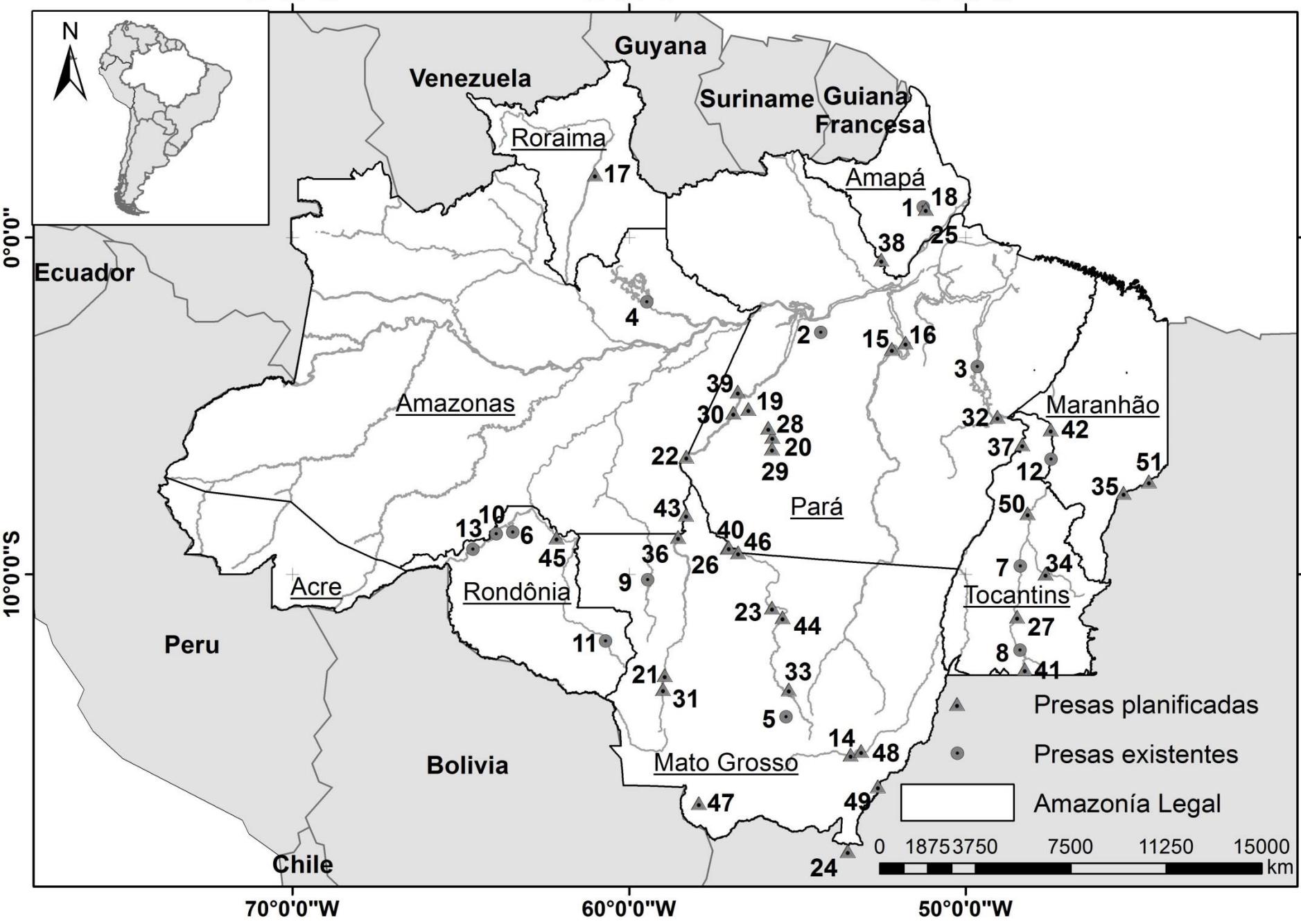


Brazil's Amazonian rivers dammed

Philip M. Fearnside

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Instituto Nacional de Pesquisas da Amazônia (INPA)

<http://philip.inpa.gov.br>

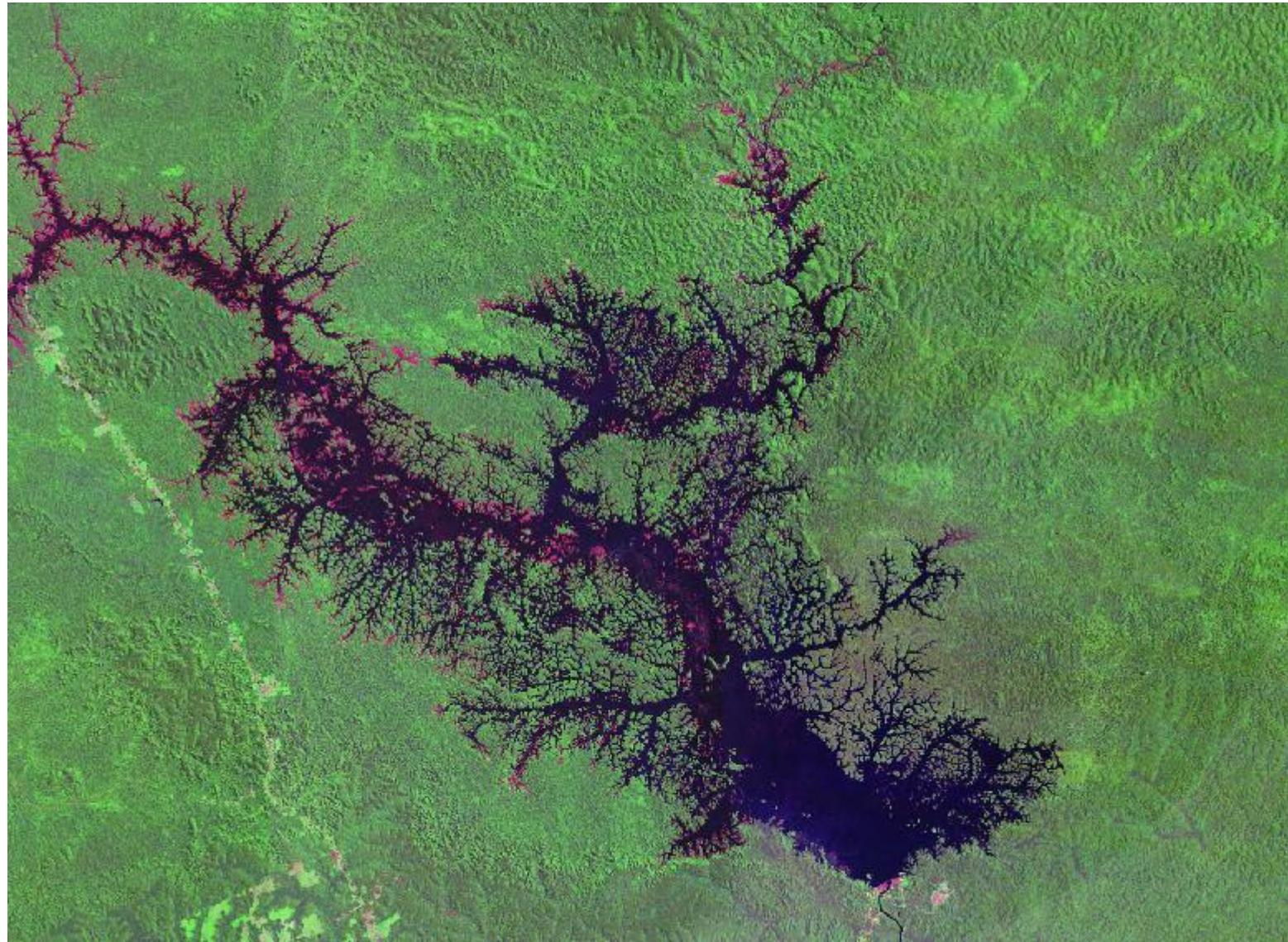


BALBINA DAM

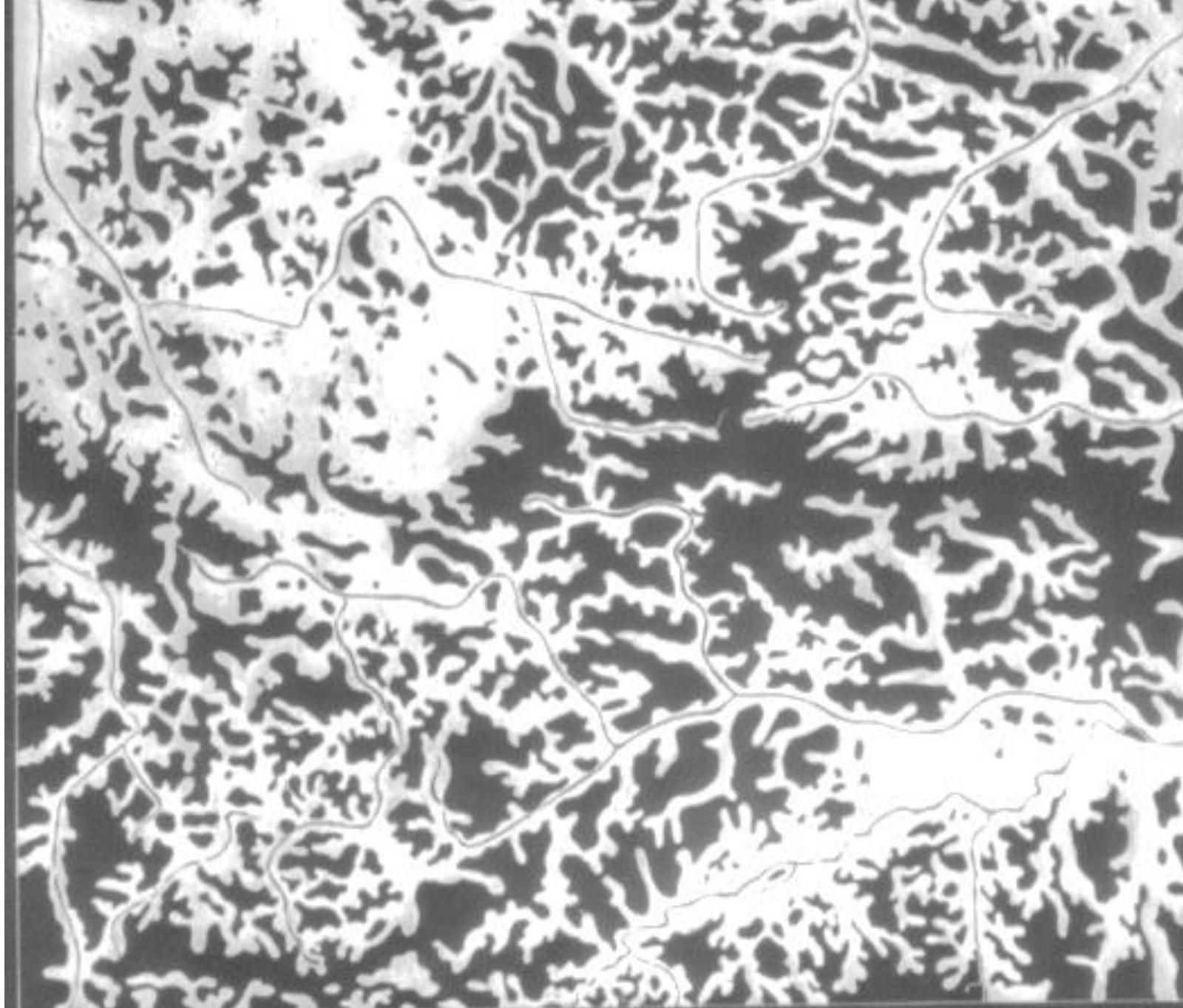


Photo P.M. Fearnside

Balbina Dam



Feitosa et al., 2015



Fearnside, 1989



Foto P.M. Fearnside

Balbina Dam



Photo P.M. Fearnside

WAIMIRI ATROARI



Ministério das Minas e Energia
Eletrobras dy Companhia Eletrica Brasileira SA
 Eletronorte
Companhia Eletrica do Norte do Brasil SA



PHILIP FEARNSIDE

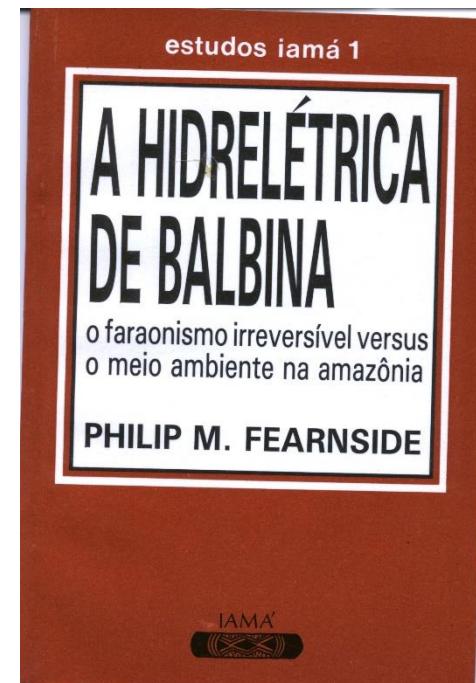
O Genocídio dos Waimiri-Atroari: um possível reconhecimento histórico.

Amazônia Real, 12 de março de 2018.

<http://amazoniareal.com.br/o-genocidio-dos-waimiri-atroari-um-possivel-reconhecimento-historico/>

Fearnside, P.M. 1989. **Brazil's
Balbina Dam: Environment
versus the legacy of the
pharaohs in Amazonia.**

Environmental Management 13(4):
401-423. doi: 10.1007/BF01867675



Tucurui Dam



Tucurui Dam, Brazil (Photo: Goldenconure.org)

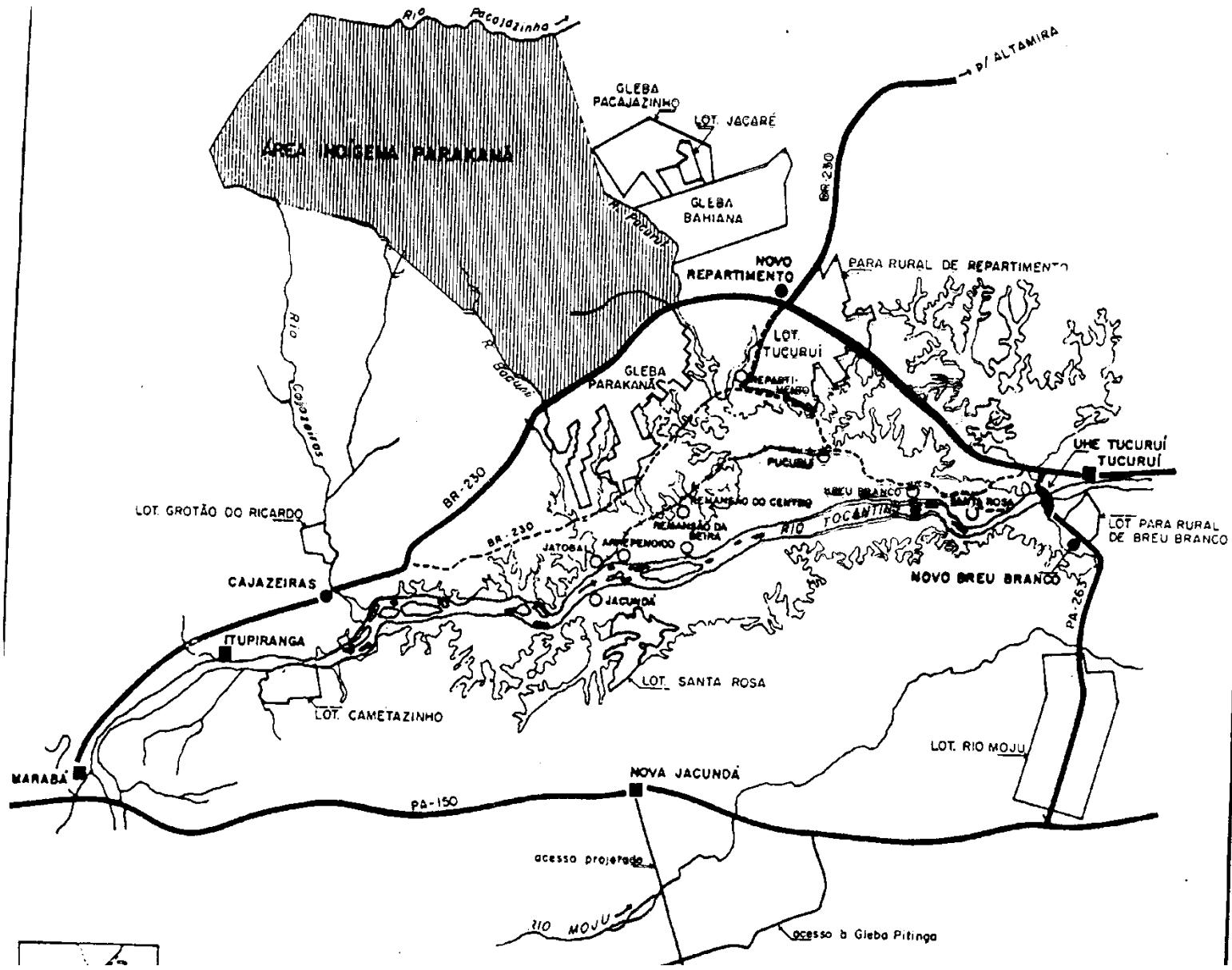




Foto P.M. Fearnside 1991



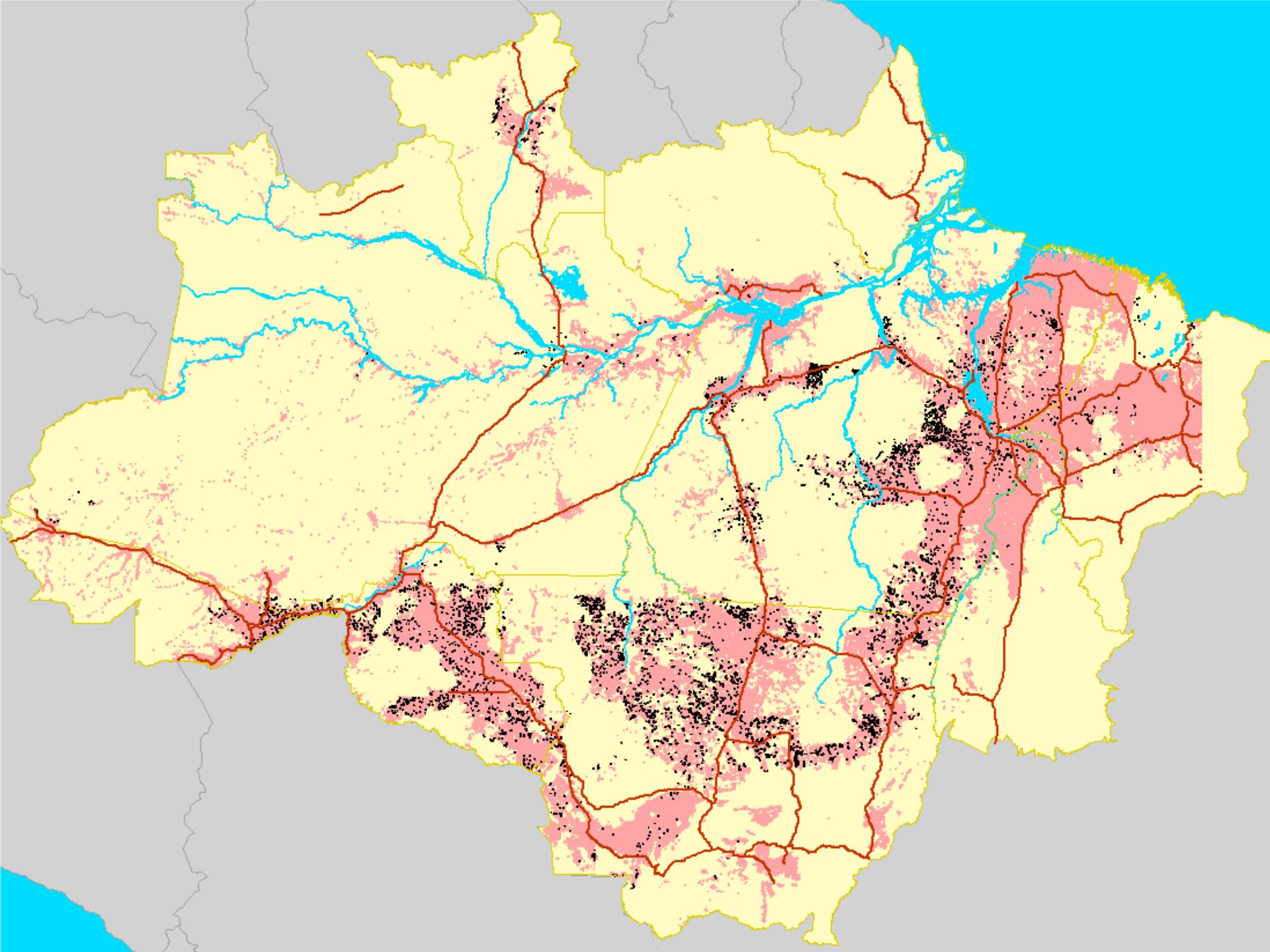
Foto P.M. Fearnside 1991



Foto P.M. Fearnside 1991



Foto P.M. Fearnside 1991





Google Earth image showing deforestation around Parakanã in the state of Pará in the Brazilian Amazon.

Environmental Impacts of Brazil's Tucuruí Dam: Unlearned Lessons for Hydroelectric Development in Amazonia

PHILIP M. FEARNSIDE

National Institute for Research in the Amazon (INPA)
C.P. 478
69011-970 Manaus, Amazonas, Brazil

defoliants used to prevent regrowth along the transmission line. Mitigation measures included archaeological and faunal salvage and creation of a "gene bank" on an island in the reservoir. Decision-making in the case of Tucuruí was virtually uninfluenced by environmental studies, which were done con-

Social Impacts of Brazil's Tucuruí Dam

PHILIP M. FEARNSIDE

Instituto Nacional de Pesquisas da Amazônia (INPA)
C.P. 478
69011-970 Manaus, Amazonas, Brazil

ABSTRACT / The Tucuruí Dam, which blocked the Tocantins River in 1984 in Brazil's eastern Amazonian state of Pará, is a continuing source of controversy. Most benefits of the power

go to aluminum smelting companies, where only a tiny amount of employment is generated. Often presented by authorities as a model for hydroelectric development because of the substantial power that it produces, the project's social and environmental impacts are also substantial. Examination of Tucuruí reveals a systematic overestimation of benefits and underestimation of impacts as presented by authorities. Tucuruí offers many as-yet unlearned lessons for hydroelectric development in Amazonia.

Consequências da Cheia Histórica na UHE Santo Antônio



Rebaixamento
do Reservatório

Desligamento
das turbinas
por restrição
hídrica

Inundação de
parte do Canteiro

Rompimento do
Log bom

Alteamento de
ensecadeiras de
jusante

Acumulo de
Sedimento na
tomada d'água

Problemas de
Vedaçāo dos Eixos
da Turbina



Photo: Russ Mittermeier.

Após 5 meses, corpo de ativista é achado em lago da usina Jirau (RO)



...

Folha de São Paulo, 25 de junho de 2016, p. A-8.

<http://www1.folha.uol.com.br/poder/2016/06/1784814-apos-5-meses-corpo-de-ativista-e-achado-em-lago-da-usina-jirau-ro.shtml>

...

Fearnside, P.M. 2013. **Decision-making on Amazon dams: Politics trumps uncertainty in the Madeira River sediments controversy.** *Water Alternatives* 6(2): 313-325. <http://www.water-alternatives.org/index.php/alldoc/articles/vol6/v6issue2/218-a6-2-15/file>

Fearnside, P.M. 2014. **Brazil's Madeira River dams: A setback for environmental policy in Amazonian development.** *Water Alternatives* 7(1): 156-169. <http://www.water-alternatives.org/index.php/alldoc/articles/vol7/v7issue1/244-a7-1-15/file>

Fearnside, P.M. 2014. **Impacts of Brazil's Madeira River dams: Unlearned lessons for hydroelectric development in Amazonia.** *Environmental Science & Policy* 38: 164-172
<https://doi.org/10.1016/j.envsci.2013.11.004>

Belo Monte Dam

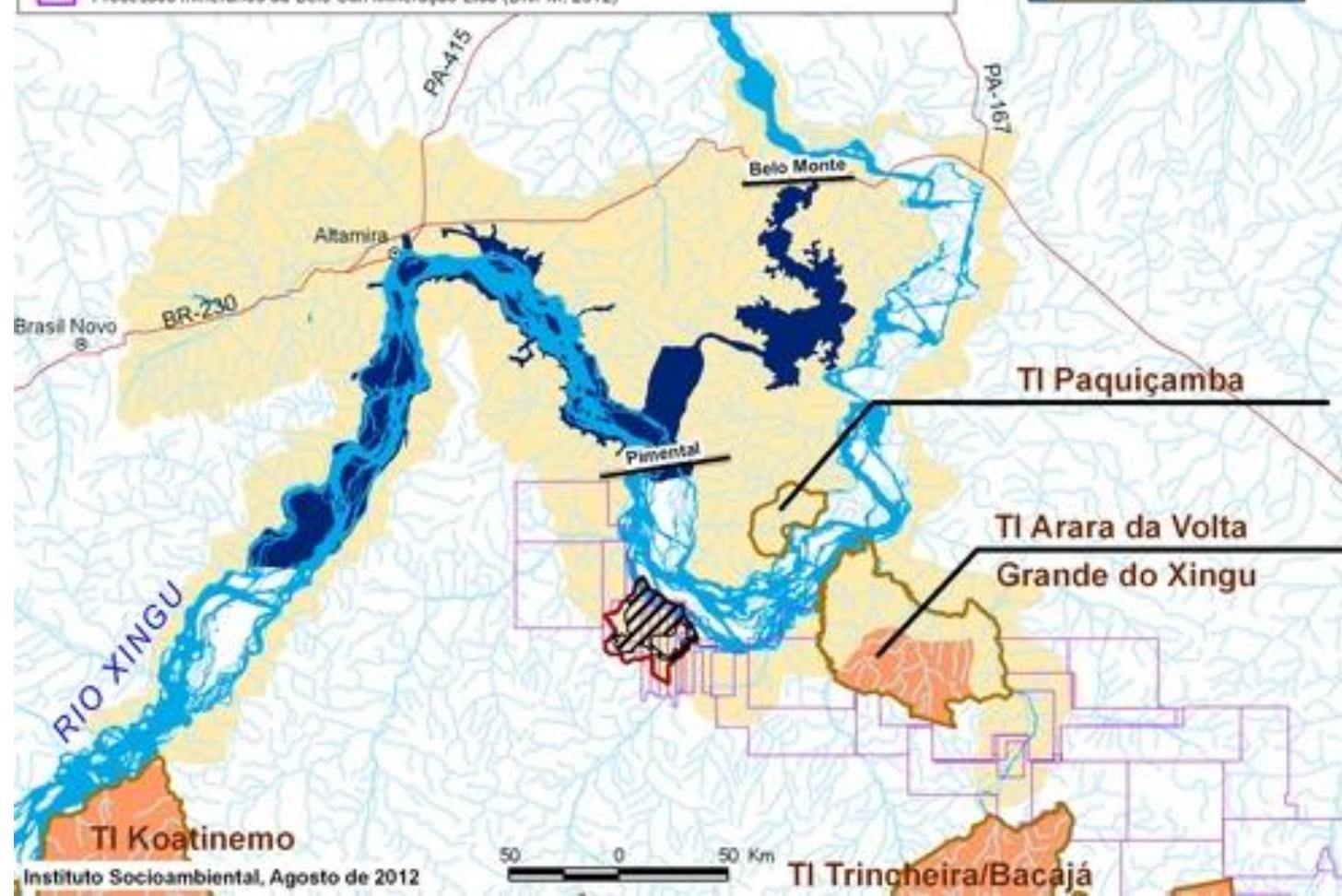


Foto P.M. Fearnside



Borges, 2015

- Municípios (IBGE, 2010)
- Hidrografia (IBGE 2010)
- Rodovia (IBGE 2010)
- Terra Indígena (ISA, 2012)
- Localização aproximada das barragens
- Área de Inundação Aproximada (EIA/RIMA - AHE Belo Monte, 2009)
- Área de Influência Indireta -meio físico, biótico e antrópico da Belo Sun (RIMA projeto Volta Grande, 2012)
- Área de Influência Direta da Belo Sun (RIMA projeto Volta Grande, Belo Sun, 2012)
- Área de Influência Direta da Belo Monte (EIA/RIMA - AHE Belo Monte, 2008)
- Processos minerários da Belo Sun Mineração Ltda (DNPM, 2012)



Instituto Socioambiental, Agosto de 2012

ISA, 2012

Volta Grande do Rio Xingu



Watts, 2019. Foto Fábio Erdos/The Guardian <https://bitly.co/55W8>

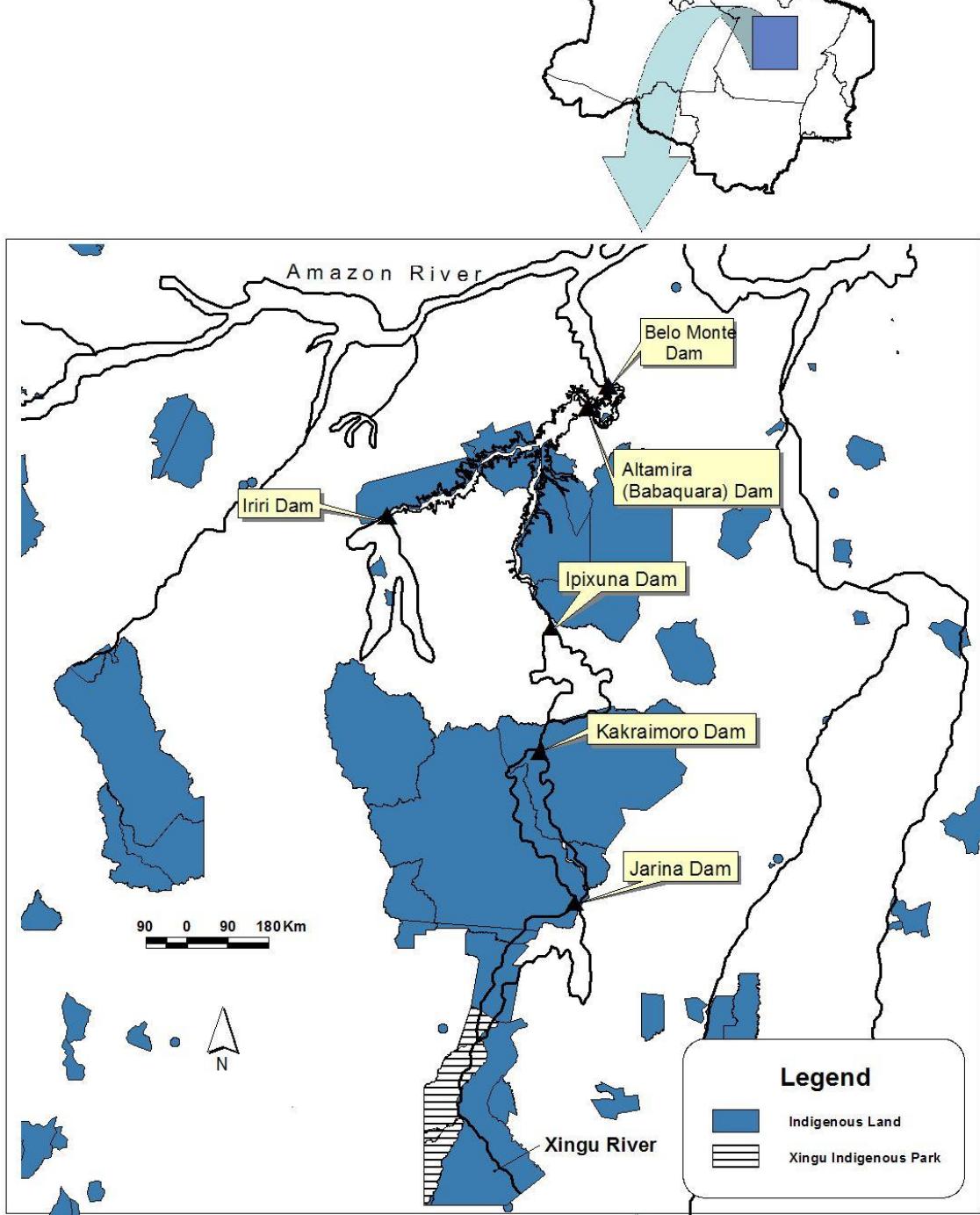
<https://news.mongabay.com/2021/06/brazils-belo-monte-dam-struggle-for-the-volta-grande-enters-a-new-phase-commentary/>

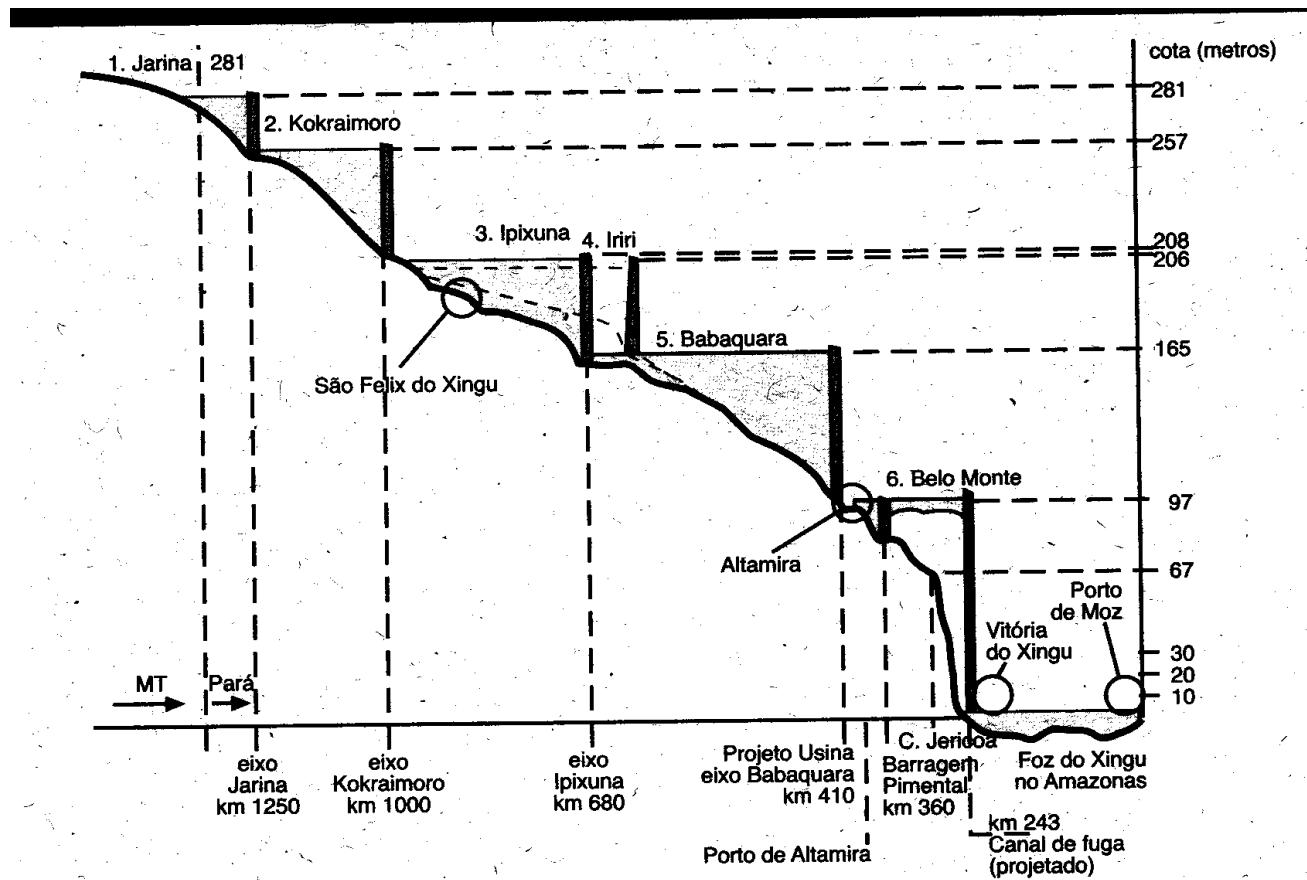


Brazil's Belo Monte Dam: Struggle for the Volta Grande enters a new phase (Commentary)

by [Philip Fearnside](#) on 21 June 2021







<https://news.mongabay.com/2021/02/brazils-belo-monte-dam-greenwashing-contested-commentary/>



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Brazil's Belo Monte Dam: Greenwashing contested (commentary)

by [Philip M. Fearnside](#) on 1 February 2021



Fearnside, P.M. 2017. **Belo Monte: Actors and arguments in the struggle over Brazil's most controversial Amazonian dam.** *Die Erde* 148 (1): 14-26
<https://doi.org/10.12854/erde-148-27>

Fearnside, P.M. 2017. **Brazil's Belo Monte Dam: Lessons of an Amazonian resource struggle.** *Die Erde* 148 (2-3): 167-184. <https://doi.org/10.12854/erde-148-46>.

Fearnside, P.M. 2017. **Planned disinformation: The example of the Belo Monte Dam as a source of greenhouse gases.** pp. 125-142. In: Liz-Rejane Issberner & Philippe Lena (eds.) *Brazil in the Anthropocene: Conflicts between Predatory Development and Environmental Policies*. Routledge, Taylor & Francis Group, New York, U.S.A. 364 pp



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SECRETARIA DE PLANEJAMENTO E DESENVOLVIMENTO ENERGÉTICO

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Plano Decenal de Expansão de Energia

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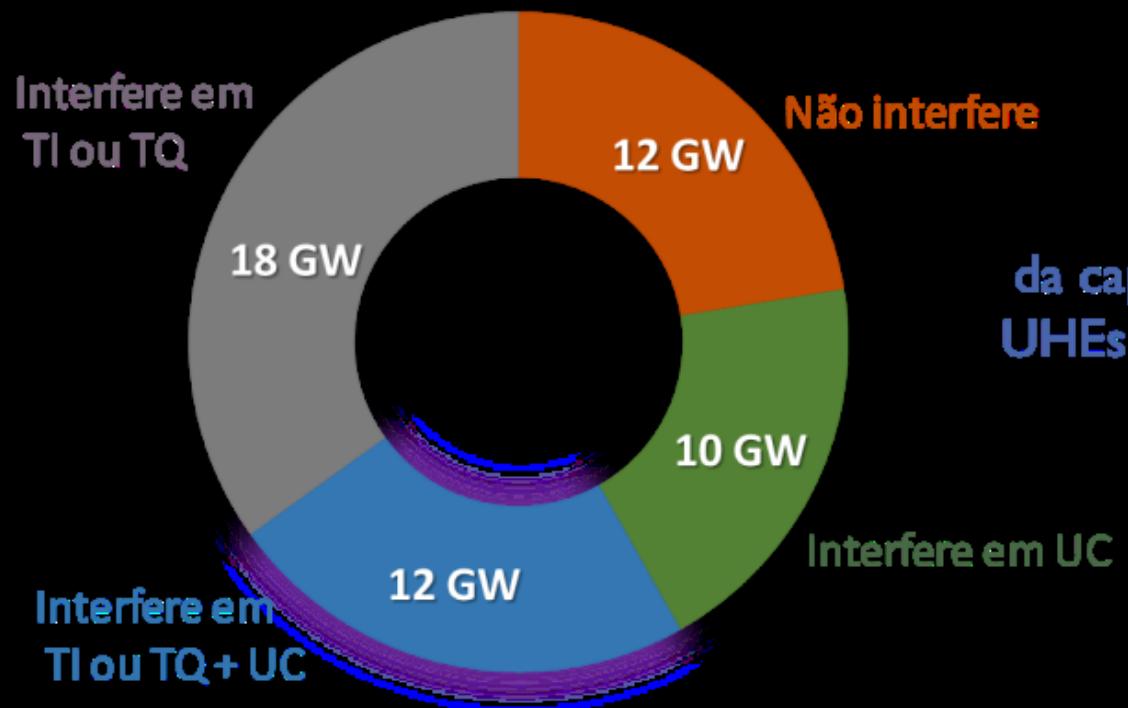
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Potencial hidrelétrico e interferência em áreas protegidas



23%

da capacidade potencial de
UHEs não sobrepõe a áreas
protegidas



DIE ERDE

Journal of the
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of Berlin

Vol. 152, No. 3 · Opinion article

Brazilian government violates Indigenous rights: What could induce a change?

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[https://doi.org/10.12854/erde-2021-584.](https://doi.org/10.12854/erde-2021-584)

<https://doi.org/10.1126/science.abj4924>



-

LETTERS

Brazil's doomed environmental licensing

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Lucas Ferrante²,

Philip M. Fearnside³

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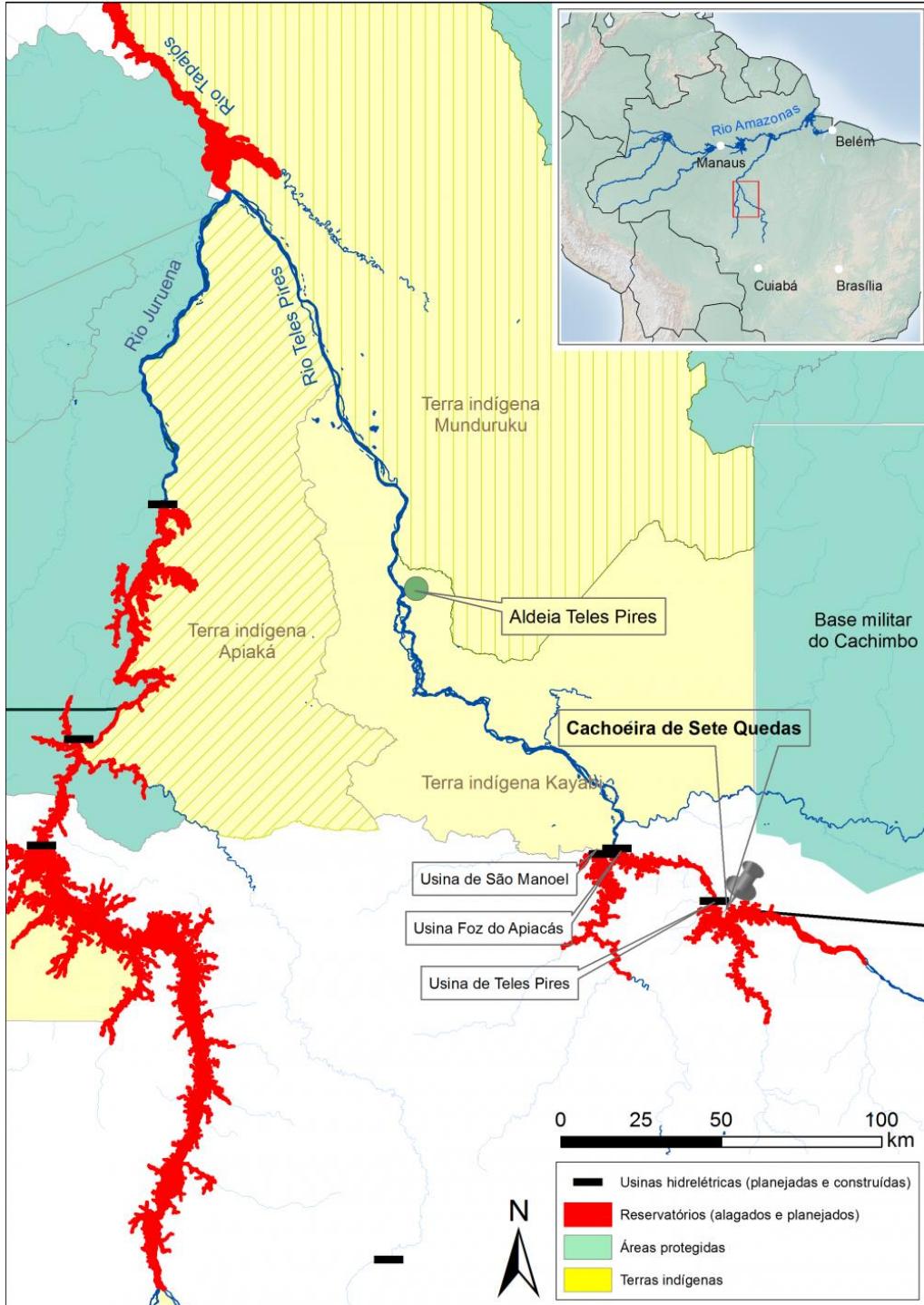
* Corresponding author. Email: renataruaro@utfpr.edu.br

Science 04 Jun 2021:

Vol. 372, Issue 6546, pp. 1049-1050

DOI: 10.1126/science.abj4924

São Manoel



Mapa por Maurício Torres

<https://news.mongabay.com/2017/09/amazon-dam-defeats-brazils-environment-agency-commentary/>



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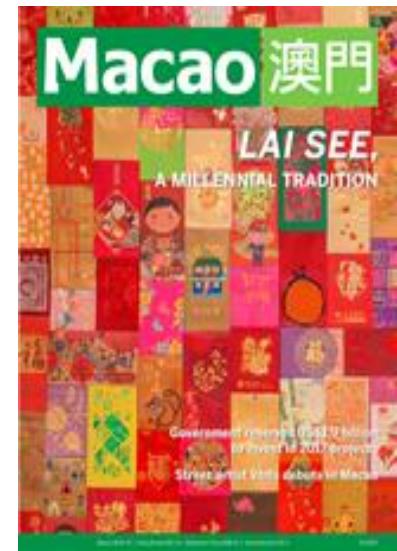
Amazon dam defeats Brazil's environment agency (commentary)

Commentary by Philip Fearnside on 20 September 2017



Energias de Portugal sells assets in Brazil to China Three Gorges

NOVEMBER 12TH, 2014



<http://www.macauhub.com.mo/en/2014/11/12/energias-de-portugal-sells-assets-in-brazil-to-china-three-gorges/>

<https://news.mongabay.com/2019/03/brazils-sinop-dam-flouts-environmental-legislation-commentary/>



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Brazil's Sinop Dam flouts environmental legislation (Commentary)

Commentary by Philip M. Fearnside on 1 March 2019



SIEMENS

• CENTRO GERAL CARGA
DE ENERG. CC-GE •

Foto P.M. Farnside



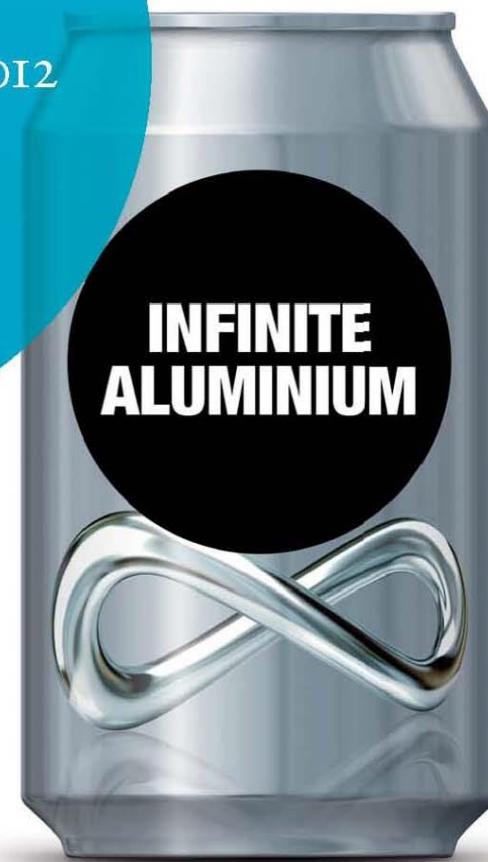
Foto P.M. Fearnside



Foto: Paulo Jares



Annual Report – 2012



04.

Sustainable Development



Agroforestry Project – Seedlings for Reforestation and Aluminum Ingots
Photo by permission of Mineração Rio do Norte S.A – MRN and Alcoa Alumínio S.A.

**ABAL sustainability report
2006**

Fearnside, P.M. 2016. **Environmental and social impacts of hydroelectric dams in Brazilian Amazonia: Implications for the aluminum industry.** *World Development* 77: 48-65. <https://doi.org/10.1016/j.worlddev.2015.08.015>

Fearnside, P.M. 2020. **Environmental justice and Brazil's Amazonian dams.** pp. 85-126. In: N.A. Robins & B. Fraser (eds.), *Landscapes of Inequity: The Quest for Environmental Justice in the Andes/Amazon Region.* University of Nebraska Press, Lincoln, NE, U.S.A. 414 pp.



Figure 4 Bubbles in a tributary in Santo
Antônio.

(Grandin 2012, p. 14)

Hydroelectric Dams in the Brazilian Amazon as Sources of 'Greenhouse' Gases

by

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National Institute for Research in Amazonia (INPA),
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Brazil

INTRODUCTION

Hydroelectric dams are commonly believed to have no serious impact on the 'greenhouse effect', in contrast to fossil-fuel use. However, the principal reason for this frequent assumption is ignorance regarding the emissions of hydroelectric dams. Reservoirs in Brazilian Amazonia (Legal Amazon) contribute to 'greenhouse' gas emissions from the region, although contributions from currently existing reservoirs are small relative to other anthropogenic sources such as deforestation for cattle pasture. The four existing 'large' (> 10 megawatt [MW]) dams in the region are: Balbina in the State of Amazonas (filled in 1987),

Little basis exists for calculating emissions from reservoirs. However, existing information can be organized in such a way as to draw the best possible conclusions given the limitations of our knowledge. The present paper



FIG. 1. Brazil's Legal Amazon region (shaded in inset maplet) with the four existing large dams.

“It’s baloney and it’s much overblown ... Methane is produced quite substantially in the rain forest and no one suggests cutting down the rain forest.”

Karolyn Wolf, spokesperson for the US National Hydropower Association responding to reports of greenhouse gas emissions from reservoirs, 1995.

Greenhouse-gas emissions from Amazonian hydroelectric reservoirs: the example of Brazil's Tucurú Dam as compared to fossil fuel alternatives

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Date submitted: 8 January 1997 Date accepted: 7 April 1997

DOI: 10.1080/0305904970946956

Environmental Impacts of Brazil's Tucurú Dam: Unlearned Lessons for Hydroelectric Development in Amazonia

PHILIP M. FEARNSIDE

*National Institute for Research in the Amazon (INPA),
C.P. 478,
69011-970 Manaus, Amazonas, Brazil*

detonants used to prevent regrowth along the transmission line. Mitigation measures included archaeological and faunal salvage and creation of a "gene bank" on an island in the reservoir. Decision-making in the case of Tucurú was virtually uninfluenced by environmental studies, which were done con-

GREENHOUSE GAS EMISSIONS FROM A HYDROELECTRIC RESERVOIR (BRAZIL'S TUCURÚ DAM) AND THE ENERGY POLICY IMPLICATIONS

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GREENHOUSE GAS EMISSIONS FROM HYDROELECTRIC RESERVOIRS IN TROPICAL REGIONS

LUIZ PINGUELLI ROSA¹, MARCO AURELIO DOS SANTOS^{1*},
BOHDAN MATVIENKO², EDNALDO OLIVEIRA DOS SANTOS¹ and
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³*Construmaq, C.P. 717, São Carlos SP, 13560-970, Brazil*

SCIENTIFIC ERRORS IN THE FEARNSIDE COMMENTS ON GREENHOUSE GAS EMISSIONS (GHG) FROM HYDROELECTRIC DAMS AND RESPONSE TO HIS POLITICAL CLAIMING

LUIZ PINGUELLI ROSA¹, MARCO AURÉLIO DOS SANTOS²,
BOHDAN MATVIENKO³, ELIZABETH SIKAR⁴
and EDNALDO OLIVEIRA DOS SANTOS⁵

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Climatic Change 75(1-2): 91-102. (2006)

GREENHOUSE GAS EMISSIONS FROM HYDROELECTRIC DAMS: REPLY TO ROSA ET AL.

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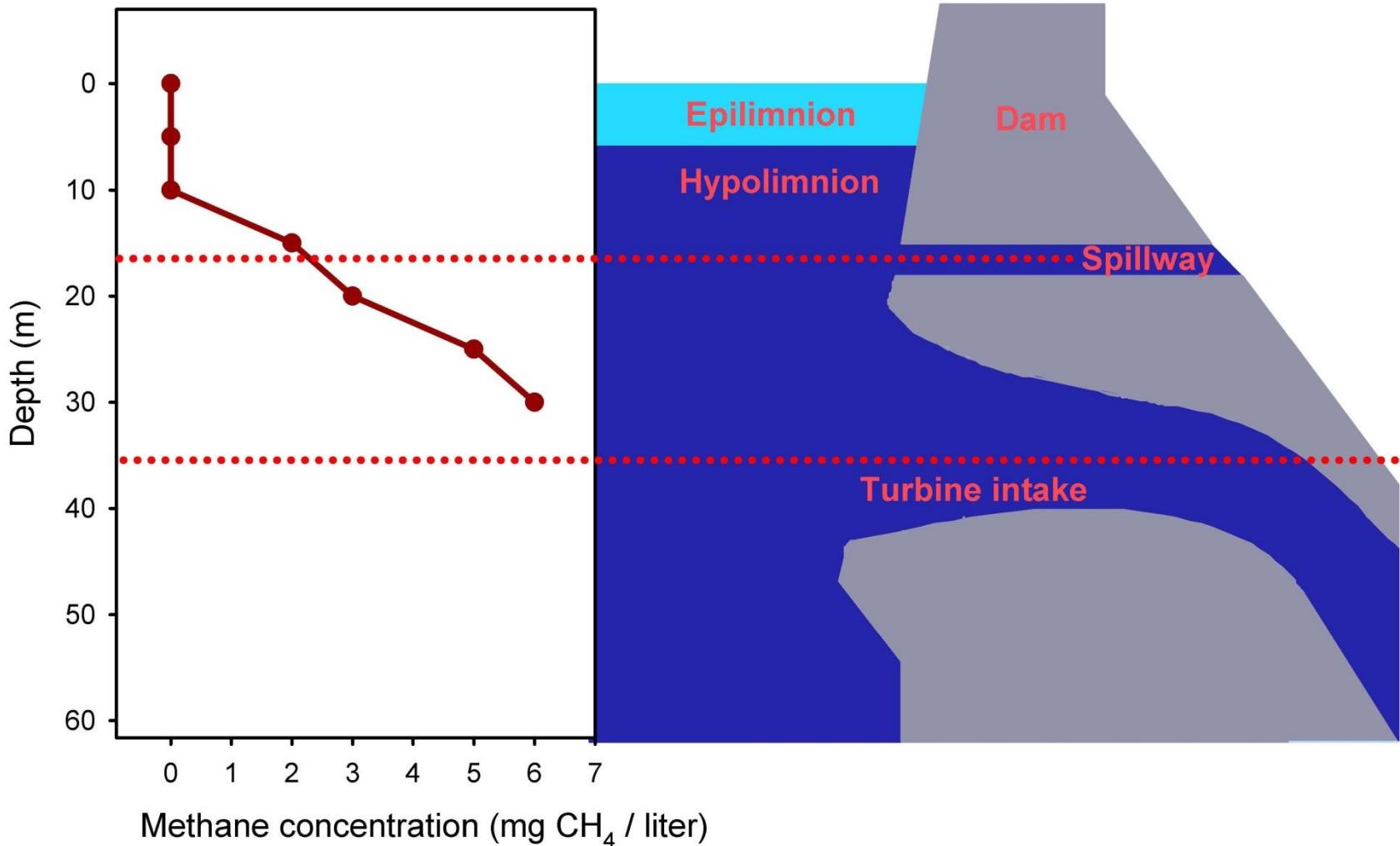
Climatic Change 75(1-2): 103-109. (2006)

Tucurui Dam



Tucuruí Foto: Museu Virtual de Tucuruí.

Tucurui Dam



Fearnside, P.M. & S. Pueyo. 2012. Underestimating greenhouse-gas emissions from tropical dams. *Nature Climate Change* 2(6): 382–384.
<https://doi.org/10.1038/nclimate1540>

Tucurui



Photo P.M. Fearnside

COMMENTARY:

Greenhouse-gas emissions from tropical dams

Philip M. Fearnside and Salvador Pueyo

Emissions from tropical hydropower are often underestimated and can exceed those of fossil fuel for decades.

Tropical hydroelectric dams, such as those in Amazonia, emit significant amounts of greenhouse gases, especially methane^{1–4}. These emissions have been underestimated or ignored in many global and national greenhouse-gas accounts. If any justification is given for omitting all or part of these emissions, it is usually that they are controversial, uncertain or with no consensus⁵. However, although uncertainty regarding the quantities emitted is substantial⁶, dam emissions need to be included in all accounting based on the best

available data and calculation methods. Much of the wide variation in the emissions ascribed to tropical dams stems from omissions and errors in accounting, rather than from the physical measurements that are nevertheless also subject to methodological problems.

The fact that substantial emissions are involved can hardly be considered uncertain, having been measured directly at reservoirs such as Balbina in Brazil² and Petit Saut in French Guiana¹. Dam emissions are of two types: reservoir surface or upstream emissions and those from the water that

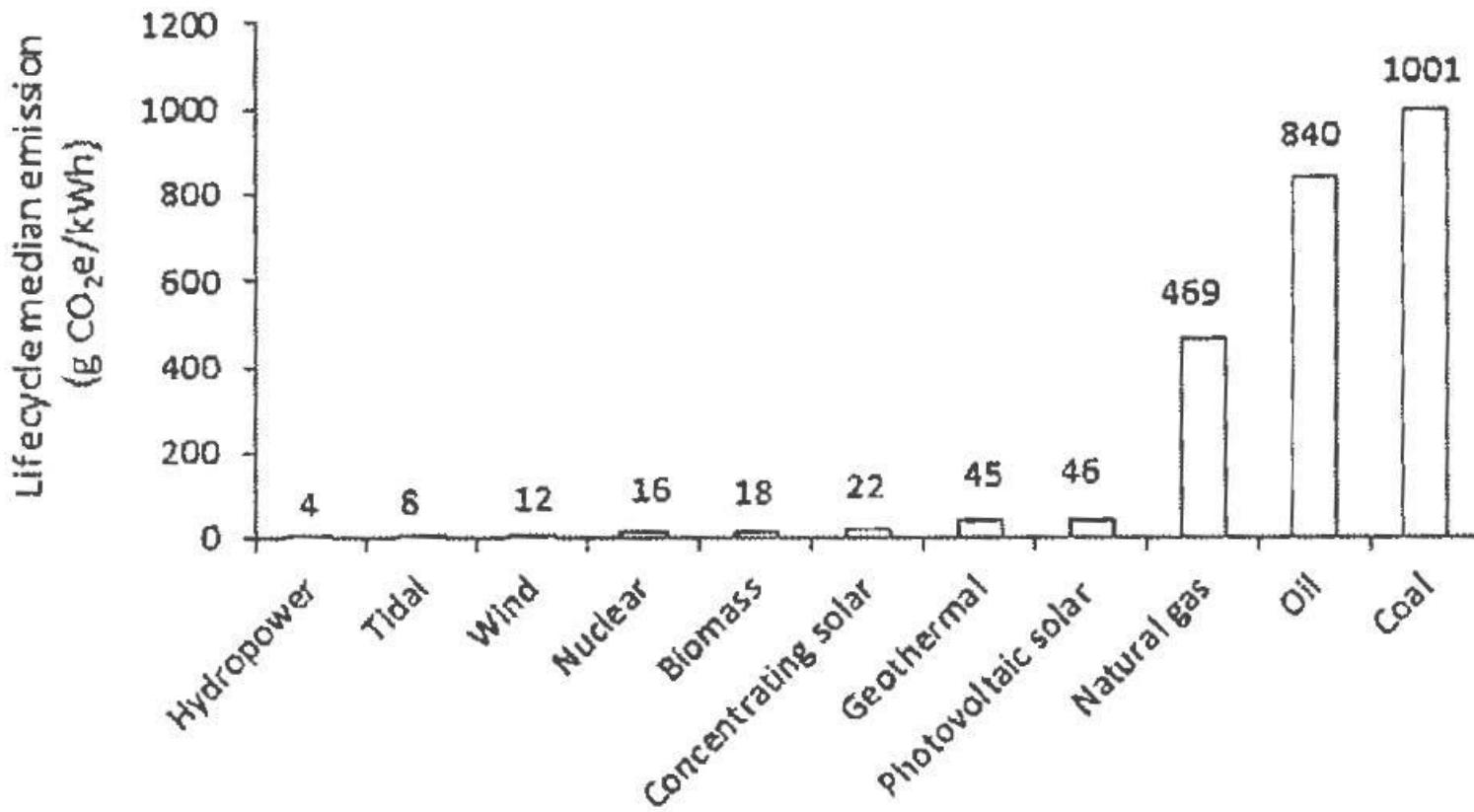
passes through the turbines and spillways (degassing or downstream emissions). Where dam emissions are counted, they often include only the upstream emissions, as in estimates by Centrais Elétricas Brasileiras S.A. (Eletrobrás)⁷. The recent Intergovernmental Panel on Climate Change special report on renewable energy reviews life-cycle assessments for various technologies and, for the typical case (the 50th percentile), ranks hydro as having half the impact or less compared with any other source including solar, wind and ocean energy⁵. The basis in

Global warming potential of methane

	Years	GWP
Kyoto Protocol	100	21
Paris Agreement	100	28
IPCC AR6	100	27.2
	20	80.8
“Basket”	50	

Renewable Energy Sources and Climate Change Mitigation

Special Report of the Intergovernmental Panel on Climate Change



Data from:

IPCC (Intergovernmental Panel on Climate Change). (2011) Renewable Energy Sources and Climate Change Mitigation: Special Report of the Intergovernmental Panel on Climate Change. Edenhofer O, Madruga RP, Sokona Y, Seyboth K, Eickemeier P, Matschoss P, Hansen G, Kadner S, Schlammer S, Zwickel T von Stechow C (eds), Cambridge University Press, Cambridge, UK, 1075 pp [available at: http://www.ipcc.ch/pdf/special-reports/srren/srren_full_report.pdf] p. 982.



Available online at www.sciencedirect.com

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Emissions from tropical hydropower and the IPCC



Philip M. Fearnside*

National Institute for Research in Amazonia (INPA), Av André Araújo, 2936, 69067-375 Manaus-Amazonas, Brazil

doi: 10.1016/j.envsci.2015.03.002



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Fearnside, P.M. 2013. **Carbon credit for hydroelectric dams as a source of greenhouse-gas emissions: The example of Brazil's Teles Pires Dam.**

Mitigation and Adaptation Strategies for Global Change 18(5): 691-699.

Fearnside, P.M. 2013. **Credit for climate mitigation by Amazonian dams: Loopholes and impacts illustrated by Brazil's Jirau Hydroelectric Project.** *Carbon Management* 4(6): 681-696.

Fearnside, P.M. 2015. **Tropical hydropower in the Clean Development Mechanism: Brazil's Santo Antônio Dam as an example of the need for change.** *Climatic Change* 131(4): 575-589. <https://doi.org/10.1007/s10584-015-1393-3>

Chapter 20

Drivers and impacts of changes in aquatic ecosystems



Pescadores vendem peixes frescos em suas canoas, no centro de Manaus (Foto: Bruno Kelly/Amazônia Real)

20.13 Recommendations

- No more Amazon dams with installed capacity ≥ 10 MW should be built. Dams with installed capacity < 10 MW for a single town or village can be built with proper environmental licensing and using a risk-based approach. Rather than building Amazonian dams, energy policy should prioritize electricity conservation, halt exports of electro-intensive products and redirect investment in new electricity generation to wind and solar sources.



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PHILIP M. FEARNSIDE

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HIDRELÉTRICAS NA AMAZÔNIA

IMPACTOS AMBIENTAIS E SOCIAIS
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