Spiraling frontier threats in Indigenous Amazonia

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Standfirst: Indigenous Lands are critical for protecting Indigenous Peoples and the Amazon. Yet they are increasingly exposed to socio-environmental frontiers, bringing violence, illegal resource extraction, and deforestation. Urgent action is required to prevent irreversible harm to both people and forests, particularly in Brazil's Vale do Javari.

Indigenous Lands (ILs) are essential for a sustainable future for Indigenous communities and the Amazon. Scientific evidence shows the importance of ILs for protecting biocultural diversity[1,2], traditional Indigenous ways of life, and critical ecosystem services needed to control global warming. Indigenous Peoples' rights to land and self-determination are frequently

undermined by weak enforcement of territorial integrity and changes in laws guaranteeing environmental protection and land ownership, leaving them vulnerable to frontiers of resource and agricultural extraction that bring conflict with outside actors. Amazonian ILs face a suite of "frontier-type" threats with widespread historical antecedents; these include wildlife trafficking, mining, forest degradation and illegal logging and fishing, often accompanied by violence and persecution of Indigenous Peoples. The rapid increase of deforestation between 2019 and 2021 across ILs of the Brazilian Amazon coincided with a weakening of environmental law enforcement protecting Indigenous Peoples and their territories[3]. Despite significant international attention to plights of Indigenous Communities—including at the COP30 summit in Belém Brazil—enforcement efforts supporting ILs are often severely under-resourced or lacking entirely. Protecting ILs from escalating pressures of encroaching extractive frontiers through enforceable, policy-based solutions is essential to avert irreversible harm to these territories, Indigenous Peoples, and far-reaching critical ecosystem services provided by the Amazon Basin's ecosystems.

Located in Western Amazonia, the Vale do Javari IL is one of Brazil's most important areas for Indigenous Peoples. Its position on the borders of Brazil, Peru, and Colombia means that it is not only subject to incursions related to illegal resource extraction[4] and evangelical fundamentalist missionaries[5], faced by many ILs, but also drug trafficking which exacerbates violence both inside the IL[4] and in surrounding towns. Encompassing an area of 8,544,440 hectares, the Vale do Javari IL is home to the world's largest concentration of voluntarily isolated Indigenous Peoples[4], and several other Indigenous groups who present different levels of interaction with society outside their territory. This includes five Indigenous Peoples who maintain significant contact with the surrounding society: the Marubo Peoples with more than a century of contact, the Mayoruna with approximately eight decades of contact, the Matis who were contacted in 1976, the Kanamari who have maintained interactions with the outside world since the rubber tapping era, and the Kulina Peoples. Two Indigenous Peoples are considered of recent contact: the Korubo (contacted by FUNAI in 1996, 2014, 2015, and 2019) and Tsohóm-Djapá (contacted in the 1960s by the Kanamari People). There are at least fourteen groups living in voluntary isolation (B. Marubo, Personal Communication 2025). These Indigenous Peoples represent traditional ethnic groups that inhabited the land before Western exploitation and colonialism. For many of these groups, isolation is a survival strategy in response to atrocities perpetrated against them in the recent past. Due to the territory's size and remoteness, many Indigenous communities of the Vale do Javari IL depend almost entirely on subsistence practices protected by territorial and ecological integrity. These groups are therefore highly susceptible to impacts of external incursions, especially those in voluntary isolation. In contrast, some families living in partial urbanization face new pressures associated with market integration and changing social dynamics in regional centers including Atalaia do Norte, Benjamin Constant, Tabatinga, Guajará, and Cruzeiro do Sul (B. Marubo, Personal Communication 2025). Regardless of degree of contact, frontier expansion, associated with illicit economies, creates overlapping risks that compromise cultural continuity and territorial sovereignty[4]. When communities are threatened and harmed their own efforts to protect their lands may be compromised, allowing more incursions, associated forest and watershed degradation, exposure to fires which can burn into rainforest during droughts that are worsened by climate change, and other negative dynamics. This destructive spiral has begun to run out of control in other ILs as well[6].

Demarcated in 2001, the Vale do Javari IL is reserved exclusively for Indigenous Peoples[7]. The IL gained international attention in 2022 when British journalist Dom Phillips for *The Guardian* and Indigenist and FUNAI (Brazil's Indigenous affairs agency) employee Bruno Pereira

were murdered by illegal hunters and fishermen[8]. Pereira had helped create the Vale do Javari Indigenous Monitoring Team, a group established and operated by local Indigenous Peoples to protect their land from invaders[8]. Despite increased awareness following Phillips' and Pereira's deaths, invasions from illegal hunting, fishing, and narcotrafficking in the Vale do Javari IL continue, prompting visits from the Chief Justice of Brazil's Federal Supreme Court and the president of FUNAI[9]. However, FUNAI has historically lacked enforcement power to effectively counter threats to Indigenous Peoples[10], particularly for groups living in voluntary isolation who rely entirely on the agency for environmental enforcement. Members of the Inter-American Commission on Human Rights traveled to Atalaia do Norte in September 2025 to investigate fulfillment of the Brazilian government's responsibilities regarding physical protection of Indigenous leaders and the IL, finding little progress despite international commotion over the events in the region (B, Marubo, Personal Communication 2025). While many other ILs are experiencing similar threats, including the Yanomami, Munduruku, Kayapo[2], and Apyterewa, the last of which accounts for approximately 20% of deforestation within all ILs[1], we highlight the Vale do Javari IL for its unique features. Most direct threats and invasions into the IL are a result of narcotrafficking, and illegal hunting and fishing associated with related money-laundering activities (B. Marubo, Personal Communication 2026). Its tri-border location and large population of particularly vulnerable voluntarily isolated Indigenous Peoples require protection that will only be possible through transnational agreements.

Data from Brazil's satellite-based monitoring system, the Program for the Calculation of Deforestation in the Legal Amazon (PRODES), from the National Institute for Space Research (INPE), show that deforestation surrounding the Vale do Javari IL has been increasing since 2008. Between 2017 and 2022, deforestation surged across 5, 10, 50, 100, and 200-km cumulative zones around the IL (Figures 1 and 2). In contrast, forest loss within the IL remained relatively stable over the same period. This small, non-permanent loss primarily reflects small rotational subsistence gardens which later return to forest cover, highlighting the territory's protective role (B. Marubo, Personal Communication 2026). Considering deforestation in 2022, the full 200-km buffer zone recorded nearly 187.5 times more forest loss than the IL (Figure 2A). Even at its peak in 2019 (2.88 km^2), deforestation within the IL was a fraction of the 50-km buffer zone, which surged to 65.04 km^2 in 2022 (Figure 2A). This trend is consistent with MapBiomas, another major land-use change dataset, which shows the average annual deforestation rate to be 33.4 times higher within the 200-km buffer zone than within the IL itself (Figure 2B). Encouragingly, annual deforestation in all buffer zones of the Vale do Javari IL declined in 2023 and 2024 but remained well above levels of the previous decade.

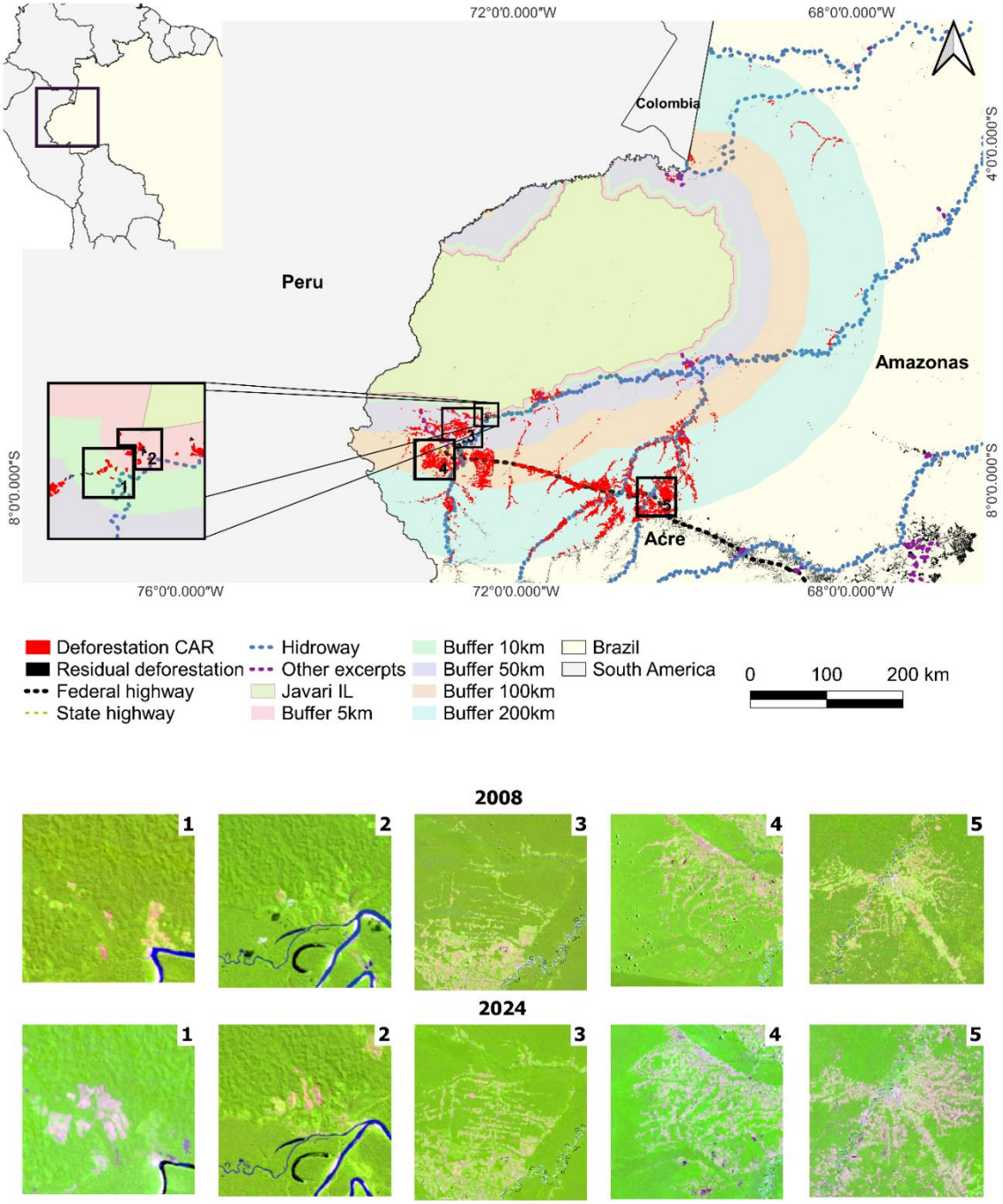

Figure 1. Geographic locations of the Vale do Javari IL, buffer zones, areas of deforestation, and deforestation within CAR boundaries. False color composite satellite images from 2008 and 2024 illustrate deforested areas within each buffer zone, with purple highlighting areas of forest loss. SICAR provides CAR data, and deforestation data was collected from the PRODES/INPE satellite monitoring system.

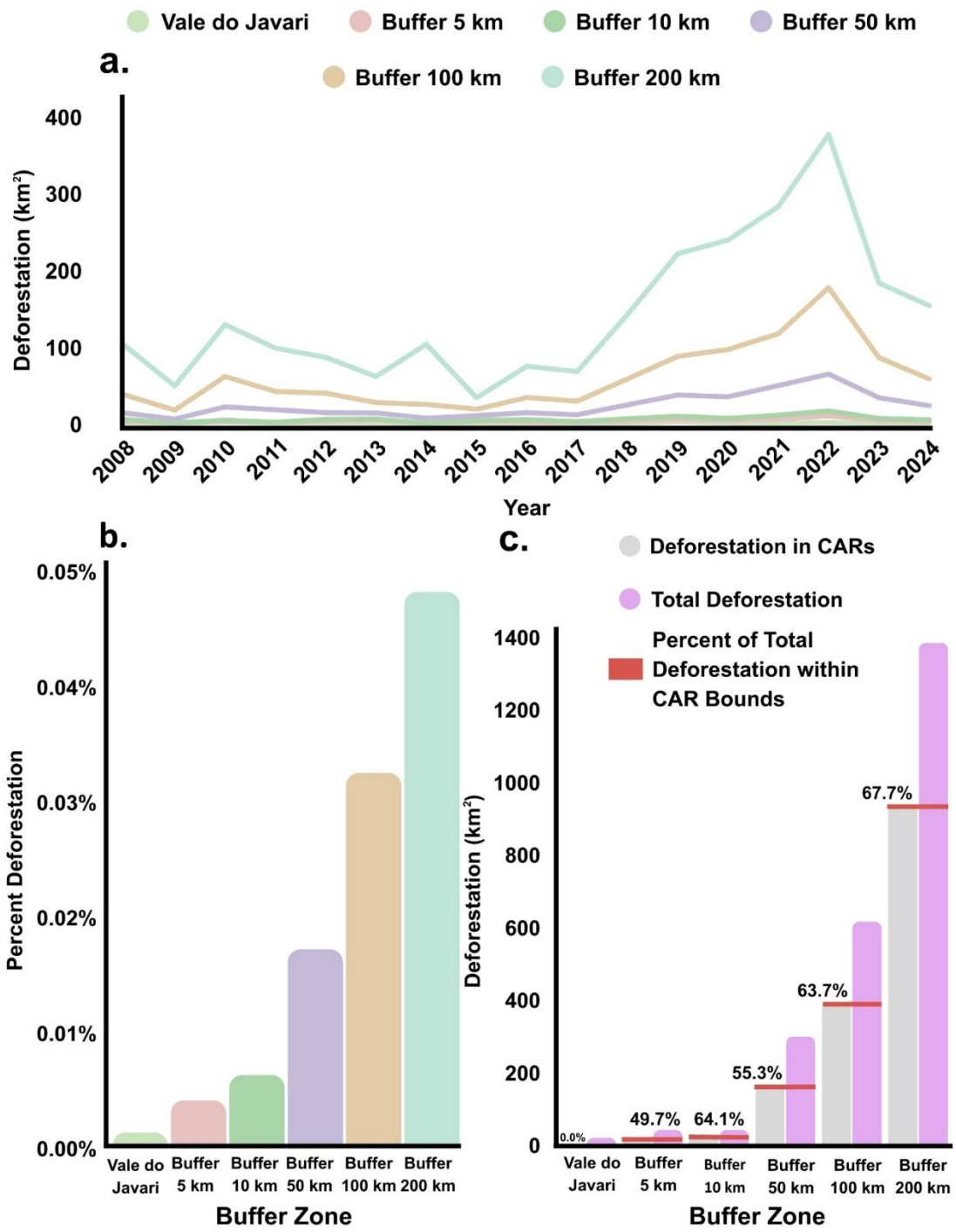

Figure 2. Deforestation trends within the Vale do Javari IL and buffer zones. Panel (A) shows annual deforestation totals (km²). Panel (B) presents the average annual deforestation from PRODES relative to forest cover from MapBiomas. Panel (C) compares total deforestation (km²) to deforestation occurring only within CAR boundaries, from SICAR. Results in panels (A) and (B) for the IL and its buffer zones represent cumulative values, meaning each buffer includes the areas of all previous zones. Results in panel (C) display non-cumulative values, indicating the individual contributions of each region of interest (the Vale do Javari and buffer zones) independently.

While buffer zones surrounding the Vale do Javari IL could contribute to the core area's protection, the Brazilian government currently recognizes legal protections for buffer zones surrounding conservation units, but not for ILs[2]. Legal protections should be extended to IL buffer zones with policies crafted to regulate activities through robust governmental enforcement, and to support sustainable community development through agroforestry programs and other efforts that can help revitalize deforestation-damaged areas[11]. These protections would strengthen conservation and cultural preservation efforts and reduce encroachment while ensuring nearby land uses do not undermine the biocultural integrity of the IL. To do this, they must strengthen environmental enforcement by supporting Indigenous monitoring groups, increasing FUNAI's administrative enforcement power, and reinforcing the four Surveillance and Inspection Bases the agency maintains in the area. FUNAI must have the necessary tools and authority, including access to firearms for security operations, to effectively protect the IL and isolated Indigenous Peoples without unnecessary bureaucracy, reliance on other agencies for enforcement, or congressional delays.

A comprehensive set of interventions and reformative policies is urgently required to curb escalating deforestation pressure around the Vale do Javari IL. One successful example of enforcement reducing frontier pressures comes from other Brazilian ILs through a claim of non-compliance with a fundamental precept, or ADPF (Arguição de Descumprimento de Preceito Fundamental) number 709, established by Brazil's Federal Supreme Court, which resulted in the removal of intruders from numerous other ILs since 2023.[12] While ADPF 709 was successful in reducing frontier pressures across those ILs, this ADPF has since been closed with no plans to extend enforcement actions through this mechanism to the Vale do Javari IL.[12]

Law enforcement must also be complemented by locally-adapted agricultural practices and community development initiatives to address the needs of surrounding communities within buffer zones. These efforts require globally concerted actions that address the tele-coupled nature of commodity chains, which ultimately drive deforestation. Local and regional stressors must be addressed under a multiscale perspective that includes co-development with Indigenous Peoples, with a view to achieving conservation goals. A past example comes from the European Union, whose 2023 Regulation on Deforestation-Free Products aims to reduce carbon emissions by requiring companies to verify that commodities such as wood and beef in its market are not associated with recent deforestation or degradation[13].

Even when policy models diverge, one lesson stands out: strong, consistent enforcement is indispensable for preventing adverse socio-environmental outcomes. Another challenge to long-term enforcement is misuse of Brazil's Rural Environmental Registry, or CAR (*Cadastro Ambiental Rural*). Originally intended for environmental enforcement of private properties, the CAR has been misused as evidence of possession over public lands in the Amazon[14], highlighting a risk within the 200-km buffer surrounding the Vale do Javari IL where boundaries registered in the CAR often overlap with deforestation (Figure 1). Based on all CAR records not listed as "canceled" as of October 2025 provided by the National CAR system (*Sistema Nacional de Cadastro Ambiental Rural*) and PRODES there is an estimated 1,543 km^2 of deforestation that occurred within CAR registrations between 2008 and 2024, representing 64% of the total deforestation that occurred in the cumulative 200-km buffer zone of the IL (Figure 2C). Based on data from the Brazilian Forestry Service (Serviço Florestal Brasileiro), there are an estimated 4.8 million hectares of government land classified as "Undesignated Public Forests" (UPFs) within the 200-km buffer zone awaiting government designation. Designating UPFs as protected areas is

crucial to stopping deforestation surrounding the Vale do Javari IL. To reduce deforestation pressure and socio-environmental risks, policies must be consistently enforced and insulated from corruption.

The Vale do Javari IL is both legally protected, but vulnerable to encroaching resource frontiers of illegality and transnational dynamics because of FUNAI's limited direct enforcement authority. These decisions made (or lack thereof) will set a precedent for how seriously Indigenous rights are protected and enforced. Neglect of one IL risks weakening the self-determination and rights to existence of all others, threatening forest conservation and biodiversity throughout the Amazon and climate regulation across the globe. All institutions must commit to the safety of Indigenous Peoples, particularly the voluntarily isolated, sharing responsibilities and maintaining planning of ongoing protection actions.

Conflict of Interest Statement
The authors declare no conflicts of interest.

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