Carbon Migration in Deciduous Forest - Soil System
− Carbon Storage and Soil Respiration −

Background

Forest - soil system is expected as a sink of carbon dioxide (CO_2) for controlling global warming. CRIEPI (Central Research Institute of Electric Power Industry) started a systematic observation for carbon fluxes and stock of organic carbon in forest - soil system in July 2001. Observation site (Kita - Saku Site) is located in Central Japan (N 36° 24', E138° 34', 1360~1380m a.s.l.). Vegetation type is deciduous forest with easy gradient. Although carbon is stocked as soil organic matter in the same level with above ground biomass, it is difficult to estimate carbon reaction in soil, and quantitative analysis method is not established. It is necessary to establish a systematic observation method to evaluate the spatial distribution of soil respiration (CO_2 efflux from soil surface) and carbon stock in soil.

Objectives

(1) Development of accurate estimation method for soil respiration with spatial and seasonal variation.
(2) Evaluation of carbon storage, flux, distribution and chemistry in forest soil - atmosphere system.

Principle Results

1. Development of New Soil Respiration Observation Method(Gas Circulation Chamber)

Portable observation apparatus for daily soil respiration was developed (Fig.1). In foregone apparatus, it is difficult to control CO_2 concentration in an observation chamber. The new circulation chamber is able to observe soil respiration actually by synchronize CO_2 concentration in the chamber with ambient concentration. Based on this new apparatus results, foregone method results and soil temperature, soil respiration estimation method at a low cost and accuracy was developed.

2. Soil Respiration in Observation Site

Base on statistical analysis about spatial variation of observed CO_2 respiration, optimum arrangement of observation points for accurate evaluation in an observed area was proposed. Using this method and observed soil temperature, annual respiration in Kita-Saku site was estimated as 6-7t C/ha/yr (Fig.2, May 2001 - Apr 2003).

3. Chemistry and Distribution of Soil Organic Carbon

Vertical distribution and chemistry of soil organic carbon (SOC), which is a source of soil respiration, was analyzed in Kita - saku site. SOC with 34 t C/ha was observed in layer between ground surface and 20cm depth. This storage was about 30-40% of carbon storage in forest - soil system. The most labile component in SOC was distributed in the layer upper than 15cm depth. SOC with 1.1 t C/ha was decomposed annually and released to atmosphere. On the other hand, runoff of carbon with leakage of soilwater was negligible.

Future Developments

Development of prediction method for SOC storage in future by enlarged applicability of soil organic matter models to Japanese mountainous forest soil.

Main Researchers:
Hideshi Ikeda, Ph. D., Research Engineer, and Shinji Yasuike, Ph. D., Research Scientists, Geospheric and Hydrospheric Environment Sector, Environment Science Research Laboratory

Reference

Yasuike, S. et al,:Development of an evaluation method for spatial distribution of soil-CO_2 efflux in forest sites. CRIEPI Report : U03010 (2003, September, in Japanese)
Ikeda H. et al., :Migration and Fixation of Organic Carbon in Vegetation - Forest soil System, Geochimica et Cosmochimica Acta, 67(18S), 2003.p A167.

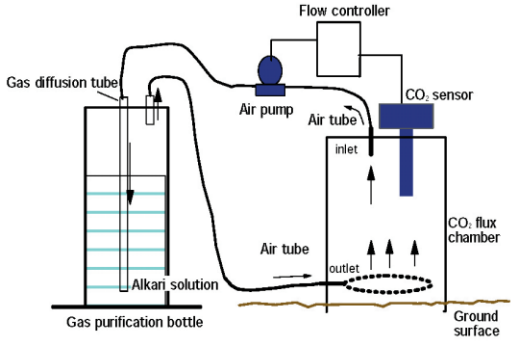

Fig.1 Schematic diagram of gas circulation chamber

An on/off flow controller connected with the air pump keeps the CO_2 concentration in the chamber at a set value. The mechanism enables the precise measurement of CO_2 efflux from soil surface (Jap. Pat. JP2001-296215A)

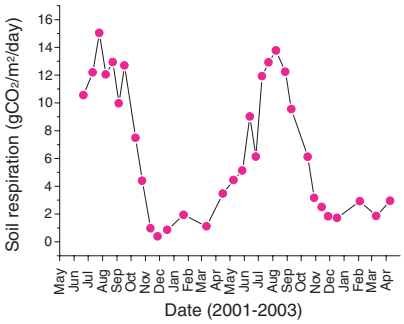

Fig.2 Seasonal change of soil respiration measured by gas circulation chamber (from May 2001 to Apr. 2003)

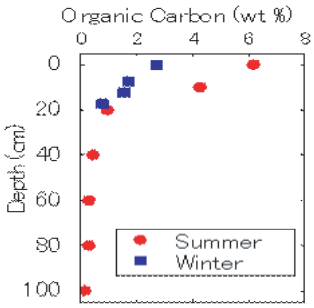

Fig.3 Depth Profile of SOC

Soil respiration highly depends on soil temperature and consequently the value increased during the summer season and decreased during winter.

More than 50% of SOC is observed in layer 20cm depth. It shows seasonal variation; high in summer and low in winter.

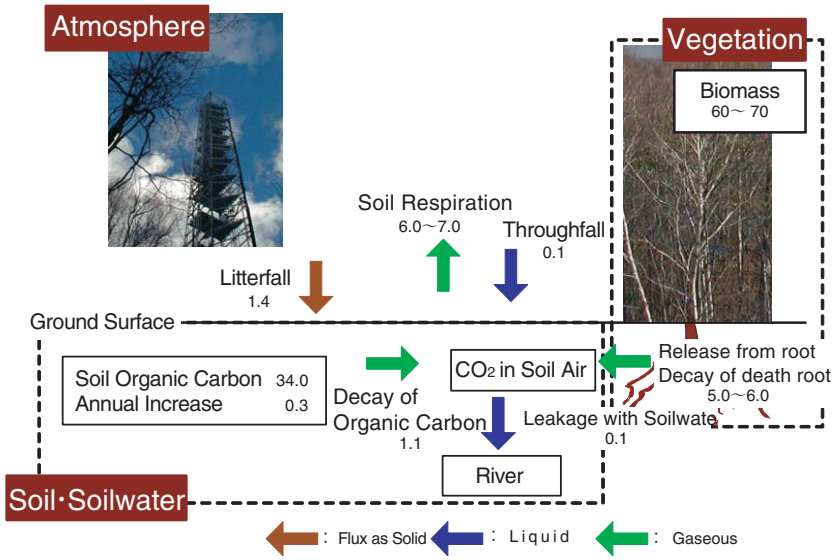

Fig.4 Storage and Annual Carbon Flux in Forest－Soil System (t C/ha, August 2001～July 2002)

Organic carbon, 1.4 t C/ha annually, was supplied as litterfall. Carbon was distributed to 0.3 t C/ha as storage in soil, and 1.1 t C/ha as decay in soil. Decayed organic carbon and released CO_2 from root are sources of soil respiration (6.0～7.0 t C/ha).