

Co-developing pathways to protect nature, land, territory, and well-being in Amazonia

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Deforestation and climate change threaten social and ecological well-being in Amazonia. Research co-produced through ethical collaborations across multiple knowledge systems can contribute toward just and sustainable futures for the region.

Accelerating deforestation and degradation in Amazonia are undermining the resilience of one of Earth's most bioculturally-diverse regions¹. Key drivers of these processes include agro-industrial and infrastructure expansion, mining, and other forms of unsustainable extractivism². Degradation and clearing of the rainforest result in losses of biodiversity and critical wildlife habitat, disruption of delicate ecological balances, reduction of atmospheric moisture recycling³ and transformation of forests from carbon sink to source⁴. Although the impacts of these ecological disruptions are far-reaching, Indigenous and other traditional peoples and communities are among the most immediately and intensely affected^{5,6}. Here, we focus on the Brazilian Amazon and use the terminology “Indigenous and other traditional communities” in recognition

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that under Brazilian law (Presidential decree 6040/2007) “traditional communities” refers to both Indigenous and other communities that sustain their livelihoods, heritage, and cultural identities through place-based knowledges and practices, e.g., *Ribeirinhos* (Fig. 1). However, we emphasize that Indigenous Peoples have distinct socio-political rights enshrined in Brazil’s constitution (Article 231) and set out by global governing bodies like the United Nations, which should not be conflated with the rights of other traditional communities.

Amazonia is heading for an irreversible environmental state that could trigger a progressive collapse of the forest–climate system⁷. Changes in heat and moisture exchange between the forest and the atmosphere are increasing extreme floods^{8,9} and droughts^{10,11}, and reducing atmospheric moisture fluxes both within and from Amazonia to other parts of the continent. This consequently reduces rainfall in regions downwind of the forest^{12–14}. Even though large-scale commodity agriculture, e.g., livestock and soybean, is a major driver of deforestation and has expanded throughout the Amazonia–Cerrado transition zone¹⁵, both traditional and industrial agricultural systems in other regions depend on the standing forest. If deforestation in the Amazon continues, projected precipitation changes could result in 1 billion United States dollars in losses annually to the agriculture sector^{16–19}.

Deforestation and degradation of Amazonian forests also have diverse social implications. Mining, for example, has caused less than 10% of the total deforestation²⁰, but it has been devastating for local livelihoods, even among isolated communities located far from the Amazonian deforestation hotspots^{21,22}. Continuing deforestation will worsen existing social disruptions and other negative impacts faced by Indigenous and other traditional communities that live in the region. Deforestation in their territories create a feedback loop of threats to Indigenous and other traditional communities, leading to further environmental degradation and social inequities². Here, we argue that new research efforts tackling threats to land, nature, territory, and well-being in Amazonia require ethically-oriented collaborations and coordinated dialogue across multiple knowledge communities, with a particular focus on respecting the territorial and intellectual sovereignty of Indigenous and other traditional communities and peoples.



Fig. 1 A riverside dweller (“Ribeirinho”) community in the Central Amazon river floodplain, close to the city of Tefé in the Amazonas state, Brazil. The Ribeirinho people skillfully navigate months of annual flooding, yet the evolving environmental changes cast shadows of uncertainty over their time-honored way of life. Courtesy of João Paulo Borges (@drone_da_amazonia).

The last line of defense

Biodiversity sustains the ecosystems that humans are part of and upon which they depend for water quality and safety, food provisioning, and climate regulation²³. For instance, traditional medicine and modern pharmaceuticals depend on healthy ecosystems and thriving biodiversity²⁴. Human-induced environmental change diminishes Amazonia’s role as a natural buffer against climate extremes and the spread of pathogens and diseases^{25,26}. About 30% of emerging zoonotic diseases have been linked to land-use change²⁷. For instance, every square kilometer of deforested land in Amazonia associated with 27 new malaria cases in humans⁵, whilst each hectare of burned forest led to ~700 cases of fire-related disease, of which about 50 occur within Indigenous territories⁶. Protecting Amazonian forests will avoid millions of respiratory and cardiovascular cases both within and beyond the region, saving billions of United States dollars in health costs every year⁶. Doing so is particularly urgent, given that Amazonia is predicted to be one of the tropical humid-forest regions most exposed to life-threatening and unprecedented heat by the end of the century²⁸.

Most conservation efforts in Amazonia fail to recognize how critical Indigenous Peoples and their territories are for preserving biodiversity and ecosystems. Indigenous Peoples have been part of Amazonia for countless generations and are the lands’ staunchest guardians against the threats of deforestation and degradation. They hold the most knowledge about their territories and have passed down these knowledges and developed ways of life that help maintain the balance of Amazonian natural ecosystems^{29,30}. Additionally, many public policies and international organizations’ mandates have been shaped without dialogue with or the leadership from Indigenous and other traditional communities. Part of the disconnect is attributable to a lack of respectful and reciprocal research partnerships with Indigenous and other traditional communities and local and global research institutions^{31,32}. This disconnect is further maintained by an inadequate understanding of, and respect for, the knowledges of Indigenous and other traditional communities, including their sciences, technologies, cultures, relationships with nature, and practices that contribute to the protection and regeneration of Amazonian ecosystems.

Indigenous territories cover ~25% of the Brazilian Amazon and are central to safeguarding global biological and cultural diversity^{33–35}. The protection of Indigenous territories and rights against deforestation and biodiversity loss^{36,37} provides numerous benefits not only to Indigenous communities⁶, but also globally by enhancing carbon storage³⁸, thereby contributing to climate change mitigation. However, the large majority of Indigenous territories have not been officially demarcated^{37,39} and, therefore, are vulnerable to land grabs, and other ecologically damaging activities such as illegal logging⁴⁰. Demarcating these territories and recognizing and respecting Indigenous Peoples’ rights, sovereignty, and self-determination is therefore crucial to tackle ongoing climate and biodiversity crises.

While the importance of biodiversity is increasingly championed by global policy leaders, as evidenced by the historic signing of the Kunming-Montreal Global Biodiversity Framework at the 15th United Nations Biodiversity Conference Of the Parties in 2022⁴¹, ongoing proposed legal changes endanger Indigenous territories and protected areas in the Brazilian Amazon and beyond. For example, Bill PL 490/2007 embeds the *Marco Temporal*, a historic cut-off point legal thesis that threatens to strip many Indigenous Peoples of their land rights⁴². Even apart from this legislation, many of the communities living within and protecting Amazonian traditional territories experience forced displacement and threats to their livelihoods and their lives. Many defenders of the integrity of Amazonian lands, including environmentalists, traditional community leaders, journalists, and human and Indigenous rights activists have been the target of

violence, including death threats, assassination attempts, and murder^{43,44}. Against this backdrop, efforts to protect Amazonia must be grounded in a commitment to the United Nations Declaration on the Rights of Indigenous Peoples, including the right to grant or withhold free, prior, and informed consent regarding projects impacting their territories⁴⁵.

The challenges and possibilities of co-producing sustainable pathways

While there is significant diversity across Indigenous knowledge systems, many of these knowledge systems approach ecological degradation as resulting from the denial of the interdependence between humans and nature^{46,47}. This denial enables people to treat nature as something that is separate from and subordinate to humanity, available as a resource for human profit, extraction, and consumption. By contrast, many Indigenous knowledges center this interdependence and the relational responsibilities that flow from it.

There is growing engagement with Indigenous and other non-Western knowledge systems by Western scientists, including those researching climate change and biodiversity loss⁴⁸. However, it is common for this engagement to recreate dynamics of knowledge extraction and appropriation by treating this knowledge in decontextualized and transactional ways rather than relating to them as knowledge systems of equal value and respecting the intellectual sovereignty of Indigenous and other traditional communities^{49,50}. This happens, for instance, when Western scientists seek to verify Indigenous knowledges through Western scientific methods or when Indigenous knowledge holders are precluded from co-defining the terms of the research engagement itself^{51,52}.

Meanwhile, mainstream policies and practices of climate mitigation, adaptation, and biodiversity protection are rarely substantively informed or led by engagements with Indigenous knowledges or community leaders, especially those most ardently committed to the defense of their territories^{53–56}. As a result, these policies and practices generally fail to consider the rights of Indigenous and other traditional communities or address the specific challenges faced by them. In some cases, these policies and practices actually worsen the situation of these communities, leading to further displacement, dispossession, and marginalization⁵⁷. Institutional research policies, practices, timelines, and funding calls in these areas are also rarely designed to support genuine knowledge co-production rooted in respectful relations, which require epistemic humility, commitment to enacting reciprocity, and collaboration across the whole research cycle, from planning to application and evaluation^{58,59}.

As a group of Indigenous and non-Indigenous researchers committed to protecting land, nature, territory, and well-being in Amazonia, we concur with many others that collaborations with Indigenous and other traditional communities must interrupt the usual extractive and paternalistic patterns of engagement, and go beyond tokenistic inclusion and consultation. We suggest instead that genuinely co-developed research must be grounded in a deep respect for traditional rights and knowledges, and a commitment to long-term relationship-building oriented by the principles of consent, trust, respect, accountability, and reciprocity^{60–63}. Research teams should expect that these processes will be challenging and complex, given that they must account for the unequal systemic power of different knowledges and the heterogeneity of perspectives held within and between knowledge communities. Achieving these advanced levels of coordination also requires recognizing the interdependence of social and ecological systems, which many Indigenous and traditional knowledge systems already do.

While the insights of multiple knowledge communities are indispensable, in order for research of this type to be both ethical and impactful, it must center on those most directly affected by anthropogenic activities, climate change, and biodiversity loss. Protecting the Amazonia's intricate web of life calls for transdisciplinary research and cross-sectorial collaborations that prioritize the needs, perspectives, and insights of Indigenous and other traditional peoples who are struggling to protect their territories and the well-being of their communities, and that include Indigenous researchers and members of local communities as central members of the research team.

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