IPB University
Bogor Indonesia

Research project of counterparts funded at IPB University

Name	Counterpart	Title
Tania June	**A03** **A07**	Spatial analyses of oil palm evaporation: Correlation matrix with micrometeorological driving forces

Research summary

This research aims to estimate the spatial distribution of oil palm evapotranspiration and its correlation with micro-meteorological variables and to increase the accuracy of spatial evapotranspiration determination by hot and cold pixel selection using the METRIC Model. Evapotranspiration was determined at various oil palm ages using Mapping Evapotranspiration at High Resolution with Internalized Calibration (METRIC) model, where the calculation of energy balance components is going to be corrected using hot and cold pixels. Landsat imagery, climate data obtained from ERA-5 reanalysis, and micrometeorological data from PTPN VI are used to calculate NDVI, land surface temperature (Ts), surface albedo, emissivity, and roughness length, where thereafter, energy balance components, i.e., net radiation (Rn), ground heat flux (G), sensible heat flux (H), and latent heat flux (LE) were determined and were used to estimate the daily evapotranspiration of oil palms. The output was evaluated and validated using observed data from micrometeorological measurements in PTPN VI Jambi Province. Total area of PTPN VI Batang Hari is 2186 Ha. The area of each afdeling I, II, and III are 676 Ha, 772 Ha, and 577 Ha. Areas of oil palm planted in 1999, 2002, and 2004 are 600 Ha, 1400 Ha, and 25 Ha, respectively (Fig. 1).

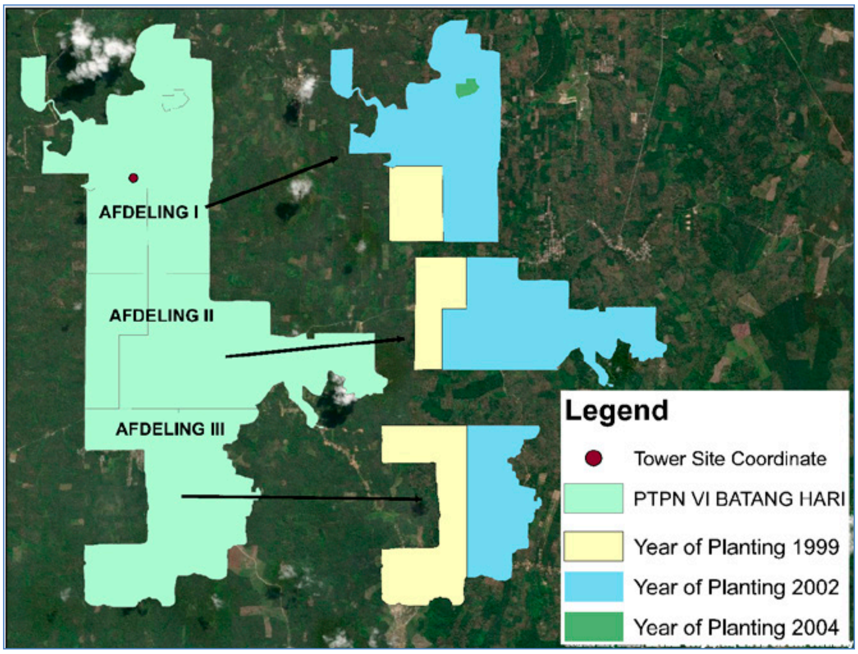

Figure 1 shows the daily spatial evapotranspiration in different planted years with and without pixel selection. For acquisition imagery August 2015, it shows that without pixel selection the means ± standard deviation of daily evapotranspiration for oil palm planted in 1999, 2002, and 2004 were 2.25 ± 0.49 mm d^{-1}, 2.24 ± 0.49 mm d^{-1}, and 2.25 ± 0.27 mm d^{-1} while with pixel selection 2.38 ± 0.19 mm d^{-1}, 2.37 ± 0.19 mm d^{-1}, and 2.34 ± 0.09 mm d^{-1}, respectively. Daily evapotranspiration in July 2016 without pixel selection for oil palm planted in 1999, 2002, and 2004 were 4.20 ± 1.08 mm d^{-1}, 4.23 ± 1.11 mm d^{-1}, and 5.12 ± 0.00 mm d^{-1} and with pixel selection 4.69 ± 0.47 mm d^{-1}, 4.71 ± 0.47 mm d^{-1}, and 5.12 ± 0.01 mm d^{-1}, respectively.

Validation of the output model was conducted using the Penman-Monteith (PM) method calculated from the micro-meteorological data from the on-site climate tower in PTPN VI Batang Hari. The observation data used in the validation process were point data therefore buffer analysis is carried out to validate various distances of spatial ET (Fig. 2). The comparison of the Root Mean Square Error (RMSE) average between daily ET from the model output and ET-PM shows = 0.19 mm d^{-1} (without pixel selection) and = 0.16 mm d^{-1} (with pixel selection) showing that model output with pixel selection can determine ET more accurately than without pixel selection.

Using average data for 2015 and 2016 (with pixel selection) a micrometeorological driving forces correlation matrix for the daily pattern was developed. Between Evapotranspiration ET with rainfall (P), air pressure (P), wind speed (Ws), relative humidity (RH), air temperature (Ta), soil temperature (Tsoil), soil moisture (SM), net radiation (Rnetto), ground heat flux (G), actual vapor pressure (e_a), sensible heat flux (H), latent heat flux (LE), LE-H, Bowen ratio (β). Each relationship between variables was estimated by Pearson's correlation coefficient. ET was strongly influenced by Rn and LE-H shown by positive correlation coefficients of 0.85 and 0.95 while H and β influenced ET with negative correlation coefficients of -0.63 and -0.75 respectively. β is strongly correlated with H shown by a positive correlation coefficient of 0.84, while SM, LE-H, and ET have a negative correlation with β shown by r= -0.58, -0.85, and -0.75 respectively. A high positive correlation be-

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tween β and H shows that biophysically if Rn is allocated more to H, it will decrease ET since H is used for heating up surrounding air and increasing temperature, while LE biophysically used by the ecosystem to transform water into vapor, and reducing the temperature, that is why LE–H had strong positive correlation coefficient with ET. The correlation coefficient also shows that Rn is allocated more to LE rather than H, this indicates that in PTPN VI, available energy is prioritized to transform water into vapor rather than heating up surface air temperature, indicating water availability in the region is sufficient.

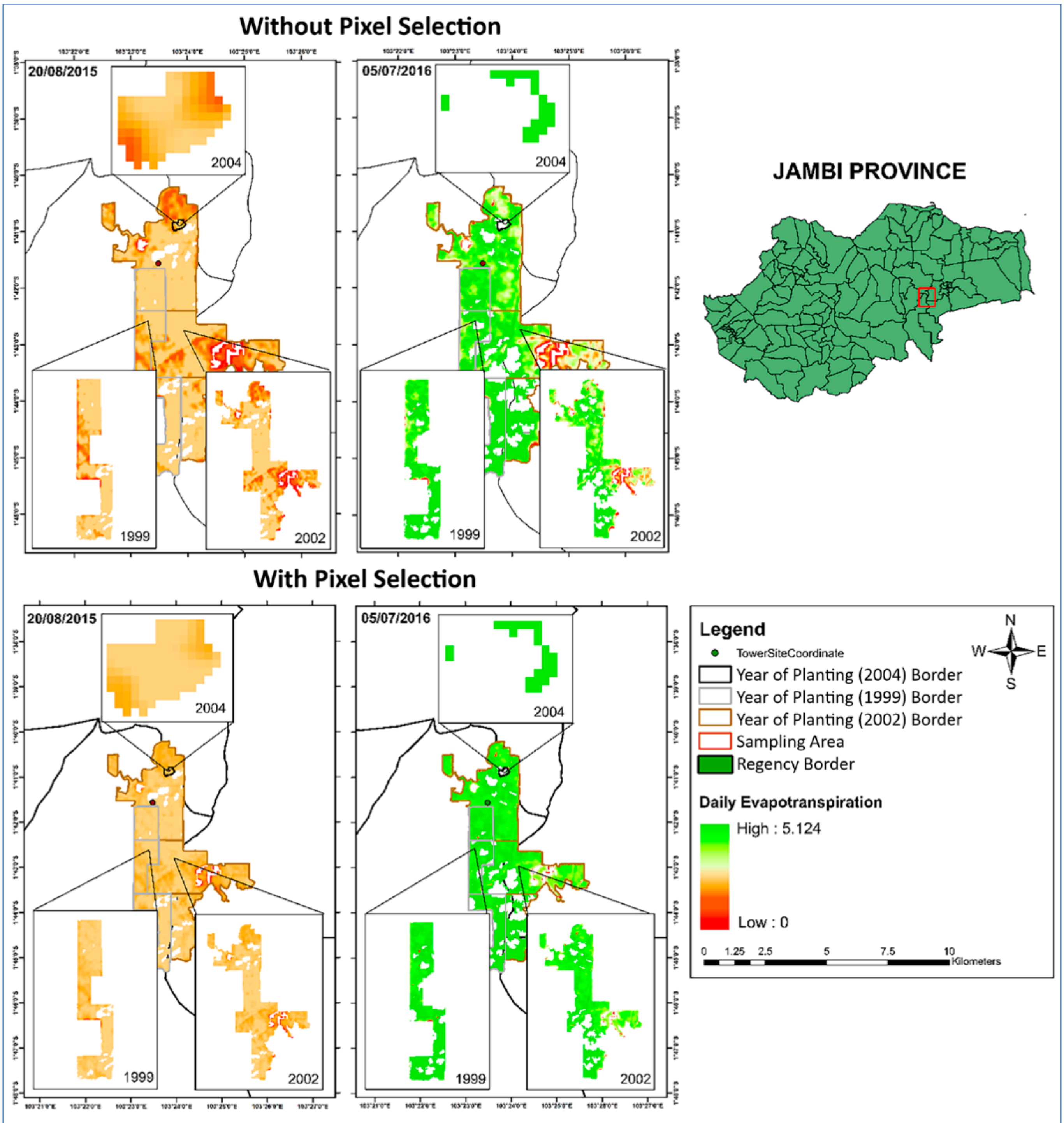

Figure 2. Distribution of spatial daily evapotranspiration in oil palm plantation PTPN VI Batang Hari, Jambi Province

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