

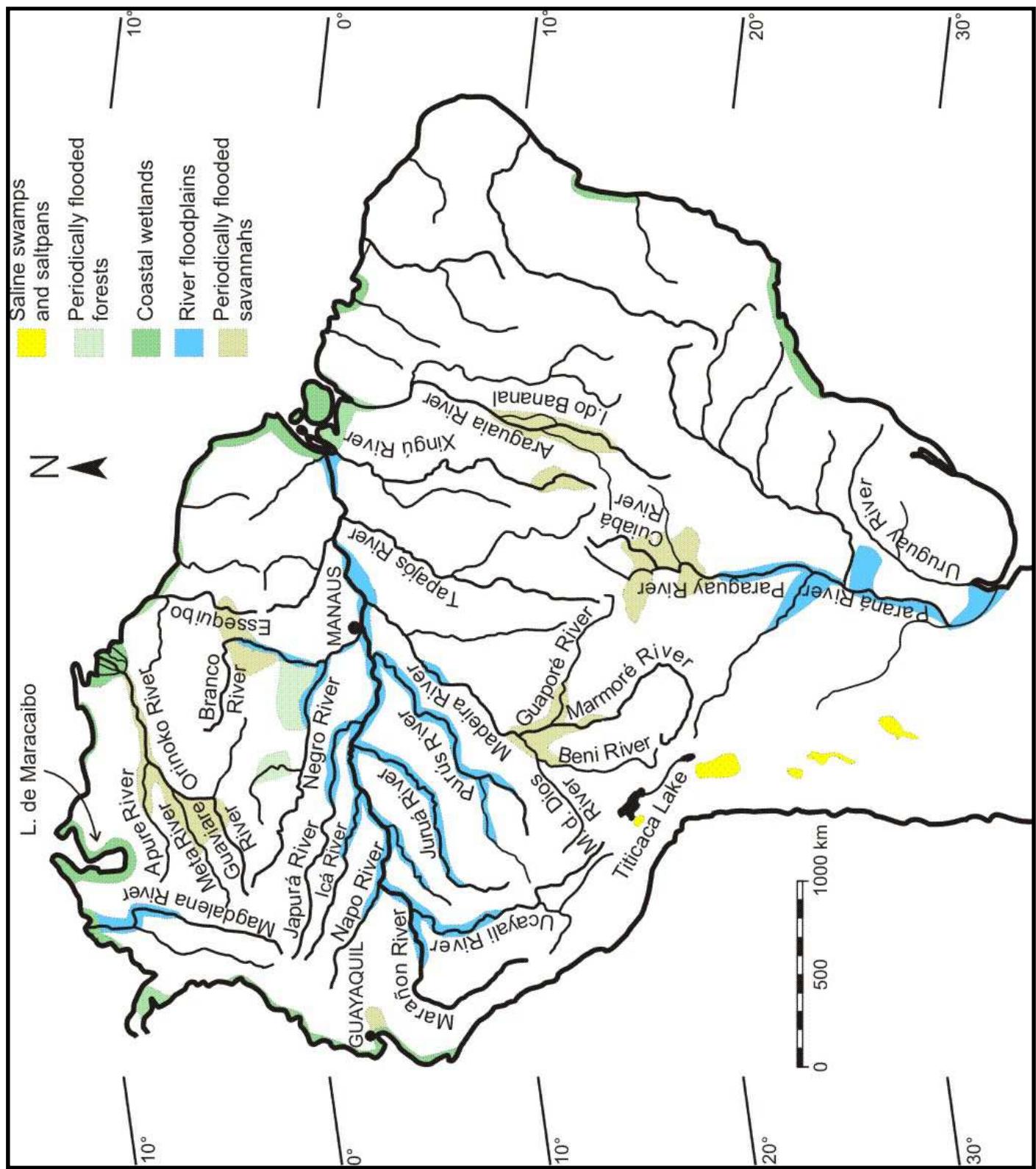


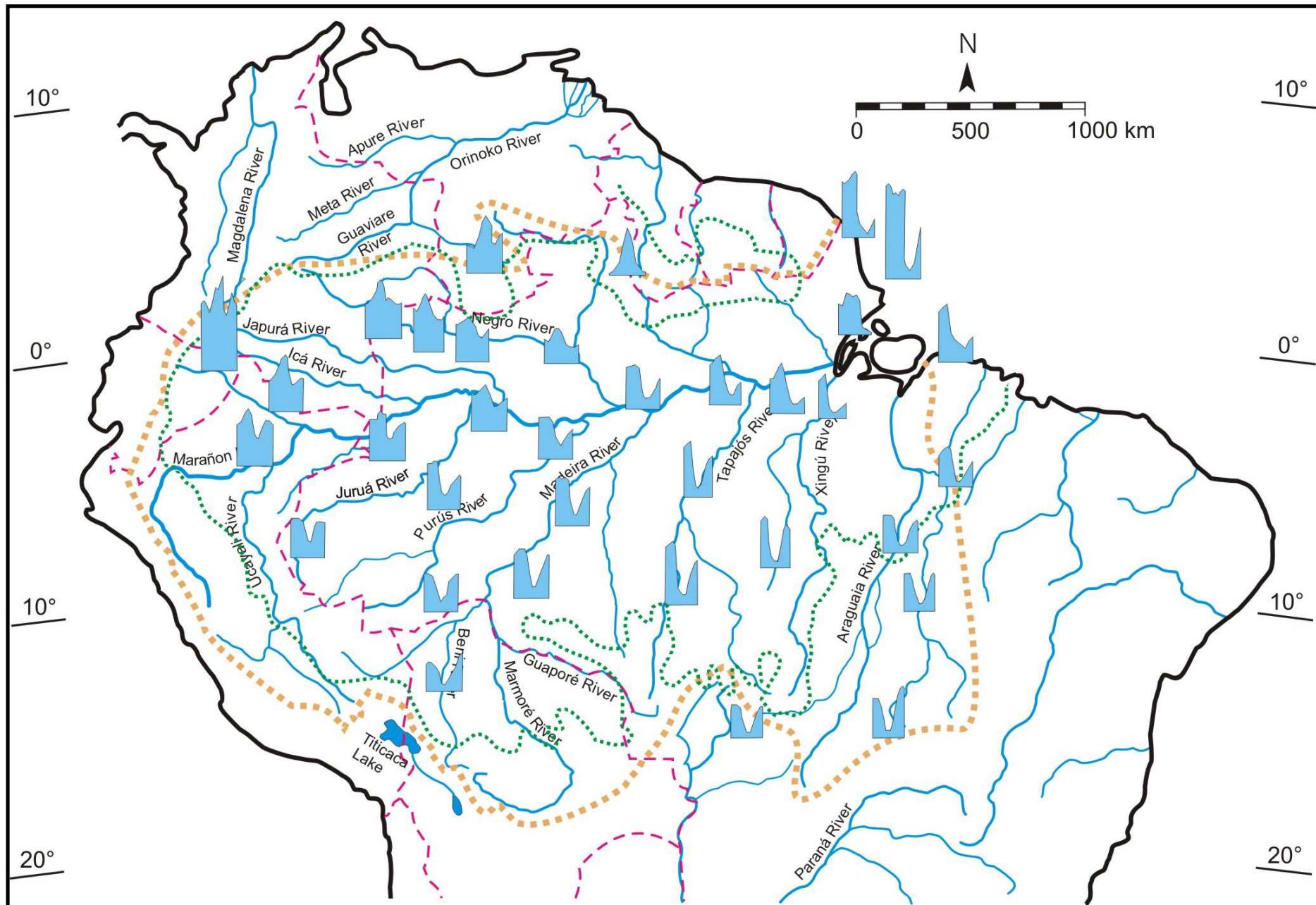
# **"Structures, Functions, Threats and Management of Wetlands under Global Climate Change Aspects: The Amazonian Experience."**

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Salati & Marques, 1984

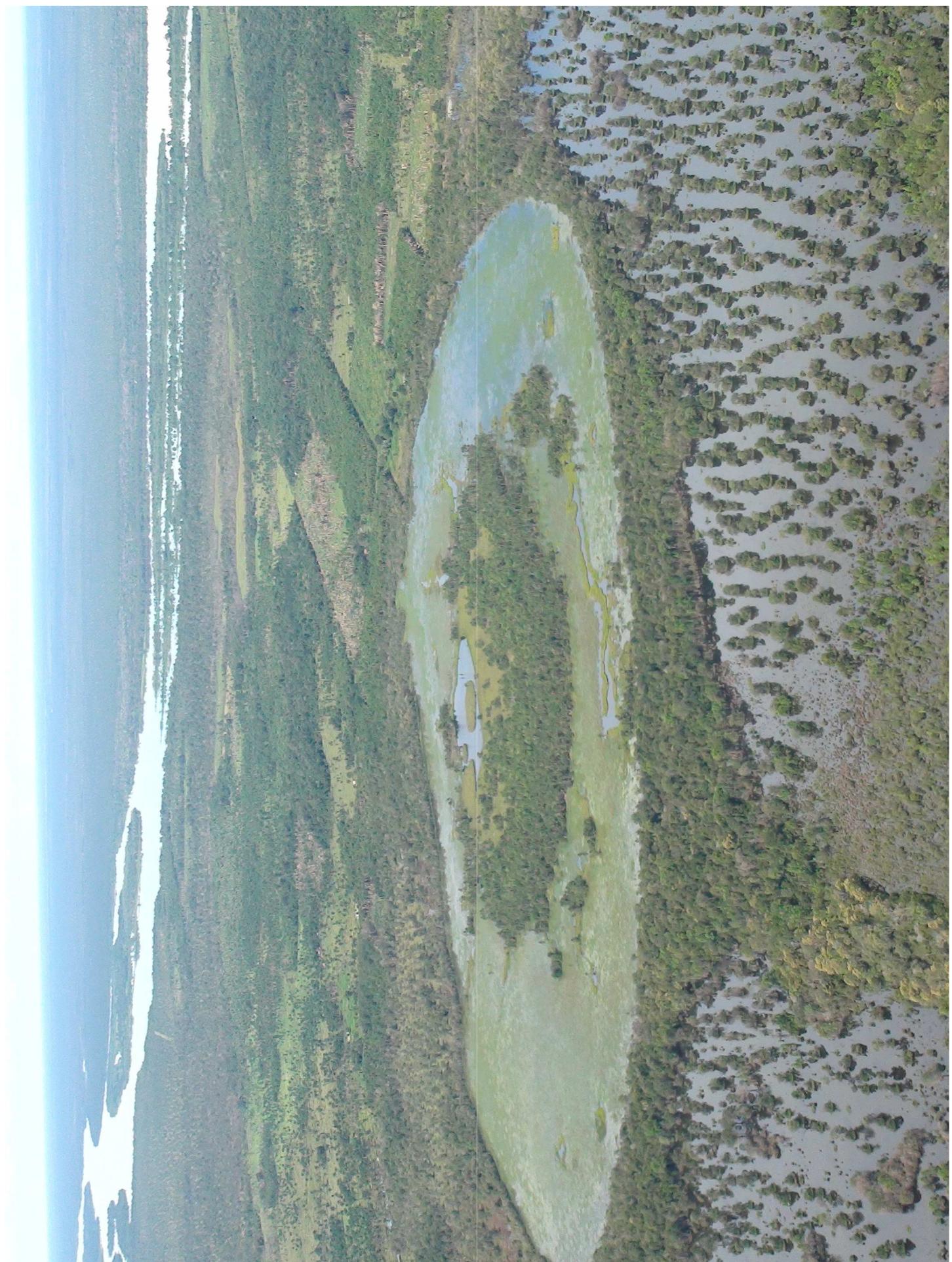














**The flood pulse is the principle driver in floodplain ecosystems**

# Types of flood pulses:

## Predictable pulsing

### Monomodal

**High amplitude (large river floodplains)**

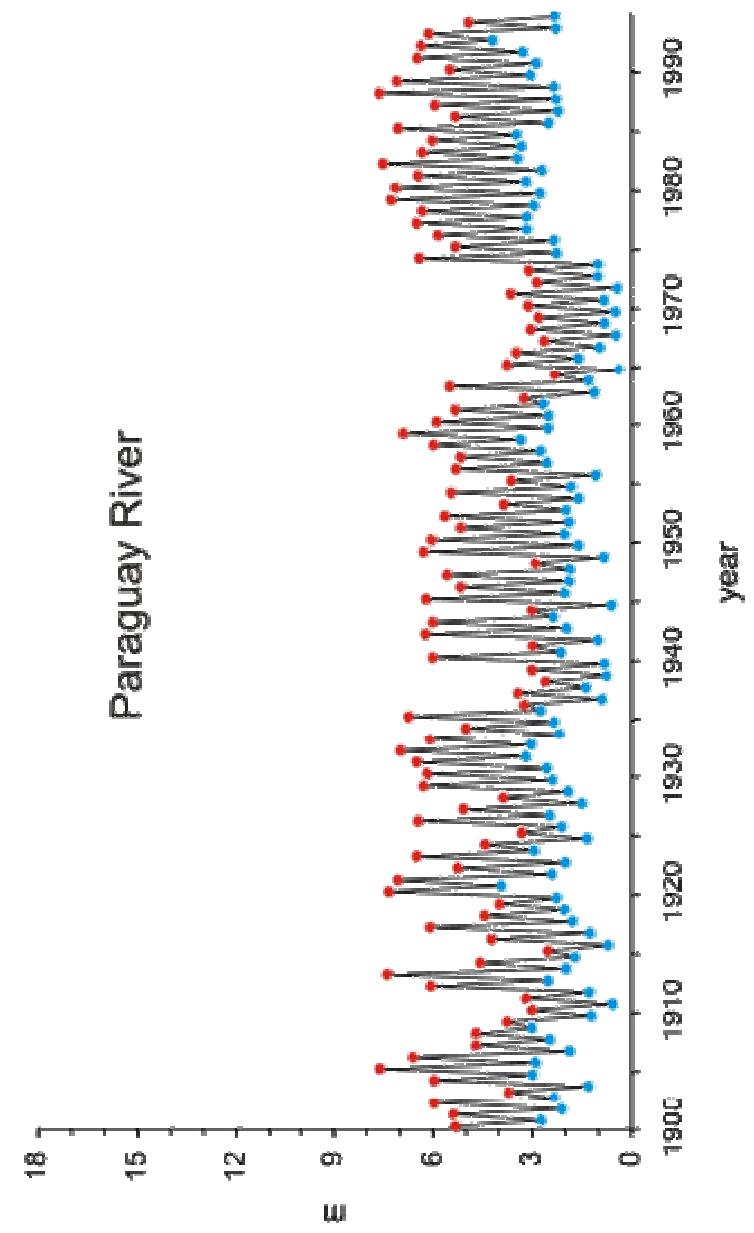
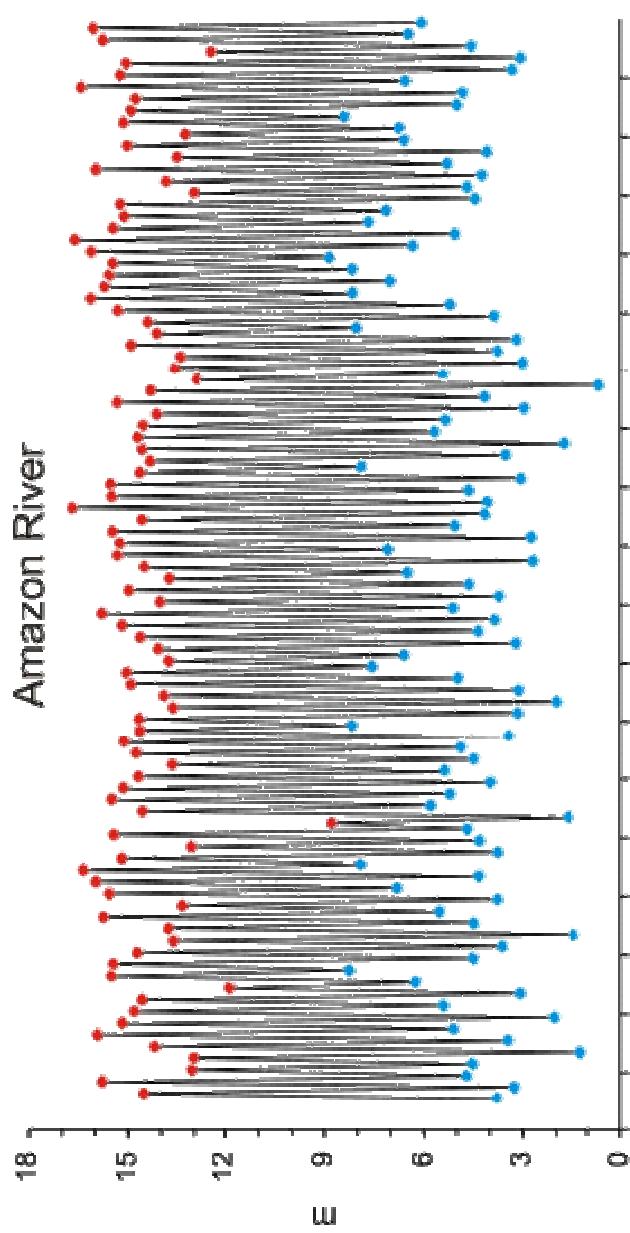
**Low amplitude (Interfluvial wetlands)**

**Polymodal (Tidal wetlands)**

## Unpredictable pulsing

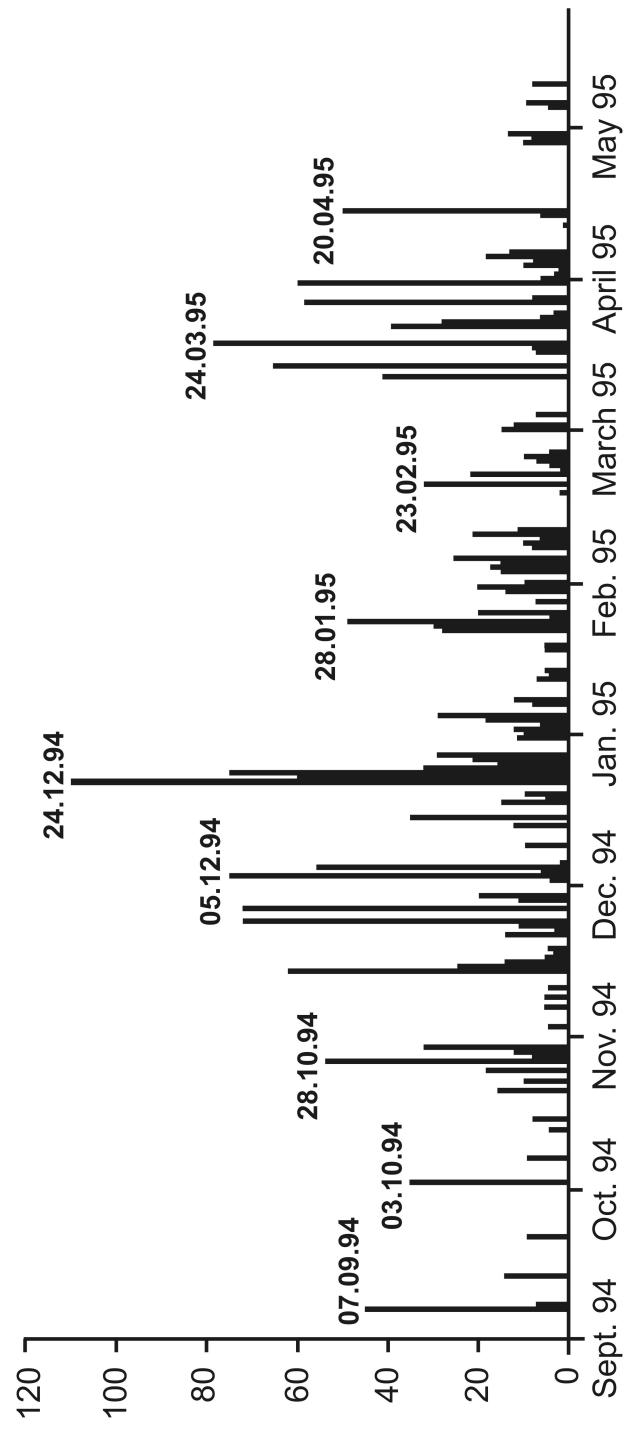
**Polymodal (Riparian wetlands along streams)**

**Occasional (in depressions in arid zones)**

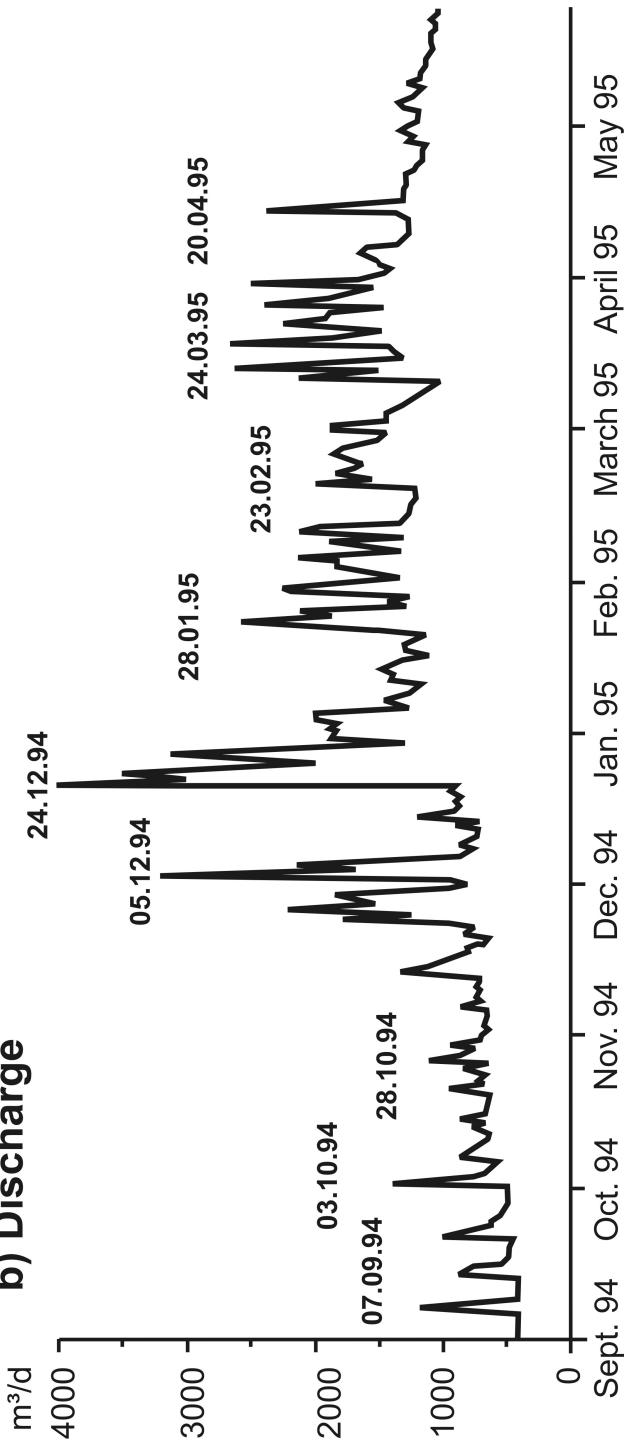


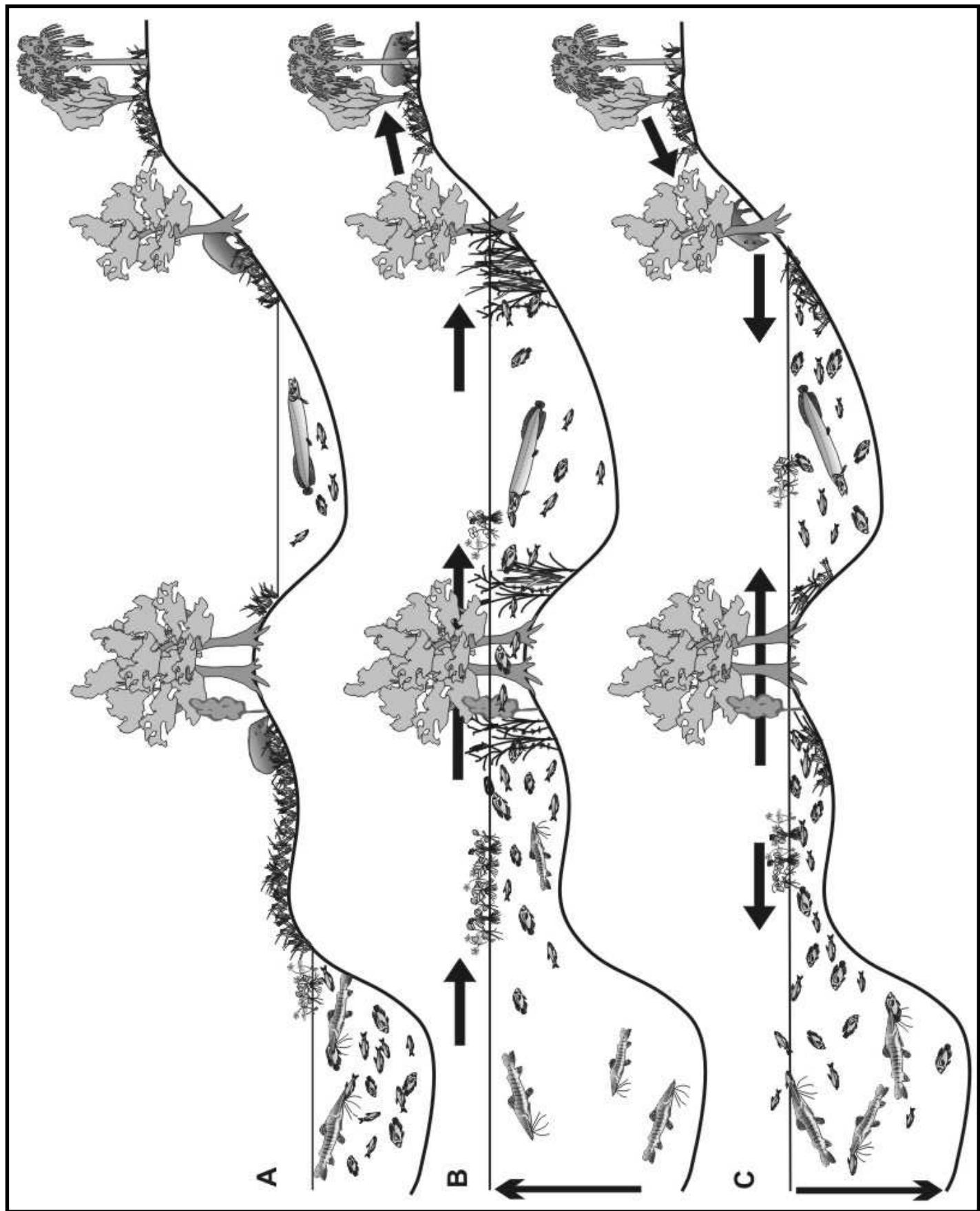


### a) Daily precipitation



### b) Discharge





About 5.000 tree species are described from Amazonia

About 1.100 tree species are described from white water river floodplains (várzeas)

About 600 tree species are described from black water river floodplains (igapós)

Approximately 10% of all Amazonian várzea tree species are ecologically and geographically restricted to this ecosystems (endemics):

Most endemics are highly flood-tolerant low-várzea tree species

**Species richness of terrestrial invertebrate groups in amazonian upland (terra firme) and floodplain forests (várzea and igapó), (data from Adis).**

### **Species richness**

	Terra firme	Várzea	Igapó
Spiders	472 (53)	130 (35)	210 (39)
Termites	90 (3)	12 (2)	11 (2)
Oribatid mites*	71 - 74	13 – 18	11 - 47
Springtails*	74		65
Symplyla	5		4 (4 in common)
Archaeognata	2		4 (2 in common)
Cicindelidae	6		11 (2 in common)
Pseudoscorpiones	29		25 (4 in common)
Diplopoda*	74		36 (11 in common)

**Flood-tolerance induces speciation processes**

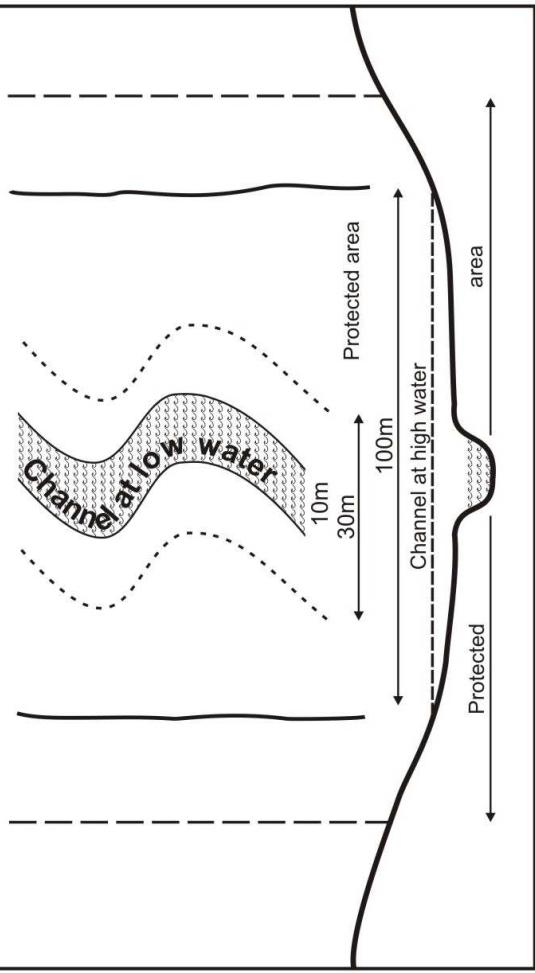
# Definition of Brazilian Wetlands

*Wetlands are ecosystems at the interface between aquatic and terrestrial environments; they may be continental or coastal, natural or artificial, permanently or periodically inundated by shallow water or consist of waterlogged soils. Their waters may be fresh or highly or mildly saline. Wetlands are home to plant and animal communities adapted to their hydrological dynamics.*

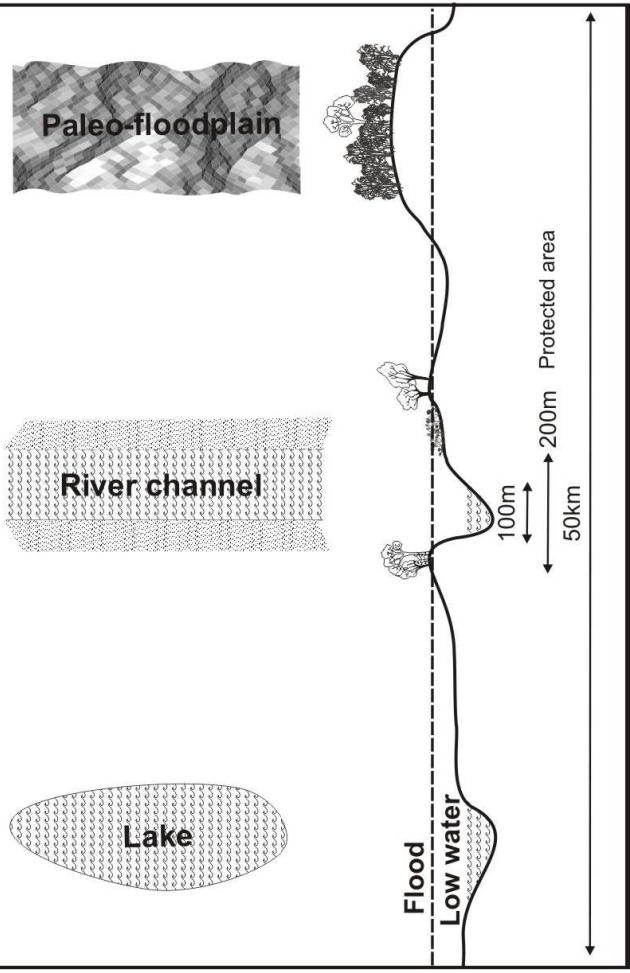
# Delimitation of Brazilian wetlands

*The extent of a wetland can be determined by the border of the permanently flooded or waterlogged area, or in the case of fluctuating water levels, by the limit of the area influenced during the mean maximum flood. The outer borders of wetlands are indicated by the absence of hydromorphic soils and/or hydrophytes and/or specific woody species adapted to grow in periodically or permanently flooded or waterlogged soils. The definition of a wetland area should include, if present, internal permanently dry areas as these habitats are of fundamental importance to the maintenance of the functional integrity and biodiversity of the respective wetland.*

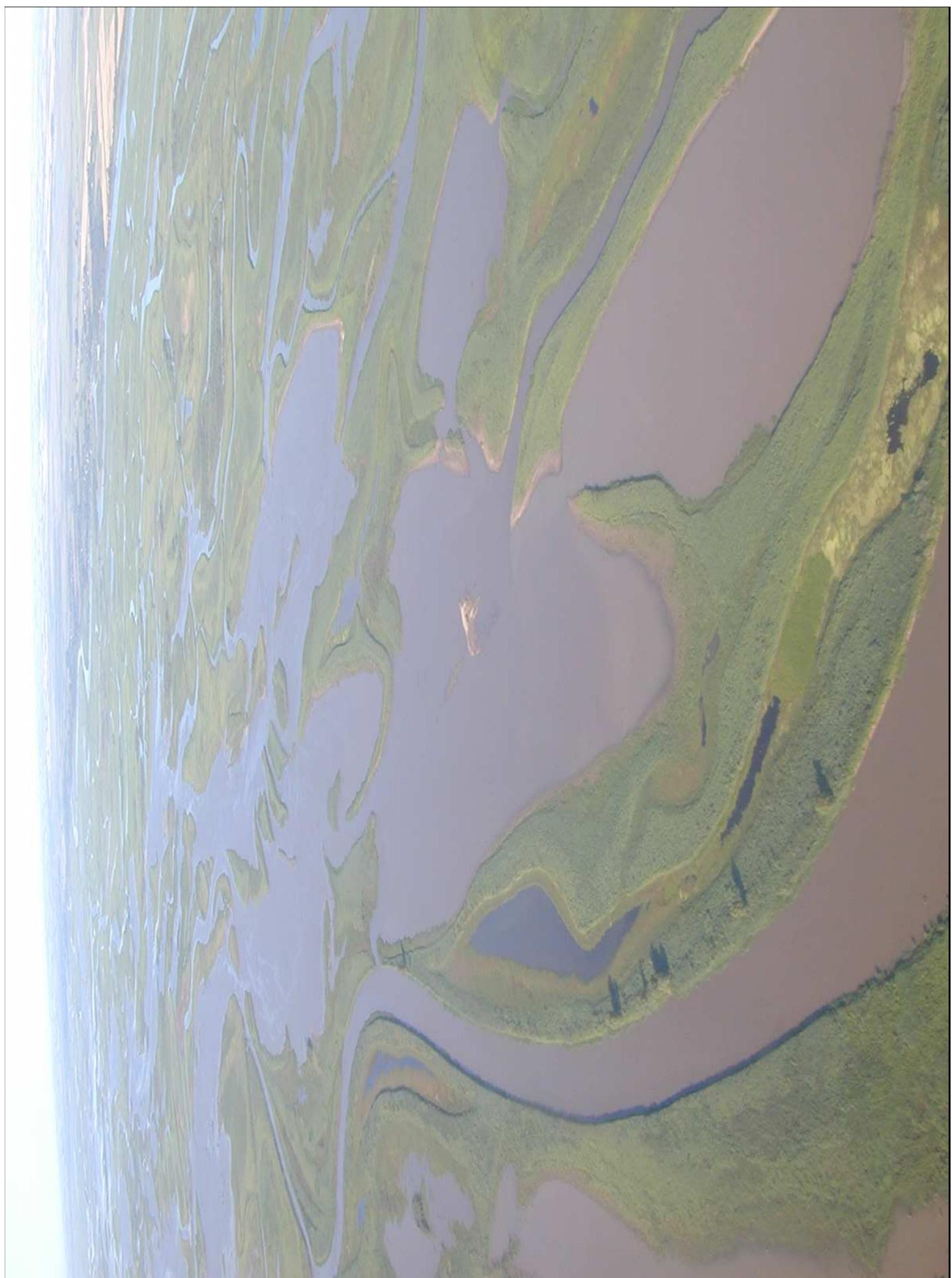
### Wetland along a small river



### **Perm. terrestrial**







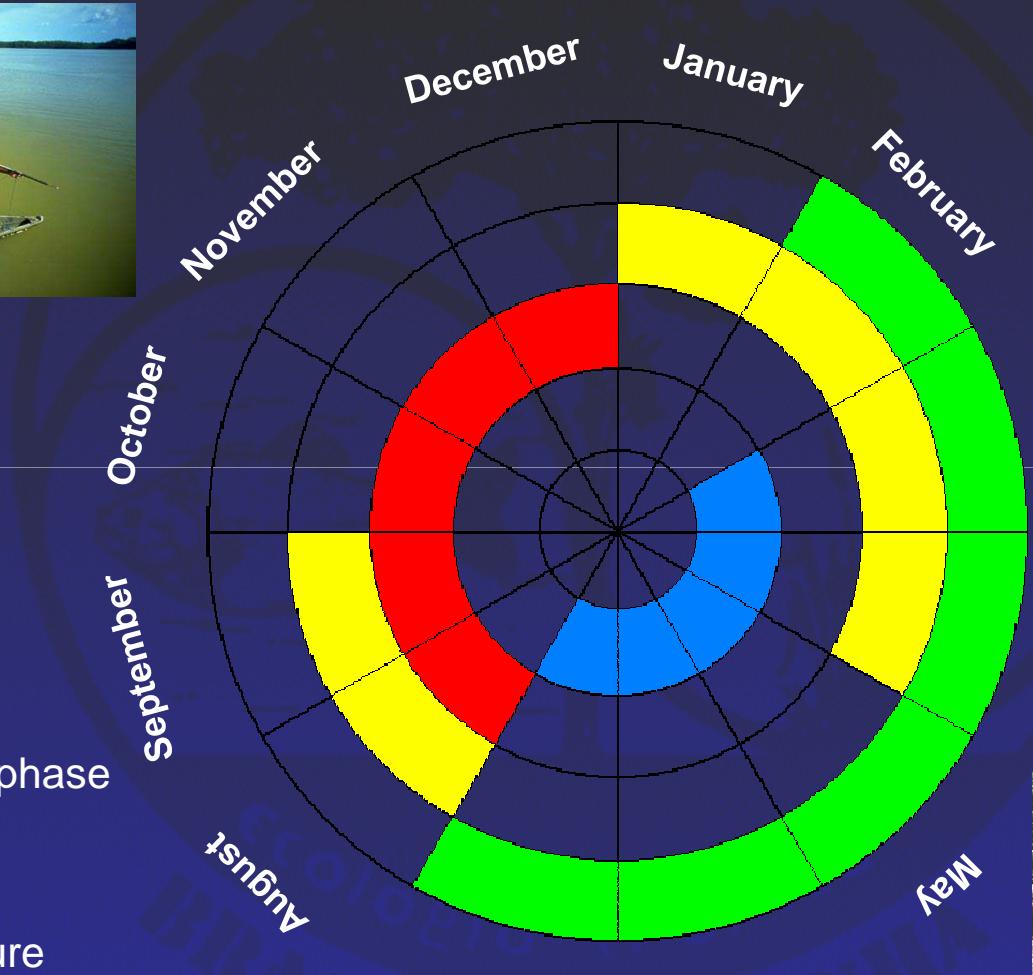
# Benefits of wetlands for the societies

- Buffering of river discharge
- Recharge of the subterranean aquifer and atmosphere
- Water purification
- Maintenance of biodiversity
- Buffering local climate
- Home for traditional populations
- Provision of renewable resources (fish, timber, non-timber products, low-intensity cattle ranching, agriculture, eco-tourism, etc.)

# Consequences for the local population



# Economic activities of the riverine populations during the year depend on the water level



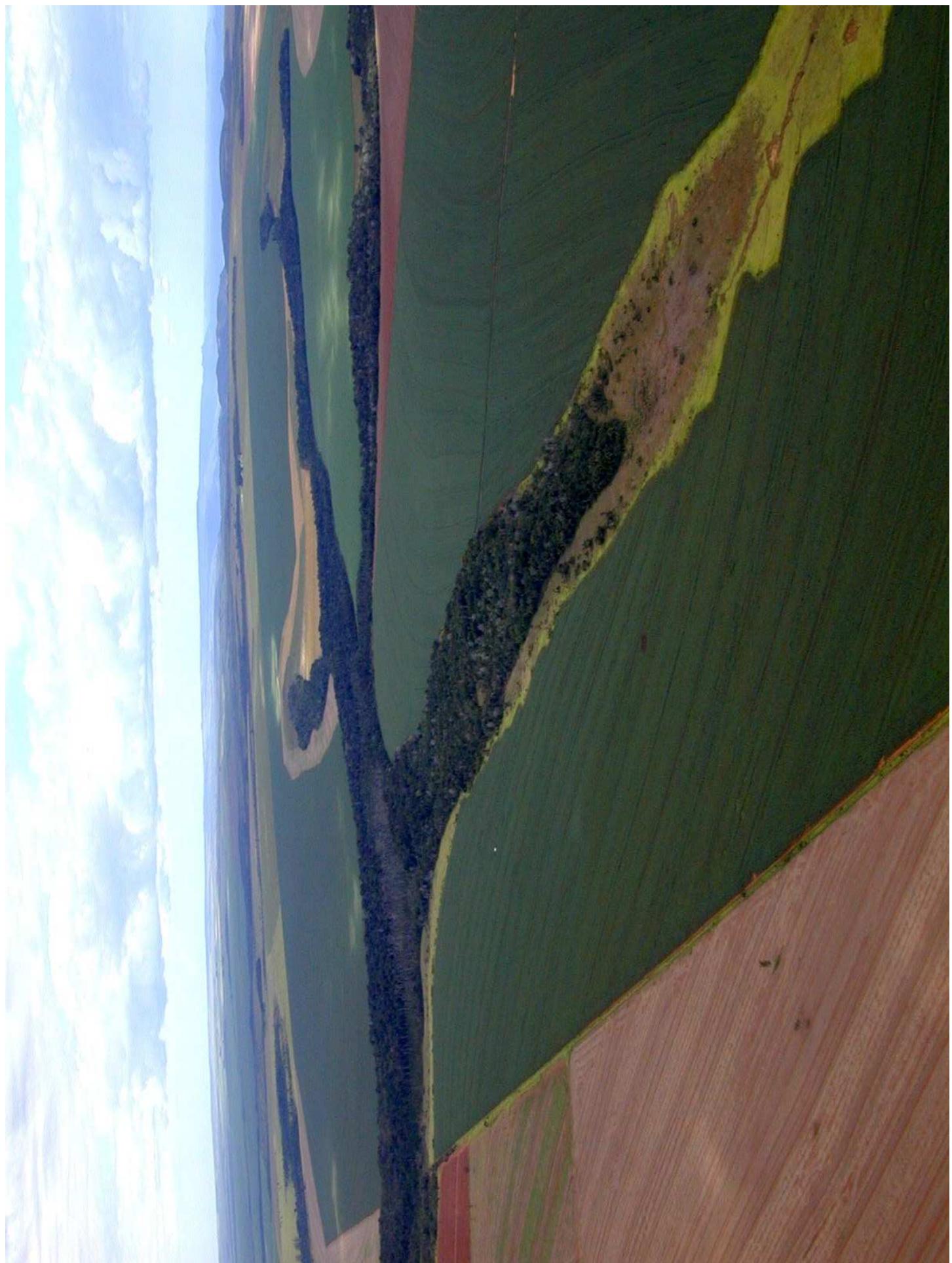
- █ Aquatic phase
- █ Fishing
- █ Agriculture
- █ Forestry

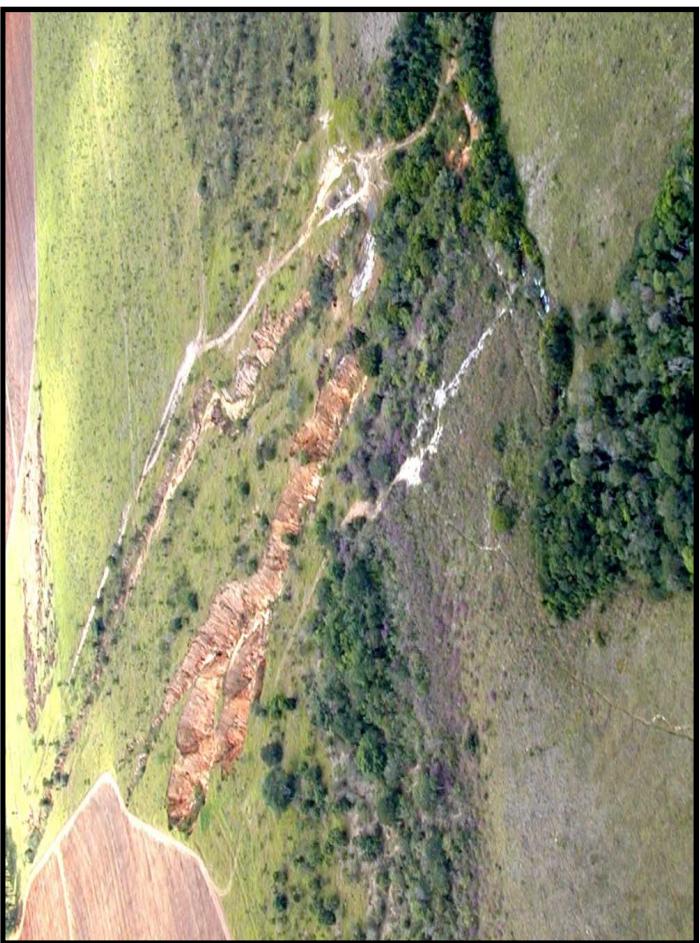
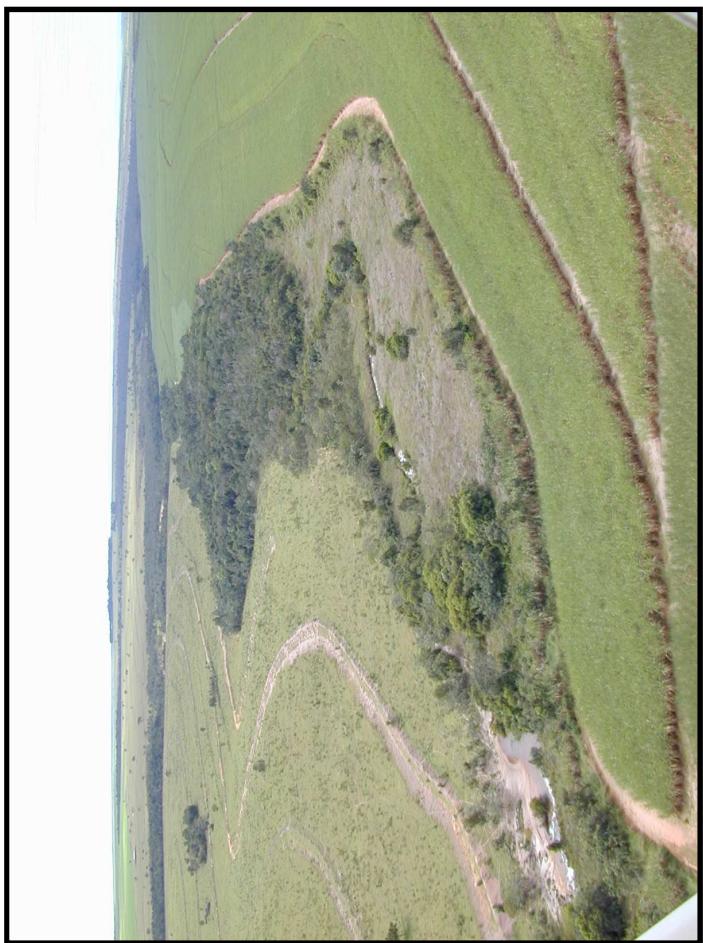


Albernaz & Ayres (1999)

## Threats

- (1) Drainage for agriculture, forestry and cattle ranching**
- (2) Construction of urban infrastructure and industrial use**
- (3) Pollution by domestic, industrial, agro-industrial and mining wastes**
- (4) Construction of hydroelectric power plants**
- (5) Canalization for ship traffic (hidrovias);**
- (6) Interruption of lateral connectivity between river and floodplain by dike construction**
- (7) Excessive exploration of natural resources (fishery, agriculture, forestry, biodiversity, etc.)**
- (8) Global climate change**

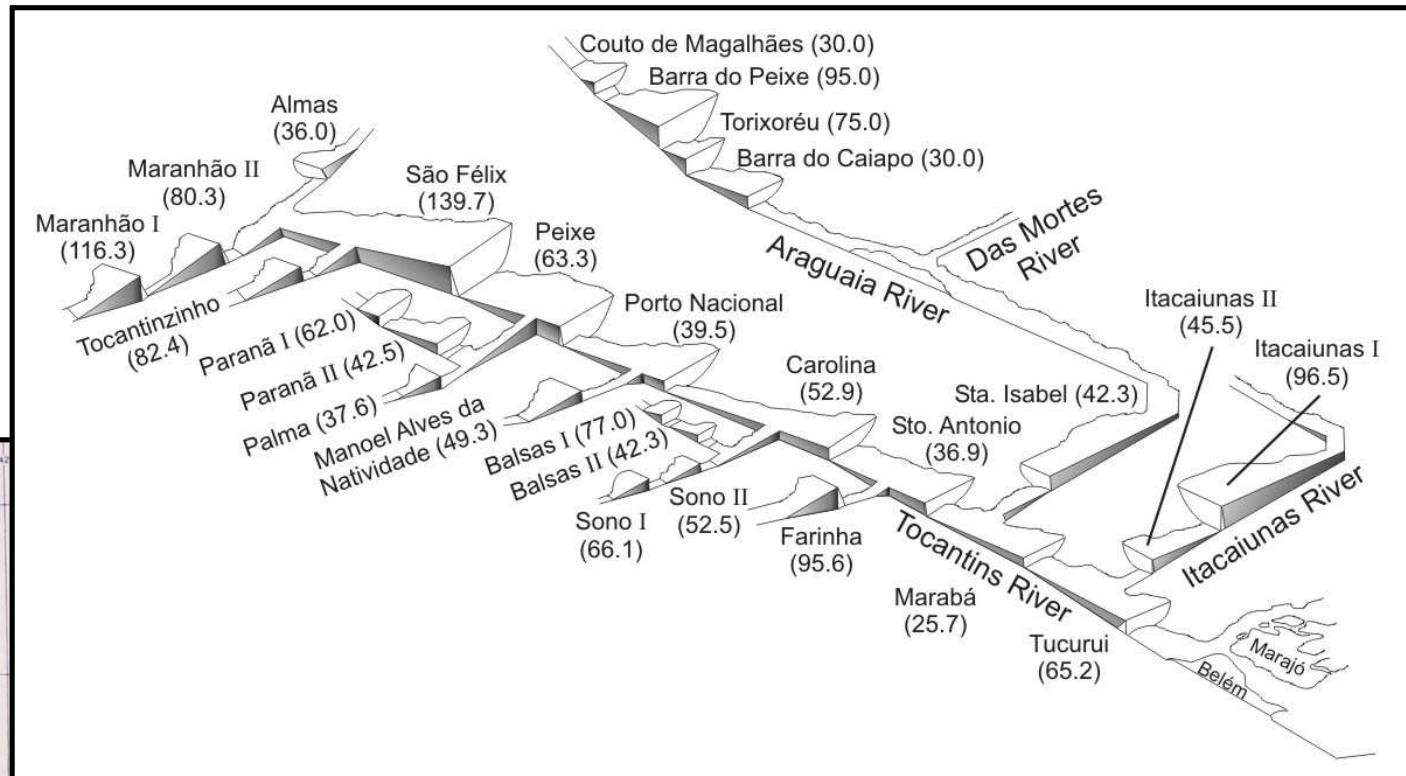
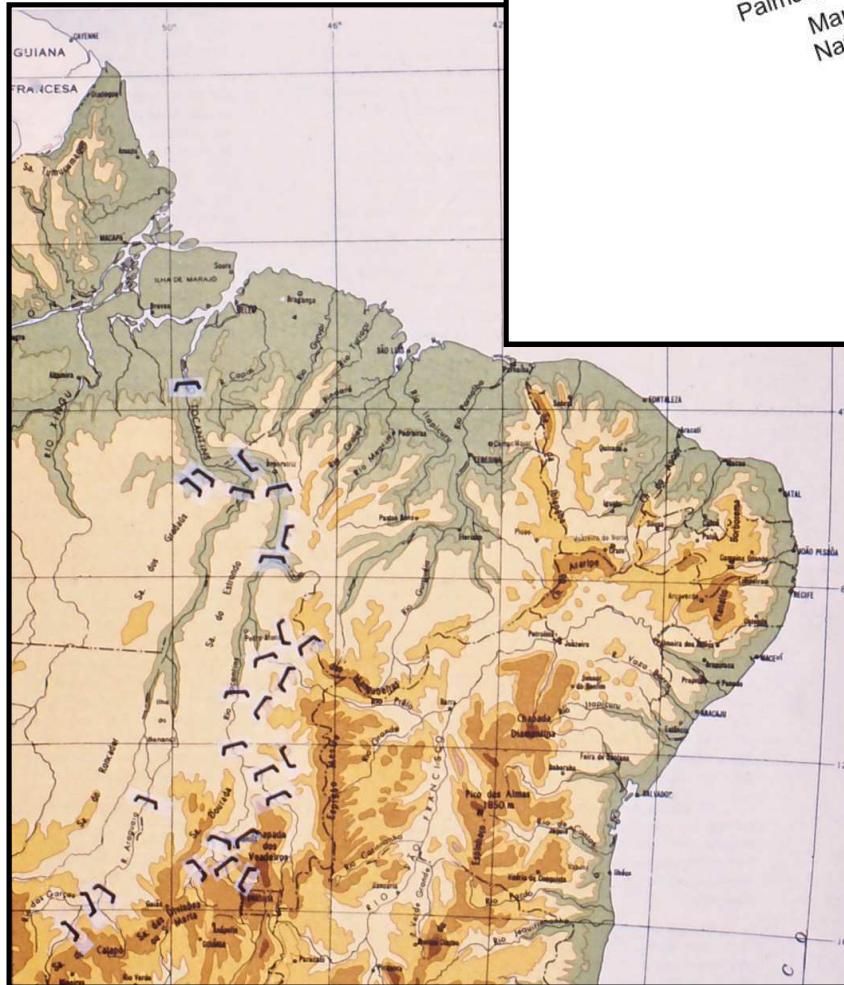












Feasibility study of large reservoirs in the Brazilian Amazon basin:

Total number: 90

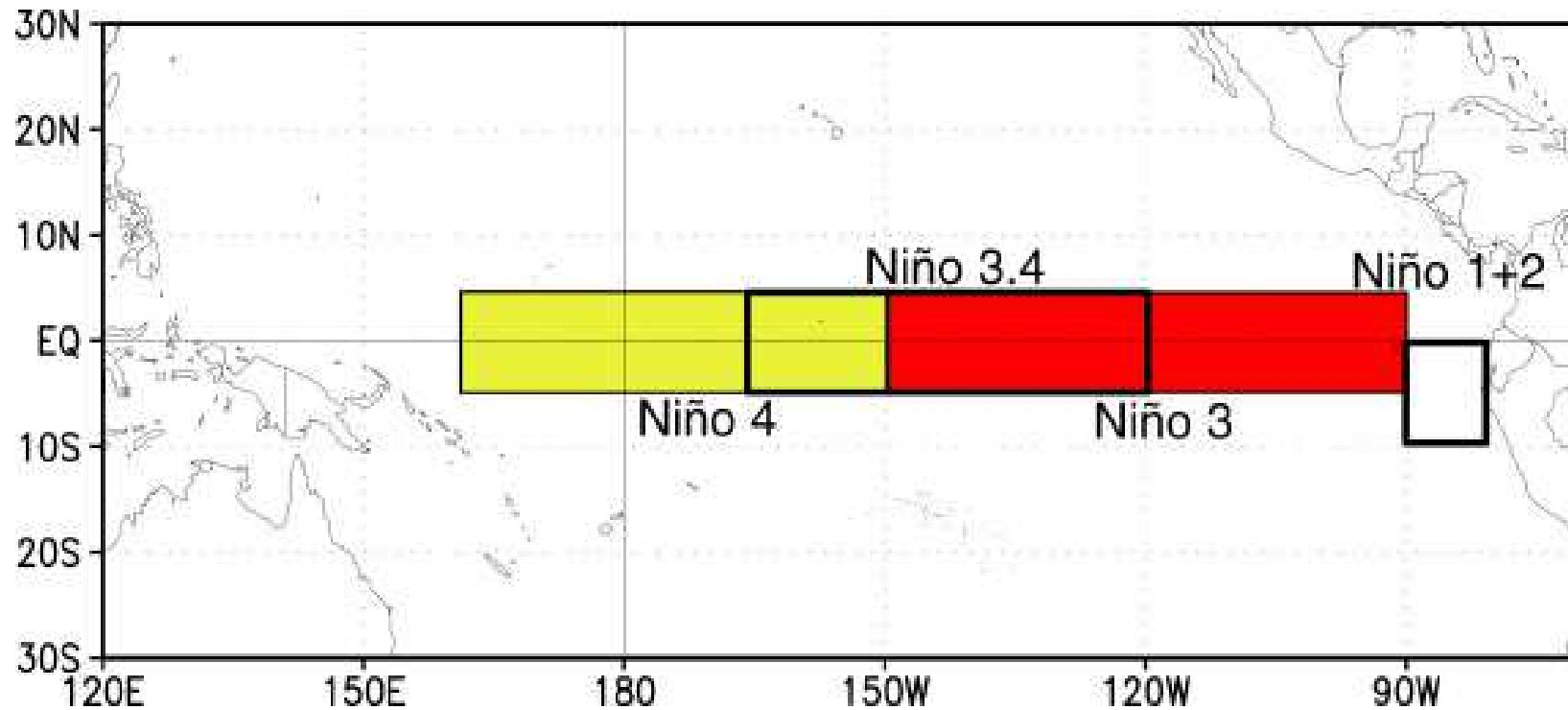
Total area: 100 000 km<sup>2</sup>

Total capacity: 100 000 MW

# Extreme low water in 2005

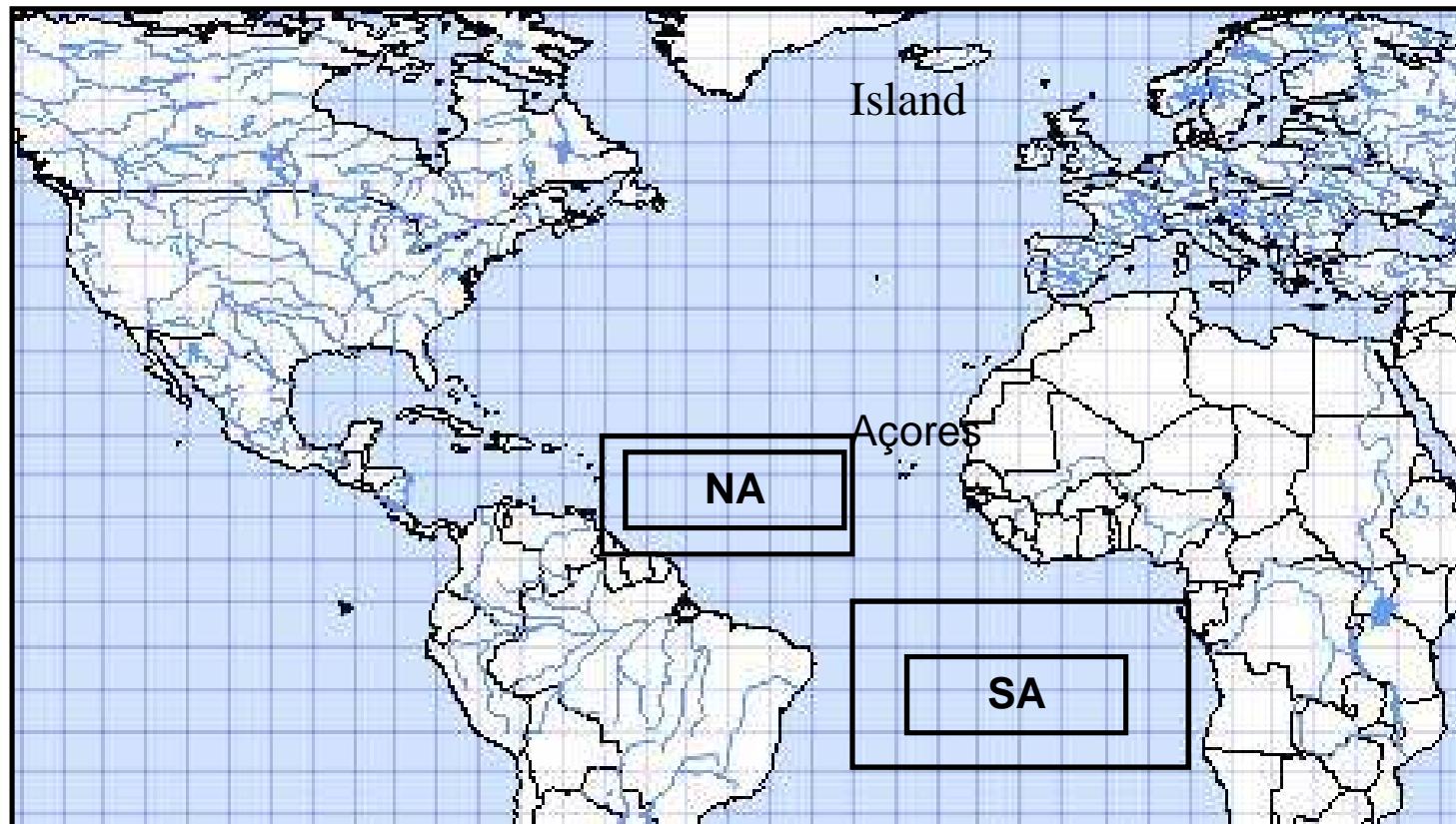


# Southern Oscillation Index (SOI) and Sea Surface Temperatures (SSTs) in the Pacific

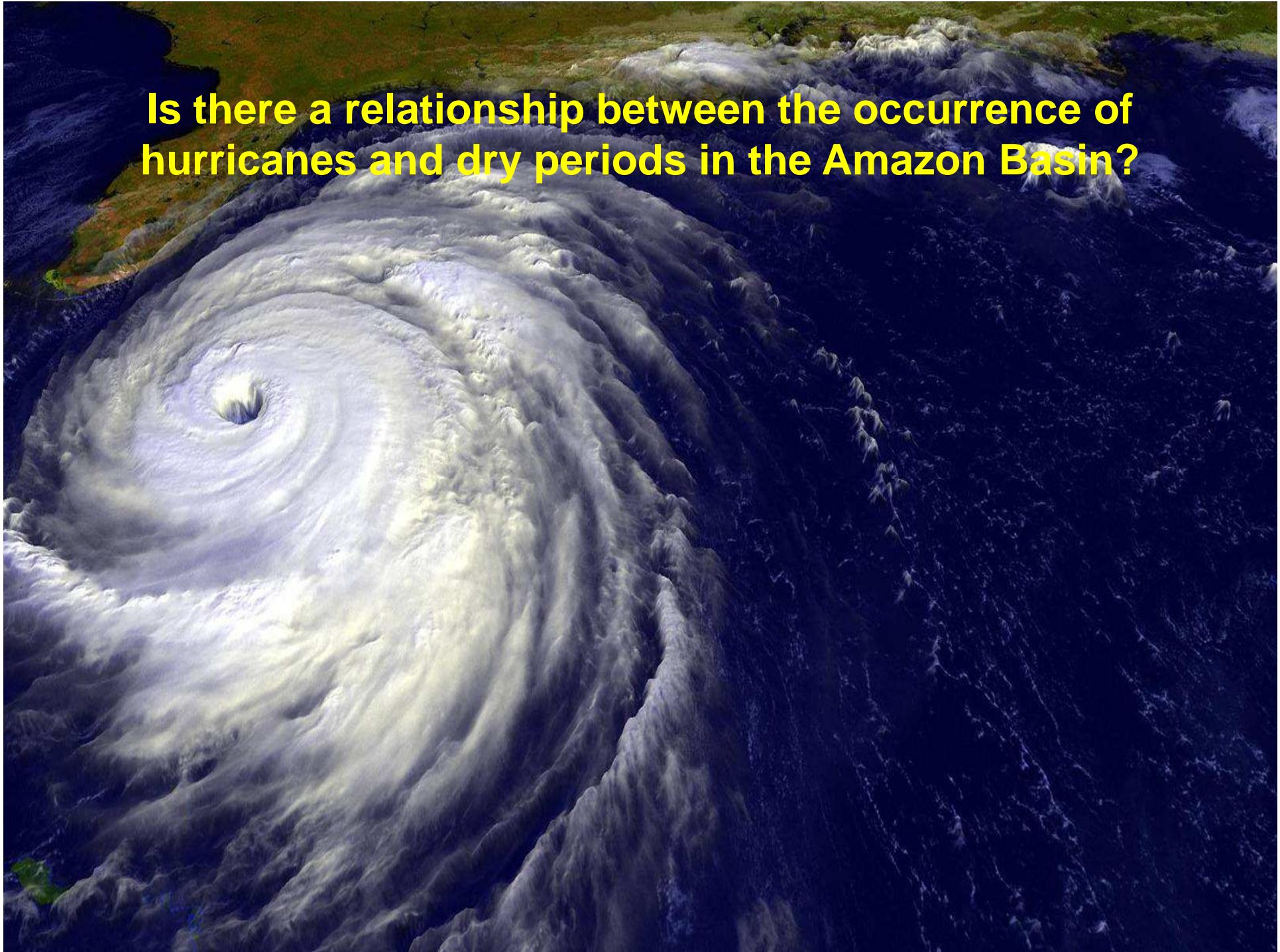


The Southern Oscillation Index (SOI) is defined as the result of the normalized differences of the atmospheric pressures between Taiti and Darwin, Australia.

# **Northern Atlantic Oscillation (NAO) and Sea Surface Temperatures (SSTs) of the Atlantic Ocean**



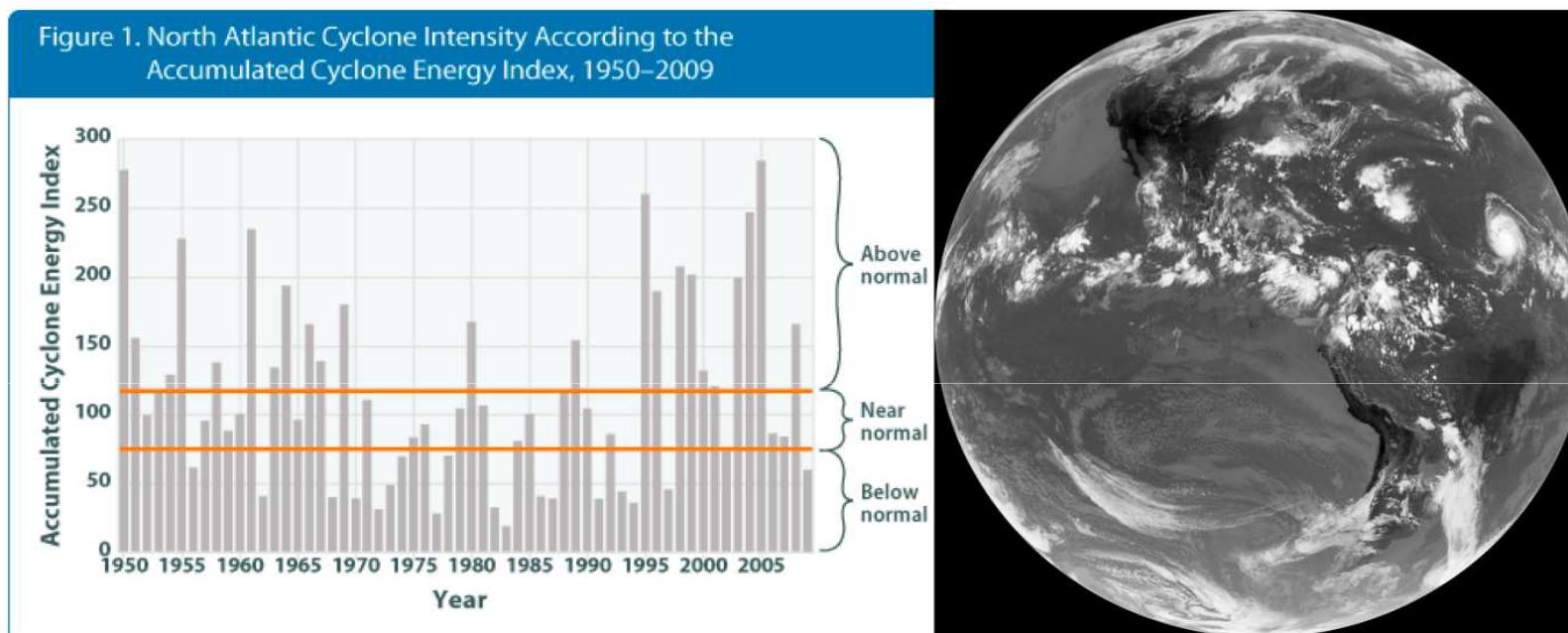
**The Northern Atlantic Oscillation (NAO) is defined as the result of the normalized differences of the atmospheric pressures between the Azores and Island**



**Is there a relationship between the occurrence of hurricanes and dry periods in the Amazon Basin?**

# Accumulated Cyclone Energy Index

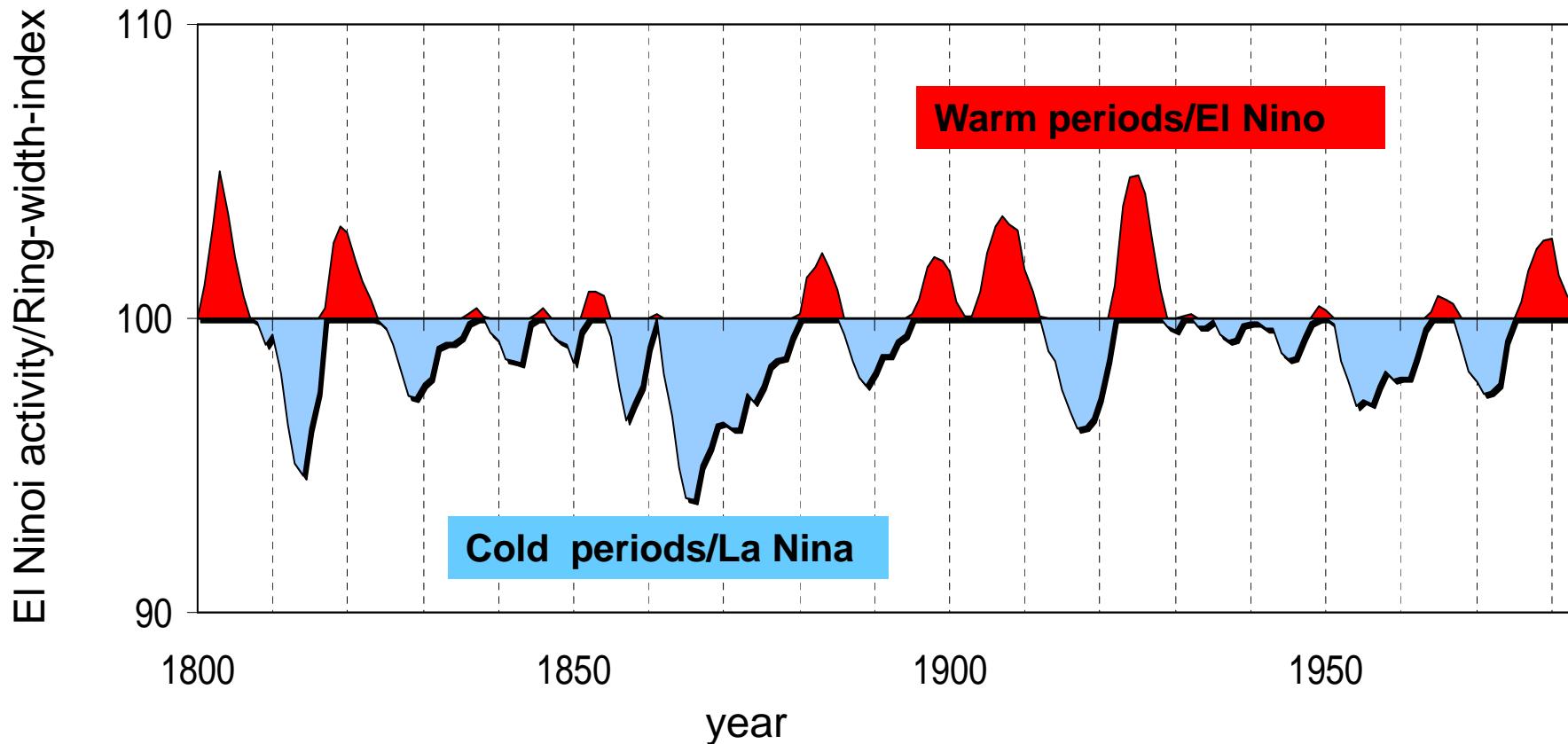
**In years of above-normal cyclone and hurricane activity in the tropical North Atlantic minimum water levels in central Amazonia are significant lower than in other years**



(1950-2011)	ACE above normal	Other years	T-value
Minimum water level (m)	16.7±1.8 (n=22)	18.2±1.6 (n=40)	3.26 (p<0.01)

Junk *et al.* (2010, modified by Schöngart)

# Decadal variability of the ENSO activity



With a so called „Low pass filter, the ring width curves were treated and pronounce then the La Nina and El Nino periods: The 20th century periods are confirmed by instrumental records.

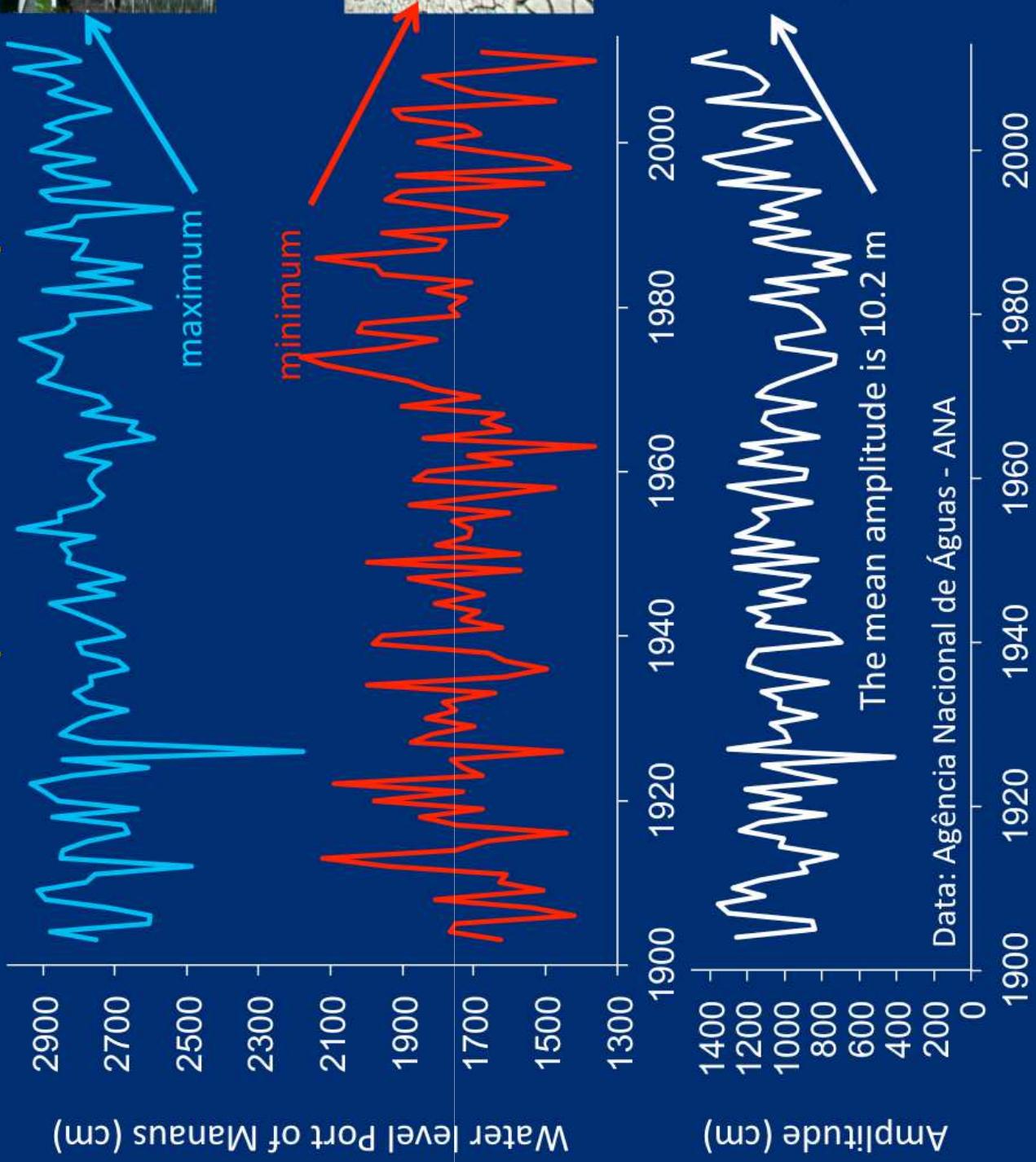
## **General predictions made by the global climate panel for South America**

- 1. Increase in temperature (2-4° C):**
- 2. Accelerated melting of snow and ice in Patagonia and glaciers in the Andes, reducing water discharge buffer capacity**
- 3. Rise in sea-level (20-60 cm)**
- 4. Variable rainfall predictions for different areas, but increase in seasonality**
- 5. Reduction of groundwater restoring mainly in northeastern Brazil**
- 6. Increase of extreme climate events**

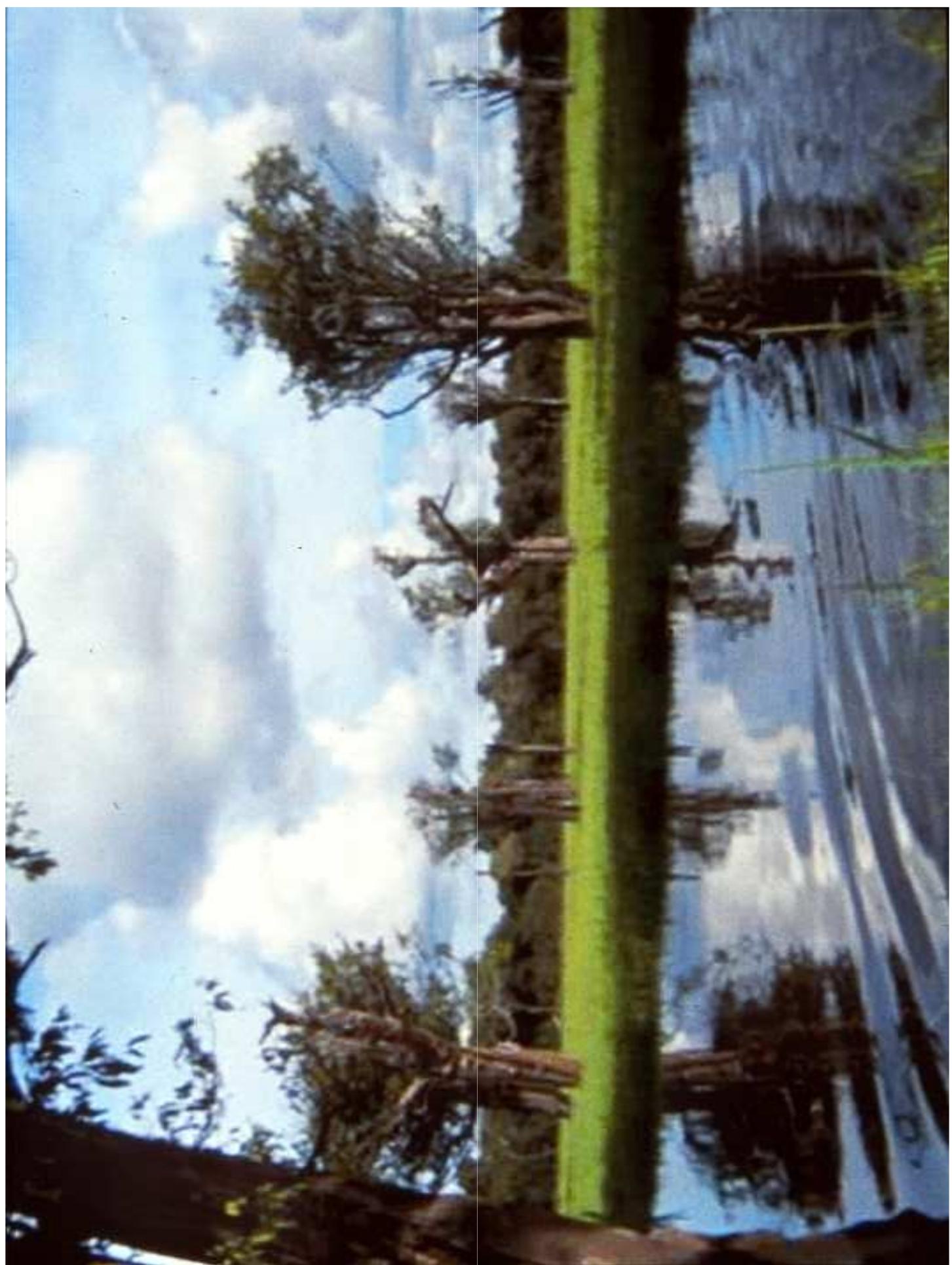
# **Floodplain responses to changes in global climate**

- 1. Changes of discharge and flood pulses in low order rivers**
- 2. Changes in discharges and increases in extreme low waters and floods in large rivers and connected floodplains**
- 3. Increase in low waters and high floods in rainwater-fed floodplains**
- 4. Increase of drought stress and wild fires**
- 5. Changes in plant and animal species composition**

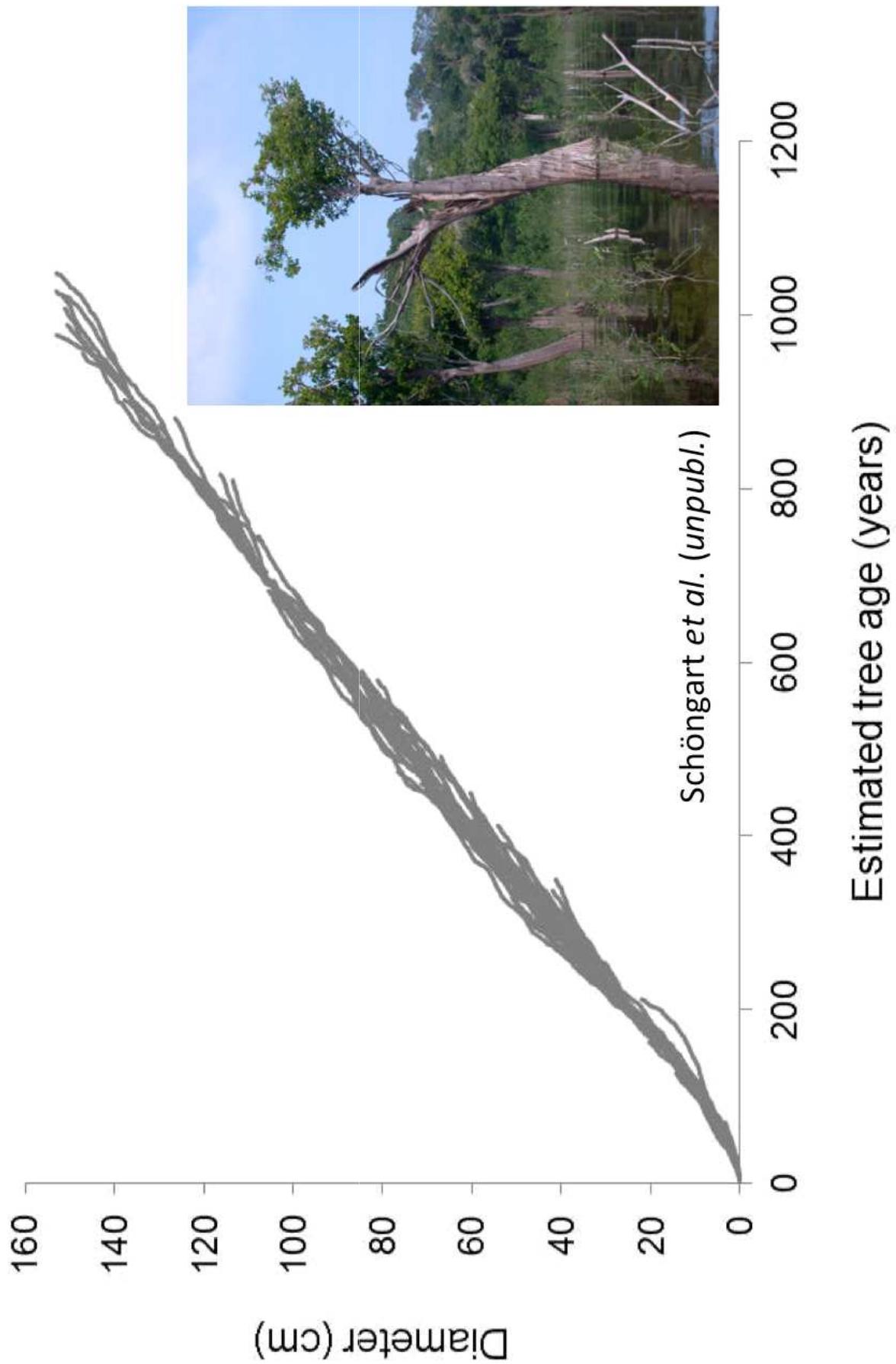
# Maximum and minimum annual water levels and amplitude at the Port of Manaus (Central Amazon) over the last 110 years



Human-induced  
climate change  
or natural  
variability of the  
hydrological  
regime?



# Constructed cumulative diameter growth curves of *Eschweilera tenuifolia*





# **Sustainable floodplain management and mitigation of deleterious human impacts**

- Inclusion of wetlands in the respective constitutions as specific ecosystems
- Elaboration of a wetland friendly legislation and its implementation
- Highest priority for sustainable management and protection of wetlands

Clustering of reservoir construction on a few appropriated rivers, and water release according to the natural flood pulse

- Improvement of the cooperation between scientists, politicians and decision makers

Thank you for your attention.

