Relationships between Forest Composition and Soil and Hydrologic Characteristics in a Tropical Forest in NW Mato Grosso

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ABSTRACT

Elucidating the factors that contribute to spatial dynamics in forest composition and structure can help inform forest management protocol, improve biomass estimates and explain controls on biocomplexity. In this study we analyzed the soil and landscape controls affecting forest attributes in the seasonally dry southwestern Amazon Basin in the municipality of Juruena, Mato Grosso (Figure 1). Ten 10x1000 m transects were established in a 25,000 ha reduced-impact logging concession and all trees ≥10 cm DBH and all lianas ≥l cm DBH were measured, identified and geo-referenced. Soils were sampled every 25 m along transects and landscape position was recorded. Three major forest types differentiated by tree species composition, biomass, soil type and landscape position were identified: 1) *campinarana*—high stem density and low biomass on sandstone outcrops, 2) palm forest—low-lying seasonally inundated areas dominated by palms and, 3) *terra firme*—low stem density and high biomass.

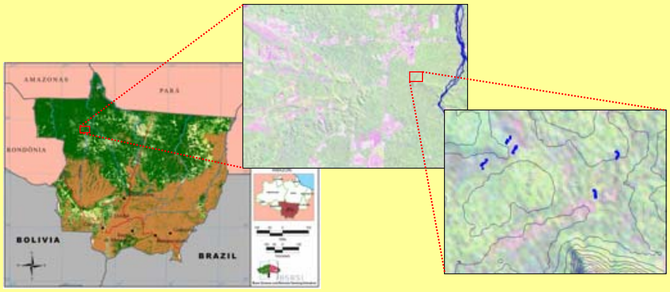

Figure 1. Study site location in Juruena municipality, Mato Grosso. Blue dots represent transect locations. Landsat imagery from 1996.

STUDY DESIGN AND METHODS

Using Landsat imagery and ground surveys, transition zones between eco-types were identified and six 10x100 m transects were established along transitions:

- Each vegetation type is represented by approximately two 10x100 m transects
- All trees, palms and lianas ≥ 10 cm DBH and, in nested 2x10 m plots, all trees, palms and lianas ≥1 cm DBH were measured, identified and geo-referenced
- Time-domain reflectometry (TDR) tubes to 1-m deep (Figure 2) and piezometers to 6-m deep were placed in unique vegetation types and are being monitored weekly to investigate hydrologic controls
- Soils were sampled every 10 m to 40 cm depth and soil pits were dug to better characterize the soil horizon in each eco-type
- 180° (fisheye) photographs were taken with a digital camera and are being analyzed for leaf area index (LAI) and % canopy openness using Gap Light Analyzer Version 2.0

RESULTS AND DISCUSSION

- In *campinarana*, <10 cm DBH stems accounted for approximately 60% of total biomass, whereas in *terra firme* and palm forest they only represented approximately 20% and 24%, respectively (Table 2)
- Palm biomass was more than three times higher in palm forest than in *campinarana* and *terra firme* (Table 2 and 3)
- Lianas made up nearly 15% of total biomass in *campinarana* compared to only 3% and 5% in *terra firme* and palm forest, respectively (Table 2 and 3)
- Stem density in *campinarana* was three times greater than in *terra firme* and palm forest (Table 4)
- *Campinarana* soil profile is characterized by a narrow layer of hard sand at 55cm depth below which reduction-oxidation features are evident (Figure 3):
  - preliminary data from TDR and piezometer measurements suggests that this restrictive layer inhibits ground water from rising to surface layers thereby contributing to low vegetation stature and biomass (Table 1)
- Dominance of water-tolerant palm species in palm forest could be attributed to perennial soil water table close to the surface as indicated by TDR and piezometer data and redox features at shallow soil depths (Table 1 and Figure 3)

Table 1. Preliminary data on soil and hydrologic properties in vegetation types ± 1 std. dev.

	Campinarana	Terra firme	Palm forest
water table depth (cm)	143±65	120±40	70±52
% volumetric water content (0-40 cm)	24±1	30±2	42±7
% volumetric water content (40-100 cm)	37±1	43±5	59±3
soil texture 40-60 cm	sand	clay loam	clay

RESULTS AND DISCUSSION (cont.)

Table 2. Biomass of ≥10 cm DBH vegetation (Mg ha^{-1}) ± 1 standard deviation.

	Campinarana	Terra firme	Palm forest
palms	2±0.1	11±0.5	52±11
lianas	1±0	3±0.2	2±0.2
trees	102±9.5	224±12	119±15
Total	105	238	174

Figure 2. Measuring volumetric water content using TRIME-FM (IMKO Gmbh)

Table 2. Biomass of <10 cm DBH vegetation (Mg ha^{-1}) ± 1 standard deviation.

	Campinarana	Terra firme	Palm forest
palms	1±0.1	11±1.5	20±6.2
lianas	37±5.4	7±1.0	9±0.9
trees	118±10.7	38±2.0	28±4.4
Total	155	56	57

NOTE: Palm biomass derived from Frangi and Lugo (1985), liana biomass from Gerwing and Farias (2000) and tree biomass from Brown et.al (1997).

Table 4. Stem density (stems ha^{-1}) and mean canopy height ± 1 standard deviation

	Campinarana	Terra firme	Palm forest
stem density ≥10cm DBH	695±55	825±25	865±140
stem density <10cm DBH	13000±1250	4400±300	3950±600
height (m)	9.8±3.5	17.4±6.1	17.0±5.5

Figure 3. Photographs of vegetation types and corresponding soil horizons

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