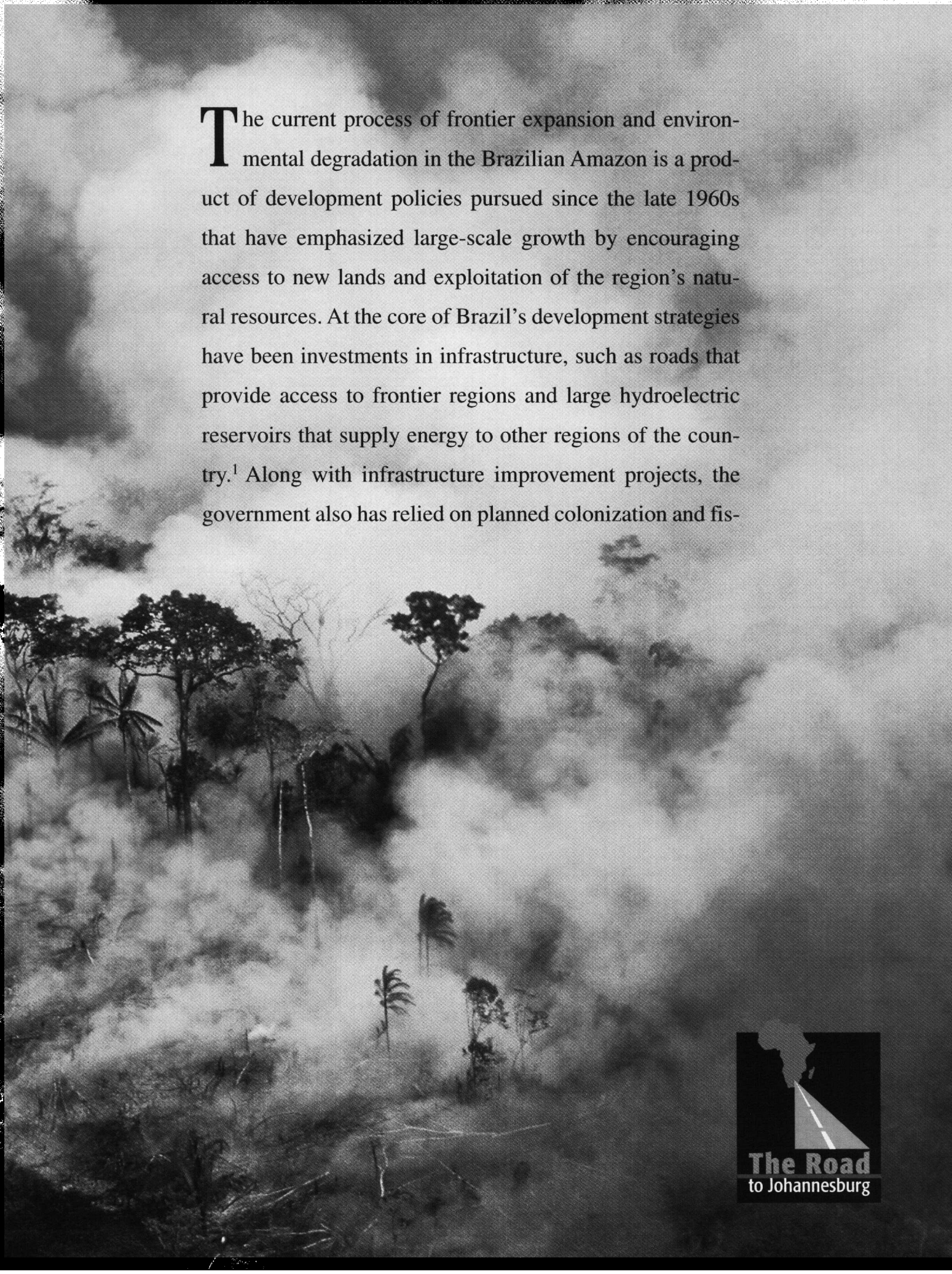
Frontier EXPANSION in the Amazon

Balancing Development and Sustainability

by Georgia O. Carvalho, Daniel Nepstad, David McGrath, Maria del Carmen Vera Diaz, Márcio Santilli, and Ana Cristina Barros



The current process of frontier expansion and environmental degradation in the Brazilian Amazon is a product of development policies pursued since the late 1960s that have emphasized large-scale growth by encouraging access to new lands and exploitation of the region's natural resources. At the core of Brazil's development strategies have been investments in infrastructure, such as roads that provide access to frontier regions and large hydroelectric reservoirs that supply energy to other regions of the country.[1] Along with infrastructure improvement projects, the government also has relied on planned colonization and fis-

cal incentives to encourage the development of economic activities such as large-scale ranching and agriculture.[2]

In the long run, these strategies have caused significant environmental consequences in the Brazilian Amazon and failed to bring lasting economic or social benefits to the majority of the region's population. In their first 35 years, these development policies have left almost 570,000 square kilometers (km^2) of deforested land along the region's highways and agricultural frontiers, not including large areas of forest ravaged by fire.[3] Approximately 50 percent of Amazonia's population lives below the poverty line.

Recently, the Brazilian government renewed its focus on centralized policy intervention strategies, which are in many ways an updated version of those that have led to frontier expansion in Amazonia since the 1960s. However, this time the rationale behind the plans is economic rather than geopolitical. (Land-use changes in Brazilian Amazonia historically have been stimulated by public policy intervention, especially when these changes have involved investments in road infrastructure and economic incentives.)

Since 1995, President Fernando Henrique Cardoso's administration has been outlining plans that emphasize the expansion of Brazil's economic infrastructure—especially developing and modernizing the transportation and energy sectors—to allow the country to compete in the global economy. However, like previous plans, this strategy could negatively affect the environment. In 1999, the government announced the *Avança Brasil* (Forward Brazil) program. As proposed, the program would add another 6,245 km of paved highways to the region's paved road network, including the Santarém-Cuiabá and Porto Velho–Manaus highways, which cut through mostly undisturbed forest areas. This paving could increase deforestation and forest impoverishment through logging and agricultural fires (logging damages and kills trees, which thins the forest canopy, reduces species diversity, and renders the area more vulnerable to escaped agricultural fires). The potential environmental impact of paving would take place on a larger scale than that of past policies because *Avança Brasil* plans to link Amazonia to global markets.[4]

Road paving could nearly double the area of Amazonian forest that is accessible to ranchers, loggers, and farmers and could open the central Amazon—an area that so far has been spared from this encroachment—to the same industries. Although the new development model could result in environmental impacts that are more widespread than past policies, this outcome is not inevitable. If these projects are implemented in the context of a regional planning process that addresses the needs of diverse stakeholders and also strengthens existing regulatory controls on land use, they could lead to sustainable development alternatives involving forest management and more intensive agricultural production on smaller areas of land.

This article compares the proposed program with those of the past, analyzes the expected effects of the new plan, and recommends policies that could be implemented along with it to mitigate negative environmental impacts.

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A truck transports timber through the Amazon. As road paving progresses into the area, increased accessibility and decreased travel times will intensify logging.

Past Amazon Development Policies

Beginning in the mid-1960s, Brazil attempted to physically and economically integrate the Amazon with the rest of the country based on a succession of frontier development efforts emphasizing fast—albeit unsustainable—economic growth. The initial impulse to develop the Amazon came from the military's nationalist geopolitical perception that Amazonia was a vacuum—strategically vulnerable and economically underutilized. Because the military was in charge of the state between 1964 and 1985, its perspective became the basis for policy. It determined that the region's environment—rich tropical forests, mineral resources, low population density, and river basins—was an obstacle to its progress rather than an asset. The military feared that the Amazon was an easy target for other countries or for illegal activities (such as

small-scale mining and drug trafficking), and it imposed a geopolitical development model with priorities that did not fit well with the region's ecological and social profile. (Figure 1 on this page shows the Amazonia region of Brazil.) For example, road building was at the core of development policy between 1965 and the mid-1980s because roads could establish access to the region, making possible frontier expansion and colonization schemes that would lead to further growth.[5]

When *Operation Amazonia* was launched in 1966, it was structured around the notion of development poles, in which chosen regions were offered a package of fiscal and financial incentives to start a population flow into the area, develop its infrastructure, and create an active economy.[6] Construction of several highways began in the late 1960s and early 1970s in line with the program (such as Cuiabá–Porto Velho–Rio Branco–Cruzeiro do Sul (BR-364) and Cuiabá-Santarém (BR-163)). The Superintendência do Desenvolvimento da Amazônia (SUDAM), the agency in charge of the Amazon's development, also established economic and tax incentives for expanding the ranching, agricultural, industrial, and basic service sectors in the region.[7]

The government's next development initiative came in 1970. The National Integration Plan (PIN), which was part of the broader National Development Plan (PND), aimed to unite the region through the construction of the Trans-Amazon highway (BR-230) and encouraged small-scale agriculture through colonization along the completed 4,800-km road.[8] But as the government reviewed its Amazon policy strategy in the mid-1970s, it discontinued support for the ambitious colonization scheme it had initiated, opting instead for corporate settlement and large-scale projects such as cattle ranching. As a result, the Trans-Amazon area, and those who had settled there, were abandoned by policy makers. The region remains mostly isolated and economically unimportant due to its inaccessibility.

Figure 1. The Amazonia region of Brazil

SOURCE: Woods Hole Research Center.

Another policy initiative came in 1974 as part of the second National Development Plan (PND II), reaffirming the shift toward large-scale agricultural enterprises and corporate settlement and adding new capital-intensive sectors to the equation of Amazon development. PND II established *Polamazonia* as the regional development program, emphasizing selective investments in 15 development poles based on large-scale, intensive economic activities such as mining, timber extraction, cattle ranching, and hydroelectric energy production. Colonization was expected to occur on its own around these projects as workers were attracted by opportunities in the region, but there were no explicit plans for frontier development or controlling the environmental and social processes brought about by the projects.[9]

These development programs were based on the premise that expanding the natural-resource export potential of the region through large-scale economic investment would generate sizeable revenues within a few years and thus help Brazil to both service its foreign debt and finance further development. The PND II and *Polamazonia* programs emphasized national development priorities, especially economic goals and the contributions that Amazonia could make to a national project through the export of its natural resources, but these strategies were not necessarily geared toward Amazonia's reality or its development interests.[10]

By the early 1980s, these policies had taken an obvious toll on the environment. About 10 million hectares of Amazon forest had been clear-cut, burned, and converted to other land uses (including pasture and slash-and-burn agriculture), which often resulted in rapid declines in soil fertility. A large portion of this area was degraded or abandoned after conversion to pasture. The majority of converted areas (74 percent) was within 50 km of roads, sug-

gesting that the new accessibility afforded by roads was a crucial factor in deforestation.[11] Road construction increased access to new frontiers, while tax incentives, subsidies, and land speculation lured entrepreneurial immigrants to the region. Land abundance and labor scarcity encouraged low-technology, low-capital activities with few labor or infrastructure requirements, such as cattle ranching, logging, and slash-and-burn agriculture.[12] Despite the relatively minimal economic returns on these activities, they continued to expand given a variety of factors, ranging from continued subsidies and land speculation to growing demand for meat and timber.[13]

Socially, the results of this wave of frontier development were not much more encouraging. Statistics for the Amazon show that it consistently lagged behind the remainder of Brazil (with the exception of the northeast) on several social indicators including income, education, and life expectancy. This gap is not decreasing; Amazonia still only supplies approximately 4 percent of Brazil's gross national product (GNP).[14] (See Table 1 on this page for a comparison of these indicators in Brazil and Amazonia.)

However, specific sectors (primarily the ranching and timber industries) were able to influence policy decisions in their favor and benefit from the development models adopted in Amazonia. Policy decisionmaking was primarily controlled by the state and by economically powerful sectors of civil society that were granted access to state bureaucracy.[15] The decisionmaking process was centralized and disproportionally favored sectors that were closely allied with the state (or allied with similar economic goals), while limiting access for sectors that were traditionally disenfranchised. Therefore, policy decisions benefited specific segments of society while failing to generate any widespread development in the region.[16]

The New Development Model: Public Policy Directives

Despite the costs and negative impact of past development strategies, there is a degree of continuity in the government's approach to the Amazon's development, although that approach is no longer primarily motivated by geopolitical concerns. One main policy that persists is the current focus on large infrastructure projects that are seemingly disconnected from social and rural development policies that could improve the population's quality of life. The renewal and expansion of the transportation and energy infrastructure has been defined as the main priority for current administration, creating incentives for production and integrating Amazonia with Brazilian, Latin American, and world markets.[17]

In 1995 the Cardoso administration outlined its Pluriannual Plan (PPA). Based on the priorities of infrastructure development and domestic and foreign investment, the PPA established *Brasil em Ação* (Brazil in Action). Investments in the transportation and energy sectors totaled R 85.7 billion ($75 billion U.S.).[18] Now in its second term, the Cardoso administration has revised and updated the PPA for the 1999–2003 period and replaced the *Brasil em Ação* name with *Avança Brasil*. The updated PPA outlines investments totaling R 1.1 trillion ($500 billion) for 358 projects in all of Brazil between 2000 and 2003. Twenty-one percent is allocated for infrastructure development, totaling R 212 billion ($100 billion). Infrastructure investment in Amazonia is estimated at R 45 billion ($22 billion).[19]

Avança Brasil is organized around seven integrated regional development axes defined in a study conducted under contract from the federal government by the Brasiliana Consortium. The consortium was headed by the National Bank for Economic and Social Development (BNDES) and included several Brazilian and international consulting businesses. Four of the identified axes include areas within Legal Amazonia—Araguaia-Tocantins, Madeira-Amazonas, Arco Norte, and Centro-Oeste.[20] (Figure 2 on page 39 maps these targeted regions.) However, a closer analysis reveals that once again the main beneficiaries are not the region's population, but rather the industrial and agricultural sectors in northern Mato Grosso and parts of the Cerrado (the savannah ecosystem of central Brazil). Transportation projects planned for the 1999–2003 PPA include

Table 1. Development indicators (1970–91)

	Amazonia			Brazil		
Indicator	**1970**	**1980**	**1991**	**1970**	**1980**	**1991**
Illiteracy (percentage of population)	41.3	43.1	25.8	33.0	25.3	19.4
Average number of years attended school	1.7	2.6	3.9	2.4	3.6	4.9
Insufficient income (percentage of population)	77.42	52.09	56.11	67.90	39.47	45.46
Access to clean water (percentage of population)	28.5	52.6	63.1	51.3	70.0	83.9
Human Development Index	0.391	0.572	0.617	0.462	0.685	0.742

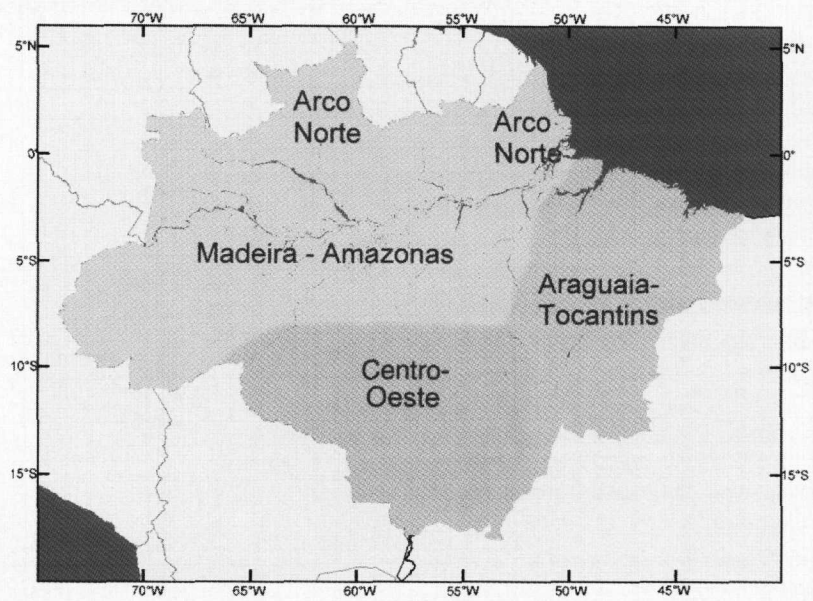
NOTE: The Human Development Index combines measurements of life expectancy, educational attainment, and adjusted gross domestic product (GDP) per capita.

SOURCE: United Nations Development Programme, *Brazil Human Development Atlas*, 1999.

two major waterways (Madeira and Araguaia-Tocantins), the construction and paving of roads such as the Cuiabá-Santarém and Porto Velho–Manaus, and the construction of approximately 1,600 km of railroads and at least five ports. These projects are all justified by the prediction that they will lead to significantly lower freight prices for soybeans and other grains and agricultural products produced mainly in Mato Grosso and Rondônia, thereby maximizing economic gains for a relatively small sector and making exports more competitive in international markets.

The economy of Amazonia would not benefit especially from this infrastructure development, because the main goal is to continue exporting commodities and natural resources with little or no aggregation of value and because there are no specific plans to develop the areas adjacent to the export corridors being created. In the official plans, there are only a few mentions of the improvement of feeder roads, investment in local market infrastructure, provision of technical or financial assistance to small-scale producers, or other measures that would contribute to both human and economic development and could eventually lead to a decrease in the forest conversion rate.[21] In spite of claims by the Brazilian government that it now favors more sustainable development strategies for the Amazon, sustainability does not appear to be a priority in the *Avança Brasil* plans.[22] The portfolio of projects for the development axes under *Avança Brasil* was coordinated by a controversial for-profit consulting business that paid much more attention to economic returns than to social or environmental priorities. Little has been done in the way of a comprehensive environmental evaluation of the combined effect of the plans.[23] Environmental nongovernmental organizations including the Instituto de Pesquisa Ambiental da Amazônia (IPAM) and Instituto Socio-Ambiental (ISA) published a study projecting the impact of road paving in the Amazon. They also organized a seminar, held in the Brazilian Senate, with the participation of civic organizations, politicians, bureaucrats, and scientists. It was only after this public awareness campaign that the government announced it would request proposals for an integrated environmental impact study (EIA-RIMA) of the projects for Amazonia.[24]

Figure 2. Integration and development axes for the Amazon as defined by *Avança Brasil*



NOTE: Arco Norte includes the states of Amapá and Roraima; Madeira-Amazonas includes the states of Amazonas, Pará, Rondônia, and Acre; Araguaia-Tocantins includes southeastern Pará, Maranhão, and Tocantins; and Centro-Oeste includes Mato Grosso.

SOURCE: Woods Hole Research Center.

The conventional method of conducting EIA-RIMAs in Brazil typically does not present an opportunity to thoroughly review or evaluate projects. When that opportunity is presented, however, it usually comes in the form of a public hearing. Speaking times are often limited to two minutes per person. In addition, studies are not required to be disseminated in advance, and their quality can be questionable, as in the case of the Araguaia-Tocantins waterway.[25] It was found that the EIA-RIMA for the waterway altered facts and projections (especially regarding the impact of the project on indigenous populations and fish) to make mitigation measures less costly to builders. In the case of *Avança Brasil*, one of the few channels for public participation came late in the process when the Brasiliana Consortium held public hearings in 1999 and 2000. However, representatives from civil society and local governments had little input during the process. These meetings were often closed to the general public and their occurrence was not divulged by mass media or was advertised only at the last minute.[26]

These are indications that Amazon development policy continues to favor sectors whose economic interests coincide with government priorities, at the expense of the region's population and sustainability. To ensure a better outcome, the process should be modified to allow more meaningful participation of major stakeholder groups and independent experts as well as improved opportunities for participation during the hearings themselves. Dissemination of

studies should be required well in advance of public hearings. In addition, it is important to address the composition of local- and state-level environmental councils (*Conselhos de Meio Ambiente*) that evaluate the EIA-RIMAs. Most of these councils are unevenly composed, with the production sector and traditional elites who are appointed by the government more heavily represented than other stakeholders.

Expected Environmental Impacts of Development Policy

Roads historically have been the principal vectors of deforestation and frontier expansion in the Amazon. Almost three-quarters of the deforestation in the area has occurred within 50 km of major highways. If implemented as currently planned, the new line of centralized policy intervention will provide access to remote areas of Amazonia and likely accelerate frontier expansion in these regions that have remained undisturbed. Assuming the new wave of frontier expansion follows the trajectory of past examples, increased access will tend to promote the types of extensive land-use activities that historically have occurred in Amazonia (such as cattle pasture formation, logging, and slash-and-burn agriculture) and increase the incidence of deforestation and accidental fires.[27] Projecting the historical relationship between road construction and forest loss to the next two or three decades, the planned road paving will produce an additional 120,000 to 270,000 km^2 of deforested land and additional forest impoverishment through logging and fire.[28] Combined with the deforestation occurring in the existing frontier, the deforested portion of the Brazilian Amazon could grow from 15 percent (570,000 km^2) today to nearly 33 percent in this time frame (Figure 3 on page 41 shows the planned road paving projects).

The next wave of frontier expansion will take place mainly in central Amazonia—an area that thus far has been spared from heavy logging and deforestation due to lack of access. The expansion of logging results from a combination of accessibility, market forces, and monitoring capacity, and road paving will likely lead to decreased transport costs and a significant expansion of the timber industry into this region.[29] (The box on page 42 describes how the timber industry is expanding along the Cuiabá-Santarém highway.) Logging operations open roads into the forest and maintain the secondary roads that farmers need to expand their ranching and agricultural activities. Farmers sell a few high-value trees to sawmills to obtain the capital to finance these activities. This exacerbates frontier expansion and furthers deforestation and forest fires.

Certainly not all projects being considered under *Avança Brasil* are detrimental to Amazonia. Some projects could stimulate the type of lasting local development the region needs. For instance, paving the Trans-Amazon, which is located in a region that has been settled mainly by small-scale producers, could intensify their production and slow down frontier expansion in the region. But even projects that can contribute to local development would need to be implemented in conjunction with environmental safeguards and regional policies to ensure that the goals of development and sustainability are achieved.

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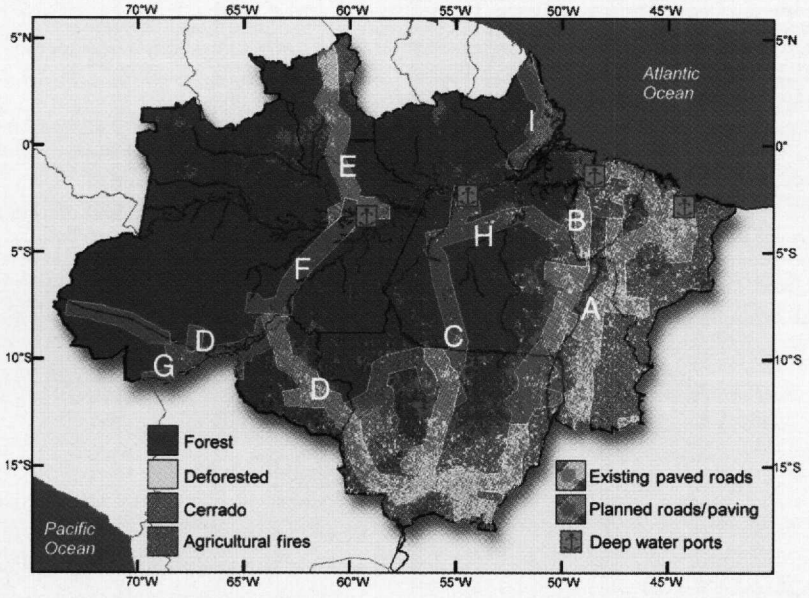
The process of paving main roads will negatively affect pristine Amazon forest areas by increasing deforestation, forest impoverishment, and agricultural fires.

Toward Development Strategies for Conservation

It is possible to foster economic development in the central Amazon while protecting 70 to 80 percent of its forests. Such a large-scale regional conservation strategy would have to move beyond the traditional practice of setting aside biological reserve areas—which currently protect only 4 percent of the region's forests. It would have to integrate local development needs and priorities into the planning of economic corridors and develop more effective ways to suppress the predatory depletion of natural resources that will characterize frontier expansion until governance adequately represents different sectors and stakeholders.

Figure 3. Planned road paving under *Avança Brasil*



Existing paved roads:
A: BR-010 from Belém to Brasília
B: PA-150
C: BR-163 from Cuiabá to the border between Mato Grosso and Pará
D: BR-364 from Cuiabá to Porto Velho
E: BR-174

Roads to be paved under *Avança Brasil*:
C: BR-163 between the Pará–Mato Grosso border and Santarém
D: BR-364 from Porto Velho to Rio Branco and on to Cruzeiro do Sul (on the Peru border)
F: BR-319 between Porto Velho and Manaus
G: BR-317 from Rio Branco to Assis Brasil (on the Peru border)
H: BR-230 (Trans-Amazon highway) from Marabá to Itaituba
I: BR-156 from Macapá to the border with Guyana

NOTE: The white buffers show areas within 50 kilometers (km) of paved roads. There is a coincidence between these areas and the pixels in yellow (deforested land, 74 percent of which is within 50 km of paved roads) and the pixels in red (agricultural fires). Both are concentrated along roads A, B, C, and D, which were paved between 15 and 30 years ago. The exception to this pattern is road E, which was paved in 1998. The yellow buffers show the roads to be paved under *Avança Brasil*, which coincide with forest areas that have so far escaped large-scale deforestation and fires due to inaccessibility. The main roads to be paved are C, D, F, G, H, and I. "Cerrado" refers to the savannah ecosystem of central Brazil. "Agricultural fires" denotes hot pixels detected by satellite. These areas may not be deforested. Some of the hot pixels are escaped fires. "Deforested" means that the area was cleared by any means.

SOURCE: Woods Hole Research Center.

Simply building and paving main roads and creating export corridors will not lead to development that benefits Amazonia. However, the obstacles to achieving sustainable development alternatives along remote stretches of newly paved highways are complex and difficult to surmount. An important step lies in expanding the planning process to include socioeconomic development along roads to be paved. This means opening the policy decisionmaking process to involve local stakeholders who are rarely consulted during the early stages (such as small-scale farmers, grassroots organizations, and local municipalities) as well as economically powerful actors (such as soy producers and road builders) who are traditionally granted access to the process.

Many areas in Amazonia are unsuitable for agriculture because of rock outcrops, rolling topography, and waterlogged soils. Land-use zoning should restrict agricultural activities on these lands. For example, farmers can become completely isolated when poor weather conditions force the closing of feeder roads for long periods of the year. Farming communities often receive insufficient or inappropriate technical support for their agricultural systems or are too poor to purchase fertilizers or necessary farm implements. If they manage to transport their crops to local towns, market facilities are often lacking. Improving the state of secondary and feeder roads—along with investments in paving main roads—could allow producers to deliver their goods to local markets and give them access to health, educational, and technical services. This in turn could increase quality of life and spur social and economic development at the local level. Without investments in secondary roads, paving main roads could reduce the viability of these marginalized farmers by lowering the prices of agricultural produce grown elsewhere.

Investments in basic infrastructure (road building and paving) must be integrated with concrete rural and sustainable development policies for the region. Among the strategies that could be considered are:

- concentrating agricultural development in already altered or degraded areas;
- creating incentives for applying techniques that improve agricultural productivity and sustainability (such as transitioning to perennial agriculture) and lower environmental impacts (relying less on fires and land conversion) in altered areas;
- developing means that allow for sustainable utilization of legal reserve

Timber Industry Follows the Path of Least Resistance

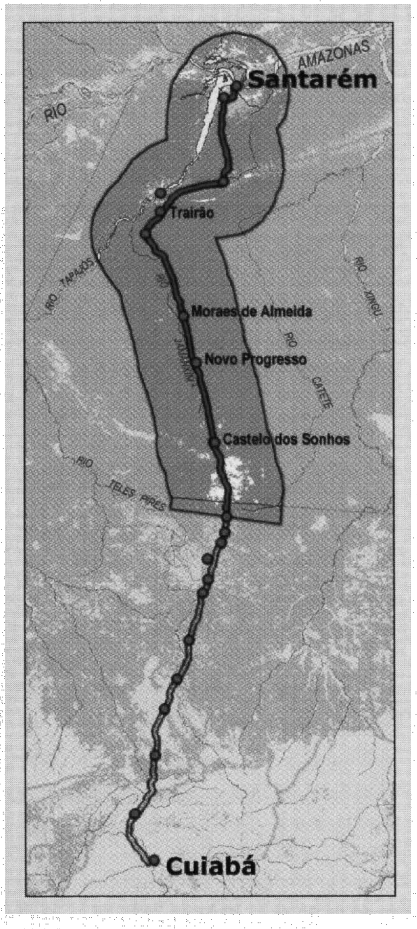
by A. Alencar, D. Nepstad, and G. Carvalho

One of the economic sectors that stands to benefit most from road paving in Amazonia is the timber industry. The Amazon region currently produces about 30 million cubic meters of timber each year, affecting more than 10,000 square kilometers of forest land.[1] As supplies of tropical timber in Southeast Asia are depleted, the Amazon will take on an increasingly important role in meeting world demand. Currently, however, about 85 percent of wood produced in the Amazon is consumed by the Brazilian domestic market.[2]

Road paving will increase the profitability of timber produced for both domestic and international markets. As forests are depleted in eastern and southeastern Amazonia, the logging industry will look to central Amazonia as the new source of production. In this sense, the Trans-Amazon highway is of critical importance to the logging industry because it provides access for both export (via the port in Santarém) and domestic sales (to the south).

In October 2000, during a trip along the Cuiabá-Santarém (BR-163), the authors encountered 117 sawmills already functioning between Trairão and Castelo dos Sonhos (near the border of Pará and Mato Grosso). These sawmills were extracting approximately 500,000 cubic meters of wood per year. Upon conducting a more thorough assessment in 2001, the number of sawmills had increased to 270. Since 1997, sawmills have been built rapidly in anticipation of the road paving and the potential savings in transportation costs. For instance, in Novo Progresso, the number of sawmills increased from 10 in 1997 to 60 in 2000.

At present, a truck may take up to 30 days to travel from Novo Progresso to the port of Santarém during the rainy season. Once the road is paved, this trip should take no longer than two days. Road paving and the consequent decrease in costs will likely lead to the intensification of logging in areas adjacent to roads being paved because it will allow for exploitation of more species and increased timber volume per hectare.



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2. S. Stone, "Growth of the Timber Industry in the Eastern Amazon: Economic Trends and Implications for Policy" (Ph.D. diss., Cornell University, 1997).

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areas by small-scale producers (such as nontimber–based extraction and low-impact logging);
- extending technical assistance to small-scale and family producers;
- creating credit instruments that compensate producers for environmentally sound behavior; and
- improving access to local markets.

Implementing these local development policies could stimulate regional development and provide economic alternatives for the population on the frontier while decreasing the need for expansion.

Integrating efforts at the federal, state, and local levels would allow government and civil society to gradually develop suitable policies, technologies, and institutional capacities to meet the challenges of development while conserving large areas. One of the main obstacles to conservation is the lack of capacity to enforce existing forest laws. Currently Brazilian law requires 80 percent of properties in Amazonia to be maintained as forest reserves. It also requires licenses for deforestation, logging, and burning.[30] However, these rules are not being enforced because the area is remote, monitoring is centralized, and human and financial resources are lacking.

Brazil's federal environmental protection agency, Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA), needs additional resources and support to carry out its functions appropriately. Its main role is one of monitoring and enforcement, and it has not been involved in the planning for *Avança Brasil*. An important step in increasing governance was the 1998 passage of an environmental crimes bill, which allows IBAMA to levy fines and jail sentences for illegal deforestation, burning, and logging activities. As a result, IBAMA recently suspended 800 timber-management plans approved in the state of Pará, creating an incentive for the region's logging industry to get serious about adopting reduced-impact forest-management practices.[31] To avoid

the temporary "boom and bust" cycles associated with conventional, high-impact logging, federal efforts must be combined with those of state agencies and continued monitoring and involvement by local actors.

In addition to empowering IBAMA, state environmental agencies can and should take a more proactive role in monitoring land-use and forest policies. It is feasible to create a licensing system based on remote sensing technology that would require land owners to provide the coordinates of their property on a current Landsat image before being issued a deforestation/burning license. With such a system, it would be possible to monitor how much land has been cleared, what kind of vegetation existed on the land, and what the land owner's activities were after being issued a license. Fees and fines could finance the licensing system and the enforcement efforts. The state of Mato Grosso is beginning to implement a similar type of scheme and, although it is in its preliminary stages, it is estimated that the state's deforestation rate will decrease sharply over the next few years. This case illustrates that with a combination of political will and resources, states can make effective use of remote sensing and geographic information systems (GIS) technology to enforce deforestation limits and control fires.[32] Another alternative, pursued by the state of Acre, involves establishing a statewide cap on deforestation and then actively promoting economic activities that depend on forests (such as rubber and Brazil nut collection and low-impact logging) as a strategy to curb forest conversion for pasture expansion.

A large part of deforestation is a result of governance lacking at the local level. Much of the timber extraction and conversion to pasture taking place in the Amazon is illegal. Controlling frontier expansion involves increasing the government's capacity to oversee these activities and enforce laws. At the local level, governance capacity to enforce forest policy—even in remote areas—could be increased significantly by decentralizing some land-use monitoring functions and actively involving municipalities with state and federal agencies in the processes of environmental planning. Municipalities could help relieve the pressure on IBAMA's scarce financial resources.

One of the biggest challenges to conserving the Amazon lies in the inability of federal, state, and local governments to enforce deforestation, burning, and logging laws.

If some state functions were decentralized and partnerships with actors on the ground (governmental and nongovernmental) were established, governance could increase in remote areas. The idea of decentralizing some state functions is not entirely untested: In the last decade Brazil has undertaken efforts to decentralize the education and health care sectors. Municipalities in Brazil already receive a larger share of the federal budget than in other Latin American countries, and their role in environmental law is recognized (although not clearly defined) both in the constitution and the national environmental system (SISNAMA, Sistema Nacional do Meio Ambiente). However, the results of such a strategy are not certain. The only experience so far is through the G-7 Pilot Program for Conservation of Brazilian Rainforests, which has incorporated a subprogram that focuses on strengthening the capacity of local governments and stakeholders to participate in the process of environmental planning and regulation. This subprogram, known as the Integrated Environmental Management Program (PGAI), is still in the early phases of implementation. Expectations are high, but so far there are no tangible results.

Some studies point out that the history of local politics in Brazil (in which favors are exchanged between public authorities and members of society for political support) renders decentralization an infeasible strategy, because it allows local elite groups to directly pressure local governments.[33] However, there is no clear evidence to support this, and it could be argued that state and federal governments are equally susceptible to these pressures. Strengthening local governments by involving multiple local stakeholders and setting clear accountability criteria is probably one of the best options for increasing governance in the frontier.

A crucial step in implementing a large-scale conservation strategy in the Amazon lies in outlining a comprehensive land-use plan. However, it is often not feasible to carry out zoning plans in new frontiers because of an inadequate capacity for on-the-ground governance. An overarching principle guiding Amazon development should be temporal zoning. This approach involves temporarily suppressing predatory land use (such as large-scale deforestation for cattle pas-

Stronger environmental guidelines and improved governance in the Amazon could lead to sustainable development and land-use planning that helps to eliminate cleared forest areas such as this one.

tures or high-impact logging) to allow more sustainable forms of these activities to develop as municipalities gain the capacity for land-use planning and monitoring. Suppressing resource exploitation does not set humans and nature in opposition. In contrast, it guarantees the long-term economic prospects of the region: Economic losses associated with temporary limits on these activities are small compared to long-term gains.

Suppressing resource extraction in the frontier tends to lead to intensified production over time, which in turn encourages the creation of more local jobs and increased profits for the local economy. For example, research shows that substituting ranching with a combination of agriculture and livestock increases earnings 3 to 26 times over. The same is true of low-impact logging, which generates more income over time than conventional logging. These methods further economic development without encouraging frontier expansion.[34]

The final element of a large-scale conservation strategy for the Amazon is a comprehensive land-use plan that would strengthen conservation areas, indigenous lands, and biological reserves before roads are paved. If adequately implemented, the plan could coordinate with projects for land-resettlement and land-ownership regularization to control land use and frontier expansion. By establishing in advance exactly what areas along roads can be used for what purposes and regularizing ownership of previously occupied areas, the government could pre-empt the actions of land speculators, loggers, and ranchers and avoid one aspect of uncontrolled frontier expansion.

Conclusions

At its core, Brazil's new policy for Amazon development is still based on road building and resource extraction. As a result, it continues to stimulate frontier expansion that leads to uncontrolled deforestation and forest impoverishment. The above comparison of past and present development strategies highlights continued dependency on a centralized development model that features costly infrastructure projects and extensive production while discounting the region's main resources. *Avança Brasil* is likely to echo past patterns of environmental deterioration as it establishes access to central Amazonia and opens the area to logging, agriculture, and cattle ranching. Road construction may result in as much as one-third of Amazonian forest being lost in two to three decades. This is a likely future scenario, but it is not unavoidable.

Sustainable development can occur if these projects are pursued in conjunction with policies and environmental safeguards that emphasize increased governance capacity and prompt the creation of economic instruments that stimulate regional development while slowing uncontrolled frontier expansion. The suggestions discussed above are a few of many possibilities. Further analysis of these and other alternatives is still necessary, as is a reconsideration of the *Avança Brasil* plans and any future

development strategies that are based on the same premises. Brazil's government has announced that it will undertake an integrated environmental impact study of the plans. This is a first step, but there is also a need to consider the wider context of infrastructure projects and realize that without linking them to consistent social and rural development policies geared toward improving the population's quality of life, sustainable development in the Amazon will remain an elusive goal.

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8. For a thorough discussion of Trans-Amazon colonization, see E. Moran, *Developing the Amazon* (Bloomington: Indiana University Press, 1981); and S. Bunker, *Underdeveloping the Amazon: Extraction, Unequal Exchange and the Failure of the Modern State* (Urbana: University of Illinois Press, 1985).

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12. Ranching and logging generate only 1.4 and 20 jobs per 1,000 hectares, respectively. They require little infrastructure: Cattle can be transported to markets in the absence of roads, and loggers can open their own dirt roads when needed. In both cases, electricity is unnecessary. See U. Lélé et al., *Forests in the Balance: Challenges of Conservation with Development: An Evaluation of Brazil's Forest Development and World Bank Assistance* (Washington, D.C.: World Bank, 2000); and S. Hecht, "Environment, Development and Politics: Capital Accumulation and the Livestock Sector in Eastern Amazonia," *World Development* 13 (1985): 663–84.

13. As discussed in O. Almeida and C. Uhl, "Developing a Quantitative Framework for Sustainable Resource-Use Planning in the Brazilian Amazon," *World Development* 23 (1995): 1,745–64, the return on extensive ranching and agriculture ranges from 2 to 11 percent and decreases after the initial years—a much lower percentage than afforded by intensifying the same activities. For more on expanding demand, see A. Angelsen and D. Kaimowitz, *Agricultural Technologies and Tropical Deforestation* (New York: CABI Publishing, 2001).

14. United Nations Development Programme, *Brazil Human Development Atlas*, 1999.

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16. For an analysis of the insertion of these sectors in Amazon policymaking processes, see Foresta, note 2 above; and G. Carvalho, "Metallurgical Development in the Carajás Area: A Case Study of the Evolution of Environmental Policy Formation in Brazil," *Society and Natural Resource* 14, no. 2 (2000): 615–32.

17. Becker, note 4 above; and Ministério do Planejamento e Orçamento (Ministry of Planning and Budget), *Plano Plurianual 2000–2003* (Brasilia, D.F.: 1999).

18. Ministério do Planejamento e Orçamento, *Plano Plurianual 1996–1999* (Brasilia, D.F.: 1995), 4.

19. Laurance et al., note 4 above; and Nepstad et al., note 4 above.

20. The region of Legal Amazonia comprises "classic Amazonia," which includes the states of Amazonas, Pará, Rondônia, Acre, Amapá, and Roraima, as well as parts of Maranhão, Tocantins, and Mato Grosso. "Classic Amazonia" includes states that are covered primarily by high forest ecosystems, rather than states where there are extensive areas of transitional ecosystems (such as Maranhão, which presents a mixture of cerrado, or savannah, and forest ecosystems).

21. Ministério do Planejamento e Orçamento, note 17 above; and P. Fearnside, "Soybean Cultivation as a Threat to the Environment in Brazil," *Environmental Conservation* 28 (2001): 23–38.

22. Ministério do Meio-Ambiente, Recursos Hidrícos e Amazônia Legal (MMA, Ministry of Environment, Water Resources and the Legal Amazon), *Brazil Integrated National Policy for the Legal Amazon* (Brasilia, D.F., 1995); and Comissão da Amazônia e de Desenvolvimento Regional, Câmara dos Desputados (Commission for Amazonia and Regional Development of the House of Representatives), MMA, *Agenda Positiva da Amazônia* (Positive Agenda for Amazonia) (Brasilia, D.F., 2001).

23. Fearnside, note 21 above; and D. Nepstad et al., *Avança Brasil: Os Custos Ambientais para a Amazônia* (*Avança Brasil*: The Environmental Costs for Amazonia) (Belém, Brazil: Instituto de Pesquisa Ambiental da Amazônia (IPAM, Amazon Institute of Environmental Research), 2000).

24. Announced by José Paulo da Silveira, coordinator of the *Avança Brasil* program (Ministério de Planejamento e Orçamento) during a presentation at the Brazilian Senate, 8 April 2001.

25. For more information, see the Amazon Financial Information Service web site, accessible via http://www.redlisted.com/brazil_araguaia.html.

26. A. Ramos, policy coordinator, Instituto Socio-Ambiental (ISA); and A. C. Barros, executive director, IPAM, personal communication with authors, Brasilia, April 2001.

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30. Government of Brazil, *Medida Provisória*, Version 2080-631.

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34. See Almeida and Uhl, note 13 above; Schneider et al., note 29 above; and P. Barreto, P. Amaral, E. Vidal, and C. Uhl, "Costs and Benefits of Forest Management for Timber Production in Eastern Amazonia," *Forest Ecology and Management* 108 (1998): 9–26.