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LETTER TO THE EDITOR

Deforestation falls but rise of wildfires continues degrading Brazilian Amazon forests

In 2023, Brazil has achieved positive environmental advances in the Amazon. Preliminary official deforestation rates are down to 9000 km^2—a fall of 22% compared with 2022 (Portal TerraBrasilis [INPE], 2023), total fire counts are down by 16% when comparing 2023 versus 2022, and of those, the specific recent deforestation fires have dropped an impressive 70% between the same period (Portal TerraBrasilis [INPE], 2023). These achievements are attributed to the re-establishment of environmental policy implementation under new Brazilian administration (Mendes, 2023). Although there is still a long way to go, for example the deforestation rate is still far above the target of under 4000 km^2 per year (Decree 9578/2018).

Further, while the emphasis is often on deforestation rates, deforestation is not the only threat to the standing forests of the Amazon. Degradation is a less visible, but also a pervasive environmental threat, with fires contributing to the growing extents of degraded forests (Lapola et al., 2023). Fire is often associated with deforestation when it is used to clear the fallen debris. Indeed 43% of the active fires detected in the Brazilian Amazon since August of 2019 are related to recently deforestation events (Portal TerraBrasilis [INPE], 2023) (recent deforestation fires). Yet there are multiple types of fires in the region (Barlow et al., 2020) and invasive forest wildfires are an important fire type that add to the amount of fires related with deforestation events. Forest wildfires drive degradation, especially during drought years (Lapola et al., 2023) including 2023–2024.

The recent and significant rise of forest wildfires in old-growth (or "primary") Amazonian forests is a concern, tempering the positive news of reduced deforestation rates. Satellite-retrieved forest wildfire counts increased by an alarming 152% in 2023 versus 2022 (Portal TerraBrasilis [INPE], 2023) (from 13,477 in 2022 to 34,012 in 2023) (Figure 1). They are leading drivers of degradation because Amazonian flora and fauna are fire-sensitive, having not evolved with fire over ecological time frames (Lapola et al., 2023). Fire-induced tree mortality in areas of primary forest often exceeds 50% of the above-ground biomass (Rappaport et al., 2018); this means that forest wildfires have potential to greatly reduce carbon stocks in the Amazon on the long-term and, thus, impact the global carbon cycle. The main protection for Amazonian forests against fire is the capacity to create a moist sub-canopy microclimate, and to contain and recycle moisture within the ecosystem (Brando et al., 2020). However, prolonged drought events, such as in 2010 and 2015–2016, decrease this capacity, increasing forest flammability (De Faria et al., 2017) and forest fragmentation that also leads to the increase of forest wildfires (Lapola et al., 2023). The 2023–2024 drought is particularly concerning because the region is being simultaneously hit by three large-scale atmospheric drought-drivers expected to last until mid-2024 (Fearnside & Silva, 2023).

Amazonians are suffering the direct and manifold consequences of the drought, which includes the increase in forest wildfires. The rising flammability is a real challenge for traditional subsistence fire-dependent farmers who must navigate a gauntlet of increased risk of their managed fires escaping and are also first in line when their forests and the foods, medicines and resources within them are impaired by invasive fires (Carmenta et al., 2021). Further, the impacts on the forests territories and resources are likely to remain long after the fires die back with long-term consequences for both rural and urban Amazonians. Urban Amazonian populations such as those in Manaus, the capital of Amazonas state and home to over 2 million people, also suffer. Manaus registered the second worst air quality in the world in October of 2023 (Watts, 2023). Other areas have recorded similar situation, including the neighbour state of Pará where forest wildfires counts in 2023 were 13,804 against 4217 in 2022 (Portal TerraBrasilis [INPE], 2023).

Under current climate conditions, degraded forests are gradually drier and susceptible to forest wildfires. Increasing command-and-control operations, expanding and better equipping fire brigades, and improving weather forecast systems and fire behaviour models are fast-response actions that need to be implemented (Brando et al., 2020). Likewise, distinguishing between different fire types to target effective and equitable responses is critical (Barlow et al., 2020). Over the long-term, creating fire-free chains of production is required, since many forest wildfires escape from cleared land, including encouraging fire-free cattle ranching, land tenure regularisation and hold accountability to those promoting arson fires for land speculation, identifying fire management adaptations, and determining feasible alternatives to fire use on smallholdings (Barlow et al., 2020).

Amazonian standing forests are a globally important socio-environmental asset. They harbour millions of tonnes of carbon that, if destabilised, would accelerate the pace of climate change with drastic impacts on rainfall and temperature. Conserving these forests, their ecosystem services, and socio-biocultural diversity safeguard Brazil's agricultural productivity, food security, and potential for the development of bioeconomic solutions. Avoiding destructive fires must be considered central to protecting Brazil's environmental

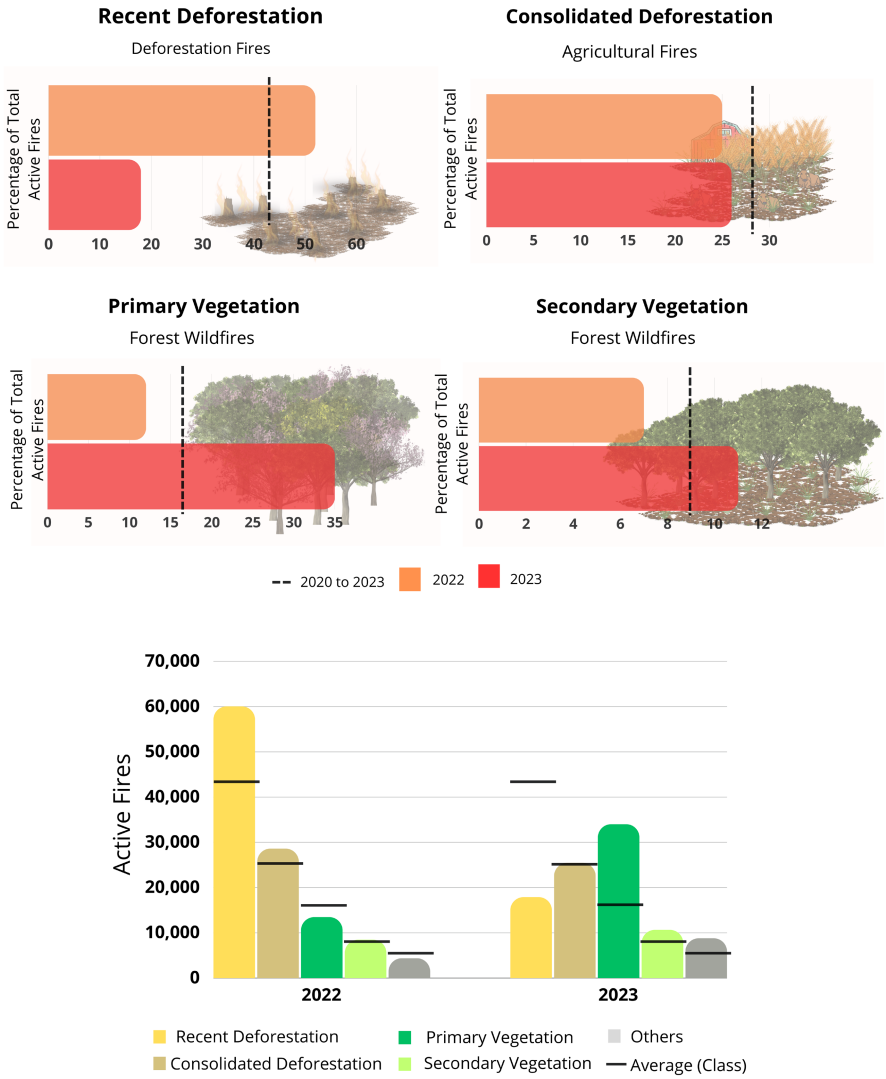

FIGURE 1 Categorisation of annual total fire counts in the Brazilian Amazon by deforestation class with data from TerraBrasilis (Portal TerraBrasilis [INPE], 2023). The dataset starts in August of 2019. First four panels (Recent deforestation, consolidated deforestation, primary vegetation, and secondary vegetation) represent the proportion of total fire counts per deforestation class for 2020–2023 ($n = 390{,}110$), in 2022 ($n = 115{,}028$) and 2023 ($n = 96{,}828$). The last panel represents the total of fire counts per deforestation class in 2022 and 2023, as well as the average per deforestation class considering the 2020–2023 period. Active fires are derived from Aqua/MODIS afternoon passages using the algorithm developed by INPE. Deforestation classes comprise recent deforestation—deforested areas mapped by the Brazilian Amazon Deforestation Monitoring Program (PRODES) over the last three previous years plus near-real time deforestation detection system (DETER) deforestation notices mapped during the previous year; consolidated deforestation—accumulated deforestation mapped by PRODES until the three previous years, including older agriculture and pasture conversion; primary Vegetation—areas considered as primary vegetation by the most recent mapping made available by PRODES; secondary vegetation—areas considered as secondary vegetation by the most recent mapping made available by the TerraClass project; and others—remaining areas such as urban.

assets, sustainable sources of income, and the cultural heritage of the Amazon. Failure to do so could imperil Brazil's leading role in an era of climate adaptation.

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Guilherme Mataveli: Conceptualization; writing – original draft; writing – review and editing. **Matthew W. Jones:** Conceptualization; writing – original draft; writing – review and editing. **Rachel Carmenta:** Conceptualization; writing – original draft; writing – review and editing. **Alber Sanchez:** Conceptualization; writing – original draft; writing – review and editing. **Débora J. Dutra:** Conceptualization; writing – original draft; writing – review and editing. **Michel Chaves:** Conceptualization; writing – original draft; writing – review and editing. **Gabriel de Oliveira:** Conceptualization; writing – original draft; writing – review and editing. **Liana Anderson:** Conceptualization; writing – original draft; writing – review and editing. **Luiz E. O. C. Aragão:** Conceptualization; writing – original draft; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in *TerraBrasilis* at http://terrabrasilis.dpi.inpe.br/en/home-page/.

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