B-4.7 Carbon Storage in Biomass and Productivity of Larch Forests in Northeastern Asia

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Abstract This paper mainly discussed the biomass and primary productivity of Larch (*Larix gmelinii*) forests, an important type of natural forest ecosystem in Daxingan Mountains region, Northeast China. The aboveground biomass and primary productivity of these forests were different significantly in different climatic zones. In the same age group, the aboveground biomass and primary productivity were generally higher in the southeast climatic zone (85.37Mg ha^{-1} for young forest), while it was generally lower in north climatic zone (41.81 Mg ha^{-1} for young forest and 55.6 Mg ha^{-1} for middle age forest). In the same vegetation type, there was a higher aboveground biomass and primary productivity in young and middle age forests than those of mature forests. Furthermore, a comparison on the aboveground biomass and primary productivity between natural larch forests in Daxingan Mountains and larch plantation in other part of Northeast China was also analyzed in this paper. Some suggestions and perspectives are given on the belowground biomass and primary productivity.

Key words Larch forest, climate gradient, aboveground biomass, primary productivity, northeastern China,

1. Introduction

Natural larch forests, mainly composed by *Larix gmelinii*, widely distribute in the Daxingan Mountains region, Northeast China. Larch forests in this region usually have a high biomass and primary productivity due to its strong acclimation to extreme low temperature (Zhou et al 1991, Xu 1998). Whittaker (1975) has reported that annual primary productivity was about 8Mg $ha^{-1}yr^{-1}$ in cold

temperature region. However, natural larch forest is believed to have a relatively higher primary productivity than this general value in Daxingan Mountains. Therefore, larch forest ecosystem would be a big carbon sink, especially in vast area of Daxingan Mountain region, which would have special significance to fix the increasing CO_2 in the atmosphere.

2. Research Objective

Recently, a lot of research works have done in Daxingan Mountain region for assessing the biomass and primary productivity of larch forests (Liu et al. 1994, Han 1994, Hong et al. 1994, Wang 1994, Xu 1998, Zhao 1996). However, because most of them was published in Chinese or only focused on part of this region, it has been difficult for international scientific communication and citation of those works. For solving this problem, with the aim of clarifying the pattern of biomass and primary productivity change in this region, a lot of data based on existing literatures are summarized in this paper. Furthermore, a comparison analysis is made between the natural larch forests in this region and plantation in other parts of Northeast China.

3. Research Methods

The division of climatic zone in Daxingan Mountain for larch forests was modified from Guan et al. (1988). There are 3 climatic zone divided. They are southeast climatic zone (SE), central climatic zone, and north climatic zone (N). In each climatic zone, age group was divided according to the forest age: young forest (less than 50 years old), middle age forest (between 50 and 100 years old), and mature forest (more than 100 years old). The data of biomass and primary production was from 355 standard plots and 1051-sampled tree (Liu et al 1994).

The comparative study on different larch forest type was carried out in Tahe forestry bureau (52°09'-53°23'N, 123°20'-125°07'E), which locate in northeast part of Daxingan Mountains. Larch forests were divided into four types according to the species composition in forest floor, i) *Larix gmelinii*-herbage forests, ii) *Larix gmelinii* - *Rhododendron dauricum* forests, iii) *Larix gmelinii-Ledum palustre* forests and iv) *Larix gmelinii*-moss forests. In each forest type, aboveground biomass and primary productivity was determined in young, middle age and mature forest, respectively. 116 plots were investigated altogether (Zhao et al. 1996).

The biomass and primary productivity of larch plantation was investigated in Maoershan Experimental forest station (45°21'- 45°25'N, 127°31'-127°34'E), part of Zhanguangcai mountain region (Ding et al. 1990).

4. Results

Aboveground biomass and primary productivity increased from north to south in the same age group. In young forest, it was up to 85.37 Mg ha^{-1} in SE climatic zone, which was nearly two fold than that in N climatic zone. Aboveground primary productivity had similar tendency. Young forest had a highest primary productivity (9.86 Mg ha^{-1} yr^{-1}) in SE climatic zone. In middle age forest group, primary productivity was 6.26 Mg ha^{-1} yr^{-1} in C climatic zone, and was rather higher than N climatic zone.

Forest type of *Larix gmelinii*-herbage had the highest value both in aboveground biomass and in primary productivity among the four types. The *Larix gmelinii-Rhododendron dauricum* forest was the second. *Larix gmelinii-Ledum palustre* forest and *Larix gmelinii*-moss forest had a small value in both parameters. However, in the same forest type, mature forest usually had a higher biomass and a lower primary productivity.

In young and middle age forests, a high forest density was usually kept and peak value could be up to 2300 trees ha^{-1}. However, the density decreased sharply in mature stage, and only 1000 trees ha^{-1} in some cases. This result indicates that there may be a severely competition after maturation, which results in the die of many individual trees. Aboveground biomass is asymptotes at 100-150 Mg ha^{-1} after maturation. For aboveground productivity, a sharp increase was observed in young and middle age. Mean value was 5.0 Mg $ha^{-1}yr^{-1}$. Whereas, a slight decrease was observed after forest maturation, with mean value lower than 4.0 Mg $ha^{-1}yr^{-1}$.

Larix gmelinii is a main species for afforestation in Northeast China and plantation area is up to two third of total afforested area. Investigation was carried out in Maoershan Experimental Forest Station, part of Zhanguancai mountains (Ding 1990). Aboveground biomass of 33-year-old larch plantation was 113.62 Mg ha^{-1} and primary productivity was 7.25 Mg $ha^{-1}yr^{-1}$. This growth rate was almost the same in natural larch forests in C climatic zone of Daxingan Mountains region.

5. Discussion

The vast area of Daxingan Mountains region, with 8-degree difference in latitude, has a climatic gradient. Larch forests well acclimated to this kind of climate, and the aboveground primary productivity changes as the latitudes changes. In SE climatic zone, it can be up to 9.86 Mg $ha^{-1}yr^{-1}$, while in N climatic zone, it was only 2.68 Mg $ha^{-1}yr^{-1}$, which was just one third of that in SE climatic zone.

Direct measurement of belowground biomass is very hard to do, so that estimation for belowground biomass and primary productivity is more difficult than aboveground. Actually, literatures on belowground biomass and primary productivity in Daxingan Mountains region are limited. Han (1994) has reported that belowground biomass and primary productivity of a *Larix gmelinii- Betula phlatyphylla* forest were about 5.74 Mg ha^{-1} (19.86% of total biomass) and 0.38 Mg $ha^{-1}yr^{-1}$ (15% of total primary productivity). Ding et al. (1990) has reported that belowground biomass and primary productivity of a *Larix gmelinii* plantation in Maoershan experimental forest station was 28.70 Mg ha^{-1} (21% of total biomass) and 1.20 Mg $ha^{-1}yr^{-1}$ (15% of total primary productivity). Therefore, future studies must pay a special attention to the belowground biomass and primary study in Daxingan Mountain region.

References

Ding, B. et al. (1990) Studies on biological productivity of artificial forests of Dahurian larch plantation. *Acta phytoecologica et geobotanica sinica,* **14**(37): 226-236. (in Chinese)

Guan, Y. et al. (1988) Zoning of original larch forest productivity of the Daxingan forestry administration Bureau in Inner Mongolia autonomous region, Beijing Forestry University,

Beijing. (in Chinese)

Han, M. (1994) A study on biomass and net primary production in a Dahurian larch birch forest ecosystem. In Zhou, X. eds., Long-tem research on China's Forest ecosystems. NEFU Press, Harbin, 451-458. (in Chinese)

Hong, Q. et al. (1994) Growth of natural larch forests in Tahe of Daxinan Mountains. *Journal of Northeast Forestry University*, **20**(2): 92-97. (in Chinese)

Liu, Z. et al. (1994) A study on the biomass and productivity of the natural *Larix gmelinii* forests. *Acta phytoecologica sinica*, **18**(4): 328-337. (in Chinese)

Wang, L. and L. Feng (1994) Biomass of herbage larch forest with variable density in Daxingan Mountain. In Zhou, X. eds., Long-tem research on China's Forest ecosystems. NEFU Press, Harbin, 459-464. (in Chinese)

Whittaker, R. H. and G. E. Likens (1975) Primary productivity of the biosphere. 305-328. Springer-Verlag.

Xu, H. (1998) Da Hinggan Ling Mountains forests in China. Science Press, Beijing. (in Chinese)

Zhao, H. et al. (1996) On forest growth of Northern slope of Daxinan Mountains. *Journal of Northeast Forestry University*, **24**(6): 1-8. (in Chinese)

Zhou Y. et al. (1991) The Vegetation of Daxingan Mountains in China. Science Press, Beijing. (in Chinese)