State of the Amazon
Freshwater Connectivity & Ecosystem Health

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Scientists find the solutions they seek to the problems they study.


Terrestrial Ecosystems

Freshwater Ecosystems

Atmosphere

Vertical

Lateral

Longitudinal

Ocean
What are the causes and consequences of hydrological alteration to Amazon freshwater ecosystems?
Four key ecosystem services

1. Maintenance of species diversity

Amazon fish species

- Described: 2,500
- North America: 1,050
- Asia-Africa: 3,000
2. Filtration, transport, and regulation of flows of water and materials
Four key ecosystem services

3. Carbon processing

River-floodplains $\sim 17$ Mg C ha$^{-1}$ yr$^{-1}$
4. Fish protein production

Sedentary spp: ~10s km

Tributary & floodplain migratory ~100s km

Long-distance migratory spp: ~1,000s km
Four key ecosystem services

4. Fish protein production

Per Capita Fish consumption rates

- Urban = 40 kg/yr
- Riverine = 94 kg/yr
Three main drivers of hydrological alteration
Dams

Natural conditions

- Evaporation
- Discharge

Natural flow variability, seasonality, and floods

Post-dam conditions

- Reservoir water storage
- Increased evaporation
- Decreased discharge

Decreased flow variability, altered seasonality, reduced floods
Land cover change

<table>
<thead>
<tr>
<th>Natural conditions</th>
<th>Local deforestation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ET</td>
<td>Decreased ET</td>
</tr>
<tr>
<td>Rainfall</td>
<td>Unchanged rainfall</td>
</tr>
<tr>
<td>Discharge</td>
<td>Increased discharge</td>
</tr>
<tr>
<td>Runoff</td>
<td>Increased runoff</td>
</tr>
</tbody>
</table>
Mining
Freshwater ecosystems under threat
Several impacts on freshwater ecosystems
Disruption of physical processes

• Biogeochemical processes

Land cover change impacts water quality
Disruption of physical processes

- Biogeochemical processes
- Altered water & sediment transport
Disruption of physical processes

- Biogeochemical processes
- Altered water & sediment transport
- Organic carbon processing
Disruption of physical processes

- Biogeochemical processes
- Altered water & sediment transport
- Organic carbon processing
- Mercury production

\[ \text{MeHg} \]
Disruption of biological processes

- Riparian deforestation
Disruption of biological processes

- Riparian deforestation
  Impacts biodiversity
Disruption of biological processes

- Riparian deforestation
  Impacts biodiversity

- Altered seasonal flow variability
  Alters selection of flood tolerant tree spp
  Alters primary productivity
Disruption of biological processes

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  Impacts lateral migrations by animals
Disruption of biological processes

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- Dam reservoirs create lentic habitats

- Threatens specialist endemic species
- Favors generalist species
- Alters assemblage structure

Impacts biodiversity
Disruption of biological processes

- Riparian deforestation
  - Impacts biodiversity

- Altered seasonal flow variability
  - Alters selection of flood tolerant tree spp
  - Alters primary productivity
  - Impacts lateral migrations by animals

- Dam reservoirs create lentic habitats

- Reduced fishery yields

Fish migratory strategies
Available policies are insufficient
Protected areas ignore hydrological connectivity
Land-use policy

- Improved law enforcement
- Changes in soy & beef supply chains
- Limited access to credit
- Increase in protected areas

Water resources legislation

Brazil’s as an example

Establishes:

• water as finite
• various uses
• vulnerable to human use
• Management at scale catchment area
• Management decentralized & participatory
Water resources legislation

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Three major deficiencies

1. Constrained by country borders
2. Focused on H₂O, not ecosystems
3. Mostly unimplemented
Environmental licensing of dams

In Brazil, aim is “to ensure that constructed dams are economically attractive with minimum environmental and social impacts”

• Inventory and viability study
• Environmental impact assessment
• Environmental impact report
• Approval → Public hearings
• Preliminary licenses
• Installation licenses
Environmental licensing of dams

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Four major deficiencies

1. Exception for dams < 10 MW
2. Species inventories not ecological studies
3. Conflicts of interest
   - Companies pay for impact studies
   - Results subject to “approval”
4. Vulnerable to external pressures

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The Way Forward

Catchment-based Framework for the Conservation of Freshwater Ecosystems

Basin-wide Integrated Strategy Implemented in All Amazonian Countries

Protected areas

Land use policy

Water resource legislation

Licensing of dams
Thank you!

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