Introduction

Tropical deforestation is the cause of 8 to 25% of worldwide, human-induced emissions of carbon to the atmosphere (Canadell et al. 2007). Despite this, the Kyoto Protocol provides no incentives for reducing deforestation (Schlamadinger et al. 2007). In 2005, at the Montreal Conference of the Parties of the UN Framework Convention on Climate Change, a proposal was formally made to include deforestation in the post-2012 UNFCCC regime (Gullison et al. 2007). Negotiations of this important new component of climate change policy must be completed by December of 2009. One important challenge in developing the "Reductions in Emissions from Deforestation and forest Degradation" (REDD) regime is to determine the cost of deforestation reduction programs, and the possible flow of benefits to indigenous peoples (Griffiths 2007). In this paper, we present an analysis of the opportunity costs of reducing deforestation to zero in a large agroindustrial Amazon landscape with a large indigenous population.

Central Questions

How much would it cost to the soy and cattle industries, per ton of reduced carbon emission, to slow deforestation in this region?

What is the potential for the carbon market to provide incentives to stakeholders for forest conservation?

Methods & Results

Forest Cover Change, 1997 - 2007

Forest cover and deforestation in 1997 were calculated from a map developed by the Brazilian National Space Research Institute (INPE), which only identifies vegetation and clearing within the forest biome. To evaluate the current extent of deforestation in the region as a starting point for analyses of future policy options, we developed a land cover classification map for the year 2007 using image segmentation and object-oriented classification techniques on a 2m-resolution ALS/SLASAR image mosaic (116 scenes, June and July 2007) (J. K. Lehmann et al., unpublished data), and a 30m-resolution (reprojected to 25m) LANDSAT ETM image mosaic (12 scenes, June-August 2007) (C. Stickler et al., unpublished data), and a 90m-resolution NASA Shuttle Radar Topography Mission (SRTM) digital elevation model (oversampled to 25 m). We distinguished 4 classes: (1) cleared areas; (2) vegetated forest areas; (3) waterf; (4) open water (the latter two were later aggregated into a single "non-forest" class).


Annual Deforestation:

We estimated annual deforestation for 2000 to 2006 using maps developed by the Brazilian National Space Research Institute (INPE 2006). For deforestation between 2006 and 2007, we applied to our 2007 ALOS-2-based classification a mask derived from the PRODES data to screen out areas classified as non-forest (including wetlands, cerrado woodlands, and other features) and as previously deforested.

Carbon Emissions:

To estimate the annual deforestation-driven carbon emissions from 2000 to 2007, we used a map of aboveground forest biomass developed for the region using remotely sensed and field-based data from or before 2000 (Saatchi et al. 2007). We estimated carbon stocks as one half of total forest biomass, assigned carbon values to each pixel of deforestation. For each year, we summed the tons of carbon emitted from the cleared areas using published estimates of the carbon content of the pastures and farm fields that replace forests following clearing (Houghton et al. 2005).

Historical Baseline:

We estimated the historical baseline for deforestation and for carbon emissions by averaging annual deforestation and emissions, respectively, from 2000 to 2007.

Annual deforestation and carbon emissions from the Xingu Headwaters

We estimate that approximately 78% of the forests in the region could be maintained for an opportunity cost of less than $20 per ton of carbon. This analysis suggests that the reduction of approximately eleven million tons of carbon emissions per year could be achieved through opportunity costs of $3200, or $33 per ton of carbon.

Over 5 years, ~53 million tons of carbon emissions reductions could be achieved for a total opportunity cost of $1.2 billion (~$215/ton). But... private landholders are not allowed to clear more than 25% of forests in the forest biome or 65% of cerrado savanna vegetation (Brazilian Forest Code)

Half Century of Carbon Payments

Given an historical baseline of deforestation of 1950 km2 per year, it would take nearly 59 years to completely clear forests outside protected areas in the Xingu. Hence, payments for reduced emissions would have to continue for at least that long, providing a long-term stream of revenue for region which could be tied to ongoing success in maintaining forest carbon stocks.

Conclusions

A REDD carbon market mechanism could reduce deforestation in the Xingu headwaters to nearly zero for less than $20 per ton of carbon in a flow of payments to private landholders and indigenous groups that would continue for approximately 50 years with substantial benefits for biodiversity conservation and water quality.

References


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The opportunity costs of reducing carbon emissions in an Amazonian agro-industrial region: the Xingu headwaters

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