Mongolia, almost two-thirds, permafrost occurs, i.e. under a certain depth, the soil is permanently frozen. Practically all forest land in the country has permafrost. During the summer period, the frost melts in the upper, active layer down to averages of 1.5-3 m.

Most forests in Mongolia are larch forests - Siberian larch (*Larix sibirica*), covering about 59 percent of the closed forest area. Important are also Scots pine (*Pinus sylvestris*) and Siberian pine (*Pinus sibirica*), covering over 5 and almost 8 percent respectively. Birch (*Betula platyphylla*, white birch, mainly) cover almost 9 percent.

Growing stock of the closed forests is estimated at 1,363 million m^3, of which about 600 million m^3 are considered exploitable. Average density is estimated at 0.53. Average volume per hectare is estimated at about 125 m^3, average tree volume to vary between 0.45 and 0.58 m^3.

Forest have a traditionally been used for many products, including timber, fuel and fodder. Determining the biomass of forests is a useful way of providing estimates of the quantity of these components. Typically, the quantity of saw-timber has been assessed by making volume estimations, but this ignores the other useful components such as smaller size wood for fuel use. Furthermore, very few to no assessments have been made of the quantity of wood present in forests that appear to have no potential for saw-timber production. Assessing the total aboveground biomass of forests, defined as biomass density when, expressed as dry weight per unit area, is a useful way of quantifying the amount of resource available for all traditional uses. It either gives the quantity of total biomass directly or the quantity by each component (e.g., leaves, branches, and bole) because their biomass tends to vary systematically with the total biomass.

Material and Methods

This research was concentrated to get answer questions given below:

- how it is possible to determine tree characteristics for larch, pine and birch
- it is possible to determine aboveground biomass from living trees
- possible to use for determination of biomass to use average dbh
- what regression model can be useful for biomass estimation of living trees

Research was completed in Yalbag tree harvesting zone Selenge province. Tree with diameter ranging from 24 to 50 cm were identified on Yalbag. Three main species selected: larch (*Larix Sibirica*), pine (*Pinus Sylvestris*) and birch (*Betula Platyphylla*).

The aboveground oven-dry-weight of trees can be measured directly by felling them, oven-drying all components and then weighing them. However, it is not realistic to do this for all inventories. Instead, a practical solution is to develop regression equations based on data from felled trees from selected plots where this is possible. The selection of these trees in multi-species forests poses a challenging sampling design, and it is recommended that the assistance of a biometrician be sought. However, as a guide, the selected tress must come from the population of interest, represent the major species in the forest, and represent all size of classes.

Selected trees were harvested and separated into leaves, needles, branches and bole components and wet mass of each was measured with a large capacity digital balance to the nearest 0.1 kg. Several sub-samples (at least five) of each component must be collected and their fresh weight determined. Then they must be oven dried to constant weight at 105℃. Weighing of dried sub-samples should be done as soon as soon possible after removing them from oven because they soon absorb moisture and gain weight. For each sub-sample, a ratio of oven-dry-to-fresh weight can be calculated and an average ratio calculated. Multiplication of the total fresh weight of each component by the corresponding oven-dry-to-fresh-weight ratio will result in an estimate of the dry weight of the component.

For the larger branches and main stem (>3 cm diameter), it is generally not practical to weigh these fresh in the field. Instead, they should be cut into sections and the volume of each section calculated. The oven-dry-weight of these sections s determined as the product of volume and density (oven-dry-weight per unit of green volume). The sum of weights of all the components results in the total oven-dried weight of the tree, generally expressed in kg.

To develop local regression equations for palm trees, diameter is a better measure of biomass than height. For each palm tree, the diameter of the main stem should first be measured. Then the stem should be cut into 2m length sections, and their volume estimated. A disk from each section should be removed and its density (oven dry weight per green volume) measured. The weight of the stem is then the sum of the product of the volume of each section and its density. The weight of the leaves then has to be determined. This can be determined by first counting he total number of leaves. Then about three to four leaves should be selected and the average of their oven-dry weight (at 105℃) determined.

Results

- Data for different three species collected and

Table 1. Regression models relation between diameter at breast height ($D_{1.3}$), and aboveground biomass(G)

Component of trees	Regression models	R^2 value
Siberian Larch (*Larix Sibirica*)		
oven-dried mass of above ground biomass of tree (total)	$G = 1.354D_{1.3}^2+165.22D_{1.3}-3152.4$	R^2=0.73
oven-dried mass of stem, kg	$G = 2.212D_{1.3}^2+218.09D_{1.3}-4171.6$	R^2=0.74
oven-dried mass of bark, kg	$G = 0.227D_{1.3}^2+7.7624D_{1.3}-148.74$	R^2=0.54
oven-dried mass of branches below 3 cm, kg	$G = 0.048D_{1.3}^2+4.7746D_{1.3}-80.224$	R^2=0.87
oven-dried mass of branches above 3 cm, kg	$G = 0.079D_{1.3}^2+7.117D_{1.3}-128.85$	R^2=0.97
oven-dried mass of leaves. kg	$G = 0.038D_{1.3}^2+4.136D_{1.3}-79.637$	R^2=0.87
bark from branches above 3 cm, kg	$G = 0.02D_{1.3}^2+1.5781D_{1.3}-27.928$	R^2=0.61
Scotch Pine (*Pinus sylvestris*)		
oven-dried mass of above ground biomass of tree (total)	$G = 3.297D_{1.3}^2+337.68D_{1.3}-7319.5$	R^2=0.99
oven-dried mass of stem, kg	$G = 2.395D_{1.3}^2+250.77D_{1.3}-5477.6$	R^2=0.96
oven-dried mass of bark, kg	$G = 0.893D_{1.3}^2+92.126D_{1.3}-2152.5$	R^2=0.74
oven-dried mass of branches below 3 cm, kg	$G = 0.034D_{1.3}^2+34.851D_{1.3}-766.82$	R^2=0.95
oven-dried mass of branches above 3 cm, kg	$G = 0.134D_{1.3}^2+14.45D_{1.3}-325.81$	R^2=0.92
oven-dried mass of leaves. kg	$G = 0.114D_{1.3}^2+12.36D_{1.3}-292.15$	R^2=0.88
bark from branches above 3 cm, kg	$G = 0.066D_{1.3}^2+6.436D_{1.3}-145.88$	R^2=0.98
Betula (*Betula Platyphylla*)		
oven-dried mass of above ground biomass of tree (total)	$G = 1.656D_{1.3}^2+107.84D_{1.3}-1386.2$	R^2=0.99
oven-dried mass of stem, kg	$G = 0.980D_{1.3}^2+70.322D_{1.3}-918.66$	R^2=0.95
oven-dried mass of bark, kg	$G = 0.685D_{1.3}^2+47.764D_{1.3}-738.29$	R^2=0.73
oven-dried mass of branches below 3 cm, kg	$G = 0.175D_{1.3}^2+12.326D_{1.3}-179.73$	R^2=0.99
oven-dried mass of branches above 3 cm, kg	$G = 0.220D_{1.3}^2+15.303D_{1.3}-233.92$	R^2=0.83
oven-dried mass of leaves. kg	$G = 0.105D_{1.3}^2+7.2563D_{1.3}-112.66$	R^2=0.99
bark from branches above 3 cm, kg	$G = 0.054D_{1.3}^2+3.8924D_{1.3}-62.886$	R^2=0.99

calculated for determination for above-ground biomass

- Calculated relationships between volume of above ground part of trees with diameter of breast height (Fig. 1, 2)
- Growing trees above-ground biomass estimation models was developed for selected species(Table 1)

In all cases, the estimation which was derived from species-specific equations was larger than those from equations generalized for all species.

Discussions

Mongolia is one of the member countries of UN Framework Convention on Climate Change. For this purpose we should to make national greenhouse gas emission inventories. To estimate the magnitude of these sources and sinks requires reliable estimates of the biomass density of the forests undergoing change.

The quantity of biomass in a forest is a result of the difference between production through photosynthesis and consumption by respiration and harvest processes. Thus it is a useful measure for assessing changes in forest structure. Changes in forest biomass density are brought about by natural succession; human activities such as silviculture, harvesting, and degradation; and natural impacts by wildfire and climate change. Biomass density is also a useful variable for comparing structural and functional attributes of forest ecosystems across

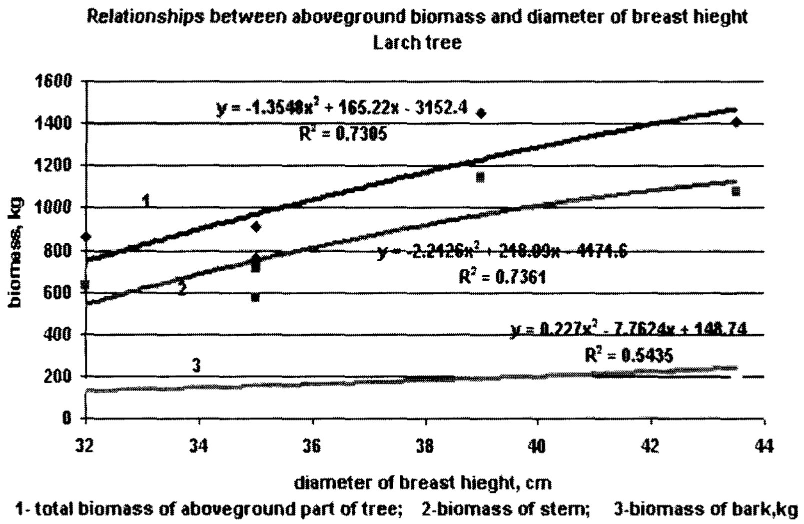

Fig. 1. Regression model of stem volume with diameter of breast height of Pine tree

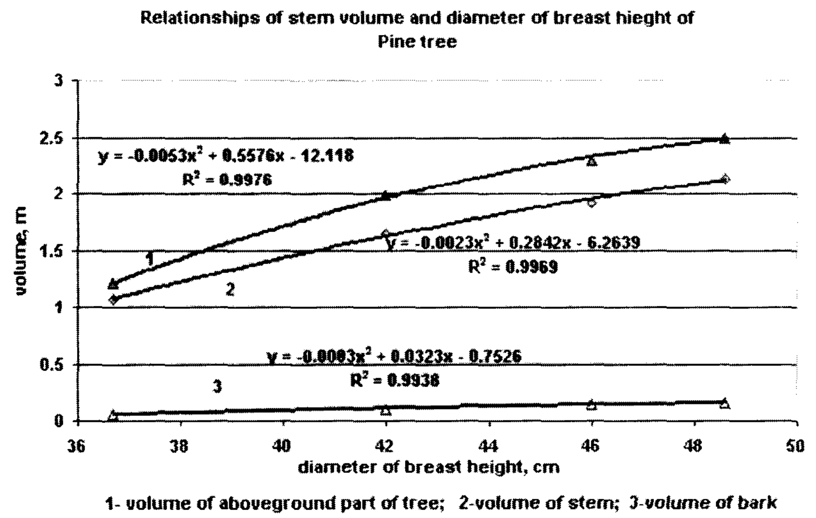

Fig. 2. Regression model of above ground biomass with diameter of breast height of Pine tree

a wide range of environmental conditions.

This primer is not intended to be an exhaustive compilation of available information on biomass estimation research over Mongolia. Rather, it is intended to present approaches that have been shown to be useful for application for further study. Improvements will only occur when estimating biomass density becomes one of the goals of a forest inventory. At this point, collection of the required data for making reliable estimates of biomass will be part of the inventory design.

In future this kind of study needed to estimate not only aboveground biomass of living trees. Belowground living mass of trees, shrubs, palms, samplings, other understory components, and dead plant mass such as litter and wood is important.