

Amazon projects pose risks to Brazil and the World

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The 29th Conference of the Parties of the United Nations climate convention (COP 29) was marked by many promises in Baku, Azerbaijan. These annual meetings attempt to address the unfolding climate crisis, and the talks this year left many crucial issues unresolved. In recent years, a series of climate-fueled disasters and extreme events such as Australian bushfires, drought and fires in the Amazon, floods in southern Brazil, Hurricane Milton in the Gulf of Mexico, and North American and Spanish floods have wreaked havoc across the world. The continued upward trajectory of greenhouse gas emissions suggests that the window for limiting warming to 1.5 degrees Celsius (°C) above the preindustrial average may already have closed, given that we have already reached that record temperature in 2024 (Ripple et al. 2024).

Unlike major global powers (such as the United States, China, and European Union countries), whose main contributors to greenhouse gas emissions are the burning of fossil fuels, deforestation is the main source of emissions in developing countries that still have large amounts of tropical forest cover, such as Brazil, Bolivia, Peru, Indonesia, and the Democratic Republic of Congo. Tropical forests store about 229 billion tons of carbon in their aboveground live woody vegetation (Baccini et al. 2012), and the conservation of these areas is vital for the mitigation of climate change (Pereira et al. 2024). The Amazon, the world's largest rainforest, plays a crucial role in climate stability. The Brazilian portion of the region stores an estimated 59 billion tons of carbon in the vegetation aboveground (Nogueira et al. 2015), whereas the other countries store roughly 20 billion tons (Fearnside and Silva 2023). Stocks in the soil are even greater, with 93 billion tons just in the top meter in the whole of Amazonia (Quesada et al. 2011). Brazil, which holds over 60% of the Amazon rainforest, plays a vital role in containing global warming and could lead the global climate agenda if it complements its current deforestation control measures with reversal of its many policies and plans that imply increased future emissions.

Brazil is making efforts to reduce deforestation and implement its National Energy Transition Policy (Governo Brasileiro 2024). The estimated deforestation rate in the Brazilian Amazon for the period from August 2023 to July 2024 was 6288 square kilometers, representing a reduction of 30.6% compared with the previous 12-month period and marking the lowest rate in the last 9 years (INPE 2024). However, these data only include clearcutting the forest (i.e., deforestation) and exclude the forest degradation caused by selective logging and the very intense fires that occurred during the same period. In addition to the slowdown in loss of Amazon forest, the clearing of Cerrado also decreased. These positive

changes reflect the results command-and-control operations by Brazil's Ministry of Environment and Climate Change. Buoyed by these encouraging results, at COP 29 Brazil presented a revised Nationally Determined Commitment (NDC), promising to reduce the country's emissions by 59%–67% by 2035 relative to the country's emission in 2005 (a year with very high deforestation). Although it was announced as “ambitious,” conflicting government actions risk making this goal entirely unattainable (ClimaInfo 2024a). The Brazilian government's current plans contradict the official narrative by supporting three fatal mistakes in the Amazon: oil extraction at the mouth of the Amazon River (figure 1a), rebuilding 407 kilometers of the BR-319 (Manaus–Porto Velho) highway (figure 1b, 1c), and the construction of 933 kilometers of the Ferrogrão Railway (Sinop–Miritituba; figure 1d).

Fossil fuels

Petrobras, Brazil's government oil company, expects to receive a license soon to drill for oil in the mouth of the Amazon River (figure 1a). IBAMA (the executive agency responsible for implementing environmental policy in Brazil) denied Petrobras's drilling request in May 2023, pointing out a series of adjustments that the company make to obtain the license. Oil drilling in the mouth of the Amazon River could have devastating consequences because of the region's status as a socially and environmentally sensitive area. This activity could affect the Great Amazon Reef System, an ecosystem that supports corals, sponges, and fish communities, which is highly fragile and poorly studied and plays an important role in maintaining the planet's ecological balance (Rodrigues 2023). Oil extraction could affect Indigenous peoples, *quilombolas* (communities of descendants of escaped enslaved Africans), and other traditional communities in Brazil and the Guianas.

Establishing a new oil field in the mouth of the Amazon River, as with other planned offshore fields along Brazil's coast and in the Amazon forest, implies continued extraction for decades to come, when the world must halt its use of fossil fuels for energy. Even the International Energy Agency, which is usually on the other side of environmental issues, has concluded that no new oil or gas fields should be initiated anywhere in the world, restricting extraction to already existing fields and reducing it to zero by 2050 (IEA 2021).

It is inconsistent for Brazil, a country that claims to support the goal of limiting global warming to 1.5°C, to aspire to be the last country in the world to cease extracting oil, which is now the government's plan (ClimaInfo 2024b). With respect to the proposed drilling in the mouth of the Amazon, President Lula has said that

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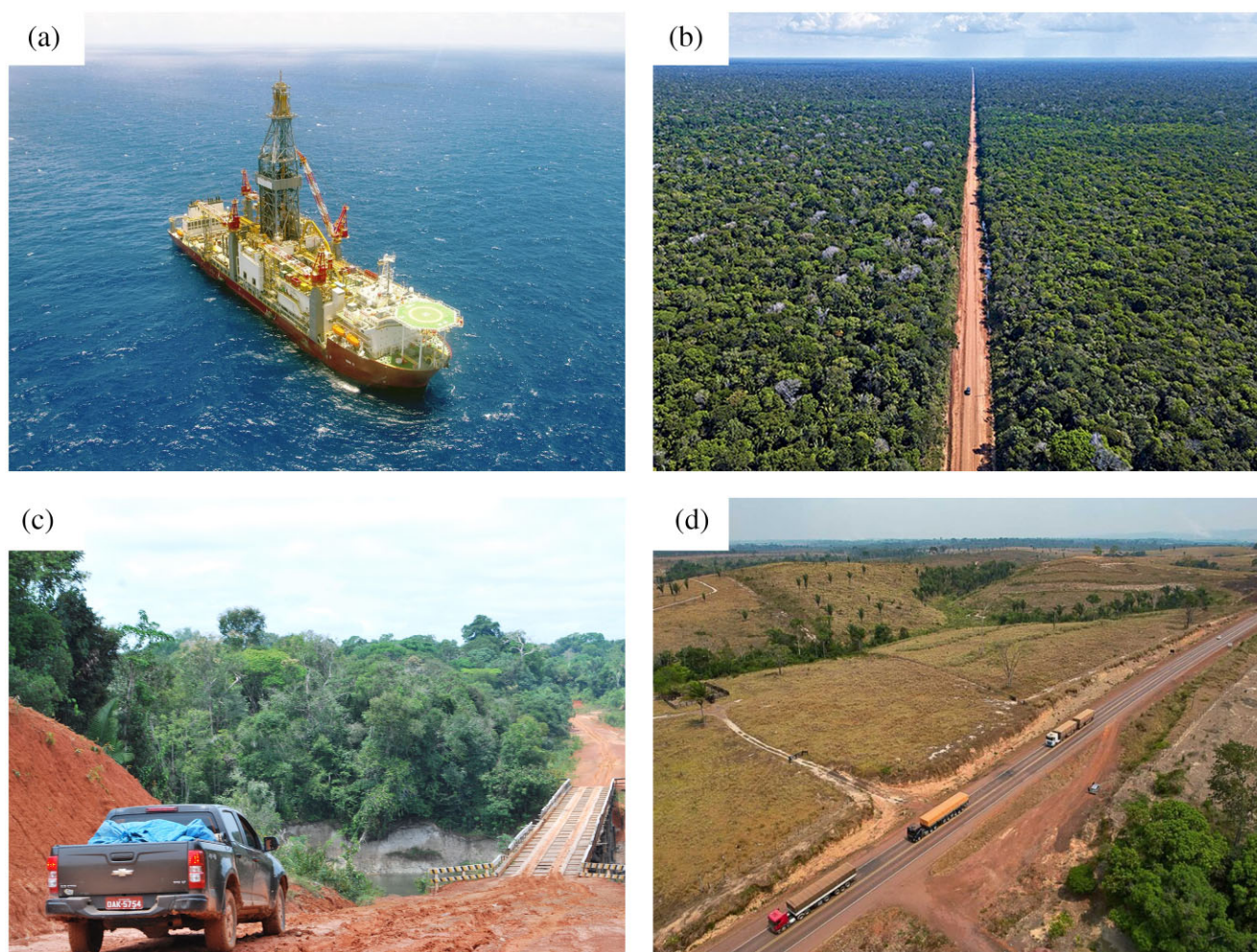


Figure 1. Brazil's hat trick for Amazon destruction. (a) Drillship sent to drill Poço Pitu Oeste, in Rio Grande do Norte. Oil extraction in the mouth of the Amazon River contradicts the promise of an energy transition. (b–c) Rebuilding 407 kilometers of the BR-319 (Manaus–Porto Velho) highway, which, together with existing and planned roads connected to it, would expose approximately half of what remains of Brazil's Amazon rainforest to the entry of deforesters. (d) The movement of trucks along BR-163, a highway to which the Ferrogrão railway is planned to be built adjacent. To build Ferrogrão, the government wants to increase the width of the BR-163 highway, cutting down more trees and affecting Indigenous lands and conservation units. Photographs: (a) Acervo Foresea, (b) Lalo de Almeida/Folhapress, (c) Philip Martin Fearnside, (d) Alberto César Araújo/Amazônia Real.

"We will not throw away any opportunity to make this country grow" (Vieceli and Nogueira 2024). Since Brazil will always want to grow, this represents a license to extract oil forever.

Highways and railways

The Brazilian Ministry of Transportation wants to rebuild 407 kilometers of the BR-319 highway (Manaus–Porto Velho; figure 1b, and 1c). BR-319, together with the existing and planned roads connected to it, would expose approximately half of what remains of the Brazilian Amazon rainforest to the entry of deforesters (Fearnside 2022). Once the roads are opened, providing access to these areas, most of what happens is beyond the government's control, regardless of political discourse on plans for "governance" (Fearnside 2024).

The Ministry of Transportation also wants to build the 933-kilometer Ferrogrão railway, which would connect the soy-producing region of Sinop, Mato Grosso, to the Port of Miritituba in the state of Pará, paralleling the BR-163 (Santarém–Cuiabá) highway (figure 1d; Killeen 2023). The Climate Policy Initiative has es-

timated that the project would cause 2043 square kilometers of deforestation (Araújo et al. 2020). Like BR-319, Ferrogrão has not yet received an installation license and lacks the legally required consultations with affected Indigenous peoples.

Except for the Ministry of Environment and Climate Change, essentially all of the rest of the Brazilian government acts to increase deforestation. The largest area of government land not designated for a particular use is in the area that would be opened by the planned roads associated with BR-319, and the National Institute of Colonization and Agrarian Reform intends to legalize land claims in such undesignated land (Vilani and Ferrante et al. 2023), a practice that is a major driver of Brazil's Amazon deforestation (Fearnside 2017). President Lula has even said he plans to create a shelf of such land for distribution (Machado 2023).

Both BR-319 and its planned side roads, such as AM-366, cross one of the best-preserved parts of the Amazon. These projects will be harmful to Indigenous peoples and to biodiversity (figure 1b–1d). They may contribute to the emergence of new pandemics, because the region is one of the largest reservoirs of pathogens in

the world (Ferrante 2024). Deforesting the area in question puts important ecosystem services at risk, such as the supply of water vapor to the winds known as *flying rivers* that maintain rainfall in the southern and southeastern regions of the country, including cities such as São Paulo (Zemp et al. 2014, Fearnside 2021), and may also influence the rainfall regime of neighboring countries such as Bolivia, Paraguay, and Argentina.

Although the forest near the southern edge of the Amazon is already losing its carbon stock (Gatti et al. 2021), projected climate change threatens much wider areas of forest, including those along BR-319 and the planned side roads that would open the vast forest area west of the highway (Flores et al. 2024). Stress on the forest in this area from drought and heat could cross tipping points beyond which the forest collapses, and this would be greatly aggravated by deforestation, logging, and fire associated with the planned roads.

The severe drought in Amazonia caused by the El Niño and the Atlantic dipole phenomena in 2023 and 2024 has been a strong contributor to forest degradation, both from tree mortality from temperature and hydraulic stress and from understory forest fires. Brazil's announced reduction of deforestation does not include forest degradation, which increases not only when the trees die or during fires but also in the following years as the dead trees decay. Even without the dramatic recent drought, emissions from Amazon forest degradation equal or exceed those from deforestation (Lapola et al. 2023).

All of this could lead to greenhouse gas emissions sufficient to push the global climate past a tipping point (Fearnside and Silva 2023). The loss of the Amazon forest would be a critical contribution to a positive feedback loop that could lead to tipping points for other ecosystems, such as coral reefs and permafrost (McKay et al. 2022). Therefore, by indirectly affecting these ecosystems, projects in the Amazon could jeopardize the zero-emission commitments of nations such as Canada, the United States, Russia, European Union countries, South Africa, China, and Australia, which will face even greater challenges in containing the destruction of their ecosystems.

Conclusions

This hat trick jeopardizes Brazil's environmental efforts and its aspiration to become a global leader in this area. We warn that, if this happens, Brazil will fail to meet its emissions reduction targets and could frustrate the net-zero plans of several nations around the world. Opening the heart of the Amazon to land grabbing, deforestation, logging, and fire would release carbon stocks that could be critical in pushing global climate past a tipping point. Prolonging fossil fuel extraction does the same, contradicting the promise of an energy transition. Brazil would be one of the biggest victims if global warming escapes control, starting with the loss of the largest and most diverse tropical region in the world and its role in providing ecosystem services vital to people's lives.

Data Availability

All data are incorporated into the article.

Author contributions

Cássio Cardoso Pereira conceived the ideas; Cássio Cardoso Pereira and Philip Martin Fearnside led the writing of the

manuscript. All authors contributed critically to the drafts and gave final approval for publication.

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References cited

- Araújo R, Assunção J, Bragança A. 2020. *The Environmental Impacts of the Ferrogrão Railroad: An Ex-Ante Evaluation of Deforestation Risks*. Climate Policy Initiative (13 March 2020). www.climatepolicyinitiative.org/publication/the-environmental-impacts-of-the-ferrograo-railroad.
- Baccini A, et al. 2012. Estimated carbon dioxide emissions from tropical deforestation improved by carbon-density maps. *Nature Climate Change* 2: 182–185.
- ClimaInfo. 2024a. Que NDC é essa? Nova meta climática do Brasil decepciona. *ClimaInfo* (10 November 2024). <https://climainfo.org.br/2024/11/10/que-ndc-e-essa-nova-meta-climatica-do-brasil-decepciona>.
- ClimaInfo. 2024b. Petrobras quer estar entre as produtoras de petróleo em 2050: Diz Tolmasquim. *ClimaInfo* (1 December 2024). <https://climainfo.org.br/2024/12/01/petrobras-quer-estar-entre-as-produtoras-de-petroleo-em-2050-diz-tolmasquim>.
- Fearnside PM. 2017. Deforestation of the Brazilian Amazon. Pages XXX in Shugart H, ed. *Oxford Research Encyclopedia of Environmental Science*. Oxford University Press. <https://doi.org/10.1093/acrefore/9780199389414.013.102>
- Fearnside PM. 2021. Lessons from Brazil's São Paulo droughts (commentary). *Mongabay* (30 July 2021). <https://news.mongabay.com/2021/07/lessons-from-brazils-sao-paulo-droughts-commentary/>.
- Fearnside PM. 2022. Amazon environmental services: Why Brazil's highway BR-319 is so damaging. *Ambio* 51: 1367–1370.
- Fearnside PM. 2024. Impactos da rodovia BR-319 –9: O discurso de governança. *Amazônia Real* (26 June 2024). <https://amazoniareal.com.br/impactos-da-rodovia-br-319-9-o-discurso-de-governanca>.
- Fearnside PM, Silva RA. 2023. Amazon region hit by trio of droughts in grim snapshot of the century to come. *Conversation* (22 November 2023). <https://theconversation.com/amazon-region-hit-by-trio-of-droughts-in-grim-snapshot-of-the-century-to-come-217652>.
- Ferrante L. 2024. A road to the next pandemic: The consequences of Amazon highway BR-319 for planetary health. *Lancet Planetary Health* 8: e524–e525.
- Flores BM, et al. 2024. Critical transitions in the Amazon forest system. *Nature* 626: 555–564.
- Gatti LV, et al. 2021. Amazonia as a carbon source linked to deforestation and climate change. *Nature* 595: 388–393.
- Governo Brasileiro. President Lula launches National Energy Transition Policy, expected to bring BRL 2 trillion in investment. *Planalto*

- (22 November 2024). www.gov.br/planalto/en/latest-news/2024/08/president-launches-national-energy-transition-policy-expected-to-bring-brl-2-trillion-in-investment.
- [IEA] International Energy Agency. 2021. Net zero by 2050: A roadmap for the global energy sector. IEA. <https://iea.blob.core.windows.net/assets/ad0d4830-bd7e-47b6-838c-40d115733c13/NetZeroBy2050-ARoadmapfortheGlobalEnergySector.pdf>.
- [INPE] Instituto Nacional de Pesquisas Espaciais. Estimativa de Desmatamento na Amazônia Legal para 2024 é de 6.288 km². INPE. https://data.inpe.br/big/web/wp-content/uploads/2024/11/NT_Amz_tx_Prodes2024_T.pdf.
- Killeen TJ. 2023. Infrastructure in the Pan Amazon: Railroad development. *Mongabay* (21 September 2023). <https://news.mongabay.com/2023/09/infrastructure-in-the-pan-amazon-railroad-development>.
- Lapola DM, et al. 2023. The drivers and impacts of Amazon forest degradation. *Science* 379: eabp8622.
- Machado R. 2023. Lula fala em criar “prateleira” de terras improdutivas para evitar invasões. *Folha de São Paulo* (27 June 2023). www1.folha.uol.com.br/poder/2023/06/lula-fala-em-criar-prateleira-de-terras-improdutivas-para-evitar-invasoes-de-terra.shtml.
- McKay ADI, Staal A, Abrams JF, Winkelmann R, Sakschewski B, Loriani S, Fetzer I, Cornell SE, Rockström J, Lenton TM. 2022. Exceeding 1.5°C global warming could trigger multiple climate tipping points. *Science* 377: eabn7950.
- Nogueira EM, Yanai AM, Fonseca FO, Fearnside PM. 2015. Carbon stock loss from deforestation through 2013 in Brazilian Amazonia. *Global Change Biology* 21: 1271–1292. <https://doi.org/10.1111/gcb.12798>.
- Pereira CC, et al. 2024. Scientists’ warning: Six key points where biodiversity can improve climate change mitigation. *BioScience* 74: 315–318.
- Quesada CA, Lloyd J, LO A, Fyllas NM, Schwarz M, Czimczik CI. 2011. Soils of Amazonia with particular reference to the RAINFOR sites. *Biogeosciences* 8: 1415–1440.
- Ripple WJ, et al. 2024. The 2024 state of the climate report: Perilous times on planet Earth. *BioScience* 74: 812–824.
- Rodrigues M. 2023. Oil from the Amazon? Proposal to drill at river’s mouth worries researchers. *Nature* 619: 680–681.
- Vieceli L, Nogueira I. 2024. Lula volta a defender exploração de petróleo na margem equatorial. *Folha De São Paulo* (12 June 2024). www1.folha.uol.com.br/ambiente/2024/06/lula-volta-a-defender-exploracao-de-petroleo-na-margem-equatorial.shtml.
- Vilani MR, Ferrante L, Fearnside PM. 2023. The first acts of Brazil’s new president: Lula’s new Amazon institutionalization. *Environmental Conservation* 50: 148–151.
- Zemp DC, Schleussner C-F, Barbosa HMJ, Van Der Ent RJ, Donges JF, Heinke J, Sampaio G, Rammig A. 2014. On the importance of cascading moisture recycling in South America. *Atmospheric Chemistry and Physics* 14: 13337–13359.