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DISCUSSION PAPER

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THE ECONOMICS OF BIODIVERSITY IN BRAZIL: THE CASE OF FOREST CONVERSION

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SUMÁRIO

RESUMO

A economia da biodiversidade neste texto será analisada como os fatores indutores ao desmatamento no Brasil que ameaçam os recursos da biodiversidade e, portanto, o principal objeto de análise será o padrão de uso dos recursos florestais no país. Alguns destes fatores somente poderão ser removidos caso ajustes estruturais na economia ocorram para corrigir as desigualdades de renda, a concentração fundiária e a fragilidade institucional das agências ambientais. Entretanto, conforme será discutido, o uso de instrumentos econômicos na gestão ambiental poderá mitigar estes fatores indutores e alterar a tendência ao desmatamento e as perdas de biodiversidade.

ABSTRACT

This paper focuses on the role of economic factors inducing deforestation in Brazil and thereby threatening biodiversity, giving particular attention to the exploitation pattern of forest resources in Brazil. Some economic factors cannot be easily reverted since reversion would require long-term structural adjustments to alleviate social inequalities, to accomplish a satisfactory land tenure reform and to solve renumeration issues inhibiting human resource enhancement in governmental agencies. However, there is still room to introduce economic incentives in order to mitigate the current trend towards deforestation and biodiversity losses.

1 - INTRODUCTION

One may define biodiversity at three levels: genetic diversity, species diversity and ecosystem diversity.[1] In the case of Brazil, diversity at each of these levels is extremely important and rich (see Box 1). Consequently, Brazil's environmental legislation has established numerous legal norms and rules restricting land use in forests, fragile areas of water catchment, estuaries, dunes and so on. In addition, strict controls on hunting, fishing and capture of endangered species are in place. A ban on further clearing of the remaining Atlantic Forest, the most altered forest ecosystem, was recently established. Moreover, logging activities and other wood-based activities may only be licensed if they comply with reforestation plans supplying wood consumption equivalents. Conservation units, first established by the Forest Code of 1930, correspond today to almost 18% of national territory if indian reserves are counted. Recently, the Environment Ministry created a national programme to support research and information dissemination (see Box 2).

However, legal instruments to protect biodiversity have not been sufficient to counteract the economic dynamics of forest conversion and water pollution.[2] The health of aquatic fauna and flora is a significant concern in light of water pollution levels from household, industrial and agricultural sources [see Seroa da Motta (1996 and 1995)], but water pollution control policies can be ineffective if forests are being quickly cleared. Therefore, we will here consider deforestation issues to be the main contributing factor to biodiversity losses in Brazil. The paper will focus on the role of economic factors inducing deforestation -- thereby threatening biodiversity -- and the exploitation pattern of Brazil's forest resources.

Deforestation in Brazil is caused mainly by agricultural and logging activities. Expansion of these activities into open access areas has been very active despite legal restrictions and enforcement actions. Apart from institutional limitations preventing effective enforcement of norms and rules, deforestation of important ecosystems is also a result of several economic factors, namely:

(i) A highly concentrated land tenure system where small farms (with less than 10 hectares (ha)) cover less than 3% of the total farming area while the share of big farms (with more than 10,000 ha) is above 40%. Additionally, very low average productivity levels per unit of area under this system of land concentration creates incentives for continuous forest clearance.

(ii) A high concentration of personal income, with 66.1% of total income accruing to the top 20% of wage-earning families, while just 2.3% accrues to the lowest 20 percent.[3] Such inequality creates an immense surplus of low-income workers ready to seek occupations in frontier areas.

[1]See Biodiversity Unit (1995) for a discussion on this taxonomy.
[2]Due to lack of data, overfishing and poaching, which are also important causes of biodiversity losses in Brazil, will not be discussed in this paper.
[3]See Bonelli and Ramos (1993).

(iii) A credit and fiscal system that favors agricultural activities that have no regard for soil agroecological features or managerial practices, resulting in an inappropriate replication of agricultural technologies in areas with distinct ecological conditions.

(iv) Land reclamation and taxation rules based on land use (e.g., area allocated to farming) which encourage and legalise clearing.

(v) High wood values in frontier areas which give logging activities an important role in financing clearing and in taking advantage of legal licensing for clearing[4].

(vi) Regional development programmes in frontier areas based on road construction which, although mostly phased out, has contributed immensely to stimulating economic activities and promoting migration flows.

Some of these factors cannot be easily reverted since reversion would require long-term structural adjustments to alleviate social inequalities, to accomplish a satisfactory land reform and to solve remuneration issues inhibiting human resources enhancement in governmental agencies. However, as will later be discussed, efforts to change economic incentives still have a significant role to play in mitigating the current trend towards deforestation and biodiversity losses.

The next section presents specific indicators of deforestation in three important forest ecosystems in Brazil, namely the Atlantic Forest, Cerrados and the Amazonian Forest. Sections 3 and 4 discuss the role of agricultural and logging activities in deforestation in Brazil. Section 5 presents very crude and limited estimates of forest user costs. Section 6 describes and analyses three existing market-based instruments applied in Brazil to promote biodiversity preservation. The final section makes a number of recommendations for economic incentives for biodiversity protection, from changes in the assignment of property rights for forest exploitation to credit incentive criteria for agricultural activities.

[4] See Seroa da Motta (1993) for a detailed discussion of the Forest Code in Brazil.

BOX 1 - Biodiversity in Brazil

Occupying a total area of 8,511,996 km^2 between 5°16'N and 33°44'S, Brazil has a broad climatic and geomorphologic variety. This variety is responsible for the presence of several important biomes and ecosystems, which lodge about 10% to 20% of the world's known living species. Among them, a large number is unique to Brazil, and many probably remain yet undescribed. It has been estimated that about 2 million plant, animal and microorganism species exist in Brazil.

The most important biomes in Brazil are the Amazonian rainforest and deciduous forests in the north, the eastern coast moist forest (known as Mata Atlântica), the savannah areas (Cerrado) in the center, the thorn forest (Caatinga scrubs) in the northeast and north, the Pantanal wetlands in the mid-west and the pine forests and the Pampa fields in the south. Also deserving attention are the wet riparian forest in north-western Amazonia (Campinarana), the coastal mangroves, sand dunes and salt marshes, all transition zones and many small areas where special combinations of climate, altitude and soil background produce singular ecosystems. Some of these great biomes were heavily damaged by human activities, such as the Mata Atlântica and the southern pine forests. Today, the agriculture frontier advances over large Cerrado areas in central Brazil and over some areas in Amazonia, especially in the Rondônia and Pará states.

According to the Brazilian Fund for Biodiversity (FUNBIO), Brazilian flora comprises about 55,000 described species, a number that representing 22% of world's total (FUNBIO, 1995). Brazil has the richest palm (approximately 390 species) and orchid (2,300 species) flora. Brazilian fauna is also very diverse, totalling nearly 6,000 vertebrate species. Among them, over 3,000 fish, 1,573 bird, 502 amphibian, 468 reptile and 394 mammal species have been described. These figures correspond to about 17% of total bird species and to 10% of all known amphibians and mammals. Brazilian invertebrate fauna are also among the world's most diverse, and the identification process is still in course.

Some native Brazilian species already have economic significance, such as many hardwood trees, the rubber tree, brazilian nuts, manioc and cashew. Pharmacological use of Brazilian species is growing steadily, and its economic potential is limitless. About 40% of Brazilian GNP comes from agroindustries, 4% from forestry and 1% from fisheries. Biodiversity activities, such as fishing and forest extractive activities employ more than 3 million people, and 17% of energy production nationwide comes from sugarcane alcohol and fuelwood. However, Brazilian agriculture relies mostly on exotic species, such as coffee, soybean, orange and sugarcane. About 31% of Brazilian exports come from these products. Almost all cattle bred in the country consists of bovine cattle and poultry that are not native species and that feed (in the case of cattle) on African grasses. Even silviculture relies mostly on foreign eucalyptus and pines.

The potential of Brazilian biodiversity remains almost untapped due to the lack of basic research and the prevailing production system that hampers alternative uses for species. Currently, a significant effort is being made on research to unveil new uses of biodiversity products in the country. There are in Brazil more than 300 M.Sc. and 150 Ph.D. level courses on biologically-related issues. In addition, the world's greatest tropical conservation units are located in Brazil, including the most complete tropical germoplasm bank.

2 - DEFORESTATION

This section presents some indicators reflecting the degree of deforestation in the main ecosystems in Brazil. The analysis will be focused on the Atlantic Forests, the Amazonian Forests and Cerrados, where data is available due to the ecological and economic importance of these areas. Not only do they have the richest biodiversity, but they also occupy economically dynamic regions of the country.[5]

[5]The Caatinga is also rich in biodiversity and plays an important role in the climatic conditions in the semi-arid northeastern regions of Brazil.

2.1 - Atlantic Forest[6]

As can be seen in Table 1, considering the country as a whole, the area now covered by Atlantic Forest vegetation is only about 8% of the total original area. The Atlantic Forests are, by far, the most threatened ecosystem in Brazil. This alarming situation sparked the introduction of a 1990 law forbidding any kind of activity which may lead to deforestation in areas covered with this vegetation. In addition, major efforts are being made to create and implement conservation units in the remaining areas to preserve the biodiversity values of this ecosystem.

The regional distribution of the Atlantic Forest shown in Table 1, predominant in the southern states, coincides with the regional development pattern which historically was characterized by agricultural and industrial development. Forest conversion has been a result of economic expansion, particularly in the last fifty years.

Table 1
Atlantic Forest Original and Remaining Areas — 1990 (Ha)

States	Original Forest Area	Remaining Forest Area	
	ha	ha	%
Bahia	11 575 425	1 267 478	11.0
Espírito Santo	4 000 000	402 392	10.1
Minas Gerais	30 356 792	876 504	2.9
Paraná	16 782 400	1 503 098	7.6
Rio de Janeiro	4 294 000	896 234	20.9
Santa Catarina	9 571 647	1 527 794	16.0
São Paulo	20 450 000	1 731 472	8.5
Rio Grande do Sul	11 202 705	656 717	4.0
Total	108 232 969	8 861 689	8.2

Sources: SOS Mata Atlântica (1993) and May & Rocha (1995).

In the last twenty years, the expansion of the agricultural frontier also took place, following the same development model adopted in the southern regions, in the central and northern regions of the country where the Cerrados and the Amazonian Forests are located, respectively. That expansion resulted in large areas of forest conversion. This was due first to the highly concentrated income and land tenure distribution existing in the country, which encouraged migration. Second, and not less important, occupation of these regions was determined by ambitious regional development programmes.

[6]See SOS Mata Atlântica (1993) and May and Rocha (1995) for details on this deforestation process.

2.2 - Cerrados

The occupation of Cerrados by agricultural activities is very manifest. According to data from the latest agricultural census (1985), an area of 50.7 million ha had been converted to cropping and livestock. More recent projections from the World Wildlife Fund indicate that almost 40% of the original Cerrados area, or approximately 70 million ha, has already been converted, reflecting an annual deforestation rate of 0.77% in the period 1985-94 (WWF, 1994). To give this agricultural occupation a more tangible dimension, the total area that had been converted in Cerrados prior to 1985 was already bigger than the territory of Spain.

The massive conversion in such a short period can be explained mainly by the favourable credit system offered to the agricultural sector in the region where rural southern families migrated to avoid the increasing land prices exacerbated by concentrated land tenure in their original regions. Since transport costs are high in this remote area, the region has intensified its activities to cash crops and cattle raising. The quality of soil in the region has demanded highly intense chemical input practices, producing obvious threats to biodiversity.

2.3 - Amazonian Forests [7]

Economic activities in the Amazonian region were mostly undertaken in cycles due to fluctuation of external demand for commodities of the region, installation of colonisation settlements and governmental development programmes and policies.

Prior to the invention of rubber vulcanisation in 1839 and its subsequent worldwide commercialisation, exploitation of the region only involved some extractive goods and sparse agricultural activities such as cocoa plantations. After the emergence of vulcanisation, rubber extraction became the main activity until its decline after World War I with the expansion of Asian production. During this period, Japanese immigrants in the states of Pará and Amazonas introduced jute and spice cultivation. The rubber cycle in the region was also responsible for Henry Ford's initiative creating rubber plantation activities in the region from 1927 to 1945 to supply the American market. With the launching of "Operation Amazonia" in 1966, livestock activities were encouraged in the region by governmental policies, though without significant impact on forest occupation. Following Henry Ford's example, another agroforestry complex was established in the Jari River basin in the state of Pará. For economic reasons, this project was transferred to Brazilian owners in 1982 with government financing.

However, it was only during the 1970s that the federal government began ambitious programmes of roads, mineral poles, colonisation and fiscal incentives for crop and livestock activities which greatly diversified the region's production and generated a process of rapid urbanization with significant migration flows from the southern parts of the country. Discoveries of large mineral deposits created the conditions conducive to the arrival of thousands of mineral prospectors.[8] All of these actions in the region

[7] See Seroa da Motta (1993) for a complete review of past and current issues in Amazonian deforestation.
[8] It is estimated that around six hundred thousand mineral prospectors are living in the region today.

caused a rapid deforestation process which consequently also affected the local communities such as the indians and those pursuing extractive activities.

While the positive economic and distributive results of this occupation are unclear, the result in terms of deforested area is pronounced. Deforestation in Amazonia cannot be measured on the basis of remaining area because it is a recent frontier region with an area four times bigger than the original Atlantic Forests. In fact, the actual Amazonian Region covers almost 50% of the country area. Table 2 presents deforestation rates for Amazonia. As can be seen in this table, when recent occupation was its the peak in 1978-89, annual deforestation was occurring at a rate of 0.54% or an equivalent area of 21,000 ha. At this rate, the region would have been totally deforested in 130 years.

In the late 1980s, the deforestation rate declined to 0.30% or less than 11,000 ha per year. Economic recession and the consequent lack of public and private resources to maintain the costly development programmes, along with increasing monitoring forced by external pressure, can explain the decreasing deforestation rates. The downward trend was reversed again during the 1990s, when the deforestation rate increased to 0.40% (almost 15,000 ha per year) in the period 1992-94. This reversal occurred mainly in frontier states and may be explained by favourable agricultural credit and pricing policies and the federal environmental protection agency's (IBAMA) budget cuts arising from macroeconomic stabilisation programmes.

Table 2

Annual Rate of Gross Deforestation in Legal Amazonia

STATES/AREA	78/89		88/89		89/90		90/91	
	Km²/year	%/year	Km²/year	%/year	Km²/year	%/year	Km²/year	%/year
Acre	620	0.42	540	0.39	550	0.39	380	0.28
Amapá	60	0.06	130	0.12	250	0.23	410	0.37
Amazonas	1 510	0.10	1 180	0.08	520	0.04	980	0.07
Maranhão	2 450	1.79	1 420	1.30	1 100	1.03	670	0.63
Mato Grosso	5 140	1.01	5 960	1.31	1 020	0.90	2 840	0.64
Pará	6 990	0.62	5 750	0.55	4 890	0.47	3 780	0.37
Rondônia	2 340	1.11	1 430	0.78	1 670	0.91	1 110	0.62
Roraima	290	0.18	630	0.39	150	0.10	420	0.27
Tocantins	1 650	2.97	730	2.00	580	1.61	440	1.26
Legal Amazônia	21 130	0.54	17 860	0.48	13 810	0.37	11 130	0.30

Source: INPE (1996).

Although the total deforested area prior to 1992 is no more than 10% of the total original area (see INPE (1996)), this deforested area turns out to be approximately equivalent to the size of the United Kingdom.

BOX 2 - Recent Governmental Initiatives on Biodiversity Protection in Brazil

Biodiversity issues have been the subject of very important governmental actions which can be seen as necessary steps toward more comprehensive policies in which economic incentives may be introduced. Their successful implementation will depend, however, on political will and institutional capability. The most recent actions are the following:

- UNCED Biodiversity Convention was approved by the Brazilian Congress in February 1994.
- In December 1994, a Presidential Decree established the Brazilian Biological Diversity Programme (PRONABIO) which aims to promote joint actions between governmental agencies and civil society in order to stimulate research (including inventories), international cooperation and dissemination activities on biodiversity issues and problems (including a national network). In the Programme's Steering Committee, half of the twelve seats are allocated to non-governmental representatives. So far, PRONABIO has two funding mechanisms. FUNBIO (The Brazilian Fund for Biodiversity), mainly devoted to private actions, is funded with US $20 million from the Global Environment Facility (GEF) and run by a committee composed of businessmen, scientists, NGOs and environmental agencies. The other fund is PROBIO (Pro-Biodiversity), which also has US $20 million, is coordinated by CNPq (The National Research Council), and focuses primarily on research activities.
- An economic and ecological diagnosis of Amazonia was recently released, the indicators from which will be used as a zoning tool for activity licensing and policy orientation.

Very recently, in August 1996, the Environment Ministry sent a bill to the National Congress to limit the legal area for agricultural clearing in the Amazonian Forest to only 20% of farming area. In addition, the bill bans the exporting of mogno and virola woods for a period of two years. The bill has been facing strong opposition from small landowners in the region arguing that the bill induces land concentration, and from large landowners arguing that it creates a barrier for profitable farming. Wood exporters also claim that it will lead to severe losses. While it is very early to predict the result of this political dispute, these measures can be seen as the first steps toward reorienting forest exploitation to non-agricultural activities and sustainable logging. The future trend of deforestation in this region will depend mainly on political and economic conditions which at this point favor the diminution of factors inducing deforestation. A radical change in land property rights assignment and the introduction of economic incentives for sustainable activities, as will be later discussed, can play an important role in slowing the deforestation process.

3 - AGRICULTURAL EXPANSION

As has been discussed, agricultural expansion is a very important factor in forest conversion in Brazil. Apart from the application of sustainable practices in agricultural activities, one effective way to mitigate biodiversity losses and rationalise forest conversion is to induce agricultural expansion according to the agroecological features of soils. That is, expansion should be directed toward areas where soils are more appropriate to cropping and livestock, and where ecosystems will be less affected.

In doing so, agricultural activities can attain higher levels of productivity with lower intensity of chemical inputs and soil losses, thereby reducing expansion over virgin forests. As will be further discussed, this does not seem to be the agricultural pattern of soil use in Brazil.

A study on agroecological features of Brazilian soils was carried out by EMBRAPA (1991)[9] in which areas are classified according to their appropriate uses, such as cropping, livestock and extractive activities/preservation[10]. The main criteria to define these features were (i) ecosystem fragility and (ii) investments required to pursue agricultural activities. The ecosystem fragility concept adopted by EMBRAPA (1991) is somewhat vague in terms of biodiversity, although it intends to capture ecosystem uniqueness and singularity and resilience to anthropic actions.

Table 3 presents areas in each region of Brazil according to the appropriate agroecological soil uses indicated in EMBRAPA (1991), the current uses of soil and differences between appropriate and current uses. Cropping and livestock uses were estimated from areas identified in the latest agricultural census (1985), including all productive areas. Extractive activities/preservation current uses were defined in the study as areas officially devoted to conservation units, indian reserves and private forests within farms.

The differences between appropriate and current uses in Table 3 offer a good indication of the sustainability of agricultural expansion in Brazil and its impacts on ecosystems. First, it can be seen that the area occupied by livestock activities, in the country as a whole, exceeds by about 800,000 km² the area suitable for them. More than 90% of this excess activity takes place in the North and Central Regions where most recent deforestation is occurring. That is, except in the Northeast Region, cattle raising is occupying inappropriate areas and, therefore, is responsible for the conversion of fragile ecosystems either through livestock expansion itself or by pushing cropping towards inappropriate areas.

An impressive area suitable for crops of about 1.6 million km² for the country as a whole is still available. It is important to note that appropriate areas available for cropping in southern regions are twice as big as in the North Region. That is, if agroecological features are taken into account, the current expansion of agricultural activities towards Amazonia cannot be recommended.

BOX 3 - Soil Erosion Costs in Brazil

Soil protection is one important ecosystem service with a sensitive market value. Due to Brazil's continental size and variety of soil, soil erosion costs cannot be easily estimated on a national basis. For different regions, physical soil loss estimates have varied from 9.5 to 179 tons per ha. The most recent and lowest estimate was presented in Cavalcanti (1995) corresponding to 6.77 ton/ha for the São Francisco River Basin. This region is characterized by very diversified agricultural activity, including irrigated and subsistence cropping and extensive areas of pasture. The same study calculated that the estimated Sao Francisco River Basin soil losses would be equivalent to US $32.16 in nutrient losses, i.e., the cost of nutrient reposition per hectare. Since this estimate is a lower-limit and the region somewhat reflects the Brazilian agricultural profile, multiplying the national agricultural area by this estimate and deducting it from the current farming fertiliser expenditure will allow one to arrive at a conservative and impressive national value for total soil erosion cost of US $5.9 billion or 14% of the national agricultural product.

[9]EMBRAPA is a state-owned company undertaking agricultural research.
[10]In fact, the classification is broader, but the categories have been aggregated here to allow for calculations.

Tabela 3 no arquivo Td0433t

Table 3
SOIL USE PATTERN IN BRAZIL

SOIL AVAILABILITY	***BRAZIL***		***NORTH***		***NORTHEAST***		***CENTRAL***		***SOUTHEAST***		***SOUTH***	
BY AGROECOLOGICAL FEATURES	***km²***	***%***	***km²***	***%***	***km²***	***%***	***km²***	***%***	***km²***	***%***	***km²***	***%***
Cropping	2 509 072	29.48	314 987	8.71	271 335	17.44	1 093 553	58.42	460 154	50.39	369 043	66.80
Livestock	996 649	11.71	68 958	1.91	407 610	26.20		0.00	389 209	42.62	130 872	23.69
Preservation	2 632 189	30.92	1 136 958	31.42	665 954	42.80	712 876	38.08	63 843	6.99	52 558	9.51
Extractive activities	2 374 030	27.89	2 097 437	57.97	211 051	13.56	65 542	3.50		0.00		0.00
Total	8 511 940	100.00	3 618 340	100.00	1 555 950	100.00	1 871 971	100.00	913 206	100.00	552 473	100.00
CURRENT SOIL USES												
Cropping *	873 296	17.22	93 531	4.99	327 227	35.59	120 735	11.03	161 762	22.63	170 041	36.30
Livestock	1 791 884	35.34	208 764	11.15	351 481	38.23	592 441	54.12	424 874	59.43	214 323	45.75
Conservation Units	484 570	9.56	404 026	21.57	20 707	2.25	26 087	2.38	21 346	2.99	12 405	2.65
Indian Reserves	1 030 634	20.33	869 153	46.41	20 648	2.25	138 143	12.62	793	0.11	1 897	0.41
Private Forests	889 836	17.55	297 303	15.87	199 254	21.67	217 350	19.85	106 173	14.85	69 756	14.89
Total	5 070 221	100.00	1 872 777	100.00	919 318	100.00	1 094 756	100.00	714 948	100.00	468 422	100.00
DIFFERENCE BETWEEN SOIL AVAILABILITY AND CURRENT USES												
Cropping	1 635 776	19.22	221 456	6.12	-55 892	-3.59	972 818	51.97	298 392	32.68	199 002	36.02
Livestock	-795 235	-9.34	-139 806	-3.86	56 129	3.61	-592 441	-31.65	-35 665	-3.91	-83 451	-15.11
Extractive activities **	2 601 178	30.56	1 663 913	45.99	636 396	40.90	396 838	21.20	-64 469	-7.06	-31 500	-5.70
Total	3 441 719	40.43	1 745 563	48.24	636 632	40.92	777 215	41.52	198 258	21.71	84 051	15.21

*Including all productive areas.
**Including conservation units, indian reserves and privates forests.
Source: EMBRAPA (1991), 1985 IBGE (Brazilian Institute of Geography and Statistics) Agricultural Census and IBGE (1994).

Table 5
Round Wood Production in Brazil - 1980-1990/91

Region	Native Forests (% total Brazil)					Planted Forests (% total Brazil)					TOTAL				
	1980		1990/91*		Variation**	1980		1990/91*		Variation**	1980		1990/91*		Variation**
	1000m³	%	1000m³	%	%	1000m³	%	1000m³	%	%	1000m³	%	1000m³	%	%
North	19 880	9.2	54 312	22.5	173.2	1 392	2.4	1 586	2.1	13.9	21 272	7.8	55 898	17.6	162.8
Northeast	74 496	34.6	73 872	30.7	-0.8	n.a.	n.a.	1 498	2.0	n.a.	74 496	27.2	75 370	23.8	1.2
Central	21 631	10.0	23 472	9.7	8.5	353	0.6	4 401	5.8	1146.7	21 984	8.0	27 873	8.8	26.8
Southeast	64 665	30.0	63 217	26.2	-2.2	48 510	82.8	44 000	58.0	-9.3	113 175	41.3	107 217	33.8	-5.3
South	34 804	16.2	26 095	10.8	-25.0	8 346	14.2	24 428	32.2	192.7	43 150	15.7	50 523	15.9	17.1
Brazil - Total	215 476	100.0	240 968	100.0	11.8	58 601	100.0	75 913	100.0	29.5	274 077	100.0	316 881	100.0	15.6

Source: Prado (1995).
(n.a.) = not available
* Average value of 1990/91. ** Variation between 1990/91 and 1980 values.

The huge surplus in appropriate areas for cropping in the Central Region becomes relatively less impressive if one considers the large deficit of appropriate areas for livestock. Results from Table 3 also show the complete lack of protected areas when extractive activities/preservation uses are compared. While in southern regions conservation units and private forests are already matching their agroecological areas, in the rest of the country a great proportion of land deemed appropriate for extractive activities and preservation is used for other purposes. In the case of the North Region and Cerrados, less than 50 percent of the areas recommended for conservation and extractive activities are already under conservation, whereas in the Northeast Region this percentage drops to less than 28 percent.

In summary, agricultural expansion in Brazil needs to be reoriented in terms of spatial dimension to reflect soil suitability if ecosystems in Brazil are to be preserved.

4 - LOGGING EXPANSION

The importance of logging expansion in the deforestation process can be shown in Table 4 where estimates of effective and potential wood commercial production from agricultural cleared areas[11] in the Amazonian region are presented for the period 1975-91 based on Prado (1995). Effective extraction refers to the wood output currently generated, while potential production is an estimate of the wood output which could be generated. The ratio of these two output values provides a good indicator of how much wood extraction is taking place through clearing for agricultural purposes.

Table 4
Potential and Effective Wood Extraction in the North Region of Brazil - 1975-1991

Time Period	Converted Forest Area (ha/year)	(A) Potential Wood Extraction from Converted Area (1000 m³)	(B) Effective Wood Extraction (1000m³)	B/A
1975/78	1 619 300	32 386	4064	0.13
1978/80	2 323 550	46 471	11476	0.25
1980/88	5 940 987	118 820	19539	0.16
1989/91	2 064 600	41 292	39087	0.95

Source: Prado (1995).

[11]"Cleared areas" refers to those observed during in the period, and includes legal and illegal clearing.

From Table 4 one may note that ratio values increased from 13 % in 1975 to 95% in 1991. That is, wood extraction is currently associated with clearing for agricultural purposes. Wood extraction output finances clearing, and legal licenses for agricultural clearing legalise wood extraction. This synergy generates private economic value to deforested lands much higher than the value that could be derived either from preservation activities or sustainable agroforestry. For instance, field surveys in traditional Amazonian logging areas presented in Almeida and Uhl (1995) estimated financial rates of return higher than 300% for wood extraction and processing activities for logging undertaken in rent lands (i.e., land for agricultural clearing). When supplies of wood come from sustainable logging undertaken in lands only devoted to logging (and not to clearing), rates of return drop to approximately 20%. Saw mills can thus count on low-cost legal and illegal supplies of wood, allowing for a very profitable financial return with which sustainable logging cannot compete.

This association was also previously observed in the Atlantic Forest. In fact, logging activities in Brazil are still mostly relying on native forests from which more than 75% of Brazil's round wood is produced. As can be seen in Table 5, the share in the national wood production coming from Amazonian wood production (North Region) increased from 9.2% in 1980 to 23.1% in 1991. This impressive share increase clearly reveals the growing importance of Amazonian wood species in logging activities.

Tabela 5 no arquivo Td0433t

5 - USER COSTS OF FOREST RESOURCES

It has not yet been possible to make accurate estimates of biodiversity values in Brazil. In fact, it was only very recently that government actions were taken to determine the precise economic dimension of ecosystem services, biological resources and social benefits arising from biodiversity in the country[12] in order to guide biodiversity policies and generate indicators for project evaluation.

Seroa da Motta (1994) and May (1993) present crude estimates of extractive output foregone due to forest conversion in terms of commercial product values which could have been generated on a sustainable basis if clearing had not occurred. The cost stream was measured as sustainable production of wood and extractive products foregone in each cleared hectare of converted forest according to each major Brazilian ecosystem. Deforestation generates a lump-sum value in, say, wood, but it foregoes a sustainable flow of wood production which would take place if vegetation were preserved. This sustainable flow was calculated based on the forest's natural vegetative growth and valued at extractive product and wood export prices.

Table 6 presents these estimates for the period 1971-85. Percentage values reflect the output foregone as a proportion of agricultural value added per converted hectare. The annual differences follow this rule: the higher the ratio between total converted area to total remaining area in each ecosystem, the higher is the proportion of user cost to value added.

Table 6
Output Foregone Values of Extractive Forest Resources in Brazil due to Deforestation - 1971-85 (US$000)

Years	Wood Product (1)	Non-Wood Products (2)	Total (1)+(2)	% of Converted Land Value Added
1971	137 984	38 250	174 233	128.2
1972	150 468	n.a.	150 468	97.1
1973	192 622	52 933	244 955	140.8
1974	316 127	52 309	368 436	190.9
1975	400 987	56 878	459 665	183.9
1976	399 021	40 780	439 401	146.3
1977	425 469	39 041	463 510	136.4
1978	364 806	41 262	406 089	114.7
1979	348 760	48 805	397 567	108.0
1980	286 808	38 172	324 981	104.5
1981	232 051	26 679	258 730	103.7
1982	167 324	32 518	199 835	113.7
1983	161 552	35 741	197 293	108.2
1984	154 929	38 992	193 731	102.6
1985	93 592	25 617	119 610	61.2

Sources: Based on estimates from Seroa da Motta (1994) and May (1993).
Notes: (1) Round wood.
(2) Extractive products: latex, chestnut, babaçu, palm cabbage and carnauba.

[12] As a first step, the author's institute (IPEA) has been recently assigned to elaborate guidelines on these evaluation issues.

Proportions of user cost to value added were thus far above 100% during the 1970s when deforestation of Atlantic Forests and Cerrados was intense, substantially reducing the original areas. From 1980 onwards deforestation was concentrated in the Amazonian Forest but did not significantly reduce the original forest areas; hence the sharp decline in user cost proportion, which reached approximately 61% in 1985. Due to lack of data on agricultural expansion it was not possible to calculate current values from 1985 afterwards. In light of the already discussed increase in deforestation in the Amazonian Forest region, it is reasonable to assume that user cost proportion values will tend to be much higher in the 1990s.[13]

In summary, biodiversity commercial values in Brazil are impressive when compared to agricultural alternative land-uses. Taking into account other biodiversity benefits, one could estimate still higher values. However, such estimates would need to be refined and further explored.

6 - MARKET-BASED INCENTIVES FOR PRESERVATION IN BRAZIL[14]

Three important economic instruments have been applied in Brazil in order to control deforestation. Two of them are basically forestry taxes and the other is fiscal compensation. In the case of frontier areas such as Amazonia and Cerrados, the application of taxes is very difficult to enforce due to their immense territory, lack of infrastructure and low population density. Therefore, one may expect that such instruments can play only a limited role in creating market-based mechanisms for biodiversity control, but can also be a very powerful means of raising revenue to strengthen institutional capacity. Fiscal compensation, on the other hand, involves of very low administrative costs and creates an actual incentive for those engaged in preservation measures. A very brief description of these existing instruments in Brazil will be presented including some recommendations for their revision.

6.1 - Forestry Taxes

6.1.1 - The National Forestry Reposition Fund

The Brazilian Forestry Code states that those exploiting or utilising forestry raw materials are obliged to undertake forestry reposition of appropriate species equivalent to the exploiter's consumption level. This requirement covers logging as well as consumption of charcoal and firewood with unknown origin. Since 1978, however, a federal norm[15] allows for those consuming less than 12,000 m^3 of forest raw material per year the option of paying a deforestation contribution instead of investing in reforestation. The rationale for this contribution is based on the assumption that reforestation by small consumers is costly to monitor and also to undertake (i.e., there are no benefits from economies of scale). A governmental fund created from

[13]In Seroa da Motta (1994) and May (1993) the values in Table 6 were discounted according to depletion periods in which forests would be completely deforested. These estimates reflected user cost values as proposed by El Serafy (see Seroa da Motta (1994)). Since user costs are low when resources are abundant, and in light of the large portion of the Amazonian Forest that is still remaining, the user cost values were only around of 2-3% of converted land value added.
[14]This section is based on Seroa da Motta and Reis (1994).
[15]This norm was created by the former Brazilian Institute for Forestry Development which is today part of the federal EPA (IBAMA).

deforestation contributions, on the other hand, would generate enough revenue to implement a more efficient forest reposition, taking into account social and political concerns.

The contribution, which may be regarded as a type of tax, was not primarily conceived as an economic incentive to curb deforestation and, in fact, did not work out as such.

Apart from the institutional limitations of IBAMA (The Brazilian Federal Environmental Agency) to carry out an effective collection of that contribution, which is legally under its responsibility, the level of the contribution value seems to be the main explanation for the failure of this instrument to change forestry production patterns in Brazil. Even if mainly intended for funding purposes, the contribution could have led to private decisions to invest in reforestation, so long as it was high enough to do so. But that was clearly not the case, since all those consuming less than the legal limit have opted to pay the contribution rather than invest in reforestation. Moreover, the value was fixed at a constant level of approximately US $4 per m^3 of wood which generated a revenue of 7 million dollars in 1992. Although indexed to price inflation, the real value has been kept constant over time without accounting for reforestation price escalation. In addition, there is no variation in contribution requirements according to species (except for non-wood species) and region.

Finally, funds from the contribution have mostly been used for budgetary purposes of IBAMA rather than for reforestation activities. Only recently has the government allowed part of this revenue to be diverted to states and NGOs willing to invest in forest activities in municipalities where reforestation may either create economic opportunities or recover deforested areas.

6.1.2 - Forestry Tax in Minas Gerais State

Since 1968 the state of Minas Gerais has imposed a forest tax in order to finance the state Forest Institute in its activities of monitoring and enforcement. Taxation is exercised on all forest products -- from logs and firewood to roots and seeds -- consumed or transformed in economic activities. Taxes are also collected in the case of legal deforestation. The tax is set at 3% of the value of forest products and is collected by the State Treasury.

For almost ten years the tax legislation was subject to judicial dispute since it was understood that the state value added tax (ICMS) was supposed to fulfil any budgetary need, and that the forest tax therefore constituted a double taxation. The outcome of this dispute was a change in the law introducing a tax level varying according to each type of forest product. In addition, reductions up to 50% of the tax due can now be granted to those undertaking reforestation which generates forest production equivalent to their consumption level. The alterations made the tax acceptable and turned it into what may almost be called a deforestation tax. Since it varies with species and products, the tax allows the Forest Institute to penalise certain uses by altering the percentages. That approach, in fact, was the strategy adopted in December 1993, when a new table of percentages was published. Use of charcoal and firewood from native forests, an important source of deforestation in the state, was charged, respectively, four and five times more than previously, whereas the values of other

items have increased no more than 100%. It is estimated that a revenue of US $11 million was collected in 1993.

Although it is very early to assess, the pattern of wood consumption in the state seems to be changing. The share of wood supply from native forests in total wood consumption for charcoal production has declined from 70% in the 1980s to almost 50% in recent years[16]. The resulting environmental effects are, however, hard to determine. On the one hand, an increase in reforestation initiatives has been in evidence; on the other hand, it is also known that part of the state demand for wood has been met by supply from other neighbouring states where such heavy taxes are not applied.

Such supply deviation, apart from inevitable losses of forest resources in the supply regions, has promoted rapid urbanization in remote areas without adequate infrastructure. The Minas Gerais forestry tax can thus be seen as a typical case of taxation producing distortions in spatial resource use. However, it is worth noting that this tax was primarily conceived as a cost-recovery instrument. Its use as an economic incentive is a matter of the political will currently prevailing in the state; the determination of tax levels is still made on ad-hoc basis without detailed modelling regarding changes in the user's economic behaviour.

6.2 - Fiscal Compensation for Land — Use Restrictions

Four states in Brazil -- Paraná, São Paulo, Rio de Janeiro and Minas Gerais -- are implementing fiscal compensation for their municipalities in which Protected Areas and/or water supply sources are located. Since 1992, in Paraná state, 1.25% of the revenue from the state tax on goods and services (ICMS, a type of value-added tax) is diverted to 112 municipalities where restrictions on land use exist in order to protect ecosystems and water supply sources. This transfer payment is deducted from the 25% share of the state tax revenue due to the municipalities, which is mainly distributed according to the value-added generated in the municipality. The payment can be seen as an attempt to place an economic value on protection activities in order to create an incentive for their conservation. Distribution of the compensation allowance is set according to the importance of the protected area, as determined by the degree of restriction stated in the creation decree. The state environmental protection agency (Environmental Institute of Paraná) then evaluates the compliance of the municipalities with the required environmental quality in the protected areas to determine the amount to be paid. The compliance monitoring system is still under implementation, but it already has successfully encouraged several municipalities to consider activities more appropriate to their natural endowment, such as ecotourism. In addition, the compensation allowance has been seen as promoting investments in sanitation and other urban infrastructure services.

In São Paulo, similar legislation was approved at the end of 1993 for areas dedicated to ecosystem protection and generation of hydroelectricity with a more modest fiscal compensation equivalent to 0.2% of the ICMS revenue. Since the measure is very recent and small in fiscal magnitude, it is difficult to predict the resulting impacts on

[16]It must be noted that technological changes and enforcement of sanctions have also contributed to the decline.

municipalities. However, another law related to preservation areas is under discussion in the state legislative and is expected to offer higher incentive levels. In the state of Rio de Janeiro, similar legislation was also presented in 1993 for approval by the state legislative. The 8% level initially set in the legislation was reduced to 3% (i.e., the percentage of the ICMS revenue due to municipalities which will be deducted and redirected). The distribution criteria would promote preservation of important ecosystems and water supply sources as well as the implementation of environmental planning in these municipalities.

Very recently in the state of Minas Gerais a similar percentage of 3% was set, although the distribution criteria will be more comprehensive, with revenue going to municipalities with programs for sanitation coverage and solid waste collection. Estimated annual revenue arising from the fiscal compensation program in the four states may reach as high as US $157 million.

7 - RECOMMENDATIONS ON NEW ECONOMIC INCENTIVES

As has been discussed, agricultural and logging activities are the main economic factors leading to deforestation. To change this deforestation pattern, one could recommend the following set of economic incentives:

1) The introduction of very solid sustainable criteria for agricultural credit incentives. In fact, the government has recently proposed legislation entitled Protocolo Verde (Green Protocol) which states that any public loan or credit incentive for any kind of economic activity can only be granted if the applicant can prove (through the possession of a green certificate) that he is complying with environmental legislation and has no outstanding environmental sanction.[17] In the case of industrial, utility and commercial activities, environmental licensing and documentation on sanctioned firms regulated by environmental agencies will be the key instruments to assign this green certificate. However, for agricultural activities there is no such environmental regulation and farms, as previously discussed, are not obliged to comply with any established technology or agroecological criteria. As noted in the legislation, the Protocolo Verde is intended to define technical parameters and rules for agricultural activities which may be applied by governmental banks.[18]

2 - Sustainable management practices for logging are already in the law. However, as already discussed , they do not succeed since plentiful wood supply is available from agricultural expansion. Even with the introduction of sustainable criteria to agricultural practices, forest clearing will continue to be a major source of wood supply. However, removing clearing criteria for titling and taxation is also regarded as an incentive for land concentration[19]. A promising policy alternative for forestry is a system of public concessions[20], similar to those applied in countries like Canada and

[17]In fact, existing legislation already included this restriction, although it did not mention sanctions and pre-operation licensing was accepted as environmental compliance. Protocolo Verde can thus be understood as a regulation pertaining to this existing legislation.
[18]Economic-ecological zoning described in Box 2 can be applied in this case.
[19]Private forest reserves can be exempted from property tax if owners comply with very strict forestry standards. Since land tax levels are not high nor fully enforced, and represent less than 0.01% of GDP, such incentive is of very limited scope.
[20]This sub-section is based on Seroa da Motta (1994).

Sweden, where long-term leasing contracts of large tracts of forests are made, by international auction, to private corporations. Contract clauses specify accepted conditions for the use of land and natural resources. Non-compliance with sustainable practices defined in concession licensing would be subject to sanctions and concession termination. Supervision and monitoring of these concessions could be shared with NGO's.

This scheme would be particularly feasible, for example, in Amazonia where there still is a large availability of unclaimed areas -- more than 25 percent according to recent surveys of the Agrarian Reform Institute (Incra). Apart from the difficulties in managing serious technical procedures (e.g., managerial practices, concession periods, stumpage fees), such a change in property right assignments may face numerous political barriers.

3) Besides forestry concessions, such fiscal instruments as the forestry tax used in Minas Gerais can be of immense importance in regulating current forestry activity if applied nationwide. The tax should be defined on the basis of marginal user cost curves in order to induce users to change their behaviour and to shift to a desirable level of forestry activity or preservation. Since forestry taxes are somewhat difficult to design and to implement due to institutional weaknesses in the environmental agencies, the revenue generated should be partially earmarked to those agencies to improve their enforcement capacity and to forestry scientific research centres where relevant expertise can be developed.

4) Fiscal compensation plans for municipalities drawn from value-added tax revenue already in place in some Brazilian states could be applied nationally. Similiarly, compensation levels could also be set on the basis of output foregone in restricted areas, rather than only on the basis of area and enforcement criteria.

5) Very generous credit and fiscal incentives for technology (R&D) are offered to Brazilian companies in Brazil. Notwithstanding, in most sectors those firms have not succeeded to increase substantially their R&D expenditure. The case of biodiversity research is not an exception. It seems, then, that these incentives should also be offered for joint-ventures with international companies, although the issues of property rights sharing and compensation still present barriers for such an alternative.

Finally, it must be noted that public awareness regarding biodiversity issues is of paramount importance in sustaining political support for biodiversity policies in Brazil and elsewhere. In this particular field, economic science has no normative prescription. International programmes addressing global ecological problems can be of great importance for Brazil given the country's immense biodiversity values. However, these programmes should consider significant compensation payments rather than donation procedures, considering the ecological services rendered to the world by Brazil. So far, international programmes have attempted to impose donors' environmental standards and behaviour on countries like Brazil without any regard to (i) cultural parameters and (ii) structural constraints which are, as this paper has discussed, the main factors affecting biodiversity losses. In light of these factors, compensation should take place without being necessarily linked to specific conservation projects, since such compensation can be a valuable source of

government revenue to revert the economic factors leading to deforestation in Brazil. Moreover, decoupling compensation and specific, often misguided, donor country conservation requirements will also generate positive public opinion and create more favourable conditions for the desirable pursuit of coherent biodiversity policies.

BIBLIOGRAFIA

ALMEIDA, O.T. and UHL, C. Identificando os custos de usos alternativos do solo para o planejamento municipal da Amazônia - o caso de Paragominas (PA). In:MAY, P. (org.). Economia Ecológica, Ed. Campus, 1995.

BIODIVERSITY UNIT. Biodiversity and its value, Biodiversity Series, Paper 1, Biodiversity Unit, Department of the Environment, Sport and Territories, Canberra, Austrália, 1995.

BONELLI, R. and RAMOS, L. Distribuição de renda no Brasil: avaliação das tendências de longo prazo e mudanças na desigualdade desde meados dos anos 70, Texto para discussão 288, IPEA/DIPES, January 1993.

CALDEIRON, S.S. (coord.). Recursos Naturais e Meio Ambiente: Uma Visão do Brasil, IBGE, Rio de Janeiro, 1993.

CAVALCANTI, J.E.A. Valoração econômica das perdas de solo no Vale do Rio São Francisco, Relatório Final de Consultoria, CODEVASF/FAO, 1995.

EMBRAPA. Delineamento Macroecológico do Brasil, Serviço Nacional de Levantamento e Conservação de Solos Rio de Janeiro, EMBRAPA, 1991.

FUNBIO. Cerimônia de instalação do Conselho deliberativo do Fundo Brasileiro para a Biodiversidade - FUNBIO. Speech notes, mimeo, Fundação Getúlio Vargas, Rio de Janeiro, 1995.

IBGE. Cadastro de Unidades de Conservação do Brasil, Diretoria de Geociências, IBGE, 1994.

INPE. Levantamento das Áreas Deflorestadas na Amazônia Legal no Período de 1991-94, Instituto de Pesquisas Especiais, 1996.

MAY, P. Perdas ambientais devido ao desmatamento no Brasil. IPEA/DIPES, mimeo, Rio de Janeiro, 1993.

MAY, P. and ROCHA, R. A Mata Atlântica do cacau: sistemas de produção e meio ambiente no Sul da Bahia, FGB/BIRD, mimeo, Rio de Janeiro, 1995.

PRADO, A. C. Exploração Florestal Madeireira, Documento 1, FUNATURA/ITTO, 1995.

SEROA DA MOTTA, R. Past and current policy issues concerning tropical deforestation in Brazil, Kiel Working Paper 566, The Kiel Institute of World Economics, March 1993.

_____. Política e gestão florestal. In: O Brasil no Fim do Século: Desafios e Propostas para a Ação Governamental, IPEA, Rio de Janeiro, 1994.

_____. Indicadores ambientais no Brasil: aspectos ecológicos, de eficiência e distributivos, Texto para Discussão 403, IPEA/DIPES, February 1996.

_____. Water quality and policy in Brazil: estimates of health costs assiciated to sanitation services and simulation of pollution taxes applied in river basins. Série Seminários 8/95, IPEA/DIPES, July 1995.

_____. Estimativas de depreciação do capital natural no Brasil. In: Perspectivas da Economia Brasileira - 1994, IPEA/DIPES, 1994.

SEROA DA MOTTA, R. and REIS, E.J. The application of economic instruments in environmental policy: the Brazilian Case, OECD/UNEP, Workshop on The Use of Economic Policy Instruments for Environmental Management, Paris, 26-27 May, 1994.

SOS MATA ATLÂNTICA Atlas da Evolução dos Remanescentes Florestais e Ecossistemas Associados do Domínio da Mata Atlântica no Período 1985-1990, Fundação SOS Mata Atlânica/INPE, São Paulo, 1993.

WWF Cerrado: Impactos do Processo de Ocupação, World Wildlife Fund, Brasília, 1995.

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