SCIENCE PANEL FOR THE AMAZON

POLICY BRIEF

THE AMAZON WE WANT

Science Panel for the Amazon

A CALL FOR GLOBAL ACTION TO MOVE THE AMAZON FOREST SYSTEM AWAY FROM TIPPING POINTS

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I. THE AMAZON AS A TIPPING ELEMENT OF THE EARTH SYSTEM

A. THE AMAZON AS AN ENTITY OF THE EARTH SYSTEM AND ITS UNPRECEDENTED ONGOING CHANGES

During COP26 in Glasgow, more than 240 renowned scientists released the Amazon Assessment Report 2021, an unprecedented initiative which articulated efforts to find sustainable pathways for the region. The Assessment warned the global community about the importance of the Amazon as a key element of the Earth's climate system and the risk of catastrophic environmental change projected for the region, including the possible crossing of tipping points.

Due to its tropical location and vast area (7 million km^2), the Amazon forest system is a key element of the Earth system, exerting a strong biophysical and biogeochemical influence both within and beyond the tropics. The Amazon is a key element of the global carbon budget, with the remaining 83% of the forest storing 150-200 billion tons of carbon in soils and vegetation. The Amazon's mature forests act as a carbon sink, absorbing around 20 PgCy-^{1} ^{1}. Amazon forests also acts like a giant water pump, as evaporative cooling provides the water vapor to generate rainfall downwind. Up to 50% of Amazonian precipitation is regionally recycled by the forest, sustaining a high flow of atmospheric moisture inland from the Atlantic Ocean and maintaining high rates of evapotranspiration year-round. The NW-SE gradient of rainfall seasonality, with longer dry seasons in the south and southeast regions, accompany a transition from forest to semi-deciduous forest and tropical savanna. Increases in dry season length and intensity generate conditions conducive to human-induced fires, which are nearly absent in the dynamics of the closed-canopy forests.

Ecological specialization and speciation in the Amazon occurred over millions of years, mediated by global biogeochemical cycles, and by the Amazon's extraordinary heterogeneity in hydroclimatic conditions, soils, nutrient availability, and biotic interactions. Its unique geological history, including the Andean uplift and the formation of the Amazon River 10 million years ago, created an extraordinary diversity of environmental conditions, which shaped a unique mosaic of >50 terrestrial and aquatic ecosystems. There is also complex bio-geophysical coupling between the high Andes and the lowland Amazon through aerial rivers and the Amazon River network. This complex system holds around 13% of the planet's vertebrate and vascular plant biodiversity, most of which remains unknown. Climate regulation and high rates of productivity within the Amazon's boundaries strongly depend on its biodiversity and forest structural complexity, which enable efficient biodiversity-mediated mechanisms to recycle nutrients and deal with water shortages, particularly in low-nutrient soils and seasonal rainfall regimes[1].

The Amazon is home to over 400 Indigenous groups, as well as riverine and Afro-descendant communities, all of whom hold profound knowledge of ecosystem functions. These societies have managed forest and savanna ecosystems for hundreds of years to millennia, increasing the productivity of landscapes, altering plant species distributions, and enhancing food availability to improve their own well-being without causing large-scale deforestation. Today, these groups play a major role in protecting the forest from modern industrial and agricultural activities that degrade ecosystems, thus maintaining the forest carbon sink inside their territories (see also SPA's publication "The role of Amazonian Indigenous Peoples in Fighting Climate Crisis").

In the last four years, the Amazon has experienced a dramatic increase in forest loss driven by environmental policy setbacks[2]. In the Brazilian Amazon, deforestation rates rose 17% in a single year, from 2020 to 2021[3]. Forest loss emits millions to billions of tons of carbon a year, depending on drought extremes, fires, and deforestation rates. These changes impact the hydrological and carbon cycles, resulting in local to global climactic changes.

Besides forest loss, the Amazon has been impacted by anthropogenic disturbances which affect forest integrity[4]. Compounding disturbances include recurrent fires that escape from agricultural fields and recently deforested areas, unsustainable timber extraction (i.e., conventional or illegal logging), and the creation of forest edges, which change the forest structure of deforested and adjacent areas. Taken together, these disturbances have reduced the resilience of the forest, especially to wildfire[2,4,5]. Increasing flammability also drives a feedback loop, whereby increasing surface temperatures and altered hydrological cycles, increase wildfire risk even further[6,7]. Forest fires have intensively impacted about 11% of the standing forest in the Brazilian Amazon[8], and contributed to approximately 17% of today's degraded forests across the Basin[9]. These fires currently represent an unaccounted source of emissions in national inventories that could vary from 20% to 50% of the annual average CO_2 emissions associated with deforestation [10–12] .

These new pressures also test the tolerance of individual species and whole ecosystems to climate variability, as well as society's ability to adapt to new regimes. The need to reverse this trajectory is therefore immediate to avoid the risk of crossing socioecological tipping points.

B. RISKS OF IRREVERSIBLE TIPPING POINTS WITHIN THE AMAZON ECOSYSTEMS

A 'tipping point' is the point at which a small change to a stressor or ecosystem state causes the whole ecosystem to shift abruptly to an alternative stable state, accelerated by amplifying (or self-reinforcing) feedback mechanisms. When tipping events become contagious like epidemics or wildfires, they may cause systemic collapse. Understanding these boundaries can help society manage Amazonian resilience and avoid crossing tipping points.

The scientific literature identifies five poten-tial tipping points in the Amazon, each one re-lated to a particular stressor: (1) 2°C mean global temperature rise relative to pre-indus-trial levels; (2) 1,000 mm of local annual rain-fall; (3) - 400 mm of maximum cumulative wa-ter deficit; (4) dry season length of 6 months; and (5) accumulated forest loss of 20%. More-over, in areas where rainfall falls below 1,800 mm per year, forests become unstable, with increased risk of crossing tipping points. These five stressors may intensify in syn-chrony (e.g., less forest could exacerbate and drive less rainfall and more fires), implying that tipping points could emerge sooner than expected. We recommend society work collab-oratively to manage these stressors and avert crossing tipping points.

The crossing of tipping points could lead to three alternative ecosystems: (i) 'degraded forests' in regions with rainfall conditions that support stable forests; (ii) 'degraded open can-opy ecosystems' in regions that support both forests and non-forest states (i.e., bistable); and (iii) white-sand savannas in both stable and bistable forest regions in seasonally-flooded areas. Each alternative is associated with different combinations of disturbances and feedback mechanisms.

Across the Amazon, compounding disturb-ances may lead to heterogeneous changes in resilience across the Basin. In the west, where the most resilient forests exist, forests could be gaining resilience, but disturbance may un-dermine this process.

Global climate change heterogeneously affects the Amazon. It is estimated that there has been an average increase of **~1ºC over the last three decades.** In addition, in southern por-tions of the Basin, the dry season has length-ened by approximately 5 weeks, while temper-ature has increased 2-3ºC in the last 40 years. In the driest parts of the Amazon, such as along the Amazon-Cerrado transition, tem-perature has risen 0.45ºC per decade and mean temperature ~1ºC in the last 20 years[13]. In the southeast, north, center, and south of the Basin, forests face increased pressure from compounding disturbances, losing resil-ience[14]. The southeast has already turned into a carbon source to the atmosphere[15], while forest composition and function are becoming more homogeneous in the south[16].

The Amazon dieback resulting from climate change, deforestation, degradation and wildfires will impact not only the region but also the globe, emitting from 110 to 275 tons CO_2eq and increasing the global equilibrium temperature by 0.1–0.2ºC[17].

C. DEFORESTATION DYNAMICS AND ECONOMIC GROWTH

From the 1960's to the 1980's, deforestation was directly encouraged by the Brazilian government as a means of supporting migration to the Amazon and promoting its economic development. More recently, migration incentives were indirect (related to large infrastructure development projects, e.g., roads and dams), yet still led to illegal land occupation1. Infrastructure projects, illicit crops, and the expansion of cattle ranching also drive deforestation in countries like Bolivia and Colombia[1,18]. This pattern of land use and land use change heavily relied on exploiting the region's natural resources, expelling Indigenous peoples and local communities (IPLCs) from their ancestral homelands, and replacing the forest with alternative, allegedly productive, uses.

In this context, the conversion of native forest to other land uses, such as pasture or cropland, has accelerated in recent decades. Amazonian forests lose more tree cover annually due to deforestation than anywhere else in the whole tropical belt19. Besides forest conversion, various drivers have caused forest fragmentation, degradation, and changes in surface temperature[20,21]. Among the pressures on Amazonian forests are: i) land speculation, mostly on public lands8; ii) intensive migration stimulated by improved road access to 'vacant' lands and attracted by the numerous jobs offered by large infrastructure projects[22]; iii) expansion of extensive, inefficient cattle pasture[23], and iv) pressure to convert pasture to commodity crops, which further drives the expansion of pasture into forests[24]. Illegal activities, such as mining, logging and extreme violence (e.g., homicides), also contribute, paving the way to capitalize high-risk investments of forest conversion on public lands (e.g., [25,26]). When there is weak or absent federal governance, these drivers interact in distinct ways, causing escalating rates of deforestation fire, as seen in the Brazilian Amazon since 2019[8].

Deforestation is not only associated with illegal activities, but also with largely unproductive ones. Although pastures occupy almost three quarters of the area that has been historically deforested[27], they typically exhibit very low productivity[28]. For this reason, nearly a fifth of the area that has been deforested has been abandoned, rather than put to productive use[27]. There is evidence that reducing deforestation does not jeopardize agricultural production. Between 2004 and 2012, when the rate of deforestation in the Brazilian Amazon fell by 84%, the region's real agricultural GDP increased by more than 50%[29,30]. This is corroborated by findings that policies that helped reduce forest loss – including command and control efforts, plus productive protected areas – did not negatively impact local agricultural production[31,32,33].

Deforestation cannot be justified as a necessary condition for expanding agricultural production or promoting socioeconomic development in the Amazon. Rather, there is ample scope for increasing production on the vast amounts of already deforested or degraded, land in the region[34]. Already open, underused areas can be a valuable input for emerging markets, such as for carbon credits or agroforestry systems (see the SPA publication "Arcs of Restoration"). In addition to increasing the productivity of deforested and degraded areas, these developing markets may generate employment opportunities and contribute to socio-economic development.

Standing primary forests offer significant economic opportunities, particularly in light of emerging mechanisms to financially compensate landholders for avoiding deforestation and degradation. For instance, under the conditions of the Lowering Emissions by Accelerating Forest Finance (LEAF) Coalition, eliminating deforestation in the Brazilian Amazon by 2031 could generate revenues of USD 18.2 billion35. LEAF Coalition transactions must abide by the REDD+ Environmental Excellence Standard (TREES) developed by the Architecture for REDD+ Transactions (ART), which allow jurisdictions that have consistently large forest stocks and low rates of loss to also benefit from compensation. This is particularly relevant for ensuring the financial future of IPLCs in protected territories.

II. THE SOLUTIONS SPACE: ENHANCING SOCIOECOLOGICAL RESILIENCE TO MOVE AWAY FROM TIPPING POINTS

A. GOVERNANCE AT LARGER SCALES: THE NEED FOR POLICY IMPROVEMENT AND INNOVATION

Policy support is of paramount importance to fight forest loss in the Amazon. There are three courses of action that must be prioritized:

1. Protect native vegetation: Brazil's experience in protecting native vegetation offers a compelling example of feasibility and cost-effectiveness. Between 2004 and 2012, deforestation in the Brazilian Amazon fell by nearly 84%, from more than 27,000 km^2 to 4,500 km^2 [29]. Conservation efforts implemented within the scope of a federal policy action plan played a crucial role in this reduction[36,37]. The plan proposed several novel policies and inaugurated a collaborative design for conservation policy planning and implementation.

The strengthening of environmental monitoring and law enforcement under the action plan, which increased law enforcement's capacity to impose binding and costly penalties, was pivotal for reducing forest loss. These efforts were not only effective for forest protection, but also cost-effective, even by very conservative estimates[36]. The strategic expansion of protected territories served as barriers to advancing deforestation in areas under pressure[38,39]. Strengthening financial instruments proved to be effective in protecting the forest, while requiring compliance with environmental and land tenure regulations as a condition of accessing credit contributed to reductions in deforestation[40].

2. Target critical regions and fight illegal activities: Prioritizing critical areas is important for fighting deforestation, because forest loss in the Amazon is highly concentrated. In Brazil, for example, just twenty-four municipalities account for nearly half of the total area deforested since 2016[29]. In the past, Brazil's strategy of targeting such municipalities with rigorous environmental enforcement was effective in reducing deforestation [32].

In addition, given that deforestation in the region is still overwhelmingly illegal[41], strengthening environmental control is an absolute priority. It is imperative that Amazonian countries eliminate the impunity currently associated with illegal forest clearings. To do this, the country must recover its capacity to provide a binding law enforcement response, which requires restructuring environmental governance to support effective sanctioning procedures and penalties. It is also critically important to combat illegal land-grabbing. Public forests awaiting designation have been heavily targeted by land grabbers who destroy the forest and forge titles to claim ownership[42]. Fighting this illegal practice is vital, not only because of its direct association with reducing deforestation, but also because it reduces crime, corruption, and violence in rural areas.

3. Account for forest degradation and protect secondary forests: Forest protection must extend beyond combating deforestation. Forest degradation reduces ecosystem resilience, making it more susceptible to future damage. It also interferes with the provision of ecosystem services, causes biodiversity loss, and reduces the forest's capacity to sequester carbon[43]. Degradation has been estimated to account for nearly 70% of global carbon emissions from tropical forests between 2003 and 2014, while deforestation accounted for the remaining 30%[44]. The area of degraded forest often exceeds that deforested, yet policy has essentially overlooked the issue. Combating degradation must be incorporated into an Amazonian conservation agenda, as well as in commitments to reduce greenhouse gas emissions[2].

Amazon conservation policies should pay more attention to boosting and protecting forest regrowth. In 2017, secondary forests covered 235 M km^2 (or 29%) of the Amazon, 77% of which was in Brazil. While only 9% of emissions from deforestation are offset by carbon sequestration by secondary forests in the Brazilian Amazon, some states, such as the State of Amazonas, offset around 18%.[45]

At present, Brazil has no official system that systematically and regularly monitors these areas. Incorporating secondary vegetation into forest monitoring systems is technically and financially feasible, but requires policy support[2,46].

B. GOVERNANCE AT LOCAL SCALES: PROMOTING LOCAL MANAGEMENT AND ENGAGING LOCAL COMMUNITIES

During the Amazon's 12,000 years of Indigenous occupation, Indigenous societies (and more recently Afro-descendant and other traditional communities) developed land-use strategies and technologies that were highly adapted to local environmental conditions1. This long-term interaction between IPLCs and their environment shaped the structure and composition of Amazonian ecosystems to suit human needs, yet did not disrupt ecosystem functions, and in some cases improved ecosystem services (see for instance, [47–53]). In the absence of large-scale deforestation, Indigenous management practices and tools created and maintained resilient forests to the modern day, while expanding food production systems that provide sustenance and income to millions of people[50,54]. Indigenous lands, lands held by other traditional communities, and protected areas under different tenure regimes currently cover 48.7% of the Amazon, protecting almost half of its remaining forests, and other terrestrial and aquatic ecosystems[55]. In the Brazilian Amazon, Indigenous peoples act as guardians of 115 million hectares of well-conserved forests56, which represent a carbon stock equivalent to more than one year of global greenhouse gas emissions (approx. 10 billion tons of carbon; [57]; see also SPA's publication 'Role of IPLCs in the Climate Crisis'). Within their territories, IPLCs have also contributed significantly to slow biodiversity loss58 and prevent the extinction of iconic species[59], which are essential to keep ecosystems resilient in the face of adversity[60]. Additionally, Indigenous land-use practices (e.g., shifting cultivation) can favor the regeneration of forests after disturbance, and support the restoration of degraded landscapes61. Strengthening the sustainable practices and knowledge of IPLCs is key to increasing forest resilience and ensuring livelihoods that enhance IPLCs' adaptation to climate change. (see also SPA's publication 'Role of IPLCs in the Climate Crisis').

The production of socio-biodiversity products within the Legal Amazon, mostly by IPLCs, reached GDP BRL 11 billion in 2020, with 50.4% of the products going to local markets, 40.7% to the rest of Brazil, and 2.6% to the world market[62]. The region contributes a mere 0.17% of world exports of tropical forest products[63]. In this sense, value-added marketing strategies already occur in local markets, which recognize territorial identity into the goods, and hence qualify the products and give meaning to their uses, expanding the range of creative opportunities for diversification of uses and strengthening the symbolic appreciation of the products' territorial identity. However, it becomes evident that strengthening this new bioeconomy requires that longer supply chains (i.e., which Includes internal markets and abroad) embody such Amazon territorial identity while capturing market values.

Rural production requires stronger governance initiatives and public policies to improve and developing supply chains. Rural producers currently retain 25% of the value generated by the goods they produce. Strengthening governance and providing support to producers can help correct asymmetries in terms of political, financial, and market relationships, especially through the provision of technical assistance and access to credit. This could simultaneously guarantee the technological development of agroecological systems to maintain or recover degraded ecosystems. The main idea behind such initiatives is to ensure IPLC's ancestral and tacit knowledge is in dialogue with Western science, while taking into account the large heterogeneity embedded within IPLCs' practices and potential.

Industrial production and services, which retain 31% and 10.4% of added value, respectively, require more systemic policies to promote cooperation, both between existing companies and between such companies and other actors in the socio-biodiverse economy. This could generate local productive arrangements that creatively improve endogenous capacities and integrate them with exogenous resources. The building system of socio-biodiverse economy is planned to be a platform for the organization, generation and processing of knowledge and information, capable of comprehensively and operationally promoting economic, social and environmental sustainability.

C. TRANSBOUNDARY COLLABORATIVE MANAGEMENT

Despite the fact that a large proportion of the Amazon is conserved within various types and designations of protected areas, representing an unparalleled opportunity to reverse the impacts of the current trajectory of human intervention and implement a new model of sustainable and socially inclusive development, two main setbacks remain to tackling deforestation and forest degradation:

(i) The growth of protected areas is in one sense a success for conservation; however, conservation may not be the primary objective in most areas, given that nearly 50% of the protected areas already existing allow for resource extraction. Moreover, 14% of the deforestation occurring within the last two decades occurred within Indigenous territories and protected areas.

(ii) Extensive, undesignated public areas are yet to be explored in terms of administrative jurisdictions, land tenure, ancestral territories, and access, and should be designated as no-go areas with a moratorium on logging activities, or areas under sustainable management.

Addressing these issues requires resources for the management of protected areas and IPLCs' territories by their peoples, and the real and effective participation of IPLCs in planning the investments that affect them.

Evaluations of conservation effectiveness in the Amazon indicate that what is mostly lacking is the implementation of a transboundary conservation vision which would develop comprehensive conservation plans for large ecoregions to ensure connectivity between ecosystems and address transboundary spillovers; this is one of the largest challenges for biodiversity conservation and climate change adaptation globally[64].

Transboundary conservation plans cannot be successfully implemented without closing the large financing gap between available resources and those required to maintain and restore natural habitats and ecosystem functions; this is particularly challenging in developing countries [65–68]. In the Amazon region conservation is largely financed with public resources, but there is a consistent tendency to reduce public budgets for environmental management[31,69]. While the strengthening of public budgets is necessary, it is also key to advance public-private partnerships to design and implement market-based, demand-driven policy instruments to influence land use[70].

The Biodiversity Financing Initiative (BioFIN)[a] identified financial mechanisms to improve conservation in Brazil, mostly in the Brazilian Amazon[71]. Recommendations include:

(i) Ecological fiscal transfer (ICMS-E, acronym in Portuguese): A fiscal transfer mechanism in use in

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[a] BioFIN proposes a criteria for identifying financial solutions combining economic, social and environmental aspects. It prioritizes mechanisms capable of: 1) generating new revenues; 2) delivering better conservation through improved effectiveness, efficiency, and synergies; 3) reorienting or realigning existing financing; 4) avoiding future expenditures caused by the loss of biodiversity and ecosystem services[78].

some states (including Acre, Amapá, Mato Grosso, Pará, Rondônia, and Tocantins) which redistributes part of the revenues from the Value Added Tax (VAT in English, ICMS in Portuguese) at the state level to municipal governments based on ecological indica-tors[72].

(ii) Payments for environmental services (PES): Vol-untary or legally-agreed arrangements which encour-age the conservation of ecosystem services by offering financial or other economic incentives. In the Brazilian case, most PES programs are related to water con-servation or carbon emissions avoidance.

(iii) Environmental Reserve Quotas (CRA for its acronym in Portuguese): An economic mechanism to offset deficits in private properties that do not enforce the minimum standards for native forest protection. Properties with less forest cover than the minimum legal requirement may compensate for their deficit on another property so long as both properties are located in ecologically-equivalent regions[73].

(iv) Tourism concessions in protected areas: protected areas administrated by public agencies sign agreements with tour operators (private companies or civil society organizations), involving different tourism-based activities (e.g., tickets, transportation, restaurants, souvenir shops) collecting revenues to support conservation while promoting sustainable development for local communities[74,75].

(v) Forest concessions in protected areas: Agreements to allow companies or communities to sustainably exploit non-timber resources from public forests; this encourages value chains for non-timber products, creates local jobs, and generates revenue for public administration[76].

These solutions have the potential to create large-scale economic opportunities. Even though many of these instruments are based on private business, they require the active involvement of the public sector, through fiscal or regulatory instruments. There is a need to adapt such financial mechanisms to local political and institutional contexts. In Brazil, weak public management capacity, institutional uncertainties, and political opposition to environmental policy are the main obstacles to large-scale implementation of these instruments.

In Colombia, UNDP (2021)[77] proposes a Biodiversity Credit System, based on the concept of "habitat banks", in which private companies fulfill obligations by buying or selling "credits" in areas where compensation requirements are merged. Also, they implement actions for the preservation, improvement, or restoration of ecosystems to compensate for negative impacts on biodiversity. It is estimated that approved, licensed projects can finance up to USD 4 million from pending compensation obligations[77]. Another possibility for Colombia is the use of royalties in areas of environmental interest, such as paramos, mangroves, or dry forests. This includes projects aimed at controlling deforestation and protecting biodiversity in the territories with the highest deforestation rates. In this case, it is estimated that a minimum of USD 98 million could be available to enhance both the execution of the public budget and the influence in the formulation of the investment budget[77].

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