



## POLICY FORUM: ENVIRONMENT

# Frontier Governance in Amazonia

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rainfall patterns that currently sustain these forests, their biological diversity, and agricultural production systems (3). Biological reserves currently protect only 4% of the region's forests, and must be expanded as part of this strategy. But, the challenge is to govern frontier expansion so that most forests remain standing and well managed, while addressing concerns for economic development. We report on

Most tropical rainforests have already been impoverished or converted to agriculture. Inaccessibility, however, has provided passive protection to the world's largest rainforest. As roads are paved into central Amazonia in the coming years, the business-as-usual scenario of frontier expansion may provoke rapid deforestation, releasing several billion tons of carbon to the atmosphere, while increasing the occurrence of accidental forest fire, species loss, and deforestation-driven rainfall inhibition (1, 2).

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However, economic development is vital, as most of the 17 million people in this region earn less than US\$100 per month. We interpret many of the infrastructure investments (including road paving and river channelization) as inevitable, and the primary challenge as one of strengthening frontier management in the region. Recent trends in Brazil's land-use regulation and management capacity could potentially conserve 70 to 80% of the forest while fostering economic development. These fragile gains are threatened by institutional weaknesses and rural violence, but could presage unprecedented large-scale tropical forest conservation if sustained and strengthened.

A regional conservation strategy that builds on the conventional emphasis on parks and reserves and seeks to maintain most of the land forested is urgently needed. Large-scale forest conservation is essential because of the tight coupling between the Amazon rainforest (only 15% of which is deforested) and the regional climate system; continued transformation to pasture and cropland could disrupt the

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**The Cuiabá-Santarém highway corridor, soon to be paved.** Through successful land-use regulation, demarcation of protected areas, local land-use planning, and improved land titling, most of the forests along this corridor might be conserved. The road slated for paving is orange. We conducted field research along the full length of the corridor. The shaded area indicates lands that fall within 100 km of the highway.

key trends at federal, state, and local levels in which government and civil society are gradually developing the policies, technology, and institutional capacity to meet this challenge.

The central components of an emerging strategy of frontier governance are enforcement of existing legislation and local land-use planning, and these can be illustrated with the Cuiabá-Santarém highway (BR-163) (see figure, left). This road was first cut through the Amazon rainforest in 1974. It traverses one of the highest concentrations of bird diversity in all of Amazonia (4) and a landscape dominated by rock outcrops and rolling topography largely unsuitable for mechanized agriculture. One thousand kilometers of the highway were never paved, however, and forest logging and conversion to cattle pasture have proceeded slowly. Only 5% of the forests within 50 km of the road have been cleared, for example, compared with 26 to 58% of the forests along roads that were paved 20 to 30 years ago (1, 2).

Representatives of an expanding soybean sector in northern Mato Grosso (see figure, this page) are now pushing to complete paving of the highway, which would save this sector \$70 million per year in shipping costs (5, 6). Highway paving would also reduce timber transport costs to both international and domestic markets for the 270 sawmills established along the BR-163 (see figure), stimulating expansion of this industry, and increasing forest vulnerability to fire (7). Such savings could provide a source of Brazilian revenues (through taxes or highway tolls) to finance frontier governance and thus decrease its dependence on international funding.

Brazil's ambitious Amazon forest policy requires forest maintenance along streams and slopes

and that at least 80% of rural properties be protected as forest reserves. It also requires licensing of deforestation, logging, and burning (8). These regulations have been difficult to enforce in the vast, remote frontiers of Amazonia, where government institutional capacity is limited. However, Mato Grosso state has made effective use of remote sensing and geographic information systems (GIS) technology to enforce forest policy. Landholders wishing to clear forest must provide the coordinates of their property, superimposed on recent Landsat imagery, to the state environmental agency. Properties totaling more than 10 million hectares—11% of the state—have been registered in this system. Deforestation permits have been denied to landholders who have exceeded the 20% deforestation limit on their property (9). The western Amazon state of Acre's "government of the forest" has established a 15% cap on deforestation and is effectively promoting economic activities that depend on forests as it suppresses pasture expansion.

Significant progress is also being made in prevention and control of accidental fires. The Brazilian fire control program for Amazonia (PROARCO) prohibits burning during the peak of the dry season. The program's implementation in 2000 was associated with a two- to fourfold reduction in the number of fires registered by satellite images from 1999 to 2000 throughout most of the heavily settled eastern and southern portion of Amazonia (10). This fire reduction cannot be explained on the basis of rainfall patterns.

The success of these regulatory efforts can be traced, in part, to the "environmental crimes" bill, passed by the Brazilian congress in 1998, which empowers the Brazilian environmental protection agency (IBAMA) to levy fines and to impose jail sentences for illegal deforestation, burning, and logging activities. Armed with this legislation, IBAMA recently suspended 800 timber management plans approved in the state of Pará, nudging the region's burgeoning logging industry toward reduced impact forest management (RIFM) practices (11), reducing fire risk (7). RIFM could provide jobs and revenues in Amazon frontiers well beyond the temporary boom-bust prosperity afforded by conventional, high-impact logging (12).

One-fourth of the forests along the Cuiabá-Santarém corridor could be protected from large-scale degradation by enforcing and strengthening the existing network of indigenous, extractive, and biological reserves (see the figure, page 629). The Kayapó indigenous groups of south-central Pará state have successfully pre-

vented encroachment by loggers, colonists, and ranchers throughout most of their 13 million-hectare reserve complex—bigger than any tropical park—and have avoided depletion of game species (13). The Tapajós national forest, one of three in the Cuiabá-Santarém corridor, has the first industrial timber concession in the Brazilian Amazon and is under close scrutiny. Reserve demarcation, monitoring, and enforcement of land-use restrictions could further strengthen this extensive reserve system.

One of the most promising trends in frontier governance is the growing capacity of municipal governments for environmental and development planning. This trend is favored by Brazil's decentralization of many federal and state responsibilities to municipal (*município*) governments, which receive a larger share of the federal budget than in any other Latin American country (14). Through the G-7 Pilot Program for Conservation of Brazilian Rainforests, state and municipal governments are working together to strengthen local institutional capacity for environmental planning and regulation, while also learning how to integrate local stakeholders into the planning process. Although municipal governments' capacity for effective land-use planning and development is still highly variable, the overall trend is positive. The long-term economic and ecological vitality of the BR-163 corridor will depend on how well local governments are able to provide the social, economic, and legal infrastructure that local populations need, while managing the region's forest, soil, and water resources.

Another important trend involves the government's efforts to take effective control of access to federal lands. In the past, frontier governance has been undermined by the black market through which public lands pass into the hands of land speculators, loggers, and ranchers (15). In the last few years, Brazil's land reform agency (INCRA) nullified the titles of more than 20 million hectares of land claims. Seven million hectares of this land were recently transferred to IBAMA for designation as conservation areas (16). INCRA must expand their regional network of offices and increase staffing to consolidate control over access to Amazon forest lands.

Lack of ministerial collaboration in planning for the future could undermine the prospects for frontier governance. One hopeful sign is that two interministerial seminars were recently held in the Brazilian Congress to discuss the environmental effects of the infrastructure investments planned for Amazonia.

If successful, the trend toward in-

creased frontier governance capacity could insure the conservation of most of the forests along the BR-163 corridor, while also fostering the sustainable development of the region's natural resources. However, powerful impediments to successful governance persist on the Amazon frontier. A bill to decrease the private property forest reserve from 80 to 50% is currently before the Brazilian Congress, against opposition by Brazilian environmental groups and many government officials. Corruption and instability still plague most frontier governmental institutions. The assassination of five rural leaders in 2001 perpetuates the rural violence that suppresses the emergence of democracy on the Amazon frontier.

However, recent trends among government agencies, private enterprise, and civil society provide evidence of an expanding political will in Brazil to manage Amazonia's abundant natural resources, protecting them from business-as-usual frontier expansion. The potential of these trends to defend public interests in the region's natural resources will only be realized, however, if they are recognized, applauded, and supported both financially and institutionally.

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