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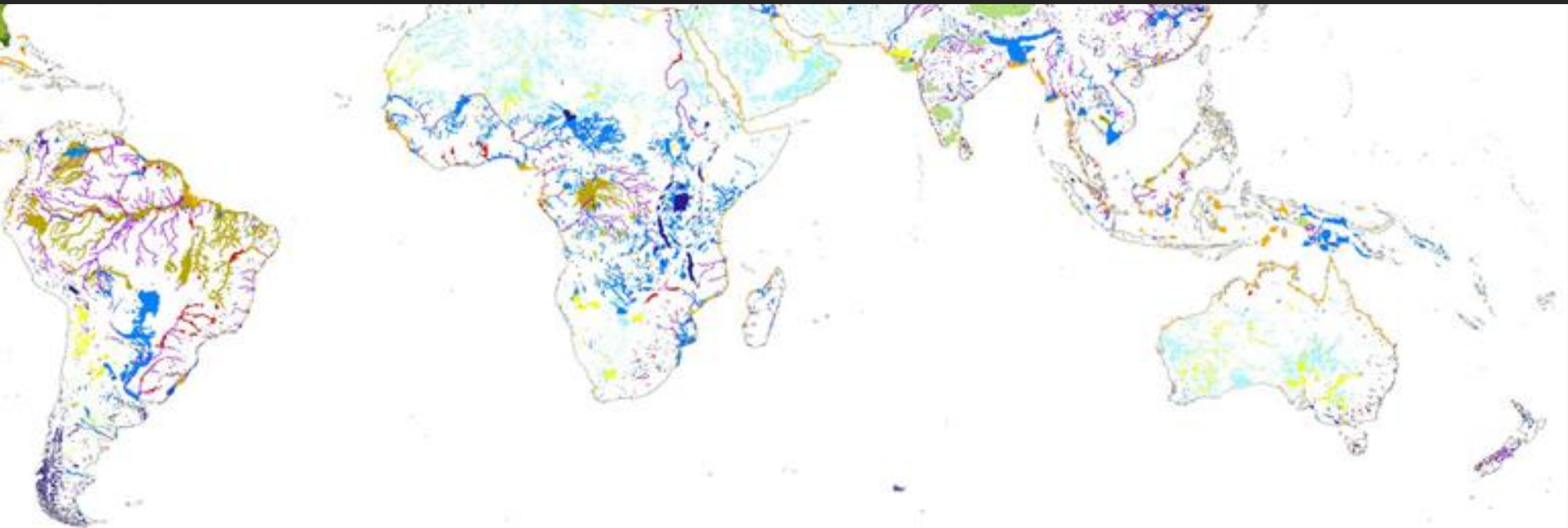


Tropical floodplain ecology: Australia compared to South America



Why compare Australia vs. South America?

- » Much ecological research has been conducted in South America
 - » Central Amazon (Brazil), Orinoco (Venezuela), Pantanal (Brazil), Parana (Argentina)
- » Tropical Australia has also been studied, albeit less extensively
 - » Magela Creek (1980s), Tropical Rivers & Coastal Knowledge since 2007
- » Far less comprehensive work in tropical Africa, Asia
 - » Relatively high human influence



Australian floodplains

Current Flood Water*
Feb. 15-18, 2009



Previous Floods:

2009	Green
2008	Dark Blue
2007	Blue
2006	Light Blue
2005	Lightest Blue
2004	Very Light Blue
2003	Lightest Blue
2002	Very Light Blue
2001	Lightest Blue
2000	Very Light Blue

* May include
cloud shadows

MODIS reference water
(Sept. 9, 2008)



Current Flood Water*
Jan. 12 - 15, 2010

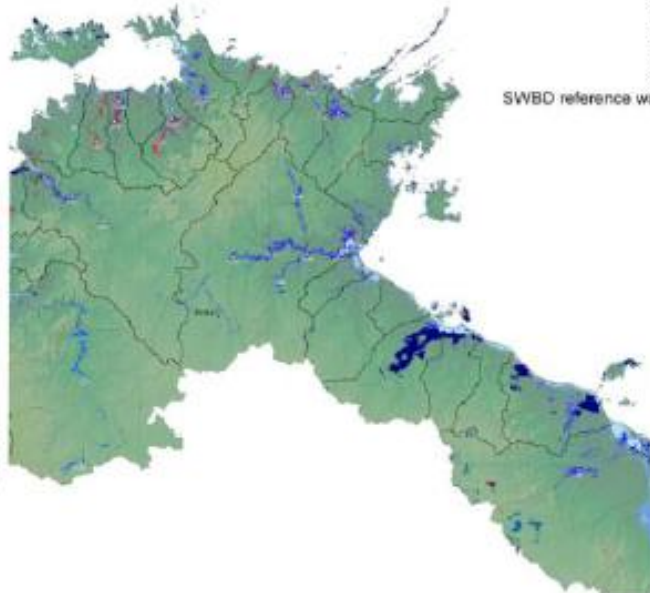


Previous Floods:

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2003	Lightest Blue
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2001	Lightest Blue

*May include
cloud shadows

SWBD reference water



Current Flood Water
Feb. 23-27, 2009



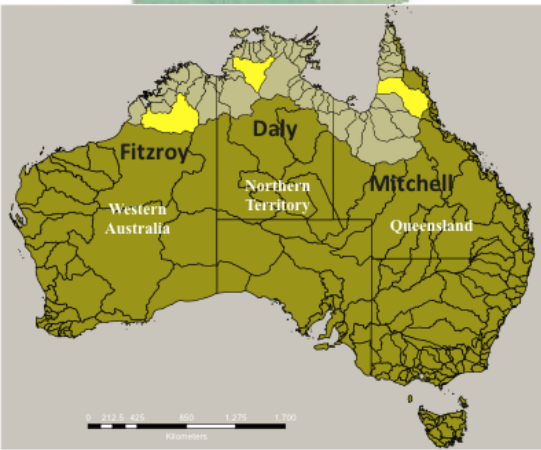
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2009	Green
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SRTM Reference Water



Ward et al. in press



South American floodplains

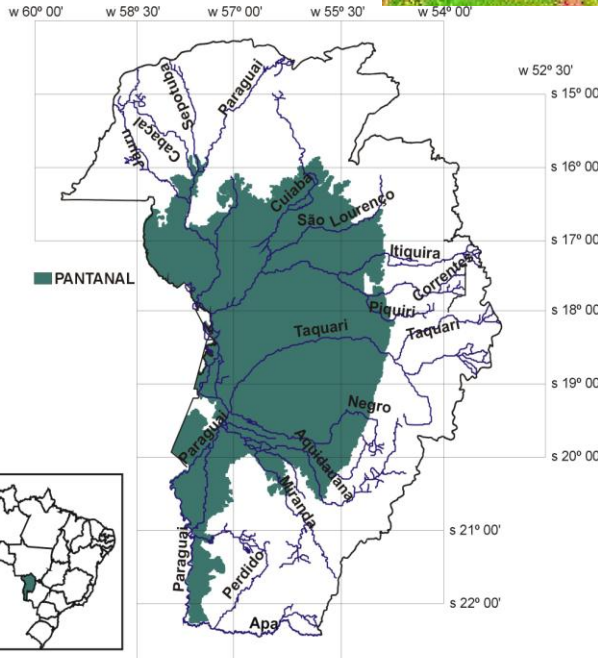


Floodplains in the wet-dry tropics are most comparable to northern Australia



Geomorphology: South America

➤ Pantanal: A mosaic of internal deltas



(Map from Programa Pantanal, Landsat mosaic from Embrapa Pantanal)

Geomorphology: South America

- Central Amazon River fringing floodplain

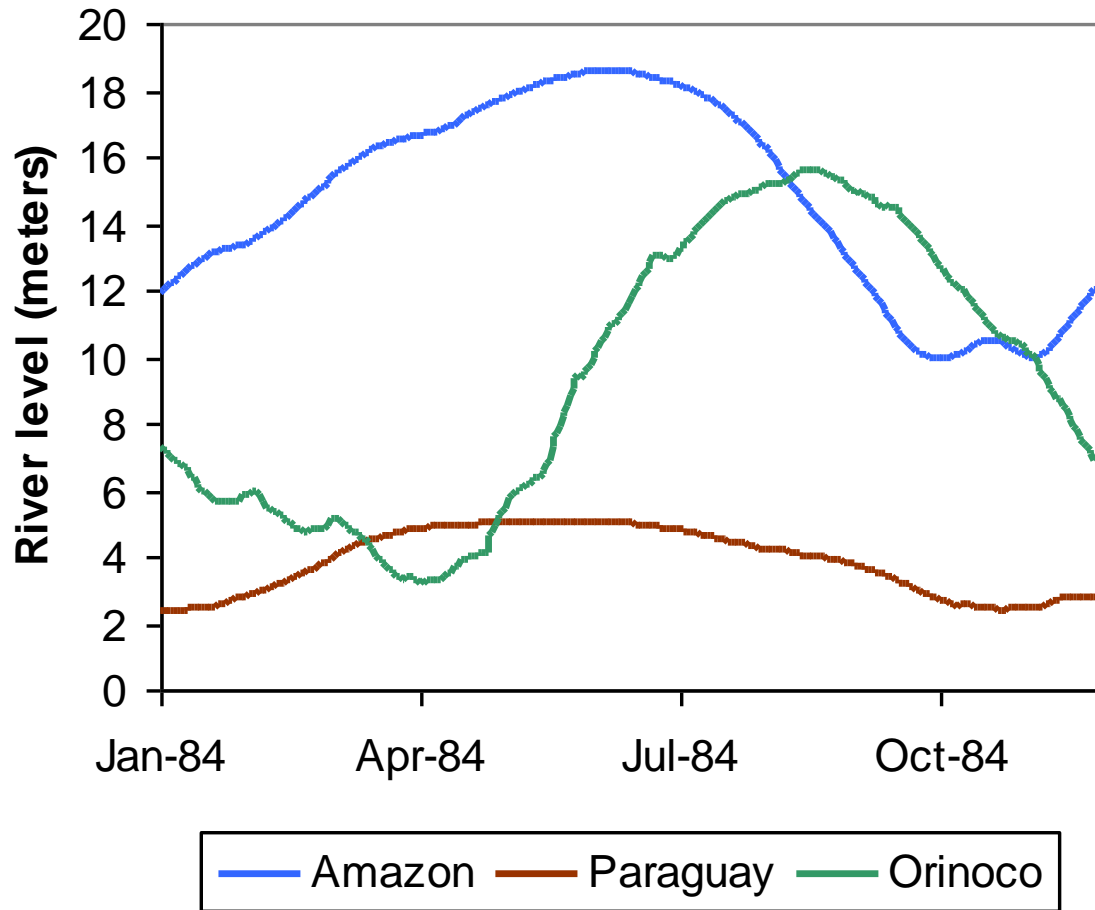


Geomorphology: South America

- Orinoco River coastal delta
 - Entirely forested
 - Mangroves dominate
 - Floodplain forest in freshwater parts



Hydrology: South America



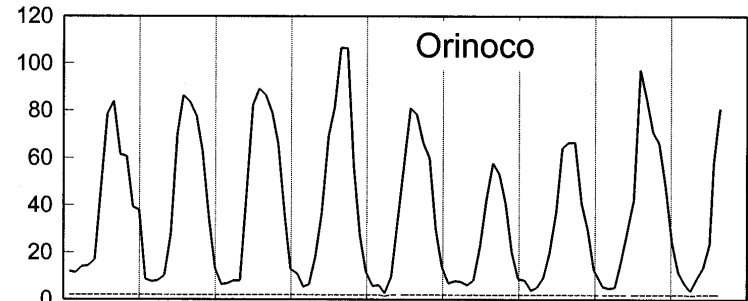
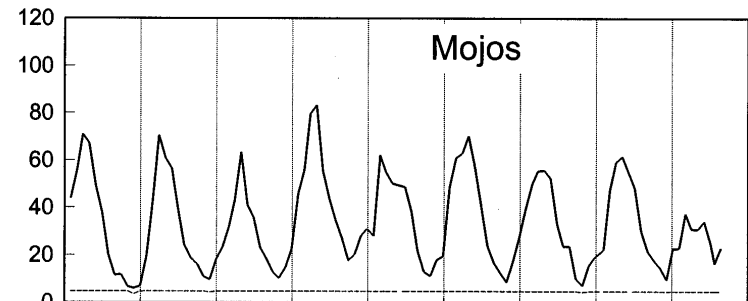
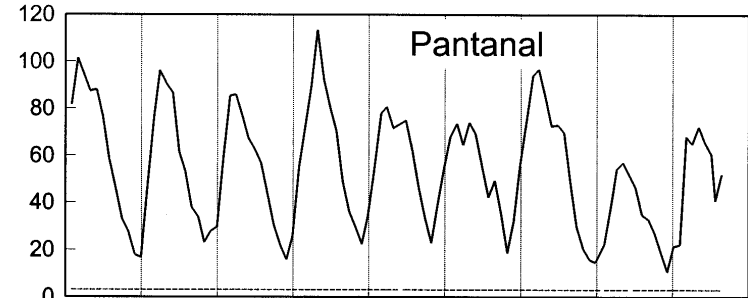
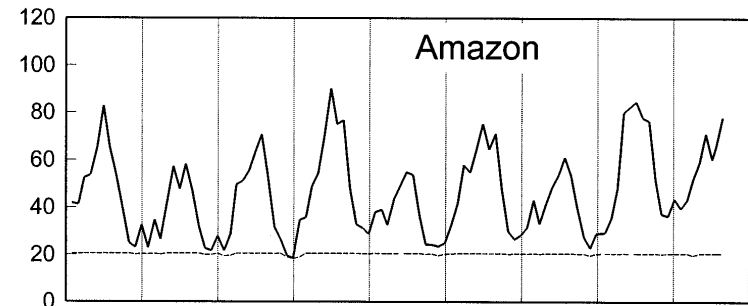
- Largest rivers of lowland South America
- Daily data
- Gradual change due to:
 - Large area of catchments
 - Floodplain attenuation

Hydrology: South America

- Passive microwave remote sensing (Hamilton et al. 2002, J. Geophys. Res.)
- Predictable, monomodal flood pulse
- Flood Pulse Concept

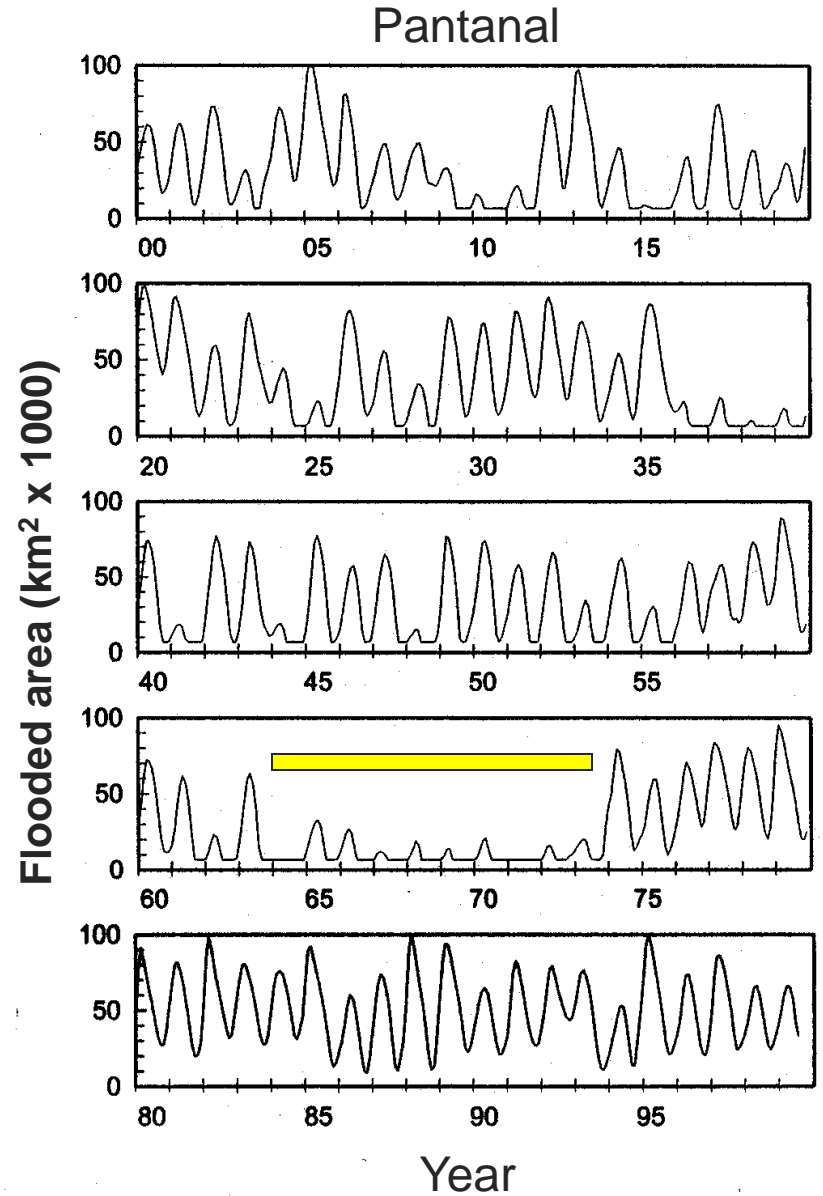
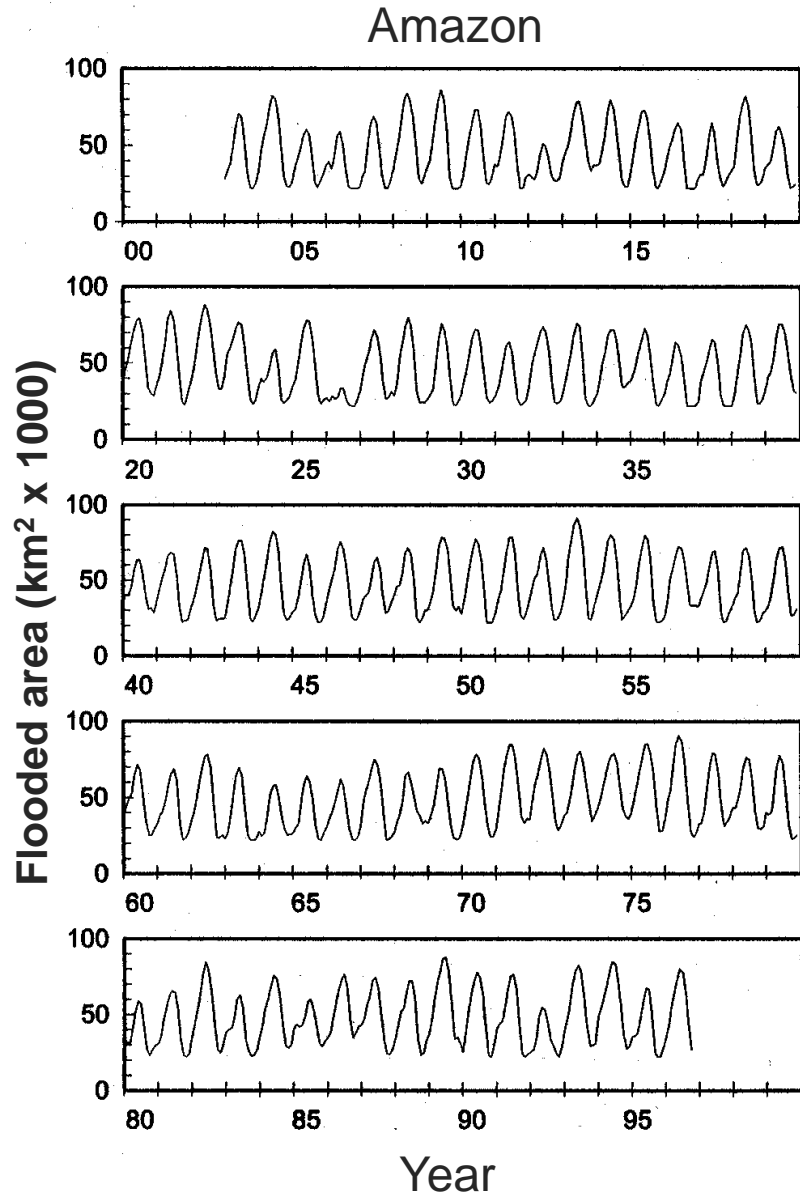


Flooded area ($\text{km}^2 \times 1000$)



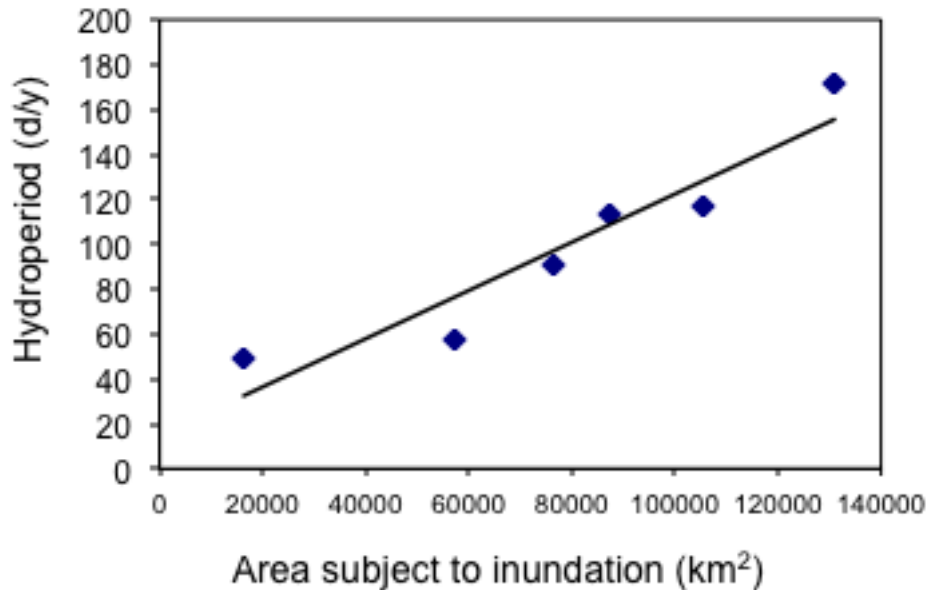
Year (1979-87)

Hydrology: South America



Hydrology: South America

Hydroperiod vs. size of floodplain



It takes longer for flood waters to drain from the most extensive floodplains.

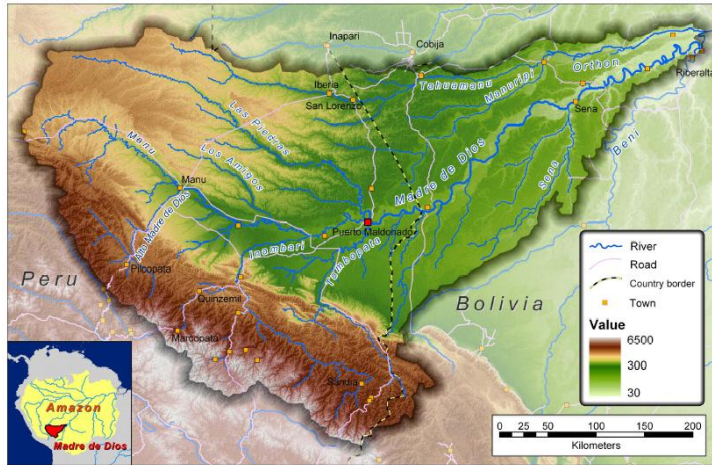
Hydroperiods measured in months allow development of aquatic plant communities...

...but floating plants have the advantage when water levels vary a lot

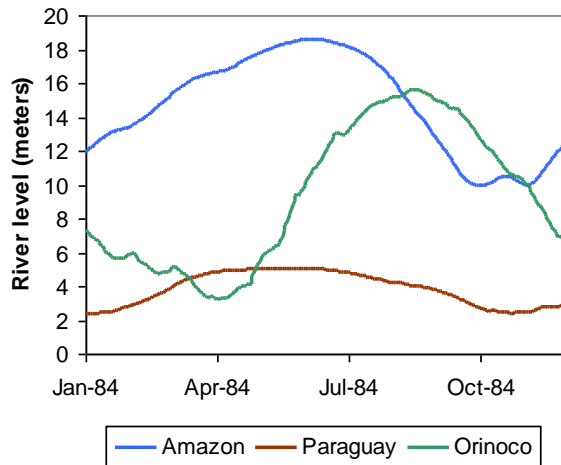
...and prolonged inundation presents limitations for the terrestrial biota.



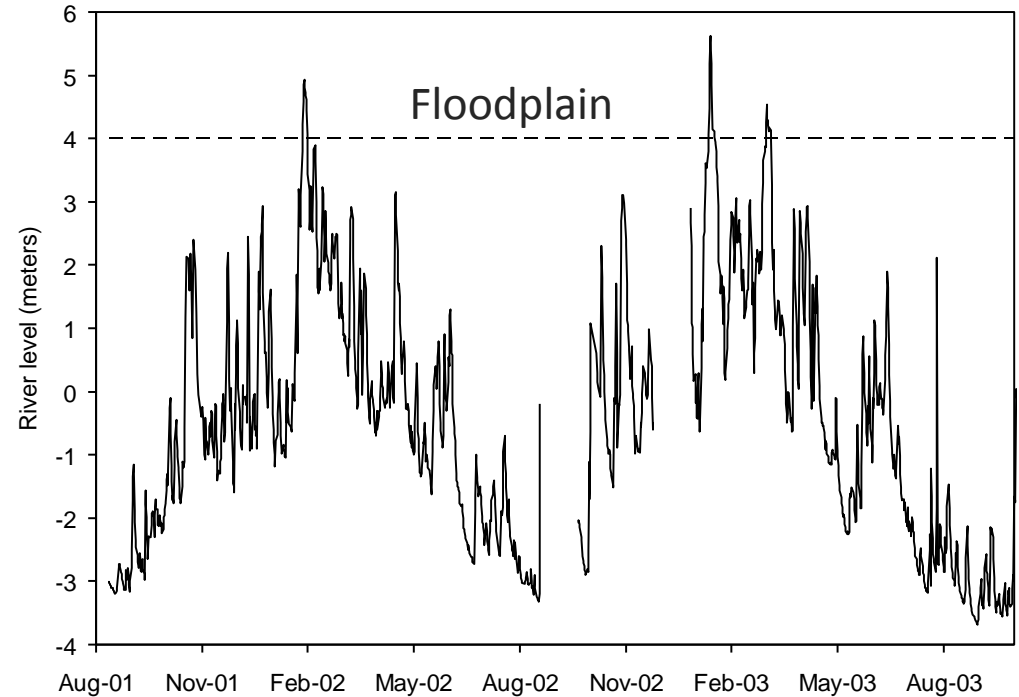
Hydrology: South America



Hydrograph of the Rio Madre de Dios, Peru



Madre de Dios stage data courtesy of Amazon Conservation Association; map from Bernhard Lehner



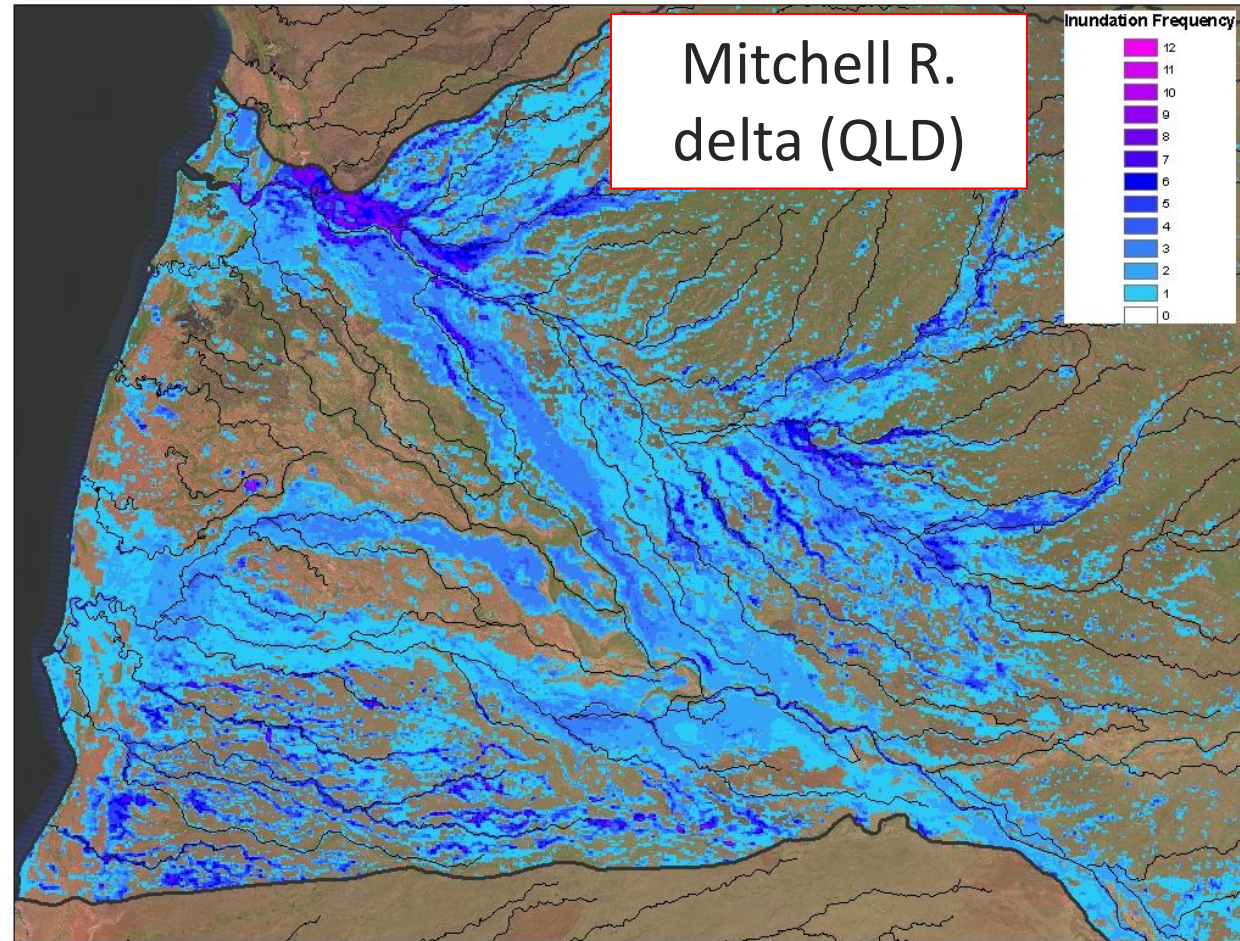
Geomorphology: Australia

➤ Most are in proximity to coasts

➤ Savannas

➤ Mangroves, salt flats near coast

➤ Deltaic floodplains



Doug Ward, unpubl.

Hydrology: Australia

- Intermittent
- Erratic
- Cyclone-driven
- Charts from Butler 2008, Nat'l Ctr Tropical Wetland Rsch

Environmental Research Institute

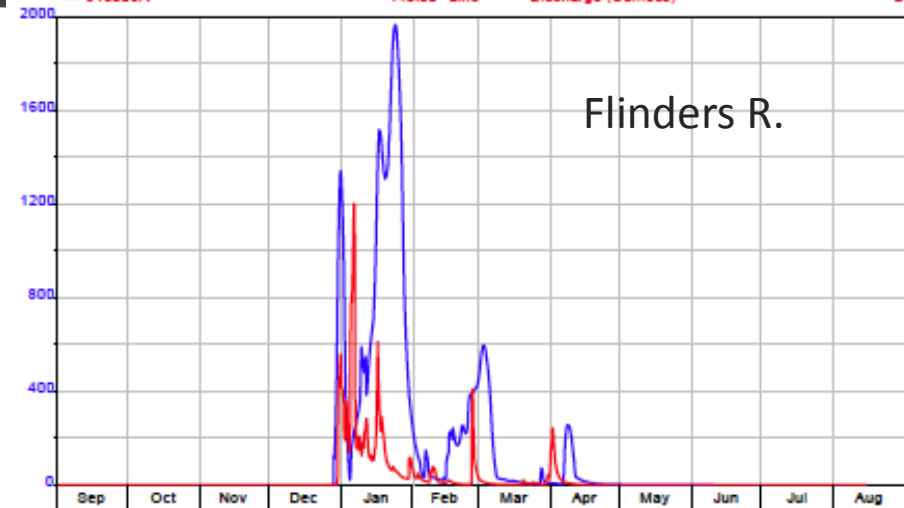
HYPLOT V129 Output 30/06/2006

Period 1 Year Plot Start 00:00_01/09/1974

1974/75

Interval 12 Hour Plot End 00:00_01/09/1975

— 915003A 140.00 Line Discharge (Cumecs) B
— 915008A 140.00 Line Discharge (Cumecs) B



Environmental Research Institute

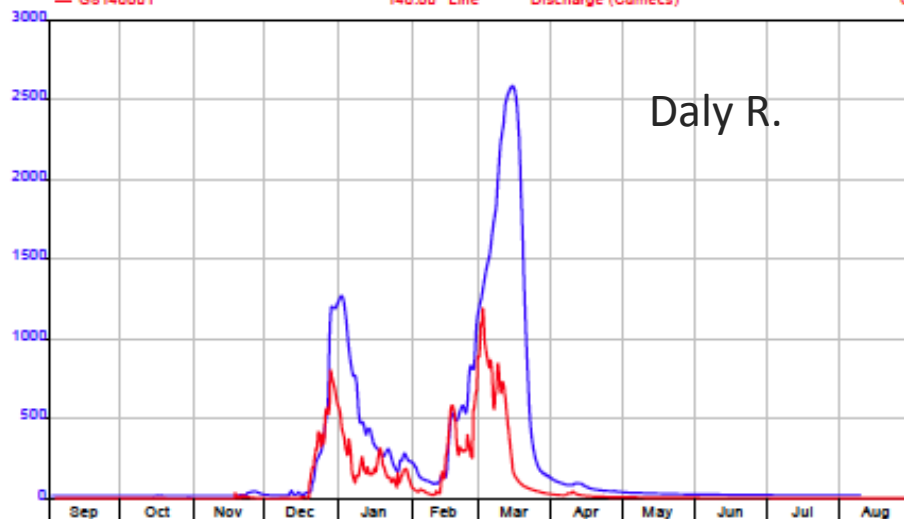
HYPLOT V129 Output 30/06/2006

Period 1 Year Plot Start 00:00_01/09/1993

1993/94

Interval 12 Hour Plot End 00:00_01/09/1994

— G8140040 140.00 Line Discharge (Cumecs) Q
— G8140001 140.00 Line Discharge (Cumecs) Q



Environmental Research Institute

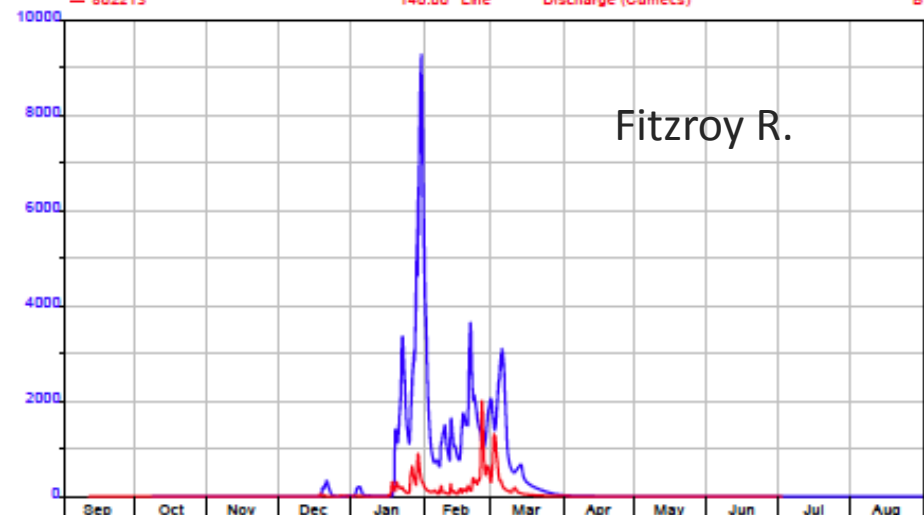
HYPLOT V129 Output 30/06/2006

Period 1 Year Plot Start 00:00_01/09/1996

1996/97

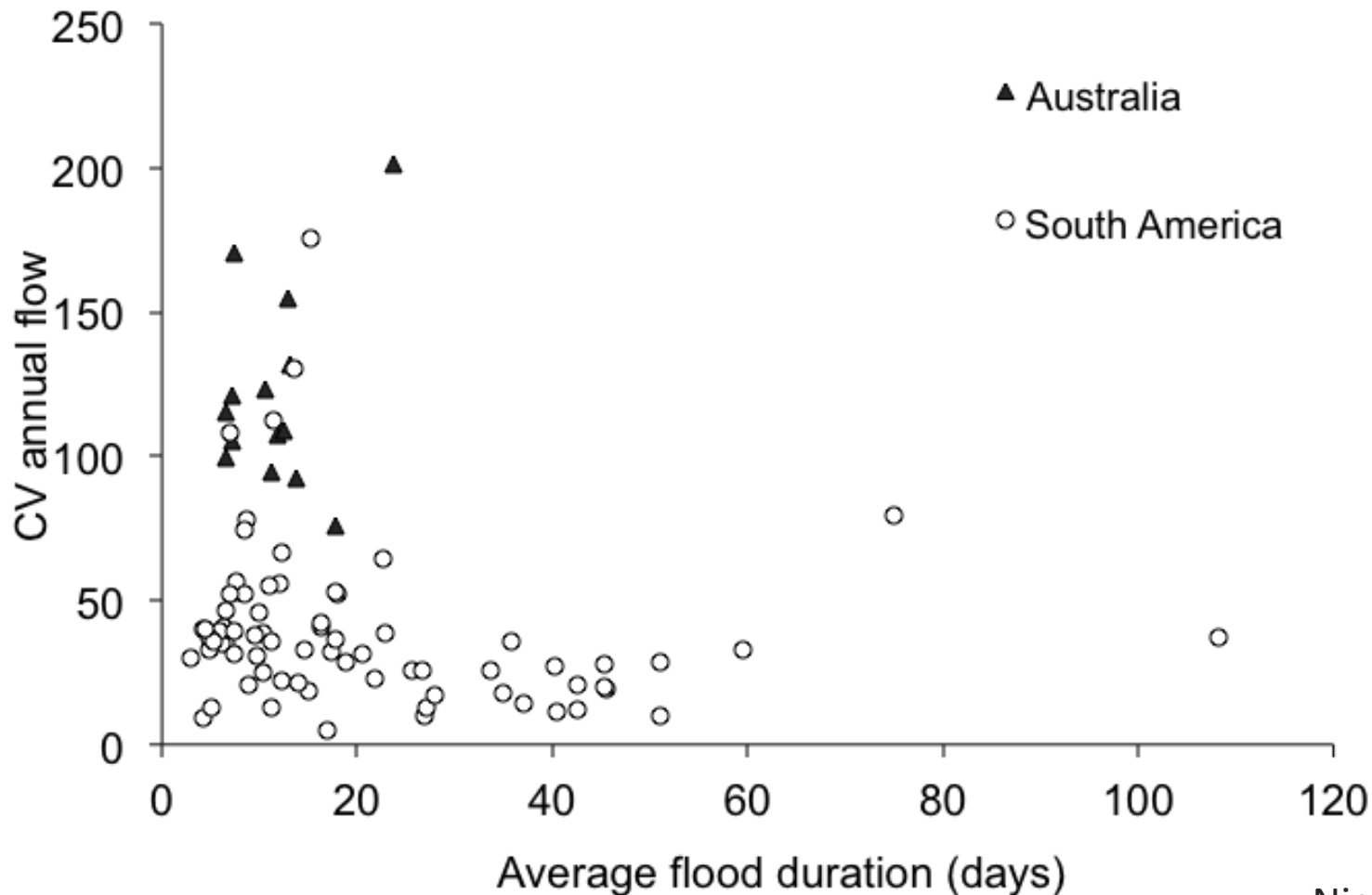
Interval 12 Hour Plot End 00:00_01/09/1997

— 802055 140.00 Line Discharge (Cumecs) B
— 802213 140.00 Line Discharge (Cumecs) B



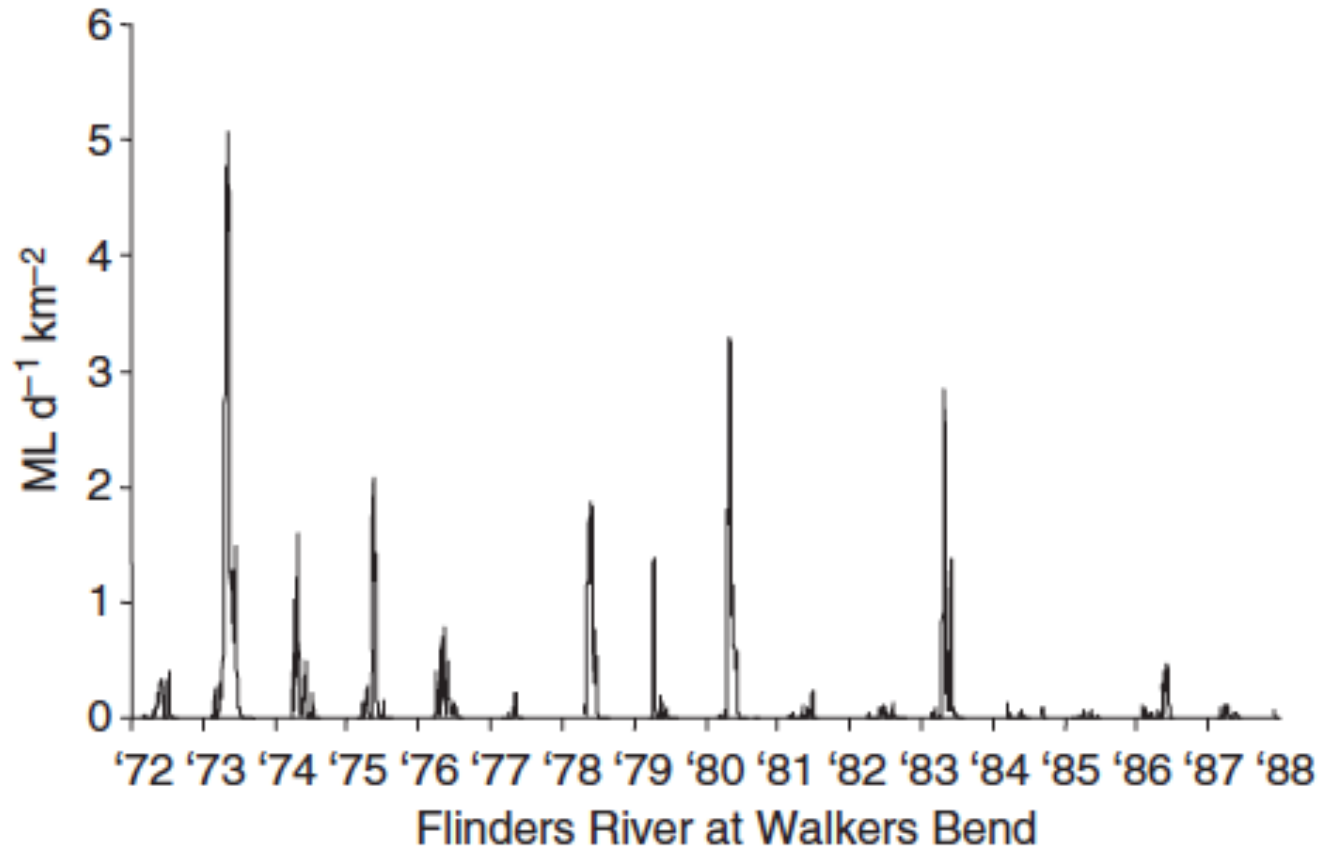
Hydrology: Australia

- Australian tropical rivers have floods of greater variability, shorter duration



Hydrology: Australia

- High interannual variability!
- Chart from Leigh & Sheldon 2008 Freshw. Biol.



Australia vs. South America

- » Australian floodplains are much less extensive than the well studied South American systems
 - » Smaller catchments
 - » Rapid runoff to coast
 - » More rapid transit of water through system => shorter hydroperiods
- » The longest inundation is associated with backflooded basins on marine plains (e.g., Magela Creek)

Australia vs. South America

- » Australian tropical floodplains are influenced by the sea
 - » Seawater penetration
 - » Tidal influence on water levels, movement
 - » Exchange of biota
 - » Vulnerable to sea level rise!
- » South America also has large coastal deltas
 - » Much more freshwater flow year-round
 - » Well vegetated; no salt flats
 - » Not macrotidal systems



Australia vs. South America

- » Australia's semi-arid catchments more readily generate sediment transport via overland runoff
- » In South American rivers, rapid runoff and high sediment loads are generally associated with Andean catchments
 - » Not all floodplains receive Andean water
 - » Those that do may be far away, and local water inputs may be important as well

Australia vs. South America

- » Australia floodplain water quality is comparable to that of South American floodplains
 - » Except where seawater influence exists!
- » Ionically dilute, modest nutrient concentrations
- » Some Australian rivers carry more and finer inorganic turbidity

Vegetation: South America

South American floodplains have variable tree cover depending on climate and inundation



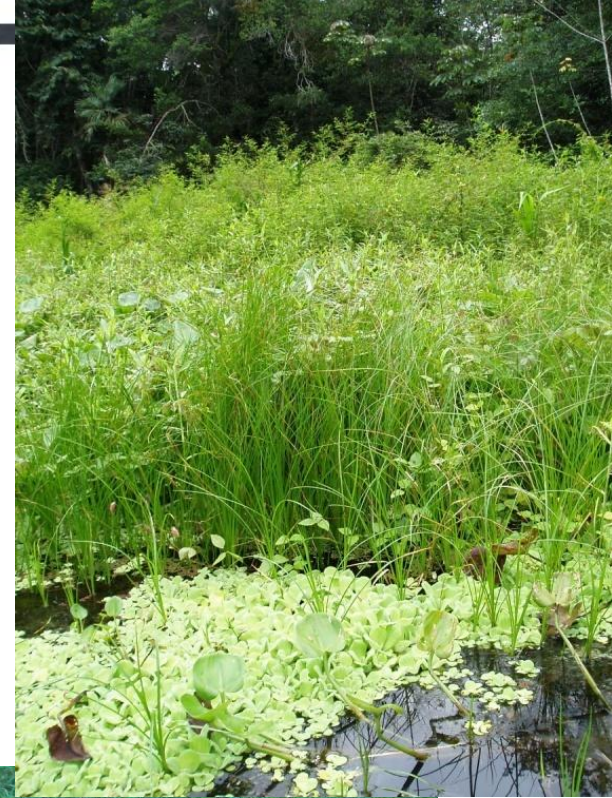
Above photo by R. Jongman



Aquatic plant production: South America

South American floodplains can show extremely high aquatic plant production

- Linked to flood pulse
- Floating emergent growth forms may alternate with terrestrial growth forms
 - Dry season production also important
- Most productive areas receive Andean water (white water)



Aquatic plant production: South America

South American savanna floodplains can resemble some Australian floodplains in aquatic vegetation



Photos by M.D. de Oliveira



Dry season: South America

Many South American floodplains have a dry season severe enough to act as an ecological bottleneck for the biota



Photo by M.D. de Oliveira

Aquatic plant production: Australia

- Australian floodplains often support vastly lower aquatic plant biomass
 - Alligator Rivers/Kakadu region is an exception
- Surprisingly little aquatic production of grasses, forbs, and algae in rivers and fringing floodplains
 - Most vascular plant production probably occurs after flood waters recede
 - Short window of time for growth



Aquatic plant production: Australia

- Areas subject to shallow, prolonged inundation, or tidal cycles, may support substantial aquatic plant production
 - e.g., sedge meadows in upper intertidal and supratidal zones
 - Also shallow perched waterholes shortly after inundation



Aquatic plant production: Australia

- Factors that may conspire against aquatic primary production in many locations include:
 - Short inundation period
 - Rapidly fluctuating water levels
 - Turbid water (light limitation)
 - Severe dry season
 - Low nutrients in soils and waters
 - Seawater penetration during the dry season



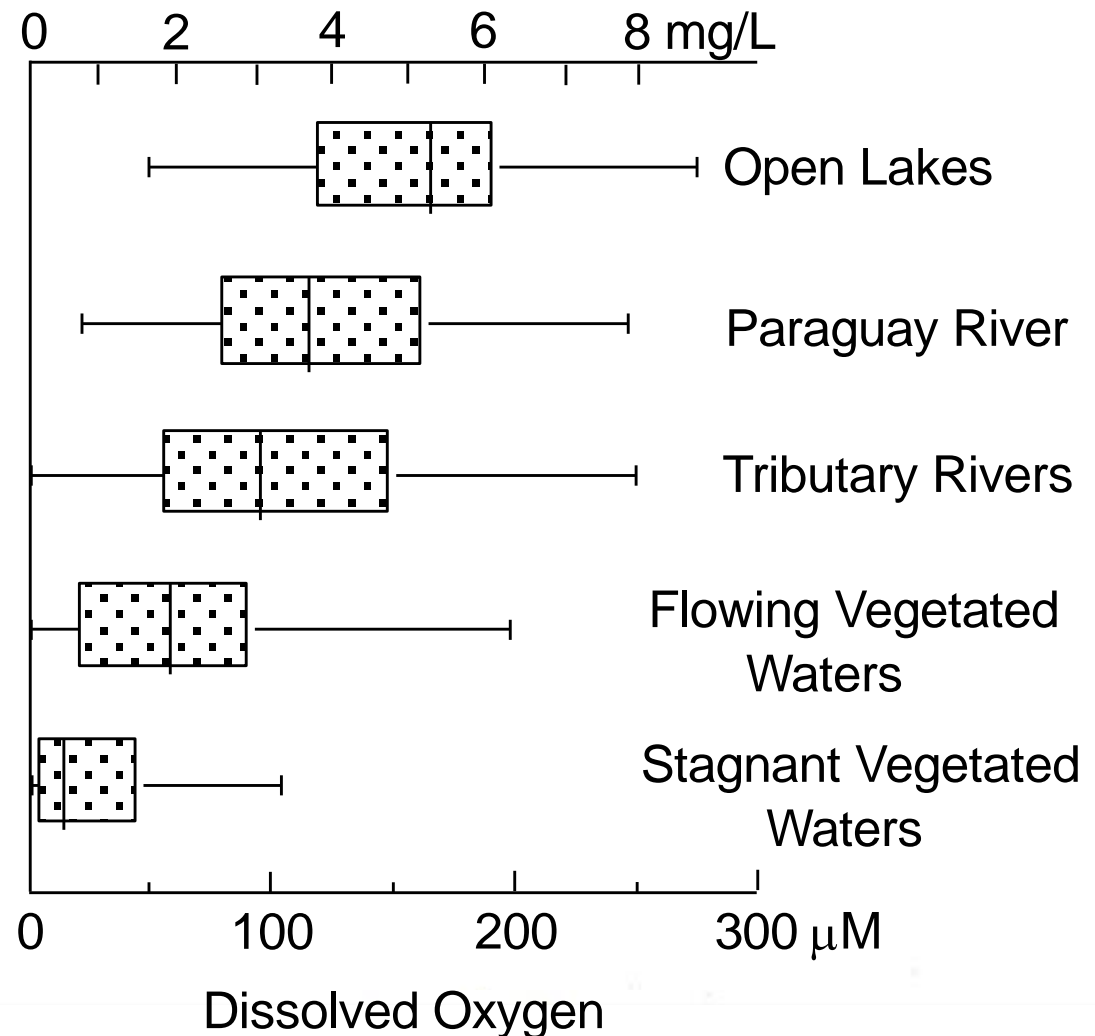
Oxygen depletion: South America

Oxygen depletion is common in South American floodplains

- Vegetated floodplain waters are often hypoxic or anoxic
- Fish kills can occur especially at rising water

Not so common in Australian floodplains?

- First flush can produce fish kills



Turbidity: South America

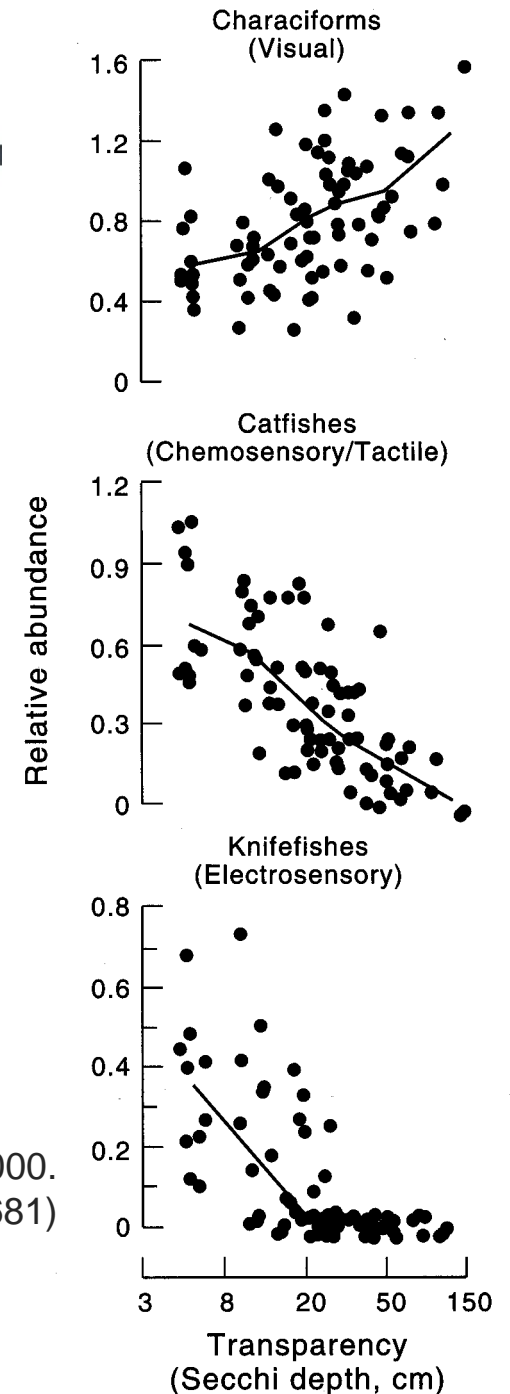
South American floodplains vary greatly in turbidity

- White water/black water

Turbidity as a structuring force for fish communities

- Visual vs. electrosensory feeders

Importance of turbidity variation in Australian floodplains?



(Lewis et al. 2000.
BioScience 50:681)



Inundation as a disturbance gradient

Australian floodplains tend to be more **hyperseasonal** ecosystems:

Long season of severe drought stress punctuated by short but intense inundation events

At what point is inundation more of a disturbance than a subsidy?

How much can the biota adapt to erratic and short-lived inundation?



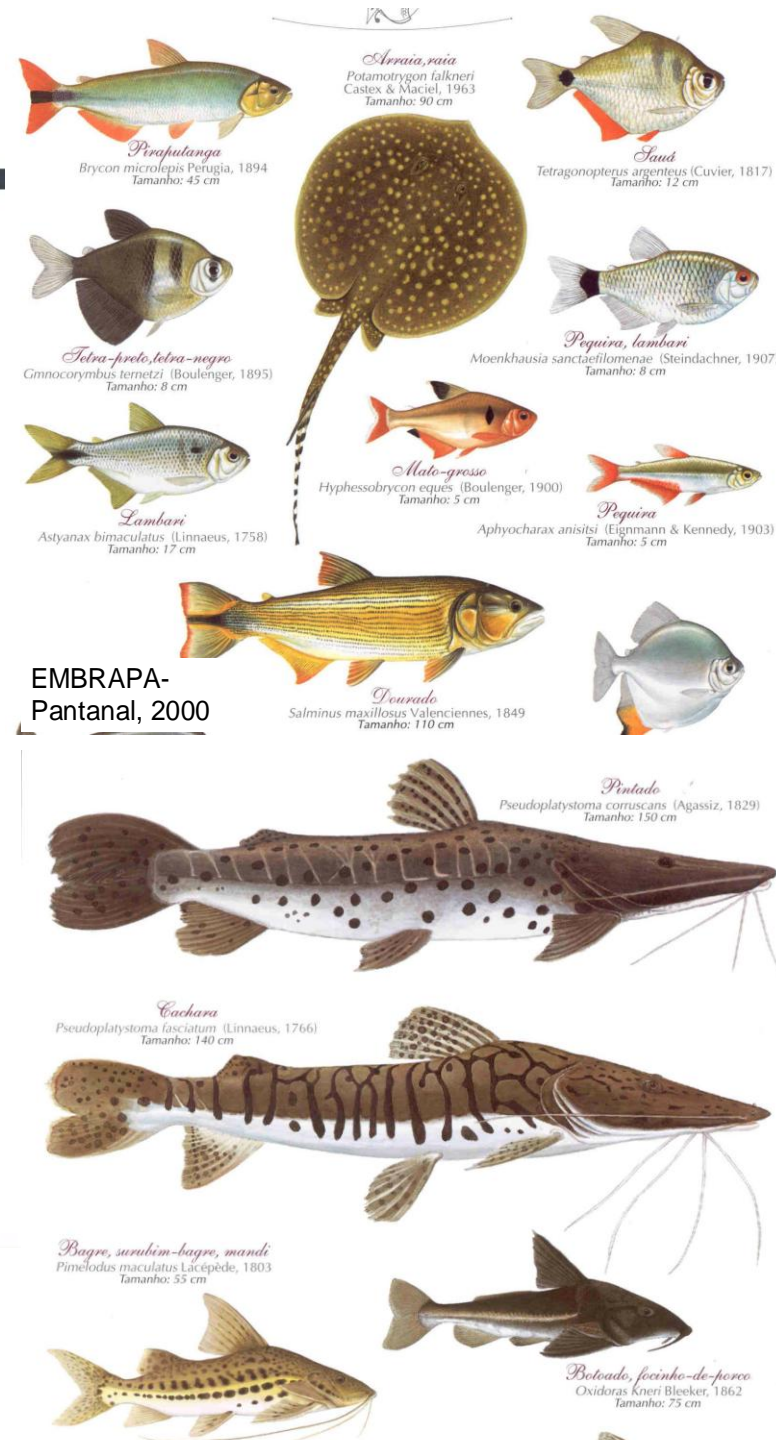
Biodiversity

Some elements of the freshwater biota may be less diverse in Australian floodplains compared with South American ones:

- Vascular plants
- Freshwater fishes

Although even in megadiverse ecosystems:

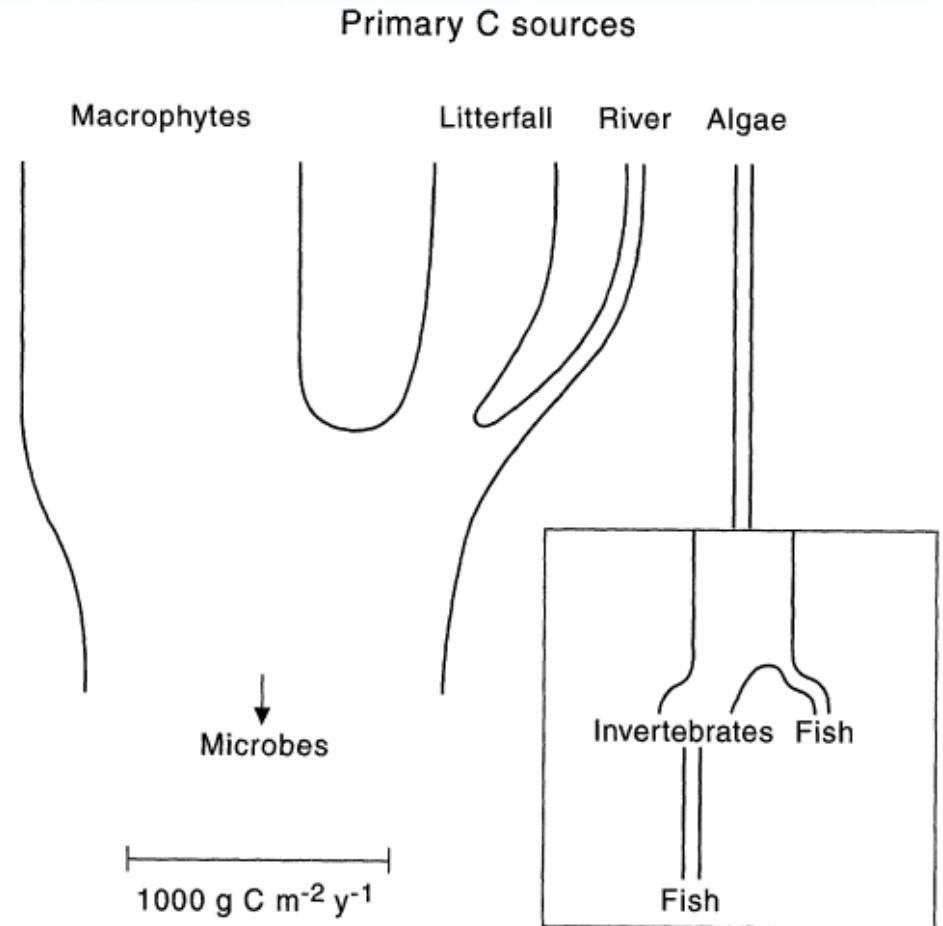
- Relatively few species dominate total biomass
- Functional redundancy is evident



Food webs

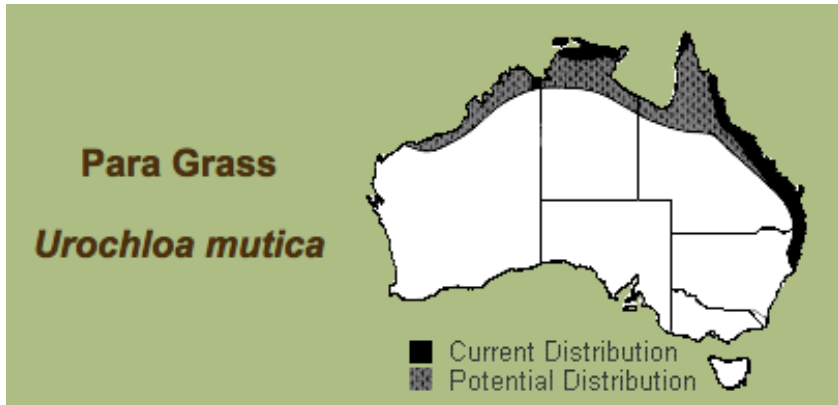
No fundamental differences in energy sources for aquatic food webs are apparent

- Algae are disproportionately important in both
- Floodplains appear critical to fish production in both



Lewis et al. 2001

Invasive species



weeds.org.au

Australian floodplains may be more susceptible to biological invasions:

Para grass
Hymenachne
Salvinia
Mimosa
Water hyacinth
Cane toads
Pigs



Many are South American invaders!

Livestock impacts

Australian floodplains may be more susceptible to livestock/pig impacts:

Drier landscape attracts animals to water bodies

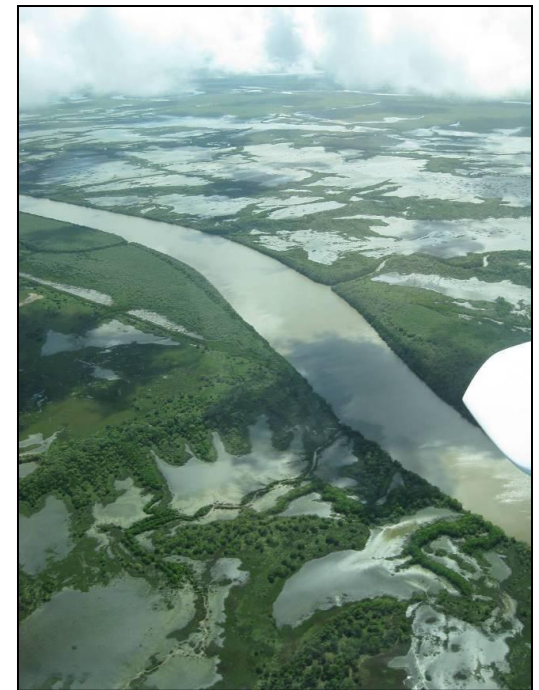
Dry season conditions not conducive to high growth rates to replace grazed/trampled plant life

These floodplains may be more important in subsidizing terrestrial animals including livestock



Australian vs. South American floodplains

- » Australia's tropical floodplain ecosystems are comparatively:
 - » Smaller
 - » Closer to the sea
 - » In drier climates with much more episodic rainfall patterns and shorter inundation periods
 - » Hyperseasonal!



Australian vs. South American floodplains



Australian floodplains may be more susceptible to:

- » Sea level rise
- » Invasive species
- » Livestock and feral mammals
 - » But perhaps more important for terrestrial subsidies?

