Mechanisms Of Biogenic Carbon Storage In Seasonal Shallow lakes From Colombian Llano And Brazilian Pantanal

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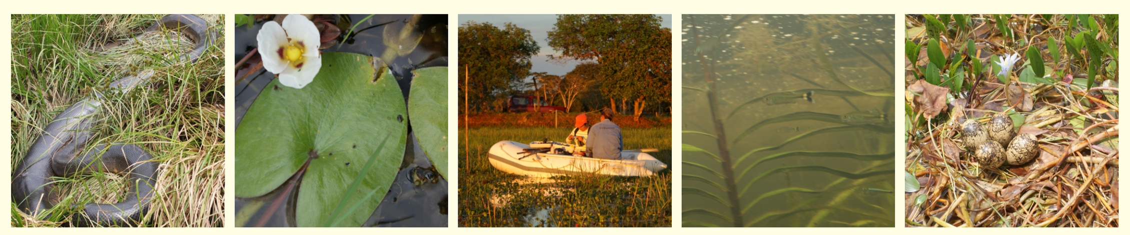
Introduction

Today, when anthropogenic carbon emissions are increasing, the carbon storage capacity of some ecosystems has become an important environmental service. Wetlands have been identified as key carbon reservoirs (Mitra et al. 2005), containing approximately between 20-25% of the terrestrial carbon in a relatively small area (Gorham 1995). However, carbon stock estimations in wetlands are widely inexact. More detailed and compatible information about carbon deposits and sequestration processes in wetlands are necessary (Adhikari et al. 2009, Mitra et al. 2005).

The focus of this research was to assess soil carbon content from seasonal shallow lakes (SSLs) and to determine their mechanisms of carbon sequestration, taking into account seasonality, geomorphology, soil constitution and primary productivity. The study will also provide first insights about the ecology and environmental services of barely studied systems.

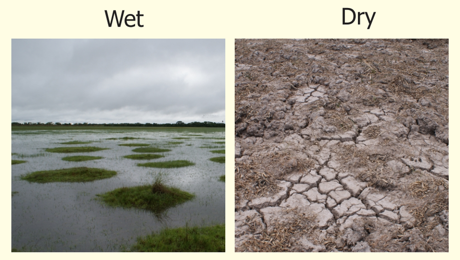
Methods

Study areas



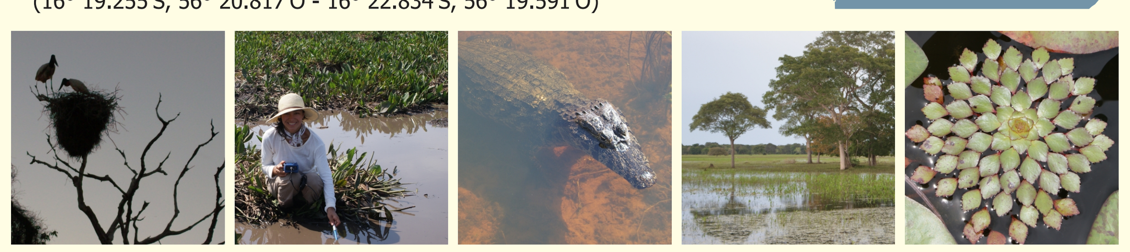
Flooded Colombian Llano, Orinoco River basin
(4º49.968'N, 72º26.793'O - 4º52.652'N, 72º32.261'O)

Wet Dry



seasons

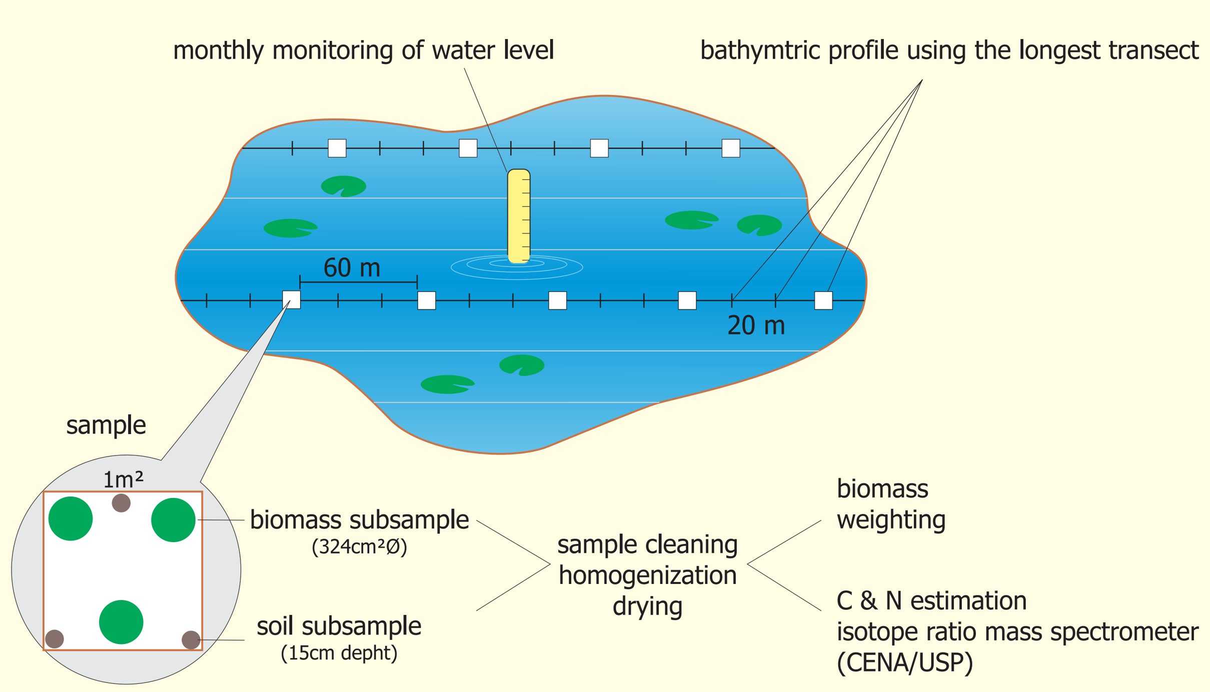
Pantanal de Mato Grosso (subregion of Pocone), Brazil
(16° 19.255'S, 56° 20.817'O - 16° 22.834'S, 56° 19.591'O)



The two study sites are seasonally flooded savannas, north and south of the Amazonian Rain Forest. They present two well-defined periods: wet and dry seasons (hydrologic variation due to the annual flood pulse (Junk 1989, Junk & Wantzen 2004)). The studied SSLs are locally known as esteros and brejos in the Llano and Pantanal, respectively.

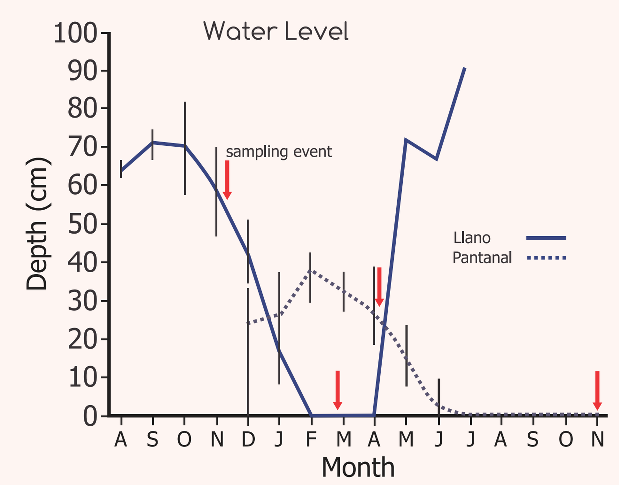
Experimental design and sampling

To assess the effect of seasonality on soil carbon storage, we sampled mostly at the end of the seasons (wet season sampling: Pantanal, 21.04.2010 - 5.05.2010; Llano, 4.11.2010 – 4.12.2010. Dry season sampling: Pantanal, 10.12.2010 – 24.12.2010; Llano, 24.02.2011– 14.03.2011). The sampling points were the same along the two seasons.

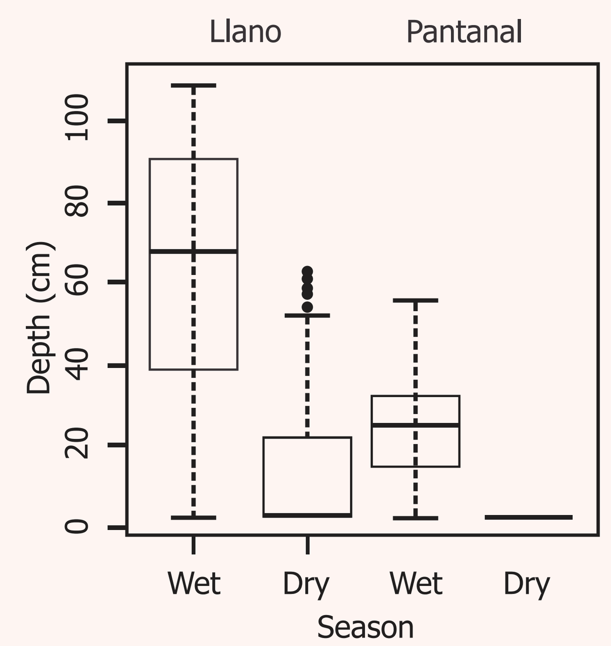


Results

Flood pulse

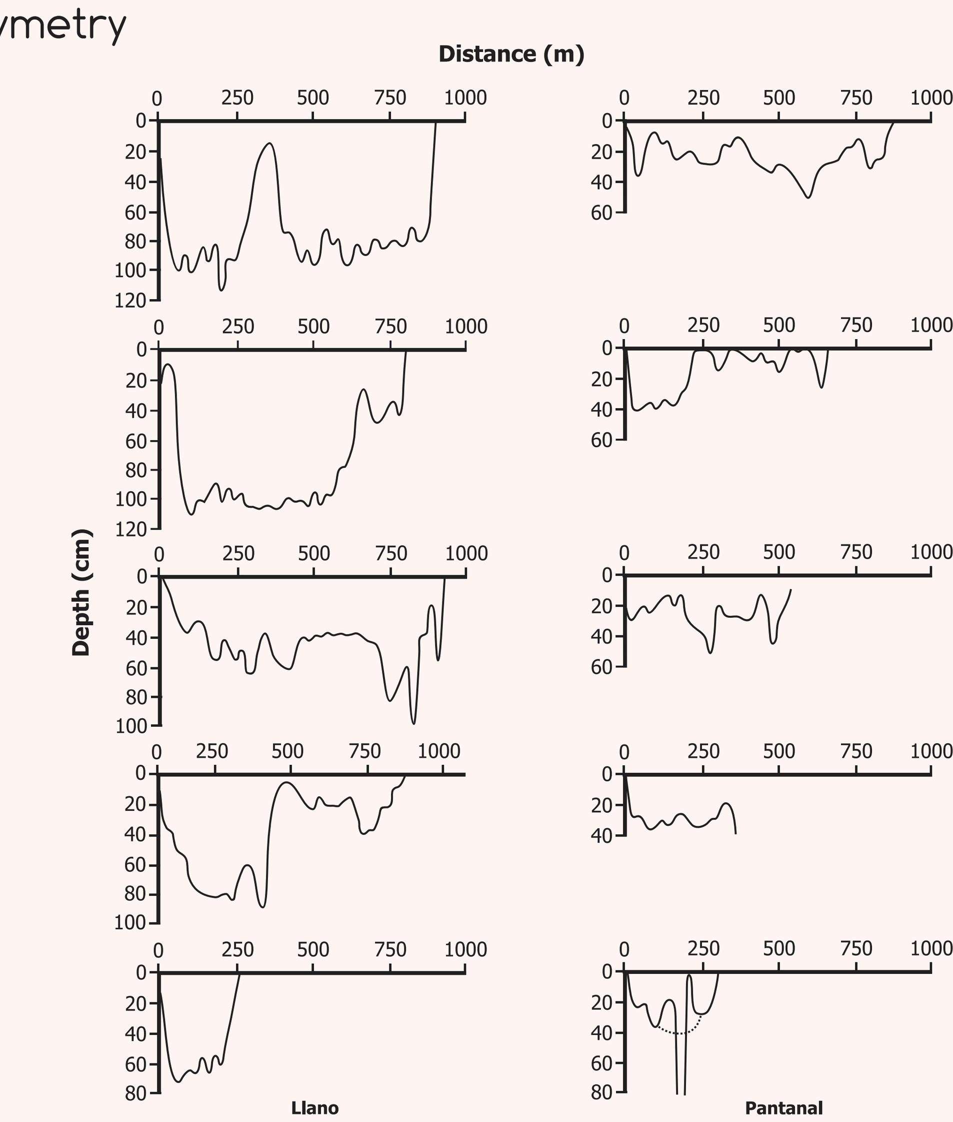


The flood pulses of SSLs from the Llano and Pantanal differ in seasonal length. Wet and dry periods in the Llano correspond to approximately nine and three months, respectively. In a different way, wet and dry seasons in the Pantanal cover approximately half and half of the year.



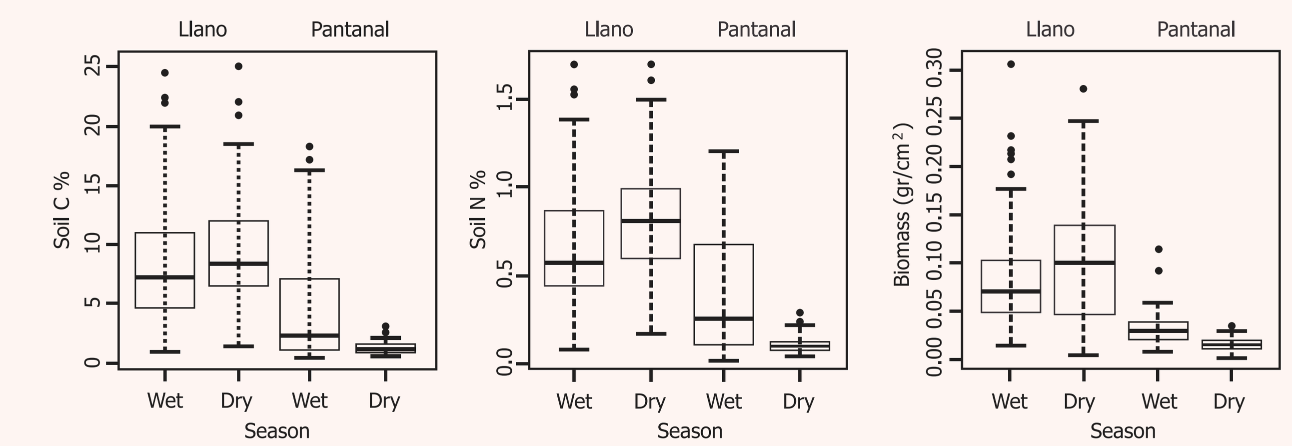
In wet season, the depth values of SSLs from the Llano were significantly higher than the other depth values. In dry season, all sampling points from Pantanal dried up completely. In this season, depth values from Llano were significantly higher than in Pantanal, as in the Llano several sampling points kept some water (Table 1).

Bathymetry



The studied SSLs in the Llano are larger than in Pantanal, they are characterized to be deeper and with more defined contour. In contrast, in Pantanal SSLs are shallower and opener wetlands, more connected with other water bodies during wet season.

Soil carbon storage, nitrogen and biomass:



Every season, 94 and 69 samples of biomass and soil were taken in SSLs from the Llano and Pantanal respectively, having a total of 324 samples.

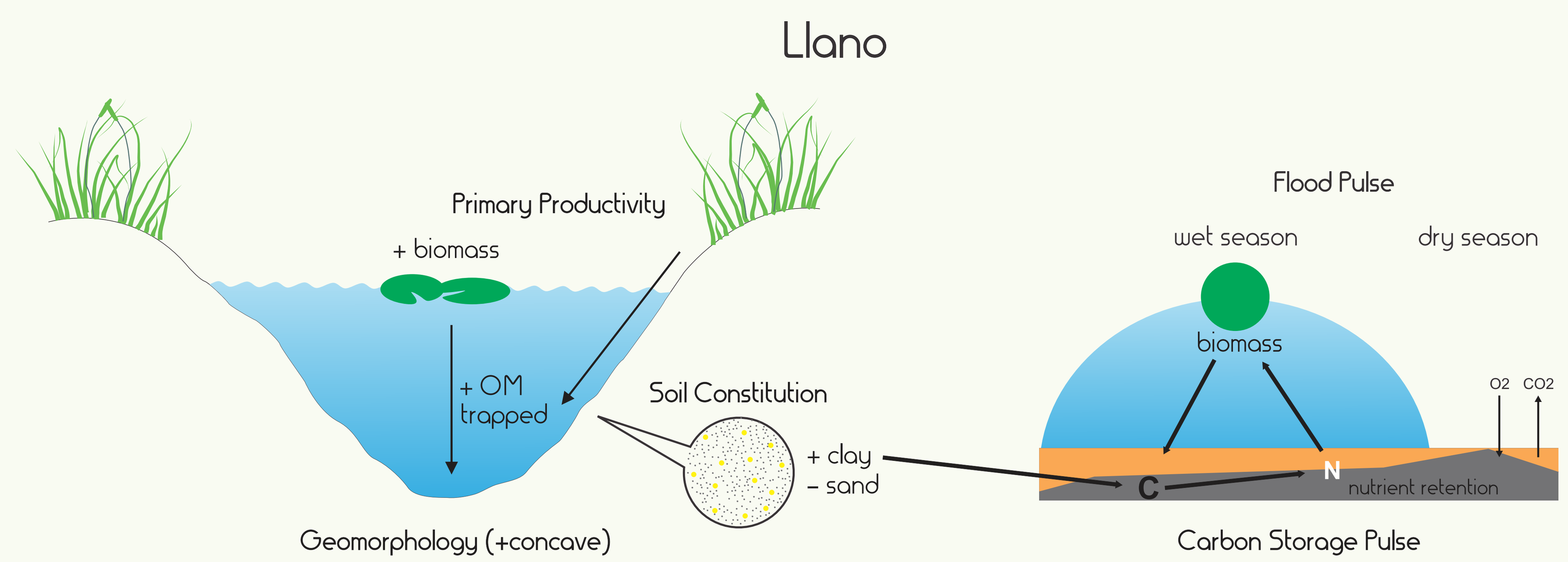
Soil C %, N % and biomass display similar variation patterns. From wet to dry season in the Llano, all of these parameters show a significant increase; while in the Pantanal they decline significantly. C %, N % and biomass from the Llano were significantly higher than in Pantanal (Table 1).

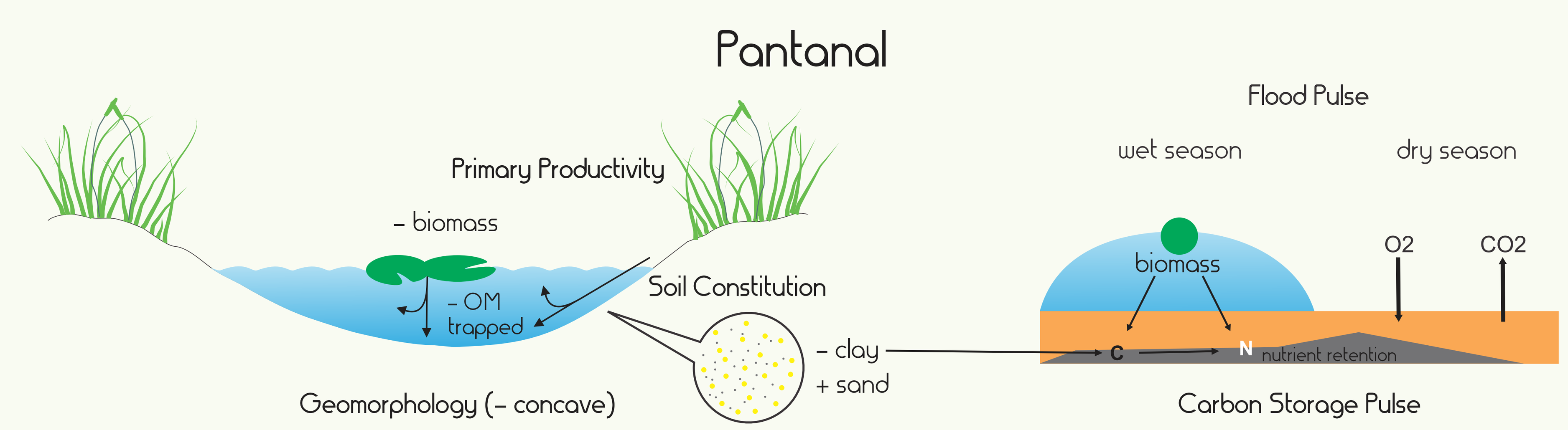
Soil nitrogen content is highly correlated with carbon content, along seasons and study areas (Llano: wet season, R^2 = 0.9453; dry season, R^2 = 0.8895; Pantanal, wet season, R^2 = 0.9153; Pan-SSL, dry season, R^2 = 0.9618).

Tabla 1: Significance of between-seasons and study area comparisons (Wilcoxon test) for depth, biomass, soil N % and C %.

Study Areas And Season	Depth (cm)			Biomass (gr/cm²)			Soil N %			Soil C %		
	Lla Wet	Lla Dry	Pan Wet	Lla Wet	Lla Dry	Pan Wet	Lla Wet	Lla Dry	Pan Wet	Lla Wet	Lla Dry	Pan Wet
Lla Dry	0.000			0.034			0.001			0.011		
Pan Wet	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000	
Pan Dry	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Conclusions





* From soil carbon dynamic in the Llano, we infer that SSLs from Pantanal have as well a peak of carbon input at early dry season.

* At the beginning of wet season, a peak of carbon input is expected, when terrestrial plants growing into SSL basins are drowned and incorporated to the aquatic system. Additionally, allochthonous OM accumulated in dry season is transported to SSLs by runoff water.

* SSL geomorphology is also related to particles transport and retention. The more concave shape of SSLs from the Llano facilitates fine particles (as clay) and carbon retention. In contrast, carbon and clay presumably are not long retained in SSLs from Pantanal, due to their shallower morphology. Soil carbon content has been associated with the presence of clay (Woomer et al. 1994).

* There is cyclical connection between carbon in soil, nutrient retention (nitrogen) and primary productivity (biomass), which again determine organic carbon sources.

* Flood pulse, basin morphology, primary productivity and physical soil constitution are interacting factors determining carbon storage in neotropical SSLs.

* Long term monitoring of SSLs will improve the understanding of their carbon storage dynamics. We conclude that SSLs from Pantanal have a carbon pulse sequestration that restarts again every year in wet season. In SSLs from the Llano, some carbon is kept at the end of dry season, resulting in an annual net carbon sequestration.

Further information for very interested people

* The SSLs present an annual predictable flood pulse caused primarily by rain and runoff water. The divergence between floodpulse patterns among the Llanos and Pantanal is mainly due to differences in the SSL geomorphology (bathymetry).

* The length variation of dry season between the Llano and Pantanal is in big part responsible for the SSL capacity to store carbon. Dry season leads to aeration and decomposition of organic matter (OM), resulting in carbon stock losses (Mitra et al. 2005).

* In the Llano, wet season is longer and deeper than in SSLs from Pantanal, in the same way stored carbon is also significantly higher.

* In SSLs distinctive carbon pulses can be shaped, according with the nature of their flood pulse. The carbon sink or source function is a stage of carbon pulse rather than a static condition.

* In the Llano, water level reduction during early dry season causes a bigger OM accumulation, increasing soil carbon contents when biomass decay and before its decomposition.

* SSLs from Pantanal store carbon during wet season. However, as a consequence of long dry season, accumulated OM is decomposed and carbon content comes near to zero.

Acknowledgments

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