



Battle for the Amazon

Brazil has waged a successful war on tropical deforestation, and other countries are trying to follow its lead. But victory remains fragile.

BY JEFF TOLLEFSON

Oziel Alves da Silva reins his horse to a stop near the edge of a pasture, and adjusts a baseball cap that has done little to protect his leathery skin from the tropical sun. Keeping an eye out for his herd, he surveys his 274-hectare ranch located in the eastern Amazonian state of Pará. Where he once dreamed of a vast open field covered with grasses and cattle, he sees nothing but palm trees that he cannot cut down.

The 39-year-old rancher is one of thousands of Brazilian landowners stymied by a historic campaign to halt the destruction of the world's largest rainforest. He was fined 720,000 reais (US\$230,000) and banned from selling cattle after trying to clear this field in 2009. Now Alves da Silva is once again operating legally, and he has little hope of expanding his pasture and increasing his herd. Along with many fellow ranchers

in the county of Brasil Novo, he has stopped cutting down trees and is trying to make peace with the law.

"We came together and decided we needed to change," he says.

Over the past decade, while the world has been busy haggling over future commitments to reduce greenhouse-gas emissions, Brazil has lowered its carbon dioxide output more than any other country through a historic effort to slow forest loss. The deforestation rate here last year was roughly 75% below the average for 1996 to 2005 — just shy of Brazil's pledge to achieve an 80% reduction by 2020. The country has managed this feat while increasing the amount of food it produces, much of it for export to a growing and hungry world.

Brazil's experience suggests that humanity has a chance to control agricultural expansion and preserve the planet's most diverse ecosystems. If other countries follow suit by protecting and expanding forests, which lock carbon up in trees and soils, they could slow the growth of global CO₂ emissions and buy the world some time to solve the thornier problem of curbing emissions from cars, power plants and industrial facilities.

"There is no question that Brazil has made a fundamental departure from the past," says Achim Steiner, executive director of the United Nations Environment Programme. "And it has given credence to the notion that forest conservation may be an important mechanism for international cooperation on climate."

Although Brazil's downward trend in deforestation has been evident for nearly a decade, it is only in the past couple of years that researchers have pieced together how the country put the brakes on an epidemic of illegal development that has eliminated roughly 20% of the Brazilian Amazon over the past half century. Even today, the story varies depending on who is telling it. This is what drew me to the Brazilian Amazon for two months last year. I travelled throughout the region, talking to scientists, ranchers, politicians, loggers and members of indigenous tribes — all with the aim of understanding how Brazil altered its environmental trajectory and where it goes from here.

Various factors conspired to curtail deforestation. The federal government designated areas in the Amazon basin for protection, cracked down on ranchers, farmers and land speculators, and put pressure on

Brazilian soldiers investigate illegally deforested land in 2009 in Pará state in the eastern Amazon.



The team promptly burned the camp to the ground, putting an end to that operation — at least for the moment.

The culprits that IBAMA encounters on the ground are often bit players, but the government is also investigating criminals higher up the chain, who make money by speculating on illegally cleared land. After I left, last August, the agency cracked down on a crime syndicate in Pará, arresting 22 people. And in February, IBAMA announced the arrest of the “largest deforester of the Amazon”: Ezequiel Castanha, a businessman in Novo Progresso who allegedly headed the syndicate and had spent months on the run. Officials say that deforestation in the region has dropped by 65% since August.

The basic outline of this enforcement strategy emerged in 2004 under former environment minister Marina Silva, a lifelong environmentalist and candidate in last year’s presidential elections. As minister, Silva tackled deforestation by strengthening IBAMA and bringing other government agencies on board. One key change she made was instituting a sophisticated system to root out corruption within IBAMA.

In parallel, the environmental group Greenpeace increased public pressure on companies by documenting the link between soya-bean farming and deforestation in media campaigns in Brazil and internationally, which pushed supermarket chains and food companies such as McDonald’s to declare a boycott on the purchase of illegally farmed soya. All of these changes helped to push the country’s major exporters to sign a moratorium in 2006, banning the purchase of soya beans from recently cleared land. Two years later, IBAMA published a blacklist of counties with the highest deforestation rates. Areas on the list faced increased enforcement by IBAMA, and landowners encountered tighter standards when they tried to take out agricultural loans. Brasil Novo was on the inaugural list, and IBAMA quickly descended on ranchers such as Alves da Silva.

Brasil Novo has since reduced its deforestation rate and is one of the latest counties to make it off the blacklist, but it was a hard road, says Zelma Campos, the region’s secretary of the environment. At a public meeting on land regulation in May last year, Campos told me that all ranchers — even law-abiding ones — had trouble marketing

local governments, while environmentalists ramped up campaigns against companies that were exporting beef, leather and soya beans from illegally cleared land. States and communities recognized that their economies were at risk, which drove them to develop their own policies (see ‘How fish and condoms can save the forest’).

Brazil’s success thus far offers potential lessons for other tropical countries where deforestation is on the rise, but the situation in the Amazon remains precarious. Enforcement has increased, but the basic factors driving deforestation — including poverty and the profitability of agricultural land — have not changed. Although the rate of land clearing in Brazil last year fell to its second lowest level since 1988, it had spiked in 2013, and some scientists expect another increase in 2015.

“Brazilians do not want deforestation,” climate scientist Carlos Nobre told me when I visited him in Brasilia, where he was finishing his term as secretary for research and development at the Ministry of Science. But clearing and planting new land remains the primary force for economic growth in the Amazon, he says. “We do not yet have an alternative model.”

INCENDIARY MEASURES

The battle against illegal deforestation in Brazil starts with satellite images of the land surface. Since 1988, researchers have been compiling high-resolution maps of the forest cover each year. They obtain low-resolution images more frequently to spot fresh openings in the forest. Over the past decade, scientists have begun providing real-time information to Brazil’s environmental enforcement agency, the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA).

In June last year, I joined an IBAMA team and its heavily armed police escort as they launched raids in southwestern Pará, which remains a hotbed for deforestation. We spent hours barrelling down shoddy roads in search of fresh clearings seen on satellite imagery. One day, the team interrogated landowners, searched homes and confiscated guns and chainsaws, but did not find the suspicious spot. A second outing in a different area looked like it was going to end the same way, but towards evening the crew found a couple of trails off the road. We hiked 50 metres through the underbrush and the sky opened up over a field of felled trees. On the other side of the road was an encampment, complete with a large tarpaulin-covered A-frame, hammocks and a propane stove.

“If we are successful in implementing this, it’s going to be a revolution.”

their beef when the blacklist came out. As a result, the local economy shrank and the tax base contracted, which undermined public services. Eventually, Brasil Novo’s only slaughterhouse was shut down. “No one wants to invest in a municipality with environmental problems,” explained Campos.

But this was just the beginning. In 2009, a 27-year-old federal prosecutor named Daniel Azeredo filed a lawsuit against various ranchers and 11 of the largest slaughterhouse operators in Pará, the state with the most deforestation in the Amazon. He warned major purchasers of beef and leather — including the supermarket chain Walmart, McDonald’s and the Adidas clothing company — that they could be held accountable for marketing illegal products. Greenpeace mounted another international public-relations campaign, and the cattle industry in Pará briefly ground to a halt.

For Azeredo, the fundamental problem was that nobody knew who owned what, which enabled outlaws to rule with violence. In a series of legal settlements, he pushed companies and local governments to support a rural land registry in Pará that was designed to help resolve conflicts over land ownership and allow the government to formally license agricultural operations. Greenpeace followed up by pushing major slaughterhouses into signing a moratorium — like the soya-bean



A condom factory in Acre uses sustainably collected latex.

HOW FISH AND CONDOMS CAN SAVE THE FOREST

Acre state is trying to build an economy that does not threaten the Amazon.

Music blared as hundreds of people gathered last September for the opening of a fish-food factory in Brazil's Acre state. Some ventured into the afternoon sunlight for a tour of the fish ponds while VIPs visited the facility, which was built with the help of Danish engineers. Nearby, construction was under way on a fish-processing plant.

Once finished, the US\$32-million complex could make Acre, on the border with Peru and Bolivia, a national powerhouse in aquaculture. Just as importantly for the state, which joined industry partners to invest in the facility, the plant could provide a source of protein that is an alternative to beef raised in cleared rainforest.

Acre is a role model at a time when governments are looking for sustainable forms of development. The aquaculture complex is the latest in a series of green investments by the governing Workers' Party, which has long put forest protection and social justice on top of its agenda.

"Acre really is the leader," says Steve Schwartzman, an anthropologist with the Environmental Defense Fund in Washington DC who has been working in the state since the 1980s. Although Acre remains relatively poor, Schwartzman says that agricultural production there is increasing, basic measures of social well-being are on the rise and economic development is growing faster than in neighbouring states. "Clearly they are doing something right."

In many ways, Acre is the birthplace of the modern Brazilian socio-environmental movement, begun by workers who tapped rubber trees and tried to stop ranchers from clearing land. Chico Mendez, leader of the rubber-tapper union, was murdered in 1988, but his colleagues went on to dominate state politics. One of them, Marina Silva, transformed Brazil's forest policy as environment minister from 2003 to 2008.

Building on its history, Acre's initial investment was in rubber, which can be sustainably harvested by rural residents. The state built a now-famous natural-latex condom factory in 2008, and offered subsidies to communities that produced the rubber. It also set up facilities to process and market Brazil nuts, another sustainable commodity. And it advanced its own system for mapping forests, calculating emissions and selling carbon credits for verified reductions in emissions from deforestation.

The German Development Bank has already bought nearly 16 million euros' (US\$17.5 million) worth of carbon credits from Acre. The state is also pursuing a deal with California that would allow businesses there to purchase credits.

Governor Tião Viana says that Acre has pursued an environmental vision, but it needs to show a return. Without sufficient investment from governments or companies, Viana says, the state's experiment will hit a wall as coffers dry up. "We need to do this together," he says. "We aren't looking for favours, we are looking for investments." **J.T.**

companies had three years earlier — on the purchase of beef from recently deforested lands.

The upshot is that the land registry has expanded from around 500 properties in 2009 to more than 112,000 today, covering 62% of the private land in the state. Deforestation in Pará has dropped by more than 57% over the same period (see 'Food and forests').

"This was huge," says Paul Barreto, a senior scientist with the Amazon Institute of People and the Environment, an environmental group based in Pará's capital, Belém. "The lawsuit was against the big companies but in the end it brought along everyone."

In 2012, faced with rural protests over the new enforcement regime, the Brazilian Congress revised its forest code. The new law scaled back various forest protections and let some landowners off the hook for past deforestation, but it also created a national land registry that was designed to serve as the basis for federal land management.

The move has triggered its own controversies. The soya-bean industry says that because the federal registry will enable the government to improve monitoring of landowners, the 2006 moratorium on sales is now unnecessary. But environmentalists argue that the registry is not ready. The debate has intensified questions about what caused the drop in deforestation, and what should come next.

FORCES IN THE FOREST

Scientists have been looking into these questions, trying to pick apart the factors that influence deforestation. In a study published last year, a research team confirmed suspicions that broader economic forces — which reduced agricultural profitability a decade ago — deserve partial credit for the initial drop in deforestation (D. Nepstad *et al. Science* **344**, 1118–1123; 2014). But deforestation rates remained low even when the economics improved; stricter enforcement and initiatives such as the moratoria seem to be why.

"It's basically a diffusion of different instruments, some of which have gained traction," says lead author Daniel Nepstad, a tropical ecologist who heads the Earth Innovation Institute, an advocacy group based in San Francisco, California. "It's impossible to quantify any of these factors individually, but they are all pushing in the right direction."

Holly Gibbs, a geographer at the University of Wisconsin–Madison, says it is possible to identify some of the more successful policies. She and her colleagues found that deforestation was higher in areas not covered by the soya-bean moratorium, including on properties that are already on the federal land registry (H. K. Gibbs *et al. Science* **347**, 377–378; 2015). Unpublished results suggest that the beef moratorium has had a similar effect on ranchers, who fear being banned from markets if they clear land.

"These moratoria are really leading to huge changes on the ground in Brazil," says Gibbs, and that raises questions about what will happen if the soya-bean moratorium is lifted as scheduled next year.

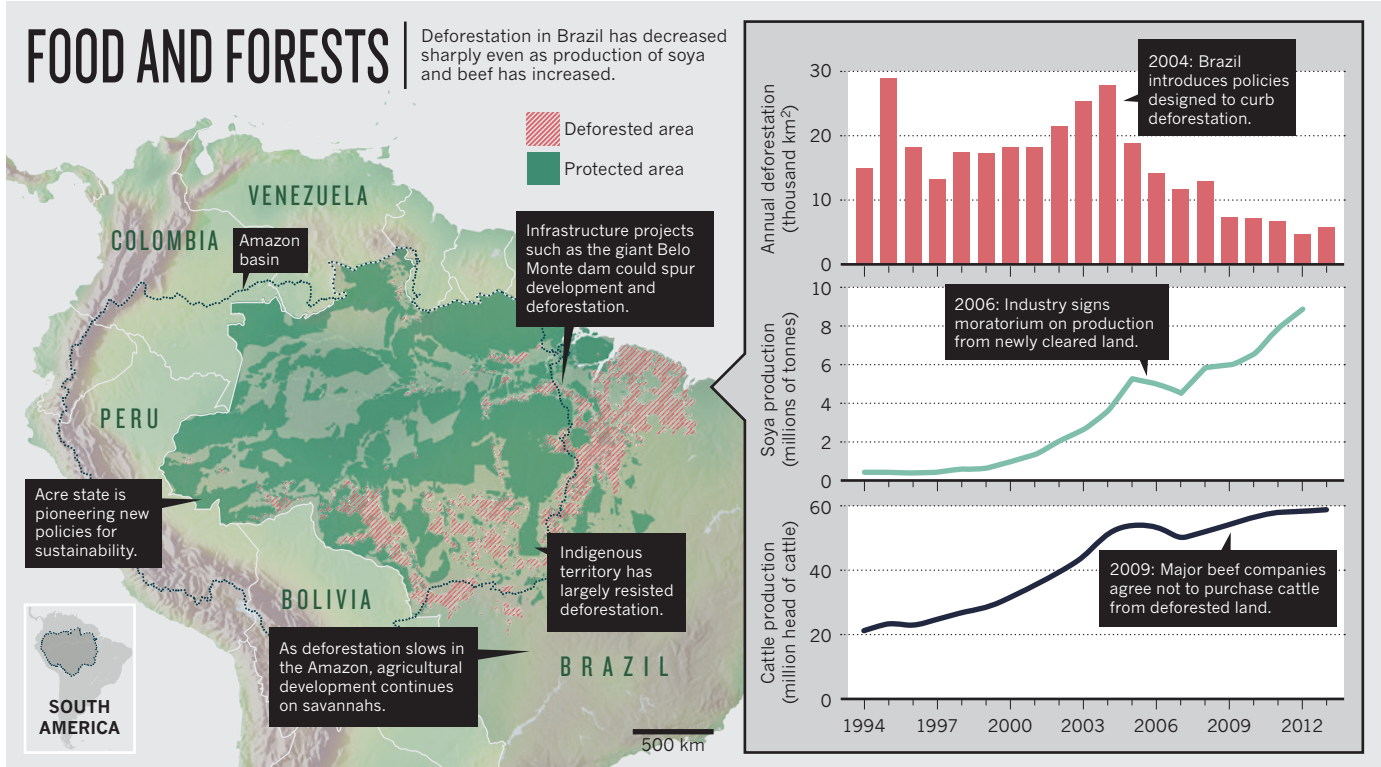
Brazilian officials nonetheless see the registry as the foundation for a new brand of land management. Government researchers are working on a monitoring system to classify and track different kinds of land use across the entire country as a complement to the national land registry. This could lead to an unprecedented capacity to track, study and promote better land use nationwide, they say.

"If we are successful in implementing this, it's going to be a revolution," says Francisco Oliveira, who heads the forest enforcement programme at the Ministry of the Environment in Brasília.

Even if the registry is successful, a fundamental challenge remains. It is cheaper for landowners — and more profitable for rogue speculators — to slash and burn forest than to rejuvenate soils and replant fallowed fields. Brazil is looking for ways to tilt the balance by improving and expanding operations on tracts of land that have already been cleared, using an influx of money designated for forest protection. In 2008, Norway agreed to pay \$1 billion if Brazil successfully reduced deforestation and thus CO₂ emissions. It was the world's first large-scale demonstration of

NATURE.COM
For a narrated
slideshow on the
Amazon, see:
go.nature.com/kqjwyd

SOURCES: MAP: INPE/NEPSTAD ET AL.; DEFORESTATION/SOYA: NEPSTAD ET AL.; CATTLE: H. K. GIBBS



a strategy called REDD (Reducing Emissions from Deforestation and Forest Degradation). And Norwegian officials visited Brazil last month to talk about a second investment.

Brazil has dispersed more than \$150 million so far for projects on issues such as agricultural productivity, biodiversity research and land-use planning. But relatively little money has gone to landowners or programmes that noticeably benefit them. "The farmers are sort of sitting there bewildered, because they are not getting the incentives they were promised," Nepstad says.

He is working with major soya-bean and beef companies, as well as government officials, on an approach that would help farmers by rewarding those who meet key standards instead of punishing them for poor performance. Landowners in counties that reduce deforestation could get easier access to low-interest loans, for instance. This approach could also involve direct payments to counties and landowners.

Brazil's experience could inform the rollout of an international REDD programme created in 2013 under the United Nations Framework Convention on Climate Change. Although it is a shadow of the plan that many had imagined, the basic idea remains the same: industrialized nations pay for carbon to be maintained or increased in trees and soils through better forest management.

This approach has received more than \$7 billion from countries such as Norway, Germany, the United Kingdom and the United States. Much of that money has been invested in projects that are intended to demonstrate the idea and help governments to improve their forest-monitoring expertise. Last year, Brazil became the first country to submit its baseline forest assessment documenting deforestation to the United Nations. In December, five other countries announced their own submissions.

Initial payments could begin as early as 2017. Although there are no current provisions for long-term funding, negotiators hope to secure money in a treaty that nations plan to sign in Paris this year. Brazil is hoping for some of that cash but is not counting on it; officials say that they will continue to focus on domestic efforts.

International attention is shifting now to Indonesia, which is clearing more forest than any other country. Norway has committed \$1 billion to the country if the government can demonstrate reductions in deforestation and emissions. Environmentalists are also transferring their

experience in Brazil to Indonesia, and have extracted promises to tackle deforestation from various international corporations that are active in the palm-oil industry there.

Scepticism remains about whether these strategies will succeed in Indonesia, which is building a monitoring and enforcement programme from scratch. But Nepstad points out that a decade ago, nobody would have believed Brazil was about to turn a corner. "There are seeds of what we saw in Brazil ten years ago in Indonesia today," Nepstad says.

FUTURE OF THE FOREST

Despite a decade of progress, the future of the Amazon rainforest remains uncertain. Some lawmakers want to scale back protected areas, and President Dilma Rousseff is encouraging investments in ports and hydroelectric dams, which could trigger more deforestation. Added to that is concern over the impacts of climate change, which threatens both the rainforest and existing crops.

Paulo Moutinho, former executive director of the Amazon Environmental Research Institute in Brasilia, fears that the government is overlooking more obvious solutions, such as designating more land for permanent protection. "It's stupid," he says, "but there's a sense in Brasilia that we have too much protected area."

Others are more sanguine. Back in Pará, Azeredo told me that Brazil's march towards law and order on the frontier is slowly paying off. With a little persistence, he says, the beef industry could achieve a reasonable level of compliance in several years' time. "We are creating a system of governance," he says. "Before, we didn't even know where to start."

This is a message that ranchers such as Alves da Silva seem to have taken to heart. "Every day that passes, government enforcement is going to increase," he says. "It's only going to get harder to break the law."

With little hope of expanding his operation, Alves da Silva concentrates on the herd at hand. He ropes and vaccinates a pair of newborn calves and then finishes for the day. As the light fades, we mount our horses and set off through his pasture. Behind us, the silhouette of the forest looms large. ■

Jeff Tollefson writes for Nature in New York and reported from Brazil on a fellowship funded by the Alicia Patterson Foundation.