AMAZONIA, DEFORESTATION OF

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I.) DEFINITIONS

A.) AMAZONIA

The Amazon River watershed totals 7,350,621 km^2, of which 4,982,000 km^2 (67.8%) is in Brazil, 956,751 km^2 (13.0%) is in Peru, 824,000 km^2 (11.2%) is in Bolivia, 406,000 km^2 (5.5%) is in Colombia, 123,000 km^2 (1.7%) is in Ecuador, 53,000 km^2 (0.7%) is in Venezuela, and 5,870 km^2 (0.1%) is in Guyana (Fig. 1). Depending on definition, Amazonia is 4-7 million km^2 in area, including in Brazil the Tocantins/Araguaia Basin (which drains into the Pará River, interconnected with the mouth of the Amazon) and the small river basins in Amapá that drain directly into the Atlantic. The forested area extends beyond the bounds of the river basin, especially on its northern and southern edges, but a number of enclaves of non-forest vegetation exist within the watershed. In addition, "Greater Amazonia" encompasses Suriname (142,800 km^2), French Guiana (91,000 km^2), and the part of Guyana outside of the Amazon River watershed (211,239 - 5,870 = 205,369 km^2), bringing the total area of "Greater Amazonia" to 7,789,790 km^2.

[Figure 1 here]

In Brazil, the "Legal Amazon" is a 5 million km^2 administrative region comprised of nine states. One million km^2 of the region was not originally forested, being covered by various kinds of savanna (especially the *cerrado*, or central Brazilian scrub savanna). The Legal Amazon was created in 1953 and slightly modified in extent in 1977. Because special subsidies and development programs apply within the region, its borders were drawn just far enough south to include the city of Cuiabá (Mato Grosso), and just far enough east to include the city of São Luís (Maranhão), both outside of the portion that is geographically Amazonian.

B.) DEFORESTATION

Deforestation refers to the loss of primary (sometimes called "mature," "virgin" or "old-growth") forest. This is distinct from cutting of secondary (successional) forests. In addition to clearing, as for agriculture or ranching, deforestation includes forest lost to flooding for hydroelectric dams. It does not include disturbance of forest by selective logging. In Amazonia, virtually all logging is "selective" because only some of the many species of trees in the forest are accepted by today's timber markets.

Wide discrepancies in estimates for "deforestation" in Amazonia have often been the result of inconsistencies in definitions, including the delimitation of "Amazonia," the inclusion or exclusion of the *cerrado* scrub savanna, classification of secondary forests as "forest" (versus already deforested), and the counting of flooding by hydroelectric dams. Differences among satellites and in interpretation of the data also contribute to discrepancies. Operationally, areas are classified as "deforested" if they are readily recognized as cleared on LANDSAT satellite imagery.

It is also important not to confuse deforestation with burning: not all land is burned when it is deforested, and many areas are burned that are either not originally forest (especially savanna) or have already been deforested (especially established cattle pastures). Amazonian forest can sometimes burn without being cleared first, as in the case of the Great Roraima Fire of 1998, but these events leave most trees standing and are not considered "deforestation."

II.) EXTENT AND RATE OF DEFORESTATION

Much more complete information for the rate and extent of deforestation exists for Brazil than for the other Amazonian countries because of Brazil's monitoring capabilities at the National Institute of Space Research (INPE). The Food and Agriculture Organization of the United Nations (FAO) compiled estimates for the status of forests in 1990 and 2000 in all tropical countries. The FAO definitions of forest types are not entirely consistent with other classifications, particularly with regard to how much of the vast Brazilian *cerrado* should be considered a "forest." FAO (2001) estimated that for the 1991-2000 period 23.1 $\times$ 10^3 km^2 of forest were cleared in annually Brazil (including areas outside of Amazonia), 2.7 $\times$ 10^3 km^2/year in Peru, 1.6 $\times$ 10^3 km^2/year in Bolivia, 1.9 $\times$ 10^3 km^2/year in Colombia, 1.4 $\times$ 10^3 km^2/year in Ecuador, 2.2 $\times$ 10^3 km^2/year in Venezuela, and 0.5 $\times$ 10^3 km^2/year in Guyana. Deforestation rates in other parts of "Greater Amazonia" were minimal: deforestation in both Suriname and French Guiana was classified as “not significant” (FAO, 2001).

LANDSAT satellite data interpreted at INPE (Fig. 2) indicate that by 2006 the area of forest cleared in Brazilian Amazonia had reached 712.6 $\times$ 10^3 km^2 (17.8% of the 4 $\times$ 10^6 km^2 originally forested portion of Brazil's 5 $\times$ 10^6 km^2 Legal Amazon Region), including approximately 100 $\times$ 10^3 km^2 of "old" (pre-1970) deforestation in Pará and Maranhão (Brazil, INPE, 2007). Over the 1978-1988 period, forest was lost at a rate of 20.4 $\times$ 10^3 km^2/yr (including hydroelectric flooding), the rate declined (beginning in 1987) to a low point of 11.1 $\times$ 10^3 km^2/yr in 1991, climbed gradually over the 1992-1994 period and then jumped to a peak of 29.1 × 10^3 km^2/yr in 1995. Following this the rate fell to 13.2 × 10^3 km^2/yr in 1997, after which it climbed again to a peak of 27.4 × 10^3 km^2/yr in 2004; the rate then fell to 14.0 × 10^3 km^2/yr in 2006 and preliminary results indicate a continued fall in 2007 (Brazil, INPE, 2007). Current values can be obtained from INPE's web site: http://www.inpe.br. Note, however, that the official explanations given by INPE as to *why* deforestation rates rise and fall (decrees affecting incentives and programs for inspection and levying fines) are unlikely to be correct (see below).

[Fig. 2 here]

III.) CAUSES OF DEFORESTATION

Amazonian countries differ greatly in the social factors driving deforestation. In Brazil, most clearing is done by large and middle-sized ranchers for cattle pasture, whereas the role of small farmers clearing for agriculture is relatively more important in the other countries. Brazil is by far the most important country in tropical forest matters in Amazonia and globally, both in terms of the extent of remaining forest and in terms of the area of forest being cleared each year.

The relative weight of small farmers versus large landholders in Brazilian Amazonia is continually changing as a result of changing economic and demographic pressures. The behavior of large landholders is most sensitive to economic changes such as the interest rates offered by money markets and other financial investments, government subsidies for agricultural credit, the rate of general inflation, and changes in the price of land. Tax incentives were a strong motive in the 1970s and 1980s. In June 1991 a decree suspended the granting of *new* incentives. However, the old (*i.e.*, already approved) incentives continue to the present day, contrary to the popular impression that was fostered by numerous statements by government officials to the effect that incentives had been ended. Many of the other forms of incentives, such as large amounts of government-subsidized credit at rates far below those of Brazilian inflation, became much scarcer after 1984.

For decades preceding the initiation of Brazil's "Plano Real" economic reform program in July 1994, hyperinflation was the dominant feature of the Brazilian economy. Land played a role as store of value, and its value was bid up to levels much higher than what could be justified as an input to agricultural and ranching production. Deforestation played a critical role as a means of holding claim to land. Deforesting for cattle pasture was the cheapest and most effective means of maintaining possession of investments in land. The extent to which the motive for defending these claims (through expansion of cattle pasture) was speculative profits from increasing land value has been a matter of debate. Hecht *et al*. (1988) present calculations of the overall profitability of ranching in which the contribution from speculation is critical, while Mattos and Uhl (1994) show actual production of beef has become increasingly more profitable, and that supplementary income from selling timber allows both deforestation and investment in recuperation of degraded pastures on the properties (Margulis, 2003). Progressive certification of Brazilian states as free of foot-and-mouth disease has opened Amazonia to the "hamburger connection" of international beef markets (Alencar *et al*., 2004; Arima *et al*., 2005; Kaimowitz *et al*., 2004). Selling off the timber can only be depended upon for a few years to subsidize the cattle-raising portion of the operations, since the timber harvest rates are virtually always above sustainable levels.

The decline in deforestation rates from 1987 through 1991 can best be explained by Brazil's deepening economic recession over this period. Ranchers simply did not have money to invest in expanding their clearings as quickly as they had in the past. In addition, the government lacked funds to continue building highways and establishing settlement projects. Probably very little of the decline can be attributed to Brazil's repression of deforestation through inspection from helicopters, confiscating chainsaws and fining landowners caught burning without the required permission from the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA). Despite bitter complaints, most people continued to clear anyway. Changes in policies on granting fiscal incentives also do not explain the decline. The decree suspending the granting of incentives (Decree No. 153) was issued on 25 June 1991--after almost the entire observed decline in deforestation rate had already occurred (see Fig. 2). Even for the last year (1991), the effect would be minimal, as the average date for the LANDSAT images for the 1991 data set was August of that year.

The peak in 1995 was probably, in large part, a reflection of economic recovery under the Plano Real, which resulted in larger volumes of money suddenly becoming available for investment, including investment in cattle ranches. The fall in deforestation rates in the years after 1995 was a logical consequence of the Plano Real having sharply cut the rate of inflation. Land values reached a peak in 1995, and fell by about 50% by the end of 1997. Falling land values made land speculation unattractive to investors. Faminow (1998) analyzed state-level land price trends in Amazonia and concluded that speculative profits cannot explain the attraction of capital to investments in Amazonian ranches (but see Fearnside, 2002).

Deforestation rates climbed steadily to another peak in

2004, after which they fell in the succeeding three years. While a repression campaign during this period undoubtedly had some effect, the decline in deforestation also coincides with falling international prices for soybeans and beef and a rise by about 50% in the value of the Brazilian real against the US dollar, making Brazilian agricultural exports less profitable. The association of major swings in deforestation rate with macroeconomic factors such as money availability and inflation rate is one indication that much of the clearing is done by those who invest in medium and large cattle ranches, rather than by small farmers using family labor.

The distribution of clearing among the region's nine states indicates that most of the clearing is in states that are dominated by ranchers. For example, in 2006 the state of Mato Grosso alone accounted for 31% of the total, while the areas of large ranches in southern Pará accounted for most of the rest. Mato Grosso has the highest percentage of its privately held land in ranches of 1000 ha or more: 84% at the time of the last (1985) agricultural census. A moment's reflection on the human significance of having 84% of the land in large ranches (and only 3% in small farms) should give anyone pause. By contrast, Rondônia--a state that has become famous for its deforestation by small farmers--had only 10% of the 1991 deforestation total, and Acre had 3%.

The number of properties censused in each size class explains 74% of the variation in deforestation rate among the nine Amazonian states. Multiple regressions indicate that 30% of the clearing in both 1990 and 1991 can be attributed to small farmers (properties < 100 ha in area), and the remaining 70% to either medium or large ranchers (Fearnside, 1993). This has been confirmed by interviews in the Arc of Deforestation where deforestation is concentrated along the eastern and southern edges of the region: only 25% of the clearing was in properties < 100 ha in area (Nepstad *et al.*, 1999a). The social cost of substantially reducing deforestation rates would therefore be much less than is implied by frequent pronouncements that blame "poverty" for environmental problems in the region.

The question of who is to blame for tropical deforestation has profound implications for the priorities of programs intended to reduce forest loss. The prominence of cattle ranchers in Brazil (different from many other parts of the tropics) means that measures aimed at containing deforestation by, for example, promoting agroforestry among small farmers can never achieve this goal, although some of the same tools (such as agroforestry) have important reasons for being supported independent of efforts to combat deforestation.

IV.) IMPACTS OF DEFORESTATION

A.) LOSS OF BIODIVERSITY

Deforestation results in loss of biodiversity because most tropical forest species cannot survive the abrupt changes when forest is felled and burned, and cannot adapt to the new conditions in the deforested landscape. The high degree of endemism, or presence of species that are only found within a small geographical range, can result in loss of species and loss of genetic variability within species even when the forest surrounding a cleared area appears to human observers to be identical to the forest that was lost.

The impact of deforestation extends beyond the area directly cleared because of edge effects and the impact of fragmentation of the formerly continuous forest into small islands that are unable to support viable populations of forest species, including their biological interactions (see Laurance and Bierregaard, 1997). In addition, fire and other disturbance regimes (including logging) are usually associated with the presence of nearby deforestation, thus further extending the impact beyond the edges of the clearings.

The impact of converting forest to another land use depends not only on the patch of land for which conversion is being considered, but also on what has been done with the remainder of the region. As the cumulative area cleared increases, the danger increases that each additional hectare of clearing will lead to unacceptable impacts. For example, the risk of species extinctions increases greatly as the remaining areas of natural forest dwindle.

Biodiversity has many types of value, from financial value associated with selling a wide variety of products, to the use value of the products, to existence values unrelated to any direct 'use' of a species and its products (Fearnside, 1999; Millennium Ecosystem Assessment, 2005). People disagree on what value should be attached to biodiversity, especially those forms of value not directly translatable into traditional financial terms by today's marketplace. While some may think that biodiversity is worthless except for sale, it is not necessary to convince such people that biodiversity is valuable; rather, it is sufficient for them to know that a constituency exists today and is growing, and that this represents a potential source of financial flows intended to maintain biodiversity. Political scientists estimate that such willingness to pay exceeds US$20/ha/year for tropical forest.

B.) GREENHOUSE GAS EMISSIONS

Carbon storage, in order to avoid global warming through the greenhouse effect, represents a major environmental service of Amazonian forests. The way that this benefit is calculated can have a tremendous effect on the value assigned to maintaining Amazonian forest. As currently foreseen in the United Nations Framework Convention on Climate Change (UNFCCC), maintaining carbon stocks is not considered a service--only deliberate incremental alterations in the flows of carbon (although this is excluded from credit under the Kyoto Protocol’s Clean Development Mechanism for the period through 2012). Even considering only this more restrictive view of carbon benefits, the value of Amazonian forests is substantial. In 2006, Brazil's 14,039 km^2/year rate of deforestation was producing net committed emissions of 239 million tons (t) of CO_2-equivalent carbon per year (Updated from Fearnside, 1997a based on Nogueira *et al*., 2007). The benefit of slowing or stopping this emission is, therefore, substantial. All human activities in 2004 emitted approximately 14 billion t of carbon yearly, expressed as carbon equivalent from all greenhouse gases (IPCC, 2007). Of this, 8 billion tons was CO_2 from fossil fuel combustion. Therefore, while slowing deforestation would be an important measure in combating global warming, it cannot eliminate the need for major reductions in fossil fuel use throughout the world.

Although a wide variety of views exists on the value of carbon, already enacted carbon taxes of US$ 45/t in Sweden and the Netherlands and US$ 6.1/t in Finland indicate that the "willingness to pay" for this service is already substantial. This willingness to pay may increase significantly in the future when the magnitude of potential damage from global warming becomes more apparent to decision-makers and the general public. At the level indicated by current carbon taxes, the global warming damage of Amazon deforestation at the 2006 rate is already worth US$ 1.4-10.8 billion/year. The value of the global warming damage from clearing a hectare of forested land in Amazonia (US$ 1,200-8,600) is much higher than the purchase price of land today. These calculations use US$ 7.3/t C as the value of permanently sequestered carbon.

C.) LOSS OF WATER CYCLING

Water cycling is different from biodiversity and carbon in that impacts of deforestation in this area fall directly on Brazil rather than being spread over the world as a whole. About 20-30% of the rainfall in the Brazilian Amazon is water that is recycled through the forest, the rest originating from water vapor blown into the region directly from the Atlantic Ocean (Lean *et al*., 1996). Of the water entering the region, about 66% returns to the Atlantic via the Amazon River, the remainder being exported to other regions (Salati, 2001). Approximately half of the water vapor that remains airborne turns towards the south (Correia, 2005). Much of this water vapor is transported by winds to Brazil's Central-South Region, where most of the country's agriculture is located. Brazil's annual harvest has a gross value of about US$ 65 billion, and dependence of even a small fraction of this on rainfall from Amazonian water vapor would translate into a substantial value for Brazil. This water is also critical to hydroelectric power generated in south-central Brazil. Although movement of the water vapor is indicated by global circulation models, the amounts involved are still poorly quantified (Marengo *et al*., 2004).

The role of Amazonian forest in the region's water cycle also implies increasing risk with the scale of deforestation: when rainfall reductions caused by losses of forest evapotranspiration are added to the natural variability that characterizes rainfall in the region, the resulting droughts would cross biological thresholds leading to major impacts (Foley *et al*., 2007). These thresholds include the drought tolerance of individual tree species and the increased probability of fire being able to propagate itself in standing forest. Fire entry into standing forest in Brazilian Amazonia already occurs in areas disturbed by logging (Cochrane *et al*., 1999). During the El Niño drought of 1997/1998, over 11,000 km^2 of undisturbed forest burned in Brazil's far northern state of Roraima (Barbosa and Fearnside, 1999). Large areas also burned in Pará (Alencar *et al*., 2006). In Amazonia, 'mega-El Niño' events have caused widespread conflagrations in the forest four times over the past 2000 years (Meggers, 1994). The effect of large-scale deforestation is to turn relatively rare events like these into something that could recur at more frequent intervals.

V.) POTENTIAL COUNTERMEASURES

A.) CURRENT EFFORTS

Current efforts to contain deforestation include the Pilot Program to Conserve the Brazilian Rainforest, financed by the G-7 countries and administered by the World Bank and the Brazilian government. Components include the "PD/A" demonstration projects (small projects carried out by NGOs), extractive reserves, indigenous lands, support for scientific research centers and directed research projects, natural resources policy (*i.e*., zoning), natural resources management (mainly forestry), *várzea* (floodplain) management, ecological corridors, fire and deforestation control (*i.e*. detection of deforestation and burning), and monitoring and analysis of Pilot Program activities in order to learn policy lessons.

In addition to the Pilot Program, the Brazilian government has a number of other programs aimed at controlling deforestation. These can be seen on the website of the Brazilian Institute for the Environment and Renewable Natural Resources

(IBAMA): http://www.ibama.gov.br. The ability of the Brazilian government to enforce environmental laws and restrain deforestation through command-and-control measures is essential, even though other more fundamental measures addressing the underlying causes of deforestation are also needed. Lack of confidence in the government's ability to control clearing has been at the root of the foreign ministry's longstanding reluctance to embrace avoided deforestation as a mitigation measure under the Kyoto Protocol. In this light, an experience with deforestation licensing and control by the state government of Mato Grosso over the 1999-2001 period has importance beyond the deforestation that was avoided in this period.

An important activity within the purview of the Ministry of the Environment is creation of protected areas. The rapid expansion of the area in reserves of a variety of types has been, and continues to be, an important long-term determinant of deforestation (Ferreira *et al*., 2005). An important priority has been demarcation of indigenous lands, which encompass much more area in Amazonia than do protected areas. Indigenous areas are particularly effective because of the active defense by their indigenous inhabitants (Schwartzman *et al*., 2000). Nonetheless, progress on rewarding the environmental services of the reserves is needed if this protection is to be maintained over the long term.

C.) NEEDED POLICY CHANGES

The most basic problem in controlling deforestation is that much of what needs to be done is outside of the purview of agencies such as IBAMA that are charged with environmental problems (Fearnside, 2005). Authority to change tax laws, resettlement policies, and road-building priorities, for example, rest with other parts of the government. The implications of infrastructure decisions are particularly important (Fearnside, 2007; Fearnside and Graça, 2006; Laurance et al., 2001; Soares-Filho *et al*., 2006).

The respite from deforestation pressure provided by economic factors such as unfavorable international commodity prices and exchange rates means that deforestation rates can be expected to increase again when these factors recover their strength, unless the government takes steps now to remove the underlying motives for deforestation. Steps needed include: applying heavy taxes to take the profit out of land speculation, changing land titling procedures to cease recognizing deforestation for cattle pasture as an "improvement" (*benfeitoria*), removing remaining subsidies, reinforcing procedures for Environmental Impact Reports (RIMAs), carrying out agrarian reform both in Amazonia and in the source areas of migrants, and offering alternative employment both in rural and in urban areas.

Although small farmers account for only about 30% of the deforestation activity, the intensity of deforestation within the area they occupy is greater than for the medium and large ranchers that hold 89% of the Legal Amazon's private land. Deforestation intensity, or the impact per km^2 of private land, declines with increasing property size. This means that deforestation would increase if forest areas now held by large ranches were redistributed into small holdings. This indicates the importance of using already-cleared areas for agrarian reform, rather than following the politically easier path of distributing areas still in forest. Large as the area already cleared is, it has limits that fall far short of the potential demand for land to be settled. Indeed, even the Legal Amazon as a whole falls short of this demand. Recognizing the existence of carrying capacity limits, and then maintaining population levels within these, is fundamental to any long-term plan for sustainable use of Amazonia.

C.) ENVIRONMENTAL SERVICES AS DEVELOPMENT

At present, economic activities in Amazonia almost exclusively involve taking some material commodity and selling it. Typical commodities include timber, minerals, the products of agriculture and ranching, and non-timber forest products like natural rubber and Brazil nuts. The potential is much greater, both in terms of monetary value and in terms of sustainability, for pursuing a radically different strategy for long-term support: finding ways to tap the environmental services of the forest as a means of both sustaining the human population and maintaining the forest.

At least three classes of environmental services are provided by Amazonian forests: biodiversity maintenance, carbon storage, and water cycling. Various ways have been proposed to calculate the magnitude of the services and for the institutional arrangements that would reward them. The Kyoto Protocol, signed in December 1997, has been a substantial advance towards rewarding the forest’s role in avoiding global warming, although political factors intervened to prevent granting carbon credit under the Protocol before 2013. Changes in the political context make some sort of credit for avoiding tropical deforestation much more likely from 2013 onwards. The Kyoto Protocol bases its carbon accounting on “additionality”, or the incremental reduction in net emissions that results from a mitigation activity, as judged by comparison with a baseline scenario representing what would have been emitted without the project.

Additionality is not the only way to calculate carbon benefits of avoided deforestation. A pre-Kyoto proposal for a system based on carbon stocks, rather than changes in flows, reappeared in 2007 as the basis of the “Amazonas Initiative”--a proposal by the government of Brazil’s state of Amazonas for system of payments based on stocks of environmental services. The original for a stocks-based system included preliminary calculations of indicators of "willingness to pay" for the services lost from 1990 deforestation in the Brazilian Legal Amazon totaling US$ 2.5 billion (assuming 5% annual discount); maintenance of the stock of forest, if regarded as producing 5%/year annuity, would be worth US$ 37 billion annually (Fearnside, 1997b). The magnitude and value of these services are poorly quantified, and the diplomatic and other steps through which such services might be compensated are also in their infancy. These facts do not diminish the importance of the services nor of focusing effort on providing both the information and the political will needed to integrate these into the rest of the human economy in such a way that economic forces act to maintain rather than to destroy the forest.

On many fronts, one of the major challenges to finding rational uses for Amazonian forest lies in gathering and interpreting relevant information. Making environmental services of the forest into a basis for sustainable development is, perhaps, the area where information is most critical. Providing better understanding of the dynamics of deforestation, as well as understanding of deforestation's impacts on biodiversity, carbon storage and water cycling, is a necessary starting point on the long road to turning environmental services into a basis for sustainable development in Amazonia.

The term "development" implies a change, usually presumed to be in the direction of improvement. What is developed and whom the improvement should benefit are items of widely differing opinions. This author holds that, in order to be considered "development," the change in question must provide a means to sustain the local population. Infrastructure that does not lead to production is not development, nor is a project that exports commodities from the region while generating minimal employment or other local returns. Aluminum processing and export provides the best example.

Production of traditional commodities often fails to benefit the local population. Conversion of forest to cattle pasture, the most widespread land-use change in Brazilian Amazonia, brings benefits that are extremely meager (although not quite zero). High priority must be given to redirection of development to activities with local-level returns that are greater and longer lasting. Tapping the value of environmental services offers such an opportunity. Keeping benefits of these services for the inhabitants of the Amazonian interior is the most important challenge in turning these services into development.

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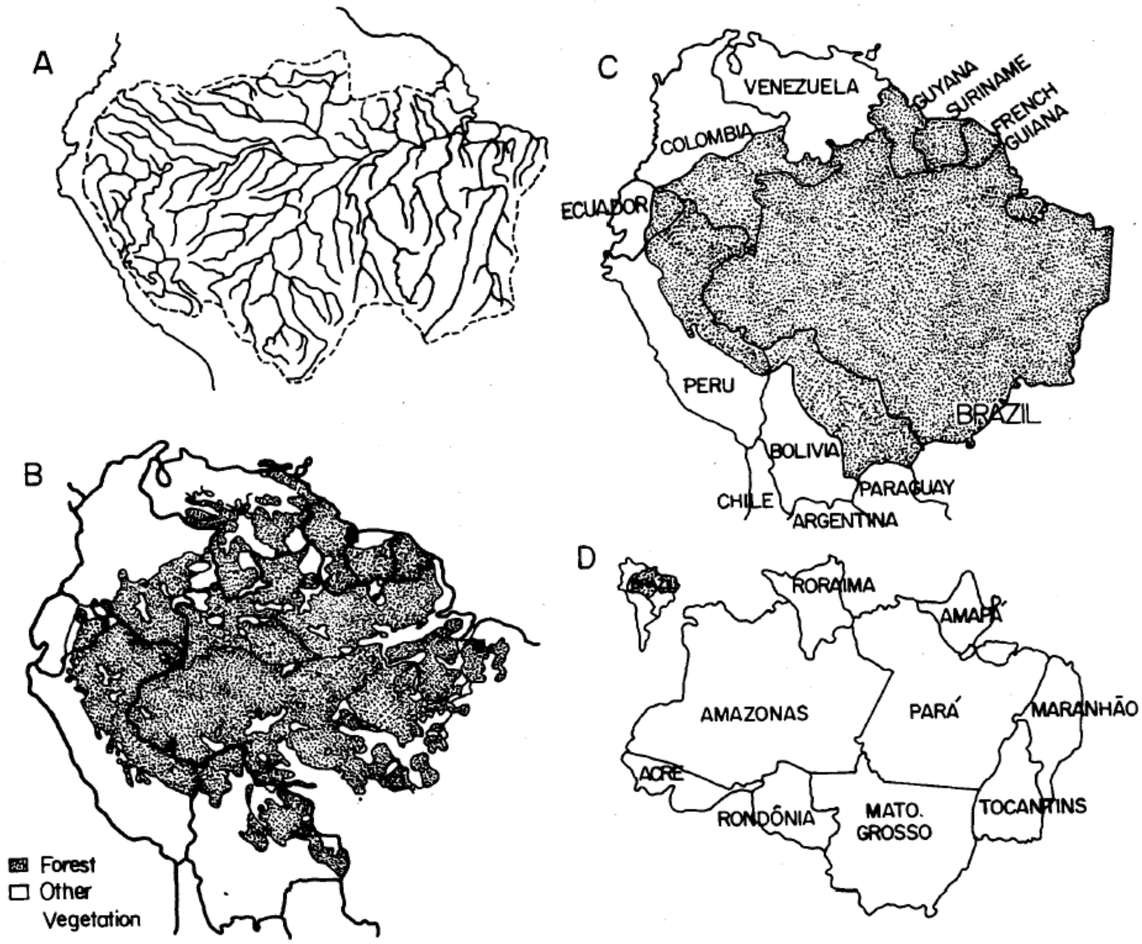
FIGURE LEGENDS

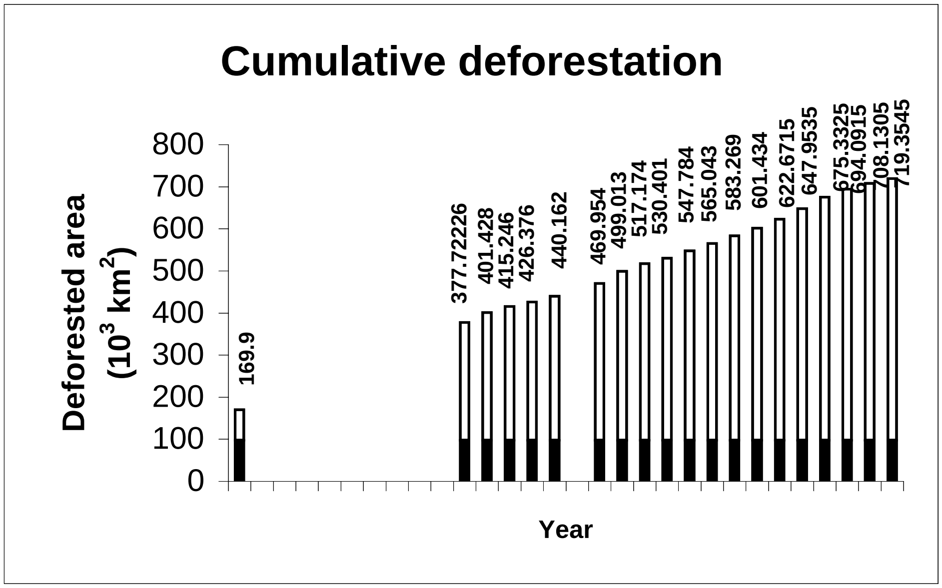
Figure 1 -- Amazon River drainage basin (including the Tocantins/Araguaia and Amapá coastal rivers), the “greater Amazon” and Brazil's Legal Amazon region with state boundaries.

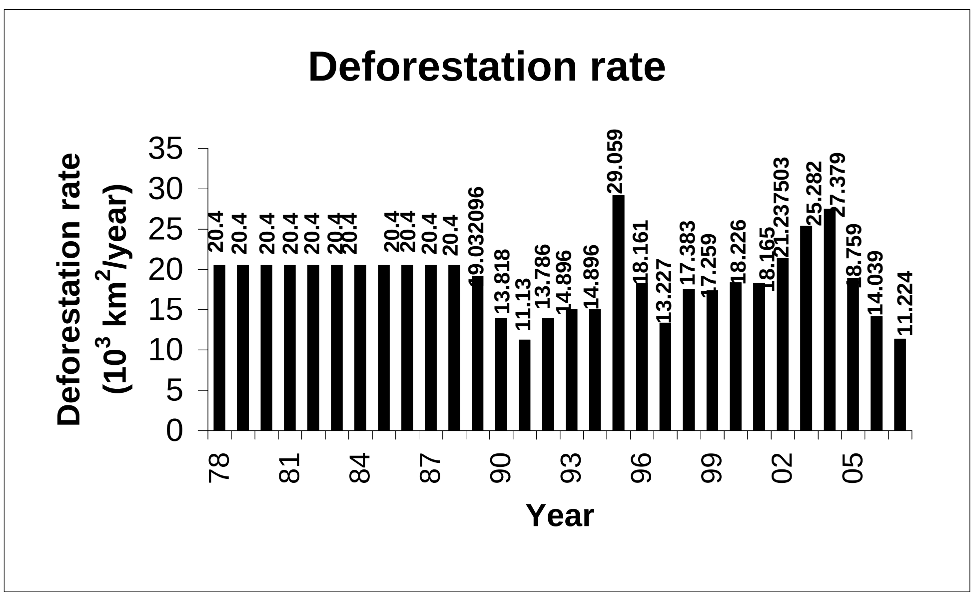
Figure 2 -- Extent and rate of deforestation in the Brazilian Legal Amazon. "Old" deforestation refers to pre-1970 clearing in Pará and Maranhão.

Fig. 1



A
B
Forest
Other
Vegetation
C
VENEZUELA
GUYANA
SURINAME
FRENCH
GUIANA
COLOMBIA
ECUADOR
PERU
BRAZIL
BOLIVIA
CHILE
PARAGUAY
ARGENTINA
D
RORAIMA
AMAPÁ
AMAZONAS
PARÁ
MARANHÃO
ACRE
RONDÔNIA
MATO.
GROSSO
TOCANTINS


Cumulative deforestation
Deforested area
(10^3 km^2)
800
700
600
500
400
300
200
100
0
169.9
377.72226
401.428
415.246
426.376
440.162
469.954
499.013
517.174
530.401
547.784
565.043
583.269
601.434
622.6715
647.9535
675.3325
694.0915
708.1305
719.3545
Year


Deforestation rate
Deforestation rate
(10^3 km^2/year)
35
30
25
20
15
10
5
0
20.4
20.4
20.4
20.4
20.4
20.4
20.4
20.4
20.4
20.4
20.4
19.032096
13.818
11.13
13.786
14.896
14.896
29.059
18.161
13.227
17.383
17.259
18.226
18.165
21.237503
25.282
27.379
18.759
14.039
11.224
78
81
84
87
90
93
96
99
02
05
Year