Research projects of counterparts funded at IPB University in 2021

Name	Counterpart	Title
Tania June, Ummu Marufah	**A03 A07**	Evaluating the impact of land use change on surface energy balance partition and rainfall in Jambi Province

Background and Objectives

Jambi is one of provinces on the island of Sumatra that experienced extensive forest transformation (Drescher *at al.* 2016). Forest degradation in Jambi has been caused mainly by the expansion of palm oil and rubber plantation. Deforestation has led to changes in surface biophysical characteristics such as albedo and surface roughness, and influencing the climate (Burakowski *et al.* 2018). This study aims to analyze land use change in Jambi and its impact on surface energy balance partition and rainfall.

Methods

The simulation of land use change was conducted using the data from the land use map of Jambi province from Melati (2017) reclassified into four types: forest, oil palm, rubber, and other land use types (shrub, grass, agriculture like soybean). Land use change was projected using the Cellular Automata-Markov (CA-Markov) of Land Change Modeler (LCM). Elevation, slope, distance to river, distance to road, and distance to forest were used as driving factors for land use change. In this land use change modelling, we performed Cramer's V test to understand the power of driving factors in influencing land use change. The surface energy balance partition was simulated using the Community Land Model (CLM). CRUNCEP from 2001 to 2015 was used as the meteorological forcing. Analysis of spatial heat flux and rainfall were performed using ECMWF, CHRIPS data and Time Series, Area-Averaged of Merged satellite-gauge precipitation estimate from NASA, respectively.

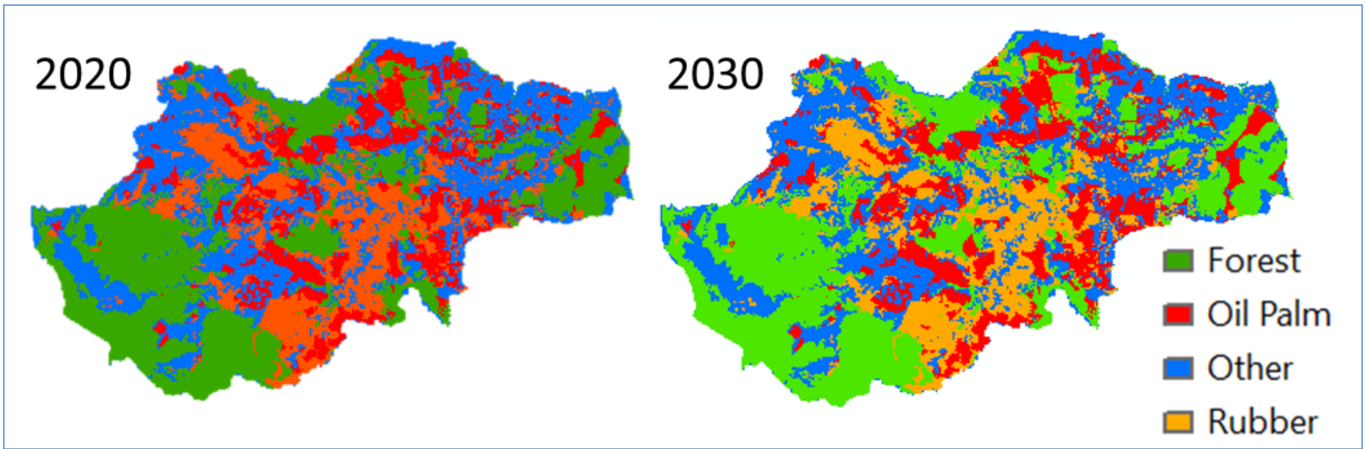

Figure 1. Projected land use cover in Jambi 2020 and 2030 (other land uses include schrub, grass and agricultural crops like soybean etc).

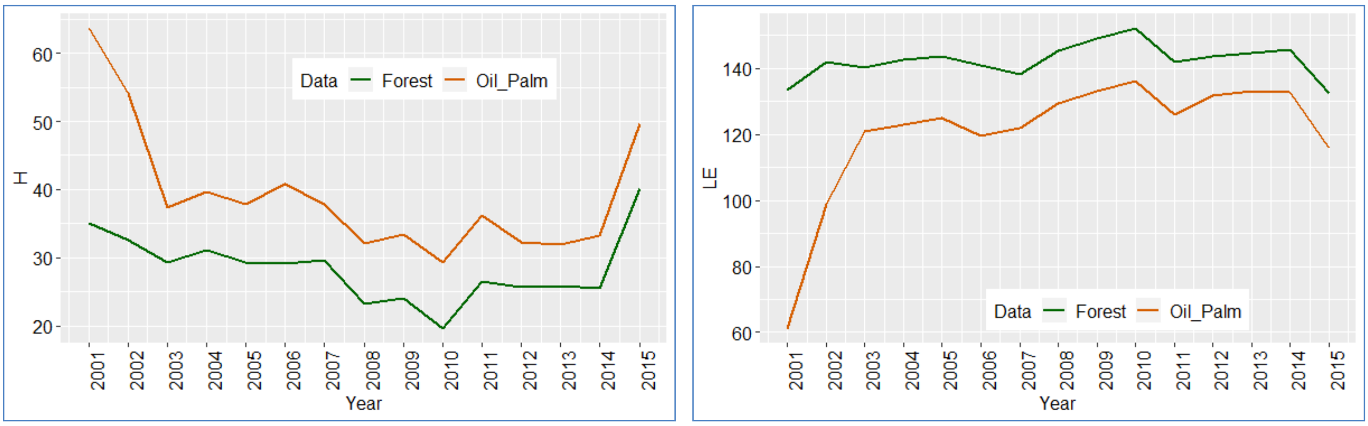

Figure 2. Comparing surface energy balance partition in forests and oil palms (simulated using CLM).

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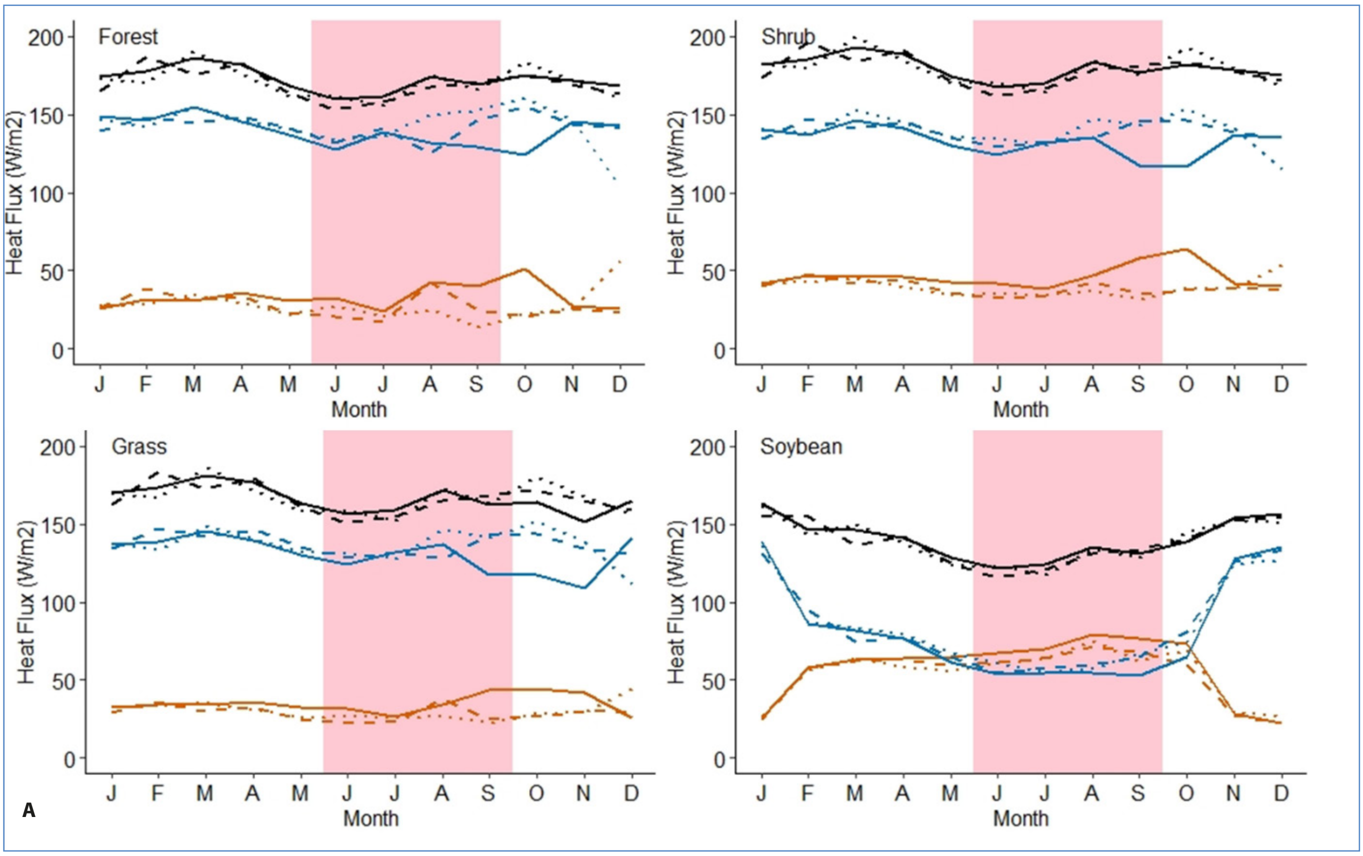

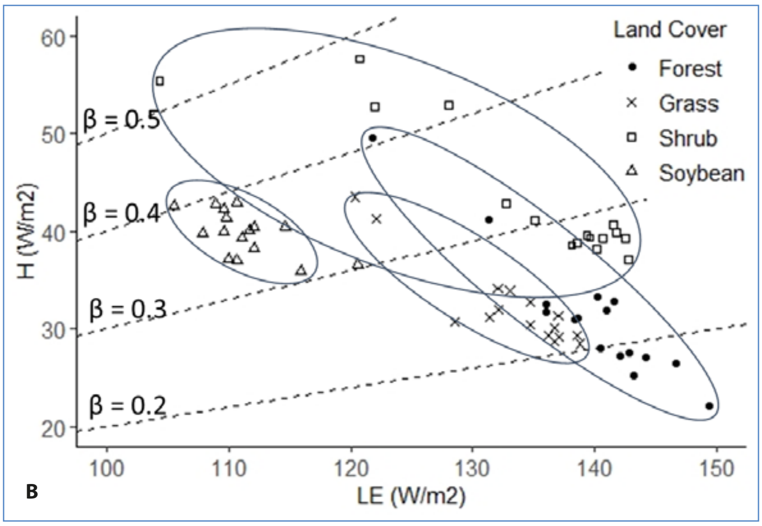

Figure 3A. Comparing surface energy balance partition in forest shrub, grass and soybean (simulated using CLM) showing sensible heat fluxes (H), latent heat fluxes (LE), and net radiation (Rn) in El Nino, La Nina, and Normal years. Pink shaded area denote dry season period.

Figure 4A. Annual average sensible and latent heat fluxes in Forest, Grass, Shrub and Soybean simulated using CLM in Jambi Province. Dash line show the value of Bowen ratio.

Results and Discussion

Important driving factors for land use change in Jambi are distance from forest and elevation. Our projected land use cover in 2020 and 2030 show that forest, rubber, and other land uses continue to decrease, while oil palm continue to increase (Fig. 1). Most land use change will occur in the lowlands since this area is suitable for plantation, especially oil palm.

Forest transformation to other land uses result in losses in Leaf Area Index (LAI), especially at the beginning of forest opening and early planting. Low LAI indicates small surface roughness. Surface roughness will affect the transfer of momentum, energy and mass. In early planting of oil palm, the differences of sensible heat flux H and latent heat flux LE between forest and oil palm is high (Fig. 2). A few years after planting, as plant become larger and has a higher LAI, LE increases and H decreases in oil palm. The value of LE (indicating evapotranspiration) remains larger in forest remain than in oil palm and other land uses (Figs. 3A and 3B), resulting in a lower Bowen ratio.

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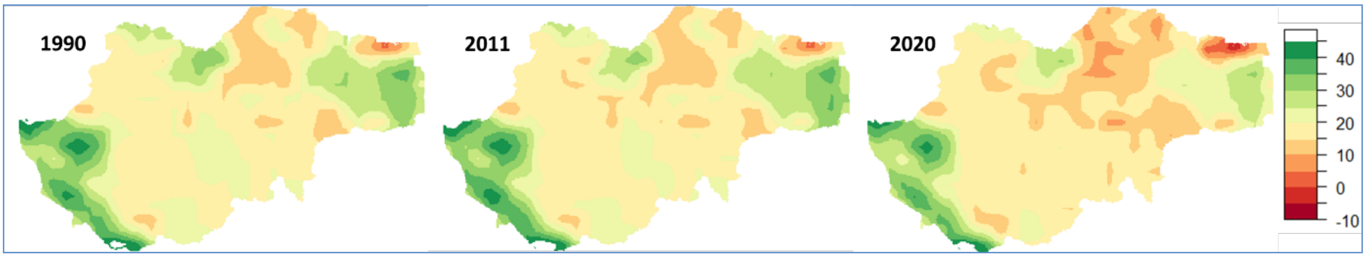

Figure 4. Average monthly sensible heat fluxes in Jambi (from ECMWF data).

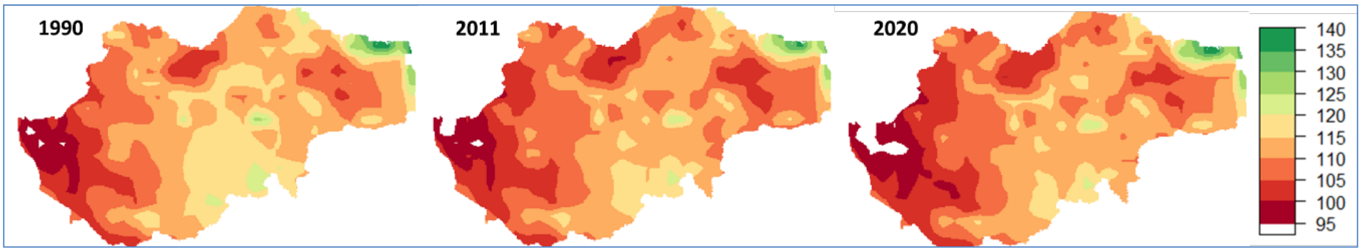

Figure 5. Average monthly latent heat fluxes in Jambi (from ECMWF data).

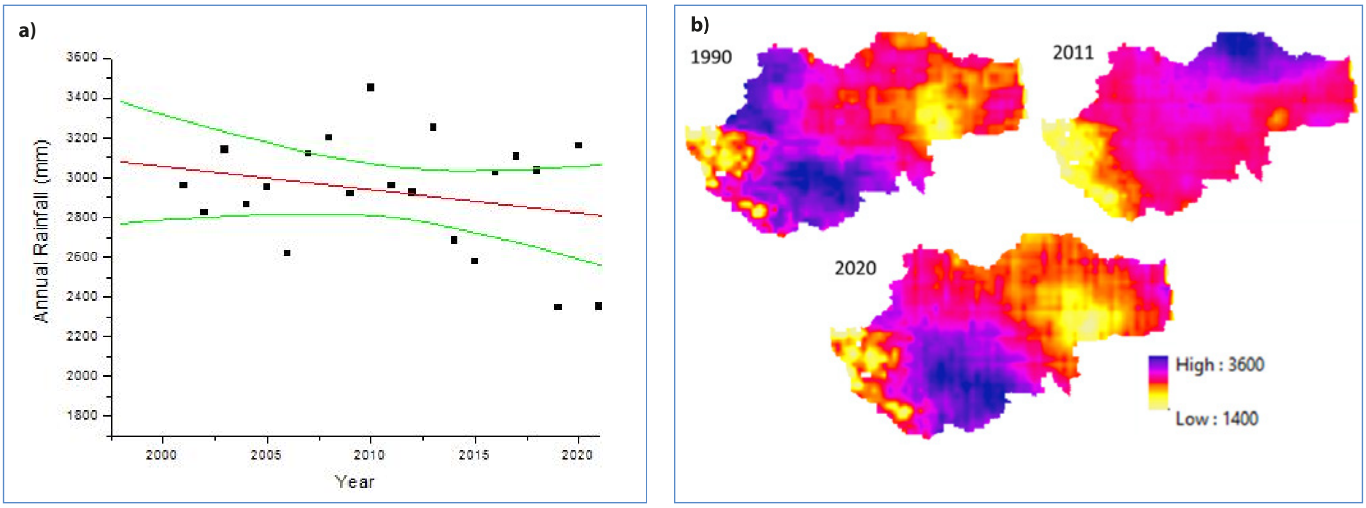

Figure 6. Average annual rainfall (a) (Time Series, Area-Averaged of Merged satellite-gauge precipitation estimate NASA) and its spatial distribution 1990 and 2020 (CHRIPS data) (b)) in Jambi Province.

The Spatial distribution of H and LE (data from ECMWF) shows that in the lowlands, both H (Fig. 4) and LE (Fig. 5) have decreased, which could be from the increasing albedo due to land use changes that have reduced net radiation, and hence LE and H. Changing surface energy balance partition will affect evapotranspiration and rainfall formation. The spatial distribution of annual rainfall from 1990 to 2020 shows a decrease in areas with high rainfall and an increase in areas with low rainfall (Fig. 51). Overall, there is a decreasing trend in annual rainfall in Jambi (Fig. 6) over the period 2000-2021 (data from NASA.gov.us).

References

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