Exploring intensification spillovers: Understanding the relationship of agricultural intensification and deforestation in the world's tropical dry forests

Marie Pratzer, Master Thesis

Abstract

Does the intensification of agriculture spare land for nature and thus slow down deforestation, or rather trigger counteracting rebound effects that motivate cropland expansion and accelerate forest loss?
Prevailing complexity in land systems makes it impossible to arrive at an explicit answer to this controversy. Yet, given the tremendous, often irreversible, social and ecological trade-offs of land use change, it is crucial to identify critical factors that condition whether intensification leads towards an expanded or contracted agricultural footprint – particularly in the weakly protected tropical dry forests already now experiencing high and rising pressure from agricultural frontiers.

Drawing upon theories and empirical evidence, I built a causal model comprising different pathways of how intensification relates to deforestation under diverse social-ecological contexts. To estimate the effect of country level yield growth on forest loss between 2000 and 2020 and investigate the established mechanisms, I applied a Bayesian multilevel modeling framework exploring both global trends and continent-specific variations.

I found that in tropical dry forests, a 100% increase in yield was associated with a 3.8% increase in forest loss. Hence, higher yields have reinforced rather than reduced forest loss, but contextual factors diversify the outcome: While economic incentives of globally integrated, commercialized commodity agriculture can trigger strong rebound effects, constraints on land availability and accessibility facilitate land sparing in the concerned areas. Likewise, Indigenous or community land management fosters land sparing, especially in South America where land formalization is comparably advanced. Governance and global trade position have not shown clear effects.

Given prevailing trends of global agriculture, among them the growing importance of agribusinesses and global markets, my findings have crucial implications on future land-use and conservation strategies – most importantly

challenging oversimplified land system representations and highlighting the need for contextual and place-specific solutions.

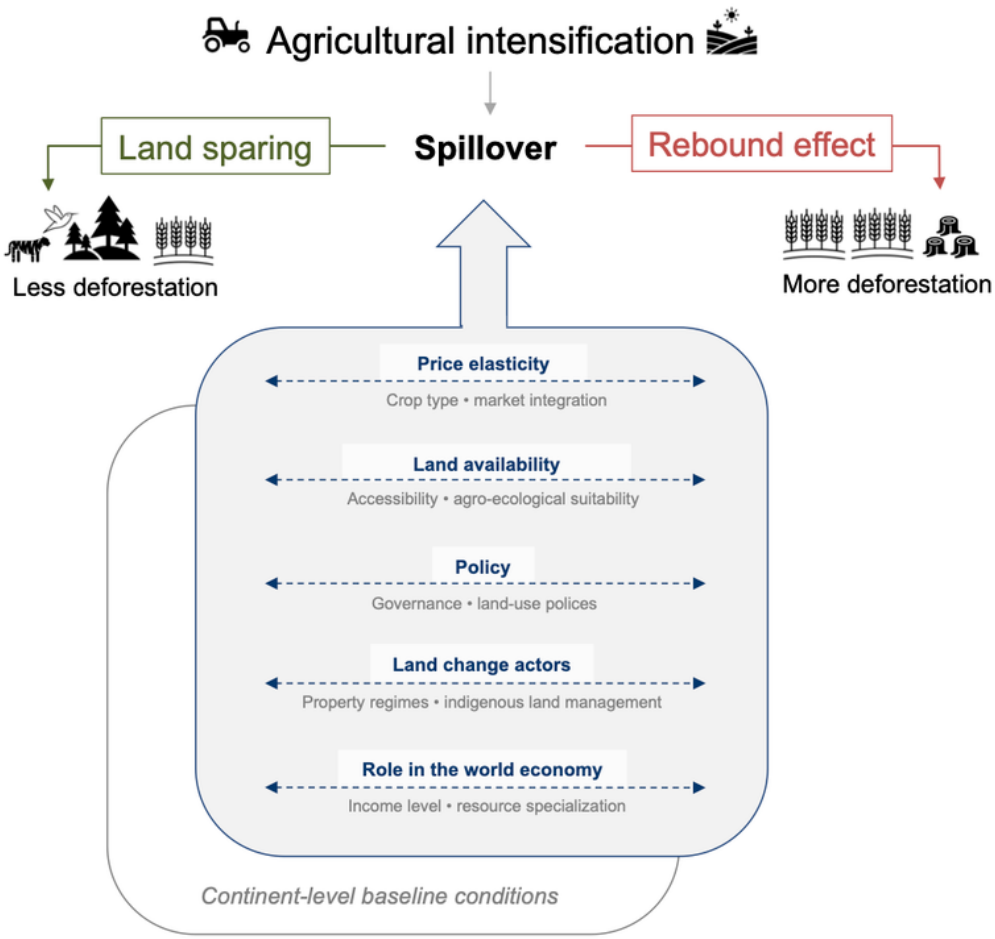

Fig. 1. Conceptual framework. The relationship of agricultural intensification and deforestation is shaped by a variety of contextual factors including environmental conditions as well as socioeconomic and structural patterns.

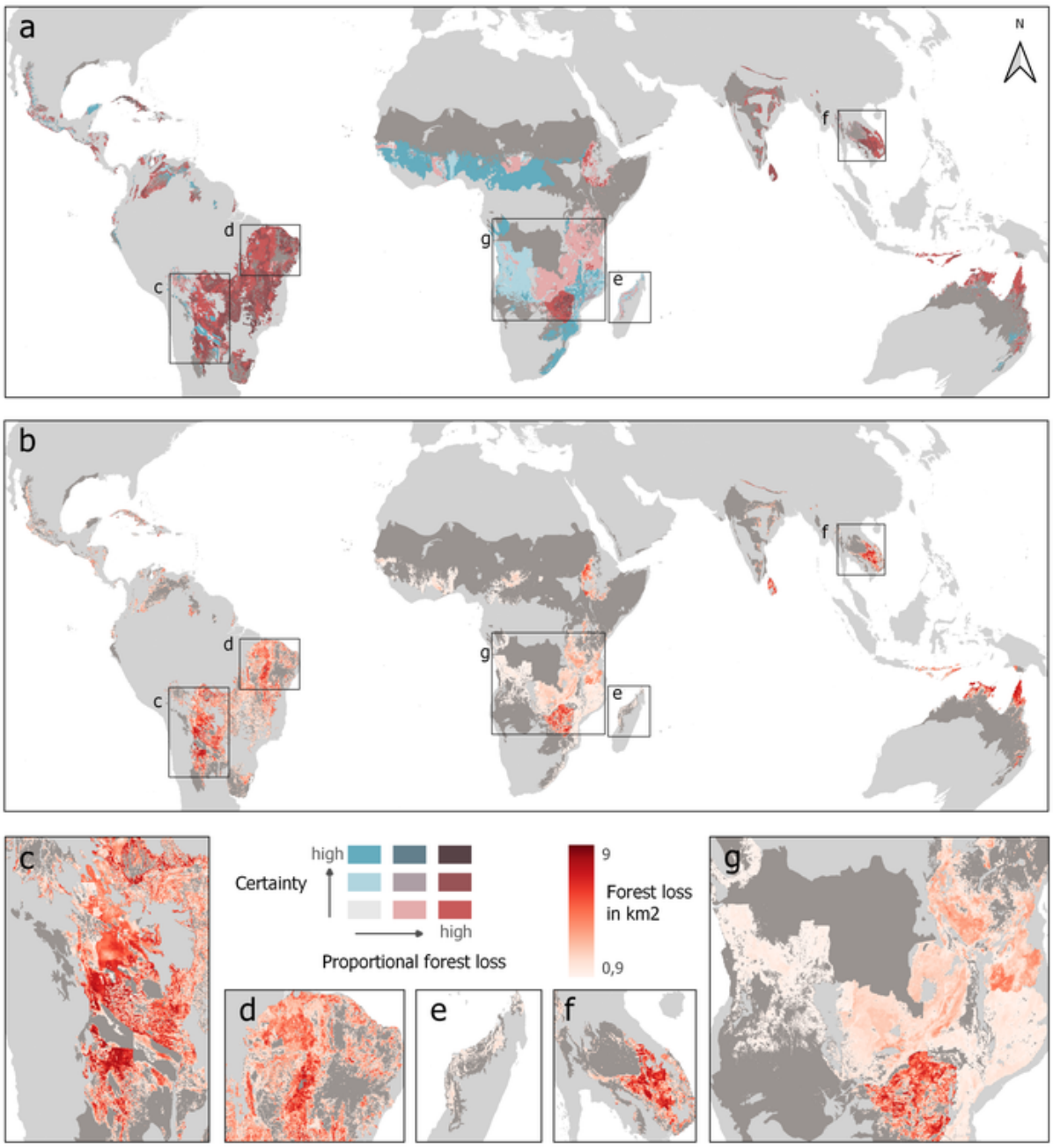

Fig. 1. Modeled forest loss from intensification spillovers based on continuing yield change patterns. Predictions draw upon a hypothetical scenario of extrapolating past 10 years' yield change 20 years into the future. The effect of population density was disregarded, and all other model parameters (nonStap, suit, IPL, special, accessibility) remained unchanged. Proportional forest loss and certainty represent the mean posterior estimate and the posterior standard error (comprising both parameter uncertainty and predictive uncertainty) (a). Forest loss in km2 was calculated by multiplying the modeled proportional forest loss per grid cell by forest cover in 2020 (b). Insets show zoom-in to deforestation hotspots in the South American Gran Chaco & Chiquitania (c), Cerrado & Caatinga (d), African Miombo and Mopane woodlands (e), Madagascar (f) and Indochina tropical dry forests (g).