B-6.1.3 Quantitative and Predictive Analysis of Carbon Cycle in Regional Ecosystem

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Total Budget for FY1990 - FY1992 6,485,000 Yen

Abstract To clarify carbon cycle in agricultural ecosystems at a regional scale, we established the method to clarify the carbon cycle in the regional ecosystem using Landsat TM data and made a map of its annual carbon flux. The study area was the basin of Koise River, Ibaraki Prefecture (30km x 30km). The annual flux varied from −493 to +40gC/m^2/yr with an average of −151gC/m^2/yr. Carbon budgets in croplands varied largely at a regional scale, suggesting that we must cover this spatial variation to estimate the regional carbon budgets.

Key Words Carbon cycle, Cropland, Region, Remote sensing, Model

1. Introduction

The carbon cycle in agricultural ecosystems at a regional scale is important to estimate the carbon cycle at a global scale. However, there are few quantitative analyses of the carbon cycle in a regional ecosystem. A satellite remote sensing technique is very useful for that. Our objectives are to establish a method to measure the carbon cycle in the regional ecosystem using remote sensing and to make a map of annual carbon flux at the regional scale.

2. Research Method

The study area was the basin of Koise River, Ibaraki Prefecture (30 km x 30 km). First, we classified the land-cover and estimated the carbon contents in the aboveground parts of plants and soils in croplands using TM data. Then, we constructed a two-compartment model of the carbon cycle in croplands, simulated carbon budgets with parameters derived from TM data, and made a map of annual carbon flux in the croplands.

3. Result and Discussion

We classified the land cover in the basin of Koise River into paddy field, cropland, grassland, broad-leaved forest, evergreen forest, bare soil, lake and city, with maximum likelihood classifier. This classification showed good reliability, 88%. Then, we estimated the carbon contents in the aboveground parts of plants in croplands (B; gC/m^2) using the following equation:

$$B^{1/2} = 110.4(NVI+1)^{1/2} -120.4,$$

where NVI = (TM4−TM3)/(TM4+TM3), and the carbon contents in soils (C; gC/m^2) using the following equation:

$$\log C(\%) = -0.0268TM3 + 1.47.$$

Moreover, we estimated the carbon contents in stubble (S; gC/m^2) using the following equation:

$$S = 0.56B - 0.17 \quad (r=0.83,\ p<0.01).$$

We developed the two-compartment model (Fig. 1), which led the equation of carbon contents in soils (C) as follows,

$$dC/dt = 0.3S - 0.02C.$$

Using this equation, we calculated the annual carbon flux ($gC/m^2/yr$) and made its map (Fig. 2).

The annual flux varied from −493 to +40 $gC/m^2/yr$ with an average of −151 $gC/m^2/yr$ (Fig. 3). It should be noted that carbon budgets in croplands vary largely within a region, suggesting that we must cover variation at this spatial scale to estimate the regional carbon budgets.

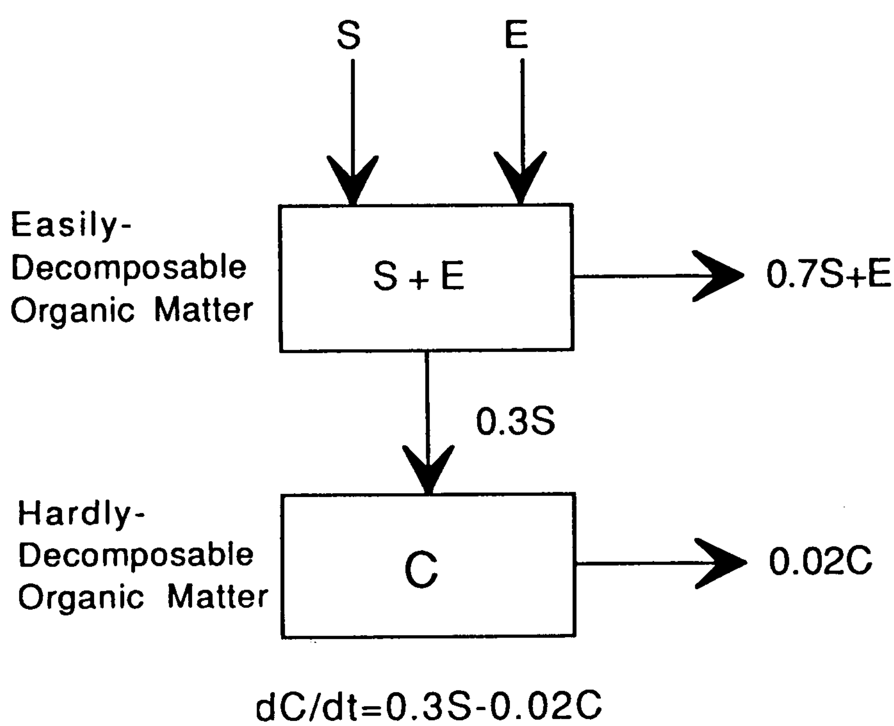

Fig. 1 Two-compartment model of the carbon cycle in croplands.
S, E and C indicate annual inputs of carbon from stubble ($gC/m^2/yr$), annual inputs of carbon from root exudation ($gC/m^2/yr$) and soil carbon contents (gC/m^2), respectively.

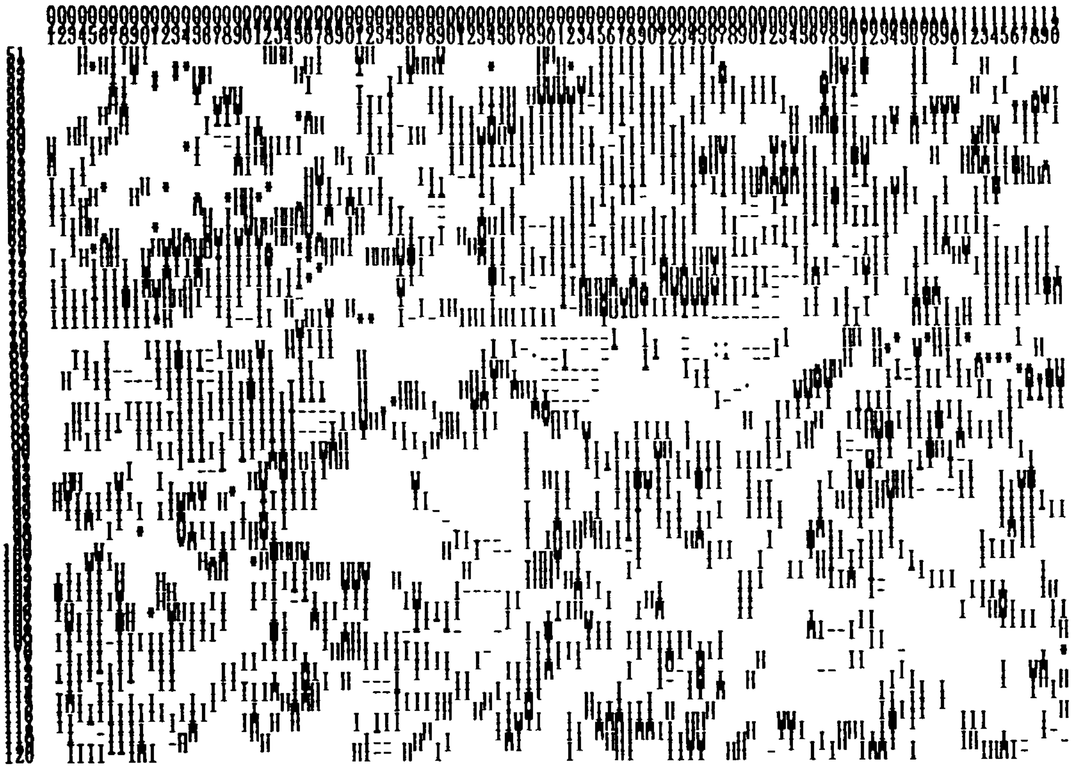

Fig. 2 Gray map of the annual carbon flux in a part of the croplands.
(*: <-300 $gC/m^2/yr$, H: -300 - -200 $gC/m^2/yr$, I: -200 - -100 $gC/m^2/yr$,
-: -100 - 0 $gC/m^2/yr$, .: >0 $gC/m^2/yr$, blank: land-covers without cropland)

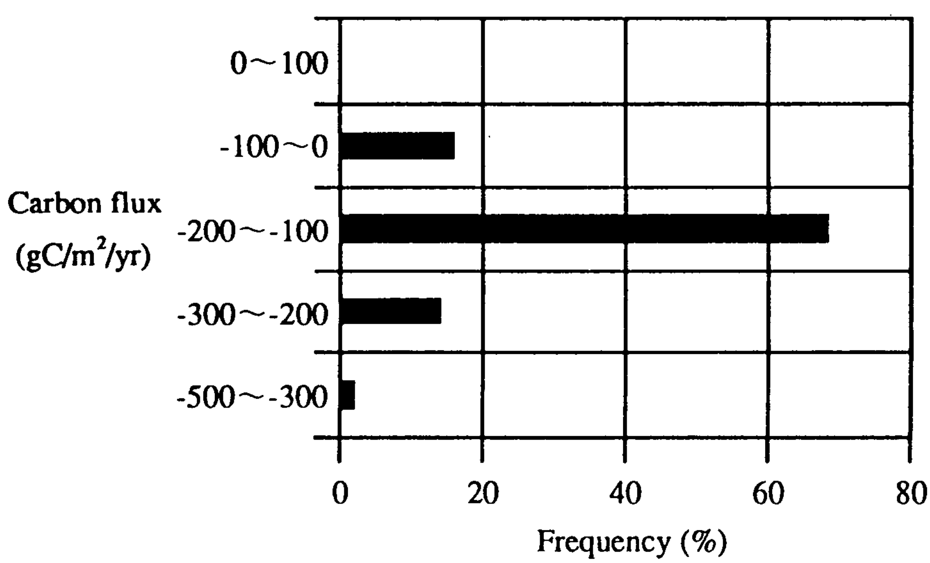

Fig. 3 Frequency distribution of the annual carbon flux in the croplands.