Forest amount affects soybean productivity in Brazilian agricultural frontier

Ludmila Rattis[1], Paulo Brando[1], Eduardo Marques[2], Nathane Queiroz[3], Divino Silvério[2], Marcia Macedo[1], and Michael Coe[1]

[1]Woods Hole Research Center
[2]Universidade do Estado de Mato Grosso
[3]Universidade Federal de Goias

November 22, 2022

Abstract

Over the past three decades, large tracts of tropical forests have been converted to crop and pasturelands across southern Amazonia, largely to meet the increasing worldwide demand for protein. As the world's population continue to grow and consume more protein per capita, forest conversion to grow more crops could be a potential solution to meet such demand. However, widespread deforestation is expected to negatively affect crop productivity via multiple pathways (e.g., thermal regulation, rainfall, local moisture, pest control, among others). To quantify how deforestation affects crop productivity, we modeled the relationship between forest amount and enhanced vegetation index (EVI—a proxy for crop productivity) during the soybean planting season across southern Amazonia. Our hypothesis that forest amount causes increased crop productivity received strong support. We found that the maximum MODIS-based EVI in soybean fields increased as a function of forest amount across three spatial-scales, 0.5 km, 1 km, 2 km, 5 km, 10 km, 15 km and 20 km. However, the strength of this relationship varied across years and with precipitation, but only at the local scale (e.g., 500 meters and 1 km radius). Our results highlight the importance of considering forests to design sustainable landscapes.

Forest amount affects soybean productivity in Brazilian agricultural frontier

Ludmila Rattis[1*], Paulo Brando[1,2], Eduardo Queiroz Marques[2], Nathane Queiroz[2], Divino Silvério[2], Marcia Macedo[1,2], Michael Coe[1]

1 – Woods Hole Research Center; 2 – Instituto de Pesquisa Ambiental da Amazônia;
*lrattis@whrc.org

INTRODUCTION

Over the past three decades, large tracts of tropical forests have been converted to crop and pasturelands across southern Amazonia…

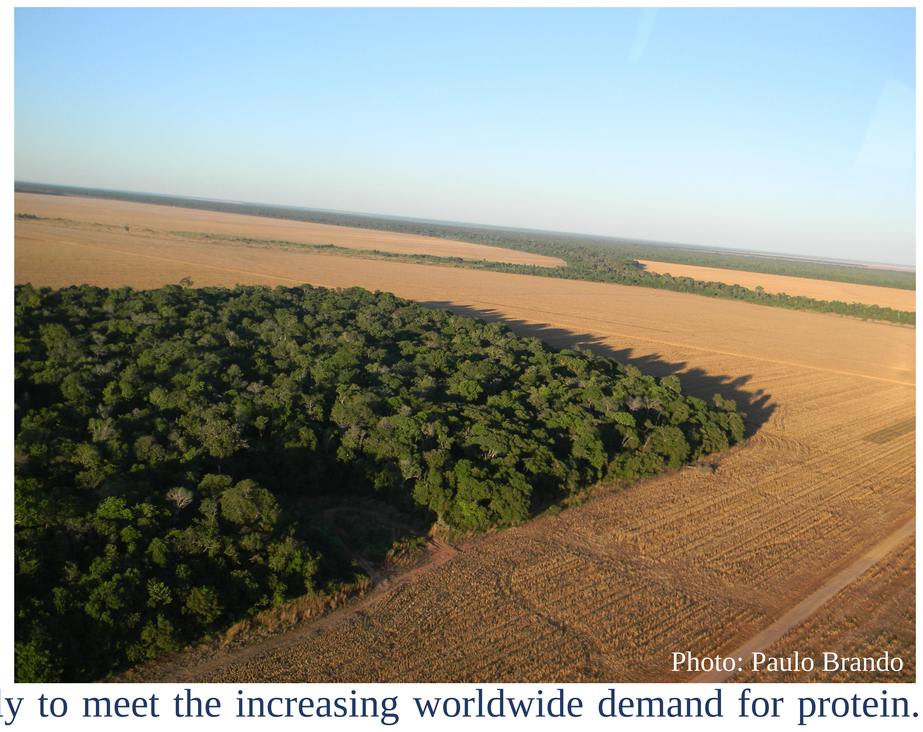


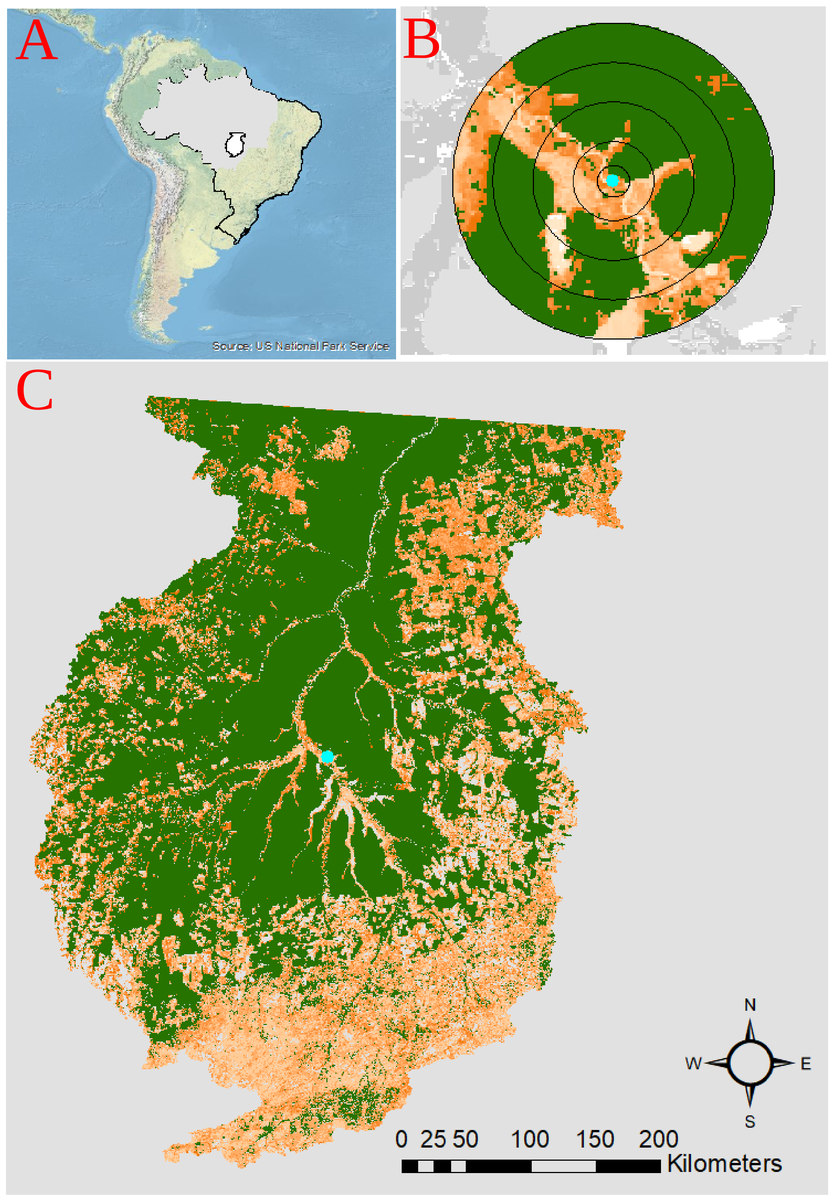
Photo: Paulo Brando

… largely to meet the increasing worldwide demand for protein. As the world's population continues to grow and consume more protein per capita, forest conversion to grow more crops could be a potential solution to meet such demand. However, widespread deforestation is expected to negatively affect crop productivity via multiple pathways (e.g., thermal regulation, rainfall, local moisture, pest control, among others).

OBJECTIVES AND METHODS

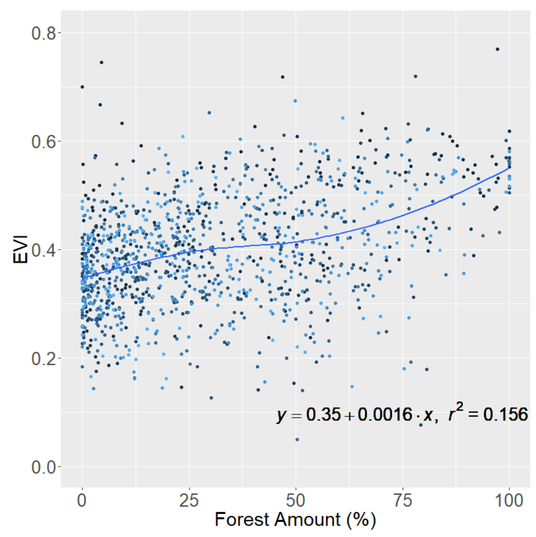
Here we quantified how forest amount and fragmentation affect crop productivity during the soybean planting season across southern Amazonia (A and C).

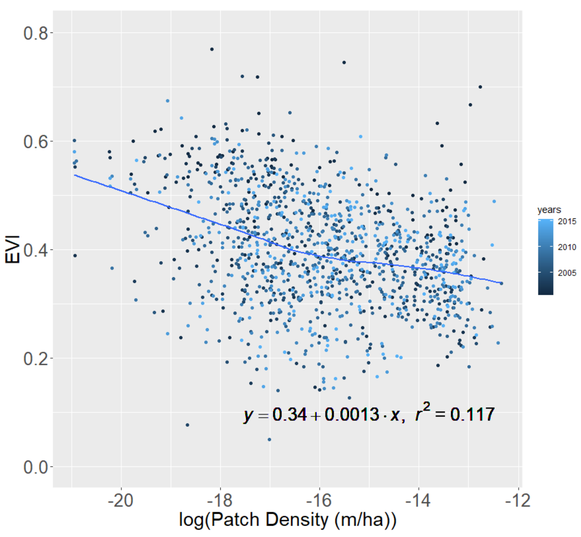
We modeled the relationship between forest amount and enhanced vegetation index (EVI—a proxy for crop productivity) at five local scales ranging from 2 km to 20 km buffers (B), between 2001 and 2015.



RESULTS

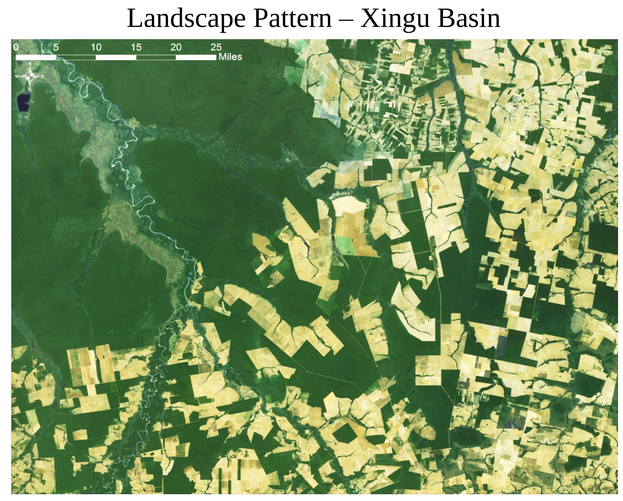
We found that the maximum MODIS-based EVI in soybean fields increased as a function of forest amount and decreased as a function of forest fragmentation at all local scales.





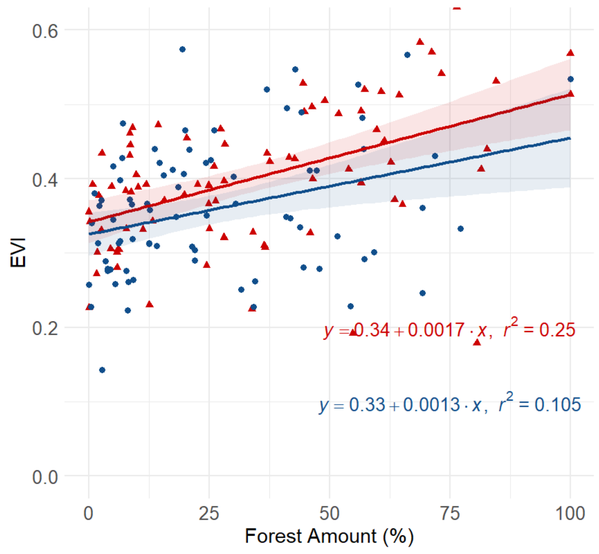
$$EVI = G\ x\ \frac{(NIR\ -RED)}{(NIR + C1\ x\ RED - C2\ x\ BLUE + L)}$$

Landscape Pattern – Xingu Basin

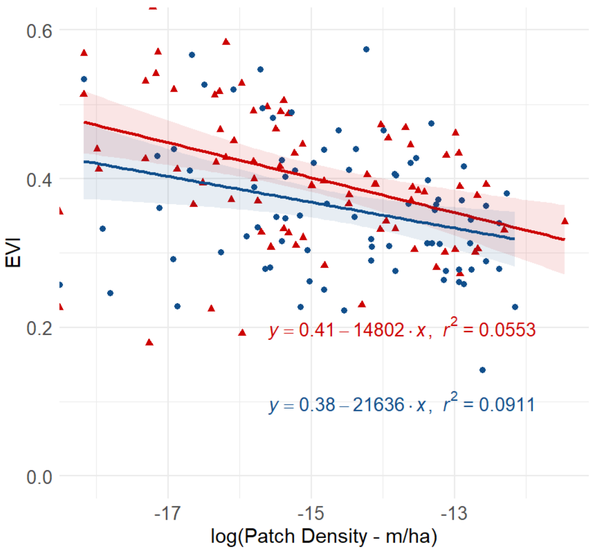


The strength of this relationship increased in hotter and drier years.

Forest Cover Change



Fragmentation



CONCLUSIONS

Forest amount crop productivity, while forest fragmentation decreased it. Forest amount increased, while fragmentation decreased crop productivity. Our results highlight the importance of considering forests to design sustainable landscapes, especially as climate becomes hotter and drier.

ACKNOWLEDGEMENTS

CAPES

CNPq
Conselho Nacional de Desenvolvimento Científico e Tecnológico

NSF