Dynamics of Biogeochemical Cycles in Secondary Vegetation of Amazonia -- ND-02

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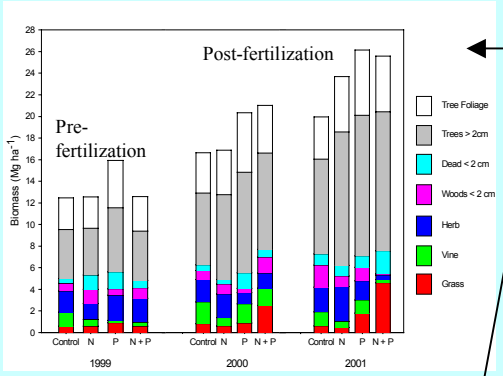
Abstract: Most deforested land in the Amazon Basin has passed through stages of secondary forest succession following agricultural abandonment. Inadequate understanding of nutrient cycles during tropical forest secondary succession precludes confidence in predictions of spatial and temporal variation of carbon sequestration, trace gas production, and nutrient losses to stream water. Hence, this proposal is motivated by three questions concerning secondary vegetation:

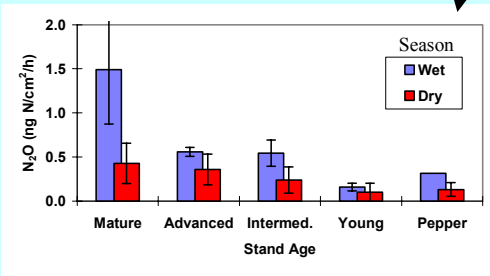
1. Do nutrients limit rates of forest regrowth?
We are addressing this question experimentally in a long-term forest fertilization study in eastern Pará. In addition, a forest chronosequence study that we completed on sandy soils will be repeated in a nearby area dominated by clayey soils, thus providing additional estimates of rates of recuperation of biogeochemical cycles during succession.

2. How well can stages of secondary forest succession be detected in satellite imagery?
Spatial extrapolation of stocks and fluxes of C and nutrients in secondary forests depends largely on identification of these ecosystems in remotely sensed imagery. Three or four stages of forest succession usually can be distinguished in Landsat imagery, but the stand ages represented by each stage vary by region, soil type, and land use history. We propose that stages of succession (early, intermediate, advanced, and mature) identified from stand characteristics and spectral properties will offer the most regionally consistent approach for characterizing successional processes and attendant changes in biomass and trace gas fluxes. We will nest ground-based measurements within images of varying resolution, including IKONOS, Landsat, and MODIS imagery. In addition, we will collaborate with studies of AVIRIS to estimate canopy N and LVIS to estimate stand height and structure to aid identification of successional forest stages.

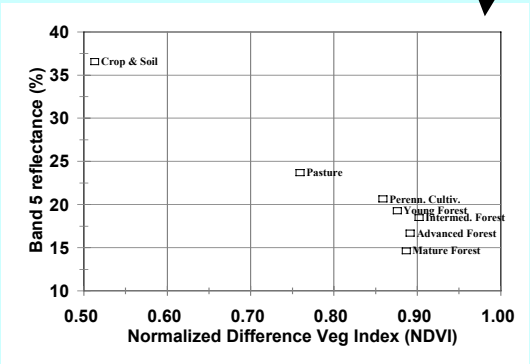
3. How does land-use affect the exchange of nutrients between terrestrial and aquatic habitats?
In both mature forests and altered landscapes the source of many elements to stream waters is not well understood because links between stream chemistry and upland nutrient status are unclear. We will measure changes in stream chemistry along 3 streams from their headwaters in remnant mature forests, through pastures, secondary forests, and large fertilized fields of rice and corn in a region of highly weathered deep Oxisols of the eastern Amazon Basin. Soils and groundwater in riparian zones will be studied in each land use.



Responses to fertilization of a 6-yr-old forest at Paragominas (Davidson et al., Ecol. Appl. In press)



N_2O emissions along a forest chronosequence and pepper farm at São Francisco do Pará



Spectral separation of land covers at São Francisco do Pará (Vieira et al. Rem. Sens. Environ. In press).

Objective 1: Do nutrients limits rates of forests regrowth?

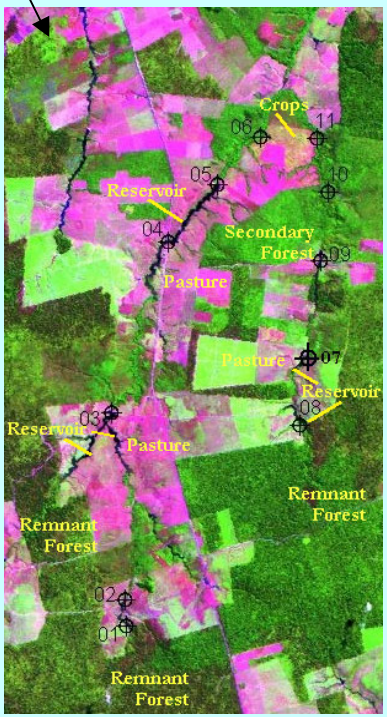
Approaches: (1) Fertilizer experiments in a secondary forest (Paragominas); (2) Chronosequence study of biomass, species diversity, soil and foliar chemistry, litterfall, and trace gas emissions in eastern Pará.

Objective 2: How well can stages of secondary forest succession be detected in satellite imagery?

Approach: Analyze spectral properties of Landsat and other imagery for a secondary forest chronosequence in eastern Pará.

Objective 3: How does land-use affect the exchange of nutrients between terrestrial and aquatic habitats?

Approach: Study changes in chemistry of 3 headwater streams in the Paragominas region as they flow from remnant forests through ranches and farms. Study riparian zone changes in soil solutions in a subset of sites.



Stream study sites in Landsat image of Paragominas area

Integration and Synthesis:

1. Fertilization and chronosequence studies will contribute to modeling of factors limiting biomass accumulation and trace gas emissions in secondary forests

2. Chronosequence studies offer opportunities for collaborations to test hyperspectral (AVIRIS) and lidar (LVIS) measurements for distinguishing among successional stages of forests.

3. Comparisons of stream chemistry, including pCO_2, with studies from other regions of the basin will permit integration of soil-type-by-land-use interactions and the importance of variation in parent material on biogeochemical processes across the basin.