Amazonian forest degradation must be incorporated into the COP26 agenda

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To the Editor – Nations will reaffirm their commitment to reducing greenhouse gas (GHG) emissions during the 26th United Nations Climate Change Conference (COP26; www.ukcop26.org), in Glasgow, Scotland, in November 2021. Revision of the national commitments will play a key role in defining the future of Earth's climate. In past conferences, the main target of Amazonian nations was to reduce emissions resulting from land-use change and land management by committing to decrease deforestation rates, a well-known and efficient strategy[1,2]. However, human-induced forest degradation caused by fires, selective logging, and edge effects can also result in large carbon dioxide (CO_2) emissions[1–5], which are not yet explicitly reported by Amazonian countries. Despite its considerable impact, forest degradation has been largely overlooked in previous policy discussions[5]. It is vital that forest degradation is considered in the upcoming COP26 discussions and incorporated into future commitments to reduce GHG emissions.

Human-induced forest degradation is the main driver of socio-environmental impoverishment[6,7] in Amazonia, and its extent is increasing[8]. Degraded forests currently occupy an area larger than that which has been deforested[8,9]. During the 2003-2015 period in the Brazilian Amazon, CO_2 committed emissions from forest fires[1] (5,904 Tg) and edge effects[2] (2,068 Tg) reached 88% of the gross deforestation emissions [1] (9,108 Tg) (Fig. 1). Aggravating this scenario, the CO_2 emissions resulting from degradation are not all immediate. Degraded forests continue to emit more CO_2 than they absorb for many years, becoming significant carbon sources[2,10]. It is critically important for all Amazonian countries to halt these emissions. This requires reporting the whole range of CO_2 emissions to the United Nations Framework Convention on Climate Change (UNFCCC), including forest degradation. If any emission source is ignored or underestimated, then the calculated amount of mitigation needed will be insufficient to prevent global warming.

Quantifying the carbon losses attributable to degradation processes is a difficult task. There are considerable uncertainties associated with degraded-forest area estimates and how each type of disturbance affects carbon fluxes. These uncertainties, however, can be reduced by combining field measurements[7,10] with an ever-increasing array of remote-sensing datasets and methods that since 2005[5] have enhanced our capacity to perform large-scale monitoring of degradation processes across both space and time dimensions[1–4,8,9]. Improved spatio-temporal estimates of forest degradation can provide valuable information to better identify and quantify degradation-related carbon emissions. More accurate and realistic models would benefit not only the Brazilian Amazon, but also other tropical forests, directly supporting Reducing Emissions from

Deforestation and Forest Degradation (REDD+) activities to boost the reduction of emissions worldwide.

Effective policies to curb deforestation do not directly address forest degradation[1,2]. In the Brazilian Amazon, while government initiatives and international pressure helped reduce emissions from deforestation[2,11], emissions from forest fires[1] and edge effects[2] increased in the 2005-2015 period. Addressing human-induced degradation requires going beyond identifying and quantifying the different types of disturbance. Above all, new strategies must be established to avoid and offset related emissions, including the sustainable use of forest resources, restoration of degraded old-growth forests[12], and protection of secondary-growth forests[13,14]. These strategies need to be incorporated into national policies and international agreements.

Reducing emissions from land-use and land-cover change will only be effective in supporting sustainable development of the Amazon region if policies address the social, economic, political, and environmental causes of deforestation and degradation. Furthermore, they have to be accompanied by incentives, land management technology, capacity building, provision of alternative income sources, territorial planning and market mechanisms to strengthen the sustainable production chains[15]. To be successful, policies that aim to address both deforestation and forest degradation must incorporate continuous on-the-ground monitoring and accountability for illegal environmental activities.

The impacts of forest degradation have been overlooked in policy discussions for too long. The COP26 discussions present an ideal opportunity to draw attention to these issues and establish much needed new strategies to reduce emissions associated with land-use and land-cover change.

References

1. Aragão, L. E. O. C. *et al.* 21st Century drought-related fires counteract the decline of Amazon deforestation carbon emissions. *Nat. Commun.* **9**, 536 (2018).
2. Silva Junior, C. H. L. *et al.* Persistent collapse of biomass in Amazonian forest edges following deforestation leads to unaccounted carbon losses. *Sci. Adv.* **6**, (2020).
3. Assis, T. O. *et al.* CO2 emissions from forest degradation in Brazilian Amazon. *Environ. Res. Lett.* **15**, 104035 (2020).
4. Harris, N. L. *et al.* Global maps of twenty-first century forest carbon fluxes. *Nat. Clim. Chang.* **11**, 234–240 (2021).
5. Asner, G. P. Selective Logging in the Brazilian Amazon. *Science* **310**, 480–482 (2005).
6. Caviglia-Harris, J. *et al.* Busting the Boom–Bust Pattern of Development in the Brazilian Amazon. *World Dev.* **79**, 82–96 (2016).
7. Barlow, J. *et al.* Anthropogenic disturbance in tropical forests can double biodiversity loss from deforestation. *Nature* **535**, 144–147 (2016).
8. Matricardi, E. A. T. *et al.* Long-term forest degradation surpasses deforestation in the Brazilian Amazon. *Science* **369**, 1378–1382 (2020).
9. Vancutsem, C. *et al.* Long-term (1990–2019) monitoring of forest cover changes in the humid tropics. *Sci. Adv.* **7**, eabe1603 (2021).
10. Silva, C. V. J. *et al.* Estimating the multi-decadal carbon deficit of burned Amazonian forests. *Environ. Res. Lett.* **15**, 114023 (2020).
11. Silva Junior, C. H. L. *et al.* The Brazilian Amazon deforestation rate in 2020 is the greatest of the decade. *Nat. Ecol. Evol.* **5**, 144–145 (2021).
12. Lamb, D. Restoration of Degraded Tropical Forest Landscapes. *Science* **310**, 1628–1632 (2005).
13. Heinrich, V. H. A. *et al.* Large carbon sink potential of secondary forests in the Brazilian Amazon to mitigate climate change. *Nat. Commun.* **12**, 1785 (2021).
14. Smith, C. C. *et al.* Old-growth forest loss and secondary forest recovery across Amazonian countries. *Environ. Res. Lett.* (2021).
15. Stabile, M. C. C. *et al.* Solving Brazil's land use puzzle: Increasing production and slowing Amazon deforestation. *Land Use Policy* **91**, 104362 (2020).

Fig. 1 | Carbon dioxide (CO_2) emissions from deforestation and forest degradation (i.e., forest fires and edge effect) within the Brazilian Amazon. (a) Annual CO_2 emissions. (b) Cumulative CO_2 emissions. To estimate the amount of CO_2 emitted to the atmosphere by deforestation and forest degradation, we compiled data from the literature[1,2] for the 2003-2015 period. The emissions by deforestation and forest fires were obtained directly from Aragão et al. (2018)[1] as annual gross emission of CO_2. Emissions by edge effects were calculated in two steps: (i) annual carbon (C) loss at the 120-m forest edges within the Brazilian Amazon was obtained from Silva Junior et al. (2020)[2]; (ii) then, we multiplied[1] all annual C loss by 3.67 to convert into gross CO_2 emissions.

Competing interests

The authors declare no competing interests.

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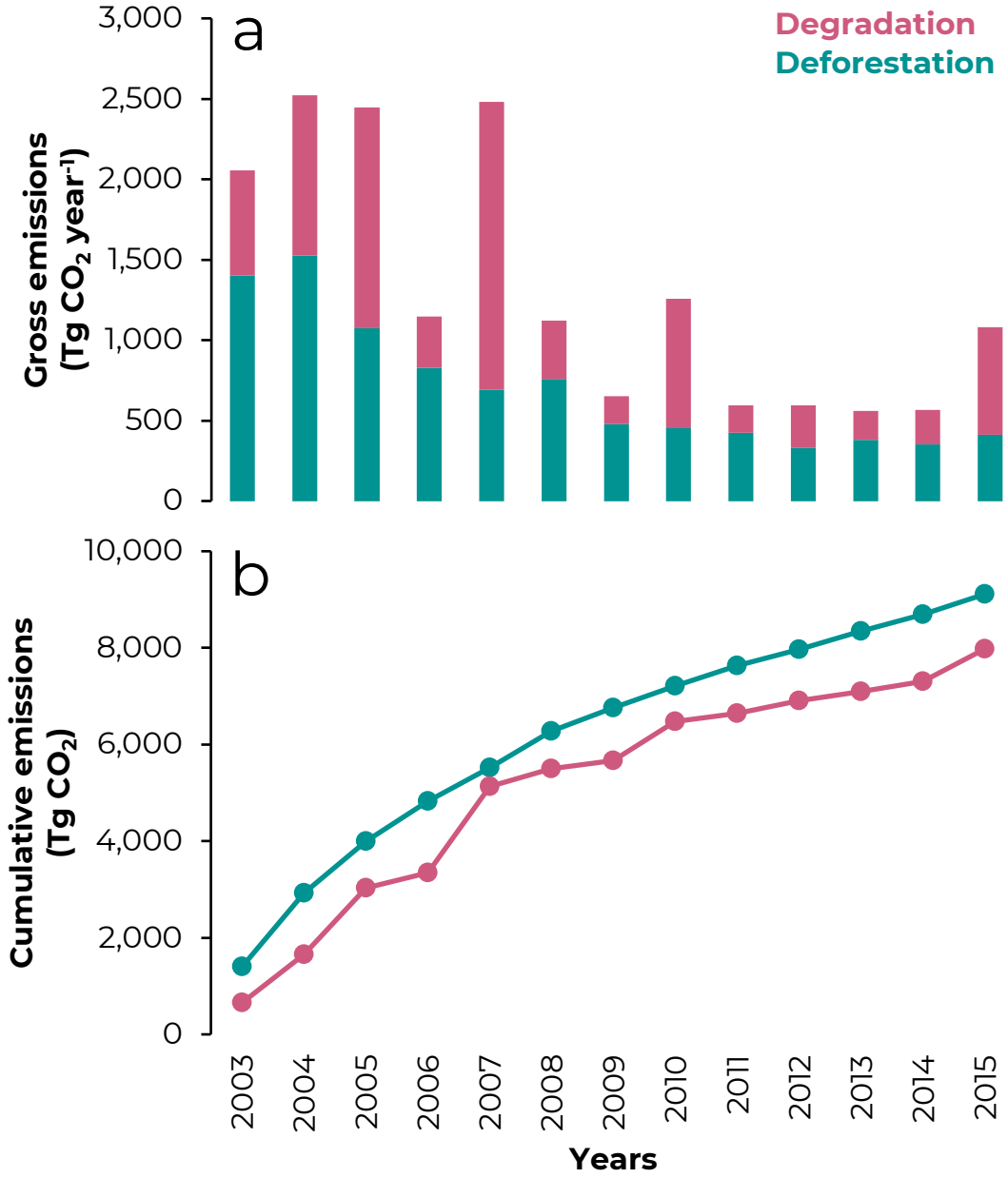
a
Degradation
Deforestation
Gross emissions
(Tg CO2 year-1)
3,000
2,500
2,000
1,500
1,000
500
0
b
Cumulative emissions
(Tg CO2)
10,000
8,000
6,000
4,000
2,000
0
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Years