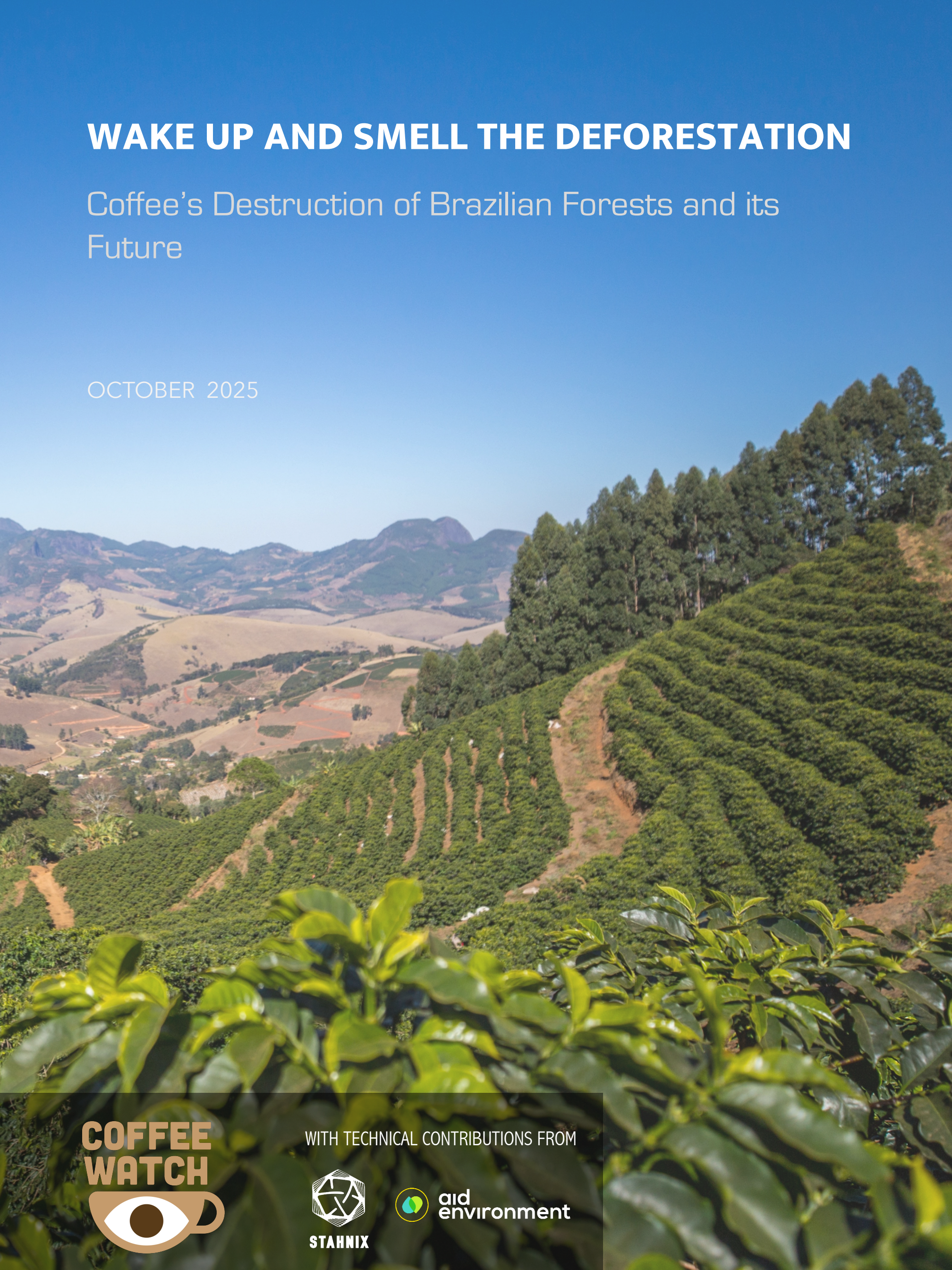
WAKE UP AND SMELL THE DEFORESTATION

Coffee's Destruction of Brazilian Forests and its Future

OCTOBER 2025



COFFEE WATCH

WITH TECHNICAL CONTRIBUTIONS FROM

STAHNIX

aid environment

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EXECUTIVE SUMMARY

Coffee is killing the forest — and the rains. And in doing so, it's killing itself.

Brazil's Atlantic Forest — the Mata Atlântica — is one of the most biologically rich yet endangered ecosystems on Earth. Once spanning 1.2 million square kilometers, today less than 10% of the Atlantic Forest remains.
What replaced it? Largely, coffee.

Brazil's dominance in global coffee reflects a rare geographic endowment — a perfect agroecological blend of elevation, temperature, rainfall, and volcanic soils concentrated across the Southeast. Brazil proudly supplies around 40% of the world's coffee — but that global dominance has come at vast ecological cost.

Brazil's dominance as the world's top coffee exporter is rooted in a long history of forest destruction — and the same extractive model still underpins it. Coffee is not just a legacy driver of deforestation — it remains a present and growing force behind it. Coffee cultivation grew by over 105% between 1990 and 2023 — from 0.6 to 1.23 million hectares, per satellite data.

Between 2001 and 2023, over 11 million hectares of forest were lost in municipalities with high density of coffee cultivation. Within that, at least 312,803 hectares of intact forest were directly cleared for coffee cultivation and satellite data reveals that forest loss within coffee farms reached 737,000 ha — with 77% of this loss falling in the Cerrado biome and 20% in the Atlantic Forest. Minas Gerais — Brazil's coffee powerhouse — also bears the largest ecological toll, with much of the 737,000 hectares of forest loss concentrated in the state.

Coffee's deforestation footprint includes both direct clearance and indirect deforestation. Coffee's expansion consistently coincides with nearby forest loss — a pattern driven by displaced land uses, road-building, and rising land speculation. While not all nearby forest loss is directly caused by coffee, the spatial pattern is clear: where coffee spreads, forests retreat. These findings are grounded in our analysis of satellite imagery, government land use data, and real-time forest loss alerts — tools that reveal both the scale and speed of coffee-linked deforestation.

But its not just the forest that loses — so does coffee.

Deforestation has triggered widespread ecological damage — from biodiversity collapse to soil degradation — but most critically, it is killing the rain. By disrupting local water cycles, forest loss is pushing key coffee regions into heat and drought. Satellite data from CHIRPS shows sustained rainfall anomalies in the coffee belt since 2014 — especially during critical flowering and bean development months. In 2014 alone, rainfall fell up to 50% below normal across zones like Minas Gerais — a 300 mm drop during peak growth months. That wasn't a one-off: since 2014, 8 of the last 10 years have seen rainfall deficits in major coffee zones — a sharp shift from prior decades.

Soil moisture readings from NASA SMAP confirm long-term drying across Minas Gerais and other core production zones. In August 2021 — peak coffee season — SMAP satellite data showed widespread soil moisture depletion across Sul de Minas, Cerrado Mineiro, and Triângulo Mineiro, with some regions losing up to 25% over just six years. Agroforestry zones like Zona da Mata showed greater moisture stability, even during this drought window — reinforcing its resilience role.

Over the past decade, Brazil's major coffee-producing regions have faced a rising frequency of severe droughts. Landmark droughts in 2016–17, 2019–20, and again in 2023 have devastated yields and exposed the vulnerability of coffee to the very deforestation it fuels — threatening the long-term viability of the industry itself. With every new drought, fire, or pest outbreak, the market reacts faster and harder — pushing up prices by over 40% in 2023–24.

This is the paradox at the heart of the crisis: coffee's destruction of forests today is killing the climate it needs to grow tomorrow. What's more, modelling now shows Brazil could lose up to two-thirds of its suitable Arabica land by 2050 under mid-range emissions pathways.

The coffee industry must face this reckoning. It can no longer hide behind outdated numbers, indirect impacts, or greenwashed pledges. It must account for its past, change its present, and safeguard its future — by acknowledging historical deforestation, ending all new forest loss (direct or indirect), restoring degraded ecosystems, and transitioning toward regenerative agroforestry, starting in the most at-risk regions. Yet despite its benefits, agroforestry remains dangerously underused — with less than 1% adoption across key coffee zones like Minas Gerais and São Paulo.

Without large-scale agroforestry adoption, Brazil's coffee sector risks economic decline, stranded assets, and exclusion from key markets like the EU. The European Union's deforestation-free regulation (EUDR), slated for enforcement in 2026 but facing possible delay into 2027, puts $2.4 billion in annual Brazilian coffee exports at risk — over half of Brazil's total coffee trade — unless supply chains prove deforestation-free.

The Mata Atlântica is down to its final fragments. Without urgent action, the coffee sector won't just lose its forests — it may lose its future.

1 BRAZILIAN COFFEE'S DUAL CRISES

Devouring Forests, And Its Own Future

Brazil's dominance in global coffee reflects a rare geographic endowment — a perfect agroecological blend of elevation, temperature, rainfall, and volcanic soils concentrated across the Southeast. The highlands of Minas Gerais, São Paulo, and Espírito Santo hover between 800–1,200 meters, offering ideal conditions for Arabica coffee: cool enough to slow bean maturation, warm enough to sustain high yields. Rainfall patterns historically delivered 1,200–1,600 mm between October and March — perfectly timed with coffee's biological rhythm. And beneath it all lies a legacy of iron-rich volcanic soils, well-drained and slightly acidic, echoing the soil signature of coffee's Ethiopian origins.[1] This combination made Brazil a natural coffee superpower where millions of hectares offer conditions that other producers can only dream of in scattered hilltop plots.

Brazil's coffee industry, proudly supplying around 40% of the world's beans,[2] has a hidden cost however: vast environmental destruction. Global coffee consumption has steadily increased over the past five years, with forecasted consumption reaching a record 169.4 million 60-kg bags in 2025/26, reflecting growing worldwide demand and tightening inventories that have pushed coffee prices up significantly.[3] As global demand climbs year after year, Brazil's forests are being cleared to meet the world's morning ritual. Coffee has helped gut the Atlantic Forest, once one of the world's richest biomes, now reduced to fragments. Once blanketed in sapucaias, copaíbas, paupereiras, and jacarandás — a forest so vibrant that Indigenous communities called it caáetê, the "true forest" — it is now carved into sun-grown coffee monocultures.[4]

And that forest loss isn't slowing - it's actually steadily encroaching into new frontiers, including the Amazon. **At its core, Brazil's coffee boom has never truly decoupled from deforestation.**

[1] Hoffmann, J. (2018). The world atlas of coffee. Hachette UK

[2,3] United States Department of Agriculture, Foreign Agricultural Service. (2025). Coffee: Annual, Brazil (BR2025-0013). U.S. Department of Agriculture.

[4] The Atlantic Forest: A biodiversity colossus in crisis | lac geo. (n.d.). https://lacgeo.com/atlantic-forest-mata-atlantica

But the damage goes deeper than forest clearance. Coffee's expansion has triggered deeper, more insidious consequences. It fuels indirect deforestation, displaces other land uses into virgin ecosystems, and distorts land markets. And the consequences are compounding. Forests regulate climate, anchor water cycles, and protect the rains coffee depends on - strip them away, and the system collapses. Droughts have grown harsher, yields are more volatile, and coffee's future more fragile. The 2014-2017 drought was not an outlier but a preview and a warning. Climate change is now accelerating this unraveling, turning rare disasters into routine shocks.

This is the paradox at the heart of the industry's success: by erasing forests, Brazil is squandering its natural coffee advantage and undermining its own future. What once promised national prosperity now teeters on ecological and economic ruin. If the industry fails to act, Brazil risks losing both its forests and its most iconic export. But the path forward still exists. It begins with truth-telling, real accountability, and a turn toward solutions like agroforestry that work with nature—not against it.

This report offers the clearest recent picture yet of coffee's deforestation footprint—and its consequences. Drawing on satellite imagery, land use data, and forest loss alerts, we reveal a crisis that's been hiding in plain sight. As EU regulations tighten and loom,[5] climate instability grows, and market accountability rises, this analysis arrives at a critical moment. What follows is a reckoning, structured in three parts: first, we trace the true scale and shape of coffee-linked deforestation; second, we unpack the self-defeating economic fallout; and finally, we chart a path to redemption—where forests become partners, not obstacles, to profit.

[5] EUDR Coffee: A comprehensive guide. Meridia. Available at: https://www.meridia.land/blog/eudr-coffee-a-comprehensive-guide

2 COFFEE'S FOREST DEBT

Quantifying A Staggering Toll

COFFEE'S ORIGINS AS A DEFORESTATION ENGINE

At the heart of Brazil's coffee dominance lies a brutal truth: the industry has been a deforestation engine. Brazil's coffee boom, producing almost 40% of the global crop, has all but obliterated the Atlantic Forest and is steadily encroaching the Amazon. But this forest debt didn't appear overnight. It was written into Brazil's coffee story from the very beginning. From the first smuggled seed in Pará to the mechanized march into the Amazon, coffee's rise has always followed — and demanded — a trail of cleared trees.

Coffee's rise in Brazil was fueled by forest clearance from the very beginning. Coffee arrived in Brazil in 1727, smuggled from French Guiana and first cultivated in Pará. But it wasn't until the early 1800s that it exploded into an export powerhouse, driven by American and European demand. As new land was cleared across the Paraíba Valley, coffee surged through Rio de Janeiro and São Paulo, transforming Brazil into the world's largest producer by the 1840s. Forests paid the price as vast tracts of the Atlantic Forest were razed for plantations, especially during the boom in western São Paulo and southern Minas Gerais, where over 500 million trees had been planted by 1900. This growth was powered by railroads, propped up by slave labor, and fueled by global consumption. By the 1920s, Brazil supplied 80% of the world's coffee but the ecological bill had already come due.[1,2,3]

Even after the "coffee cycle" crashed during the Great Depression, the deforestation engine didn't stop — it just moved. Mechanization and sun-grown methods enabled expansion into new states like Paraná, Espírito Santo, and Bahia, intensifying yields and soil degradation alike. By the 1970s, frost and land exhaustion in the Southeast pushed cultivation into the Amazon, particularly Rondônia, triggering another wave of forest loss.[2,3] Infrastructure projects and frontier policies cracked open the Cerrado and remaining Atlantic Forest, accelerating habitat destruction and fragmentation. By 1990, less than 12.4% of the Atlantic Forest remained — down from over one million square kilometers — with coffee a central driver of this devastation.[4]

Brazil's modern coffee belt — spanning Minas Gerais, São Paulo, Espírito Santo, Paraná, and Bahia — now anchors the country's high-yield production. These southeastern and central states offer the perfect blend of altitude, rainfall, and soil fertility, sustaining the bulk of Brazil's output – more than 90% according to TRASE data. As shown in Figure 2.1, this belt (outlined in black) captures the core geography of Brazil's coffee economy, including regions where historic and recent expansion overlap with previous deforestation fronts. While smaller pockets of coffee also exist in Amazonian states like Rondônia, Mato Grosso, and Pará, the analysis in this report focuses squarely on the coffee belt — where most of Brazil's production, infrastructure, and forest impact are concentrated.

[1] Hoffmann, J. (2018). The world atlas of coffee. Hachette UK

[2] Coffee-driven deforestation in Brazil - Commodity Trading Guru. Available at: https://commoditytrading.guru/sustainability-ethics/coffee-driven-deforestation-in-brazil/

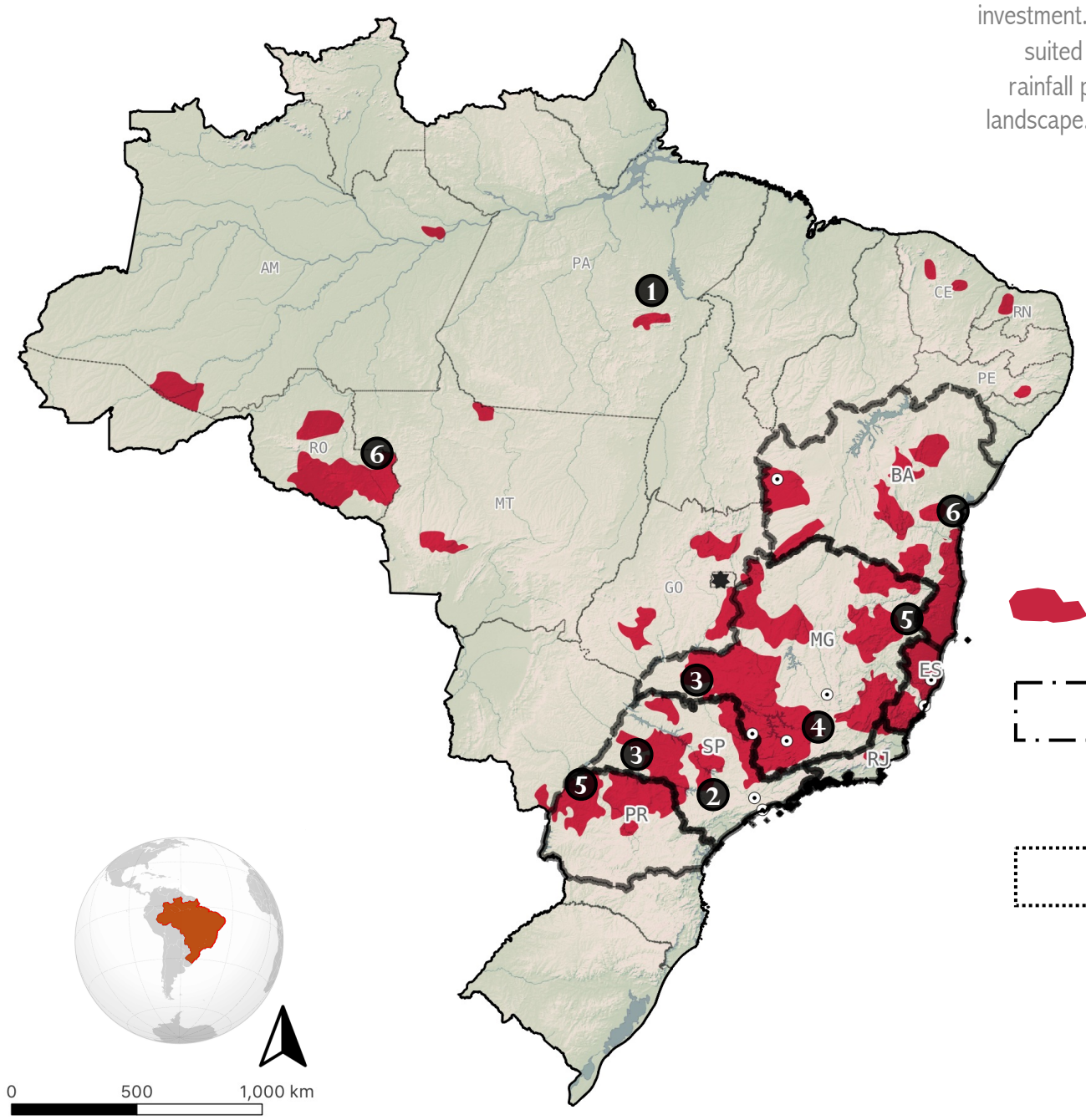
[3] Laakkonen, S. (1996). The roasted forests: coffee and the history of deforestation in Brazil. In Sustainable forestry challenges for developing countries (pp. 229-247). Dordrecht: Springer Netherlands.

[4] Butler, R.A. (2020) Brazil's Atlantic Forest (Mata Atlântica), WorldRainforests.com. Available at: https://worldrainforests.com/mata-atlantica/

FIGURE 2.1

NATURE'S PERFECT BLEND: BRAZIL'S COFFEE ADVANTAGE FLOWS FROM GEOGRAPHIC ENDOWMENTS IN THE SOUTHEAST

Brazil's dominance in global coffee isn't just about scale or investment. It reflects a rare geographic endowment uniquely suited to coffee — optimal elevation, historically aligned rainfall patterns, and fertile soils across a vast continuous landscape. This perfect blend of inherited natural advantage is concentrated most strongly in the Southeast.



HIGH YIELD COFFEE AREAS
STYLIZED REPRESENTATION FOR ILLUSTRATIVE PURPOSES
BASED ON TRASE, MAPBIOMAS & SPAM DATA

MAJOR COFFEE PRODUCING STATES
MG – MINAS GERAIS
SP – SAO PAULO
ES – ESPIRITO SANTTO
PR – PARANA
BA - BAHIA

OTHER COFFEE PRODUCING STATES
RO - RONDONIA
MT – MATO GROSSO
GO - GOIÁS
PA – PARA
AM – AMAZONAS
CE – CEARÁ
RN – RIO GRANDE DO NORTE
PE - PERNAMBUCO

1727–1800

EARLY CULTIVATION IN PARA 1

Coffee introduced to Brazil in 1727 by Francisco de Melo Palheta - smuggled from French Guiana and initially cultivated in Pará (PA). By 1770, coffee reached Rio de Janeiro, primarily for for local consumption and remained a minor crop until the early 19th century.

1800–1850

EXPANSION INTO SOUTHEAST 2

Booming global demand drove rapid growth across the Paraíba Valley in Rio de Janeiro (RJ) and São Paulo (SP). Brazil became the top global producer by the 1840s, clearing vast tracts of Atlantic Forest with heavy reliance on slave labor.

Brazilian Coffee Plantation in the 19th century
(From an engraving in the 'Travels of Rugendas')

1850–1900

SHIFT TO WESTERN SÃO PAULO AND MINAS GERAIS 3

Production moved west as soils depleted. By 1900, São Paulo (SP) held over 500 million coffee trees. This boom resulted in the conversion of vast tracts of the Atlantic Forest into agricultural land. Railroads like Mogiana drove deeper deforestation across western SP and southern MG.

1900–1930

OVERPRODUCTION AND EXPANSION INTO MINAS GERAIS 4

Brazil produced 80% of global coffee by the 1920s. The 1906 Taubaté Agreement incentivized further expansion, especially in MG and exacerbating Atlantic Forest deforestation. The 1930s crash burned millions of bags, but cleared land remained in production. The "coffee cycle" ends, but coffee remains a key export.

1930–1960

DIVERSIFICATION AND MECHANIZATION 5

The global economic downturn led to a decline in coffee prices and a push for economic diversification. Despite this, coffee cultivation persisted, with mechanization increasing efficiency and enabling expansion into new areas, including parts of Paraná (PR) and Espírito Santo (ES). Mechanization and sun-grown methods increased yields but intensified environmental impacts.

1960–1990

SHIFT TO THE AMAZON AND ENVIRONMENTAL IMPACT 6

Coffee moves into new regions— Espírito Santo (ES), Paraná (PR), and later Bahia (BA) —as older lands degrade. In the 1970s, severe frosts and soil degradation in traditional coffee-growing areas prompted the relocation of coffee cultivation to the Amazon, particularly in Rondônia (RO). This shift led to significant deforestation in the Amazon region, as forests were cleared to make way for coffee plantations. Major infrastructure projects open up new frontiers, accelerating deforestation, especially in the Cerrado and Atlantic Forest.

Only 12.4% of the original Atlantic Forest remained by now, down from about one million km², with coffee as a major cause.

THE INDUSTRIAL GEOGRAPHY OF BRAZILIAN COFFEE

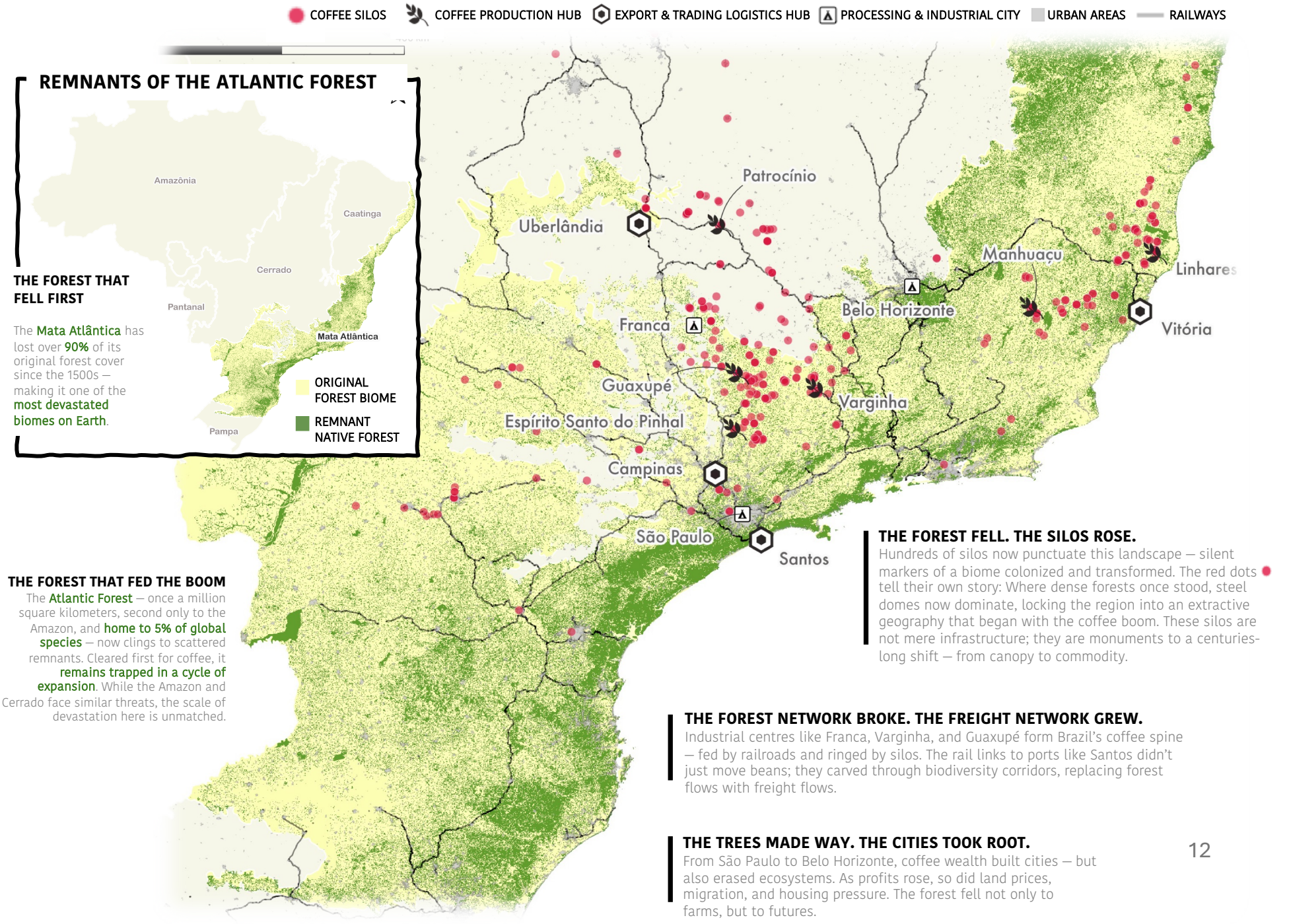
Coffee's impact didn't stop at forest clearing — it reconfigured the entire geography of southeastern Brazil. As the coffee boom surged across São Paulo, Minas Gerais, and Espírito Santo, its impact extended far beyond the plantations themselves. Forests were not only felled for farms — they were replaced with silos, railroads, export hubs, and urban growth. Hundreds of coffee silos now mark these regions like silent sentinels, signaling a system of extraction that took deep root. Towns such as Franca, Varginha, and Guaxupé emerged as processing and logistics hubs, supported by an expanding freight rail network that carved through biodiversity corridors to connect with ports like Santos.[5,7,9] As illustrated in Figure 2.2, what began as an agricultural expansion became a full-fledged industrial geography — one that transformed ecosystems into commodity pipelines and redefined how land was valued and used.

The Atlantic Forest was not only cleared for coffee but it was displaced by an entire system built around it. The coffee economy didn't stop at the farm gate. It triggered urban expansion, speculative land markets, and rural-to-urban migration, all of which drove further deforestation. As profits rose, so did the push for housing, roads, and services, especially around major coffee-producing zones. Cities like São Paulo and Belo Horizonte expanded rapidly and often on land once blanketed by forest. Meanwhile, the rise of mechanized, sun-grown coffee systems increased land pressure and ecological stress. These systems required cleared, exposed landscapes, stripping away forest nutrients and accelerating soil exhaustion. By the late 20th century, the Atlantic Forest had become collateral damage in a century-long agro-industrial transformation — fragmented, degraded, and largely unprotected (see Remnants in Figure 2.2). Its destruction was not accidental; it was embedded in the logic of Brazil's coffee expansion.[6,8,9]

FIGURE 2.2

BREWED ON BORROWED LAND: COFFEE BOOM ETCHED A FOREST DEBT INTO BRAZIL'S LANDSCAPES

Coffee didn't just replace the forest. It replaced the logic of the landscape. What began with colonial coffee booms grew into a system of extraction, infrastructure, and expansion — one that still defines the Atlantic Forest's geography today.



MAPPING THE CONTEMPORARY COFFEE FOOTPRINT

Brazil's coffee empire was built on forest destruction and that expansion hasn't stopped. It's still unfolding today, using the same extractive blueprint. This report does not rely on assumptions or conjecture, it's grounded in data that lets us map the damage with unprecedented clarity. To quantify the recent extent of coffee's deforestation footprint, we relied on a suite of independent, transparent, and satellite-driven datasets — namely MapBiomas, Hansen, and SPAM — each offering a unique lens on land use change.

- **MapBiomas,**[10] a collaborative initiative led by Brazil's Climate Observatory (Observatório do Clima/SEEG) and powered by a network of NGOs, universities, and tech partners (including Google via Google Earth Engine), delivers detailed annual land cover and use maps of Brazil with 30 m resolution, enabling precise distinction between coffee plantations and forest cover. To map farm-level boundaries, we also drew on Brazil's official rural cadastre system, SIGEF (Sistema de Gestão Fundiária).[10] Managed by INCRA, SIGEF provides verified rural property boundaries used to identify and validate coffee farm extents.
- **Hansen Global Forest Change,**[11] developed by the University of Maryland with support from Google and NASA, offers annual global forest loss maps at 30 m resolution that enables precise tracking of deforestation in coffee-producing regions.
- **SPAM (Spatial Production Allocation Model),**[12] developed by IFPRI and IIASA, estimates crop distribution by combining satellite imagery, agricultural statistics, and land use data

Together, these tools — grounded in remote sensing and spatial modeling — give us a robust, cross-validated picture of coffee's expansion.

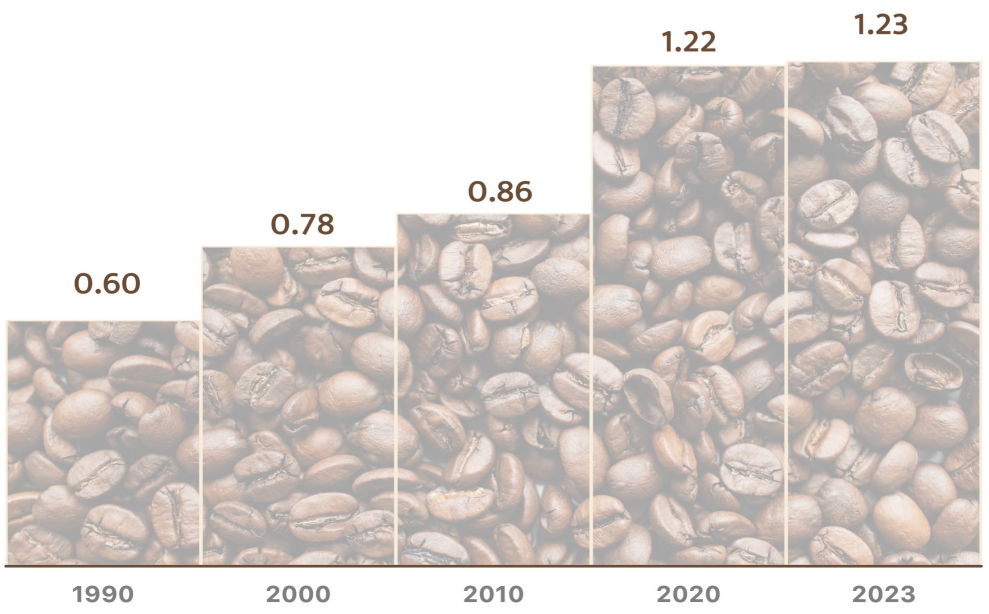
To capture this broader footprint, we analyzed forest loss across all municipalities where MapBiomas identified coffee cultivation — a method that reflects not just direct clearance, but the wider land-use pressures coffee unleashes. **While no dataset is flawless, their convergence tells a consistent story: coffee has been and still is spreading into forests.**

Coffee's expansion hasn't slowed but it's surging forward at a breathtaking scale, redrawing Brazil's landscapes in real time. From historic heartlands to new frontiers, Brazil's coffee footprint is still growing — often at the expense of forest. Between 1990 and 2023, planted area more than doubled from 600,000 to over 1.25 million hectares, according to satellite-based MapBiomas data and SPAM estimates (Figure 2.3). Growth is no longer confined to traditional zones. While southern Minas Gerais remains the powerhouse, explosive booms are now erupting in Espírito Santo's coastal strip, São Paulo's interior, and southern Bahia. These shifts reveal a broader reality: Brazil's coffee map isn't just expanding — it's being redrawn (Figure 2.4). And that redraw has consequences.

FIGURE 2.3

BRAZIL'S COFFEE FOOTPRINT KEEPS GROWING

Coffee cultivation grew by **over 105% between 1990 and 2023**, rising from 0.6 million to 1.23 million hectares, according to satellite-based land cover mapping data MapBiomas and SPAM. Most expansion occurred in Minas Gerais, São Paulo, and Espírito Santo, as the maps in Figure 2.4 reveal.



[5] Watson, K. (2001). Deforestation, Coffee Cultivation, and Land Degradation: The Challenge of Developing a Sustainable Land Management Strategy in Brazil's Mata Atlântica Rainforest. Lund: Master's Programme in Environmental Science, Lund University.

[6] Marcilio-Silva, V., & Marques, M. C. (2017). New paradigms for Atlantic Forest agriculture and conservation. Biodiversity, 18(4), 201-205

[7] Harvey, C. A., Pritts, A. A., Zwetsloot, M. J., Jansen, K., Pulleman, M. M., Armbrecht, I., ... & Valencia, V. (2021). Transformation of coffee-growing landscapes across Latin America. A review. Agronomy for sustainable development, 41(5), 62.

[8] Solórzano, A., Brasil, L. S. C. D. A., & de Oliveira, R. R. (2021). The Atlantic Forest ecological history: From pre-colonial times to the Anthropocene. In The Atlantic forest: History, biodiversity, threats and opportunities of the mega-diverse forest (pp. 25-44). Cham: Springer International Publishing.

[9] Laakkonen, S. (1996). The roasted forests: coffee and the history of deforestation in Brazil. In Sustainable forestry challenges for developing countries (pp. 229-247). Dordrecht: Springer Netherlands.

[10] https://brasil.mapbiomas.org/en/ for MapBiomas and https://sigef.incra.gov.br/ for SIGEF

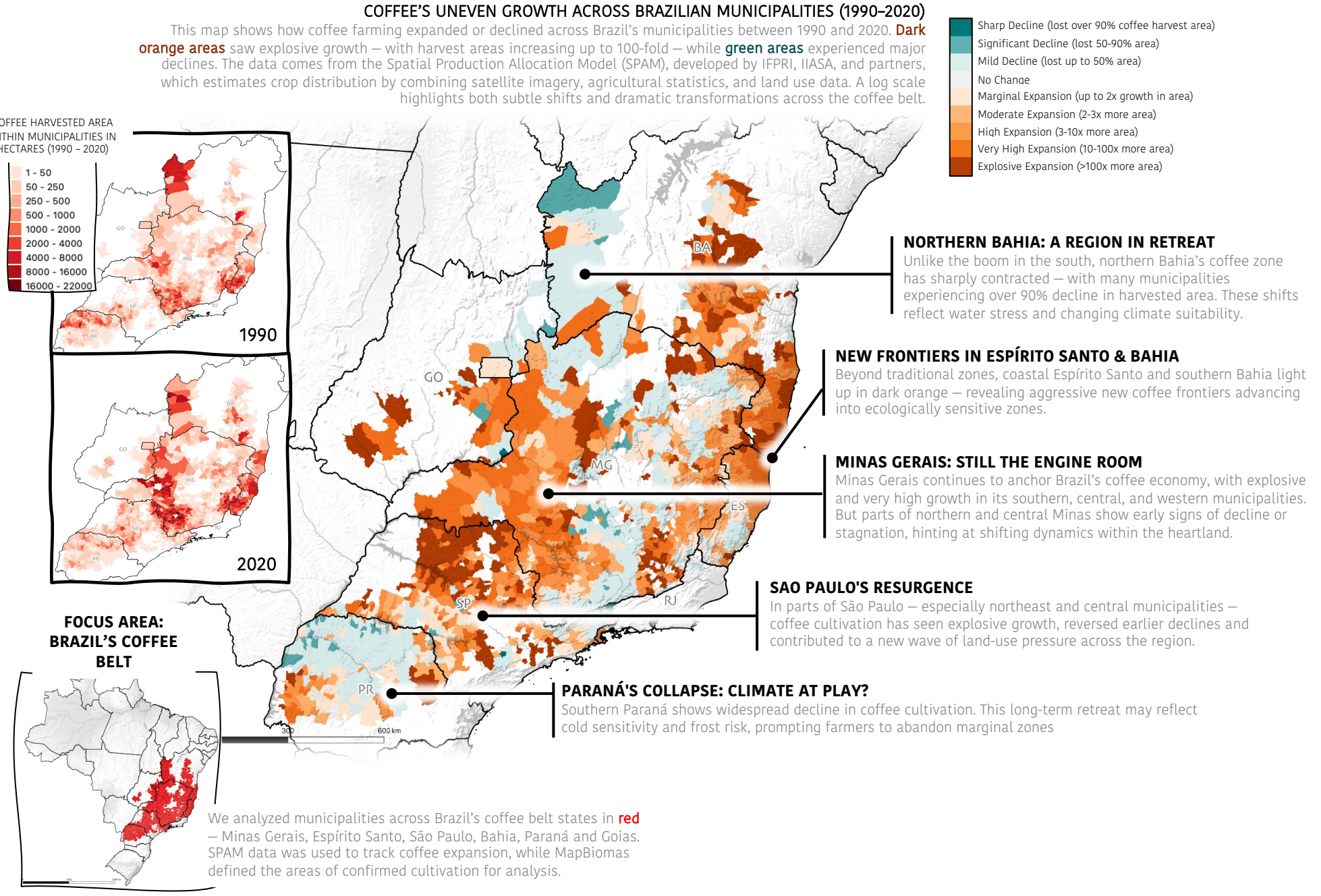
[11] https://glad.earthengine.app/view/global-forest-change

[12] https://www.mapspam.info/

FIGURE 2.4

BOOM WITHOUT BRAKES: COFFEE KEEPS PUSHING PAST OLD FRONTIERS

Brazil's coffee footprint continues to grow — doubling since 1990 and still expanding fast. As cultivation deepens in the Minas Gerais heartland, new frontiers are rising across Espírito Santo, Bahia and São Paulo. Explosive growth has overtaken new biomes, while stable zones mask hidden churn. Coffee's advance is both vast and volatile — redrawing the geography of Brazil's coffee economy.



This more recent expansion comes at a high cost and Brazil's most precious biomes are footing the bill. As cultivation deepens across the coffee belt, forests continue to fall. Since 2001, coffee municipalities in the coffee belt have lost 11 million hectares of forest, with 312,803 hectares directly razed for coffee by 2023. We defined direct coffee-driven deforestation as forested areas in 2000 that were converted into coffee plantations by 2023, using MapBiomas' annual land use layers. To reinforce these findings, we cross-referenced with Hansen's Global Forest Change dataset — an annually updated Landsat-based benchmark of forest loss. Our analysis shows that between 2001 and 2023, over 737,000 hectares of forest were cleared inside coffee farm boundaries.

The Cerrado — a biodiversity hotspot and vital water source — absorbed 77% of this loss, with a staggering 569,239 hectares gone. The Atlantic Forest, already critically endangered, lost another 145,043 hectares. Even the Caatinga wasn't spared. This is no longer just a story of distant past damage. It's an unfolding crisis — one that threatens some of Brazil's last remaining ecological strongholds.

Coffee's ecological toll is highly concentrated — but not always where you'd expect. Just 252 municipalities account for over half of all forest loss inside coffee farms. Many of these are classified as "explosive growth" zones, where coffee is advancing at breakneck pace and outpacing governance capacity (Figure 2.5). But the damage isn't limited to new frontiers. Municipalities with long-term, "stable" coffee presence — including iconic growing regions — still accounted for 39% of forest loss. In places like Minas Gerais, this means damage is not just a symptom of frontier expansion but of ongoing intensification. What looks like business as usual often hides an invisible churn of land conversion.

Zooming in reveals the full extent of this transformation — and how coffee reshapes entire regions. Satellite data shows a clear and disturbing pattern: forest loss clusters tightly around zones of rapid coffee growth (Figure 2.5). Espírito Santo's coastal boom overlaps directly with deforestation hotspots in the Atlantic Forest. Inland São Paulo — long thought past its prime — now shows renewed coffee-driven clearance in fragile Cerrado areas. And in Minas Gerais, Brazil's coffee crown jewel, central and western municipalities have become ground zero for biome-scale ecological loss. This is not a scattered pattern. It is systemic, persistent, and increasingly difficult to ignore.

MINAS GERAIS: GROUND ZERO

While multiple states contribute to Brazil's coffee output, production is highly concentrated and nowhere more so than in Minas Gerais. Responsible for just under half of the country's crop, and close to one-sixth of the world's supply, the state anchors both national and global coffee supply chains[13]. The scale is staggering: one plantation alone in Minas Gerais produces more coffee than entire countries like Panama or Bolivia.[14]

Unsurprisingly, Minas is also where coffee's environmental footprint hits hardest. Our analysis with AidEnvironment confirms that much of the 737,098 hectares of forest loss identified within coffee farms between 2001 and 2023 is concentrated in this state.

Official figures from IBGE and CONAB once painted a very different picture — suggesting a long-term decline in Brazil's coffee area. According to IBGE's Municipal Agricultural Production (PAM) surveys, harvested coffee area fell from approximately 2.5 million hectares in 1990 to about 1.9 million hectares by 2023. On the surface, this points to a sector shrinking in footprint — a narrative at odds with remote-sensing evidence. But these self-reported statistics, grounded in surveys with inconsistent methodologies and outdated field data, have increasingly diverged from satellite-based assessments. Over time, discrepancies between official data and independent tools like MapBiomas have narrowed — not because satellites became smarter, but because early estimates were likely inflated and current estimates are conservative.[15]

FIGURE 2.5

COST OF THE BOOM: COFFEE'S FOOTPRINT SPREADS, FORESTS SHRINK FURTHER

Coffee farm's expansion continues to exact a steep ecological price — clearing over 700,000 hectares since 2000 in the coffee belt. Explosive growth hotspots in Minas, Espírito and São Paulo now overlap with zones of intense deforestation – with 77% of cumulative forest loss striking the savanna-rich Cerrado and 20% hitting the endangered Atlantic Forest.

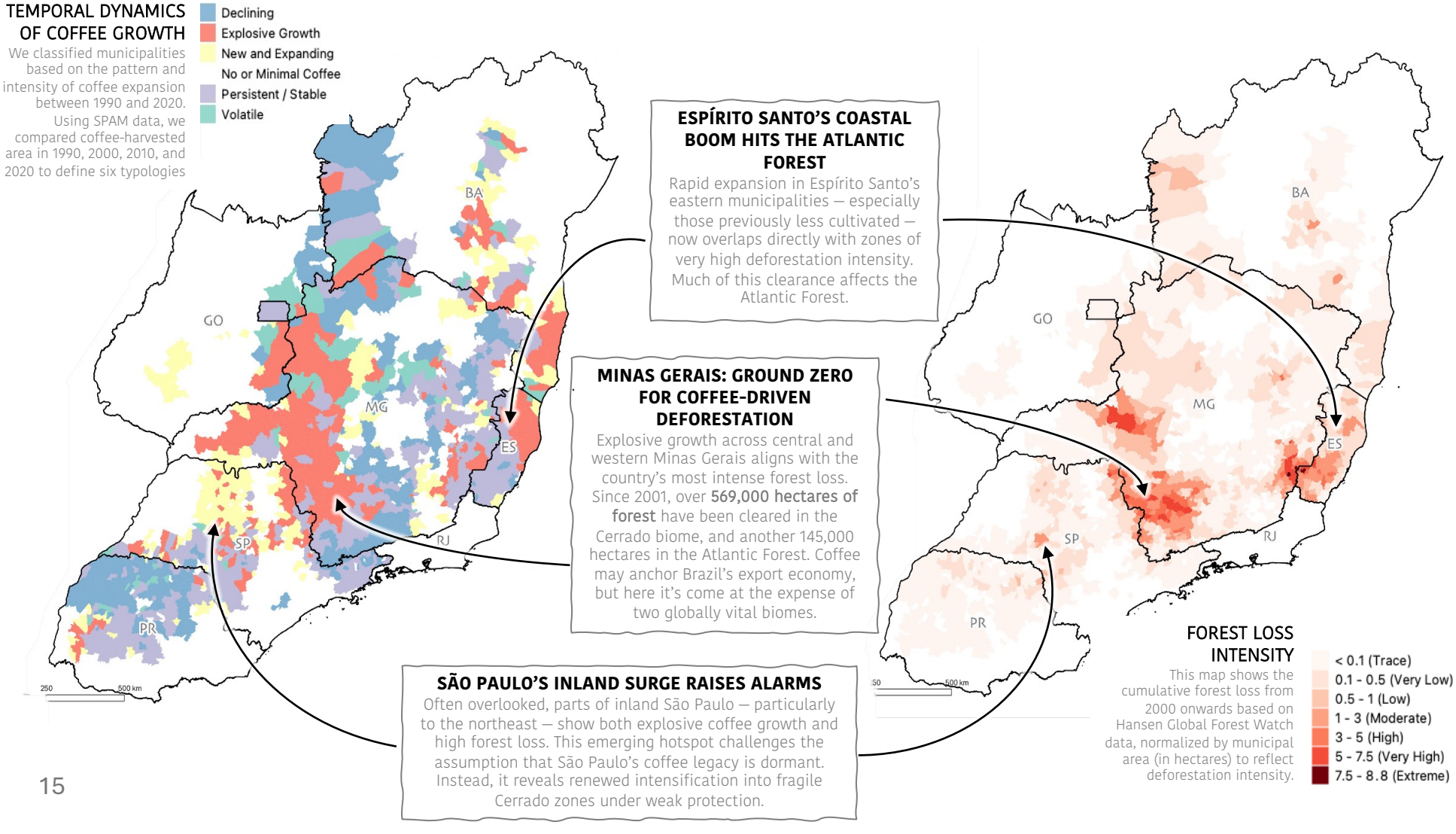
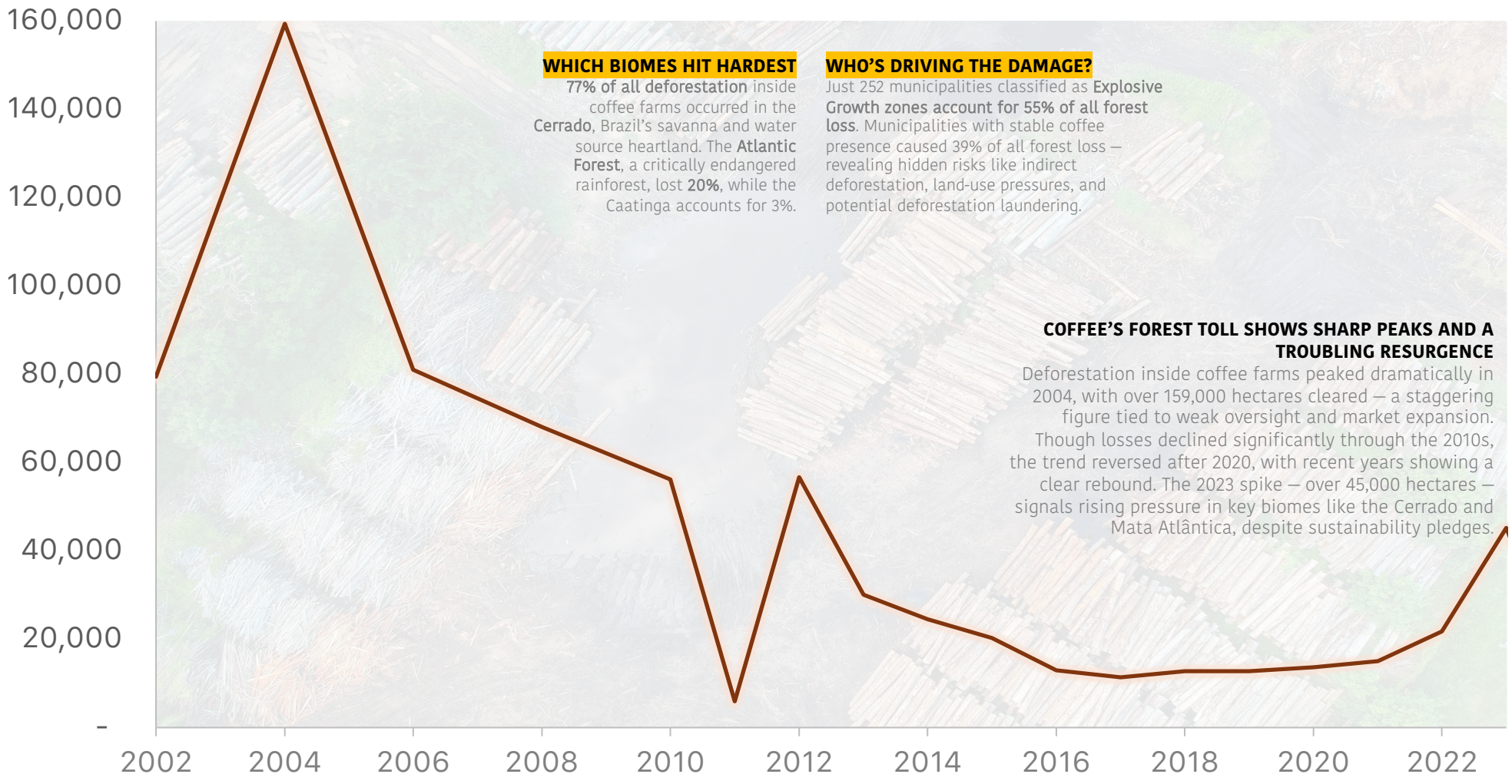


FIGURE 2.6

ANNUAL FOREST LOSS INSIDE COFFEE PROPERTIES IN BRAZIL'S COFFEE BELT (2002–2024)

This graph shows yearly deforestation (in hectares) occurring within land parcels classified as coffee properties, based on MapBiomas land cover and property boundaries across Brazil's major coffee-producing biomes.



MapBiomas, built on transparent algorithms and consistent satellite imagery, provides a neutral vantage point — one less prone to institutional bias or commercial pressure. SPAM's 2020 estimate of 1.46 million hectares — broader in national coverage but coarser in resolution — aligns with this trend and fills key gaps in states like Rondônia and Pará. Taken together, these remote-sensing platforms offer an independent, transparent view of land-use change — one that cuts through politics, resists manipulation, and reveals coffee's true and growing footprint.

Trase export data,[16] further reinforces this broader footprint: while the heart of Brazil's coffee production remains in Minas Gerais, Espírito Santo, and São Paulo, cultivation also extends into less scrutinized frontier states like Amazonas, Mato Grosso, Pará — and especially Rondônia. Rondônia has quietly become a major exporter of robusta coffee, often overlooked in deforestation debates, despite its increasing presence in export supply chains.

This geographic dispersion underscores the importance of nationwide monitoring systems that go beyond the Southeast's arabica plantations.

INDIRECT FOOTPRINT AND DEFORESTATION LAUNDERING

In Southeast Minas Gerais, coffee is not just expanding — it is redrawing the landscape. Forests, savannas, and transitional ecosystems are being replaced by industrial monocultures at an alarming rate. Having mapped the broader deforestation footprint of coffee in Minas Gerais, we now zoom in to see how this transformation unfolds on the ground. Property-level analysis reveals not only where coffee is planted, but also how its presence shapes surrounding landscapes. The following maps in Figure 2.7, developed with AidEnvironment, show a striking spatial overlap between coffee plantations and nearby deforestation. Not all forest loss occurs within coffee plots—many cleared areas extend beyond them, hinting at coffee's indirect role in reshaping ecosystems.

[13] United States Department of Agriculture, Foreign Agricultural Service. (2025). Coffee: Annual, Brazil (BR2025-0013). U.S. Department of Agriculture.

[14] The Coffee Buyer's Guide to Brazil - exploring coffee production in Brazil (2022) Barista Hustle. Available at: https://www.baristahustle.com/lesson/cbgb-5-01-exploring-coffee-production-in-brazil/

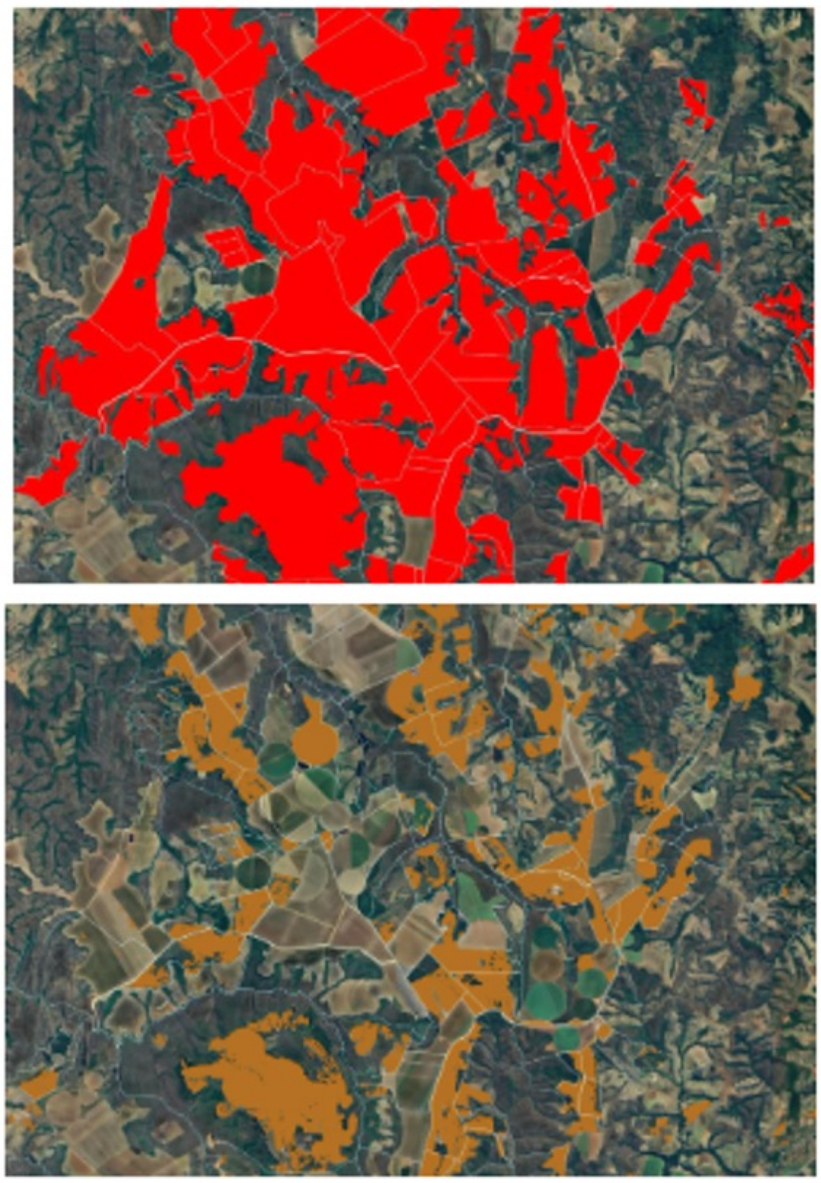
[15] Exclusive: Brazil admits to problems with coffee crop views, plans revision (2022) | Reuters. Available at: https://www.reuters.com/markets/commodities/exclusive-brazil-govt-admits-problems-with-coffee-crop-views-plans-revision-2022-09-23/

[16] TRASE (Transparent Supply Chains for Sustainable Economies) is a platform developed by the Stockholm Environment Institute (SEI) and Global Canopy. It links subnational production data to international trade flows using customs records, trade databases, and municipality-level sourcing. TRASE enables supply chain transparency and deforestation risk tracking across commodities like coffee. Accessed at www.trase.earth

FIGURE 2.7

THE HIDDEN FOOTPRINT: INDIRECT DEFORESTATION

These satellite maps show how coffee reshapes entire landscapes — not just by replacing forests, but by displacing cattle, pushing roads into remote areas, and inflating land speculation. Much of the surrounding forest loss occurs near, but not within, coffee plots — exposing an indirect footprint that is larger, deeper, and harder to trace. This is deforestation laundering in action: coffee moves in after forests fall, profiting from prior destruction while sidestepping accountability.



These close-up views confirm a critical pattern: not all forest loss within coffee-producing areas is directly replaced by coffee. Red zones of deforestation frequently spill beyond the brown zones of mapped plantations. But that doesn't absolve coffee of responsibility. In fact, this spatial mismatch reveals something deeper regarding coffee's indirect role in driving deforestation beyond its footprint. By occupying land, coffee displaces other activities like cattle and annual crops into nearby forests. It drives new roads and infrastructure that fragment ecosystems and open remote areas to exploitation. And as land values rise, speculation triggers a fresh wave of clearance — often before the first seed is planted.[17]

Coffee's impact doesn't stop at the plantation fence. It fuels indirect deforestation on a scale that dwarfs direct clearance — pushing cattle deeper into virgin forests, building roads that invite loggers, and inflating land markets that drive speculative clearing.

TRASE transition data and MapBiomas analysis reveal a stark pattern of "deforestation laundering": many coffee plantations now sit on land first cleared for pasture that was itself carved from forests in earlier waves. At first glance, it may appear that coffee is merely replacing cattle, not forests. But this masks a deeper complicity. By occupying pre-cleared land, coffee quietly absorbs deforestation it didn't initiate but clearly benefits from — distancing itself from environmental blame while embedding itself in the profits of past forest loss. The result is a powerful indirect footprint that rivals direct clearance. Coffee may not always wield the axe, but it follows in the footsteps of those who did — reaping rewards from a landscape stripped bare. This isn't progress — it's ecological strip-mining.

Brazil's coffee boom has not ended — it has simply shifted shape, and moved into the shadows. The core storyline remains the same: high returns, weak enforcement, and a growing global thirst for coffee continue to drive land clearance. But the locations are shifting, the tools are more extractive, and the landscapes more fragile. What once seemed like a historical problem is now an urgent one — unfolding with precision, speed, and alarming clarity. The consequences will echo well beyond the coffee belt – ecologically and economically.

[17] Harvey, C. A., Pritts, A. A., Zwetsloot, M. J., Jansen, K., Pulleman, M. M., Armbrecht, I., ... & Valencia, V. (2021). Transformation of coffee-growing landscapes across Latin America. A review. Agronomy for sustainable development, 41(5), 62.

3 ECOLOGICAL RECOIL & ECONOMIC RIPPLES

Rainfall Lost, Yields Down, Market Chaos

COFFEE'S FOREST DEBT BECOMES A CLIMATE AND FINANCIAL DEBT

Coffee-driven deforestation is more than an ecological crisis — it is a debt crisis. The coffee industry has amassed a massive Forest Debt: over 737,000 hectares of forest loss within coffee plantations, a biodiversity collapse, and mounting carbon emissions. The Mata Atlântica, once home to jaguars, tamarins, and 800 tree species per hectare, is now fragmented patches—coffee's monocultures breed pests, creating green deserts. Each hectare cleared releases massive CO_2, while agroforestry could store double the carbon that monoculture coffee stores. The social cost is no less stark. On Indigenous Tikmüün lands, 40% of territory has been illegally taken for plantations. Child labor has spiked post-drought, with fieldhands earning just $0.10/kg. Human trafficking abounds in Brazilian coffee, alongside slavery and other labor abuses.[1] Coffee's promise of prosperity has become a trail of broken trust.

But the forest ecology isn't the only loser — coffee is also facing an economic reckoning. Deforestation has unleashed a cascade of ecological damage, but its most devastating impact is on rainfall. Forests regulate rainfall—lose them, and coffee starves. By dismantling local water cycles, forest loss is driving Brazil's coffee heartlands into heat and drought. Coffee, a crop highly sensitive to microclimates, is now suffering from the very deforestation it caused.

Forest loss is disrupting the very rains Brazil's coffee belt depends on. For centuries, Brazil's southeastern highlands thrived under one of nature's most generous arrangements: fertile soils, ideal altitude, and rainfall patterns finely tuned to coffee's biological cycle. But as the forest fell, so did the rains. What once was a climate advantage is now unraveling into a liability. Today, Brazil's coffee epicenter — Minas Gerais, São Paulo, and Espírito Santo — sits at the heart of a deepening rainfall crisis. Deforestation across the Amazon, Cerrado, and Atlantic Forest has disrupted both regional and local hydrological cycles. The coffee sector is beginning to feel the climate cost of its own ecological transformation.

HOW FOREST LOSS BREAKS THE RAINFALL ENGINE

Deforestation doesn't just destroy ecosystems — it breaks the rainfall engine. Brazil's forests – especially the Amazon – once powered a vast atmospheric conveyor belt. Known as "flying rivers," these airflows carry moisture from the Amazon across the country, fueling rainfall as far south as Minas Gerais (Figure 3.1). This mesoscale evapotranspiration system depends on healthy, contiguous forests to function. As upstream biomes like the Amazon and Cerrado are fragmented, their ability to generate and export moisture collapses. Scientific estimates suggest that up to 40% of rainfall in Southeast Brazil is sustained by this forest-driven system.[2] Without it, rains arrive late, leave early, or vanish altogether.

[1] Coffee and human rights abuses (2024) Coffee and Human Rights Abuses | Coffee Watch. Available at: https://coffeewatch.org/coffee-and-human-rights-abuses/

[2] Spracklen, D., Arnold, S. & Taylor, C. Observations of increased tropical rainfall preceded by air passage over forests. Nature 489, 282–285 (2012)

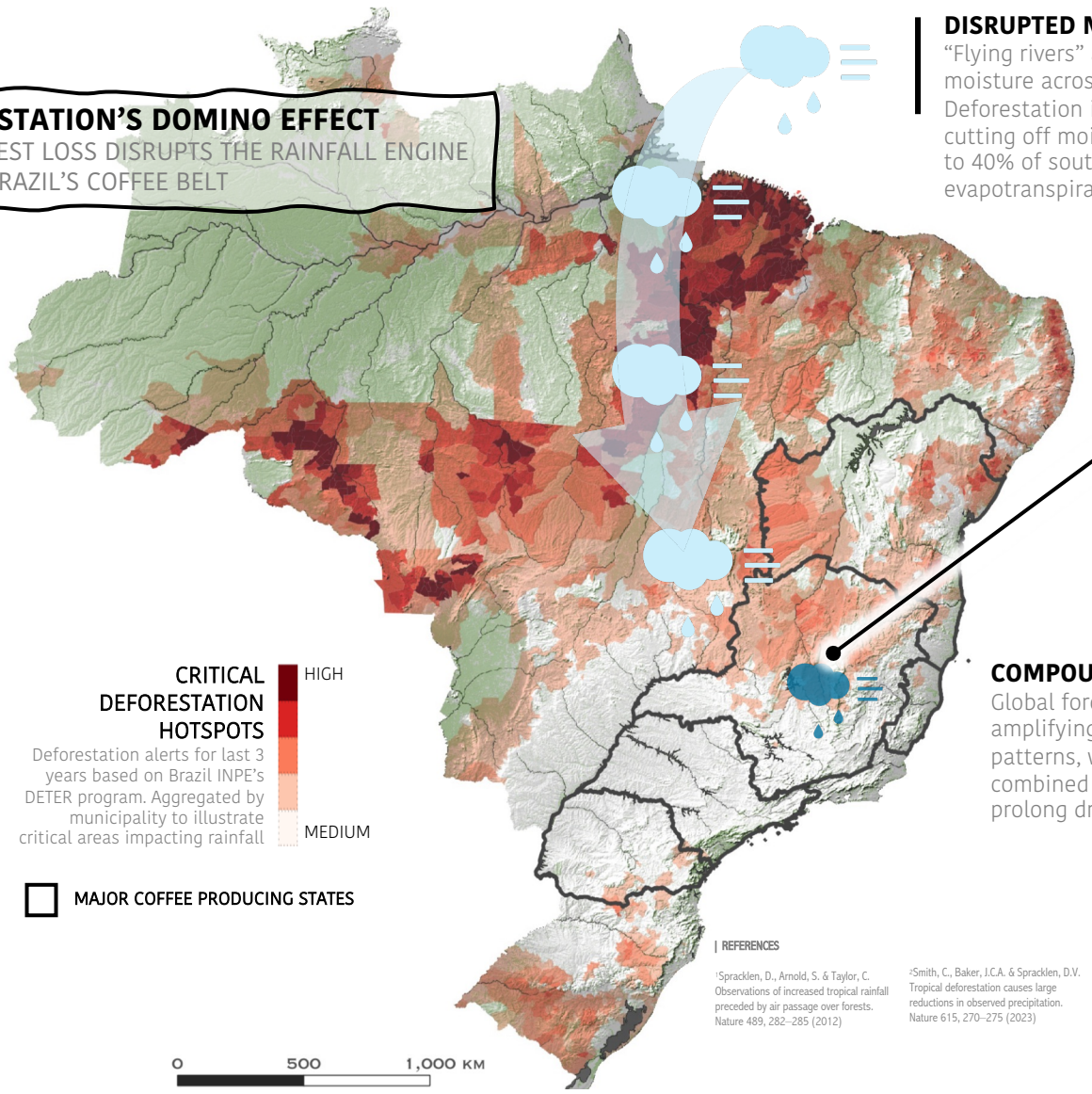
FIGURE 3.1

BREWING INTO COLLAPSE: FORESTS FELL, THE RAINS SHIFTED, COFFEE PAYING THE PRICE

Once sustained by forest-fed rain systems, Brazil's southeastern highlands now sit at the heart of a deepening rainfall crisis. Deforestation across the Amazon, Cerrado, and Atlantic Forest has disrupted local and regional moisture cycles — with the 2014 drought marking a turning point where coffee began to feel the climate cost of its own landscape transformation.

DEFORESTATION'S DOMINO EFFECT

HOW FOREST LOSS DISRUPTS THE RAINFALL ENGINE ACROSS BRAZIL'S COFFEE BELT



1 DISRUPTED MESOSCALE EVAPOTRANSPIRATION

"Flying rivers" are vast air currents that transport Amazonian moisture across Brazil, fueling rainfall far downstream. Deforestation in the Amazon and Cerrado disrupts this system, cutting off moisture supply to coffee regions like Minas Gerais. Up to 40% of southeast rainfall depends on forest-driven evapotranspiration[1]

2 MICROCLIMATE BREAKDOWN

Even modest deforestation near farms disrupts local rainfall. A 2023 Nature study found that clearing just 1% of forest within a 25 km radius reduced local rain by 0.25%, and deforested areas received up to 28% less rainfall than nearby intact forests[2]

3 COMPOUNDED BY MACRO SHOCKS

Global forces like El Niño and long-term warming are amplifying Brazil's rainfall extremes. El Niño disrupts moisture patterns, while rising temperatures increase evaporation. When combined with deforestation, these macro shocks intensify and prolong droughts in coffee regions[3]

| REFERENCES

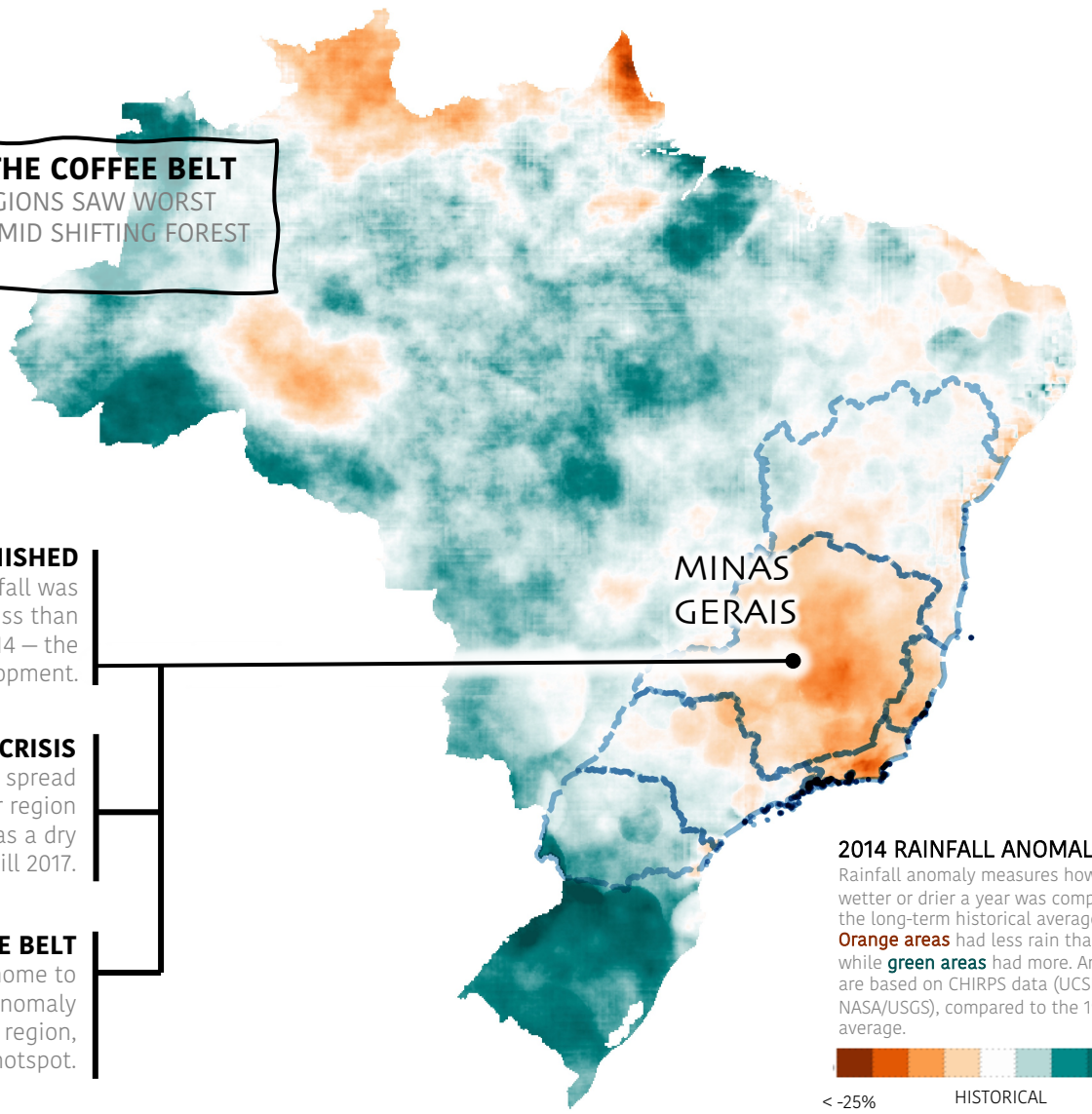
[1]Spracklen, D., Arnold, S. & Taylor, C. Observations of increased tropical rainfall preceded by air passage over forests. Nature 489, 282–285 (2012)

[2]Smith, C., Baker, J.C.A. & Spracklen, D.V. Tropical deforestation causes large reductions in observed precipitation. Nature 615, 270–275 (2023)

[3]Almeida Silva, Karita, et al. "Influence of El Niño and La Niña on coffee yield in the main coffee-producing regions of Brazil." Theoretical and Applied Climatology 139 (2020): 1019-1029

RAINFALL RECKONING IN THE COFFEE BELT

IN 2014, BRAZIL'S TOP COFFEE REGIONS SAW WORST DROUGHT IN DECADES UNFOLD AMID SHIFTING FOREST COVER AND CLIMATE



WHEN RAINS FINALLY VANISHED

In key parts of Minas Gerais, rainfall was up to 50% below normal (300mm less than average) from January to March 2014 — the peak of bean development.

PREVIEW OF BRAZIL'S BREWING CRISIS

The 2014 drought didn't just hit one pocket — it spread across Brazil's entire coffee belt. With no major region spared, there was no fallback — and what began as a dry year spiraled into a multi-year crisis spanning till 2017.

GROUND ZERO: THE COFFEE BELT

The drought's bullseye was Brazil's Southeast — home to over 70% of the country's coffee output. The anomaly map shows rainfall collapse precisely over this region, turning the world's coffee engine into a climate hotspot.

Even small clearances near coffee farms can destabilize local weather. While large-scale biome loss breaks regional systems, localized deforestation creates microclimatic impacts that compound the damage. A 2023 study in Nature found that clearing just 1% of forest within a 25 km radius of a farm can reduce local rainfall by 0.25%. In more heavily deforested areas, rainfall can drop by up to 28% compared to nearby intact forests.[3] In a crop as sensitive to seasonal timing as coffee, such micro-scale disruptions (Figure 3.1) can trigger flowering failures, reduce cherry development, and cascade into yield shocks.

Macro climate forces are amplifying and compounding the decline of the rainfall engine. Global climate dynamics are now compounding the forest-driven decline. El Niño events, known to disrupt moisture flow across South America, have grown more extreme and frequent. These events raise temperatures and suppress rainfall, while long-term warming increases evapotranspiration and depletes soil moisture.[4] When layered atop deforestation, these macro shocks deepen and prolong drought conditions in coffee-producing regions. Brazil's climate is no longer just unpredictable. It's becoming structurally unstable.

THE 2014–2017 DROUGHT: A TURNING POINT

The 2014 drought marked a turning point — the moment Brazil's coffee heartland began to suffer the climate cost of its own deforestation. Once sustained by forest-fed rainfall, the southeastern highlands of Brazil — responsible for over 70% of the country's coffee output — found themselves at the epicenter of a severe and prolonged rainfall collapse. In early 2014, the CHIRPS satellite dataset,[5] recorded rainfall anomalies of up to 50% below normal in critical zones like Minas Gerais, with losses of 300mm during the core development period between January and March. This was not a coincidence. As forests fell across the Amazon, Cerrado, and Atlantic Forest, the region's moisture engine began to unravel, with evapotranspiration losses, disrupted cloud formation, and broken flying river pathways cascading into real-world consequences for farms.

The rainfall maps in Figure 3.1 show this collapse with unnerving precision: a dense orange blotch over the coffee belt, signaling a hotspot where landscape change had come full circle.

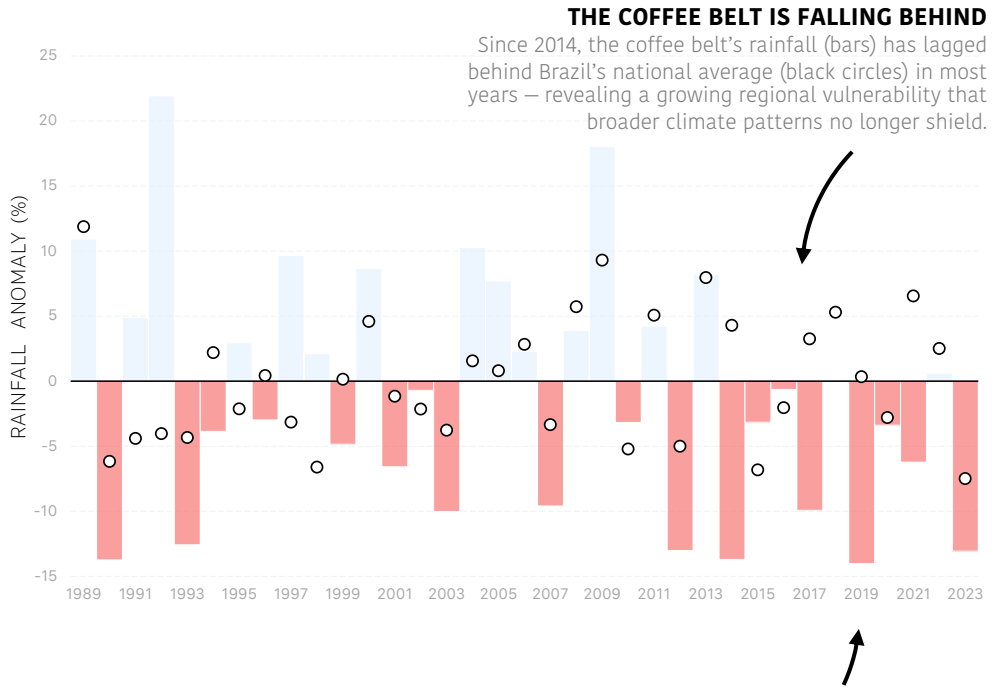
But the 2014 drought wasn't an isolated shock — it triggered a cascading crisis that exposed how vulnerable Brazil's coffee belt had become. Without forest buffers or regional climate resilience, the drought spread across nearly all major growing regions. There was no fallback. As yields dropped and prices surged, the impacts rippled across supply chains and consumer markets.[6] What began as a single-season shortfall spiraled into a multi-year drought spanning 2014–2017 — a period now widely recognized as one of the most consequential environmental stress events for Brazil's coffee industry.

Satellite-derived rainfall anomalies from CHIRPS confirm this long arc: persistently below-average precipitation across key production zones, well outside historical variability. While climate cycles like El Niño played a role, it was the weakened ecological foundation — the forests that once regulated and recycled regional moisture — that left Brazil's coffee sector exposed. A self-inflicted fragility had been laid bare.

FIGURE 3.2

NOT JUST 2014 — A DRYING TREND HAS SET IN

Over the last decade (2014–2023), southeastern Brazil saw rainfall deficits in 8 out of 10 years, turning rare cyclic shocks into a new norm.



[3] Smith, C., Baker, J.C.A. & Spracklen, D.V. Tropical deforestation causes large reductions in observed precipitation. Nature 615, 270–275 (2023)

[4] Almeida Silva, Karita, et al. "Influence of El Niño and La Niña on coffee yield in the main coffee-producing regions of Brazil." Theoretical and Applied Climatology 139 (2020): 1019-1029

[5] CHIRPS (Climate Hazards Group InfraRed Precipitation with Station data) is a global rainfall dataset developed by the Climate Hazards Center at the University of California, Santa Barbara (UCSB). It blends satellite imagery with in-situ rain gauge observations to produce high-resolution (~5 km) rainfall estimates from 1981 to present. CHIRPS is widely used in drought monitoring, agricultural forecasting, and climate research due to its balance of spatial coverage, temporal continuity, and accuracy in data-sparse regions.

[6] Worst drought in decades hits Brazil Coffee Belt as buyers brace for Price Rise (2014) The Guardian. Available at: https://www.theguardian.com/world/2014/feb/25/brazil-drought-threatens-coffee-crops

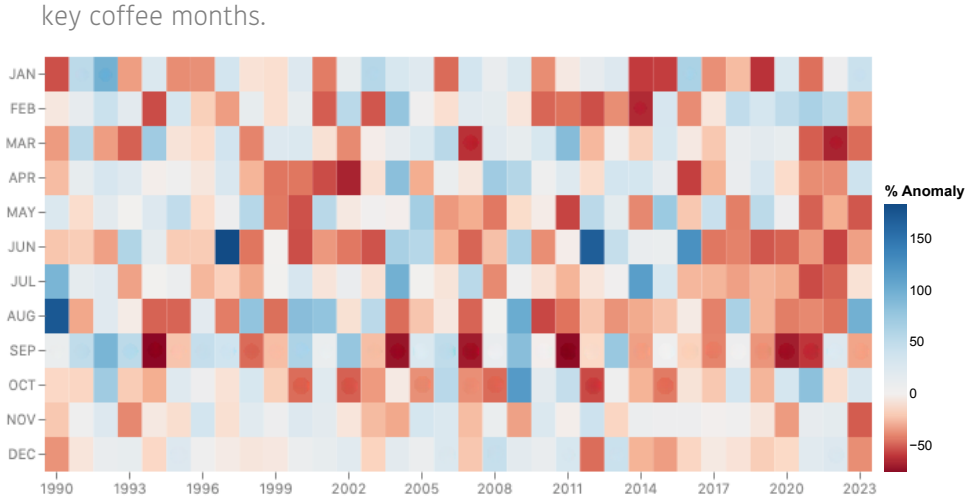
DROUGHTS ARE THE NEW NORMAL

The shift from climate anomaly to climate vulnerability is now unmistakable: droughts are no longer the exception — it's becoming the baseline. What was once seen as the occasional drought has now hardened into a new normal across Brazil's southeastern coffee belt. Since the fateful 2014–2017 drought, the region experienced rainfall deficits in 8 out of 10 years — a sharp departure from previous decades, where deficits were scattered and intermittent. CHIRPS rainfall anomaly data in Figure 3.2 confirm the trend: since 2014, average rainfall across the coffee belt has consistently lagged behind national norms, revealing a growing regional vulnerability that broader climate systems no longer buffer. The 2014-2017 drought alone dropped rainfall 15%, slashed yields by 30%, and drove prices up by 50% — a single drought cycle triggering a global shock.[7] Now, these so-called "rare" years are no longer rare at all.

FIGURE 3.3

FROM ANOMALY TO SEASONAL RECURRENCE

Once rare, extreme rainfall anomalies now span entire growing seasons — heatmap reveals an unmistakable shift toward persistent deficits during key coffee months.



SEASONAL STRESS, YEAR AFTER YEAR

Critical coffee flowering and harvest months have repeatedly fallen outside agronomic rainfall thresholds, pushing plants into water stress during key development windows.

It's not just less rain — it's less rain at the worst possible time. Since 2012, average rainfall in southeastern Brazil has stayed 6–12% below historical norms — a sustained pressure on coffee yields and plant resilience. Beyond the yearly averages, timing matters — and coffee is most vulnerable when water stress strikes during flowering and bean development.

A deep dive into monthly CHIRPS anomaly data reveals a disturbing seasonal trend: deficits are no longer scattered or rare, but now cluster tightly around Brazil's key coffee months. From January to March — the critical window for bean formation — rainfall has repeatedly fallen below agronomic thresholds. In 2014, this drop was particularly acute: rainfall in parts of Minas Gerais was 300mm below normal, or nearly 50% short. The result? Widespread crop failure. The heatmap visualization in Figure 3.3 shows how these dry spells now dominate the seasonal calendar, shifting from occasional blips to routine features. This seasonal mistiming has become a quiet stress multiplier, turning routine dry spells into yield-shaping events. Projections now warn of up to 20% less rainfall by 2030 across Brazil's core coffee zones — a future where the droughts of today may soon look like the good years.[8]

The coffee belt is now caught in a double bind: chronic drought and seasonal mistiming. In short, Brazil's coffee heartland isn't just facing less rain — it's facing rain that arrives too late, too early, or not at all. Extreme dry spells now span entire growing seasons, as evidenced by the thickening bands of red across the heatmap (Figure 3.3) in recent years. What was once an occasional climatic stressor has become a structural threat, reshaping risk across farms, forecasts, and futures. Brazil's coffee engine is now running on an increasingly unreliable water supply.

Minas Gerais is the beating heart of global coffee — and the first to feel the sting of a shifting climate. Accounting for close to one-sixth of global supply, Minas Gerais anchors Brazil's dominance in the coffee world. Its landscapes — from Sul de Minas to Cerrado Mineiro — have long delivered the volume and quality that shape international markets. But Minas's dominance now rests on fragile ground. The state's forests, once buffers of rain and moisture, have steadily receded, and in their absence, the risks have deepened. As the rainfall pattern shifts, Minas has become the test case for coffee's ecological limits.

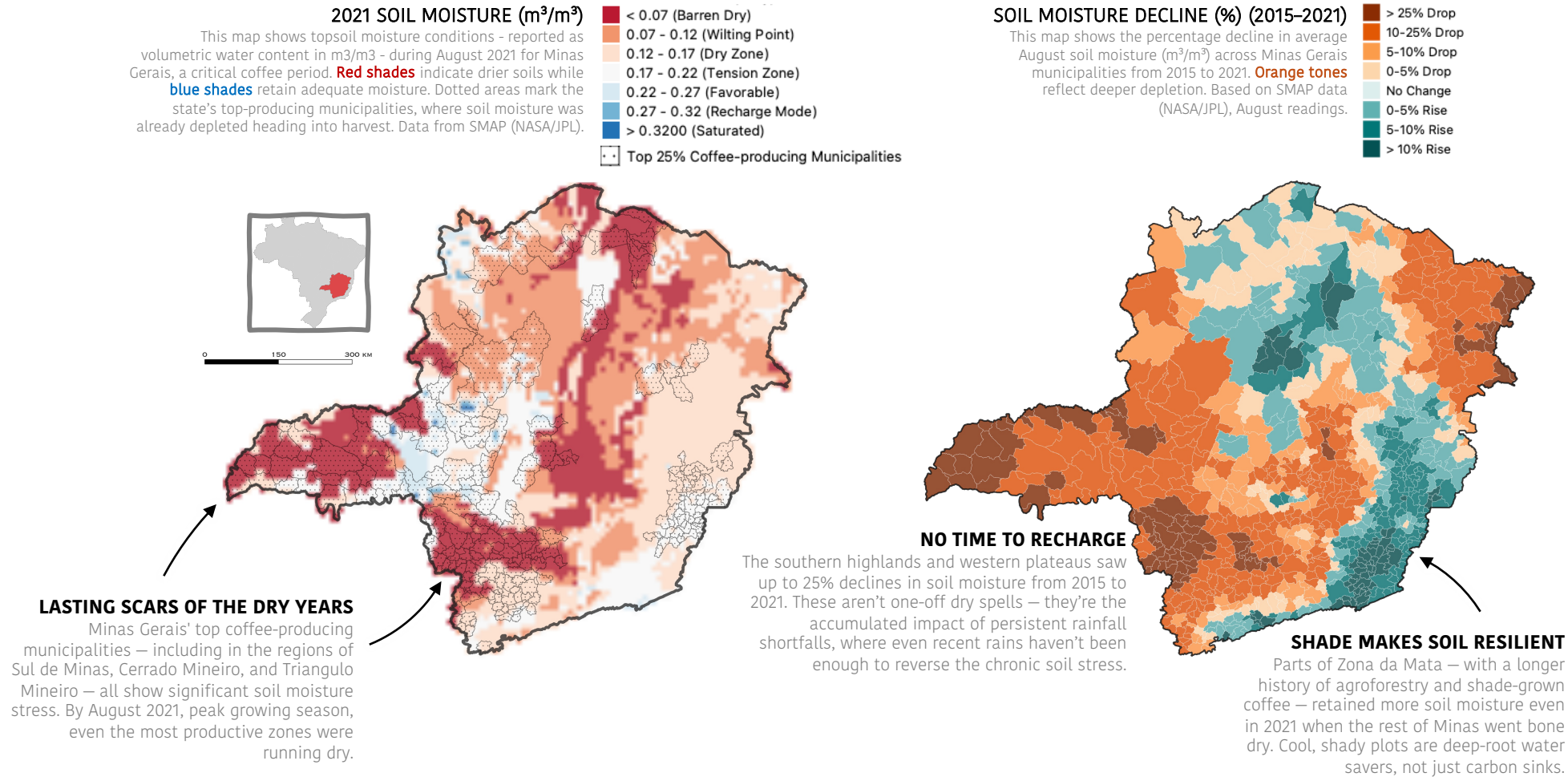
[7] Nobre, C. A., Marengo, J. A., Seluchi, M. E., Cuartas, L. A., & Alves, L. M. (2016). Some characteristics and impacts of the drought and water crisis in Southeastern Brazil during 2014 and 2015. Journal of Water Resource and Protection, 8(2), 252-262.

[8] Dias, C. G., Martins, F. B., & Martins, M. A. (2024). Climate risks and vulnerabilities of the Arabica coffee in Brazil under current and future climates considering new CMIP6 models. Science of the Total Environment, 907, 167753.

FIGURE 3.4

DEFICIT TO DEPLETION: WITHOUT FORESTS, RAIN RUNS OFF, ROOTS DRY OUT

Years of disrupted rainfall have taken a toll on the land itself. By 2021, large parts of Minas Gerais — Brazil's most important coffee state — showed stark signs of soil moisture collapse, particularly in high-yield regions. These maps reveal the lingering footprint of a decade of drying.



CHRONIC DRYING OF COFFEE LANDS

By 2021, even Brazil's coffee crown jewels were visibly parched — the land itself showing signs of collapse. A snapshot from August 2021 — peak coffee season — reveals the damage. NASA Soil Moisture SMAP satellite data,[9] in Figure 3.4, shows widespread soil moisture depletion across Minas Gerais, particularly in the state's most productive regions: Sul de Minas, Cerrado Mineiro, and Triângulo Mineiro. The municipalities in these regions, marked in dotted outlines, weren't just dry — they were cracked open by years of rain deficits.

Red zones, denoting volumetric moisture below sustainable levels, paint a stark picture: the crops weren't just thirsty — the roots were gasping. Despite some recent rainfall, there simply wasn't enough time, or forest, for the soil to recharge.

This wasn't a one-off dry year — it was the cumulative scar tissue of a decade of drying. Zooming out, a second SMAP analysis shows that parts of Minas' southern highlands and western plateaus saw up to 25% declines in August soil moisture over just six years (Figure 3.4). These aren't seasonal setbacks. They're chronic wounds — the consequence of repeated rainfall shortfalls that compound over time. Even when rains return, the soil doesn't bounce back instantly. Without sufficient forest cover to anchor moisture, shade the ground, and slow runoff, the landscape itself begins to lose its memory of water. Deep-rooted crops like coffee feel the deepest cuts.

And yet, in regions like Zona da Mata — where agroforestry and shade-grown methods persist — soil moisture levels held steadier, even in 2021. Cool, tree-shaded plots helped retain sub-surface moisture,[10] acting as climate buffers and offering a quiet lesson in resilience.

[9] NASA's SMAP (Soil Moisture Active Passive) mission provides global data on surface soil moisture, helping monitor drought, crop stress, and land-climate interactions. Launched in 2015, SMAP uses satellite-based microwave sensors to measure how much water is in the top 5 cm of soil, with near-global coverage every few days. The data is widely used for agriculture, climate monitoring, and environmental research.

[10] de Souza, H. N., de Goede, R. G., Brussaard, L., Cardoso, I. M., Duarte, E. M., Fernandes, R. B., ... & Pulleman, M. M. (2012). Protective shade, tree diversity and soil properties in coffee agroforestry systems in the Atlantic Rainforest biome. Agriculture, Ecosystems & Environment, 146(1), 179-196.

FIGURE 3.5

BREWING VOLATILITY: ECOLOGICAL LOSS AND SPECULATION BEHIND COFFEE'S PRICE SPIKES

Coffee prices have surged time and again — driven by a growing mix of extreme droughts, biodiversity collapse fuelling pest outbreaks, and frost events. As these shocks become more frequent and compound, speculative market behaviour is amplifying volatility in ways never seen before.

Roasting the market: how increasing extreme events fuel speculation loops

The frequency and intensity of shocks to Brazil's coffee system — from ecological to climatic — have increased over the past couple of decades. Market speculation now acts as an accelerant: each extreme event doesn't just strain production, it fuels cycles of fear, hoarding, and price volatility across global markets. More recently (2023–2024), Brazil's coffee industry faced a mix of pest pressure, drought, and erratic weather. These have collectively contributed to a tight global supply and historically high prices (e.g. price surges of over 40% over 2024–2025)

ECONOMIC RIPPLES OF THE ECOLOGICAL CRISIS

The economic shock is already underway — and it's being driven from the ground up. The long tail of deforestation is now hitting Brazil's coffee economy where it hurts. Landmark dry spells in 2016–17, 2019–20, and again in 2023 have slashed yields, pushed up production costs, and fueled global price volatility.[11] In 2016, a 15% drop in rainfall triggered a surge in global prices. In 2021, Brazil's market swung wildly again. These aren't natural climate cycles alone — they're the blowback of a century of landscape change. The crisis is self-inflicted. What once fueled coffee's rise now threatens its future.

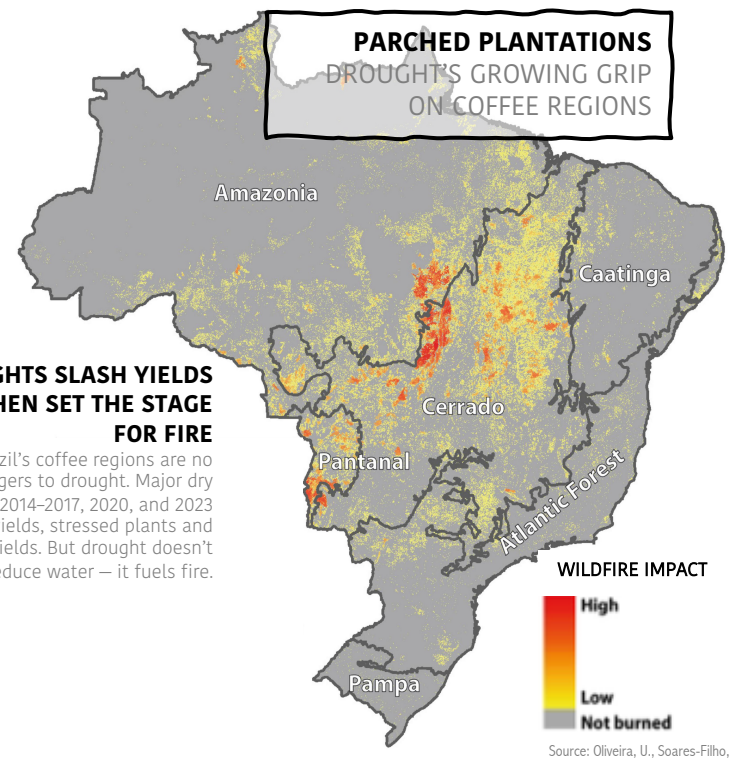
The boom promised prosperity, but the bust is self-inflicted. Brazil's coffee industry was once hailed as a national success story — a model for rural growth, foreign exchange, and global dominance. But the very engine of this prosperity has turned on itself. By expanding into ecologically sensitive regions and gutting forests to make way for sun-grown monocultures, the sector traded short-term yields for long-term vulnerability. As deforestation undermines rainfall and microclimate stability, the coffee belt has become locked into a cycle of self-induced drought and declining resilience. The result is no longer just lower production — it's a volatile market on the edge.

Each dry year now sets off a chain reaction across global prices. The 2016 drought was an early red flag but this was only a preview. In 2021, a brutal combo of drought and frost doubled prices overnight — only to crash them months later when low-quality, drought-damaged beans flooded the market. What was once treated as an anomaly is now a pattern. As seen in the price chart in Figure 3.5, nearly every major price spike over the last three decades coincides with climatic or ecological disruption in Brazil. From 1994 to 2024, the volatility has worsened, driven not just by declining yields, but by speculation reacting to increasingly frequent supply shocks.

BOX 3.1

BURNING FIELDS: DROUGHT, WILDFIRES, AND THE SCORCHED FUTURE OF COFFEE

The same forces reducing rainfall are also fueling fire. As shown in the wildfire impact map, Brazil's coffee belt — especially in the Cerrado and transitional zones — is now one of the country's most fire-prone regions. Major dry years like 2014–2017, 2020, and 2023 have ignited a deadly trio of aridity, heat, and wildfires. These fires don't just burn trees — they dry out soils, scorch coffee plants, and degrade future yields. Fire damage exposes crops to erosion and heat stress, creating a vicious cycle where every flame worsens the droughts to come.



DROUGHTS SLASH YIELDS — THEN SET THE STAGE FOR FIRE

Brazil's coffee regions are no strangers to drought. Major dry spells in 2014–2017, 2020, and 2023 slashed yields, stressed plants and slashed yields. But drought doesn't just reduce water — it fuels fire.

COFFEE'S EXPANSION PATH IS NOW A FIRELINE

The map here shows how rising aridity is now igniting a new threat: wildfires, especially across the Cerrado and transitional zones where coffee production is expanding. Fires damage trees, dry out soils, and leave plants exposed to heat and erosion — compounding the climate risks already battering the crop.

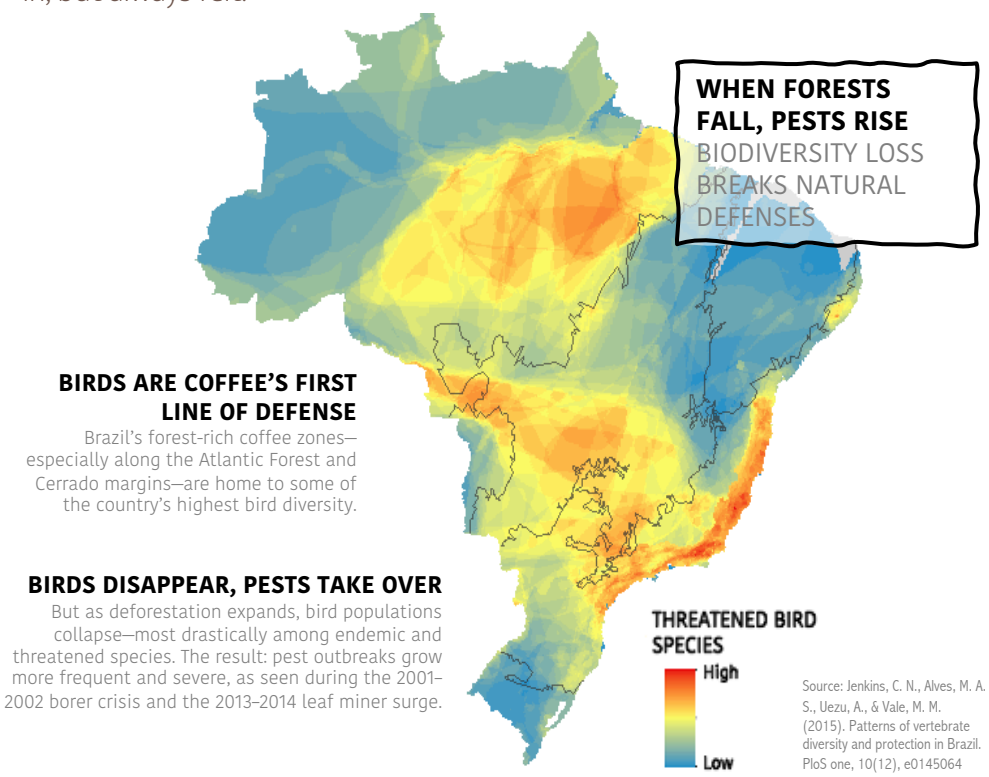
Source: Oliveira, U., Soares-Filho, B., Bustamante, M., Gomes, L., Ometto, J. P., & Rajão, R. (2022). Determinants of fire impact in the Brazilian biomes. Frontiers in Forests and Global Change, 5, 735017

[11] Cunha, A. P. M., Zeri, M., Deusdará Leal, K., Costa, L., Cuartas, L. A., Marengo, J. A., ... & Ribeiro-Neto, G. (2019). Extreme drought events over Brazil from 2011 to 2019. Atmosphere, 10(11), 642.

BOX 3.2

WHEN FORESTS FALL, PESTS RISE: THE HIDDEN COST OF BIODIVERSITY COLLAPSE

Brazil's forest-fringed coffee zones host some of the country's richest bird diversity — natural allies in controlling coffee pests like the berry borer and leaf miner. But as deforestation tears through the Atlantic Forest and Cerrado margins, bird populations collapse, especially among endemic and threatened species. Pest outbreaks have followed: a major borer crisis in 2001–2002, a leaf miner surge in 2013–2014, and rising chemical use ever since. Less biodiversity means more pesticide dependence, weaker plant health, and greater climate sensitivity — risks that are rarely priced in, but always felt.



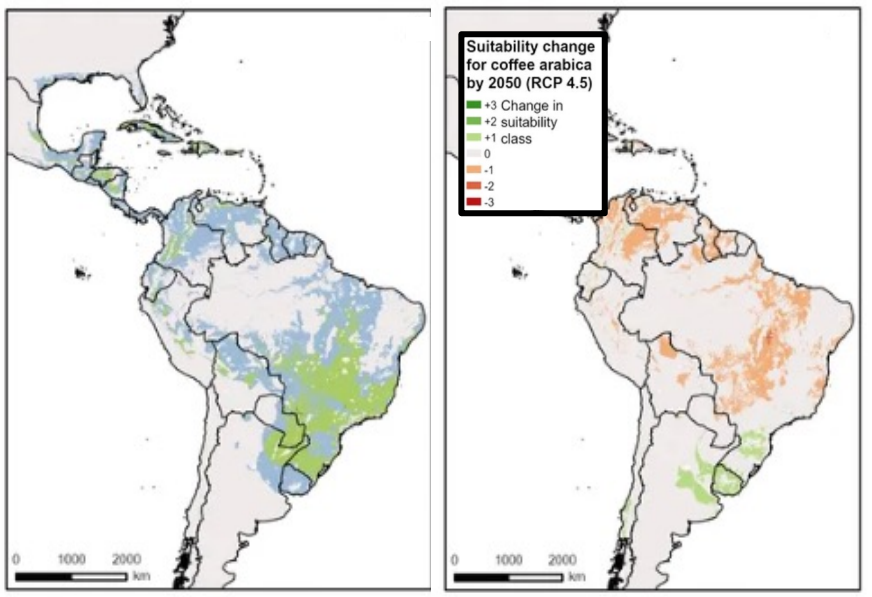
Today, ecological failure is driving financial chaos. With every new drought, fire (Box 3.1), or pest outbreak (Box 3.2), the market reacts faster and more aggressively — amplifying the ripple effects of local stressors across global trade. In 2023–2024 alone, a potent mix of pest resurgence, deepening drought, and erratic rainfall patterns pushed Brazil's coffee system into another crisis. Prices surged by over 40% (Figure 3.5), triggering a new wave of hoarding, speculation, and panic buying.[12] This isn't just a climate crisis — it's a feedback loop between ecological collapse and financial markets, where each new shock magnifies both environmental and economic instability.

Coffee isn't just reacting to climate shocks — it's amplifying them. The irony is brutal: a crop that drove deforestation is now crumbling under the environmental costs of its own expansion. Market volatility isn't just a response to climate — it's a mirror of ecological collapse. And as if ecological instability weren't enough, recent tariff wars have added a new layer of turmoil: U.S.–Brazil trade tensions in 2025 triggered tariffs of up to 50%, further distorting prices and exposing how deeply external shocks can compound ecological risk.[13] With each new harvest, Brazil's coffee sector becomes more exposed, more speculative, and more brittle. Unless the industry rapidly shifts toward ecological restoration and risk reduction, it risks pricing itself — and its producers — out of the future.

BOX 3.3

CLIMATE'S FINAL BLOW: TWO-THIRDS OF COFFEE LAND AT RISK BY 2050

Climate change is set to tip the system into unviability. Modelling shows that under a mid-range emissions pathway (RCP 4.5), Brazil could lose up to two-thirds of its suitable Arabica land by 2050. Already, yields in top zones are down 20%, battered by erratic rainfall and rising heat. Even "normal" years now fail to fully recharge the system. Without intervention — especially large-scale agroforestry and climate-smart adaptation — the sector will bleed both acreage and output in the decades ahead.



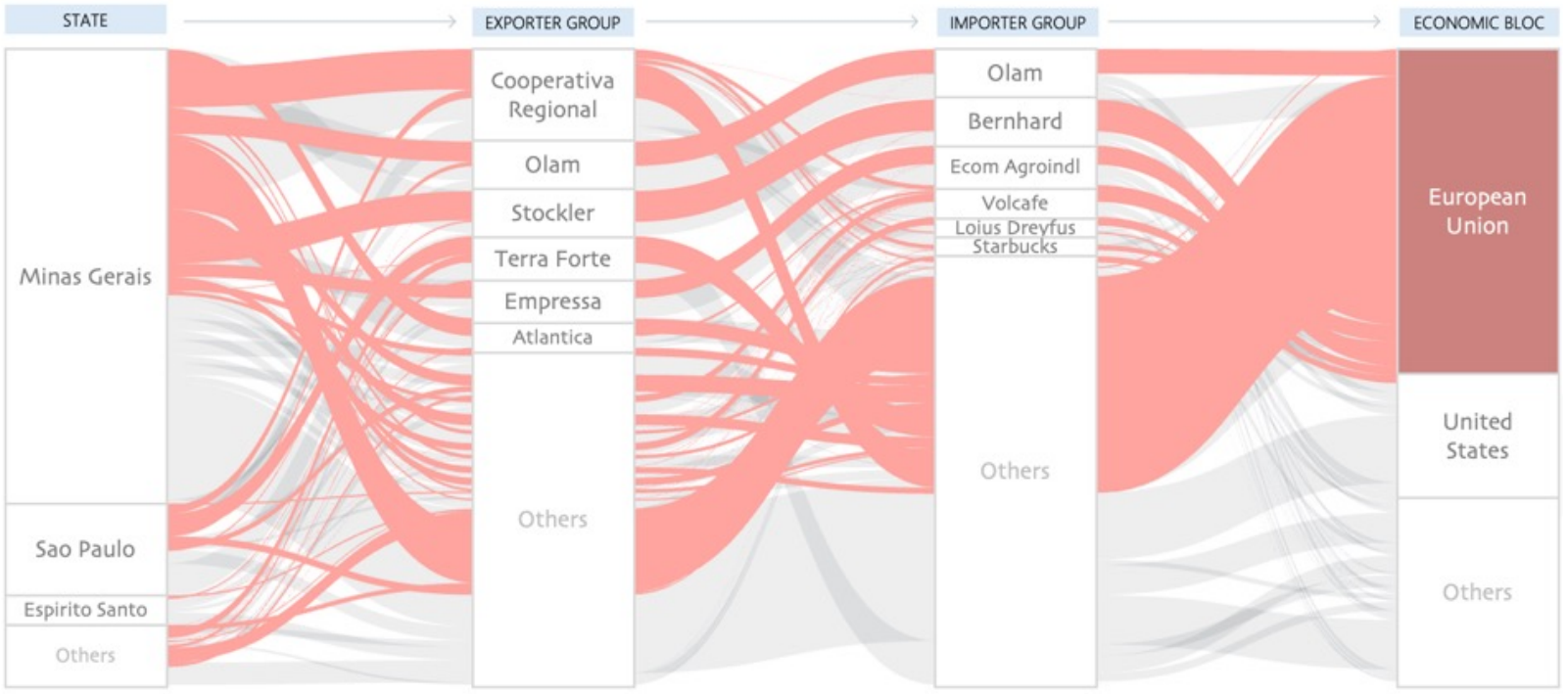
Source: Grüter, Roman, Tim Trachsel, Patrick Laube, and Isabel Jaisli. "Expected global suitability of coffee, cashew and avocado due to climate change." PloS one 17, no. 1 (2022)

[12] Amrouk, E. M., Palmeri, F., & Magrini, E. (2025). Food and Agricultural Organization - Global coffee market and recent price developments.
[13] Coffee Watch (2025). How Tariff Wars and Tariffs Crush Coffee-Growing Countries. https://coffeewatch.org/how-tariff-wars-and-tariffs-crush-coffee-growing-countries/

FIGURE 3.6

THE FINAL FILTER: EUDR RISKS BLOCKING HALF OF BRAZIL'S COFFEE TRADE

As ecological risks mount, EU regulations threaten billions in exposed supply chains — and exporters may soon face a bitter reckoning.



Source: Trase (https://trase.earth), Brazil Coffee Supply Chain Dataset (2016–2017), Trade Value (USD)

BILLIONS AT THE BRINK

Over $2.4 billion in Brazilian coffee exports — more than 52% of national trade — flows into the EU, now subject to strict deforestation-free requirements under the 2026 EUDR. With supply chains still largely unmapped, even compliant producers' risk being caught in the regulatory crossfire — putting entire export flows in jeopardy.

Brazil's coffee boom was built on forest loss — but that same deforestation has now destabilized the climate foundation the industry depends on. More frequent droughts, rising temperatures, pest outbreaks, and market volatility are no longer anomalies; they are the new operating conditions. The shocks of 2016, 2021, and now 2024 have revealed the system's fragility — and the steep price of ecological short-termism. With up to half of Brazil's coffee land projected to become unsuitable by 2050,[14] the model that once drove prosperity is fast becoming unviable (Box 3.3).

EUDR AS THE FINAL MARKET FILTER AND COMPANY ACCOUNTABILITY

The European Union's new deforestation-free regulation (EUDR) is about to translate these ecological failures into further economic fallout. From 2026, coffee entering the EU must be proven free of deforestation—a requirement that threatens to put over $2.4 billion in Brazilian exports at risk according to TRASE trade volume data (Figure 3.6), more than half the country's coffee trade. Yet supply chains remain opaque, and many exporters are unprepared. Even compliant farmers risk getting caught in the regulatory crossfire if traceability gaps aren't closed. What was once treated as a reputational issue is now becoming an existential market filter — one that could shut the door on billions in trade if the sector fails to adapt. Although enforcement is now expected to be delayed beyond 2026 amid EU "IT system" concerns, critics warn the pause risks dulling momentum and weakening accountability just as deforestation-linked coffee reaches its peak.[15]

Coffee Watch's accountability work shows that this crisis is not abstract — it has corporate fingerprints. In 2025, our investigation with AidEnvironment found that JDE Peets — the world's second-largest coffee company, sourcing 8% of global beans — was potentially linked to multiple Brazilian farms that cleared land after the EUDR cut-off date, with six case studies across Minas Gerais and Bahia revealing non-compliance risks if beans from those farms enter EU markets.[16] JDE Peets is not an outlier: these findings form part of Coffee Watch's ongoing Accountability Series, which scrutinises the practices of leading coffee multinationals and their traders by mapping company assets, sourcing hubs, and supply chains against deforestation alerts.

And this is only the beginning: Coffee Watch's forthcoming Rondônia report will show how coffee has already cleared Amazon rainforest after the EUDR's 2020 cut-off date — with six new non-compliance cases documented, including farms where coffee was planted directly on freshly deforested land.[17] This expansion into the Amazon underscores that the risks go far beyond the Coffee Belt — and that corporate accountability must extend wherever coffee spreads.

Coffee's deforestation debt has become an ecological and financial liability — yet within the very landscapes under pressure, there are pathways to recovery. In the shaded pockets of resilience — where trees still stand and soils still hold moisture — agroforestry offers a glimpse of a more stable, climate-ready future.[18] What was once sidelined as niche is now emerging as a necessary pivot - not just as a climate solution, but as a business imperative.

[14] Grüter, Roman, Tim Trachsel, Patrick Laube, and Isabel Jaisli. (2022)"Expected global suitability of coffee, cashew and avocado due to climate change." PloS one 17, no. 1

[15] https://www.foodnavigator.com/Article/2025/09/30/are-it-problems-really-to-blame-for-eudr-delay/

[16] Coffee Watch / AidEnvironment (2025). Compliance Checker: Company Profile – JDE Peet's. Amsterdam: AidEnvironment, April 2025. https://aidenvironment.org/publications/compliance-checker-company-profile-jde-peets/

[17] Coffee Watch / AidEnvironment (2025). Compliance Checker: Coffee Cases in Brazil's Rondônia. Amsterdam: AidEnvironment, September 2025. (forthcoming)

[18] Rice, R. A. (2018). Coffee in the crosshairs of climate change: agroforestry as abatis. Agroecology and Sustainable Food Systems, 42(9), 1058-1076.

Araras (red and green macaws) glide over Brazil's vanishing forests – majestic and vibrant symbols of an ecological balance now at risk. As coffee expands, agroforestry offers a lifeline to preserve their habitat while cultivating a future.

4 COFFEE'S REDEMPTION

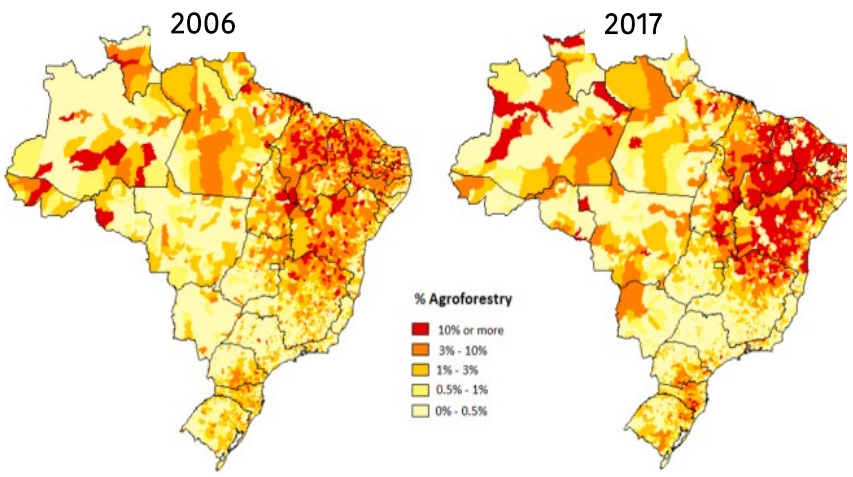
Forests as Profit Partners

The evidence is clear: deforestation linked to coffee production is not only a moral failure — it's an economic liability that may turn coffee farms into stranded assets. Forest loss is killing the rain, destabilizing yields, and threatening the long-term viability of the coffee industry itself. But this crisis also presents a critical opportunity for course correction. Addressing past harms and preventing future damage must become core pillars of how coffee is grown, traded, and consumed. The coffee sector must now move from denial to accountability — and from business-as-usual to genuine transformation.

BOX 4.1

NO SHADE, NO COFFEE: AGROFORESTRY IS THE LAST DEFENSE

Agroforestry is not just a sustainable alternative—it may be coffee's last lifeline. It's a natural shield against nearly every climate and ecological stressor discussed so far. Yet despite its transformative potential, adoption remains far too limited. As the map shows, agroforestry has expanded in parts of Brazil—but mostly in non-coffee regions and for other crops. In key coffee-growing zones, uptake is still below 1% of area, leaving plantations exposed to escalating shocks.



Source: Maia, Alexandre Gori, Gabriela dos Santos Eusebio, Maria do Carmo Ramos Fasiaben, Andre Steffens Moraes, Eduardo Delgado Assad, and Vanessa Silva Pugliero. "The economic impacts of the diffusion of agroforestry in Brazil." Land use policy 108 (2021)

Agroforestry isn't just a sustainable alternative — it may be coffee's last line of defense. Brazil's plantations face a cascade of climate shocks, from scorching drought and erratic rainfall to soil degradation and pest outbreaks. But agroforestry — by reintroducing trees into coffee landscapes — helps buffer nearly every one of these risks.[1] It shades crops from heat, improves soil moisture retention, reduces frost severity, revives bird habitats that keep pests in check, and restores ecological balance. In an era of intensifying volatility, trees may be coffee's best insurance policy.

Yet despite its benefits, agroforestry adoption remains dangerously low in coffee zones. The most vulnerable regions — including much of Minas Gerais and São Paulo — have seen less than 1% of coffee area transition to agroforestry.[2] Instead, the model has taken root elsewhere: in non-coffee regions and among farmers growing cacao, fruits, or timber. This geographic mismatch leaves Brazil's coffee belt exposed, precisely where resilience is needed most. The science is clear, the tools exist — what's missing is will and scale.

This isn't just an ecological opportunity — it's now a business imperative. Coffee can no longer afford to chase short-term yields at long-term cost. Forests and trees must be reintegrated into the production model — not as a niche add-on, but as a core operating principle. For companies facing ESG scrutiny, for farmers confronting yield losses, and for consumers demanding ethical supply chains, agroforestry offers a rare win-win-win. Scaling it is not just good practice — it's an urgent strategy for survival.

[1] Rice, R. A. (2018). Coffee in the crosshairs of climate change: agroforestry as abatis. Agroecology and Sustainable Food Systems, 42(9), 1058-1076.

[2] Maia, A. G., dos Santos Eusebio, G., Fasiaben, M. D. C. R., Moraes, A. S., Assad, E. D., & Pugliero, V. S. (2021). The economic impacts of the diffusion of agroforestry in Brazil. Land use policy, 108, 105489.

WHAT THE COFFEE INDUSTRY MUST DO

Acknowledge and Compensate for Past Deforestation:

Companies must publicly acknowledge and take responsibility for deforestation in their supply chains — including illegal clearance in protected and Indigenous areas. This includes transparent disclosure, remediation, and, where possible, restitution. No longer optional, they are prerequisites for credibility and access to regulated markets.

Enforce Zero-Deforestation Commitments:

Adopt and implement strict no-deforestation policies and commitments with clear cut-off dates. Monitoring must be real-time, spatially precise, and independently verified — leveraging satellite data and supply chain traceability tools down to the farm level.

Empower Community-Led Monitoring and Accountability:

Partner with local communities, Indigenous Peoples, and civil society groups who are often the first to detect environmental violations. Community-led bottom-up monitoring systems must become part of mainstream accountability frameworks.

Restore What's Been Lost:

Invest in forest restoration — not just to repair ecosystems, but to reduce long-term climate risk. Reverse ecological damage by restoring degraded lands, reconnecting fragmented habitats, and protecting watersheds. Such efforts build resilience to droughts and extreme weather, but also builds trust with consumers.

Shift to Climate-Smart Regenerative Agroforestry:

Transition from monoculture coffee to agroforestry systems that integrate shade trees, native vegetation, and ecological diversity. These systems not only store twice as much carbon as monocultures but also support up to 19 times more biodiversity (Silva et al., 2020). This isn't charity—it's an economic lifeline, redirecting investment from deforestation traders and stranded assets to sustainable farms.

WHAT THE EUROPEAN UNION MUST DO

As the top importer of Brazilian coffee, the European Union has both leverage and legal obligations. The upcoming enforcement of the EU Deforestation Regulation (EUDR) and Corporate Sustainability Due Diligence Directive (CSDDD) in 2026 must not be symbolic. EU compliance authorities must be proactive and vigilant - verifying the traceability and deforestation-free status of Brazilian coffee, supporting civil society monitoring efforts, and holding non-compliant companies accountable under the law.

- **Demand Full Traceability:**
  EU buyers must ensure all coffee imports are traceable to the plot of origin — and probably free of deforestation.

- **Support Civil Society Monitoring:**
  EU funds and partnerships should help scale grassroots watchdog efforts — the most effective early warning systems we have.

- **Hold Non-Compliant Firms Accountable:**
  Enforcement must be consistent and consequential. Non-compliance with EUDR should carry real penalties — not just reputational damage, but market exclusion.

Strong, coordinated enforcement of these policies could help reverse the deforestation spiral and narrative — transform the coffee sector from a deforestation driver into a force for forest protection and climate action.

The EU must also confront its own paralysis. The recent EUDR enforcement delays — officially blamed on IT readiness — risk signaling that bureaucracy matters more than forests. Each month of postponement weakens accountability, emboldens corporate foot-dragging, and undermines Europe's credibility as a climate leader. If the EU expects producing nations to meet deforestation-free standards, it must first demonstrate the political will and administrative competence to enforce them on schedule.

A symbol of power, now trapped in a vanishing world. As the Atlantic Forest falls to coffee and chainsaws, even its fiercest guardians like the *jaguar* are left with nowhere to hide.

5 THE CLOCK IS TICKING

Save Forests, or Lose Coffee

Brazil's Atlantic Forest — once a jewel of biodiversity, now critically endangered — is being sacrificed for coffee. This investigation lays bare a troubling truth: a global industry built on the quiet destruction of one of Earth's most precious ecosystems. Coffee cultivation, both direct and indirect, has reshaped landscapes, accelerated climate extremes, displaced Indigenous Peoples, and pushed countless species to the brink. With every cup consumed, we edge closer to losing the last fragments of this irreplaceable biome.

The coffee sector must now reckon with its environmental debt. This means more than words. It means radical transparency, real-time deforestation accounting, and large-scale investment in forest restoration, agroforestry, and Indigenous-led monitoring. The era of delay and denial is over. If the industry fails to reform, it risks economic collapse — and the loss of its own climate foundations.

It's time for the coffee industry to fix what it broke. Coffee is racing against a deadline. With forests lost, rains in retreat, and markets on the line, the choice is stark: embrace forests as allies, or collapse. The 2014-2017 drought was ignored. The 2026 EUDR ban won't be. The path forward is clear — regenerative agroforestry, zero-deforestation, and true accountability.

Coffee can still rewrite its story. But the clock is ticking. And Brazil's forests — like your morning brew — can't wait.

Endemic to the Atlantic Forest, these *golden lion tamarins* are not just losing their forest, coffee is losing its future too. Without habitat, both wildlife and the industry teeter on the edge of extinction.

COFFEE WATCH

coffeewatch.org