Sustainable development and challenging deforestation in the Brazilian Amazon: the good, the bad and the ugly

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Agricultural expansion, opening of new roads and migration of people to unexploited areas are all major causes of Amazon deforestation; thus many sectors share the responsibility for reversing it.

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The Amazon region comprises 61 percent of Brazil's land area (5.3 million square kilometres), with a population of 20 million people. The region has the largest continuous tropical forest in the world and hosts around 20 percent of the world's plant and animal species. The potential for an economy based on forest resources is enormous. Although Brazilian participation in world trade of forest products is still small (around 3 to 4 percent) relative to other sectors (e.g. 20 percent in the meat sector), the forest sector comprises 8.6 percent of Brazilian exports and provides 6.5 million jobs. In south and southeastern Brazil, the forest plantation sector in particular has competitive advantages for growth, considering the climate, infrastructure and technological expertise. The diversity of the native forests in the Amazon similarly offers commercial potential that has not yet been fully explored. However, the equation for a balanced development associating economic growth with social and environmental benefits is not yet solved.

This article gives a broad overview of past and future challenges for development in the Brazilian Amazon, as well as recent achievements. In recognition of some similarities between the Amazon basin and the popular image of the American Far West, it borrows from the title of Sergio Leone's 1966 epic Western film *The good, the bad and the ugly* to observe the phases of Amazon development. However, the order is reversed to finish on an optimistic note, since much has been achieved. Passing from the worst to the best situation, the article addresses the drivers of deforestation in the region, the contribution of science and technology to the solution of critical issues and the advancement of rules and regulations that can help orient land use in the Brazilian Amazon.

Expansion of large-scale agriculture, while offering economic opportunities for Brazil, is the newest driver of deforestation in the Amazon region

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Planting of soybean for animal feed and biofuel also drives forest conversion indirectly by displacing cattle ranchers to forested areas where land is cheap (state of Mato Grosso)

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Unsustainable harvesting practices increase forest degradation and related biodiversity loss (Acre, Brazil)

THE UGLY

In the past three decades, land use in the Brazilian Amazon has been characterized by the intense exploitation of natural resources which has resulted in a mosaic of human-altered habitats without effectively improving quality of life and income distribution for the local population. About 17 percent of the Amazon forest, or 60 million hectares – an area equivalent to France – has been converted to other land uses in the past 30 years (INPE, 2008). Most of this area has been transformed into low-productivity pastures. These changes were the result of former strong governmental incentives for forest conversion and population migration to the region, characterizing a development pattern at that time where forests were seen as barriers for economic growth.

The trees in the Amazon forests contain 60 to 80 billion tonnes of carbon, more than the global emissions generated by humans in a decade. Deforestation in the Brazilian Amazon alone releases about 200 million tonnes of carbon annually, accounting for 3 percent of global net carbon emissions and 70 percent of national emissions (Houghton, 2005).

Around 1.5 million hectares per year are harvested for timber (Asner *et al.*, 2005), often using unsustainable practices that increase forest degradation and related biodiversity loss. Almost one-third of the Amazon forest has been degraded by the use of unsustainable practices. In addition, the summed effect of deforestation, degradation, and poor harvesting and slash-and-burn agricultural practices puts millions of hectares of forests at high fire risk. In El Niño years, forests are even more susceptible to fire because long periods of drought make forests drier and result in accumulation of fuel (dead leaves) on the ground (Nepstad *et al.*, 2004).

Forest exploitation and conversion have not brought true development, employment opportunities, better income distribution for local populations or environmental benefits to the region. Currently, about 45 percent of the population of the Brazilian Amazon has income below the poverty line.

THE BAD

Deforestation in the Brazilian Amazon results from the complex interaction of many direct and indirect drivers such as mining, logging, subsidies for cattle ranching, investment in infrastructure, land tenure issues, low law enforcement and the high price of grains and meat.

In recent years, however, large-scale agriculture has experienced sizeable expansion and become the newest driver of deforestation in the region. Brazil is one of the world's top producers and exporters of sugar cane, soybean, oranges and other products (FAO, 2008). In the nine states of the Brazilian Amazon, the area under intensive mechanized agriculture grew by more than 3.6 million hectares from 2001 to 2004 (Morton *et al.*, 2006). Particularly during this period, the greatest increase in area planted to soybean was in Mato Grosso, the Brazilian state with the highest deforestation rate (40 percent of new deforestation). By displacing cattle ranchers, soybean production has pushed the Amazon deforestation frontier further north. Between 2001 and 2004, the area deforested for cropland and mean annual soybean price in the year of forest clearing were directly correlated (Morton *et al.*, 2006). Forces driving the expansion of mechanized agriculture include lower transportation costs as a result of improved local infrastructure (roads, railroads, ports and waterways); higher international soy-

Deforestation, degradation, and poor harvesting and slash-and-burn agricultural practices lead to high fire risk for millions of hectares of Amazon forests

IPAM

bean prices; increased soybean demand from European markets because of the mad-cow disease (bovine spongiform encephalopathy); and rapid economic growth in China (9 percent per year) (Nepstad, Stickler and Almeida, 2006), which consumes great quantities of poultry and pork fed with soybean.

Soybean can also be used for biofuel. The Brazilian Government has declared the obligatory addition of 2 percent biofuel into petroleum diesel starting in 2008. In 2013, the proportion will increase to 8 percent, increasing biofuel consumption to 2.5 million litres per year. This policy, together with the announced interest of other countries in alternative fuels, has encouraged local producers to increase their soybean plantation area. About 2 million hectares will be needed just to meet the new Brazilian demand. In addition, Brazil has built up technological expertise in ethanol production from sugar cane.

Although the increased demand for soybean and the growth of biofuels represent excellent opportunities for Brazil, the challenge is to increase production without encouraging new deforestation. The Ministry of Agriculture states that the total area of already deforested and arable land in Brazil is more than enough to increase soybean plantations without need for further deforestation. For instance, the national production of ethanol could be doubled by using only 3.3 percent of Brazil's 90 million hectares of arable land. However, care must be taken to prevent new deforestation caused by displacement of other economic activities such as cattle ranching, which has already occurred. When biofuels increase demands for crops, prices will rise, farms will expand and displaced ranchers will clear new lands, usually in forested areas where land prices are still low. New occupation of areas that used to be remote, and which are associated with weak governmental presence and land tenure problems, tends to be chaotic.

Agribusiness has been one of the strongest forces for the implementation of new infrastructure in the region, especially roads. The current governmental infrastructure plan for the Amazon includes road paving, new hydropower projects and construction of waterways and ports. It has the potential to change drastically the social, economic and environmental situation of the Amazon. Paved roads can generate economic and social benefits, but also deforestation and forest degradation if not accompanied by regional planning. Studies have shown that more than 70 percent of deforestation occurs within 50 km of paved roads, while at most 7 percent occurs along unpaved roads (IPAM, 2000). The promise of a new highway (Br163) in the central Amazon has already taken many new sawmills to the region and redirected migration.

Seeking sustainable development in this particular region, civil society promoted a popular movement for participatory regional planning. The federal government then created a working group with the participation of 21 federal institutions to elaborate the "Br163 Sustainable Plan" based on studies and public hearings. State and federal governments adopted the plan, making a commitment for further actions and public policies associated with Br163. This initiative demonstrated the influence that well organized local civil society can have.

Regional planning demands synergy among public policies. In this regard, decision-makers can benefit from predictive models, which can show, among other things, trends in the forces of deforestation depending on different political choices. For instance, based on the historical relationship between deforestation and roads in the Brazilian Amazon, Soares-Filho *et al.* (2006) built a model that predicts Amazon deforestation under eight different scenarios depending on the number of new roads or roads paved and various development parameters. The output is projected scenarios of Amazon development up to 2050.

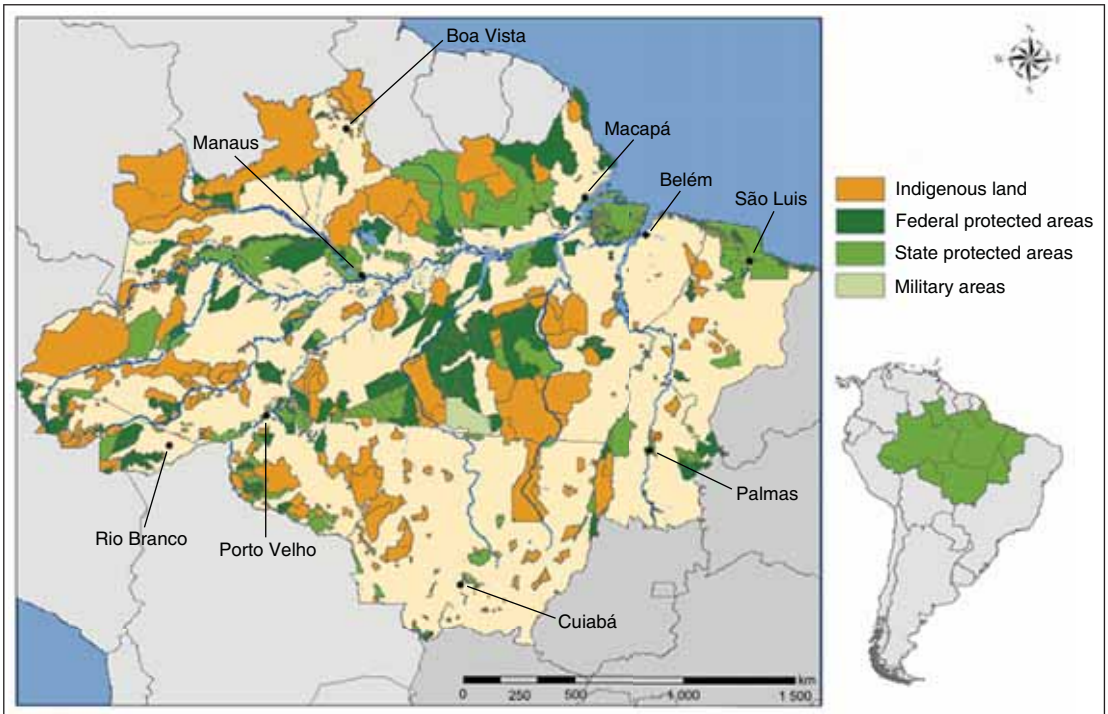
At one extreme is a "business-as-usual" scenario which includes all pavement of roads scheduled until 2027 (14 000 km of roads), low law enforcement, agricultural expansion and population growth and migration. According to the model, in this scenario 40 percent of Amazon forests would be lost between 2003 and 2050 (closed-canopy forest formation reduced from 5.3 million to 3.2 million square kilometres).

At the other extreme is a "governance" scenario which includes pavement of 11 500 km of roads up to 2026 along with law enforcement, agro-ecological zoning (preventing agricultural expansion onto inappropriate areas) and expansion and conservation of protected areas. The difference in deforestation between these two scenarios would be 1 million square kilometres.

The deforestation facilitated by road pavement and low law enforcement could also dramatically increase the annual net carbon emissions from the Amazon. The model predicts that under the business-as-usual scenario 32 billion tonnes of carbon would be emitted by 2050 (equivalent to four years of current global annual emissions), contrasted with 15 billion tonnes of carbon under the governance scenario.

Soares-Filho *et al.* (2006) also analysed the potential species loss in these two scenarios. By 2050, about 100 mammal species (30 percent) would lose more than 40 percent of the forests within their distribution ranges under the business-as-usual scenario, compared with 39 species (10 percent) under the governance scenario.

Protected areas assume an important role in forest and biodiversity conservation. For instance, almost 40 percent of mammal distribution ranges are within protected areas (Azevedo-Ramos *et al.*, 2006). Impacts of roads would be felt in 89 indigenous lands, 22 protected areas and 68 priority areas for biodiversity conservation – in 28 percent of protected areas overall (IPAM, 2000).



Protected areas in the Brazilian Amazon

Source: Ministry of Environment, Brazil

The analysis of Soares-Filho *et al.* (2006) showed that under a business-as-usual scenario, protected areas would do little alone, contributing to a reduction of new deforestation to 7 percent below the business-as-usual baseline. On the other hand, protected areas associated with a governance scenario could avoid one-third of the deforestation projected to occur by 2050 under the business-as-usual scenario.

THE GOOD

Most of the recommendations included in the governance scenario of Soares-Filho *et al.* (2006) have been put into action and enforced.

The federal government now acknowledges that reducing deforestation is not exclusively the concern of the Ministry of Environment, as it was historically believed to be. The government has established a committee involving 14 ministries to design and execute a plan for reducing Amazon deforestation. Monitoring and control of illegal deforestation have been particularly intensified. Brazil has advanced and transparent remote-sensing systems for monitoring deforestation, giving monthly and annual estimates (DETER and PRODES, respectively). The reports are posted on the Internet (www.inpe.br), and images are available for verification by members of civil society. A similar system for detecting illegal logging (DETEX) is being developed. Collaborative monitoring activities shared by the federal police and the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) resulted in the arrest of more than 500 people involved in illegal deforestation or logging in 2005 and 2006. Moreover, 20 million hectares of new federal protected areas were established in those two years in the Brazilian Amazon (about 10 percent of the total). Currently, 48 percent of the Brazilian Amazon (about 201 million hectares) is in some kind of protected area (see Figure). These actions, together with a decrease in international soybean prices, have reduced Amazon deforestation by 52 percent since 2004 (INPE, 2008).

Brazil's energy matrix is considerably cleaner than that of other developing countries. About 20 percent of its energy production comes from renewable sources (wood, charcoal, sugarcane derivatives and others), and if hydroelectric energy is included this percentage goes up to around 60 percent. About 23 percent of the country's greenhouse gas emissions come from fossil fuel combustion and 75 percent from land use changes, primarily Amazon deforestation (Ministry of Science and Technology, Brazil, 2004). By reducing deforestation since 2004, Brazil has avoided the emission of approximately 200 million tonnes of carbon.

Strengthening the social, environmental and economic importance of forests, a new public forest management law was established in 2006. It stipulates that all public forests should remain public and retain their forest cover. They can be transformed into protected areas, allocated to traditional populations or sustainably used for economic purposes under forest concessions. The same law

created the Brazilian Forest Service, which has the responsibility to manage and protect the public forests. The law also established the National Fund for Forest Development, which supports forest-based activities such as research, capacity building and economic activities related to forest management. Another important change was the decentralization of forest management and monitoring, previously under federal government responsibility. Now, every Brazilian state has its share of responsibility for issuing forest management permits and for preventing illegal logging and deforestation.

As a means of strengthening the forest-based economy in the Amazon basin and as a part of major regional planning, the federal government is creating Sustainable Forest Districts – areas where public policies, concerning for example forest management, land tenure, energy, industry, education and science and technology, will be implemented to stimulate forestry or forest recovery. One district of 19 million hectares has already been created in the central Amazon (Br163). Two others are being planned in the Amazon.

FINAL REMARKS

The obstacles to sustainable rural development and conservation in remote areas are complex and difficult to overcome. New waves of people migrating to unexploited areas in search of better life opportunities and easy profit will make the prevention of illegal logging and deforestation a continuous struggle unless local institutions are reinforced and the State becomes more present in affected remote areas. Adequate policies based on land-use regulation, local governance and law enforcement could reduce deforestation and biodiversity loss and allow economic growth. Containing migration to the region still poses challenges, however. Brazilian agrarian reform, for example, has supported the creation of several new legal rural settlements in the Amazon. According to the new public forest management law, the settlers should develop forest-based activities in areas where there is forest cover. This means that rural public policy should now promote forest resource use (with training, credit and technology) instead of only agriculture. Otherwise, these settlers may become the new drivers of uncontrolled deforestation.

The production of biofuels offers important opportunities for Brazil – but policies must ensure that these opportunities do not come at the cost of new deforestation in the Amazon.

Support and incentives are needed to maintain the increasingly extensive protected areas. In this regard, the Brazilian Government proposed to the United Nations Framework Convention on Climate Change (UNFCCC) that developing countries should be compensated for reducing deforestation below their national historical rates, since the consequent reductions in carbon emissions generate benefits for all humanity.

Development has followed various phases in the Brazilian Amazon. Having reached a phase in which forest protection and sustainable use are promoted, the country needs to make this position permanent. Despite the achievements, challenges remain. Yet there is now stronger political and civic will to deal with them. ◆

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