The Forest Be Mine: Analyzing the Impact of Mines on Deforestation in Indonesia

Bachelor Thesis

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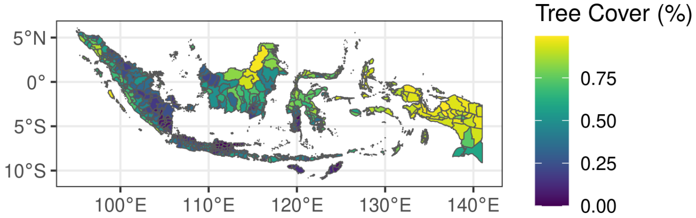
View the thesis repo on GitHub

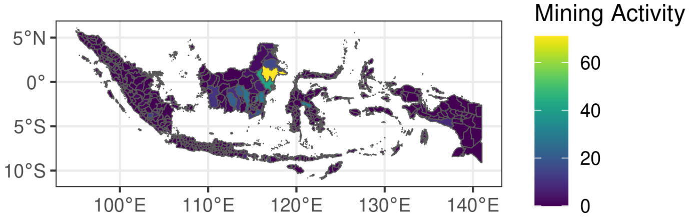
Introduction

- Indonesia has the **eighth-largest forest area** worldwide
- But it accounts for the **third-highest** rate of forest loss
- About 6.5% of Indonesia's GDP come from the **mining sector**
- To what extent do **mines** influence Indonesian **deforestation**?
- I used land use **data** by the European Space Agency (ESA, 2021), socioeconomic data by Indonesia's statistics office (see, e.g., Badan Pusat Statistik [BPS], 2021), mining polygons by Maus et al. (2020), and night light data from VIIRS (Elvidge et al., 2021)

Exploring the Data

- **Mining activity** is largely concentrated in Kalimantan
- Mining activity as plotted here is an **index** constructed from mining area and nightlight activity How?





Modeling Approach

- **Dependent:** Either tree cover percentage in a given municipality or tree cover area
- **Explanatory:** Either the presence of a mine (yes/no) or the mining activity as measured by the constructed index More
- Estimated as a linear **panel** with year and municipality FE
- **Effects:** Significant and negative in Models (1), (2), and (4); insignificant in Model (3) More

$$tp_{it} = mine_{it}\beta + \boldsymbol{x}'_{it}\boldsymbol{\gamma} + \mu_i + \psi_t + \varepsilon_{it} \quad (1)$$

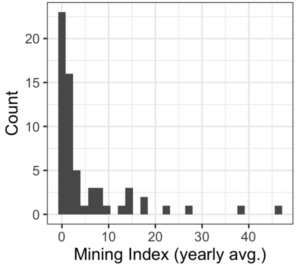
$$ta_{it} = \beta mine_{it} + \boldsymbol{x}'_{it}\boldsymbol{\gamma} + \mu_i + \psi_t + \varepsilon_i t \quad (2)$$

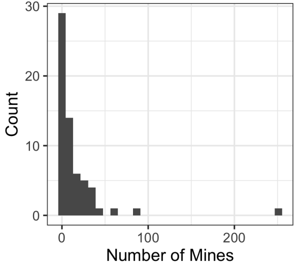
$$tp_{it} = \beta activity_{it} + \boldsymbol{x}'_{it}\boldsymbol{\gamma} + \mu_i + \psi_t + \varepsilon_i t \quad (3)$$

$$ta_{it} = \beta activity_{it} + \boldsymbol{x}'_{it}\boldsymbol{\gamma} + \mu_i + \psi_t + \varepsilon_i t \quad (4)$$

Attention When Approaching Mines!

- **Top panel:** If we average the mining activity index over all years, by municipality, some stand out to have systematically higher values
- Kutai Kartanegara has a value of about 38, Katai Timur has 46. **But why?**
- **Lower panel:** But Kutai Kartanegara also has 252 mines, which may explain the high mining value
- What happens if we **exclude Katai Timur**?
- Re-estimating models (3) and (4) now yields significantly positive coefficients in both cases (5,6) Show me the numbers!





Forest Paths to Continue On

- **Data availability** is an issue: Mining polygons at different points in time, better socioeconomic data, ...
- **Spatially explicit** extension of the model
- Explicitly accounting for agricultural economic activity, ...

Appendix

Back to Start

Appendix (1)

Go Back (Approach) Go Back (Outliers)

	Dependent variable:					
	Tree Cover Area	Tree Cover Pct.	Tree Cover Area	Tree Cover Pct.	Tree Cover Area	Tree Cover Pct.
	(1)	(2)	(3)	(4)	(5)	(6)
Mine (Dummy)	-0.063^{***} (0.007)	-0.009^{***} (0.001)				
Mining Activity			0.0004 (0.0005)	-0.0002^{**} (0.0001)	-0.005^{***} (0.001)	-0.0004^{***} (0.0001)
Expenditure	0.00004^{***} (0.00000)	0.00000^{***} (0.00000)	0.00004^{***} (0.00000)	0.00000^{***} (0.00000)	0.00003^{***} (0.00000)	0.00000^{***} (0.00000)
Expected Schooling	0.002 (0.004)	0.003^{***} (0.001)	0.002 (0.004)	0.003^{***} (0.001)	0.003 (0.004)	0.003^{***} (0.001)
Life Exp. at Birth	0.025^{***} (0.004)	0.001^{**} (0.001)	0.025^{***} (0.004)	0.001^{**} (0.001)	0.026^{***} (0.004)	0.001^{**} (0.001)
C/R FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,587	5,587	5,587	5,587	5,576	5,576
R^2	0.036	0.022	0.020	0.009	0.036	0.012
Adjusted R^2	-0.065	-0.080	-0.083	-0.095	-0.065	-0.091
F Statistic	46.995^{***} (df = 4; 5059)	28.571^{***} (df = 4; 5059)	25.242^{***} (df = 4; 5059)	10.907^{***} (df = 4; 5059)	46.899^{***} (df = 4; 5049)	15.811^{***} (df = 4; 5049)

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Appendix (2) Go Back (Exploring) Go Back (Modeling)

Mining activity index by mine:

$$activity_{mt} = area_m \cdot light_{mt},$$

where $activity$ is the mining activity index, $area$ is the mining area from Maus et al. (2020), $light$ is the adjusted median night light value, and m, t are indices for individual mines and years, respectively.

Aggregation of the mining index to city/regency level:

$$activity_{it} = \begin{cases} 0 & \text{if } M = 0 \\ \sum_{m=1}^{M} activity_{mt} & \text{if } M > 0 \end{cases},$$

where M is the number of mines in a city or regency and i is an index for the individual cities and regencies.

References

Full thesis reference list in thesis PDF on GitHub

List of references mentioned *in this presentation*:

Badan Pusat Statistik. (2021). *Human Development Index* (Data Set). https://www.bps.go.id/indicator/26/413/1/-new-method-human-development-index.html

Elvidge, C. D., Zhizhin, M., Ghosh, T., Hsu, F.-C., & Taneja, J. (2021). Annual Time Series of Global VIIRS Nighttime Lights Derived from Monthly Averages: 2012 to 2019. *Remote Sensing*, *13*(5). https://doi.org/10.3390/rs13050922

European Space Agency. (2021). *Land Cover CCI Product User Guide Version 2.1* (Data Set). https://datastore.copernicus-climate.eu/documents/satellite-land-cover/D5.3.1_PUGS_ICDR_LC_v2.1.x_PRODUCTS_v1.1.pdf

Maus, V., Giljum, S., Gutschlhofer, J., da Silva, D. M., Probst, M., Gass, S. L. B., Luckeneder, S., Lieber, M., & McCallum, I. (2020). *Global-scale mining polygons (Version 1)* (Data Set). https://doi.org/10.1594/pangaea.910894