SIMULATING EFFECTS OF LAND USE CHANGE ON CARBON FLUXES WITH A PROCESS MODEL IN SUBTROPICAL HILLY RED EARTH

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ABSTRACT

A process model was used to simulate changes in the carbon fluxes and stocks at a site that was transformed a grassland to a plantation at Qian Yanzhou. The total carbon storage of the zonal vegetation (evergreen broadleaf forest) was simulated and taken as the saturated carbon storage value of that site. The simulated vegetation density and soil organic carbon (SOC) were compared with the observed. The simulates indicate that after 20 years planting of the needle leaf forests (*Pinus Massoniana*, *Cunninghamia lanceolata* and *Pinus elliottii* ect) on ex-grassland, the net carbon storage increase in the plantation was 8.03 kg C/m^2, in which the vegetation carbon storage increased 8.5334 kg C/m^2 and the soil carbon storage decreased 0.518 kg C/m^2. The total carbon storage of 20 years plantation is 58.6％ of the saturated value. The study also shows that between 0 and 7 years of land use change the soil carbon was decreased and between 7 and 20 years it was predicted to increase slowly.

METHDOLOGY

Model description

The model used in the study is the Atmosphere-Vegetation Interaction Model (version2, AVIM2) that was developed for simulating seasonal and interannual variations in biophysical and biogeochemical processes at the land surface. This new version couples the original AVIM with a soil organic carbon (SOC) model. The AVIM includes a plant growth model and a soil vegetation atmosphere transfer (SVAT) scheme. The SVAT simulates energy transfer and water cycle: radiation transfer and sensible heat exchange as well as rainfall, interception, drainage, surface runoff, infiltration, evapotranspiration, etc. Photosynthesis, respiration, dry matter allocation among plant organs, and decomposition of organic matter are simulated in the plant growth model. The SOC submodel divides soil organic matter into active, slow and passive organic pools. First-order equations are used to calculate the rates of the decomposition of the 3 pools, and litter quality, soil moisture, temperatures, and soil texture are considered to affect the decomposition rates. Turnover of active soil organic matter (SOM) and formation of passive SOM is estimated based on the decomposition rates and the transfers of the organic matter between the 3 pools.

Study site

This experiment site is one of the “Chinaflux” network, locating in South China at 26°44′48″N, 115°04′13″E. The land cover of the site was wild grassland before 1983, the year the network station setup. The land cover of Qian Yanzhou changed much after 1983, the area of wild grassland decreased from 83.2% in 1983 to 5.2% in 1997 and the area of forest increased from 0.88% in 1983 to 60.11% in 1997. The needle leaf forests planted in this site were not disturbed by human activities after planting. The Chinese government planted much plantation in the red earth hilly area of the southern China after 1980s. The land use change in Qian Yanzhou is such an example.

Experiment design

This experiment aims at estimating the carbon fluxes and storages change after land use change and estimating the carbon increase potential of the site. The simulation was conducted by running the model to equilibrium first and then doing the following 3 experiments: 1) Assuming the vegetation at the site as the zonal vegetation (evergreen broadleaf forest) and running the model to simulate the soil and vegetation carbon density change during 1962 to 2000; 2) Assuming the vegetation at the site as the grassland over the year 1962 to 2000 and simulating the net primary productivity (NPP), the vegetation and soil carbon density; 3) Assuming the vegetation as grassland during 1962 to 1982 and as needleleaf forest after 1983. Simulating the NPP, soil and vegetation carbon changes in the plantation.

RESULT

Table 1 shows the simulated and observed vegetation and soil carbon density at Qian Yanzhou in 1998. The number in the bracket is observed data. It shows that the simulations are agreed with the observations.

Table 1. Simulated and observed vegetation and soil carbon density at Qian Yanzhou in 1998.

Vegetation	Soil carbon(kg C/m^2)	Vegetation carbon(kg C/m^2)
Grassland	8.5999(8.9504)	0.688(0.5843)
Neadleleaf forest	7.6793(7.4488)	8.2293(10.1866)

Observed data source: *J. Y. Li*, 2001.

In 2000, the simulated total carbon storage in soil and vegetation is 29.48 kg C/m^2, 17.29 kg C/m^2 and 9.26 kg C/m^2 in zonal vegetation, plantation and grassland, respectively. The mean NPP is 0.667 kg C/m^2a in zonal vegetation and is 0.541kg C/m^2 in grassland. The simulated NPP of plantation increased from 1983 to 1990 and fluctuated after 1990. In 2000, the net carbon storage increased in the plantation is 8.03 kg C/m^2 compared to the grassland，in which the vegetation carbon storage increased 8.5334 kg C/m^2 and the soil carbon storage decreased 0.518 kg C/m^2. The total carbon storage of 20 years plantation is 58.6％ of the saturated value.

Between 0 and 7 years of grassland to forest the soil carbon was predicted to decrease by an average of 0.1725 kg c/m^2 per year and between 7 and 20 years it was predicted to increase by an average of 0.085 kg c/m^2 per year.

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