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Estimation of natural carbon sequestration in eastern Thailand: preliminary results

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Abstract

We estimated carbon sequestration in Pará rubber tree plantations using a remote sensing approach and then compared the results to known figures for carbon sequestration resulting from soil-water interaction. The preliminary zone investigated is in Wangchun, eastern Thailand, and covers about 20 km^2.
Carbon sequestrated during soil-water interaction was estimated using a hydrological model taking into account variations in alkalinity and topography. We found that soil-water interaction resulted in the sequestration of 0.04 tons $C/km^2/year$. The amount of naturally stored carbon in the Pará rubber plantation using THAICHOTE satellite imagery and specific biomass equations, was found to be 645 tons $C/km^2/year$.
The magnitude of these preliminary results suggests that the flux of carbon storage in Pará rubber plantations could play a substantial role in the global carbon cycle.

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Keywords: carbon sequestration; remote sensing; Pará rubber; Eastern Thailand.

1. Introduction

Pará rubber is a perennial plantation with a very high growth rate and is economically important in southeast Asia. Quantifying the high biomass rapid growth may allow us to evaluate the potential plant ability to sink CO_2 from the atmosphere. If that ability is confirmed, Pará rubber plantations could then be considered as long term carbon storage sites.

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However, the flux of CO2 in the earth's surface is shared between biochemical and geochemical processes [1]. In this study, we estimated the amount of carbon stored in Pará rubber trees during their growth and compared it to the amount of carbon sequestrated by the process of soil-water interaction in the same zone.

2. Carbon storage in Pará rubber plantations

We estimated the total biomass and carbon content in Pará rubber tree plantations using THAICHOTE satellite imagery. The zone, located in Wangchun - eastern Thailand (coordinates 773149 E, 1470376 N and 778149 E, 1434376 N) covers about 20 km^2. Data collected from December 2011 to April 2012 (dry season), includes multispectral, panchromatic, and stereo pair images.

The images were initially corrected for topographic and atmospheric conditions [2-3] and we then applied vegetation indices, texture and color (IHS). We defined specific balance equations to determine the total biomass and carbon content in Pará rubber plantations. A total of 60 sample plots, measuring 20 x 20 meters, were identified with an average density of 48,750 trees/km^2. The mean diameter-at-breast height (DBH) was 1.7 meters and the total height of individual trees was measured in the field. For every individual tree, a stage class was evaluated by the *RRIM600* species-specific biomass model [4].

The results of our calculations indicate that the net surface area occupied by Pará rubber tree plantations is 13.38 Km^2 and that the mature stage class covers 40% of the area, while young and harvested stage classes cover 13% and 20% respectively of the "green " surface area. We found the amount of C storage in our field conditions to be 203,800 tons.

The mature stage class has the highest capacity for carbon sequestration, corresponding to 890.8 tons C/km^2/year while the younger stage class has the least capacity for storage, 467.6 tons C/km^2/year, and the harvested stage sequester 576.9 tons C/km^2/year. The average carbon sequestration is estimated to be 645 tons C/km^2/year.

3. Carbon Storage in soil –water interaction

Geochemical processes in soil-water interaction involve dissolution and precipitation of mineral phases and complex biogeochemical reactions [5]. We observed variations in alkalinity between the different soil layers of between 2 and 4 mmol/L, in agreement with previous variations observed in East Thailand [6, 7]. We assumed that alkalinity variations, resulting in mineral dissolution and precipitation reflect the soil-water geochemical net carbon storage [8].

The variation in soil water fluxes was evaluated by the physically-based hydrological model SWAT (Soil Water Assessment Tool) [9] operating on a daily time step. Based on water balance, the water storage per year in pore soil can be evaluated by the following Eq.1:

$$SW_t = SW_o + \sum_{i=1}^{t} (R_{day} - Q_{surf} - E_a - W_{seep} - Q_{gw}) \tag{1}$$

Where SW_t is the final soil water content expressed in mm of H_2O, SW_o is the initial soil water content, R_{day} is the amount of daily precipitation on day, Q_{surf} is the daily surface runoff, W_{seep} is percolation and by pass flow in soil profile bottom and Q_{gw} is the daily return flow of the water, t is the time integration (1 year). The SWAT model requires input on topography, soils, land use and