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Natural riches of Amazonia, deforestation and its consequences

Abstract

Amazonia's greatest riches are in the environmental services provided by its natural ecosystems. These avoid the global warming that would be provoked by releasing their carbon stocks, recycle water that is essential to rainfall in Amazonia and in other areas (including São Paulo), and maintain biodiversity. While some progress has been made towards maintaining forest by tapping the value of these services, the forces of destruction have grown much faster, since incentives to clear the forest have been higher than the ones to conserve it. Destructive uses provide assured and immediate profits, whereas conserving forest for environmental services depends on financial rewards that are uncertain and removed in time.

Biodiversity

About two-thirds of the Amazon forest is in Brazil, the rest being shared by Bolivia, Peru, Ecuador and Colombia, while "greater" Amazonia encompasses tropical forests in Venezuela and the Guyanas. The natural richness of Amazonia is very great, with both the largest remaining area of the world's tropical forest and the largest amount of fresh water (the annual flow of the Amazon River is five to six times larger than that of the world's second largest river: the Congo). Amazonia's biodiversity (in terms of number of tree species per hectare) reaches a peak where the topography begins to rise at the foot of the Andes Mountains. Amazonia has an estimated 40,000 plant species, 3000 fishes, 1294 birds, 427 mammals, 427 amphibians and 378 reptiles (da Silva *et al.*, 2005). Average endemism (the proportion of species that only occur here) is high, but it can be higher in some other tropical forests, such as the remaining patches of Brazil's Atlantic forest. Endemism refers to the degree to which species only occur in only one geographical area, thus the definition of this geographical area determines what is considered endemic. One approach divides Amazonia into eight "areas of endemism" (da Silva *et al.*, 2005). Another is to divide the region into many grid cells and assign an arbitrary statistical threshold for the spread of the distribution to other grid cells (Kress *et al.*, 1998). Either way, the western portion of Amazonia generally has both the largest number of species and the greatest endemism in the region, and some of the highest levels in the world.

Climate

Each hectare of Amazonian forest has a high biomass, but some other tropical forests, such as those in Southeast Asia, have higher per-hectare biomass. However, the vast area of Amazonia makes the total biomass and carbon stock much higher in this region, giving it an unparalleled role in future climate regulation. Forest "biomass" refers to the dry weight of the vegetation (mainly trees). From the point of view of greenhouse-gas emissions, total biomass is the important measure, which includes not only live trees and not only what is above ground, but also dead biomass and roots. In 2013 the mean estimated biomass of Brazil's 4.2 million km2 "Amazonia biome" was 338.8 tons, or 163.5 tons of carbon per hectare, and the total biomass stock, despite loss of 16.7% to deforestation since the early 1970s, was still 121.2 billion tons, or 58.6 billion tons of carbon in 2013 (Nogueira *et al.*, 2015). Maintaining Amazonian forest avoids global warming and sustains the region's water cycle, which plays a key role in supplying water vapor that produces rain in non-Amazonian parts of Brazil (including São Paulo) and in neighboring countries such as Paraguay and Argentina (Fearnside, 2004, Arraut *et al.*, 2012).

Deforestation

Amazon forest is threatened by deforestation (clear cutting). The cumulative total cleared in Brazil's portion of the Amazon forest is now 20%, about 90% of this clearing having occurred in just

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Figure 1: *Deforestation for soybean production*

Figure 2: *Amazon rainforest in Manaus*

the last four decades (Brazil, INPE, 2015a). For comparison, Brazil's portion of the Amazon forest is approximately the size of Western Europe, and by 1995 the deforested area surpassed the area of France. Continued clearing through 2014 has added the areas of Austria, Switzerland and Portugal. At the peak of clearing an area the size of Belgium was felled in a single year. Annual deforestation rates in Brazil declined from 2004 to 2012, after which the rate oscillated at approximately the same "low" level through July 2014. The 5012 km^2 cleared from August 2013 to July 2014 is still a substantial area. The decline in deforestation rates to the 2012-2014 plateau is explained by a variety of economic setbacks and easily reversed administrative measures (e.g., Assunção *et al.*, 2012), all of which offer fragile protection on the longer term. Most important is a 2008 resolution by Brazil's Central Bank that no public bank loans can be given to landholders with irregularities reported by IBAMA, the federal environmental agency (BACEN Resolution 3.545/2008). The restriction on bank loans has immediate effect, unlike IBAMA's fines, which can be appealed almost endlessly. The credit restriction greatly increases the impact of any given level of government investment in inspection and enforcement. Unfortunately, the restriction could be removed at any time at the stroke of a pen, and this is a goal of the "ruralist" voting block in the National Congress.

Brazil's deforestation has long been subject to highs and lows, usually as a result of major economic cycles (Fearnside, 2005). The deforestation rate declined from 1988 (the first year of annual monitoring) to 1991 as a result of economic recession. The rate then rose as the economy recovered and jumped to an all-time high in 1995. This peak was due to the "Real Plan" package of economic measures implemented in June 1994, ending hyperinflation and releasing large amounts of money that had been held in short-term money-market investments. Deforestation then plunged until 1997 as the price of land fell by half (also a result of the Real Plan), ending the generalized land speculation that had previously been so profitable. This greatly reduced clearing to defend land claims. Deforestation then climbed to a peak in 2004 as exports rose, becoming more profitable with weakening of the Brazilian real. After 2004 the downturn mentioned earlier began: the exchange rate declined from nearly R$4/US$ to a low of R$1.5/US$. This made exporting soybeans and other commodities much less profitable, since expenses are in reais and the returns are in dollars. In addition, the international price of soybeans (in dollars) declined steadily over the 2004-2008 period, with the exception of a brief rise at the end of 2007. Beef prices in Brazil (corrected for inflation) followed the same pattern.

After July 2014 a sharp upturn in deforestation became apparent (Brazil, INPE, 2015b; Fearnside, 2015; IMAZON, 2015). Among the contributing factors may be anticipation of Brazil's October 2014 elections: such upturns prior to elections

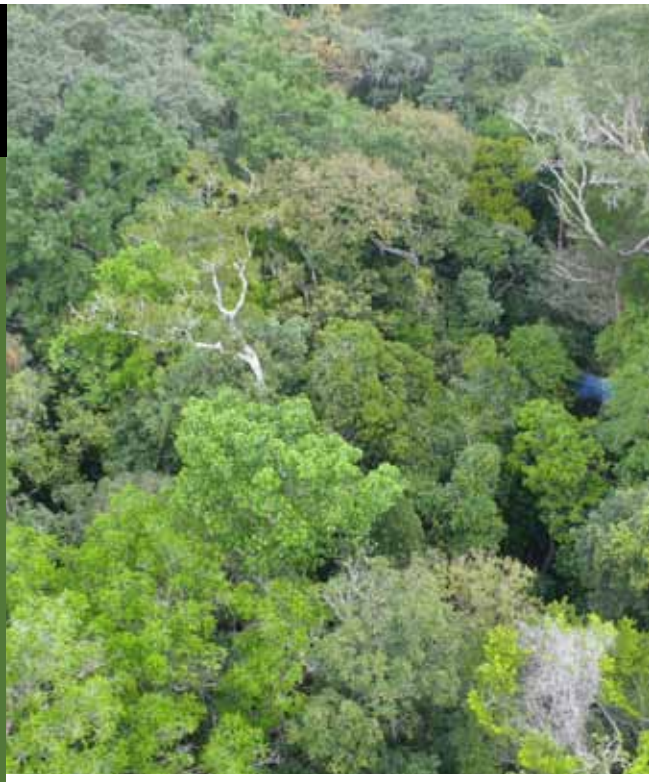

Figure 3: *Amazon rainforest (Aerial view)*

Figure 4: *Land preparation for soybean production*

are a common pattern as a result of sudden releases of government funds, relaxation of enforcement of environmental restrictions, and expectation of "amnesties" for past violations (see Fearnside, 2003).

Despite the lower rates of clearing in recent years, the underlying forces driving deforestation continue to grow, including ever more roads, investment and population. The growing political power of agribusiness and ranching interests has weakened deforestation restrictions such as Brazil's "forest code", environmental impact requirements for infrastructure projects, and the system of protected areas (e.g., Fearnside, 2008a; Fearnside & Figueiredo, 2015). The Brazilian real is currently in free-fall with no end in sight, making soy and beef exports far more profitable than they were when the deforestation decline took place. Creation of new protected areas is essentially halted (Alencastro, 2014), existing reserves continue to be degazetted (Bernard *et al.*, 2014), government expenditures on enforcing environmental laws have been drastically cut (Leite, 2015), political appointments signal deforesters that environmental protection will have low priority (Tollefson, 2015), and plans for Amazonian roads continue as fast as funds permits (Brazil, MoP, 2015). Nevertheless, there is some good news in improved monitoring capabilities and governance arrangements (both governmental and through corporate actors) (e.g., Nepstad *et al.*, 2014, Gibbs *et al.*, 2015a,b).

All Amazonian countries are the scenes of deforestation and environmental destruction by mining, hydroelectric dams, oil exploitation, logging and other activities. All have top-level governmental support for development projects in Amazonia with serious consequences for the forest. Because they open access to land with multiple potential uses, decisions on infrastructure do not represent one-time subtractions from the forest, but rather set in motion processes that continue to remove and degrade forest for many decades in the future (Fearnside & Laurance, 2012).

Environmental services

It is the richness of Amazonia's environmental services in maintaining climate and biodiversity that offers the hope of changing these priorities (Fearnside, 1997, 2008b). Various controversies surround the politics of how to account for and pay for these services (Fearnside, 2012a,b). Unfortunately, there is not much time to resolve these issues due both to the rapid pace of forest loss and degradation and to the rapid pace of climate change. A lasting solution to deforestation requires that region's economy be based on maintaining the forest rather than destroying it.

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