

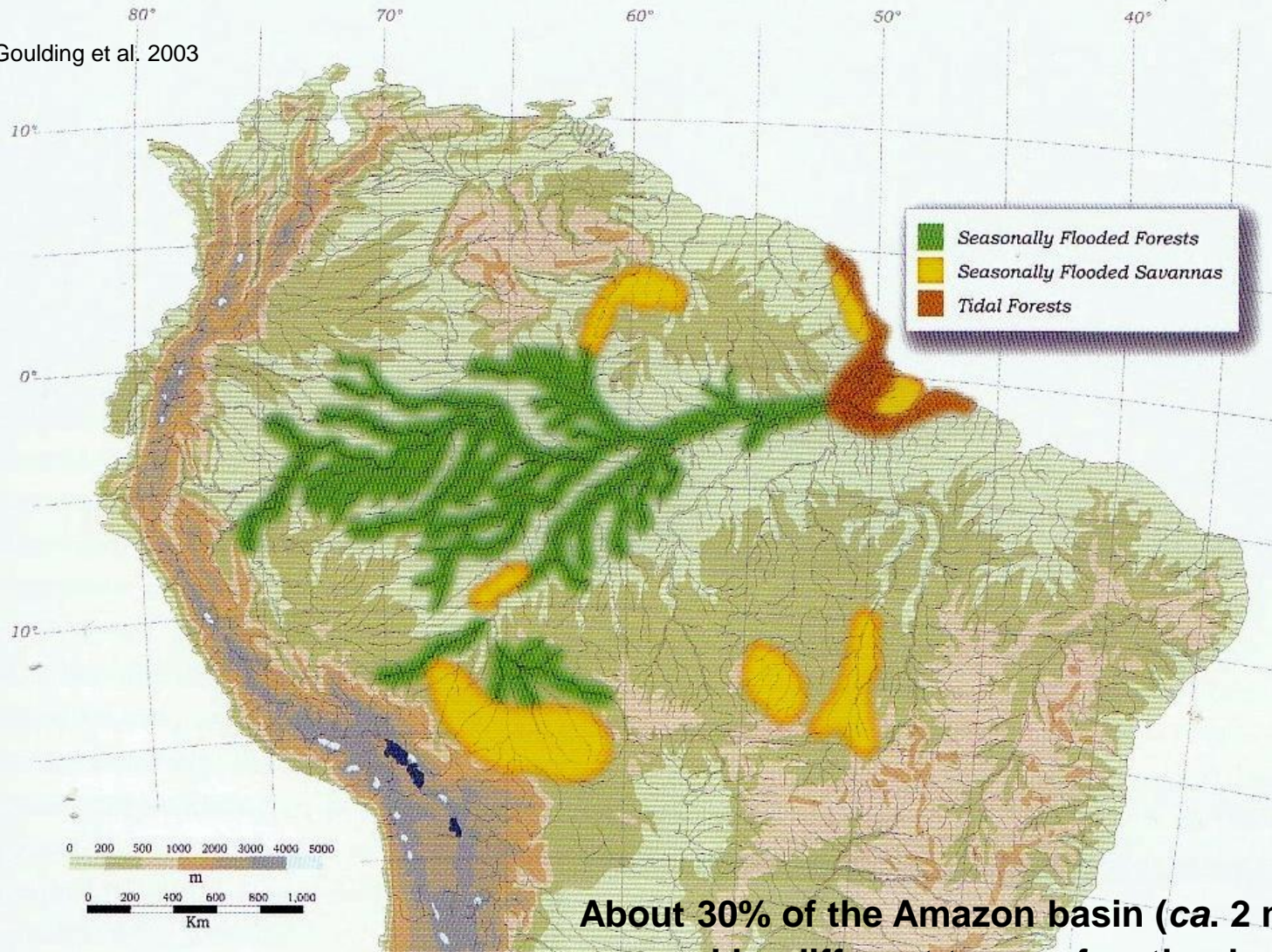
Floristic variation across 600 km of inundation forests along the Negro River, central Amazonia

Juan Carlos Montero, Albert Reif, Maria Teresa Piedade, Florian Wittmann



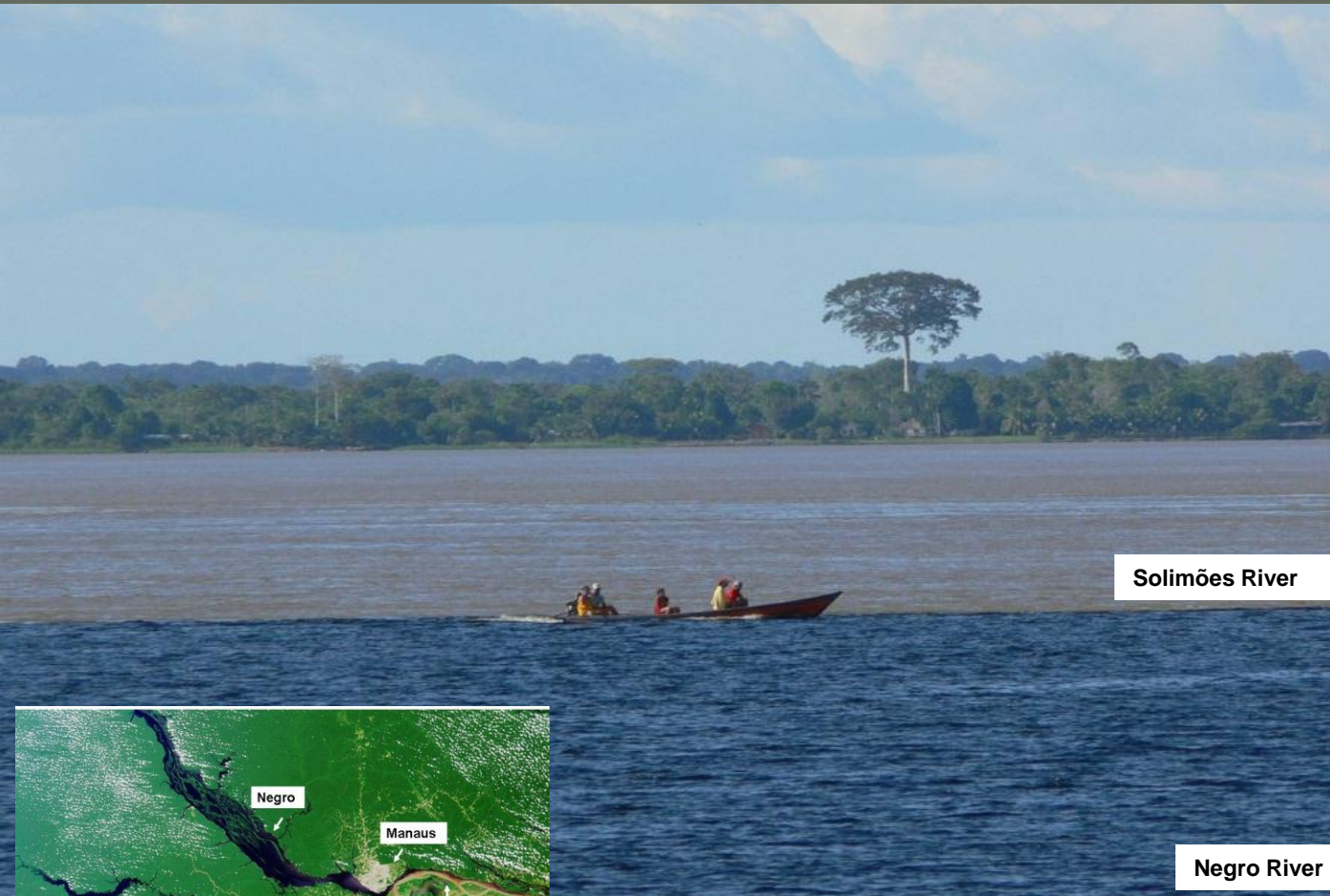
Amazonian wetlands

Goulding et al. 2003



About 30% of the Amazon basin (ca. 2 millions of km²) is covered by different types of wetlands (Junk et al. 2011).

Seasonal flooded forests



Solimões River

Negro River

Várzea forest
ca. 300.000 km²

Igapó forest
ca. 100.000 km²



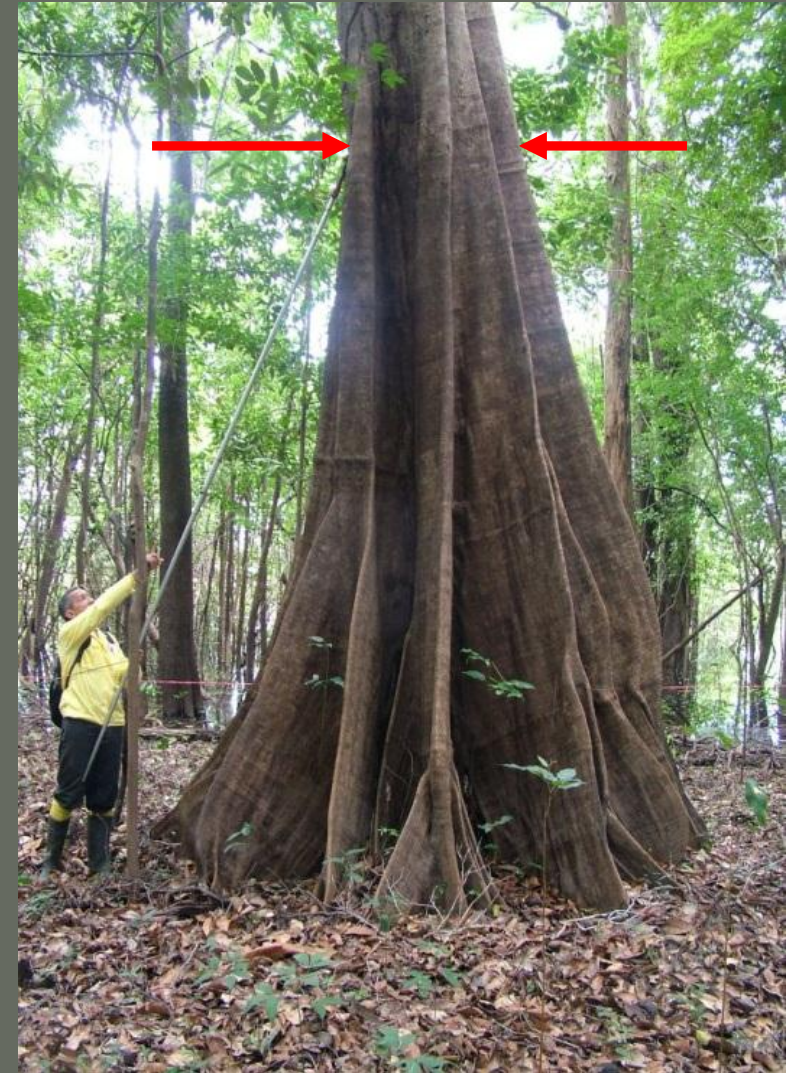
(Prance, 1979; Junk, 1997)

The Negro River: largest black-water river in the world



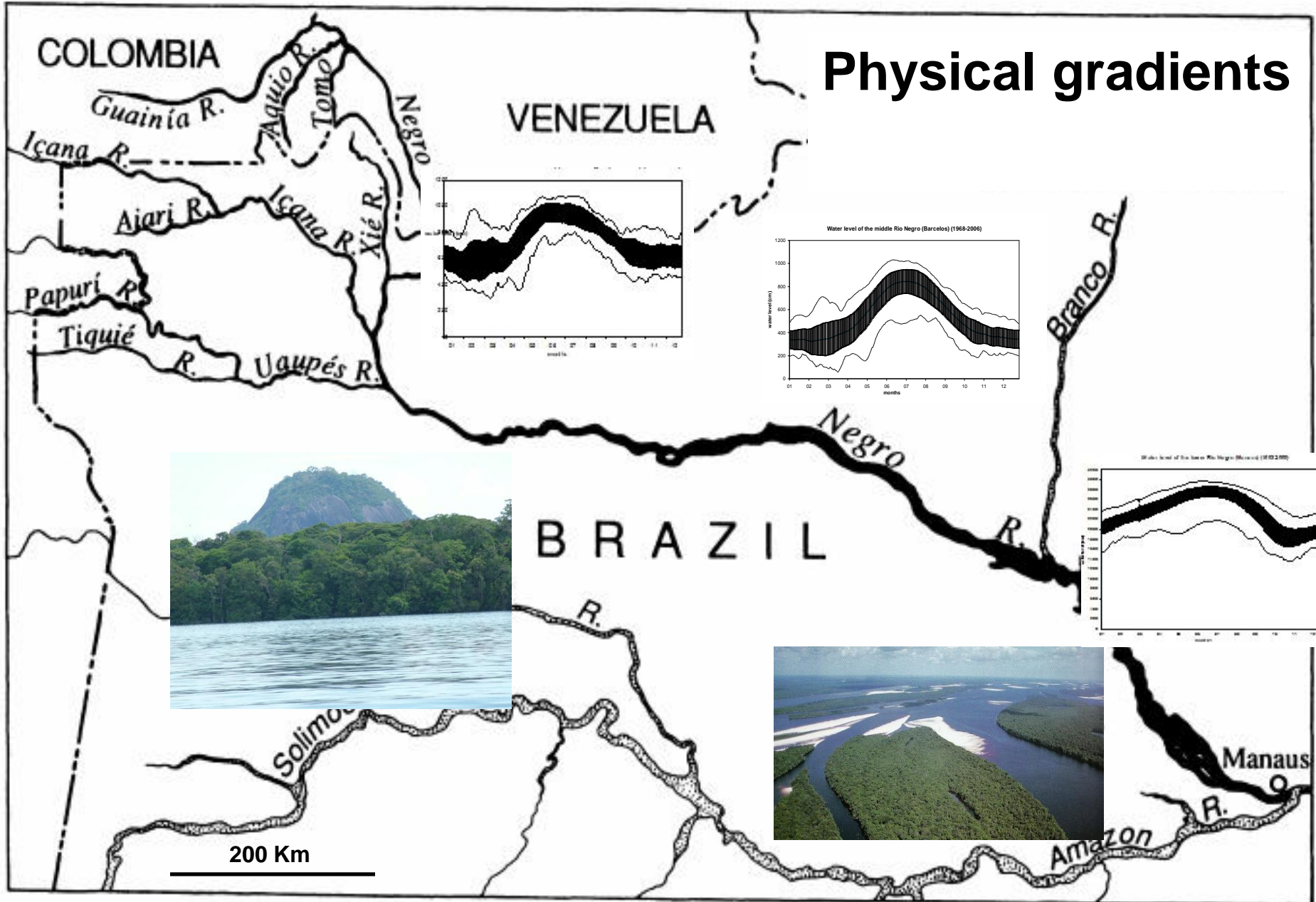


The igapó forests



Flood amplitudes range from 3.6 m at the upper reach to 9.3 m near its lower reach, and subject the floodplain vegetation to periodically inundations lasting from 50 to 230 days year⁻¹.

Physical gradients

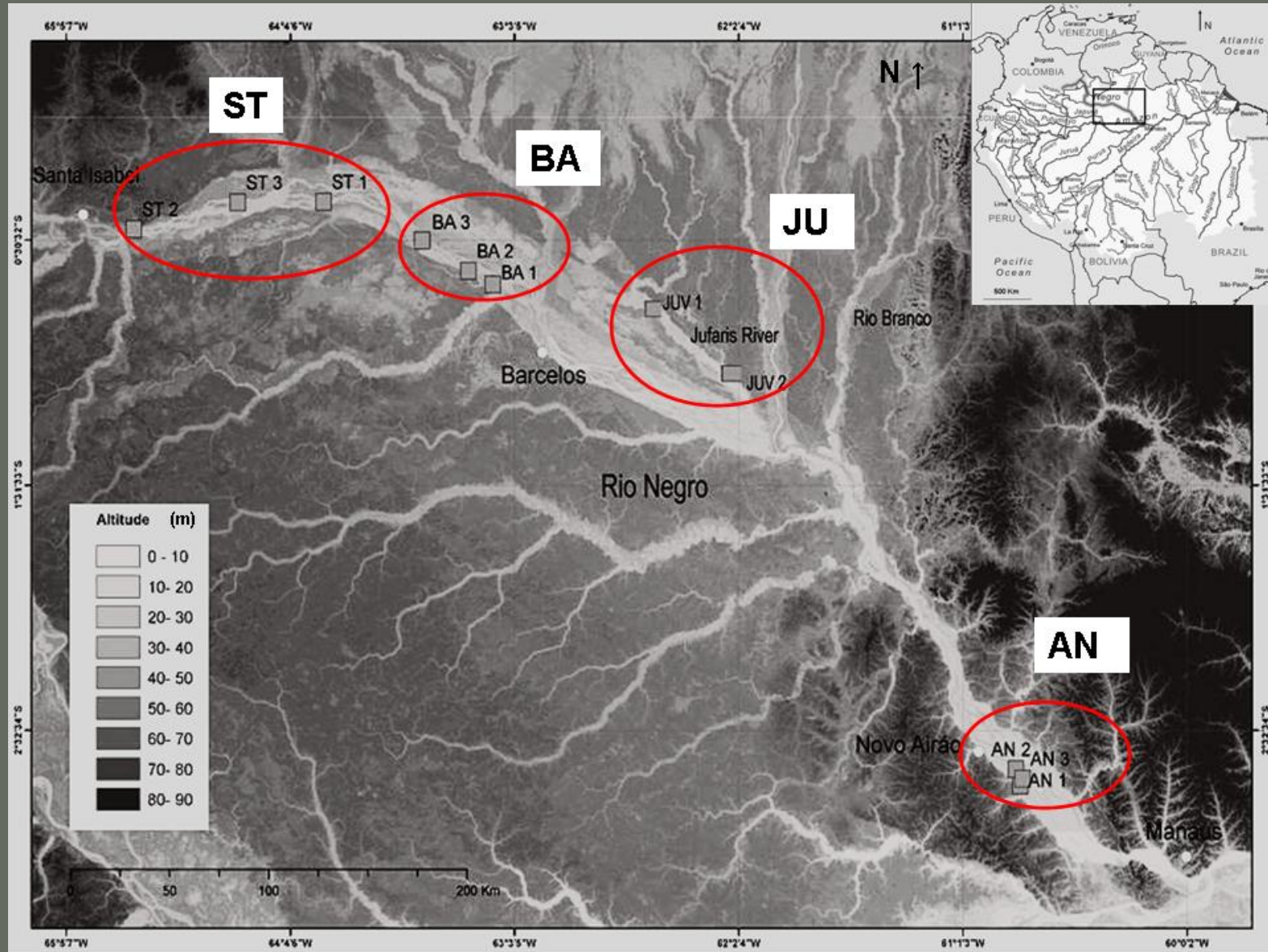


(a) How do species composition, tree richness and diversity vary along the course of the river?

(b) Can we detect alpha-diversity gradients of Igapó forests across geographical locations and geological formations?

(c) What are the differences of alpha diversity compared to Várzea?

Research sites



Floristic inventories

Late successional forest (i.e. mature forests).

Overall, 160 plots 25 x 25 m (625 m²) : 48 (ST); 36 (BA), 28 (JU) and 48 (AN) totalizing 10 ha.

All trees >10 cm diameter at breast height (DBH) were recorded.

Data Management

Importance Value Index (IVI) (Curtis & McIntosh, 1951).

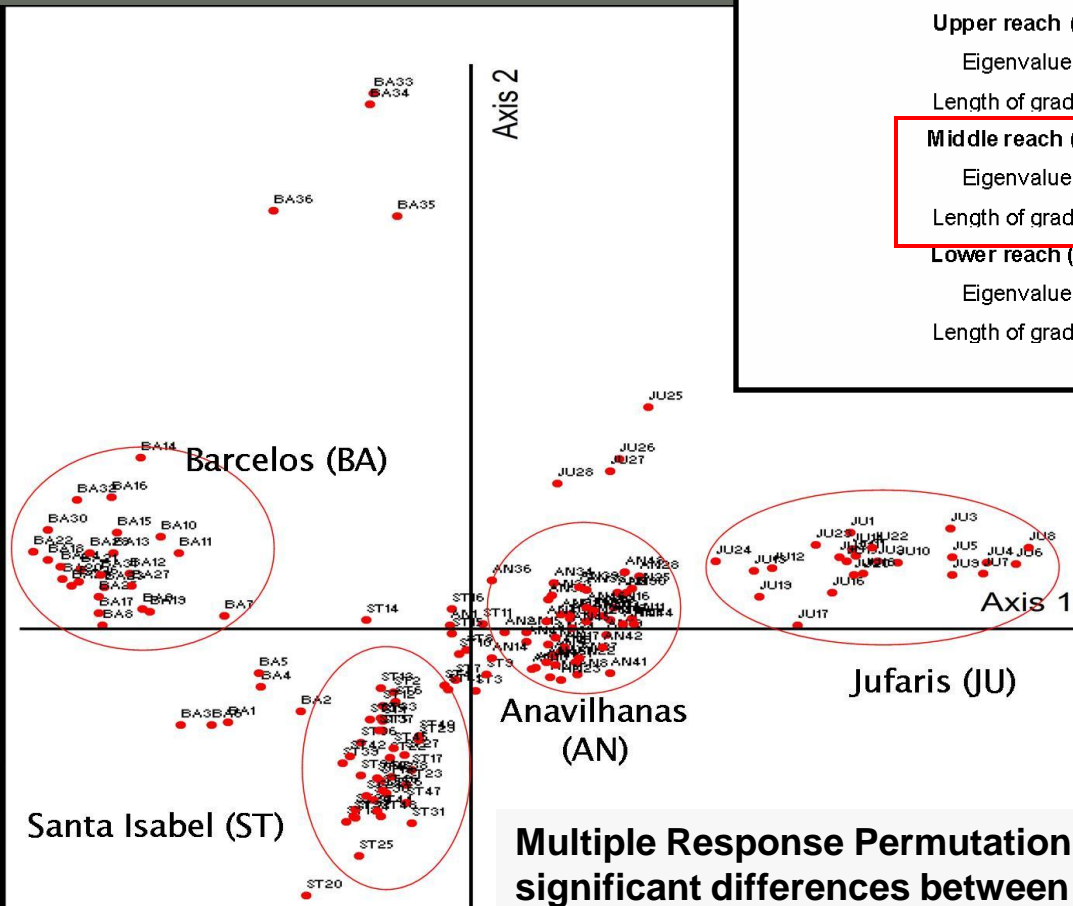
Fisher's alpha coefficient (Fisher et al, 1943).

Detrended Correspondence Analysis (DCA, Jongman et al, 1987).

Published data on black-water systems (BAD data: Best Available Data)

Spatial heterogeneity

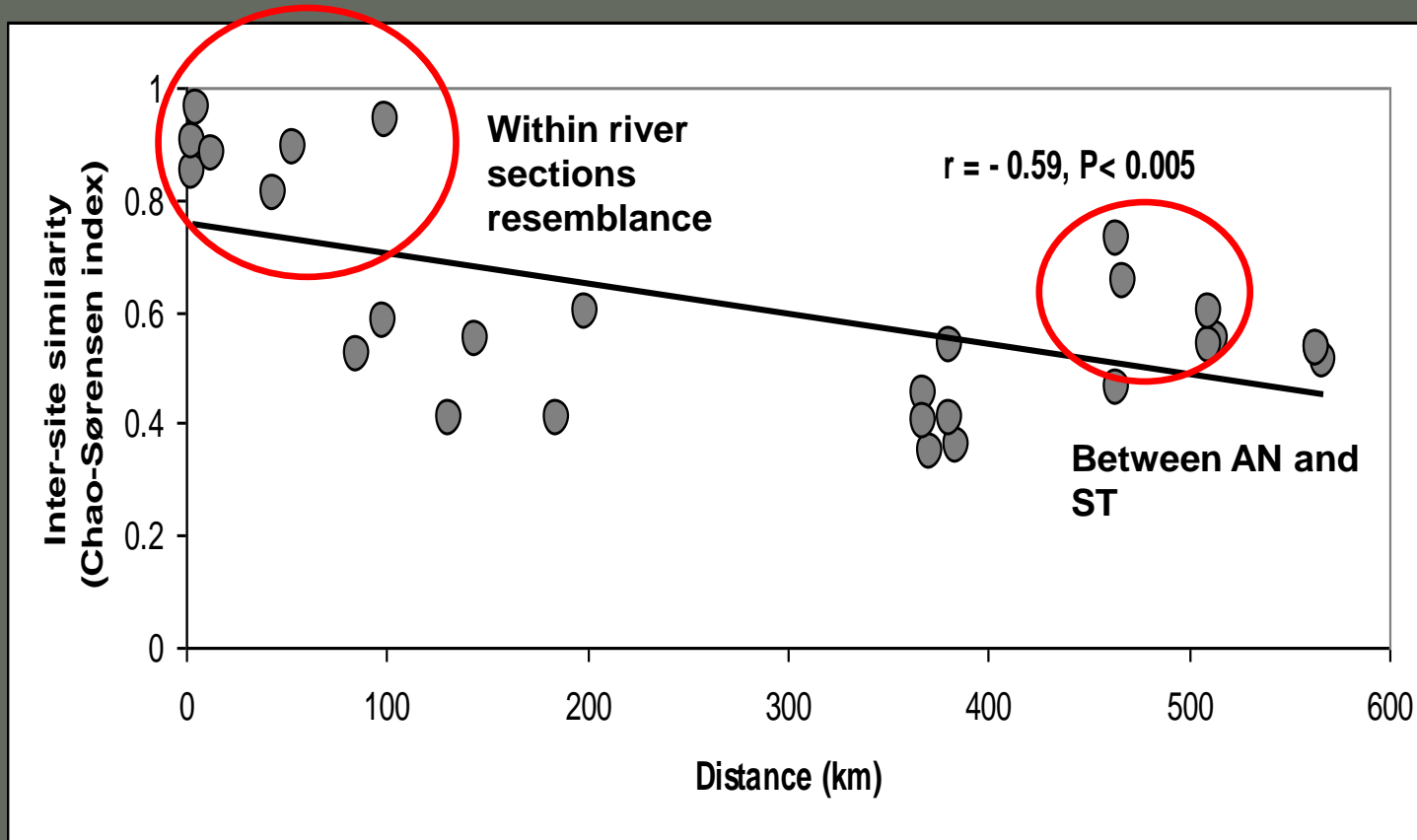
DCA Analyses	Axis 1	Axis 2	Total inertia of species data
Whole dataset			
Eigenvalues	0.67	0.42	7.79
Length of gradient	5.44	5.87	
Excluding the tributary Jufaris River (JU)			
Eigenvalues	0.64	0.38	6.15
Length of gradient	4.16	4.78	
River sections			
Upper reach (ST)			
Eigenvalues	0.36	0.15	2.97
Length of gradient	2.78	2.60	
Middle reach (BA)			
Eigenvalues	0.66	0.15	2.79
Length of gradient	4.33	1.87	
Lower reach (AN)			
Eigenvalues	0.26	0.19	2.92
Length of gradient	2.38	1.95	



Data of the tributary river exhibits that the overall length of gradient decreases drastically

Multiple Response Permutation Procedure (MRPP) detected significant differences between river sections ($P < 0.001$).

Floristic resemblance between river sections



Floristic similarity is higher within river sections, however, there is also high similarity between the upper (ST) and the lower section (AN), despite being separated by ca. 500 kilometers

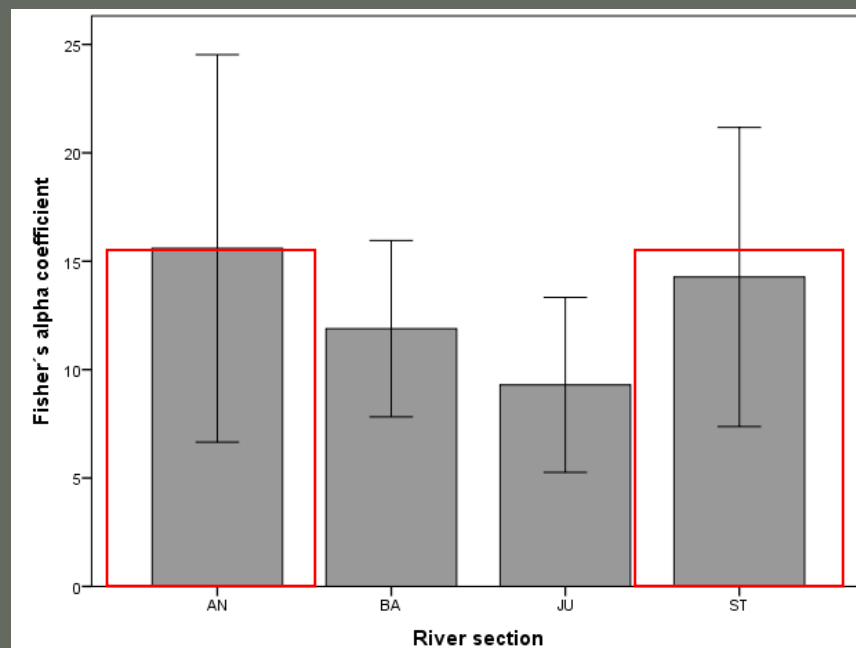
Tree composition

River section	Species	rFre (%)	rAbu (%)	rDom (%)	IVI (%)
Upper section Santa Isabel (ST, 3 ha)	<i>Gustavia augusta</i>	5.26	17.88	7.56	10.23
	<i>Hevea brasiliensis</i>	5.64	9.45	12.08	9.06
	<i>Eschweilera atropetiolata</i>	5.00	7.48	10.62	7.70
	<i>Micrandra siphonioides</i>	2.44	2.47	5.70	3.54
	<i>Mollia lepidota</i>	3.33	2.92	3.86	3.37
Total species: 108	Σ	21.67	40.15	39.82	33.90
Middle section Barcelos (BA, 2.25 ha)	<i>Mabea caudata</i>	5.09	12.69	8.50	8.76
	<i>Swartzia sp</i>	3.90	2.67	17.89	8.16
	<i>Duroia sp</i>	4.41	13.66	5.87	7.98
	<i>Licania heteromorpha</i>	4.92	7.35	5.86	6.05
	<i>Ocotea sp</i>	4.41	4.68	4.95	4.68
Total species: 79	Σ	22.73	41.05	43.07	35.63
Lower section Anavilhanas (AN, 3 ha)	<i>Aldina heterophylla</i>	4.72	8.61	40.04	17.79
	<i>Heterostemon mimosoides</i>	6.67	20.93	5.71	11.10
	<i>Eschweilera aff. amazoni ciformis</i>	5.83	7.73	4.54	6.04
	<i>Peltogyne excelsa</i>	2.92	3.50	4.80	3.74
	<i>Licania apetala</i>	3.06	3.28	2.55	2.96
Total species: 102	Σ	23.02	44.05	61.64	41.63
Tributary Jufaris river (JU, 1.75 ha)	<i>Mouriri angulicosta</i>	4.55	8.10	7.03	6.56
	<i>Sclerolobium chrysophyllum</i>	4.55	4.50	5.75	4.93
	<i>Sacoglottis guianensis</i>	4.33	5.54	4.80	4.89
	<i>Pterocarpus rohrii</i>	1.73	5.82	6.89	4.81
	<i>Aldina heterophylla</i>	4.55	3.05	6.38	4.66
Total species: 83	Σ	19.71	27.01	30.85	25.85

Importance indexes show high species turnover (beta diversity), indicating floristic discontinuities along the river sections.

Species richness and diversity

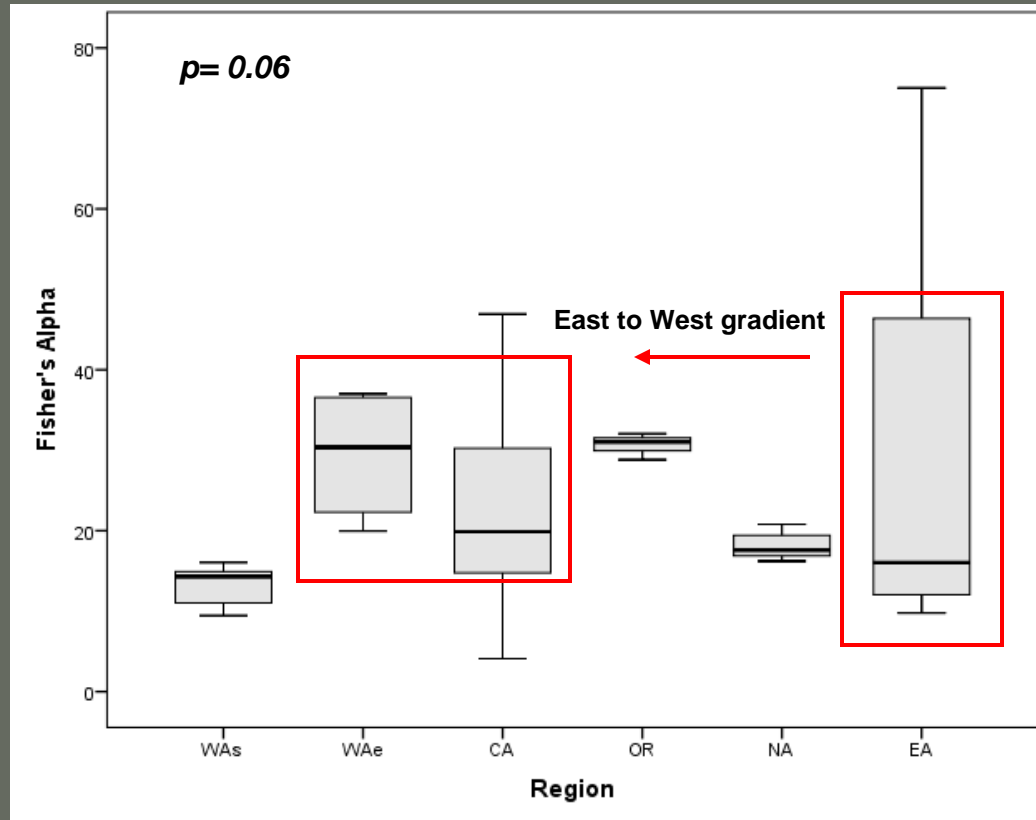
Mean species richness and alpha diversity do not differ consistently between river sections



River section	Sites	N	S	Fisher's index (α)
Upper section Santa Isabel (ST)	ST 1	504	64	19.43
	ST 2	500	67	20.81
	ST 3	573	60	16.88
Middle section Barcelos (BA)	BA 1	722	68	18.41
	BA 2	808	57	13.99
Lower section Anavilhanas (AN)	AN 1	468	79	27.24
	AN 2	398	51	15.54
	AN 3	505	63	18.99
Tributary Jufaris river (JU)	JU	593	57	15.44

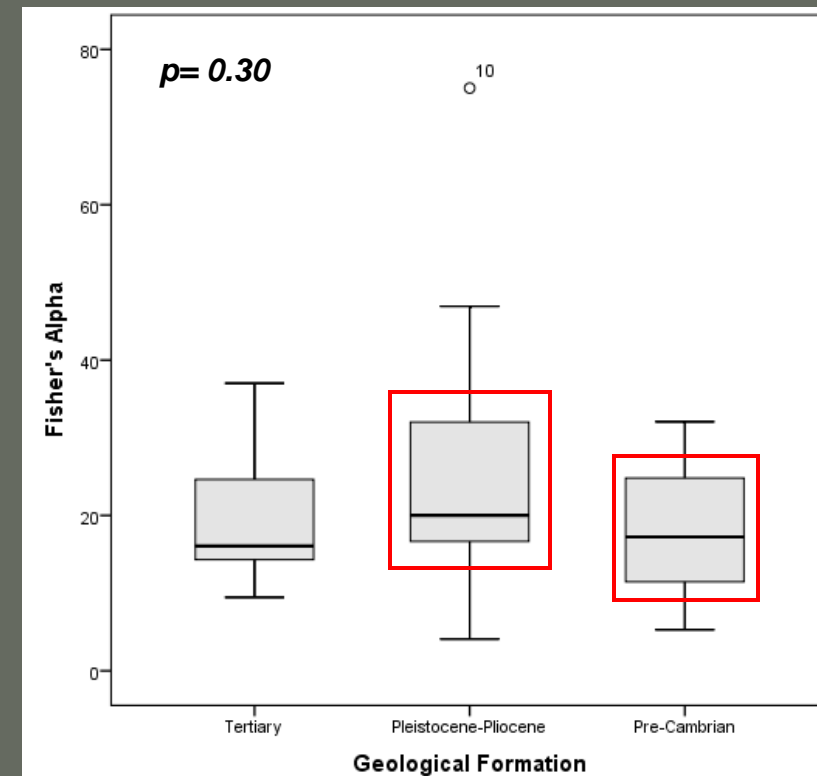
The Tukey test revealed no significant differences between Anavilhanas (AN) and Santa Isabel (ST) sites ($P = 0.88$).

Diversity gradients at continental scale

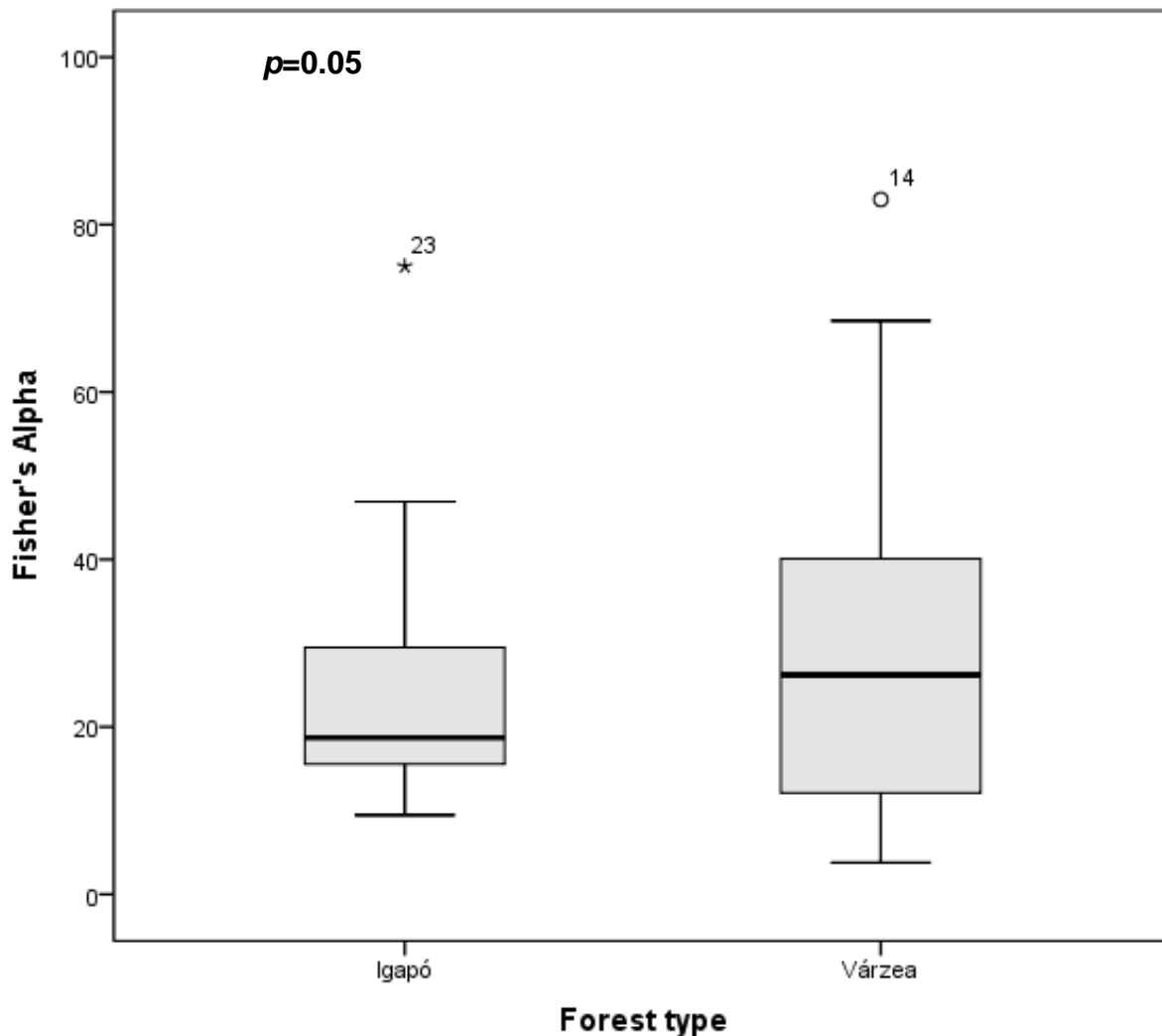


There is a trend of increasing alpha-diversity in a east to west gradient

There is a gradual decrease of alpha diversity while increasing the age of the geological formation



Comparing diversity of Igapó with Várzea



In terms of alpha diversity, Várzea forests is more diverse than Igapó. However, the contribution of tributary rivers suggest that beta diversity along Negro River may increase as a function of regional species pools

Conclusions

Although species richness and alpha diversity may not consistently differ between river sections, species turnover (beta diversity) is high.

A suite of few species dominates each river section. These species are different in each section, indicating a patchy arrangement of the Igapó forest.

Floristic similarity increases, while geographic distances between sites decrease. Thus, within river sections floristic resemblance is higher than between river sections.

At continental scale there is a trend of increasing diversity from the eastern Amazon to west equatorial Amazon, representing an east to west gradient. We found a gradual decrease in diversity with increasing age of geological formation.

The late –successional igapó forest of the Negro River is one of the species-poor forest types in the Neotropics. Compared to Várzea it is the poorest inundation forest in the Amazon.



Lower Negro River, near Manaus

**Thanks for your
attention!!!**