LAND USE

Cracking Brazil's Forest Code

Brazil's controversial new Forest Code grants amnesty to illegal deforesters, but creates new mechanisms for forest conservation.

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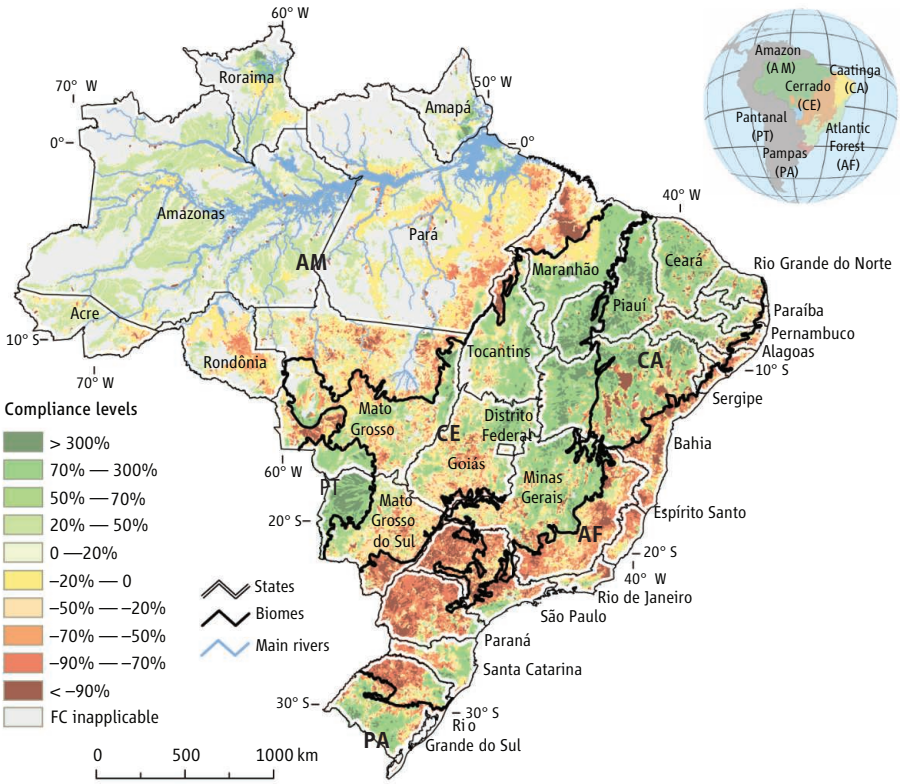
Roughly 53% of Brazil's native vegetation occurs on private properties. Native forests and savannahs on these lands store 105 ± 21 $GtCO_2e$ (billion tons of CO_2 equivalents) and play a vital role in maintaining a broad range of ecosystem services (*1*). Sound management of these private landscapes is critical if global efforts to mitigate climate change are to succeed. Recent approval of controversial revisions to Brazil's Forest Code (FC)—the central piece of legislation regulating land use and management on private properties—may therefore have global consequences. Here, we quantify changes resulting from the FC revisions in terms of environmental obligations and rights granted to land-owners. We then discuss conservation opportunities arising from new policy mechanisms in the FC and challenges for its implementation.

Created in 1965, the FC was transformed during the 1990s into a de facto environmental law via a series of presidential decrees. As of 2001, the FC required landowners to conserve native vegetation on their rural properties, setting aside a Legal Reserve (LR) that occupies 80% of the property area in the Amazon and 20% in other biomes [supplementary material (SM), fig. S1, and table S1]. The law also designated environmentally sensitive areas as Areas of Permanent Preservation (APPs), aiming to conserve water resources and prevent soil erosion. APPs include both Riparian Preservation Areas (RPAs) that protect riverside forest buffers, and Hilltop Preservation Areas (HPAs) at hilltops, high elevations, and steep slopes.

The FC severely restricted deforestation on private properties but proved challenging to enforce, particularly in the Amazon. As deforestation rates rose in the early 2000s, efforts to strengthen enforcement increased pressure on the farming sector, which triggered a backlash against the FC. The agribusiness lobby took advantage of a favorable political moment, related to a substantial drop in deforestation rates in the Brazilian Amazon, to propose creation of a new FC, which was approved in late 2012 (*2*). Some criticize the legislation for being too lenient on landowners; others maintain that it is a barrier to agricultural development. Regulations detailing key implementation mechanisms of the revised FC are still under negotiation.



Compliance levels under Brazil's 2012 FC. Percent difference between the remaining area of native vegetation and the area required to comply with the 2012 FC. Positive values indicate forest surpluses or land that may be legally deforested. Negative values indicate forest debts or land that requires restoration. See SM for details.

Amnesty for Illegal Deforestation

The 2012 FC maintains conservation requirements for LRs and RPAs—i.e., land that may not be deforested (table S1). These two requirements protect 193 ± 5 Mha of native vegetation containing 87 ± 17 $GtCO_2e$ (see the map). Changes in the definition of HPAs reduced their total area by 87% (table S8).

Because the new law differentiates between conservation and restoration requirements, the 2012 FC reduced by 58% Brazil's "environmental debt"—i.e., areas of LR and RPA deforested illegally before 2008 that, under the previous FC, would have required restoration at the landowner's expense (fig. S2). This was accomplished by forgiving the LR debt of "small" properties, ranging in size from 20 ha in southern Brazil to 440 ha in the Amazon. Under these new rules, 90% of Brazilian rural properties qualify for amnesty. Further reductions resulted from including RPAs in the calculation of the LR area, reducing the LR restoration requirement to 50% in Amazonian municipalities occupied predominantly by protected areas, and relaxing RPA restoration requirements on small properties (table S1).

Together, these measures decreased the total area to be restored from 50 ± 6 to 21 ± 1 Mha, of which 78% encompasses LRs and 22% RPAs (tables S2 and S3). Reductions in the environmental debt were uneven across states and biomes, affecting mainly the Amazon, Atlantic Forest, and Cerrado (fig. S2). These losses may have a large impact on

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biodiversity conservation (*3*) and forest restoration programs (*4*), especially in the Atlantic Forest, where only 12 to 16% of the original forest cover remains (*5*).

Furthermore, both old and new FCs allow an additional 88 ± 6 Mha of legal deforestation on private properties (table S4 and the figure). This area of native vegetation, exceeding LR and RPA conservation requirements, constitutes an "environmental surplus" with the potential to emit 18 ± 4 $GtCO_2e$ (SM, §2.1).

New Mechanisms for New Markets

Although the 2012 FC reduces restoration requirements, it introduces new mechanisms to address fire management, forest carbon, and payments for ecosystem services, which could reduce deforestation and bring environmental benefits. Perhaps the most important mechanism is the Environmental Reserve Quota (Portuguese acronym, CRA), a tradable legal title to areas with intact or regenerating native vegetation exceeding the FC requirements. The CRA (surplus) on one property may be used to offset a LR debt on another property within the same biome and, preferably, the same state. Implementating the CRA could create a trading market for forested lands, adding monetary value to native vegetation. This CRA market could potentially abate 56% of the LR debt (fig. S3). Given the high costs of forest restoration (*6*), exchange of CRAs could become a cost-effective way to facilitate compliance, meanwhile protecting forest surpluses that might otherwise be legally deforested. A balanced use of CRAs should focus on improving functional and ecological attributes of forested landscapes, e.g., habitat integrity (and thus biodiversity), carbon stocks, and water balance regulation, crucial for maintaining hydroelectric power generation in Brazil (*7*).

One of the strongest arguments of the agribusiness lobby is that forest restoration conflicts with agricultural production. Our results suggest that, with respect to land availability, this concern is unfounded. Of the 4.5 ± 1 Mha of RPAs slated for restoration, only 0.6 ± 0.35 Mha are currently occupied by crops, representing less than 1% of all croplands nationwide. Moreover, if restoration of the remaining LR debt (after compensation via CRAs) occurred exclusively in pasturelands unsuitable for agriculture, as few as ≈ 550,000 ha of required restoration would remain in arable lands (SM §§2.2 and 2.3 and figs. S3 to S5). Such a large-scale transition from cattle ranching to agriculture would require substantial increases in stocking densities to sustain current levels of meat production and allow for forest restoration. To this end, Brazil has created a national Low-Carbon Agriculture (ABC) program that provides ~U.S. $ 1.5 billion in annual subsidized loans aimed at increasing agricultural productivity while reducing associated carbon emissions and supporting forest restoration (table S5).

Key to success of the FC is the Rural Environmental Registry System (SICAR), a georeferenced Web system that will enable documentation of over 5 million rural properties, improving transparency and providing a pathway to environmental compliance. SICAR could facilitate the market for CRAs and payments for ecosystem services [for example, (*8*)], which will be critical to offset the often-prohibitive costs of forest restoration, especially for small landowners. We estimate that elimination of the FC debt via forest restoration would sequester up to 9 ± 2 $GtCO_2e$ (SM, §2.1).

Enforcement and Private Initiatives

Effective implementation of Brazil's 2012 FC will be enormously challenging. The first crucial challenge is to convince the agribusiness sector of the potential gains from the new FC. Even though law enforcement activities have intensified in recent years, the agribusiness constituency has historically taken advantage of the government's relatively weak enforcement of environmental laws. Amnesty afforded by the new FC could lead to the perception that illegal deforesters are unlikely to be prosecuted and may even be exonerated in future law reforms. To meet this challenge, Brazil must continue to invest in its monitoring and enforcement capabilities. Satellite-based deforestation monitoring systems maintained by the National Institute for Space Research (INPE) need to be expanded to other Brazilian biomes and adapted to detect subtler land-use changes, including forest degradation and deforestation in savannahs, riparian forests, and small remnants of the Atlantic Forest.

More important, there is a need to strengthen and integrate efforts across the myriad state and federal agencies responsible for implementing the FC, establishing clear land tenure, granting environmental licenses, and supporting agricultural production. This integrated system must be transparent and harnessed to economic incentives for conservation; otherwise, it might only exhort landowners to exercise rights to deforest (*9*).

Fortunately, private initiatives are aligning to assist landowners in attaining compliance. These include international certification standards, commodity roundtables, and boycotts of agricultural products grown in recently deforested or high-biodiversity areas. Increasingly, farmers and ranchers are adhering to voluntary registries that require commitments to improving social and environmental performance [for example, (*10*, *11*)]. Both certification schemes and voluntary registries may eventually enable access to special markets that provide financial incentives to participating producers. These mechanisms are particularly important in the Cerrado, the most coveted biome for agribusiness expansion, given its 40 ± 3 Mha of environmental surplus that could be legally deforested (table S4). Moreover, conservation efforts must aim at expanding protected areas outside the Amazon. Whereas these areas cover 46% of the Brazilian Amazon, the level of protection in other major biomes (7% of the Cerrado and 2.6% of the Atlantic Forest) is well below the 17% recommended by the 10th Convention on Biological Diversity. Conservation initiatives will be vital to protect large expanses of native vegetation, particularly in the Cerrado and Caatinga, where additional protection by land-use zoning is low.

Brazil has achieved an unprecedented success in reducing deforestation in the Amazon. However, this gain is not yet secured. Recently, deforestation rates ceased to decline in the Amazon and Atlantic Forest, and surged in the Cerrado (fig. S6). Our analysis suggests that the FC will allow additional deforestation, especially in the Cerrado and Caatinga. Economic incentives for conserving forests, including the Warsaw Framework for Reducing Emissions from Deforestation and Forest Degradation as REDD+, will be essential to help implement the FC and to enable Brazil to better reconcile environmental conservation with agricultural development.

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Supplementary Materials

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