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Statistical Evidence That Forests Support Agricultural Livelihoods in Brazil by Limiting Dry Spells in the Rainy Season

Co-author: Jordan Rosenthal-Kay, Tufts University

Through agriculture, a large share of South America's livelihoods are tied to hydroclimatic services provided by the forests of the Amazon basin (Marengo, Jones, Alves, & Valverde, 2009). From 1977 to 2013, 15% of this forest was lost (Hansen et al., 2013; United Nations Food and Agriculture Organization, 2010). Recent extreme weather events have focused attention on the potential that deforestation of the Amazon may already be disrupting the region's economy, building support for protective interventions. It is unclear how much of recent South American climatic variability can be attributed to deforestation; thus, appropriate interventions, and the benefits that they provide, are uncertain. This study quantifies impacts of forest loss on hydroclimate, agriculture, and its associated effects on livelihood indicators. We performed statistical analysis linking forest cover, climate, and agriculture to investigate the impacts of dry spells during the wet season (veronicos) on agricultural output in an important agricultural region of Brazil. Veronicos are anticipated to be a key driver of agricultural yield losses in Brazil (de Carvalho, Assad, Evangelista, & da Silveira Pinto, 2013; Rosenzweig, Elliott, & Deryng, 2013), and are hypothesized to increase with deforestation (Gourdji, Läderach, Valle, Martinez, & Lobell, 2015). We show that on balance in the Cerrado and Southern Amazon, a key agricultural region of Brazil, veronicos have increased significantly since 1981. However, the most pronounced increases in the frequency of veronicos are not always adjacent to deforestation. Nonetheless, a substantial share of the change in veronico frequency can be explained by teleconnected deforestation. We find that deforestation has had a significant impact on not only agricultural output but also on the Gross Domestic Products of agricultural states and Human Development Indices of cities dependent on agriculture disrupted by veronicos. We use this linkage to compare livelihood shocks measured with other sources of livelihood disruption. We argue that valuation of forests is incomplete without the quantification of not only local, but also widely distributed hydroclimatic services. Our findings can aid the formulation of governance seeking to limit livelihood disruptions from deforestation-driven losses to hydroclimatic services.

Keywords: Climate, Livelihoods, Forests, Agriculture