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Modelling Long-Term Impacts of Climate Change on Rubber Plantations and Options for Adaptive Forest Management

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Abstract

Rubber plantations have expanded rapidly in Montane Mainland South East Asia in past decade. The impact of long-term environmental changes on carbon stock dynamics of rubber plantations is constrained by site-specific growth conditions and still not fully understood. In order to improve regional forest management, we jointly used field survey and modelling tools to predict rubber biomass development at tree-, plot-, watershed- and landscape- scale in Naban National Nature Reserve, Xishuangbanna. Rubber trees/plots level parameters were used to calibrate the Land Use Change Impact Assessment (LUCIA) model. The potential response of tree growth (biomass annual increment) and latex production (latex annual increment) to various climate change scenarios was simulated from low CO_2 emission scenario (RCP2.6) to high CO_2 emission scenario (RCP8.5) for rubber plantation with a 40-year rotation length. These results were used in the large-scale forest scenario model EFISCEN (European Forest Information SCENario model) to upscale impacts of various climate- or management-driven scenarios into 2055. According to LUCIA simulation outputs, rubber plantations cultivated at high elevation (above 900 m asl) benefited more from future warming climate. The total biomass and cumulative latex increased 28 % and 48 % from baseline to RCP8.5. We also tested three scenarios with EFISCEN model applied at landscape level, namely: 1) climate promoted increase scenario - "growth increase scenario", 2) other land use conversion into rubber plantations scenario - "species change scenario" and 3) combined impact scenario - "integrative scenario". Simulations revealed obvious patterns of carbon stock increase in the growth increase scenario, i.e. the regional carbon stocks were increased by 30 % and species annual increments also increased by 50 %. Our simulations from EFISCEN model suggested that future climate change may greatly impact on rubber tree growth at large (landscape-) scale, while LUCIA simulation reported at tree- and plot- level the influence of climate change might be compensated or decreased by local management strategies. Combined process-based model and landscape scenario model applications for rubber-based system help in better understanding climate change impacts on ecosystems. Our results could be relevant also for other rubber-cultivated regions particularly thus in mountainous regions.

Keywords: Carbon sequestration, climate change, forest management, latex production, rubber-based system

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