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"Filling gaps and removing traps
for sustainable resource management"

Improving the Model Prediction of Soil Temperature under Rubber Plantations

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Abstract

The expansion of natural rubber plantations in the tropics has been the major driving force for deforestation and forest degradation in mountainous Southeast Asia, coupled with losses of ecosystem functions. The observed losses of soil organic carbon due to organic matter decomposition is mainly influenced by soil temperature, which is a key variable in Land Use Change Impact Assessment (LUCIA) model. However, measured records of site-specific soil temperature are often not available, especially in regions where data are hard to acquire. This has led to a number of studies on estimating and modelling soil temperature with easy-to-get data.

The current study aims at calibrating and further developing the existing Kang soil temperature model, to make it more suitable for the application in tropical rubber plantations. The model is a hybrid model based on heat transfer physics and empirical relationships between air and soil temperature, considering the effects of canopy and ground litter on heat attenuation. Input data needed for the model include daily air temperature and leaf area index (LAI). Our model development includes: (i) adding an additional coefficient to the ground litter term, followed with parameter optimisation; and (ii) developing a litter decomposition function calibrated for rubber plantations, and integrating this function into the existing soil temperature model.

The study is done within the framework of SURUMER project and data used for model development were collected from two locations in Naban Nature Reserve in Yunnan, southwest China. As outcomes, two model versions were validated and can be provided to users, depending on their data availability. Package A needs measured air temperature and LAI on a daily basis, and Package B additionally needs litter dynamics data. Both models outperformed Kang's model significantly, with increased Nash-Sutcliffe efficiency and decreased mean absolute error at 10 cm, 20 cm and 40 cm soil depths.

Keywords: Modelling, rubber plantations, soil temperature

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