The effect of Indonesia's moratorium on deforestation clusters

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Abstract

Tropical deforestation accounts for roughly 10% of annual carbon emissions, more than the combined emissions from road, rail, air, and marine transportation, worldwide. Any viable effort to mitigate climate change will have to address tropical deforestation. This paper assesses the impact of Indonesia's 2011 moratorium on new deforestation in Indonesian Borneo. The results suggest that, relative to Malaysian Borneo, the moratorium shifted the spatial distribution of deforestation, rather than reducing the overall rate, as intended. The proportion of new clearing activity that took place on the periphery of pre-existing clusters significantly increased with the phased enactment of the moratorium. The overall effect was a significant *increase* in the overall deforestation rate. We model this event through a spatial dynamic programming problem, noting that cleared land is an input in the production of agricultural products. The results are significant in determining the efficacy of the moratorium, since it is likely that the long-term rate of deforestation may be a better metric of success — as long as the two-year limit is extended.

Points to make (in no particular order):

1. Tropical deforestation accounts for roughly 15% of annual carbon emissions, more than the combined emissions from road, rail, air, and marine transportation, worldwide.
2. Borneo is 73% Indonesia, 26% Malaysia, and 1% Brunei (which is not considered in this study to keep it compact). It is home to one of the oldest rainforests in the world.
3. The moratorium constrained investment in new deforestation clusters, shifting the spatial distribution of deforestation and ultimately increasing the overall rate of deforestation.
4. Indonesia announced the two-year moratorium in May 2010 to be enacted in January 2011, but it wasn't actually enacted until March 2011 after disputes between government, industry, and environmental advocates. Three stages of the moratorium.
5. The moratorium was catalyzed by a $1 billion promise from Norway, cash on delivery to Indonesia, contingent on a reduction in the deforestation rate. The promise of aid made the government's previously feeble attempts to manage deforestation much more credible.
6. We use the island of Borneo as a social lab, of sorts, given that Malaysian Borneo is similar in weather and agricultural output as Indonesian Borneo, but was not subject to the moratorium. While the border was drawn based on physical attributes of the land – to divide the watersheds – the similarity of the two sides is reasonable. The one complication may be that Indonesian Borneo is three times the size of Malasian Borneo, potentially affecting the possible spatial dispersion.
7. The overall effect of the moratorium was an *increase* in the rate of deforestation, relative to Malaysia, but to decrease the proportion of deforestation due to new clusters. The spatial pattern of deforestation became more condensed, with clearing occuring disproportionately on the periphery of pre-existing clusters.
8. The new paradigm under the moratorium resembles the short-term response to increased supply of cleared land, on the outskirts of existing clusters. Lower cost to clear, no investment.
9. Intertemporal leakage. Induced short-term behavior in place of long-term behavior, potentially waiting out the two-year moratorium.

Tables and figures

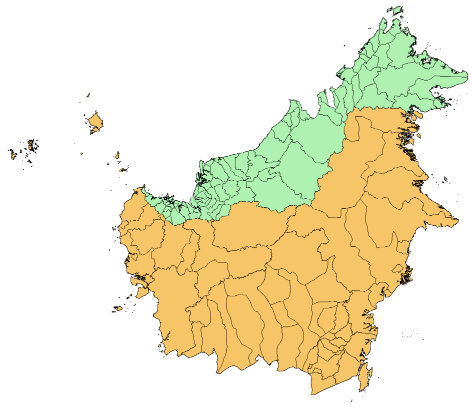


Figure 1: Sample area, Malaysia in green and Indonesia in orange. Borders indicate subprovinces.

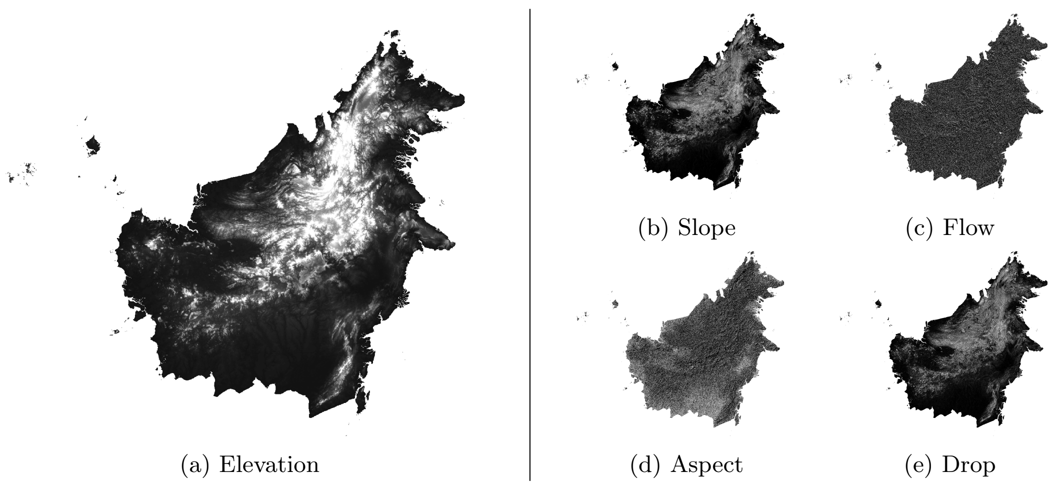
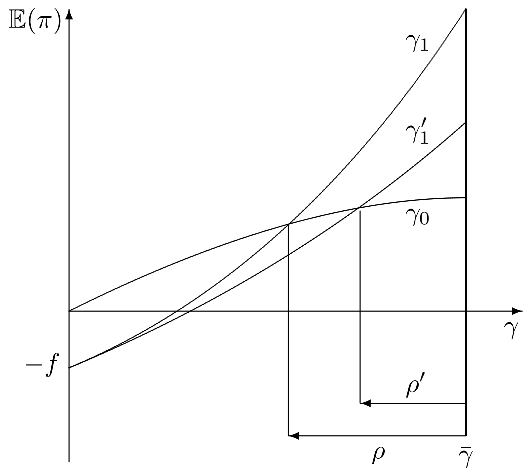
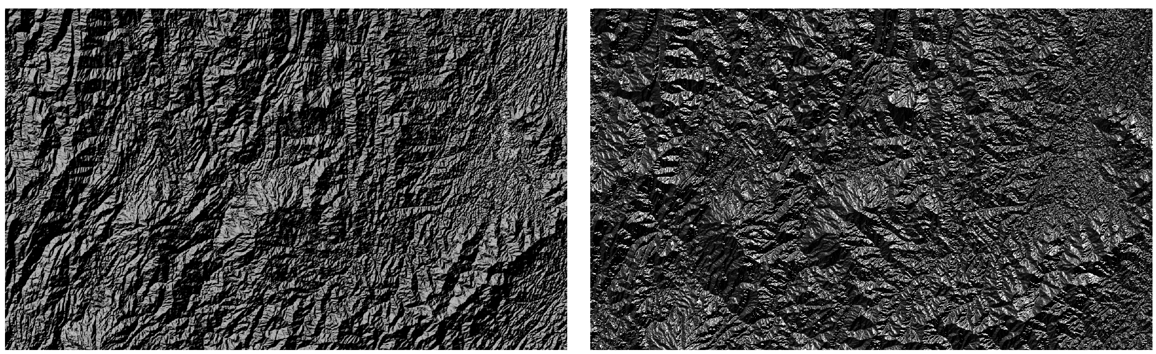


Figure 2: Map of the digital elevation model (left) with derived data sets (right) indicating slope, hydrology, and terrain roughness, 90m resolution.

Figure 3: Illustration





(a) Hillshade

(b) Flow direction

Figure 4: Detailed images of two derived data sets for the same area.

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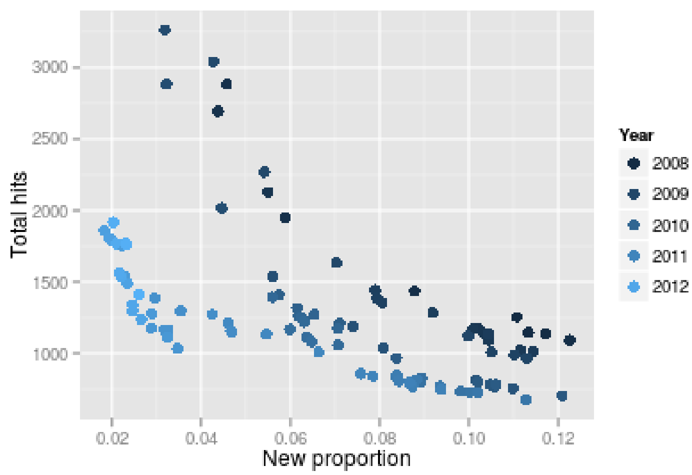
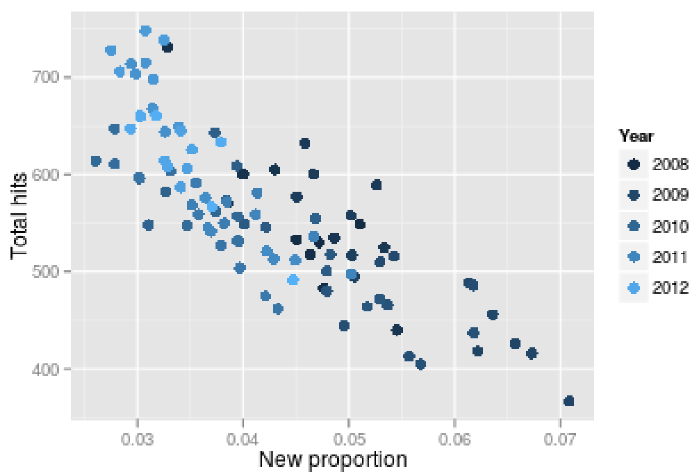


(a) Indonesia



(b) Malaysia

Figure 5: Relationship between total rate and proportion of new clearing activity, stratified by time period.

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Table 1: Proportion of deforestation from new clusters

	(1)	(2)	(3)
(Intercept)	0.04552^{***}	0.06408^{***}	0.06506^{***}
	(0.00192)	(0.00536)	(0.00746)
cntry	0.03790^{***}	0.03790^{***}	0.02947^{***}
	(0.00271)	(0.00263)	(0.01055)
post	-0.01117^{***}	0.00047	-0.01334
	(0.00346)	(0.00460)	(0.04075)
cntry:post	-0.04021^{***}	-0.04021^{***}	0.11524^{**}
	(0.00489)	(0.00475)	(0.05763)
pd		-0.00530^{***}	-0.00558^{***}
		(0.00144)	(0.00207)
pd:cntry			0.00241
			(0.00292)
pd:post			0.00253
			(0.00732)
pd:cntry:post			-0.02822^{***}
			(0.01035)
R^2	0.64452	0.66756	0.68762
Adj. R^2	0.63913	0.66081	0.67635
Num. obs.	202	202	202

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

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(a) Proportion of new cluster deforestation

(b) Overall deforestation rate

Figure 6: Time series for Malaysia baseline (blue) and Indonesia (red); grey areas indicate the three phases of the moratorium, allowing for uncertainty in the deforestation data.