LBA Abstract

Pattern to Process in Amazônia: Measurement and Modeling of the Inter-Annual Dynamics of Deforestation and Regrowth

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INTRODUCTION

This proposal seeks to understand the interannual variability in deforestation and abandonment rates in the Brazilian Amazon region. We propose six Tasks which integrate satellite remote sensing measurements at basin and site scales, field-based case studies at the farm and household scale, and models. We propose to couple our results with other projects and studies under LBA, providing data and models on deforestation rates, its spatial pattern, and regrowth. We pose two questions:

(i) Are the inter-annual dynamics and rates of deforestation and abandonment to secondary forest significantly different than the decadal mean values in Amazonia , and can this account for a dampening of the biogenic source of carbon apparent in annual observations of atmospheric carbon dioxide and oxygen?

(ii) Through the integration of socioeconomic and satellite data and the development of dynamic deforestation models, can we improve our understanding of the dynamics of deforestation and the various controls on rates of deforestation and regrowth?

To answer these question we will measure inter-annual rates of deforestation and regrowth for the whole basin using stratified sampling methods with Landsat data. We then establish intensive case studies using multi-temporal (annual) satellite data at specific sites to estimate transition dynamics and transition probabilities for secondary growth turnover in simple LUCC models. Finally we Conduct field-based case study analyses of the decision-making processes for farmers and other land-managers, using key informant surveys and models. This is new work, not currently funded by another source, but we collaborate with other funded projects to meet our objectives.

RATIONALE

Land-use / land-cover change (LUCC) is an important driver of ecological change in Amazonia. It has a large influence on hydrology, climate, and global biogeochemical cycles (Crutzen and Andreae 1990, Houghton 1991, Houghton and Skole 1990, Salati and Vose 1984, Shukla et al. 1990). Although important, our understanding of Amazonian land cover change is inadequate for three reasons:

(i) we lack accurate measurements of the inter-annual variations in the rate and geographic extent of deforestation and we do not know if interannual variability in deforestation rates significantly influences fluxes in water, energy, carbon, and trace gases.

(ii) we do not know the quantitative importance of secondary growth and its annual variability, nor do we understand the overall dynamics of secondary growth, including its probability distribution function from one region of Amazonia to the next, how fast it regrows, how long it persists before being recleared, how often it is recylced, how land management affects these processes.

(iii) we have a poor understanding of the human and land use factors which control the rates of deforestation and abandonment, and the role secondary growth as part of land use system.

We propose research which will significantly enhance our understanding of tropical land use and cover change by analyzing in fine spatial and temporal detail the dynamics of forest clearing and abandonment in the Brazilian Amazon. We build upon previous research but propose much more detailed analyses than before by exploring the inter-annual variation in deforestation rates and the dynamics of secondary growth, and by investigating the factors which control land use processes at a range of scales from the farm-scale using case studies in the field to the basin scale using demographic and economic statistical databases.

Research Questions. This proposal will be constructed around two research questions:

1.) Are the inter-annual dynamics and rates of deforestation and abandonment to secondary forest significantly different than the decadal mean values in Amazonia, and can this account for a dampening of the biogenic source of carbon apparent in annual observations of atmospheric carbon dioxide and oxygen?

2.) Through the integration of socioeconomic and satellite data and the development of dynamic deforestation models, can we improve our understanding of the dynamics of deforestation and the various controls on rates of deforestation and regrowth?

GOALS AND OBJECTIVES

The overall goal of the research is to improve our understanding of the process of land use and land cover change in Amazonia through an approach which links satellite observations of land cover change at fine spatial and temporal resolution (patterns) to case-study-based analyses of land use changes (processes). We aim to understand what controls the relative magnitude of clearing and abandonment on an annual basis, leading to the development of simple diagnostic LUCC models which could link to carbon and ecosystem process models derived in other parts of LBA.

An important part of this work will be the development of models which track perturbations and responses on an annual basis. This would begin the next generation of completely coupled models, using non-average datasets, satellite measurements, and measures of human disturbance.

These overall goals are consistent with the goals defined in the NRA under Theme 1: Land Cover and Land Use Change:

How we will link the spatial and temporal dynamics of patterns of land-cover change with analyses of the underlying proximate, intermediate, and ultimate determinants of land-use change;

How we will develop new diagnostic and prognostic models of land-cover and land-use change with direct coupling to feedbacks from biophysical processes provided by other components of LBA research;

How we will derive an improved understanding of spatial and temporal scaling, from the farmer to the basin scales; and

How our work contributes directly to the IGBP/IHDP LUCC Focus 1 and Focus 2.

We propose a research effort with the following specific Research Objectives:

Research Objective 1: To measure inter-decadal rates of deforestation and regrowth and its spatial pattern at less than 100 m resolution over the whole using Landsat data from Landsat Pathfinder;

Research Objective 2: To measure inter-annual rates of deforestation and regrowth for the whole basin using stratified sampling methods with Landsat data between the inter-decadal inventories from Objective 1;

Research Objective 3: Amazônia-wide coupling of sociodemographic, agricultural, and econometric data at the municipio level for a suite of specific variables in order to develop land-use change variable sets;

Research Objective 4: Establish intensive case studies using multi-temporal (annual) satellite data at specific sites to estimate transition dynamics and transition probabilities for secondary growth turnover in simple LUCC models;

Research Objective 5: Conduct field-based case study analyses of the decision-making processes for farmers and other land-managers, using key informant surveys and models;

Research Objective 6: Couple empirical results and models of LUCC at the basin and site level to biogeochemical models through collaboration with other teams and utilization of an existing terrestrial carbon model.

Objectives 1, 2, and 3 are analyses at the basin scale. Objective 1 provides insight into the inter-decadal trend in deforestation rates and secondary growth (a synoptic approach). Objective 2 provides through annual sampling an estimate the inter-annual deforestation

rates for the aggregate region; it does not provide a detailed map, but it would elucidate the interannual variation in clearing and abandonment rates. Objective 3 utilizes standard Brazilian demographic, agricultural and economic census data in conjunction with the satellite analysis from Objective 1 at the municipio level to investigate basin-wide relationships between land use change and land cover change for basin scale models.

Objectives 4 and 5 are analyses at the Study Site scale. Objective 4 quantifies, through satellite measurements, detailed land cover transition sequences, transition probabilities, and interannual LUCC dynamics across a range of environments and situations to develop a process-level understanding of the land management controls on clearing and abandonment at the field level. Objective 5 couples the satellite observations to field-based surveys to develop diagnostic models of the LUCC process, which can be scaled to the basin in conjunction with Objectives 1-3.

Research Objective 6 is a synthesis effort which ties the LUCC analyses and models to biogeochemistry, in particular carbon models, to explore the significance of interannual variability. We will complete in collaboration with other members of the LBA Science Team.