

## Amazonian forest degradation must be incorporated into the COP26 agenda

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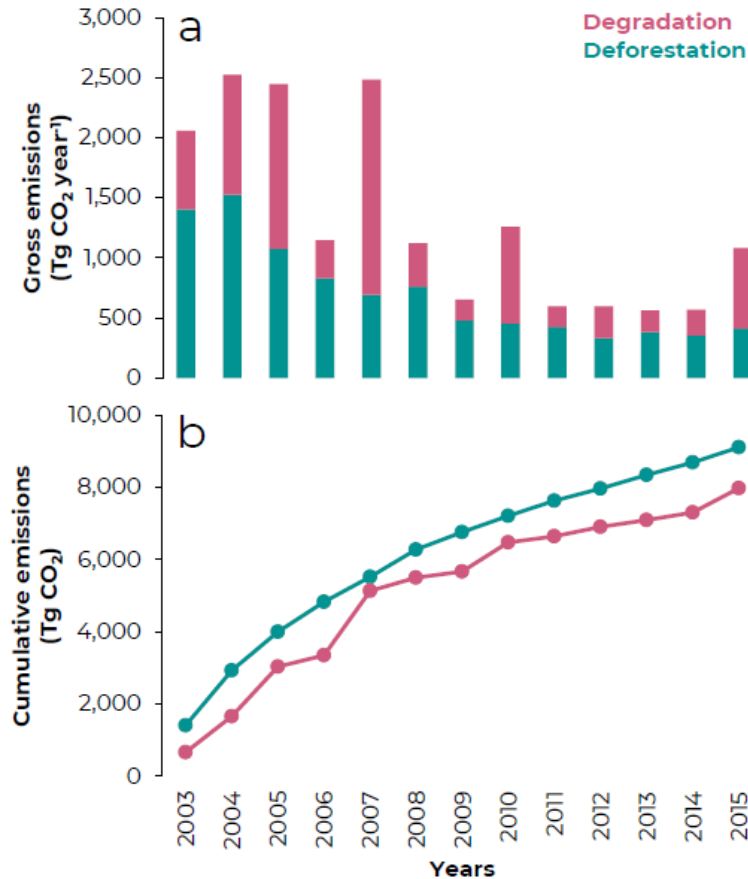
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45 **To the Editor** – Nations will reaffirm their commitment to reducing greenhouse gas (GHG)  
46 emissions during the 26th United Nations Climate Change Conference (COP26;  
47 [www.ukcop26.org](http://www.ukcop26.org)), in Glasgow, Scotland, in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

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

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**Fig. 1 | Carbon dioxide (CO<sub>2</sub>) emissions from deforestation and forest degradation (i.e., forest fires and edge effect) within the Brazilian Amazon.** (a) Annual CO<sub>2</sub> emissions. (b) Cumulative CO<sub>2</sub> emissions. To estimate the amount of CO<sub>2</sub> emitted to the atmosphere by deforestation and forest degradation, we compiled data from the literature<sup>1,2</sup> for the 2003–2015 period. The emissions by deforestation and forest fires were obtained directly from Aragão et al. (2018)<sup>1</sup> as annual gross emission of CO<sub>2</sub>. 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)<sup>2</sup>; (ii) then, we multiplied<sup>1</sup> all annual C loss by 3.67 to convert into gross CO<sub>2</sub> emissions.

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<sup>7,10</sup> with an ever-increasing array of remote-sensing datasets and methods that since 2005<sup>5</sup> have enhanced our capacity to perform large-scale monitoring of degradation processes across both space and time dimensions<sup>1–4,8,9</sup>. 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.

104 Effective policies to curb deforestation do not directly address forest degradation<sup>1,2</sup>. In the  
105 Brazilian Amazon, while government initiatives and international pressure helped reduce  
106 emissions from deforestation<sup>2,11</sup>, emissions from forest fires<sup>1</sup> and edge effects<sup>2</sup> increased in the  
107 2005-2015 period. Addressing human-induced degradation requires going beyond identifying  
108 and quantifying the different types of disturbance. Above all, new strategies must be established  
109 to avoid and offset related emissions, including the sustainable use of forest resources,  
110 restoration of degraded old-growth forests<sup>12</sup>, and protection of secondary-growth forests<sup>13,14</sup>.  
111 These strategies need to be incorporated into national policies and international agreements.

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

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

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