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THE BIG CLIMATE SOLUTION OF THE

Amazon Forest

NEEDS THE CARBON MARKET

On the road to COP 30, Brazil can unlock the carbon market and lead the world in nature-based solutions to the climate emergency

AUTHORS AND RESPONSIBLE INSTITUTIONS

Authors:

Daniel Nepstad[1], Ronaldo Seroa da Motta[2], Juan Pablo Ardila[1], Monica De Los Rios[1], André Moura Andrade[1], Luiza Muccillo[1], Lucelia Avi[1], Francis Rinaldi Frigeri[1], Thuanny Vieira[1]

Institutions:

Earth Innovation Institute, Berkeley, California and Cuiabá, Mato Grosso[1]; State University of Rio de Janeiro, Rio de Janeiro[2].

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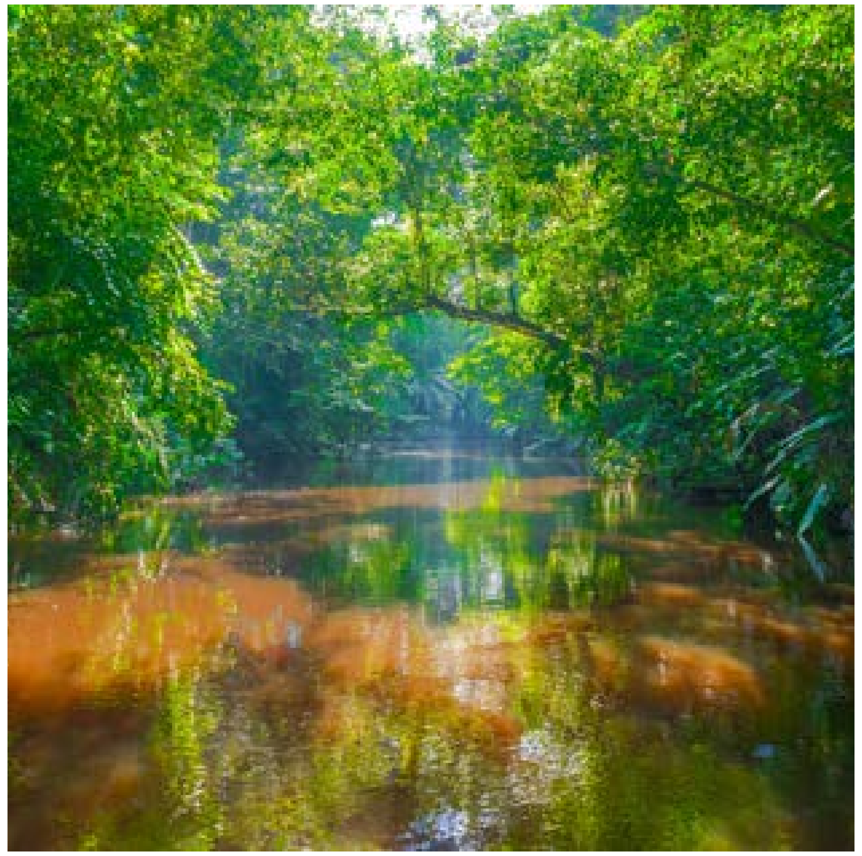

Executive Summary

01 In recent years, the Amazon forest has become a net source of 1 to 3% of global anthropogenic carbon emissions and around half of Brazil's emissions as the strength of the primary forest “carbon sink” has weakened.

02 The Amazon forest could again become a major carbon sink–a giant “sponge” that absorbs 1 to 2% of global emissions–if deforestation continues to decline steeply, if innovations in forest fire prevention and control are replicated, and if natural forest regeneration is released on abandoned lands; this transition would bring major social and economic benefits inside and outside the Amazon, including sharp declines in illnesses and deaths from air pollution.

03 If the transition occurs quickly, building upon the recent 45% decline in Brazilian Amazon deforestation, the “Amazon forest climate solution” (AFCS) could deliver twice the net emissions reductions from 2025 through 2030 as the 27 nations of the European Union are on track to achieve during the same period.

05 This AFCS is achievable in the near future, through a transition to a new forest economy, that produces more food on an ever smaller land area, diversifies production and values the forest.

05 For the AFCS to succeed, significant new funding that is efficiently deployed on the ground will be needed.

06 In the short term, the sale of carbon credits from "Jurisdictional REDD+" (JREDD+) programs is the only mechanism that is ready to play this role.

07 JREDD+ promotes Reductions in Emissions from Deforestation and forest Degradation and increases in carbon removal by naturally-regenerating or restored forests (hence the acronym, "REDD+") that are certified as carbon credits that can be sold to generate revenue to fund the shift to a new forest economy.

08 Unlike private forest carbon projects, that focus on emissions reductions and enhanced removals at the scale of individual farms or community territories, JREDD+ rewards the collective performance across entire states or nations.

09 JREDD+ revenues are allocated to programs developed specifically for and with indigenous peoples, traditional communities, farm sectors and others; participation in these programs is voluntary, and they place no restrictions on how land managers use their land–another major distinction from private projects.

10 JREDD+ credits are only certified if social safeguards are observed through extensive consultation with all key rural stakeholders and respecting indigenous territories, conservation areas, and land use rights in accordance with the Forest Code.

11 The JREDD+ programs of the states of Brazil's Legal Amazon could generate a revenue of $10 to $20 billion from emission reductions between 2023 and 2030 and a price per credit of $10 to $20. Four states that are most advanced in JREDD+ programs could issue 100 million credits in 2026. The emissions reductions already achieved in 2023 and 2024 reductions could generate revenue of $1.5 billion in 2026, a bit larger than the total volume of donations to the Amazon Fund since 2008.

12 The JREDD+ programs are best seen as a bridge mechanism, accelerating the transition to the AFCS while other mechanisms, such as the Tropical Forest Forever Fund, are designed and implemented. This opportunity is even more relevant given the downturn in the carbon market, caused in part by questions about the integrity of the credits generated by isolated forest carbon projects.

13 JREDD+ is threatened today by widespread misunderstanding of how it works

14 The Brazilian government, as host of COP 30, is poised to unlock the potential of JREDD+ by:

- Building confidence in forest carbon credits through deeper understanding of JREDD+;
- Engage JREDDD+ programs of Brazilian States in carbon credit transactions under Article 6 of the Paris Agreement;
- Encouraging Petrobrás to lead oil & gas companies to buy JREDD+ credits;
- Building JREDD+ into commodity trade relationships, beginning with China.

Introduction

Nature is a huge global carbon pollution sponge.

- The world's forests, grasslands and soils absorb a third of the carbon dioxide released into the atmosphere by human activities each year; together with the oceans, nature absorbs more than half of humanity's carbon pollution[1].

- Protecting and enhancing this large global "carbon sink" must be a top priority of efforts to solve the climate emergency; it is the mega short-term solution that gives the world time to decarbonize energy systems.

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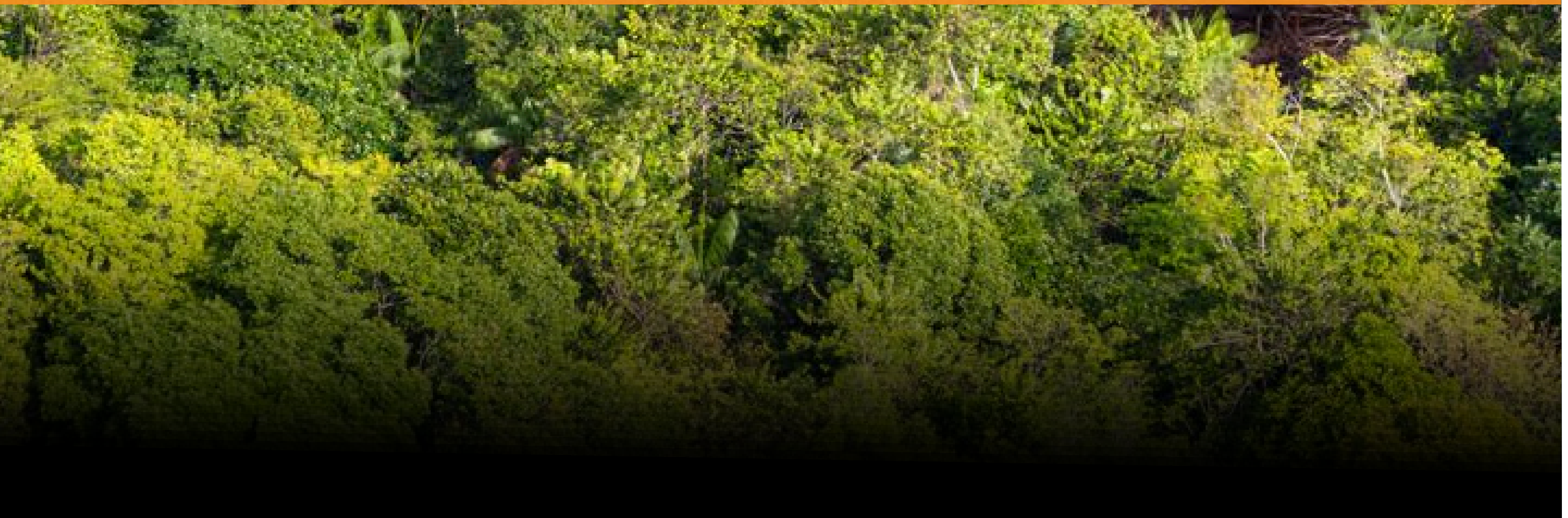
THE BIG AMAZON FOREST CLIMATE SOLUTION

the first major ecosystem where humanity could begin to secure and strengthen the natural terrestrial carbon sink.



The Amazon Forest Climate Solution (AFCS), described in this report, could reduce net emissions by 1.5 GtCO2eq between 2025 and 2030, nearly twice the reduction target of 0.8 GtCO2eq over the same period for the 27 countries of the European Union[2] (see Figure 1). This estimate is based upon a synthesis of the best available data and projections and can be considered as an illustration of the potential magnitude of the AFCS, albeit with significant uncertainties (see Annex 1).

- The EU is decarbonizing its economy faster than any other bloc of countries in the world, supported through a series of public policies including an emissions trading system (EU ETS) set up in 2005.

To be sustainable in the long run, the AFCS must be grounded in a new forest economy that is improving the livelihoods and well-being of indigenous peoples, traditional communities and farmers by increasing the value and volume of forest and farm products.

The primary forests of the Amazon are a carbon sink, although the amount of carbon they accumulate has been falling over time[3].

- This sink is estimated at 2.0 GtCO2eq from 1990-1999 falling to 0.7-1.4 GtCO2eq in 2000-2009; (see Annex 1).

The opportunity of the Amazon climate solution should be highlighted at COP 30, the first UN climate summit within the Amazon.

THE AMAZON FOREST AND RAIN

Rain in the Amazon[4] and beyond[5] depends on the forest itself because of the large amount of water vapor it releases to the atmosphere throughout the year, even during long dry seasons[6].

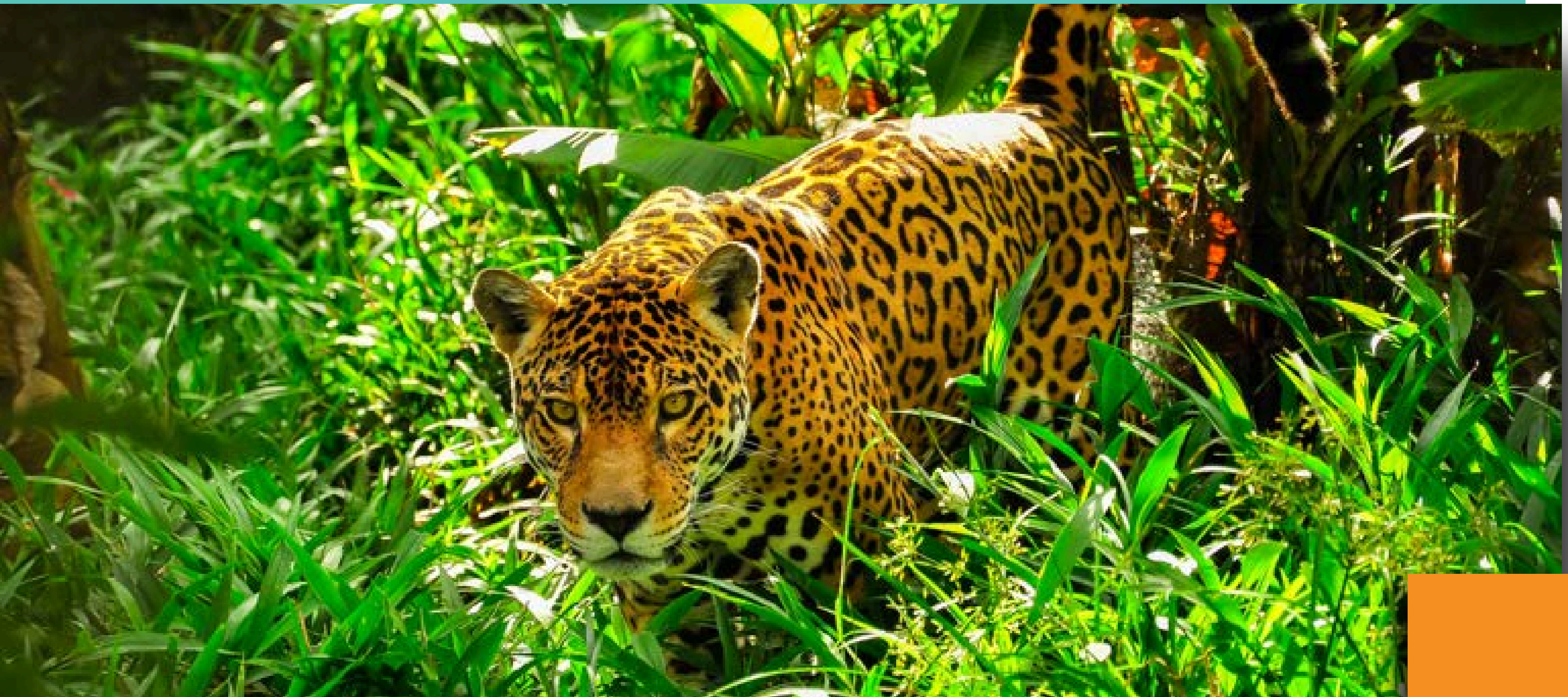
- The future of Brazilian agriculture[7], the food security of rural communities and flood control in Brazilian cities is more secure with more forests.

Forest loss destabilizes rainfall in the Amazon, increasing the degradation of tall, carbon- and species-rich, fire-resistant forests to become short, carbon- and species-poor vegetation that is susceptible to fire. A vicious downward cycle is already happening in which forest loss together with climate change causes increasingly severe droughts, increasing forest fires, which further weakens the rainfall system[8,9,10].

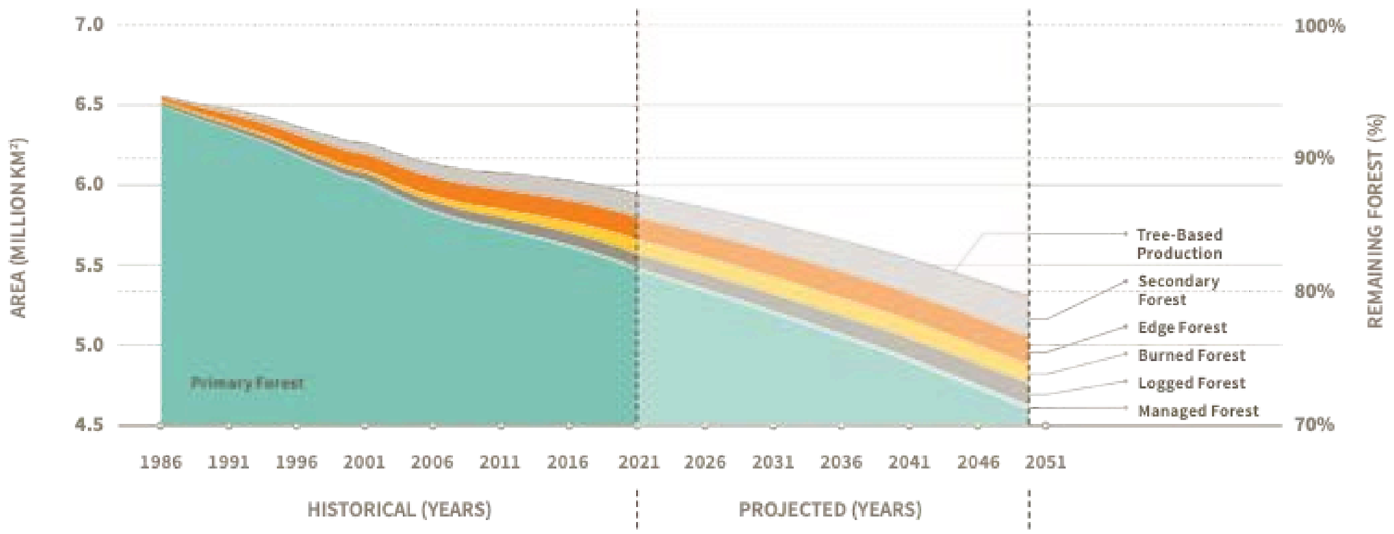
In the southeastern Amazon, the dry season is already one month longer because of the combined influence of forest loss and climate change[4].

AMAZON FOREST AND CARBON TRAJECTORIES

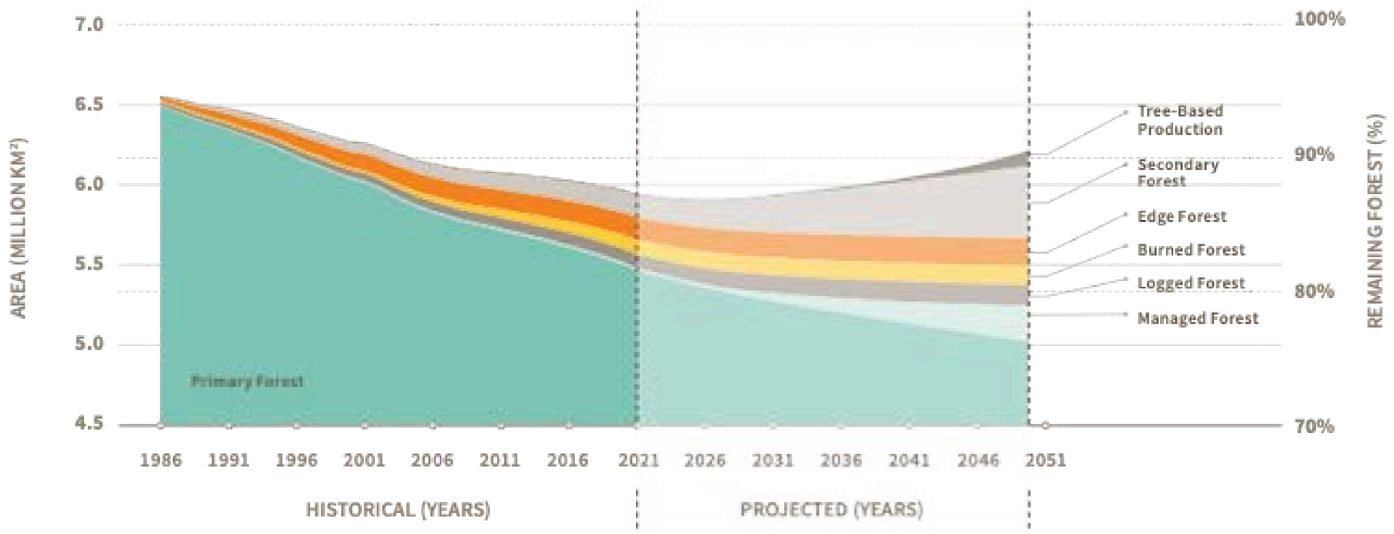
Figure 1: Trajectories of Amazon forest area (primary, degraded, secondary) and the net forest carbon emissions resulting from these changes in forest area under the "business-as-usual" scenario and the "Amazon forest climate solution" scenario. Assumptions and methodology can be found in Annex 1.



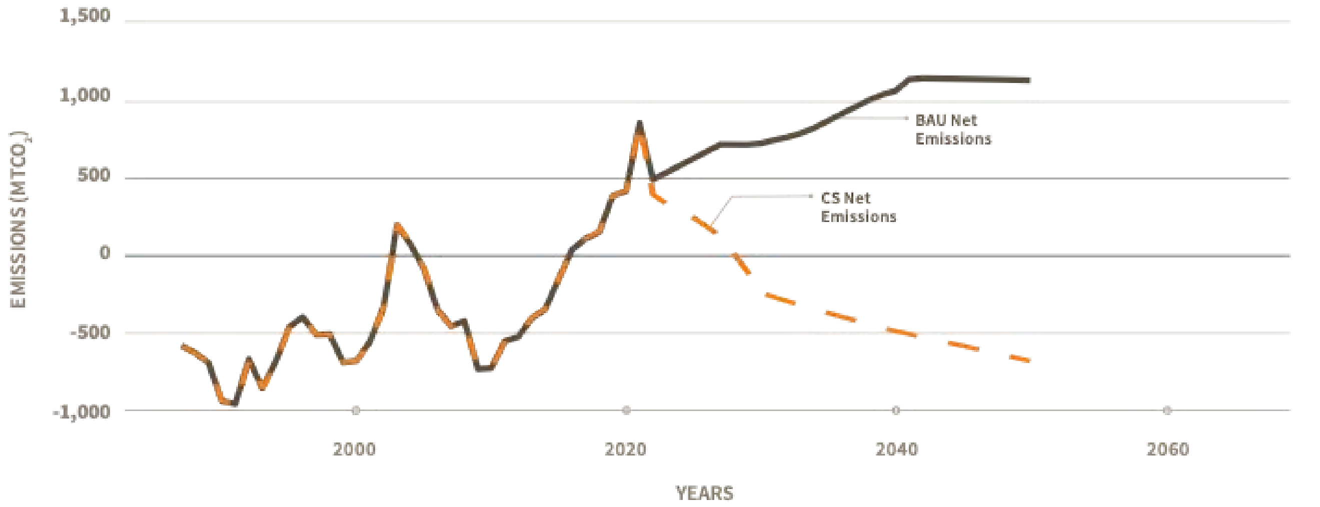
PanAmazon Area | *Business as Usual Scenario*



PanAmazon Area | *Climate Solution Scenario*



Net Emissions BAU and CSS Scenario



The steps to achieve the Amazon solution are challenging but feasible. In the Brazilian Amazon, they are:

Continue slowing deforestation

Accelerate

the increase in livestock productivity that is already underway[11], with special focus on including calving operations run by small-scale producers;

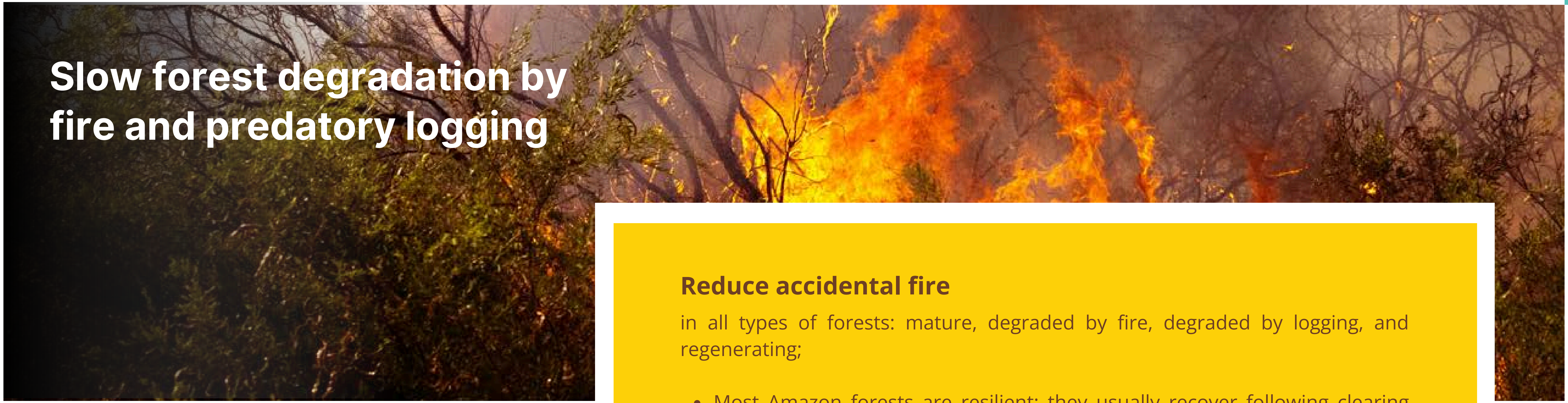
Diversify

production on land that is “freed up” by intensifying production livestock, with agroforestry systems, perennial crops, fish farming and other “low carbon” production systems; this diversification becomes easier when the risk of accidental fire is greatly reduced; and

Facilitating and Enforcing Legal Compliance

with the Forest Code and other land legislation, continuing the implementation of federal and state Plans for the Prevention and Control of Deforestation and Forest Fires; modernizing the government agencies responsible for implementing the law.

Slow forest degradation by fire and predatory logging



Reduce accidental fire

in all types of forests: mature, degraded by fire, degraded by logging, and regenerating;

- Most Amazon forests are resilient; they usually recover following clearing and degradation if they are protected from fire, absorbing carbon and feeding the region's rainfall system with year-round evapotranspiration.
- Forest fires can be greatly reduced through decentralized and integrated fire management plans, as required now by the National Integrated Fire Management Policy[12] and as is demonstrated by research[13,14].
- Reducing accidental fires would bring tremendous social benefits such as lower rates of respiratory diseases and mortality caused by exposure to fire smoke[15], a lower risk of losing investments in tree-based production systems, improved pastures, fencing, and buildings; and fewer interruption of transportation and transmission routes for energy.

Eliminate predatory logging

by accelerating the industries transition to reduced-impact logging practices;

- Low-impact logging reduces forest damage without reducing profitability[16].

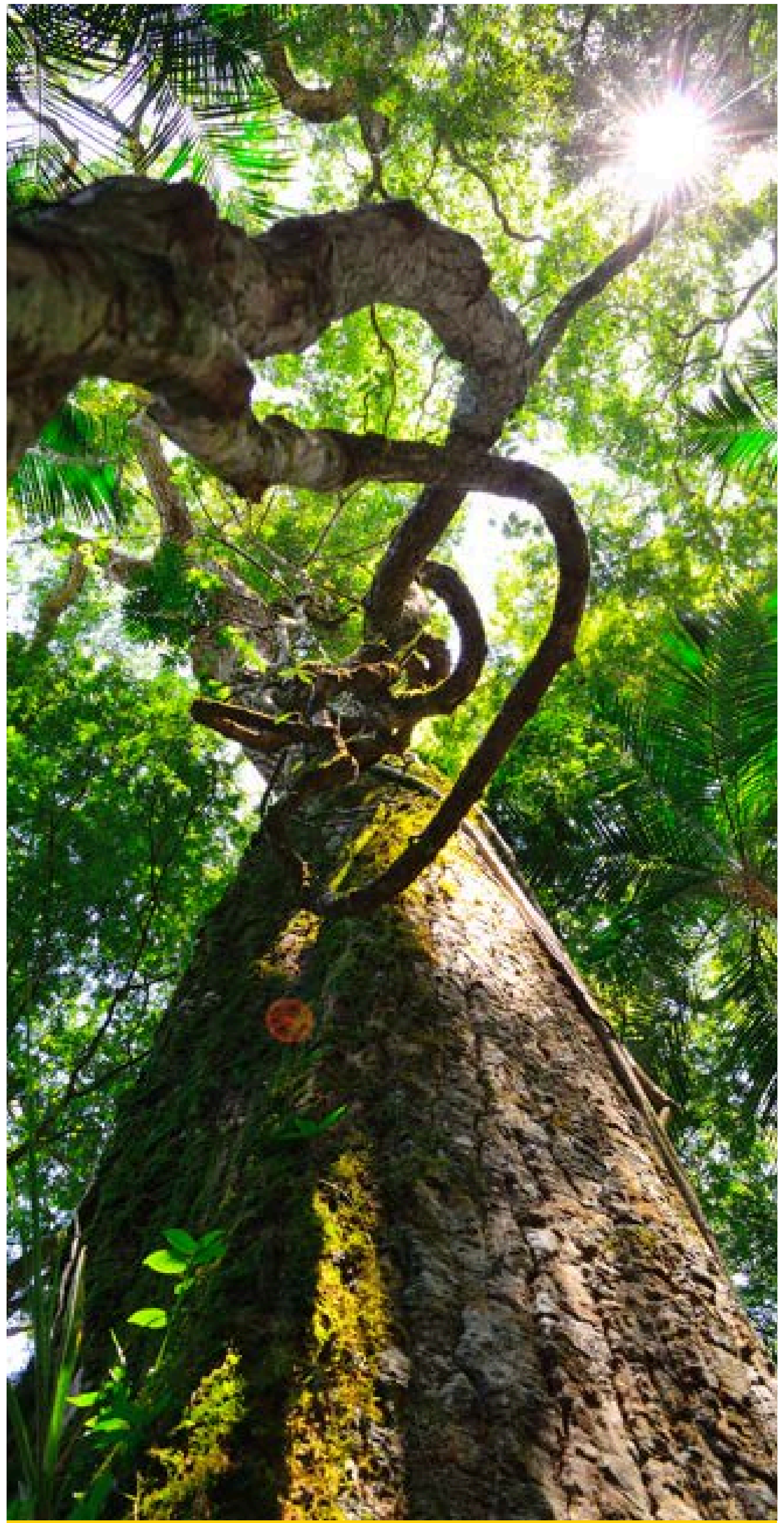
Regenerate and restore forests

Allow forests to regenerate on land that was cleared then abandoned

- 21% of deforested land[17] in the Amazon is marginal for production and, hence, abandoned or semi-abandoned, returning to forest through natural forest regeneration.
- Secondary forests help maintain rainfall in the region by recovering the year-round evapotranspiration of the primary forest[18].
- Regulations adopted by many Brazilian states[19] requiring a license to clear secondary forest once they surpass a threshold size, creating a perverse incentive for rural landholders to keep their secondary forest from getting too big.
- A system of positive incentives is needed for landholders who maintain their secondary forests, unlocking a major expansion of the area of these forests.

Focus forest restoration in areas with low potential for natural regeneration

Forest restoration is much more expensive than natural forest regeneration and should be used where there are barriers to natural regeneration.



Bioeconomy

Indigenous peoples, traditional communities and farmers need new bioeconomies to increase their well-being and income.

Non-timber forest products, perennial crops and fish farming can generate revenues of up to R$4,000.00 per hectare[20].

THE JREDD+ PROGRAMS OF BRAZILIAN STATES ARE KEY TO ACHIEVING THE AMAZON CLIMATE SOLUTION

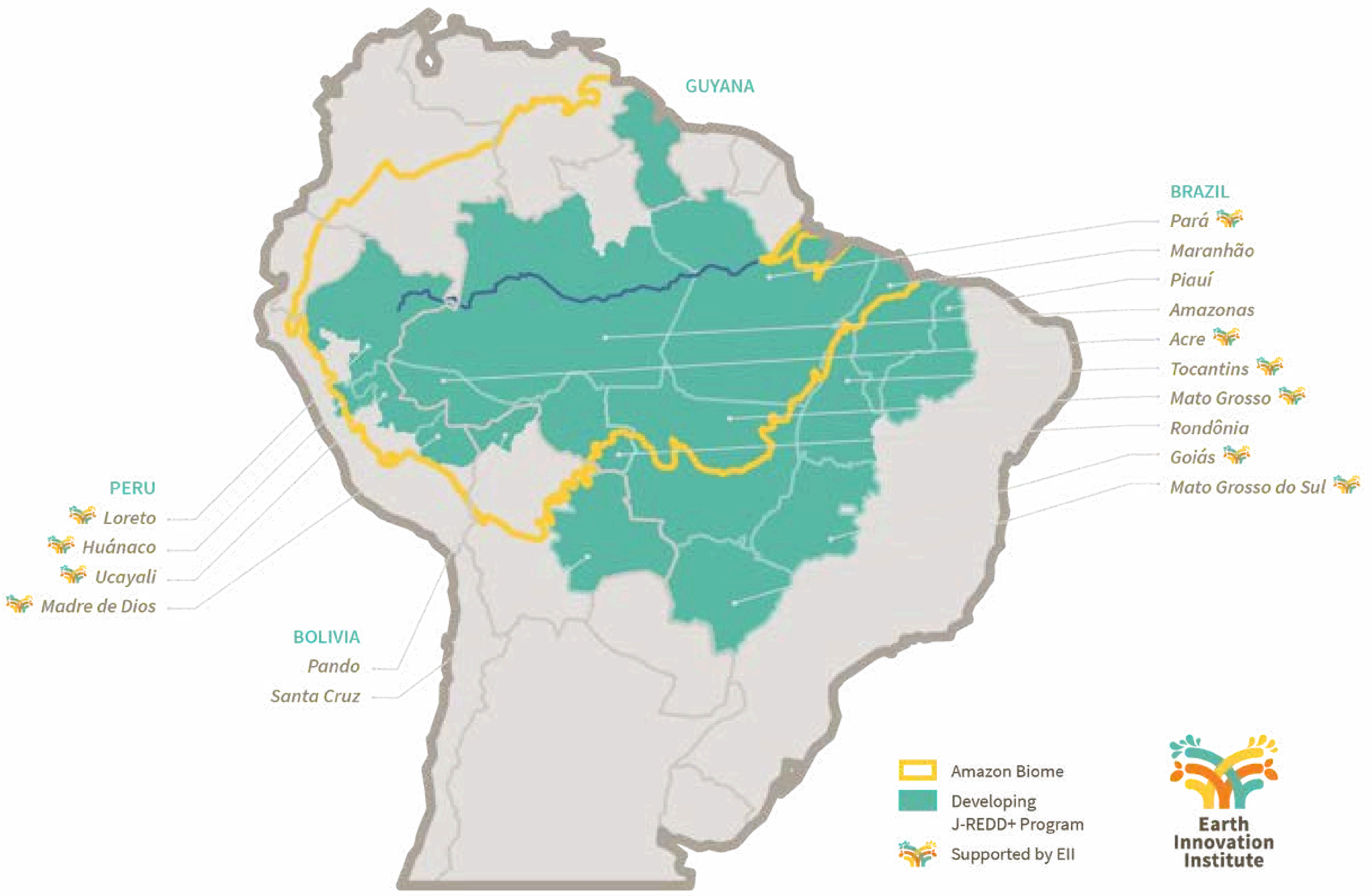


Figure 2. Map of states and one nation (Guyana) that are developing or hoping to develop JREDD+ programs with the intention of selling carbon credits. The regional governments of Peru are waiting for permission from the national government to go ahead.

Most of the Amazon and Cerrado Biomes of Brazil are Located in States that are Developing JREDD+ Programs

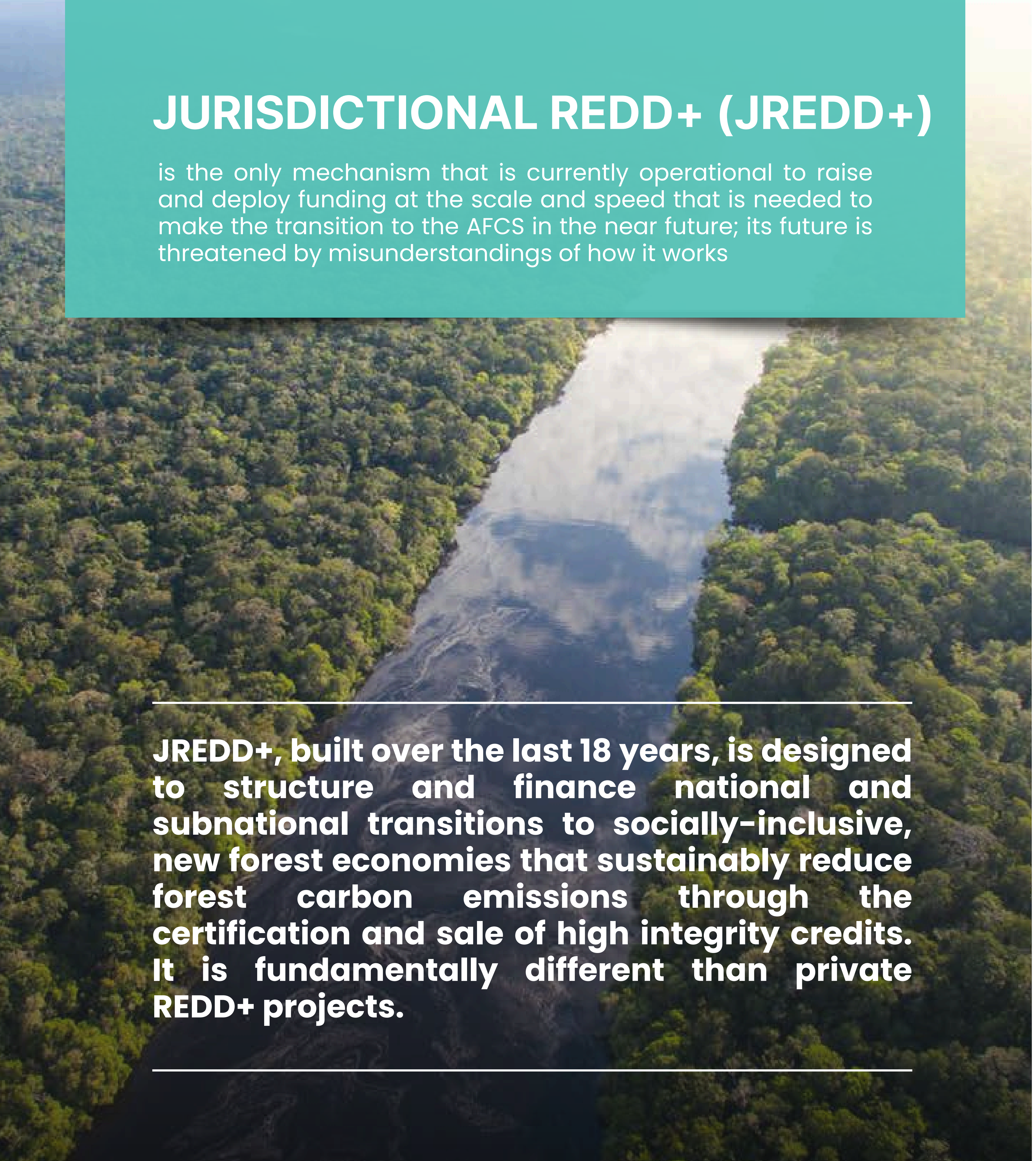
Nine states in the Amazon and Cerrado biomes of Brazil are developing jurisdictional REDD+ programs

Two Brazilian states, Pará and Tocantins, have signed Emissions Reduction Purchase Agreements (ERPAs) with companies that have committed to buy credits once they are issued; these credits would be based upon emissions reductions that were already achieved; as of June 2025, no states have issued credits.

Two states, Acre and Mato Grosso, have previous experience with JREDD+ through the "pay-for-performance" mechanism, in which donors pay for emissions reductions but do not receive carbon credits in return. This is the mechanism behind Brazil's Amazon Fund.

- Acre and Mato Grosso are likely to sign ERPAs with buyers over the coming months,

In developing their JREDD+ programs, the states of Acre, Pará and Tocantins are currently engaged in intensive consultation processes with indigenous peoples, traditional communities, and farm sectors to gather input to proposed benefit-sharing strategies and sector-specific subprograms.



JURISDICTIONAL REDD+ (JREDD+)

is the only mechanism that is currently operational to raise and deploy funding at the scale and speed that is needed to make the transition to the AFCS in the near future; its future is threatened by misunderstandings of how it works

JREDD+, built over the last 18 years, is designed to structure and finance national and subnational transitions to socially-inclusive, new forest economies that sustainably reduce forest carbon emissions through the certification and sale of high integrity credits. It is fundamentally different than private REDD+ projects.

In general, JREDD+ programs that adopt the TREES standard (The REDD+ Environmental Excellence Standard) are systemic[21], deeply participatory[22], and conservative[23], underestimating climate benefits.

Widespread misunderstanding of how JREDD+ works could weaken or kill JREDD+ programs, costing Brazil billions of dollars in funding

First, JREDD+ does not constrain or restrict the ways in which indigenous people, traditional communities, or farmers use their land and forests. That is because JREDD+ creates forest carbon credits based upon the collective emissions reductions and enhanced removals of entire states and nations. It does not tie credits to the emissions or removals that take place on individual farms or community territories.

Second, JREDD+ is voluntary. It operates offering conservation incentives through public policies and laws and through tailored programs for indigenous peoples, traditional communities and farmers that are developed with their participation, but who are not obliged to participate in these programs. JREDD+ consultations processes are, appropriately, designed to provide input to these public policies and programs.

Third, JREDD+ carbon credits are based upon historical emissions reductions and enhanced removals–in other words, changes in forest carbon flows. **It does not establish ownership over the carbon that is stored in forests.** Communities and landholders in states with JREDD+ programs are free to engage in forest carbon projects that are tied directly to the forest carbon in their territories. These project-level credits are simply subtracted from the much larger pool of JREDD+ credits to avoid double counting.

Fourth, JREDD+ provides funding and economic incentives to increase the well-being of indigenous people, traditional communities, farmers and other rural actors and to increase the volume and value of forest and farm products that reinforce forest protection and regeneration.

THE POTENTIAL JREDD+ CREDITS OF THE AFCS THROUGH 2030

are one billion tCO2eq that could generate $10 billion in revenues at a price of $10/tCO2eq

We modeled an AFCS scenario to provide an illustrative example of its potential magnitude :

We assume (summarized in Annex 1):

- Emissions from deforestation and from forest degradation by fire and logging decline 90% by the end of 2030, 95% by the end of 2040, and 98% by the end of 2050 measured against the average annual value from 2018-2022;

    - In Brazil, where deforestation rates have declined 45% since 2022, we assume deforestation declines linearly through 2030 from the lowest level recorded in 2023 or 2024;

- Assumes that the rate at wich secondary forest are cut or burned will fall to half its current rate.
- The primary forest carbon sink, estimated at 2.0 GtCO2eq/year in the 1990s and 0.7-1.4 GtCO2eq/year in the 2000's[24], is assumed to be 0.1 GtCO2eq/year in 2020-2030 declining to zero in the 2030's (Business-as-Usual scenario) and remaining at 0.1 in the AFCS scenario[25].

Under this AFCS scenario, the states of the Brazilian Amazon could issue one billion TREES credits based on emissions reductions from 2023 through 2030.

- This estimate does not include the removal of carbon by the Amazon's secondary forests, which can also be converted into credits using the TREES standard.

The sale of Brazilian JREDD+ credits based upon pre 2025 emissions reduction should begin in 2026, with a potential volume of nearly 100 million sold by the four most advanced states: Acre, Mato Grosso Pará and Tocantins.

- With an average price of $10/credit, these 100 million credits could generate $1 billion. By comparison, all donations to the Amazon Fund since its creation in 2008 total $1.4 billion.

Table 1. Potential jurisdictional REDD+ credits in the states of the Legal Amazon by the end of 2030.

POTENTIAL 'TREES' CREDIT VOLUME (MILLION TONNES OF CO2EQ)									
	Measured		Projected						
State	2023	2024	2025	2026	2027	2028	2029	2030	Total
Acre	11,0	0,9	12,8	14,6	16,4	2,9	5,3	7,7	71,4
Amapa	0,0	0,6	0,6	0,7	0,7	0,2	0,2	0,3	3,2
Amazonas	18,3	8,3	25,6	32,8	40,1	5,4	15,1	24,7	170,3
Maranhão	-5,3	2,2	5,5	8,9	12,3	4,2	7,6	10,9	46,3
Mato Grosso	22,0	-13,1	31,1	40,3	49,4	11,3	23,5	35,7	200,1
Pará	36,9	26,9	51,7	66,4	81,1	8,9	28,5	48,1	348,5
Rondônia	23,1	29,1	31,7	34,3	36,9	3,3	5,9	8,5	172,8
Roraima	3,8	4,3	5,6	6,9	8,2	1,1	2,5	3,8	36,2
Tocantins	17,2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Amazonia Legal	127,0	59,1	164,6	204,9	245,1	37,2	88,4	139,7	1.048,8

- Using the TREES standard, calendar year, and a reference period of 2018–2022 for all states except Tocantins, which used 2015–2019.
- Deforestation emissions estimated from PRODES data using emission factors from the Brazilian FREL. Forest fire emission estimates derived from MapBiomas fire maps and FREL emission factors.
- Based on the premise of a 90% reduction in annual emissions from 2018–2022 to be achieved by 2030, with a linear reduction starting in the year of the lowest emission (2023 or 2024).
- The volume of potential credits for 2023 is the sum of potential credits from 2020–2023; potential credits for 2024–2030 were not estimated due to the different reference period.

Potential revenue (USD) from the sale of JREDD+ credits by the states of the Legal Amazon through the end of 2030 at a price of $10/tCO_2eq$

POTENTIAL REVENUE FROM THE SALE OF JREDD+ CREDITS (USD MILLIONS)									
	Measured		Projected						
State	2023	2024	2025	2026	2027	2028	2029	2030	Total
Acre	$ 110	$ 9	$ 128	$ 146	$ 164	$ 29	$ 53	$ 77	$ 714
Amapa	$ (0)	$ 6	$ 6	$ 7	$ 7	$ 2	$ 2	$ 3	$ 32
Amazonas	$ 183	$ 83	$ 256	$ 328	$ 401	$ 54	$ 151	$ 247	$ 1.703
Maranhão	$ (53)	$ 22	$ 55	$ 89	$ 123	$ 42	$ 76	$ 109	$ 463
Mato Grosso	$ 220	$ (131)	$ 311	$ 403	$ 494	$ 113	$ 235	$ 357	$ 2.001
Pará	$ 369	$ 269	$ 517	$ 664	$ 811	$ 89	$ 285	$ 481	$ 3.485
Rondônia	$ 231	$ 291	$ 317	$ 343	$ 369	$ 33	$ 59	$ 85	$ 1.728
Roraima	$ 38	$ 43	$ 56	$ 69	$ 82	$ 11	$ 25	$ 38	$ 362
Tocantins[5]	$ 172	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Amazônia Legal	$ 1270	$ 591	$ 1.646	$ 2.049	$ 2.451	$ 372	$ 884	$ 1.397	$ 10.488

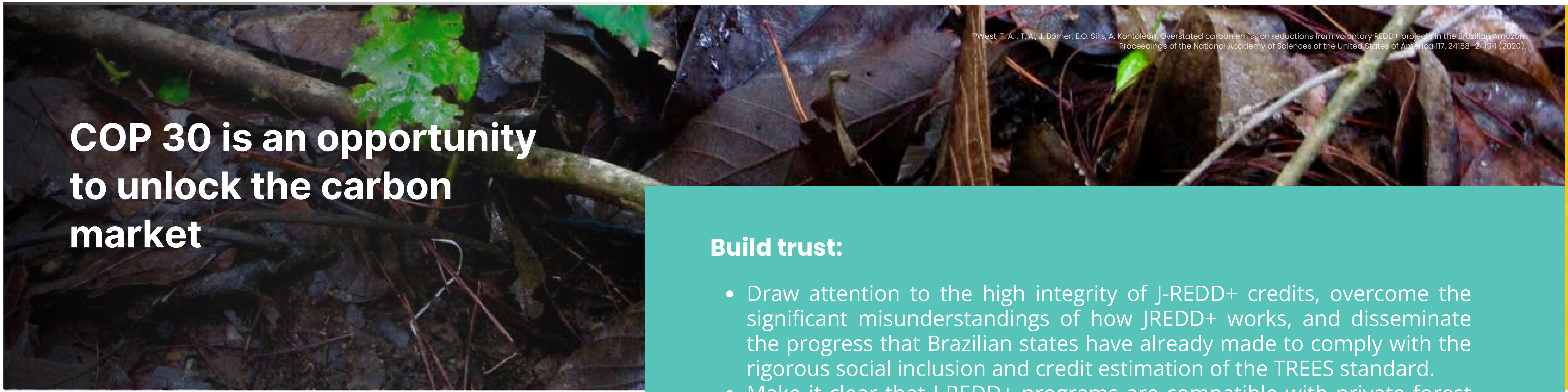
- Note: It takes 2 to 3 years for emission reductions to be certified as credits and sold.

The voluntary carbon market is retreating just as Brazilian states are preparing to issue and sell a large volume of credits

- The volume and price of credits on the voluntary market fell again in 2024 as confidence in credits continue to fall, in part because of evidence of overestimated their climate benefits[26] and inadequate consultation of private REDD+ projects.

- Total global transactions of voluntary carbon credits have been reduced to 84 MtCO2e from the peak of 516MtCO2e in 2021. Although forest and land-use private carbon credits have remained around 37 MtCO2e in the period 2023-2024, they have also declined from the peak of 227 MtCO2e in 2021 to of 227 227 MtCO2e in 2021[27].

- Note that the states of PA, TO, AC and MT, as shown before, alone could offer credits already in 2026 above the current trade levels. JREDD+, due to its high climate and social integrity, represents a response to the crisis of confidence in forest carbon credits opening up the demand for voluntary transactions. Therefore JREDD+ should not be hindered by internal regulatory barriers, which reinforces the urgency of regulating Law 15.042, which establishes the Brazilian Emissions Trading System.



COP 30 is an opportunity to unlock the carbon market

In order to close major deals for the sale of high integrity credits from Brazil's J-REDD+ programs en route to COP 30, complementing and benefiting from the current focus on the new “Tropical Forest Forever Fund”, the Brazilian government is poised to:

Build trust:

- Draw attention to the high integrity of J-REDD+ credits, overcome the significant misunderstandings of how JREDD+ works, and disseminate the progress that Brazilian states have already made to comply with the rigorous social inclusion and credit estimation of the TREES standard.
- Make it clear that J-REDD+ programs are compatible with private forest carbon projects and fully aligned with Brazil’s COP 30 and NDC goals

Create opportunities for state JREDD+ credits in Article 6.2:

- Make it clear to Brazilian states that they will have access to transactions under Article 6.2 of the Paris Agreement if Brazil exceeds its 2030 target. With the prospect of higher prices for their JREDD+ credits, as is expected through Article 6.2, states can do more to reduce emissions.
- In one scenario, an emission reduction threshold could be established for states that is linked to the minimum emissions reductions and increases in removals that will be needed to reach Brazil’s 2030 Nationally-Determined Contribution goal under the Paris Agreement; states could transact their emissions reductions beyond this threshold as part of a national program for the international transfer of mitigation results (ITMOs) under Article 6 of the Paris Agreement.

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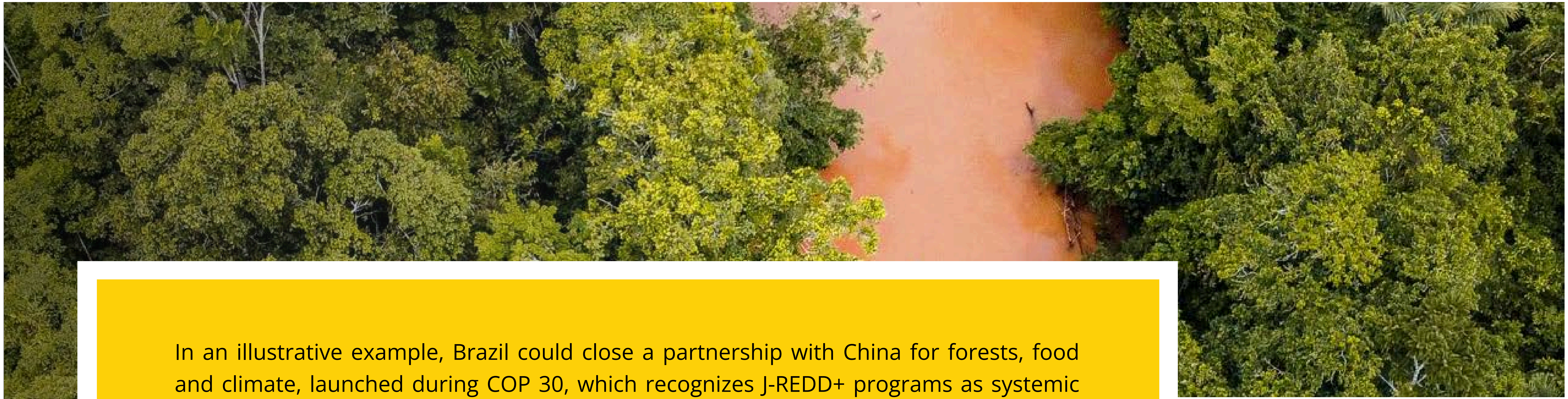
Petrobras' role

- Petrobras could lead a group of oil companies which, during COP 30, commit to buying JREDD+ credits equivalent to a small percentage of their "scope 3" emissions (from the combustion of their oil and gas).
- For example, a volume of purchases equivalent to 1% of Scope three emissions from the entire gas and oil industry would increase tenfold the current demand for forest and land-use credits in the voluntary market.

Promote J-REDD+ programs in international trade relations

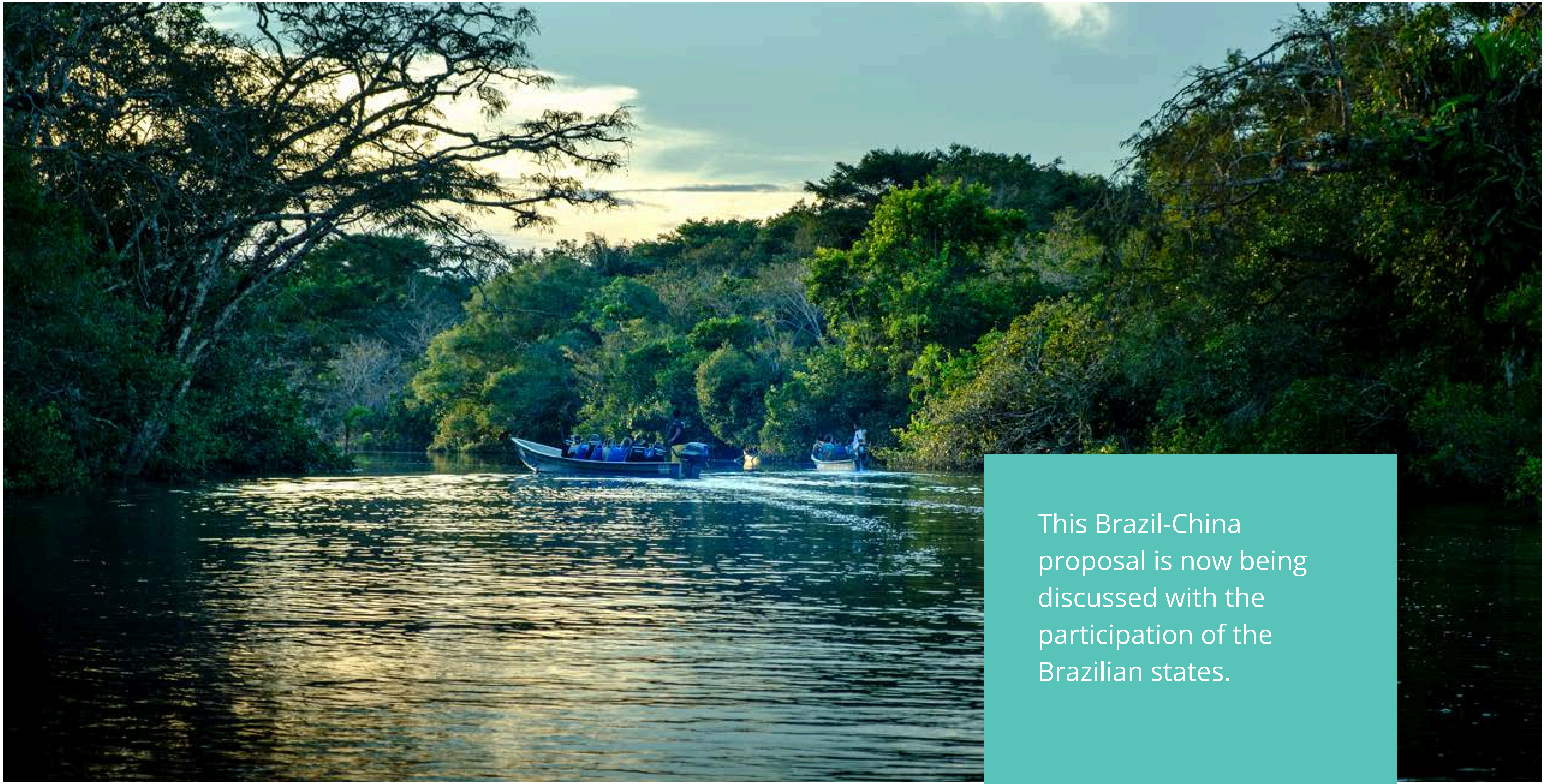
J-REDD+ provides an opportunity for supply chain initiatives that are designed to reduce deforestation, currently focused on farm-level deforestation cut-off dates, to establish a link with regional deforestation reductions and with the public policies behind these reductions.

- Today, this link does not exist. Supply chain initiatives against deforestation, such as the Soy Moratorium and the European Union's deforestation regulation (EUDR), have no way of recognizing or supporting regional declines in deforestation.
- Trade relations in agricultural commodities could bring financial benefits to Brazil through the sale of J-REDD+ carbon credits to trading partners, either in the context of voluntary decarbonization strategies or for compliance with mandatory targets.



In an illustrative example, Brazil could close a partnership with China for forests, food and climate, launched during COP 30, which recognizes J-REDD+ programs as systemic approaches to solving deforestation and forest degradation.

- The food trade relationship between Brazil and China is the largest in the world; China could recognize the J-REDD+ programs of Brazilian states wich include major exporters of soy and beef, investing in these programs through the purchase of credits.
- Chinese demand today for beef from precocious animals, called “BoiChina[28]” and motivated by Chinese concern about “mad cow” disease (Bovine spongiform encephalopathy), is aligned with the intensification and greater productivity of production systems livestock in Brazil, a major national priority under the “Green Path” program[29]. BoiChina, by promoting precocious animals, also reduces the density of methane produced by fermentation enteric-something not yet accounted for in this commercial relationship.



This Brazil-China proposal is now being discussed with the participation of the Brazilian states.

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[21] JREDD+ programs demand greater capacity and transparency from public institutions, strengthening environmental governance and the creation and alignment of public policies.

[22] JREDD+ programs are required to carry out a lengthy consultation process to engage stakeholders — traditional and indigenous communities, rural producers and other economic agents, both public and private — to ensure the social integrity of the results and compliance with socio-environmental safeguards.
West, T. A. , T. A., J. Börner, E.O. Sills, A. Kontoleon. Overstated carbon emission reductions from voluntary REDD+ projects in the Brazilian Amazon. Proceedings of the National Academy of Sciences of the United States of America 117, 24188–24194 (2020).

[23] For example, the J-REDD+ standard, TREES, does not allow crediting of carbon removals from forests degraded by fire or predatory logging and protected from fire, it uses a historical baseline that is reduced every five years. Increased emissions caused by climate change itself, such as the severe drought and large-scale wildfires of 2024, are not recognized by TREES. Moreover, the TREES standard requires deep deductions from potential carbon credits to account for leakage, uncertainty and performance reversals.

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[25] We assume that the greater forest cover under the AFCS scenario will mean more stable rainfall and fewer severe drought events.

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ANNEX 1. DATA AND ASSUMPTIONS USED TO ESTIMATE THE MAGNITUDE OF THE AMAZON FOREST CLIMATE SOLUTION SCENARIO

Estimates of historical and future trajectories of mature, degraded and secondary forest areas across the PanAmazonian region and the emissions and removals associated with these trends were based on scientific literature and official data wherever possible. The ACFS scenario developed here is only one of many possible ACFS trajectories of forest loss, degradation and recovery. We provide it as an illustrative example of the potential magnitude of the ACFS and the potential near-term revenues JREDD+ could provide if this scenario is implemented.

This Policy Brief presents a summary of the findings of a study that we are in the process of publishing in the peer review literature.

Deforestation:

The future trend of deforestation was based on the area of annual deforestation estimated by the INPE PRODES program (2024) in Brazil and by MapBiomas (2024) for the other countries.

For the BAU scenario, we assumed that the average annual deforestation area for the period 2017-2021 would continue through 2050.

In the AFCS (CS) scenario, we used this same historical average, decelerating by 90% in a linear path between 2023 through 2030, by 95% from 2031 through 2040 and by 98% from 2041 through 2050.

Forest fire:

In the BAU scenario, estimates of the area of forest fire were based on measurements by Matricardi et al. (2020, extrapolated to the PanAmazon) for the period 1986-2000 and by Brando et al. (2020, extrapolated for the PanAmazon, R8.5 climate scenario) for the period 2001-2050. In this scenario, we assume 80% of burned forests are subsequently deforested (Matricardo et al. 2020), that forests lose 36% of their biomass following fires (which assumes some recurrent fire), and that burned forests accumulate 1.5 tC/ha/year for 12 years following fire.

In the CS scenario, we assume the same historical values as in the BAU scenario, but decelerating by 90% linearly from 2023 through 2030, 95% from 2031 through 2040 and 98% from 2041 through 2050.

Logging:

We estimated the area of degradation due to predatory logging based on Nepstad et al. (1999) and Asner et al. (2005) extrapolated to the Pan-Amazon, with the same levels of biomass loss and accumulation as following fire. As with fire, we assume 80% of logged forests are subsequently deforested (Matricardo et al. 2020). In the CS scenario, we assumed a shift to low-impact logging at the same rate as reductions in deforestation; as a result, the percentage of logged forest area that is subsequently deforested declines as the logging industry continues its shift to low-impact harvest and as the area of deforestation declines.

ANNEX 1. DATA AND ASSUMPTIONS USED TO ESTIMATE THE MAGNITUDE OF THE AMAZON FOREST CLIMATE SOLUTION SCENARIO

Forest edge effects:

We estimated the area of forest edge degradation based on the Matricardi et al. 2020 study extrapolated to the PanAmazon. In the CS scenario, we assumed that the area of forest affected by edge effects will decline linearly in tandem with the area of deforestation in the CS scenario. Biomass loss and accumulation are as for forest fire.

Secondary forests:

The historical change in area of secondary vegetation for the PanAmazon was based on MapBiomas (ref). Under the BAU scenario, this historical trend was assumed to continue into the future, with small net gains in area each year as abandonment outpaces clearing or burning. Under the CS scenario, we assume that the annual of loss of secondary forest declines by half, resulting in a secondary forest area that is expanding and growing older far more rapidly than under BAU. We assume that secondary forests on average accumulate 2.4 tC/ha/year (ref).

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