LBA-ECO ND-04 Secondary Forest Vegetation and Soil Carbon and Nutrient Stocks, Brazil

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Revision date: February 23, 2012

Summary:

This data set reports the carbon and nutrient stocks of above-ground vegetation and soil pools at three locations where post-pasture secondary forest recovery ranged from 0 to 14 years since abandonment. These sites are located in the state of Amazonas, Brazil, along the road BR-174 north of the city of Manaus within three fazendas (cattle ranches) now in various stages of grazing, pasture abandonment, or pasture reclamation: Fazenda Rodao (km 46), Embrapa-District of SUFRAMA (DAS) pasture research site (km 53) and Fazenda Dimona (km 72).

From September 2000 to July 2001, measurements were obtained for aboveground biomass (cite ND-04 Sec For Recovery), foliage and wood samples were collected and analyzed for total nutrient (C, N, P, K, Ca and Mg) concentrations, and soil samples from 0 to 45 cm depth were collected and analyzed for total nutrient (C, N, P, K, Ca and Mg) concentrations. Total carbon (C) and nutrient stocks were calculated for various vegetation and soil pools to gain an understanding of the dynamics of nutrient and C buildup in regenerating secondary forests in central Amazonia (Feldpausch et al., 2005). There are 2 comma-delimited ASCII data files with this data set.

Data Citation:

Cite this data set as follows:

Feldpausch, T.R., M.A. Rondon, E.C.M. Fernandes, S.J. Riha. and E. Wandelli. 2012. LBA-ECO ND-04 Secondary Forest Vegetation and Soil Carbon and Nutrient Stocks, Brazil. Data set. Available on-line (http://daac.ornl.gov) from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. http://dx.doi.org/10.3334/ORNLDAAC/1069

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This data set was archived in February of 2012. Users who download the data between February 2012 and January 2017 must comply with the LBA Data and Publication Policy.

Data users should use the Investigator contact information in this document to communicate with the data provider. Alternatively, the LBA website [http://lbaeco-archive.ornl.gov/] in Brazil will have current contact information.

Data users should use the Data Set Citation and other applicable references provided in this document to acknowledge use of the data.

Table of Contents:

1. Data Set Overview:

Project: LBA (Large-Scale Biosphere-Atmosphere Experiment in the Amazon)

Activity: LBA-ECO

LBA Science Component: Nutrient Dynamics

Team ID: ND-04 (Fernandes / Wandelli)

The investigators were Feldpausch, Ted R.; Fernandes, Erick C.M.; Rondon, Marco Antonio and Riha, Susan J. You may contact Feldpausch, Ted R. (trf2@cornell.edu).

LBA Data Set Inventory ID: ND04_C_Nutrient_Stocks

Over the past three decades, large expanses of forest in the Amazon Basin were converted to pasture, many of which later degraded to woody fallows and were abandoned. This research, conducted from November, 2000 to July, 2001, examined post-pasture forest recovery in 10 Amazonian forests ranging in age from 0 to 14 years since abandonment. The study sites were located in the state of Amazonas, Brazil along the road BR-174 north of the city of Manaus. Measurements were obtained on aboveground biomass and soil nutrients to 45 cm depth, and computed total site carbon (C) and nutrient stocks, to gain an understanding of the dynamics of nutrient and C buildup in regenerating secondary forests in central Amazonia (Feldpausch et al., 2004).

Related Data Set

- LBA-ECO ND-04 Secondary Forest Recovery, Structure, and LAI, Central Amazonia, Brazil

2. Data Characteristics:

Data are provided in two comma-delimited ASCII files.

Fazenda Name Code	Fazenda Name / Description
DAS	Embrapa Amazonia Ocidental Agricultural District of SUFRAMA (DAS) pasture research site, BR-174 Km 53-54 (North of Manaus)
Rodao	Fazenda Rodao: BR-174 Km 46 (North of Manaus)
Dimona	Fazenda Dimona: ZF-3 Km 72 (North of Manaus)

File 1. ND04_Secondary_Forest_Carbon_and_Nutrient_Stocks.csv

Column	Heading	Units/format	Description
1	Location_ID		Sampling location ID code, consisting of fazenda name code + forest site number within the fazenda (See data file: ND04_Secondary_Forest_Plot_Information.csv)
2	Stand_age	years	Secondary forest age at the onset of the study (years since pasture abandonment) in ranges: 0 to 2, 2 to 4, 4 to 6, 6 to 8, 12 to 14
3	Pool		Identification of the pool measured; includes three soil pools - soil 0-15 centimeters depth - soil 15-30 centimeters depth - soil 30-45 centimeters depth, and two vegetation pools: - wood - foliage
4	C	Mg ha-1	Carbon pool size in megagrams per ha (Mg ha-1). **Diameter at breast height (DBH) was measured for all live trees with diameters greater than or equal to 1 cm. Dry biomass was calculated using allometric equations for each tree and estimates were converted to megagrams per hectare (Mg ha-1). C content from wood cores and bark from other samples were determined by laboratory analysis.**
5	N	kg ha-1	Nitrogen pool size in kilograms per ha (kg ha-1)
6	P	kg ha-1	Phosphorus pool size in kilograms per ha (kg ha-1)
7	K	kg ha-1	Potassium pool size in kilograms per ha (kg ha-1)
8	Ca	kg ha-1	Calcium pool size in kilograms per ha (kg ha-1)
9	Mg	kg ha-1	Magnesium pool size in kilograms per ha (kg ha-1)
There are no missing data values.			

Example data records:

```
Location_ID,Stand_age,Pool,C,N,P,K,Ca,Mg
DAS-1,0 to 2,soil 0-15,24.7,2215.1,4.7,38.8,92.9,41.4
Rodao-1,0 to 2,soil 0-15,19.5,1381.3,8.4,22.7,60.6,25.3
```

```
Rodao-4,2 to 4,wood,0,0.2,0,0.1,0.1,0
DAS-2,4 to 6,wood,8.8,47.9,2.6,38.2,33.8,7.1
DAS-3,12 to 14,foliage,15.6,464.6,19.1,178.1,235.3,93.4
Dimona-2,12 to 14,foliage,16.1,501,18.2,150.5,270.7,84.2
```

File 2. ND04_Secondary_Forest_Plot_Information.csv

Column	Heading	Units/format	Description
1	State		Study location state: Amazonia
2	Region		Study location region: Manaus
3	Km_marker	km nn	Study location kilometer marker along the highway BR-174 running north from Manaus to Venezuela, or ZF-3, a feeder road to BF-174
4	Fazenda_name		Fazenda name (See Fazenda Name / Description above)
5	Locaton_ID		Sampling location ID code, consisting of fazenda name code + forest site number within the fazenda
6	Stand_age		Secondary forest age at onset of study, i.e. years after pasture abandonment: 0 to 2, 2 to 4, 4 to 6, 6 to 8, 12 to 14
7	N_plots	Numeric	Number of plots in forest
8	Plot_dimensions	m	Plot dimensions as width of plot in meters X depth of plot in meters (m)
9	N_subplots	Numeric	Number of sub-plots in the plot
10	Subplot_dimensions	m	Sub-plot dimensions as width of sub-plot in meters X depth of sub-plot in meters (m)
11	Plot_area	m^2	Total area sampled per plot in meters squared (m^2)
12	Forest_area	m^2	Total area sampled per forest in meters squared (m^2)

Example data records:

```
State,Region,Km_marker,Fazenda_name,Location_ID,Stand_age,N_plots,Plot_dimensions,N_subplots,Subplot_dimensions,
Plot_area,Forest_area
Amazonas,Manaus,km 54,Embrapa DAS Experiment,DAS-1,0 to 2,12,10x10,1,10x10,
100,1200
Amazonas,Manaus,km 54,Embrapa DAS Experiment,DAS-2,4 to 6,4,15x15,3,4x5,
60,240
Amazonas,Manaus,km 54,Embrapa DAS Experiment,DAS-3,12 to 14,4,20x20,3,5x7,
105,420
Amazonas,Manaus,km 72,Fazenda Dimona - ZF3 ,Dimona-1,6 to 8,4,15x15,3,4x5,
60,240
Amazonas,Manaus,km 72,Fazenda Dimona - ZF3 ,Dimona-2,12 to 14,4,20x20,3,5x7,
105,420
Amazonas,Manaus,km 72,Fazenda Dimona - ZF3 ,Dimona-3,6 to 8,4,15x15,3,4x5,
60,240
Amazonas,Manaus,km 46,Fazenda Rodao,Rodao-1,0 to 2,4,15x15,1,15x15,
225,900
Amazonas,Manaus,km 46,Fazenda Rodao,Rodao-2,6 to 8,4,15x15,3,4x5,
60,240
Amazonas,Manaus,km 46,Fazenda Rodao,Rodao-3,4 to 6,4,15x15,3,4x5,
60,240
Amazonas,Manaus,km 46,Fazenda Rodao,Rodao-4,2 to 4,4,10x10,1,10x10,
100,400
```

Site boundaries: (All latitude and longitude given in decimal degrees)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Amazonas (Manaus) - EMBRAPA CPAA pasture research station (Amazonas (Manaus))	-60.03	-60.03	-2.518	-2.518	World Geodetic System, 1984 (WGS-84)
Amazonas (Manaus) - Fazenda Dimona (Amazonas (Manaus))	-59	-59	-2	-2	World Geodetic System, 1984 (WGS-84)

Amazonas (Manaus) - Fazenda Rodao (Amazonas (Manaus))	-60.02365	-60.02365	-2.57156	-2.57156	World Geodetic System, 1984 (WGS-84)

Time period:

- The data set covers the period 2000/11/01 to 2001/07/15.
- Temporal Resolution: Vegetation samples were collected in one campaign completed between late June and early July 2001. Nutrient concentrations were scaled up using DBH and biomass measurements from an earlier campaign done in December 2000/January 2001.

Platform/Sensor/Parameters measured include:

- FIELD INVESTIGATION / ANALYSIS / ABOVEGROUND BIOMASS
- FIELD INVESTIGATION / ANALYSIS / NUTRIENTS
- FIELD INVESTIGATION / ANALYSIS / REFORESTATION

3. Data Application and Derivation:

The carbon and nutrient stock data represents some of the first ground-based post-pasture secondary forest data that could be used in support of forest succession, nutrient reallocation, and carbon accumulation modeling for central Amazonia. Integration with remotely sensed data could provide ground-based measurements for classification of secondary forest recovery over central Amazonia.

4. Quality Assessment:

The less than or equal to 1 cm diameter constraint imposed by the limits of the allometric equations may significantly underestimate biomass and nutrient stocks given the absence of root and biomass measurements of young secondary forest vegetation less than 1 cm DBH. Shrubs and herbaceous vegetation dominate early pasture succession and secondary forest understories contributing considerable quantities to C and nutrient stocks (McKerrow, 1992). Wood core measurements may overestimate nutrient concentrations in young stands since a greater proportion of the sample core is nutrient rich bark.

5. Data Acquisition Materials and Methods:

Study sites:
The study sites are located in the state of Amazonas, Brazil along the road BR-174 north of the city of Manaus. The terrain is undulating with an elevation of 50-150 m.a.s.l. The plateau soil is classified as dystrophic, isohyperthermic, clayey kaolinitic Hapludoxes with approximately 80 to 95% clay. Regional climate is tropical humid and the mean temperature is 26.7 degrees C. Mean annual rainfall in Manaus is 2.2 meters with March and April the wettest months.

Ten secondary forests were selected within three fazendas (cattle ranches) now in various stages of grazing, pasture abandonment, or pasture reclamation: Fazenda Rodao (km 46), Embrapa-District of SUFRAMA (DAS) pasture research site (km 53), and Fazenda Dimona (km 72). Secondary forest selection was based on forest age (time since pasture abandonment), and independence from other plots within the same fazenda. Within the selected forest, (time since pasture abandonment, 0-14 years), we established four plots of 100 m2 to 400 m2 area. Within each plot 3 subplots ranging in size from 35 to 225 m2 were established as well. See Feldpausch et al. (2004) for more details.

Biomass and tissue analyses:
Within each subplot we measured the diameter at breast height (DBH, measured at 1.3 meters above the ground surface, or above prop roots where they occurred) for all live trees with diameters greater than or equal to 1 cm. Using two sets of allometric equations developed in the region (for stems greater than 5 cm diameter from Nelson et al. (1999), for smaller stems from Mesquita unpublished data) we calculated dry biomass for each tree and converted the estimates to megagrams per hectare (Mg ha-1). Biomass data are reported in related data set (cite ND-04 Sec For Recovery).

Vegetation nutrient stocks:
In late June/early July of 2001 we collected mature sun leaves from the canopies of 15 randomly selected trees with diameters greater than or equal to 1 cm. From the same trees we took two core samples of wood and bark at 1.3 meters height. Foliage and wood samples were pooled into three sample composites of 5 trees each. Tissue was dried at 70 degrees C, ground and analyzed for total nutrient (C, N, P, K, Ca and Mg) concentrations using standard Embrapa laboratory techniques (Silva, 1999).

Using species specific foliage to wood ratios (RCG Mesquita unpublished manuscript) we partitioned the biomass estimates into wood and foliage components. We then calculated the aboveground carbon and nutrient stocks by multiplying the mean nutrient concentrations for foliage and wood by the allometric estimates of each biomass component for individual trees.

Soil analysis:
In early November 2000 we sampled soil to 45 centimeter depth in three depth classes (0-15, 15-30, and 30-45 cm) within each of the four plots per forest. The four soil samples per depth in each forest plot were composited and 4-6 subsamples were withdrawn from the composite. Soil composites were combined in the field, air dried in solar dryers, visible charcoal and roots were removed by hand, then soils were milled and sieved through a 2 mm sieve prior to analysis for C, N, P, K, Ca and Mg. Extractable soil P and exchangeable K were analyzed using a Melich-I double acid extraction (0.05 M HCl and 0.0125 M H2SO4). Exchangeable Ca and Mg were extracted with a 1M KCl solution. Total soil N was determined by the Kjeldhal technique and total soil C by wet digestion (Silva, 1999). Nutrient concentrations were multiplied by bulk densities (not reported) for each depth class to calculate soil nutrient stocks on a per hectare basis.

6. Data Access:

This data is available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) or the EOS Data Gateway.

Data Archive Center:

Contact for Data Center Access Information:

E-mail: uso@daac.ornl.gov
Telephone: +1 (865) 241-3952

7. References:

Feldpausch, T.R., M.A. Rondon, E.C.M. Fernandes, S.J. Riha, and E. Wandelli. 2004. Carbon and nutrient accumulation in secondary forests regenerating on pastures in central Amazonia. Ecological Applications 14(4):S164 - S176.

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Silva, F.C. d. 1999. Manual de analises quimicas de solos,plantas e fertilizantes. EMBRAPA Communicacao para Transferencia de Technologia. Brasilia, Brasil.

Related Publications

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- Feldpausch, T., S.J. Riha, E.C.M. Fernandes, and E. Wandelli. 2005. Development of Forest Structure and Leaf Area in Secondary Forests Regenerating on Abandoned Pastures in Central Amazonia. Earth Interactions 9(6):1-22.