

Climate Adaptation in the Amazon

Developing Pathways for Effective Strategies

Key messages

- The Amazon faces climate threats that place it under increasingly high risks, requiring strategic adaptation and resilience actions, integrating the social, biophysical, economic, and institutional dimensions in Amazon biome.
- Adaptation actions must prioritize the most vulnerable populations, recognizing the relationships of economic, cultural, physical, and human interdependence that exist between the forest, climate, and society.
- Stakeholders must structure each strategic activity at the convergence of scientific knowledge, political negotiations, and international partnerships to ensure their benefits.
- The pursuit of reducing and nullifying the negative impacts of extreme climate events on Amazonian societies serves as a starting point for prioritizing local actions.



Why Extreme Climate Events Matter

Climate change knows no national borders. In the Amazon region, the climate crisis intertwines social inequalities and ecological transformations. The biome's climate mechanisms connect eight countries through Amazonian atmospheric circulation, while human actions directly influence this pattern and affect supply, water security,

and social stability.^{1,2} The core of the adaptation agenda for the Amazon is to understand that the climate crisis is no longer a future problem, but is already materializing in the present. Understanding social, economic, and climate risks is the first step to defining priorities, organizing action agendas, and directing resources strategically.³

Glossary

SUSTAINABLE DEVELOPMENT GOALS (SDGS)

Set of 17 global goals established by the United Nations to eradicate poverty, protect the planet, and ensure prosperity for all by 2030. The SDGs cover topics such as zero hunger, health, education, gender equality, clean water, renewable energy, climate action, and global partnerships, among others.

2030 AGENDA

UN global plan composed of the SDGs to eradicate poverty, protect the planet, and promote prosperity. The term “2030” refers to the established deadline: by the year 2030, the 193 signatory countries propose to achieve the designated goals through integrated actions in social, economic, and environmental dimensions.

FLYING RIVERS

In the Amazonian context, tree evapotranspiration releases enormous volumes of moisture that are carried by trade winds from east to west; upon encountering the Andes mountain range, they are diverted south, bringing rain to the Center-West, Southeast, and South of Brazil, as well as neighboring countries.

GLOBAL ADAPTATION INDICATORS

Internationally standardized metrics to measure and monitor the progress of climate change adaptation actions in different countries and contexts. As of this publication date, this is still in progress.

SSP5-8.5 (SHARED SOCIOECONOMIC PATHWAY 5-8.5)

Climate scenario of globally shared socioeconomic trajectory, represents a future of high greenhouse gas emissions. This scenario projects a world where development is fueled by fossil fuels, with accelerated but unequal economic growth, absence of effective climate policies, and intensive exploitation of natural resources.

SOCIO-ENVIRONMENTAL VULNERABILITIES AND THE URGENCY OF ADAPTATION

Beyond climate scenarios and projections that already demonstrate increasing temperature and decreasing total precipitation in the Amazon, climate extremes are increasingly growing in frequency, intensity, and duration. These events function as climate “triggers,” initiating the occurrence of cascading impacts on social and ecological systems. An example are the **flying rivers**, which carry moisture and foster the Atlantic-Andes connection, where a climate event in the North Atlantic can act as a trigger affecting the flying rivers, redirecting intertropical convergence zone and propagating a drought scenario. This generates long-range transboundary risks that can destabilize the region’s political and social systems.⁴

The degradation of the biome directly threatens local populations whose survival depends on the forest for food, water, income, and cultural identity. The loss of biodiversity weakens the forest’s resilience and amplifies social risks, creating a vicious cycle in which local and traditional communities become more exposed to extreme events. Amazon is, therefore, the epicenter of shared vulnerabilities: the erosion of its biodiversity means, at the same time, erosion of human capacity to resist and adapt to climate change.^{5,2,13}

Research indicates that the dry season has already become significantly longer, hotter, and drier, and in these regions, the carbon balance has reversed: instead of absorbing, the forest begins to emit,

on average, ten times more CO₂ than areas with deforestation below 20%. Aerial surveys conducted between 2010 and 2018 estimate that, annually, the region emits approximately 87 million tons of CO₂, contributing to strengthen an increasingly worrying cycle of environmental degradation.^{6,7,8}

The Amazon faces unique challenges for advancing integrated planning, which demands coordination among the eight countries, each has its own institutional capacities and national priorities. In this context, strengthening resilience becomes one of the central pillars of the adaptation agenda, recognizing that local mitigation actions are essential, but need to be articulated and expanded from adaption perspective to anticipate and avoid tipping point.

CHANGES IN CLIMATE CYCLES AND THE NEW REALITY

Since 2000, the Amazon has experienced the warmest decades ever documented, marked by four severe droughts (2005, 2010, 2015-16, and 2023-24). Each event was surpassed in magnitude by the subsequent event, demonstrating a clear worsening trend. The main droughts mechanisms are El Niño and the warming of the Tropical North Atlantic Ocean; both events, combined with heat waves, influenced the 2023-24 drought.⁹

Dry Season Length is a critical climate element for sustaining tropical forests, being a tipping point element. Last year drought is a climate extreme event example marked by exceptionally scarce rainfall and heat waves.



DEVELOPMENT OF NATURE-BASED SOLUTIONS FOR VULNERABLE COMMUNITIES IN UPPER TAKUTU

The Amazon Basin Project – Implementation of the SAP (Strategic Action Program from ACTO), in partnership with the University of Guyana and the National Hydrometeorological Service, carried out an innovative Nature-Based Solutions (NBS) intervention in two communities susceptible to recurrent flooding in the Upper Takutu region, in southern Guyana: Lethem and Tabatinga. The action aimed to reduce the impacts of these extreme events, which have intensified with climate change, affecting homes, access roads, economic activities, and generating risks to public health.

In Tabatinga, natural channels were rehabilitated and expanded, streams were desilted, and vegetation barriers were installed along the banks, allowing excess rainwater to drain in a controlled manner and preventing flooding in residential areas.

In Lethem, in the Culvert City neighborhood, artificial depressions with permeable layers were created to function as temporary retention basins, promoting soil infiltration and reducing the volume of water reaching the lowest points in the city.

The results were remarkable. Communities reported a significant decrease in the frequency and duration of flooding, as well as improvements in urban mobility and a reduction in material damage. Hydrological modeling confirmed that areas susceptible to flooding decreased even during episodes of heavy rain.

The interventions also generated additional benefits, such as increased aquifer recharge, sediment control, and landscape enhancement. A central component of the initiative was the strengthening of local capacities: managers and technicians received practical training to plan, monitor, and maintain the measures implemented, ensuring their long-term continuity.



Towards An Integrated Regional Climate Agenda

Amazon is experiencing a decisive moment in which science and policy need to converge to transform commitments into effective results. Concrete action occurs through cooperation between regional, national, and international levels, in a balance between political cooperation and scientific foundation.¹¹ Figure 1 below synthesizes this vision, structured on four integrated action pillars:

In the scope of National Policy, Legitimated Participation represents the consolidation of networks of authorities and executive institutions, ensuring that each Amazonian country is formally represented and has an active voice in decisions. This political dimension strengthens representativeness and ensures that regional strategies are not just technical guidelines, but commitments assumed by governments.

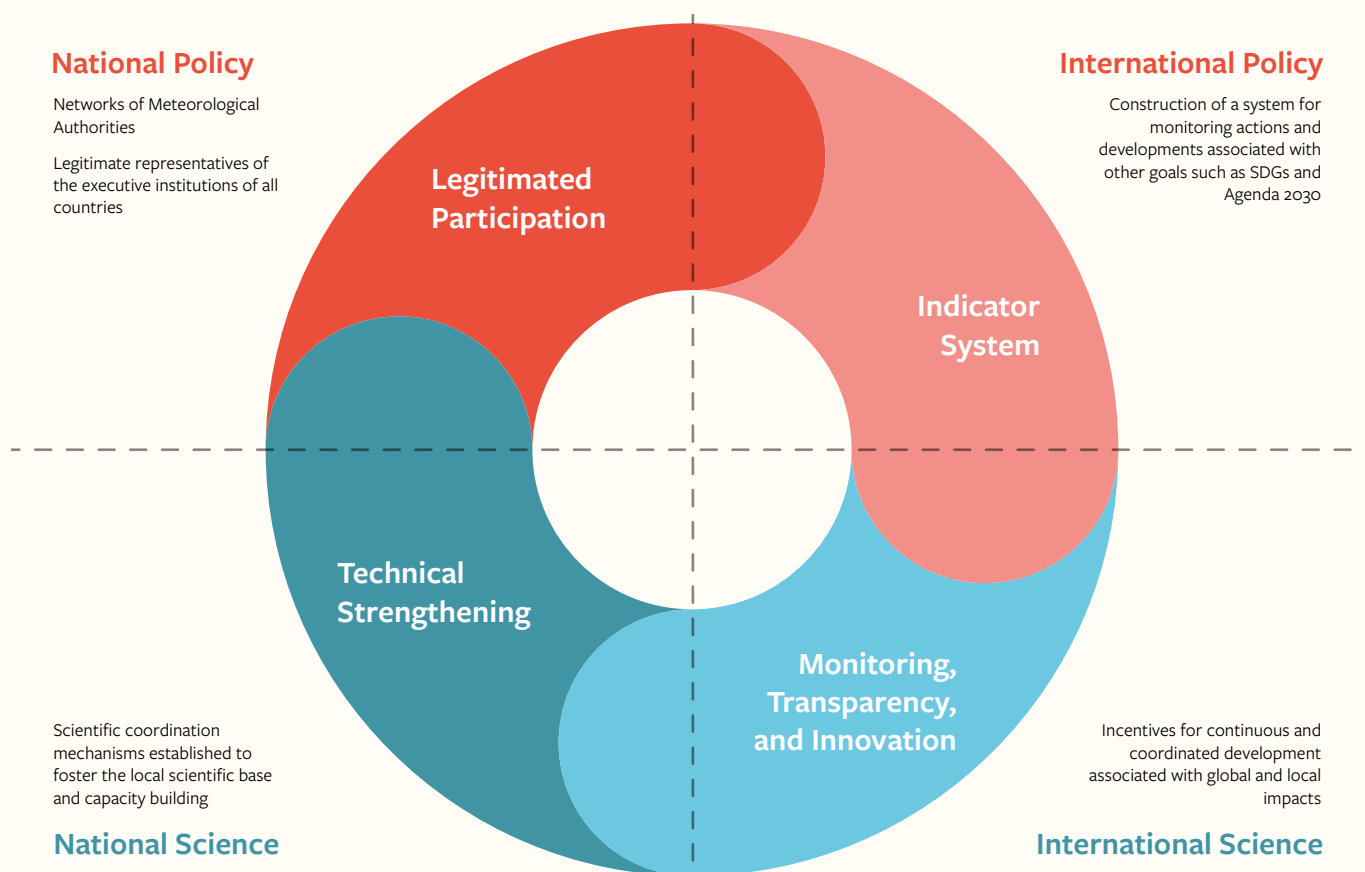
In the International Policy dimension, the Indicator System connects the Amazon to global agendas, such as the SDGs and 2030 Agenda, through the customization of global adaptation indicators to the Amazonian reality, considering the specificities of a cross-border biome. Adaptation must contemplate priority themes and integrate data on indigenous peoples and local communities, ecosystem limits, different technical capacities, and social dimensions, such as gender, race, and territoriality. The construction of comparable and transparent metrics allows not only monitoring progress, but also legitimizing Amazonian claims

in multilateral forums, consolidating the region as a strategic actor in global climate action.

In the National Science dimension, Technical Strengthening emerges as an indispensable condition for transforming knowledge into action. Building resilience involves scientific articulation that, through knowledge management, fosters local knowledge base by expanding technical capacities in each country. Thus, data and models produced gain political relevance when appropriated by governmental and community actors.

Finally, in the International Science quadrant, the Monitoring, Transparency, and Innovation pillar establishes incentives for continuous and collaborative development. Interoperable data systems and regional observatories, such as ORA, become central instruments for monitoring local and global impacts, allowing the Amazon to be integrated with the most advanced trends in applied scientific innovation.

These four elements, when isolated, produce specific advances; but, when articulated, they configure a true path to impact. Through the interaction of political legitimacy, international indicators, technical strengthening, and global innovation, the Amazon can demonstrate leadership in confronting climate change. This approach inspires a new form of regional cooperation that unites science, society, and governments toward a common goal: ensuring the resilience and sustainability of the world's largest tropical biome.



Recommendations

STRENGTHEN REGIONAL CROSS-BORDER POLICY ON CLIMATE CHANGE

Strengthen regional cross-border policy on climate change in a transversal perspective within the ACTO, Interministerial Commission on Climate Change and Environment, as a space for articulation and joint action by countries for joint responses to extreme events that goes beyond preparation for emergency events.

IMPLEMENT A COMMON TECHNOLOGICAL PLATFORM FOR ADAPTATION

Implement a common technological platform for adaptation, which aligns methodologies for measuring extreme events and harmonizes data on strategic sectors for Amazonian countries, in addition to using more advanced technology practices in favor of social action and the environment.

DEFINE A STRATEGIC ACTION AGENDA ON AMAZONIAN SECTORS

Define a strategic action agenda on Amazonian sectors such as biodiversity, indigenous peoples, cities, and economy, thinking about customized lines of action for these sectors.

CATALYZE CLIMATE FINANCING FROM INVESTORS IN THE AMAZON

Catalyze climate financing from investors in the Amazon for adaptation projects and deforestation reduction.

ESTABLISH COOPERATION TOOLS THAT FOCUS ON REGIONAL RESILIENCE

Establish cooperation tools that focus on regional resilience and can articulate the synergistic positive impacts of national actions together with the sphere of regional cooperation, focused on landscape management and public awareness focused on a long-term vision.

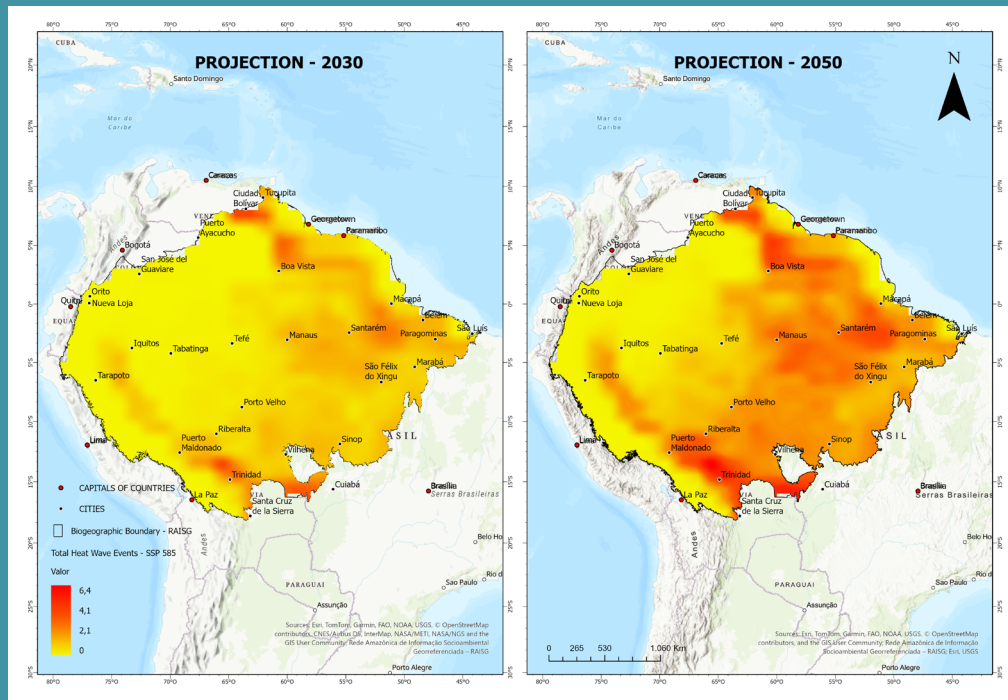


Amazonian Trajectories

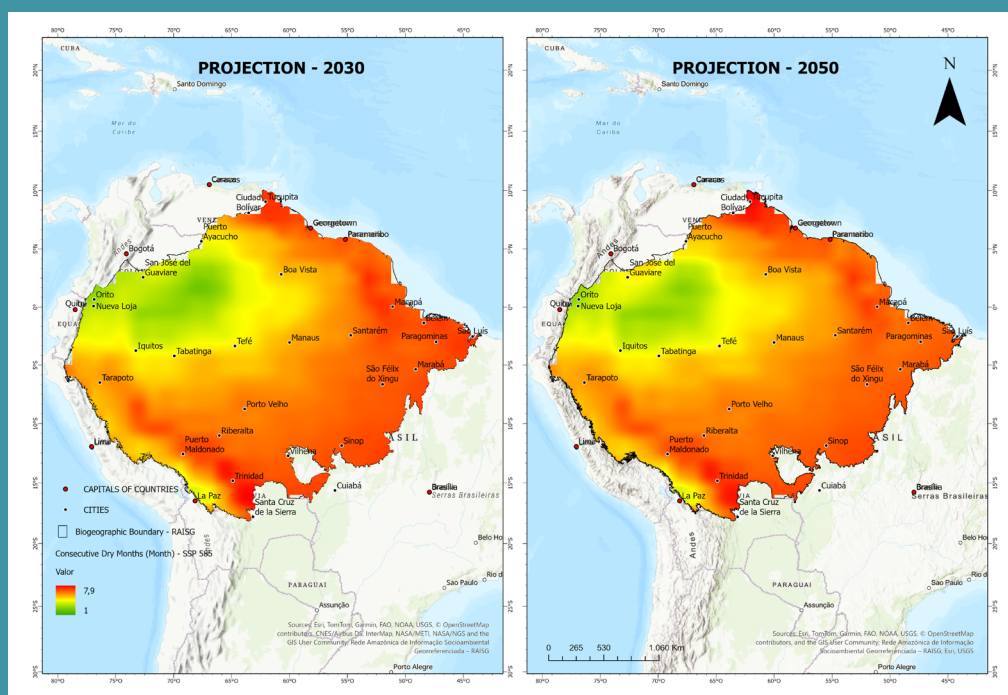
Beyond precipitation and temperature changes climate modeling shows increasing extreme heat events and dry season duration. Next maps shows climate threats projections for 2030 (short) and 2050 (medium) term.

Heat wave frequency is projected to increase significantly. These events are defined as at least 5 consecutive days with maximum temperatures exceeding 40°C. The escalation concentrate primarily along the eastern arc of the Amazon territory, extending from Guiana and Suriname

through western Maranhão state to the northern Bolivian Amazon. The central-western Amazon will also experience considerable intensification and will continue at least until 2050.



Map 1: High emissions climate scenario (SSP5-8.5) for total heat waves in the time horizons of 2030 (left) and 2050 (right).



Map 2: High emissions climate scenario (SSP5-8.5) for consecutive dry months for the time horizons of 2030 (left) and 2050 (right).

Generated projections indicate that extreme heat events will become longer and more frequent, generating persistent thermal stress for those living in the biome's territory, especially for socially more vulnerable populations and particularly sensitive groups such as the elderly, children, and workers exposed outdoors (Map 1).¹⁰ Projections for dry season duration show the lengthening of the dry season, with greater increase in the southwestern region of the biome (Map 2). Together, these projections reveal a scenario in which extreme events converge in time and space. Climate threats demonstrate increasing synergies, ceasing to be merely diffuse and sporadic events, and becoming systematic, cumulative, and disruptive disturbances, along the same lines as the 2023-24 drought.

Longer extreme temperatures duration and dry season prolongation lead to potential increases in direct and indirect impacts on the populations health and well-being. Climate change effects of will propagate through the ecosystem, creating systemic risks of increased mortality of fish and mammals, lack of water and safe food for riverside communities, and interruption of river transport.^{9,10}

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References

- 1 Auer et al. (2025). Critical intervention points for European adaptation to cascading climate change impacts. *Nature Climate Change*.
- 2 Change, N. I. P. O. C. (2023b). *Climate Change 2022 – Impacts, adaptation and vulnerability*. In Cambridge University Press eBooks.
- 3 Machado et al. (2024). Emergency policies are not enough to resolve Amazonia's fire crises. *Communications Earth & Environment*, 5(1).
- 4 Carter et al. (2021). A conceptual framework for cross-border impacts of climate change. *Global Environmental Change*, 69, 102307.
- 5 Flores et al. (2024). Critical transitions in the Amazon forest system. *Nature*, 626(7999), 555–564.
- 6 Gatti et al. (2021). Amazonia as a carbon source linked to deforestation and climate change. *Nature*, 595(7867), 388–393.
- 7 Matricardi et al. (2020). Long-term forest degradation surpasses deforestation in the Brazilian Amazon. *Science*, 369(6509), 1378–1382.
- 8 Qin et al. (2021). Carbon loss from forest degradation exceeds that from deforestation in the Brazilian Amazon. *Nature Climate Change*, 11(5), 442–448.
- 9 Marengo et al. (2024). The drought of Amazonia in 2023–2024. *American Journal of Climate Change*, 13(03), 567–597.
- 10 Van Daalen et al. (2024). Bridging the gender, climate, and health gap: the road to COP29. *The Lancet Planetary Health*, 8(12), e1088–e1105.
- 11 OTCA (2025). *Ministros das Relações Exteriores dos países amazônicos adotam a Declaração de Paramaribo e reforçam seu compromisso com a Amazônia*. <https://otca.org/pt/ministros-das-relacoes-exteriores-dos-paises-amazonicos-adotam-a-declaracao-de-paramaribo-e-reforcam-seu-compromisso-com-a-amazonia/>
- 12 Jones et al. (2024). An Indigenous climate justice policy analysis tool. *Climate Policy*, 24(8), 1080–1095.
- 13 Giammarese et al. (2024). Reconfiguration of Amazon's connectivity in the climate system. *Chaos an Interdisciplinary Journal of Nonlinear Science*, 34(1).

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AMAZON REGIONAL OBSERVATORY (ARO)

ARO is ACTO's reference center that integrates data, tests innovations, and disseminates information to support member countries in cooperation and decision-making.

AMAZON COOPERATION TREATY ORGANIZATION (ACTO)

ACTO is an intergovernmental organization formed by eight Amazon countries: Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela, which signed the Amazon Cooperation Treaty, making it the only socio-environmental bloc in Latin America.

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