Tropentag, September 16-18, 2015, Berlin, Germany

"Management of land use systems for enhanced food security: conflicts, controversies and resolutions"

Rubber Cultivation Weakened the CH_4 Sink Function of Tropical Upland Soil, Comparing with Rainforest

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Abstract

Rubber plantations have been expanded in past decades in the Mekong region where they were not traditionally grown. Investigation of gaseous carbon loss from soil is an important component of evaluating the impact of land use change on carbon dynamics and ecosystem functions. According to observed drop of soil respiration rates and high soil moisture in rubber plantation in rainy season when rainforest kept high rate, we hypothesised that rubber cultivation might change the tropical upland soil into CH_4 source periodically, which result to less net CH_4 oxidation by the soil comparing with rainforest. In order to find out how rubber cultivation affected the CH_4 processes in soil, we set 4 plots in transect that included rainforest and rubber plantations at age of 9, 17 and 30 years. We measured CH_4 flux with closed chamber method for half a year, and analysed CH_4 concentration profiles three times and $\delta^{13}C$ ratio of CH_4 once at soil depth of 5 cm, 10 cm, 30 cm and 70 cm. Monthly CH_4 flux measurements had large variation and there was no consistent difference between rainforest and rubber plantations in the early dry season. Comparing with older rubber plantation, more negative CH_4 flux was observed from rainforest and 9 years rubber plantation in the late dry season. The first gas profile sampling in dry season without rainfall events showed CH_4 concentration ranging from 0.43 ppm to 1.31 ppm, with lower values in deeper soil. The second profile sampling in dry season after heavy rain displayed different response, CH_4 concentration in rainforest and 9 years rubber plantation changed range to 0.17 ppm-1.61 ppm, while it changed to 0.46 ppm-22.36 ppm in 17 and 30 years rubber plantation with higher concentration in deeper soil. CH_4 concentration profiles indicated that with increasing of age, rubber plantation tended to change into CH_4 source in response to heavy rains. $\delta^{13}C$ ratio of CH_4 in soil varied from -49.73‰ to -38.05‰, with higher enrichments in deeper soil. The isotopic carbon signature in CH_4 confirmed weaker CH_4 oxidation in rubber plantations than rainforest, and decrease of oxidation rates caused by converting rainforest to rubber plantations might stabilise at certain age of cultivation.

Keywords: CH_4 oxidation, rainforest, rubber plantation, stable isotope carbon ratio, upland soil

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Exploring Effects of Aboveground and Belowground Biomass on Soil Erosion During Rubber Development by Applying Usle Model

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Abstract

Aboveground and belowground biomass can both contribute to soil conservation in forestland. However, quantitative linkage among tree canopy, plant and litter cover, roots and their changing roles with growth of plantation has been rarely studied. Universal Soil Loss Equation (USLE) model has been widely used in soil loss prediction in agriculture but rarely applied in woodland system. This study applies USLE model for prediction of soil loss during rubber plantation development and identifies the major factor controlling water erosion. Soil erosion was measured in rubber plantations of 2, 10, 18, 25 and 36 years age. Rainfall, soil texture and carbon content at top 5 cm , density of fine roots, canopy radius for each age of rubber plantation, understory plant cover and litter cover were determined using Gerlach troughs, soil coring, photography, respectively. Soil loss of rubber plantation with different ages varied from 52 g m^{-2} to 277 g m^{-2} with highest soil loss of mid-age (10 and 18 years) and lowest of old (18 and 36 year) rubber. Cover and management factor of rubber plantation represents erodibility of system in USLE model. It was equal to 0.02, being thus much higher than in forest (0.005). Though canopy of tree expanded during its growth, erodibility change of the system turned out to increase from 0.01 of young rubber to 0.03 of mid rubber and decrease to 0.008 of old rubber. Erodibility of rubber system was little affected by tree canopy, however, mainly controlled by root system from trees and plant cover from understory vegetation. Fine root density and plant cover were introduced into USLE model with expression of Cpc = e-0.023pc and Croot=e-0.004fRD respectively. During rainy season, highest erodibility of rubber system was found in August due to herbicide application. It is recommended that understory plant cover should be kept over 70 % for young rubber, over 90 % for mid and 55 % for old rubber in order to maintain good soil conservation function of rubber plantation.

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Keywords: Fine root, Plant cover, Rubber plantation, soil erosion, USLE model

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Ecosystem Services in Southwest China: Local Stakeholders' Priorities

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Land management can only be sustainable if the needs and interests of various stakeholder groups are incorporated in land use planning. As direct participation in such planning is often limited, there is an urgent need for more transparency of other stakeholders' priorities amongst decision-makers. In a biodiversity hotspot such as Xishuangbanna, Southwest China, where strong economic forces favour cash crop monocultures such as banana and rubber with the consequence of heavy degradation, knowledge about stakeholders' perception and valuation of (non-economic) ecosystem services (ESS) is of utmost importance.

This raises methodological questions, particularly in a situation where decision and power structures are nontransparent and cleartop-down-hierarchies in practice are overlaid by highly informal decision structures which are based on personal relations, such as in China.

The SURUMER project, aiming at the development and at least partial implementation of sustainable rubber cultivation strategies, has carried out sociological studies on these issues. The main research questions in this context are:

- What are local stakeholders' priorities of ESS?
- How to identify and value these?
- And how to communicate the findings with decision-makers?

This paper discusses the methods which have been developed for the specific context, preliminary results as well as consequences for future research.

In general, the approach is a triangulation: Qualitative information has been acquired amongst two main groups of actors (village heads and regional bureaus) during informal talks, semi-structured in-depth interviews, meetings and workshops. Quantitative data has been collected in a ranking exercise. The ladder has been adapted stepwise: As a pure list has brought only vague results and problems with ranking such abstract issues came up, later on the ESS have been visualised more clearly and participants were asked to value the importance of each ESS.

The results show that data collected from various sources not only provides an integrated view of the future land-use scenarios, but also increase the credibility of information by means of triangulation. For further analysis it is seen as very important to know and explain the differences between the various local stakeholder groups.

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Meet the Balance of Carbon Emission and Land Use Productivity - Case Study from Naban National Nature Reserve, Xishuangbanna

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Abstract

Land use planning for Low Emission Development Strategy (LUWES) is a crucial platform for sustainable land use management, which aims to decrease carbon emissions while maintains land use productivity/ economic growth in landscape. In Naban National Nature Reserve (NNNR), Rapid Carbon Stock Appraisal (RaCSA) approach was applied to evaluate time-averaged carbon stock of dominate land use types, namely upland forest, lowland forest, upland rubber plantation, lowland rubber plantation, bush and grassland, and agricultural crops. These values were used for upscaling and C stock estimate in landscape. Historical and current land use change patterns was assessed by creating transition matrix from 1989, 2007 and 2012 land use land cover maps. The top four land use changes were from bush and grassland to upland forest, from bush and grassland to agricultural crops, from agricultural crops to upland forest and from upland forest to upland rubber plantation, which had a percentage change of total area value of 39.45 %, 16.25 %, 8.38 % and 7.39 % respectively. From 1989 to 2012, the land use change induced 0.18 Mt carbon emissions and 0.73 Mt carbon sequestrations. The net carbon sequestration was 0.55 Mt with a sequestration rate of 20.62 Mg C ha^{-1}. In next step, the REDD Abacus (Reducing Emissions from Deforestation and Forest degradation Abatement Cost Curves and Simulator for Scenarios of Policies) software will be used to simulate business as usual scenarios and other emission-reduction scenarios within landscape. Opportunity cost will serve as a good indicator for providing reference benefit of various land use types within specific rotation life, it refers to the potential economic gains if certain types of land use change not happening. The analysis can provide a simple first approximation of potential avoidable emissions which driven from incentive mechanisms in the past. Results of this study can provide an entry point for the discussion on the feasibility of compensation-based mechanism of climate change mitigation actions, moreover, it can also serve as the foundation for more complicated process-based modelling for providing reference for local decision makers.

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Keywords: Carbon emission, land use productivity, low emission land use planning strategy, RaCSA, REDD Abacus