Title: Forest Biomass and Land-Use Change in Central Africa: Reducing Regional Carbon Cycle Uncertainty"

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Abstract

Central Africa contains the second largest block of tropical forest remaining in the world, and one of the largest carbon reservoirs on Earth. The carbon dynamics of the region differ substantially from other tropical forests because most deforestation and land use is associated with selective logging and small-scale landholders practicing traditional "slash-and-burn" agriculture. The region is quite unlike the Amazon and Southeast Asia, where large-scale agricultural operations and clear-cut logging, respectively, predominate.

Despite estimates of 1-2 PgC/yr released to the atmosphere from tropical deforestation, the amount released from Central Africa is highly uncertain relative to the amount released from other tropical forest areas. The uncertainty in carbon fluxes results from inadequate estimates of both rates of deforestation and standing stocks of carbon (forest biomass). For example, recent estimates of deforestation in tropical Africa vary by more than an order of magnitude, and estimates of carbon stocks in soils and biomass are comparably variable.

We propose to improve estimates of the current global flux of carbon by focusing on central Africa, one of the least studied and least understood regions in terms of carbon dynamics and human impact on the environment. The proposed work seeks to determine the net annual flux of carbon from Central Africa that is attributable to changes in land use. The research has three components.

First, we will determine average annual rates of deforestation through sampling with Landsat over the periods 1986 and 2000 and already acquired 1960's maps derived from aerial photos for the 1960-80's period. To account for the variability of deforestation rates across the region, we propose using a 2% random sample in a 20 km buffer each side of the road network, covering 66% of the total forest area, since 90% of deforestation occurs in less than 10 km of the road network. We will also develop maps of recent land-use/land-cover change, and quantify rates of land-cover change from logging (degradation), agriculture (deforestation), and regrowth. We will distinguish several types of land-cover transitions, including "deforestation" of mature, old secondary forests, to cropland, "degradation" of forests due to selective timber harvest, and "regrowth" of different-aged stands after logging and crop abandonment.

The second component of the work will determine stocks of carbon in aboveground biomass. Biomass of the Central Africa forests will be estimated through two approaches. One approach will be "indirect" using Geographic Information System (GIS) and remote sensing technology, based on a classification of land-cover types, with different types being assigned average biomass values on the basis of existing data from a combination of forest inventories, ecological long-term plot studies or literature review, climatic and soil datasets and limited new field measurements. We propose to assemble

data on carbon stocks (biomass and soil C) from existing networks of field measurements across central Africa. The second approach for estimating aboveground biomass will be an hybrid approach, based on an exploration of the feasibility of direct measurement of forest canopy variables (e.g., canopy height, roughness, density) using a combination of LIDAR measurements (single return laser) from two selected sites and high resolution remote sensing sensors (ETM+, IKONOS, ASTER) to derive biomass estimates and assess of spatial heterogeneity of forest volume and above-ground biomass in the region. This component of the work will make use of existing data from extensive forest inventories in northern Congo, including more than 1.2 million ha sampled for structure and composition by our collaborator the "Congolaise Industrielle des Bois", several ecological plots (> 100 ha). For use of the LIDAR and IKONOS data, we propose limited additional fieldwork to investigate the relationship between measured tree height, crown size and biomass.

Using the results of the first two components of the research (rates of deforestation and forest biomass), we will, for the third component, calculate the annual fluxes of carbon resulting from land-use change (deforestation, logging, and regrowth). We propose to use two carbon models developed by Houghton that have been used previously to calculate fluxes of carbon from land-use change at global and regional scales. We are well positioned to conduct this work through our previous participation in interdisciplinary programs in central Africa, including the Alternatives to Slash and Burn (ASB) Program, the US AID-funded Central Africa Regional Program for the Environment (CARPE), the Global Forest Watch Africa Initiative (WRI), and the ECosystems of Inter-Tropical Forests (ECOFIT) program. The proposed research will substantially enhance the existing central Africa GOFC network by expanding upon our forest monitoring activities previously funded under the NASA-LULCC GOFC umbrella and initiate a Central Africa CArbon Network (CAFCAN). Our research will also benefit the new AfriFlux network (Land-Atmosphere Interaction and Ecosystem Dynamic in Africa) by augmenting remote sensing and field measurements of carbon stocks and rates of change.