Carbon Transfer and Accumulation in Forests, Wetlands and Farmlands

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Abstract

The operation of the spent nuclear fuel reprocessing plant in Rokkasho, Japan, is accompanied by the discharge of a small amount of ^{14}C mainly in the form of $^{14}CO_2$, which is transferred into terrestrial ecosystems and accumulated in them. In order to predict the fate of this discharged ^{14}C, it is necessary to develop transfer and accumulation models of carbon in terrestrial ecosystems such as forests, wetlands, paddy fields, farmlands and pastures, which are found around the reprocessing plant.

We selected the following as target forests and plantations in the study: a forest co-dominated by beech (*Fagus crenata*) and hiba (*Thujopsis dolabrata*) trees, a deciduous broad-leaved forest dominated by oak (*Quercus crispula*) trees, and two tree plantations of 21-y-old and 67-y-old Japanese cedar (*Cryptomeria japonica*) trees. The net primary productivities at the target forests were obtained as the sum of the growth rate of tree and litter fall by field observations and the allometry equation of the tree.

To obtain the decomposition rates of soil organic matter and their temperature dependency, soil samples from the forests, wetlands, paddy fields, farmlands and pastures were incubated in the laboratory at different temperatures (10, 20, and 30°C), and respired CO_2 amounts from the soil samples were measured during the periods for up to ~500 d. The decomposition rate of labile and resistant soil organic matter was approximated by an exponential decay functions. The rate constants of decay functions for the labile and resistant soil organic matter were fitted to the Arrehenius equations to obtain the rate constants depending on temperature. To investigate soil microbial communities during the incubation, incubated soils were analyzed using the denaturing gradient gel electrophoresis (DGGE) method during the periods for up to ~280 d. The results showed no major changes in microbial species composition for each incubated period of each soil sample.

To investigate the decomposition rates of plant residues and transfer of decomposed products to soil organic matter in paddy fields, farmlands and pastures, mixtures of ^{13}C-labelled plant material and soil of each study field were packed into glass-fiber filter bags, and buried in each study field. Amounts of ^{13}C in the glass-fiber filter bags were measured at predetermined intervals during the periods for up to ~590 d after burying. The decomposition rate of plant residue or litter in each field was approximated by exponential decay functions.

A model program for the framework of the ^{14}C transfer and accumulation model in farmlands was constructed and successfully tested for its basic input/output function.

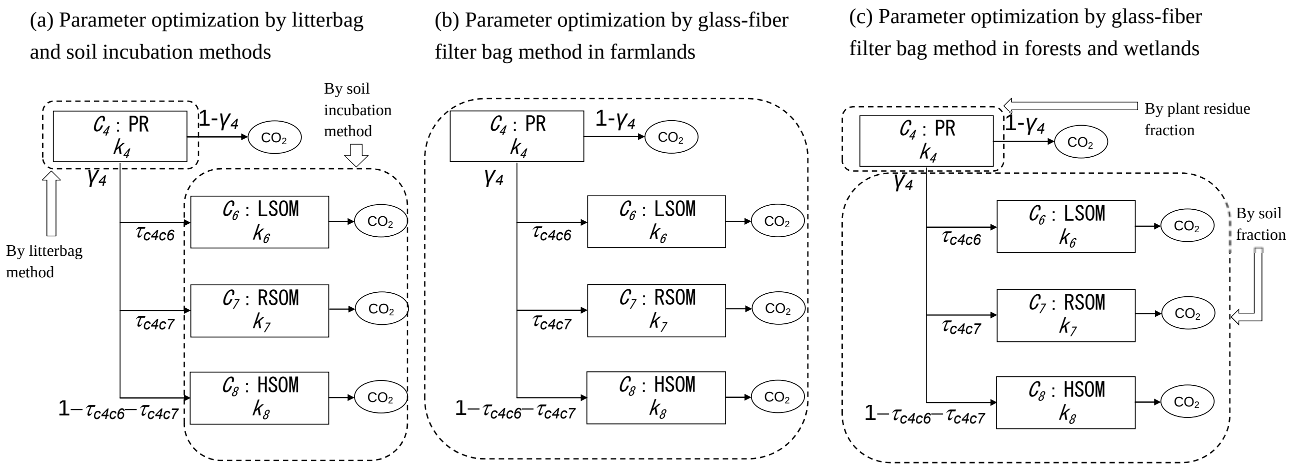

Fig. 1 Schematics of the litter and soil carbon transfer and accumulation model.
PR, LSOM, RSOM, and HSOM indicate plant residue, labile, resistant, and highly resistant soil organic matter, respectively.

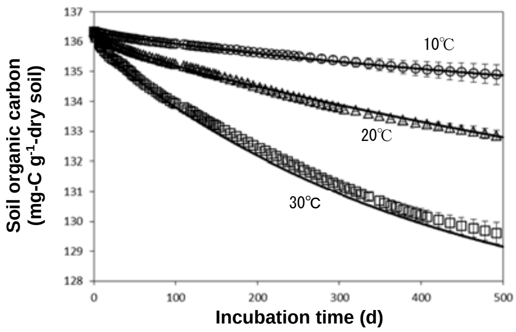

Fig. 2 Decrease in the organic carbon of incubated soils collected from the 21-yr-old Japanese cedar (*Cryptomeria japonica*) plantation.

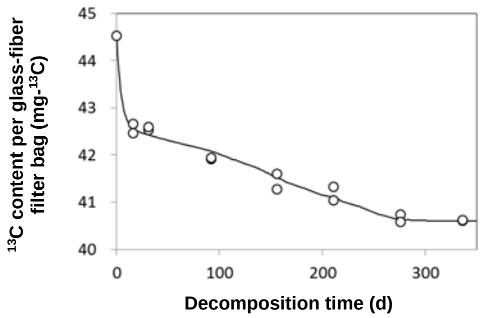

Fig. 3 Decrease in ^{13}C content per glass-fiber filter bag recovered from a carrot field on farmland.