Key connections in Amazonian stream corridors

Team membership

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Abstract

Deforestation in the Amazon has the potential to alter the biogeochemistry of carbon and major nutrients over large regions and to alter the movements of these materials among adjoining ecosystems. Small streams dominate the total length of stream channels in the landscape. They receive material from adjacent uplands and contribute material to larger rivers. Because of their position, small streams and their riparian zones thus play a key role in the landscape as regulators of material fluxes between terrestrial ecosystems and larger rivers of the Amazon Basin. Our goal is to develop an understanding of how carbon (C) and nutrients are transformed as water moves from uplands through small streams to larger rivers in forested and deforested landscapes. We will do this by: 1) focusing on carbon and nutrient transformations in riparian zones and small stream channels—key connection points in the landscape where these transformations are potentially of major importance but very poorly known in tropical landscapes; 2) comparing these transformations in drainage basins with different proportions of forest and pasture land use and in streams of different sizes, and; 3) coupling our process level work with information on land use and riparian zone structure derived from remote sensing and models of stream channel processing to predict regional changes in biogeochemical budgets.

Objective

To develop an understanding of how C and nutrients are transformed as water moves from uplands to small streams and to larger rivers in forested and deforested landscapes.

Small streams in Rondônia before and after forest clearing. This photo also shows the extensive alteration of the riparian zone that often occurs with deforestation.

Research Questions and Approaches

We will address the following questions:

Question 1: What controls the movement of C and nutrients from uplands across riparian zones into streams and how does the relative importance of these controls change with land use?

We will determine the spatial variability of water flow paths and groundwater C and nutrient concentrations through riparian zones in paired drainage basins of forest and pasture. We will also survey groundwater characteristics of riparian zones in forest and pasture streams with a range of riparian characteristics. A series of ^{15}N tracer experiments are planned in forest and pasture riparian zones to identify the magnitude of key processes and to quantify rates of N transformation in forest and pasture riparian zones.

Question 2. How are the transformations and movements of C and nutrients in small stream channels influenced by land use?

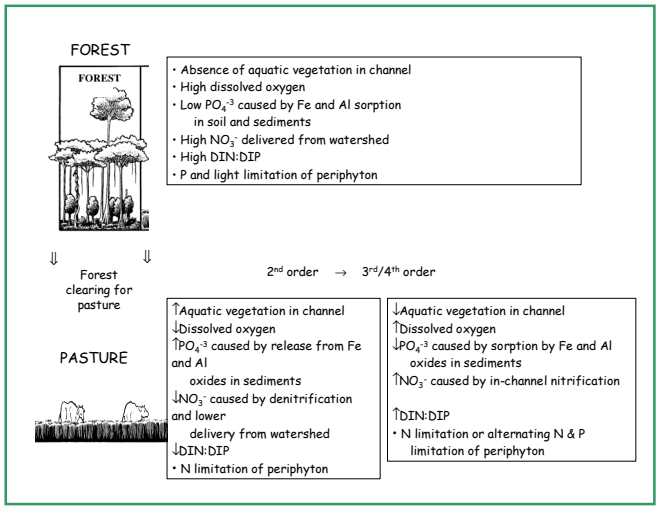
We will use ^{15}N tracer additions in forest and pasture streams to determine key processes and rates of C and N transformation in stream channels. We will quantify production and consumption of stream dissolved organic C and dissolved inorganic C using isotopic and molecular tracers. This evaluate the importance of land use, soil type and riparian vegetation structure by surveying DOC, DIC, and nutrient characteristics in a wide variety of 2nd to 5th order streams that span a range of these characteristics in central Rondonia.

Question 3: How do we scale relationships between stream biogeochemistry and basin characteristics from small drainage basins to larger basins?

We will analyze satellite images to classify areas to land use type, riparian zone type and the length channels of different stream orders in forest and pasture. We will then model C and N transformations and downstream transport in streams of various sizes in different land use types in a variety of ways. These include simple regression models that link C and nutrient concentrations to soil, land use and riparian characteristics, a dynamic stream channel model based on nutrient concentration and isotope data derived from the 15N experiments, and a dynamic coarser-scale a multi-compartment model of stream C and N cycles designed to predict concentrations in larger rivers. The dynamic models will integrate watershed areas and length of stream channels that pass through different land use types and to evaluate changes to C and nutrients that occur in increasingly complex and fragmented deforested landscapes.

By bringing together studies of land and water biogeochemistry and linking them with an understanding and modeling of changes in processes that occur in key points in the landscape, this project will provide new information on how land-water biogeochemical fluxes change when forest is replaced by pasture. It will put this information in a framework to predict the effects of forest-to-pasture conversion on stream water quality and C and nutrient transport in rivers on a regional basis.

Some past results



Conceptual model of changes in stream biogeochemistry after deforestation based on results from work in small forest and pasture streams in central Rondônia.

Students sampling organic matter and invertebrates in a small forest stream

Significance of Proposed Work

The proposed research will advance our understanding of the consequences for aquatic ecosystems of the most pervasive land use change now taking place in the Amazon Basin, the conversion of tropical forest for pasture. This work will provide important new information on transformations of C and nutrients that occur in riparian zones and in small stream channels. It will further modeling and prediction of the effects of deforestation on stream water quality and downstream transport of C and nutrients in small drainage basins.

This work will integrate an understanding of upland-stream linkages into a landscape perspective that takes into account both the extent and geographical arrangement of forest conversion to pasture. Several aspects of this research will be useful for managing water quality in river corridors of the Amazon: 1) the effect of thresholds of land use in drainage basins; 2) the influence of riparian zones and the extent of riparian vegetation; and 3) the effects of small stream channels in forest and pasture on C and nutrient retention and release.

Our role in integration and synthesis

We will integrate our work with other research teams within and related to LBA to provide an integrated picture—from uplands to river channels—of how deforestation influences the biogeochemistry of Amazonian drainage basins. We have developed interactions with a number of LBA teams that link our work with terrestrial ecosystems upslope of our focus, in larger rivers downstream of our focus and with groups working on similar land-water linkages using different approaches