B-4.1 Estimation for Storage and Changes in Carbon Accumulated in Larch Ecosystems

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Abstract Carbon storage in aboveground and belowground biomass, soil organic carbon within 1-meter depth was estimated in a larch (*Larix kaempferi*) plantation located on Tomakomai Flux Tower Research Site, southwestern Hokkaido. C in aboveground biomass, belowground biomass, and soil were 33tonC/ha, 9tonC/ha, and 26tonC/ha, respectively. Soil organic carbon (SOC) storage in larch plantations on Andisol and Brown Forest soil region was also estimated. SOC accumulation rates based on years after volcanic eruption and SOC storage in soil profile were 0.910 and 0.10 tonC/ha/yr, respectively. Another research site for long-term CO_2 budget study was established in Hokkaido University Forest, located on northern Hokkaido.

Key Words Larch forest ecosystem, Andisols, Brown forest soils, Soil organic carbon, Soil carbon accumulation rate

1. Introduction

The contribution of carbon sequestration by forest ecosystems in carbon dioxide flux is one of the central scientific issues today. Forest ecosystems in northeastern Asia have a great influence on CO_2 budget, because most of the forests are larch (deciduous conifer), which has active sequestration period and dormant period in a year.

Larch was a main plantation species after World War II in Hokkaido Region. Unfortunately, there was not so precise ecosystem study on larch plantation that regional estimation of C sequestration by mature larch plantation is still difficult. Mature larch plantation forests, 500-meter square blocks, were large enough for CO2 flux study without fetch problems. We established flux research monitoring site in Tomokomai National Forest in 1999, in order to build up cross check system between flux data and ecological data.

2. Research Objective

In this sub theme, the objectives are to estimate biomass carbon storage and soil organic carbon storage in larch plantations. We also estimate the SOC storage regime among

soil types in Hokkaido and its accumulation rate using buried tephra.

3. Research Method

We obtained allometric regression relationship between DBH (diameter at breast height of individual trees) and aboveground and belowground parts in adjacent plantation stand. Dry weight of each part was calculated and stand biomass was estimated in the study site.

Soil survey was conducted in four larch plantations. One was in Andisols, another in Brown Forest Soils region, and rest of two were Brown Forest Soils with heavy clay texture. All soil samples were air-dried and sieved through 2-mm sieving mesh. Then fine earth fraction less than 2mm were analyzed for organic carbon and total nitrogen determination. The SOC and total N storage was calculated by multiplying C and N concentrations, thickness of horizon, bulk density, fine earth ratio, rock fragment ratio.

Another monitoring research site in northern Hokkaido was selected in Teshio Experiment Forest, Hokkaido University Forest in 1999 and 2000. Meteorological data and stream runoff data in small watershed were obtained.

4. Result

Estimated carbon in flux research site was 33 tonC/ha in aboveground, 9 tonC/ha in belowground, and 26 tonC/ha within 1-m depth of soil. Soil is typical immature soil derived from volcanic ash, which was erupted in 1739 form Mt. Tarumae. Upper 25 cm soil layer is coincides with this latest big eruption in 1739. Soil organic carbon accumulation rate in research site was calculated as 10.0 $gC/m^2/yr$ (0.10 tonC/ha/yr), dividing 26 tonC/ha by 260 yrs.

The SOC storage in Andisols was examined in eastern Hokkaido region (Pilot Forest 230). Since the soil profile showed several buried layers with high organic carbon content, SOC storage was 188 tonC/ha. Although tephra dating is not precise in this region, we can detect two remarkable layers dated 1850 and 2280 yrs B.P. The SOC accumulation rate was calculated as 9.1 $gC/m^2/yr$ (0.091 tonC/ha/yr), dividing 188 tonC/ha by 2065 yrs.

Larch plantation near Sapporo City (Hitsujigaoka) located on the Brown Forest Soil region had relatively large amount of SOC storage within 1-m depth of soil. The Hitsujigaoka soil derived from old mudflow of volcanic sand and conglomerates had so high bulk density and organic C contents that total SOC storage was large. On the other hand, larch plantation in northern Hokkaido region in Teshio Experiment Forest had relatively small amount of SOC storage.

Another long-term monitoring study site for detecting CO2 flux change by conversion natural mixed forest to larch plantation was established in Teshio Experiment Forest, northern Hokkaido. SOC storage in natural mixed forest soil was 159 tonC/ha. According to the meteorological data obtained, mean annual temperature was 5.9°C, and mean annual wind velocity was 2.0 m/sec. Runoff in stream channel was observed during April to late November. Maximum snow depth was 118 cm.

5. Discussion

Soil organic carbon storage in larch plantation forests in this study varied in wide regime. Table 1 shows the SOC and total N (TN) storage, and CN ratio.

Table 1. SOC, TN and CN ratio of soils in this study.

Site	Soil type	SOC	TN	CN ratio
Tomakomai	Immature	26.2	1.91	13.7
Pilot Forest 230	Andisols	188	14.3	13.1
Hitsujigaoka	Brown Forest soils	181	13.6	13.4
Teshio larch	Brown Forest soils	87.2	7.40	11.7
Teshio natural	Brown Forest soils	159	10.3	15.5

Unit of SOC and TN are tonC/ha and tonN/ha, respectively.

The regime of SOC storage in Andisols was ranging from 100 to 250 tonC/ha (Takahashi & Sanada 1998). The typical mesic Andisols has higher regime more than 200 tonC/ha. The soil of Pilot Forest is thought to be the average SOC level. The soil in Hitsujigaoka had large SOC storage, because of thick A horizon with high C content. Soils of Tomakomai, Pilot Forest and Hitsujigaoka showed similar CN ratio about 13. Two soils in Teshio Experiment Forest had quite different SOC storage. This suggests that vegetation conversion from a natural mixed forest to larch plantation caused serious surface soil erosion after reforestation.

The SOC accumulation rates estimated in two volcanic soils were similar, as shown in Table 2.

Table 2. Soil organic carbon accumulation rate in two volcanic soils.

Site	Years after dating tephra	SOC above tephra	rate
Tomakomai	260 yrs	26 tonC/ha	0.10 tonC/ha/yr
Pilot Forest 230	2065 yrs	188 tonC/ha	0.091 tonC/ha/yr

These two estimated rates were close to other studies of soil development on volcanic island and vegetation recovery on mudflow chronosequence (Schlesinger 1991).

References

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