Analysis of IPCC Relative Stock Change Factor at Farmland Land Uses in the Ikushunbetsu Watershed

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Recently, the influence of land use change on soil carbon stock change is analyzed in terms of global warming mitigation option. The IPCC (2006) suggested an indicator called relative stock change factor (RSCF) to simply estimate the soil carbon stock potential. The RSCF is based on the assumption that any soil gets to equilibrium under the same cultivation method. RSCF is defined as the relative value of the soil carbon stock equilibrium of 0-30cm depth after 20 years. The difference of RSCF between different years becomes the change in soil carbon stock. Since RSCF is a relative value, the amount of carbon stock must be obtained quantitatively to analyze the amount changed. To evaluate the soil carbon stock, it is necessary to make a spatial analysis. It is important to compare values taken at different time and places and scale up those point data to a regional scale. The accompanying error is of concern. The analysis using geographic information system (GIS) is highly required.

The objective of this study is to analyze the RSCF in a watershed and compare it to measured soil carbon values in 1976, 2005 and 2007. It is analyzed how appropriate RSCF can estimate the soil carbon stock change and the carbon stock potential in the study area is discussed.

The study site is the Ikushunbetsu Watershed, Central Hokkaido, Japan. The main land use in that area is paddy rice, wheat, soybean, onion, vegetable and grassland. The land use in 1976 was obtained from the statistics of the Mikasa city. Ground survey was conducted in 2003, 2005 and 2007. For 1976, 1998 and 1994, land use distribution was obtained from a 25,000:1 map. The spatial information was digitalized using ArcView9.1. Management method of each land use was obtained from statistics for 1976, and from farmers inquiry in 2005 and 2007. The RSCF consists of land use factor, management factor and input factor (2006). Each factor was separately defined for each land use for 1976, 2005 and 2007 based on the default values suggested for mineral soils in temperate regions. The average value of the whole watershed is the weighted mean based on the proportion of each land use.

In 1976, 14 soil profiles were analyzed by the Basic Survey on Soil Fertility. In 2005 and 2007, 51 and 49 points were investigated, respectively. A map was created by kriging the points and only the area with artificial land use was extracted to calculate the mean of the watershed.

The RSCF in 1976, 2005 and 2007 were 1.11, 0.98 and 0.99, respectively. The main reason for the difference was the decrease in paddy rice fields which changed the land use factor from 0.94 to 0.87. The soil carbon concentration was 34.1(SD 13.9), 28.1(10.9) and 26.2 (8.7) g C kg^{-1} in 1976, 2005 and 2007, respectively. The soil carbon in 0-30cm depth was 91.4(SD 45.6) Mg C ha-1 in 1976 and 83.1(26.9) Mg C ha^{-1} in 2007. The change ratio was 0.90, which was close to that of RSCF (0.89). It was concluded that RSCF can estimate the soil carbon stock change in a watershed scale. If paddy rice field proportion increases from 23% to 50%, RSCF increases to 1.17, if no-tillage is practiced it increases to 1.10, if the carbon application increased in paddy rice, wheat and onion fields, it increases to 1.09. Thus soil carbon can be increased by 8.3-15.0 Mg C ha^{-1}.

The soil carbon concentration in 2005 showed significant positive correlation to that in 2007 (R^2=0.553), whoever, no relation was found with the value in 1976 to 2005 and 2007. The ratio of carbon concentration of 2005 to 1976 ranged from 0.3-1.5. The ratio of RSCF at each sampling point of 2005 to 1976 ranged from 0.6-1.2, underestimating the real change. There was no correlation between the measured carbon change ratio and RSCF ratio.

It was concluded that RSCF can be used to estimate the average change in a watershed scale, but to estimate at point scale, a site specific factor is required.