CARBON FLUXES RESULTING FROM LAND-USE CHANGES IN THE STATE OF MORELOS, MEXICO

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ABSTRACT

This report presents information on land use changes and carbon stocks and fluxes resulting from land use-change in the subtropical dry forest of the State of Morelos, Mexico. Biomass components of standing vegetation were estimated from 40 quadrats (400 m^2 each) distributed across this ecosystem. Regional land use changes using forest cover for two different periods (1976 and 1993) and present forest cover, as well as measurements of soil organic matter and soil organic carbon were used to predict carbon stocks and fluxes in this ecosystem. The results showed for the period of 1976-1993 that the annual deforestation rate is 0.87% indicating that approximately 20,000 ha of subtropical dry forest were lost during this period and that 57% of the original ecosystem has been lost since 1950. On the other side, intensive agriculture, including induced grasslands increased (22 000 ha) 15% of the total studied area largely at the expense of the tropical dry forest. Land use changes from the subtropical dry forest to agriculture contributed to carbon emissions of 6.49 Tg, of which standing biomass averaged 2.79 (± 0.28) Tg, root biomass averaged 1.75 (± 0.18) Tg, and soil organic carbon averaged 1.95 (± 0.2) Tg. Projected land-use changes will likely contribute to an additional carbon flux of 2.88 (± 0.14) Tg by the year 2050. Practices to conserve, sequester, and transfer carbon stocks in this ecosystem are discussed as a means to reduce carbon flux by deforestation practices.

INTRODUCTION

Carbon dioxide is one of the main greenhouse gases and is emitted by fossil fuel combustion, deforestation and cement production. The annual global deforestation rate is of the order of 13.7 M ha for the period of 1990-1995 and it accounts for between 20 and 25% of the C emissions. Deforestation figures for Mexico point to between 300 000 and 1,500 000 ha per year, with an annual average of 650,000 ha. Land use changes from forests to agriculture, grasslands, and urban areas are quickly diminishing the area of tropical forests [*Semarnat*, 2002]. Tropical forests are quickly diminishing the area around the globe. The subtropical dry forests, which once distributed in the Pacific lowlands from Sonora to Chiapas, Mexico, occupying an area of approximately 16 M ha, have lost 70% of its original area [*Quadri de la Torre*, 2000]. Sustainable practices to conserve and restore forest cover of subtropical dry forests are required in order provide economic, social, and ecological benefits, where the estimation of carbon stocks and fluxes from land use changes are critical to understand one potential environmental service provided by these forests. The objectives of this study were to estimate the rate of deforestation and the carbon stocks and emissions by land use changes in the subtropical dry forest of Morelos, Mexico.

MATERIALS AND METHODS

The sate of Morelos, Mexico is located in the central portion of the country. It is between the main transversal mountain range called Eje Neovolcanico and the Balsas depression. The deforestation rate was estimated from land use maps called series I and II edited by Inegi. Remote sensing data collected during 1976 and 1993 was used to edit land use data in Series I and II, respectively. Land use changes for this period were estimated using Arc View GIS system. A forest inventory was conducted in 40 quadrats (10 x 40 m) to estimate aboveground biomass components. Root biomass was estimated from research conducted on this tropical ecosystem. Soil organic matter and carbon were estimated from soil cores of the upper 30 cm of soil depth taken in soils covered by subtropical dry forests and neighboring soils with other land uses. Estimates of carbon stocks in tropical dry forests considered soils and biomass. In other land uses (agriculture and grasslands), carbon stocks were estimated from soils and carbon in aboveground was assumed to be missing. Soil depth was simulated to be 50 cm.

RESULTS

The estimated deforestation rate for the period of 1976 to 1993 was 0.81% in contrast to the average of 1.70% estimated from other sources of information [*Trejo and Dirzo*, 2000; *PEOT*, 2000; *Semarnat*, 2002\]). This figure indicates that approximately 20,000 ha shifted from subtropical dry forests to other land uses (irrigated and rainfed

agriculture). Projections of the area covered by subtropical dry forest indicates that in the 1950s there were 250,000 ha, for the year 2000 there were approximately 100,000 ha and that by the year 2050 there would be approximately 50,000 ha left of this ecosystem (Fig. 1). The average carbon stock in aboveground biomass and roots (fine and coarse) in soils was 23 Mg ha^{-1} and 30 Mg ha^{-1}, respectively. These statistics are in agreement with research conducted on this issue in other places of the subtropical dry forest [*Castellanos et al*., 1991]. Soil organic carbon was higher in tropical dry forests (4.75 ± 0.85 %) than in agricultural fields (2.42 ± 0.58%). These figures compute carbon emission estimates of 6.50 Tg for the period of 1950 to 2000 and it will likely be 9.40 Tg for the period of 1950 to 2050 (Fig. 1). Practices to conserve the tropical dry forest and mitigate carbon emissions must include the promotion of carbon credits, the implementation of agro-silvicultural practices, conservation tillage practices, enforcement of laws and regulations of land use changes, among others.

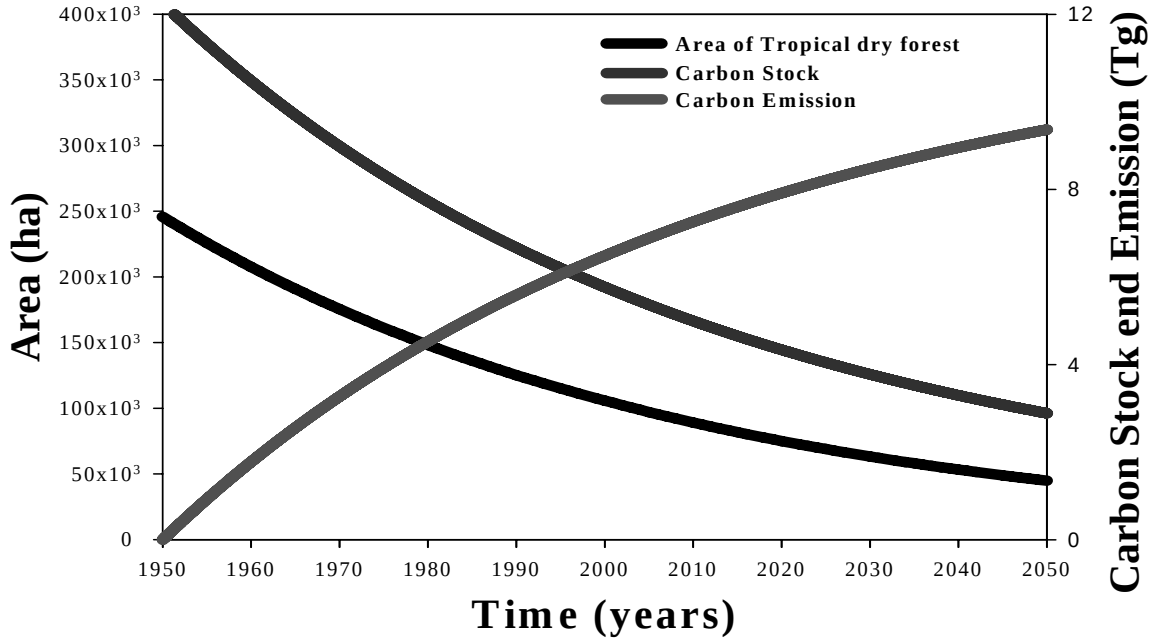

Fig. 1. Projections of carbon stocks, emissions and the area covered by tropical dry forest in the State of Morelos, Mexico.

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