The Woods Hole Research Center
IPAM - INSTITUTO DE PESQUISA AMBIENTAL DA AMAZÔNIA
UFMG UNIVERSIDADE FEDERAL DE MINAS GERAIS

United Nations Framework Convention on Climate Change (UNFCCC)
Conference of the Parties (COP), Fourteenth session

1-12 December 2008
Poznan, Poland

Reducing Emissions from Deforestation & Forest Degradation REDD

Forest carbon monitoring and landscape modeling in support of REDD: The Xingu River headwaters of the SE Amazon

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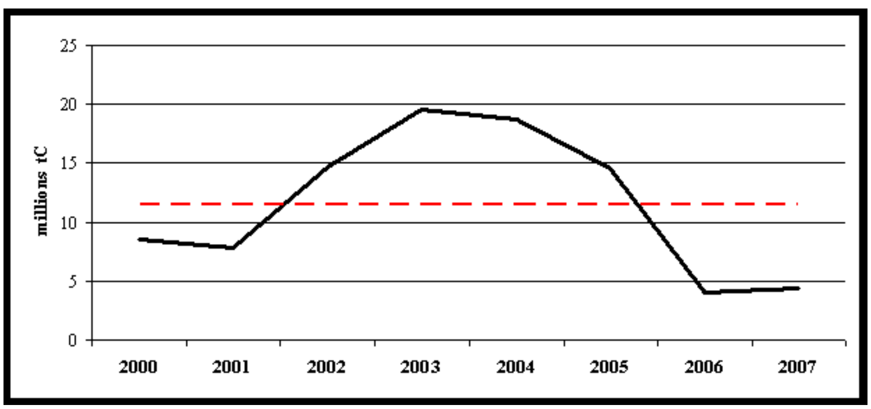
Reduction of Emissions from Deforestation and Degradation (REDD) has emerged as one of the most exciting components of climate negotiations. However, there is a lack of concrete experiences on the ground for putting REDD into practice at a scale beyond the “project”-level. REDD programs will work best if they have reliable and robust forest carbon monitoring programs and effective processes for engaging stakeholders. We present approaches to forest carbon monitoring and policy-relevant modeling in support of stakeholder processes for the Xingu headwaters region in the southeastern Amazon basin (3 times the size of Costa Rica).

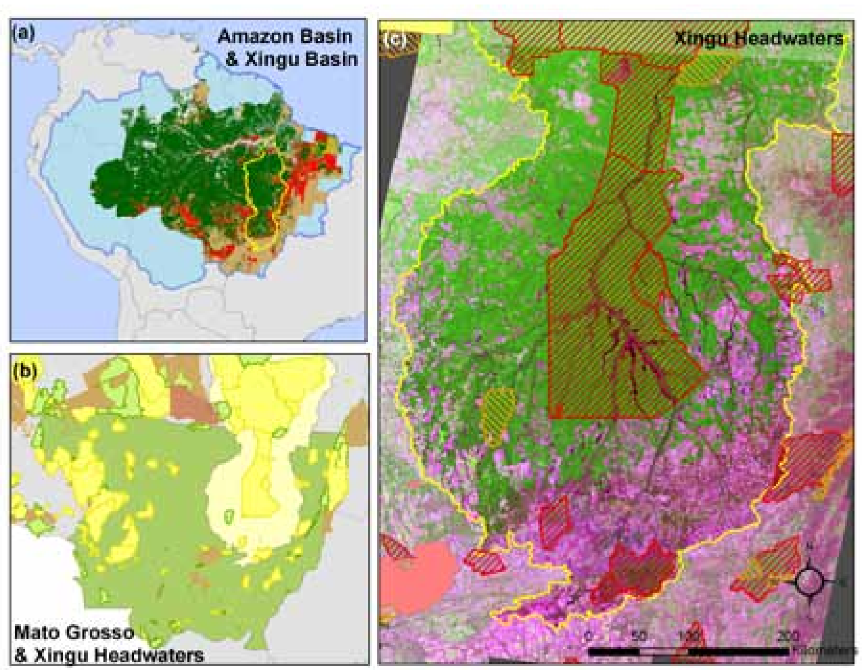


Annual Carbon Emissions — Average Annual Carbon Emissions

The Context

The 175,630 km^2 Xingu River headwaters region is located in the northeast of Mato Grosso state, in central Brazil. Deforestation in the Xingu headwaters region represents between 5 and 13% of total annual Brazilian Amazon deforestation between 2000 and 2007. The historical baseline of carbon emissions in the region is ca. 10.9 MtC, or ca. 1% of total global annual emissions of carbon from land-use/land-cover change.

The Xingu River headwaters lie at the heart of a rapidly expanding agro-industrial frontier that surrounds a large network of indigenous lands. The streams and rivers of the major protected forest areas that lie at the center of the region—the Xingu-Capoto/Jarina- Menkragnotí-Panará indigenous lands complex, which comprises 20% of the headwaters area and is home to 16 indigenous groups—are under growing threats from sedimentation, agrochemical run-off, and associated fish die-off from the unprotected headwaters regions outside of the park boundaries. (a) The Amazon Basin region, showing areas of deforestation (red) within the Legal Amazon. The Xingu River basin is outlined in yellow; (b) The state of Mato Grosso (green), with federal and state conservation areas (light green) and indigenous areas (yellow) and major federal and state roads (red) shown. The Xingu River headwaters region is shown in light yellow; (c) The Xingu River headwaters region, with indigenous lands and protected areas shown (red hatching). Indigenous territories cover approximately 36,000 km^2 within the Xingu headwaters.



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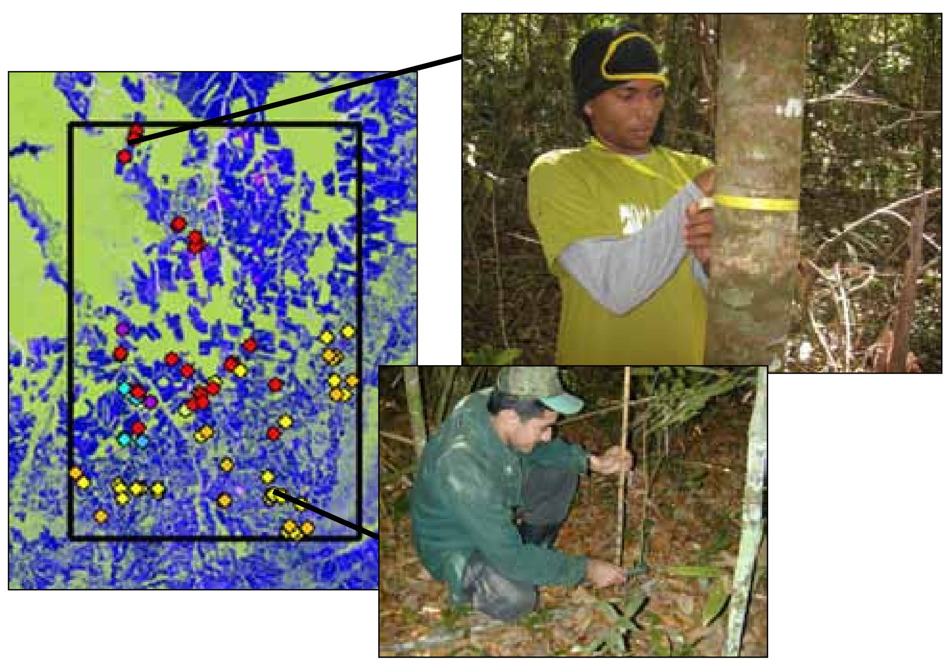
Mapping and Monitoring Forest Cover

A key component for REDD programs to be most successful is a viable forest monitoring system that provides accurate, high-resolution, maps of forest cover, ideally every year. Optical sensors (such as Landsat) have been most widely used for forest mapping at high spatial resolution (ca. 30 m), e.g. in the Brazilian PRODES system. However, tropical regions are frequently cloud covered, and although cloud-free optical imagery in the Xingu region can generally be obtained during the dry season (June-August), obtaining high-resolution optical imagery during the wet season is nearly impossible.

Radar sensors can overcome this problem, as radar waves encounter essentially no interference from clouds and smoke when imaging land surfaces. A radar sensor with a dedicated global forest and wetlands observation strategy was launched aboard the Japanese ALOS satellite in 2006. In a first pilot study in the Xingu headwaters region, a first-order forest/non-forest map has been produced with 92% accuracy using ALOS data, which compares well to 94% accuracy using Landsat data. The usefulness of ALOS radar data is also emphasized due to excellent geometric quality of ALOS radar imagery which can readily be assembled with minimal user input to generate large regional mosaics. In the near future, high resolution, cloud-free maps of tropical forests such as in the Xingu, will be easily accessible through Google Earth, but local organizations must know how to use these data in support of REDD programs.

Monitoring Carbon Stocks

Monitoring carbon stocks using satellite technology is more difficult than monitoring forest cover because the carbon content of forests is a function of the size of trees and other vegetation which can be difficult to measure remotely. However, it is possible to use a combination of remote sensing tools and field measurements to calibrate satellite images to develop maps of carbon stocks and use these to monitor change in carbon stocks due to forest clearing, forest degradation, or forest regeneration. Improved field-calibrated remotely sensed carbon estimates will be used to drive carbon flux models. Techniques currently under development for the Xingu region and elsewhere are based on a suite of sensors (optical, radar, and lidar) (see Goetz et al. for further discussion.).



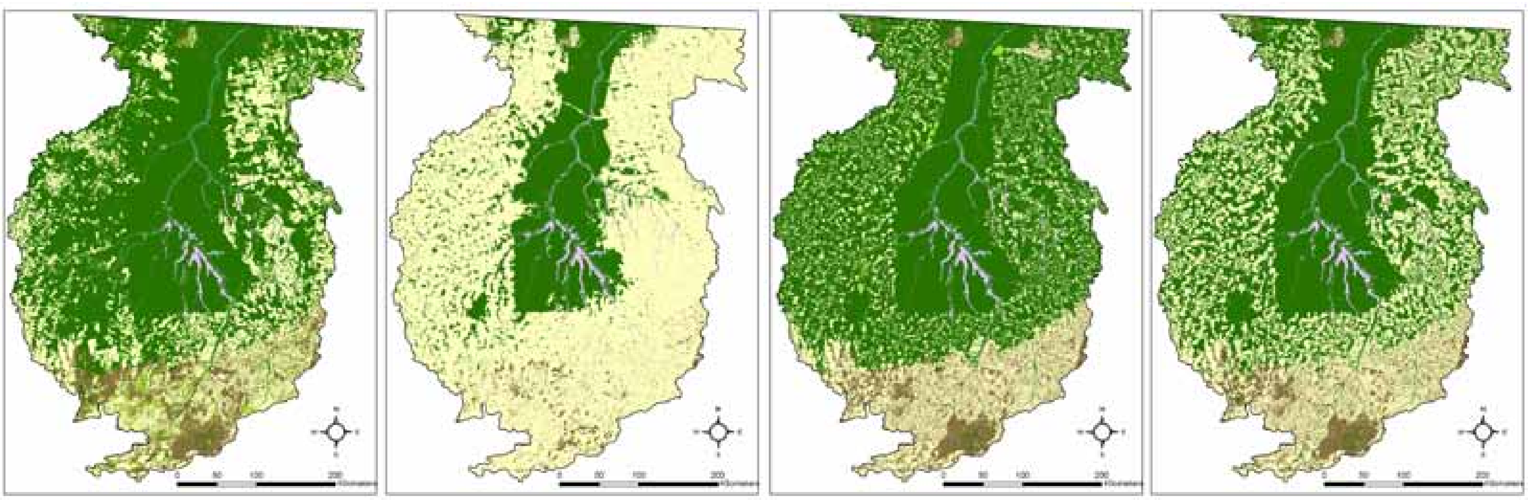
Field technicians measure the height and diameter of vegetation in standardized plots, use visual assessment techniques, and collect the geographic location of standardized plots throughout the region to calibrate a satellite image to produce a map of biomass using standard statistical regression methods. This capacity is being built with organizations that work in the Xingu region.

Policy-Sensitive Simulation Models as a Tool for Strengthening Stakeholder Participation

REDD programs will depend upon effective engagement of forest stakeholders in discussing concepts (e.g. forest carbon, climate change, land-use policies, land tenure and rights) that are quite abstract. Spatial landscape simulation models are an effective tool for illustrating to stakeholders how different policy options can affect deforestation patterns and carbon emissions, and potential carbon income to forest stakeholders. Such simulations have the potential to improve the quality of stakeholder negotiations, providing visual and quantitative measures of policy options. For example, in the Brazilian Amazon, a big debate concerns how best to implement the federal Forest Code, which requires a certain percentage of each private rural landholding to be set aside as forest. The forest cover and carbon maps for the Xingu presented here illustrate the effect of a 50% legal forest reserve in comparison with an 80% reserve (currently required by law for private rural properties located within the forest biome).

Forest Cover under Simulated Policy Scenarios: Forest cover (in green) (a) in 2007, (b) in 2035 using historical deforestation rates and assuming "business as usual" in the future, (c) in 2035 with 80% of private properties with forest cover, and (d) in 2035 with 50% of private properties in forest cover. Amount of forest cover for each scenario is relative to the 2007 landscape.

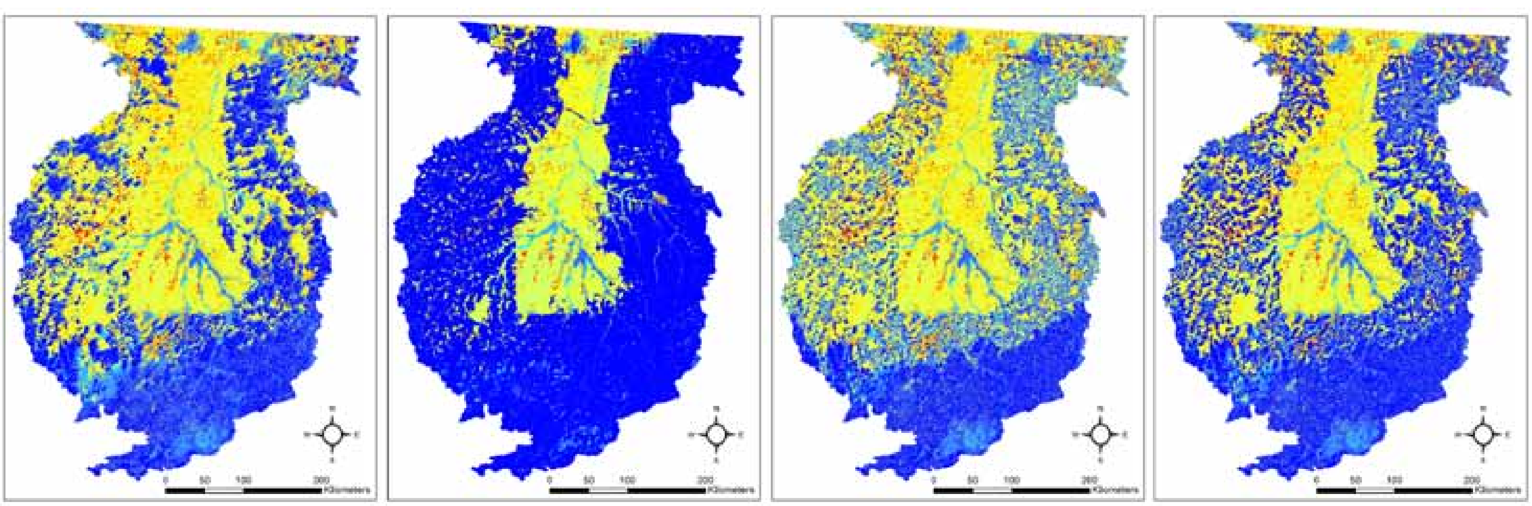
(a) (b) (c) (d)



2007	2035 Business as Usual -62,000 km²	2035 80% Legal Reserve +9,000 km²	2035 50% Legal Reserve -12,000 km²

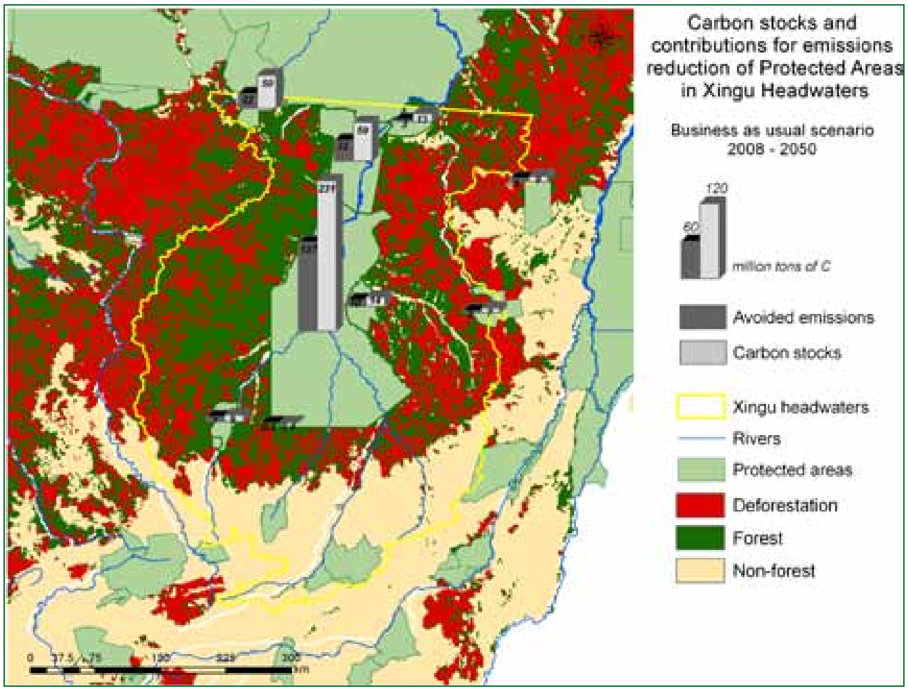
Simulated Forest Carbon Stocks: Carbon stocks for each scenario are relative to the 2007 landscape

(a) (b) (c) (d)



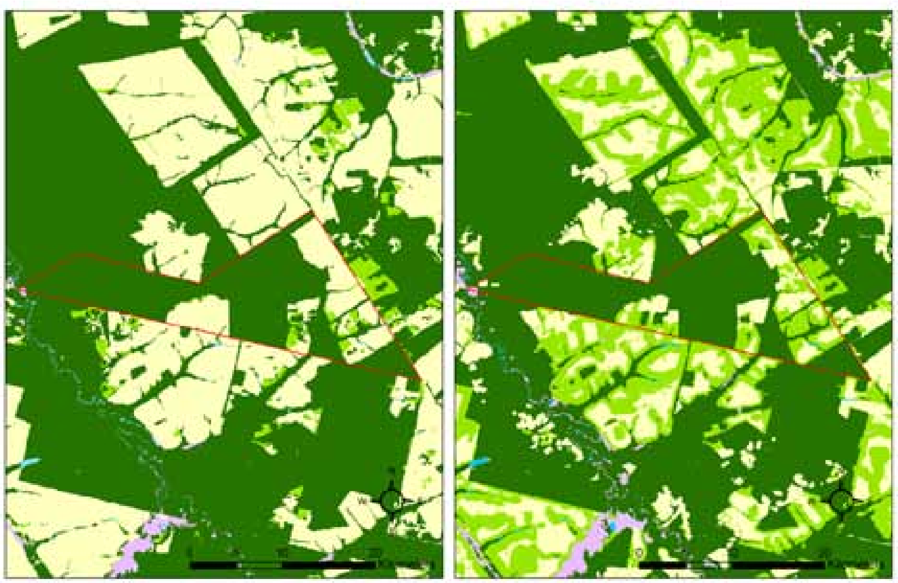
2007	2035 Business as Usual -400 MtC	2035 80% Legal Reserve +34 MtC	2035 50% Legal Reserve -87 MtC

Estimating carbon emissions reductions by individual indigenous territories and other protected areas.



Indigenous lands and protected areas inhibit deforestation in the Amazon both within their boundaries (Nepstad et al. 2006) and across the entire region. We simulate the contribution of individual state and federal protected areas and indigenous territories to future carbon emissions reductions by running the model with and without each individual area.

Simulating carbon stocks on individual ranches and farms



2007 **2035**

We simulate the carbon stocks on individual properties under different scenarios of the legal reserve. The model restricts deforestation where the minimum amount of legal reserve is reached and "regrows" forest where there is insufficient forest cover, as illustrated in this landscape for an 80% legal reserve requirement compared to the current landscape.

Acknowledgements:
Our thanks to Oswaldo Carvalho, Paulo Moutinho, Scott Goetz, David McGrath, Elizabeth Braun, and Raquel Dieguez in reviewing, editing, and preparing this report. Support for the research presented in this report was provided by The Gordon and Betty Moore Foundation, The David and Lucile Packard Foundation, US National Administration for Space and Aeronautics LBA-ECO Project, the US Agency for International Development, and the Blue Moon Fund, the Brazilian National Research Center (CNPq) and the European Union.

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