Ecological Implications of Erratic Floods in Large River Floodplains of the Andean Amazon Region

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The Flood Pulse Concept (Junk et al. 1989)

- Floodplains are **transitional** between aquatic and terrestrial zones.
- Large unmodified watersheds produce **flood pulses of long duration** and extensive seasonal floodplain inundation.
- Small or modified systems produce frequent **flood pulses of shorter duration**.
- **Predictable** pulses allow organisms to adapt to and benefit from inundation.
- **Unpredictable** pulses act as a disturbance and impede adaptation.
The Natural Flow Regime concept can be extended to Flood Regimes on floodplains.


The Napo River

- Drains $10^5$ km$^2$ of a highly diverse and largely undisturbed region of the western Amazon in Ecuador and Peru.
- Fringed with extensive floodplains along 800 km of lowland reaches.
- Exceptional levels of biodiversity may be related to flood regimes.
  - Intermediate disturbance hypothesis
Water levels of the Napo River

- Highly variable and less predictable flow and flood regimes (multiple short pulses).
- Contrasts with more predictable, mono-modal regimes of the Amazon, Orinoco, Parana rivers.
- Stage fluctuations range from 4 m in upper reaches to 9 m in lower reaches, vs. 16 m in the central Amazon.
Water levels and precipitation

- Less pronounced seasonality in the Napo.
- Hydrograph coupled to precipitation events towards the upper reaches and decoupled (like the Amazon) towards the lower reaches.

**downstream Napo - Peru**

**upstream Napo - Ecuador**

**Central Amazon - Brazil**

Source: INAMHI-SENAMHI, Hybam Project.

Source: ANA, Brazil.
Napo River has smaller amplitude of water levels than the Central Amazon.

- Lower depth of flooding.

- Deepest flooding occurs at floodplain sites proximal to river.

- Floodplain biota less adapted to cope with deeper floods?
Duration: Floodplain Hydroperiod

- Large variability in flood duration and depth.
- Proximity and hydrological connectivity to river explain depth and duration of flooding.
- Elevation of sampling sites relative to river unknown.
  - Some sites may be on perched terraces?
Frequency: Napo River hydrographs

- Higher frequency of floods towards the Andes.
- Inundation may act more as an ecological disturbance towards the Andes.

Source: INAMHI-SENAMHI, Hybam Project.
Most floodplain sites showed shallow, continuous inundation.
Timing and flashiness: Predictability

- Lower flood predictability in upstream reaches.
- Much flashier than Central Amazon!
River control of floodplain inundation?

In some places it may to some extent:

But often it doesn’t:

Caveat: only modest river floods occurred during the study
Sources of flood water

- Major ions as hydrological tracers
- Na$^+$ and Mg$^{2+}$ highest in Andean rivers
- Lowland waters are more dilute in ions although similar in proportions

![Graph showing Na$^+$ and Mg$^{2+}$ concentrations in flood water samples from Napo River and Yasuní River.](image)
Sources of flood water

- Floodplain waters span the range from river water to local water
- Most are dominated by local water
- Diversity of water sources may increase floodplain biodiversity
Floodplain Hydrological Regimes Compared

Dry Season vs. Moist

Arid vs. Moist

Erratic, short vs. Predictable, long

- Andean Amazon
- Central Amazon
- Pantanal
- Tropical Australia
Ecological implications: Do erratic floods matter?

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<th>Ecological phenomenon</th>
<th>Central Amazon</th>
<th>Andean Amazon</th>
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<td>Abundant</td>
<td>Sparse</td>
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<td>Fish life cycles tied to flood pulse</td>
<td>Closely</td>
<td>Unknown – perhaps less?</td>
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<td>Flooding resets vegetation succession</td>
<td>Sometimes</td>
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